Green Diamond Resource Company

California Timberlands Forest Management Plan

August 2023

A copy of this Forest Management Plan is available on Green Diamond's website: www.greendiamond.com

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Acronyms and Abbreviations

AHCP	Aquatic Habitat Conservation Plan
AQMB	Air Quality Management Board
ATV	All-terrain vehicle
BLM	Bureau of Land Management
BMP	best management practices
BOF	Board of Forestry
CCAA	Candidate Conservation Agreement with Assurances
CCHF	California Comprehensive Harvest Forecast (Replaces HSAF)
CCR	California Code of Regulations
CDF(CalFire)	California Department of Forestry and Fire Protection
CDPR	California Department of Pesticide Regulation
CEG	Certified Engineering Geologist
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
CMAI	Culmination of mean annual increment
CMZ	Channel Migration Zone
CRC	California Redwood Company
CWA	Clean Water Act
CWD	Coarse Woody Debris
dbh	diameter at breast height
DCA	Dynamic Core Area
DEIS	Draft Environmental Impact Statement
DFG	California Department of Fish and Game
DFW	California Department of Fish and Wildlife (Department changed name from California Department of Fish and Game to California Department of Fish and Wildlife in 2013)
DMG	California Division of Mines and Geology
EEZ	Equipment Exclusion Zone
ECP	Erosion Control Plan
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ELZ	Equipment Limitation Zone
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FBRI	Forest Biometrics Research Institute
FEIS	Final Environmental Impact Statement
FHCP	Forest Management HCP
FMWDR	Forest Management WDR
FPA	Forest Practice Act
FPR	California Forest Practice Rules
FPS	Forest Projection and Planning System

HCP	Habitat Conservation Plan
HCVF	High Conservation Value Forest
HPA	Hydrographic Planning Area
HSAF	Harvest Stand Availability Forecast (Replaced with CCHF)
IA	Implementation Agreement
IIPP	Injury and Illness Prevention Program
IPM	Integrated Pest Management
ITP	Incidental Take Permit
LWD	large woody debris
MATO	Master Agreement for Timber Operations
MSP	maximum sustained production
NAHC	Native American Heritage Commission
NCRWQCB	North Coast Regional Water Quality Control Board
NEPA	National Environmental Protection Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NSOHCP	Northern Spotted Owl Habitat Conservation Plan
PALCO	The Pacific Lumber Company
PCT	Precommercial Thin
RMWDR	Road Management WDR
RMZ	Riparian Management Zone
RPF	Registered Professional Forester
RSA	Representative Sample Area
RWQCB	Regional Water Quality Control Board
SFERMP	South Fork Elk River Management Plan
SFERWWDR	South Fork Elk River Watershed-wide Waste Discharge Requirements
SMZ	Slope Management Zone
SOD	Sudden Oak Death
SPCP	Sensitive Plant Conservation Plan
SSS	Steep Streamside Slope
STA	Special Treatment Area
SWRCB	State Water Resources Control Board
SYP	Sustained Yield Plan
TDWMP	Terrestrial Deadwood Management Plan
THP	Timber Harvesting Plan
TMDL	total maximum daily load
TPZ	Timberland Production Zone
TREE	Terrestrial Retention of Ecosystem Elements
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WDRs	Waste Discharge Requirements
WLPZ	Watercourse and Lake Protection Zone

Section 1 - Introduction

This management plan covers Green Diamond Resource Company's California timberlands. The operation of Green Diamond's tree nursery in Korbel, CA is excluded from this management plan, as is the company's other divisions located in Washington, Oregon, Montana, the U.S. South.

Green Diamond Resource Company manages and operates its California timberlands for timber production and other purposes pursuant to California's Timberland Productivity Act, the Z'Berg-Nejedly Forest Practice Act, the Board of Forestry's Forest Practice Rules, various other state laws, and Green Diamond's internal management documents, policies and guidelines. The internal documents, policies and guidelines include federal Habitat Conservation Plans, an "Option (a)" document filed with the California Department of Forestry and Fire Protection, programmatic agreements with California Department of Fish and Game and the Regional Water Quality Control Board regarding roads and crossings, and other agreements with state agencies, internal management guidelines, and internal management systems. This Forest Management Plan is an umbrella document that describes how these management documents form an integrated strategy for managing the forest.

The intent of the Management Plan is to give an overview of Green Diamond's management objectives, land and resource base, forest planning and operation practices, conservation strategies and other issues that affect forest management. The management and planning documents referred to in this Management Plan are updated and/or amended periodically. Some short-term planning tools are updated monthly, while some documents and reports are updated annually or biannually. Longer term plans are revised at 3-to-5-year intervals, and major guidance documents, such as HCPs, have a 50 year life with periodic amendments to reflect changing conditions. This management plan will be revised as needed to reflect significant changes in management strategy or in response to changed conditions.

Section 2 - Management Objectives

Green Diamond Resource Company's mission is to increase the value of our forests while assuring that we do not negatively impact the public trust resources. The objective is to manage the forestlands as sustainable, productive timberlands using the best scientific, safety, ethical, economic and environmental stewardship principles. This goal is key to long-term economic opportunity and quality of life for company employees, operating communities and for generations to come. To this end, Green Diamond is guided by five core values:

- **Safety** – Maintaining a safe, healthy work environment for our employees and contractors.
- **Integrity** – Adhering to the highest ethical standards in all our business dealings.
- **Stewardship** – Practicing sustainable forestry and working collaboratively with other parties in initiating innovative forest and wildlife management programs that will foster our role as responsible land stewards.
- **Community** – Supporting the people, organizations and programs that improve the quality of life in the communities we call home. This objective includes our employee community. We are committed to treating our employees with respect and to fostering a work environment in which diversity and communication are valued and recognized.
- **Profitability** - Operating efficiently and profitably and in a manner that will enhance the long-term value of our assets.

Section 3 - Green Diamond Overview

3.1 Land base and ownership status

Green Diamond Resource Company (Green Diamond) owns and manages approximately 400,966 acres of land in Del Norte, Humboldt, and Mendocino Counties in northern California (Map 1). The bulk of Green Diamond's ownership is within 20 miles of the coast, with the eastern-most tract located approximately 50 miles inland. The holdings range in size from isolated 20-acre parcels to contiguous blocks of over 100,000 acres. While most of this land is held in fee, 3,444 acres are perpetual cutting rights, which are generally treated the same as the fee ownership for the purpose of the management plan. The acreage includes 1,215 acres in temporary cutting rights, which will expire in 2024. Green Diamond does not own mineral rights to all fee owned timberlands. A Company-wide research project is ongoing to consolidate Green Diamond title and mineral ownership on Company timberlands. These acreages are likely to adjust over time to reflect real property transactions involving Green Diamond. Green Diamond is encumbered by utility right-of-way easements which pre-date our timberlands FSC certification. Since these easements include the ability for utility companies to conduct vegetation removal and/or treatment (including herbicide application without FSC approval) within said rights-of-way, they have been excluded from the scope of our Forest Management certification.

Green Diamond's California timberlands are divided into northern and southern operating areas. The northern area is located north of the Bald Hills county road and is commonly referred to as the Klamath area. The southern area is located south of the Bald Hills road and is referred to as the Korbel area. The areas are divided into management tracts which are numbered and named. The tract boundaries were developed to reflect management considerations such as road networks, timber types, or age classes and reflect previous ownership patterns. Table 1 lists the tracts and corresponding acreage.

Table 1 – Green Diamond Ownership by Tract

Southern Operating Area Tracts		
Number	**Name**	**Acres**
1	Sproul Creek	9,386
2	Fruitland Ridge	103
3	Hunter Ranch	2720
5	Willits	18,662
6	Rio Dell	1,315
7	Boyscout Tract	954
8	Carlotta	2,078
9	Grizzly Creek	2,007
14	Salmon Creek - Fortuna	7,853

15	Jacoby Creek	2,186
17	Wiggins Ranch	18,923
18	Snow Camp	4,003
19	McKay	6,340
22	Mad River West	11,377
23	Greenwood Heights	110
24	Mad River East	9920
26	Cal Barrel	12686
27	Christmas Prairie	8,391
28	Korbel	1,492
32	Mad River Ply	126
34	McKinleyville Tract	3,645
35	Mather Creek	1,517
36	Holmes Tract	275
37	Fieldbrook	535
38	Ribar	1950
40	North Fork	7,377
41	Mitsui Tract	2,248
42	Basin	7500
43	Little River Tract	22948
44	Wiregrass	4,854
45	Beach Creek	13,519
46	Berry Summit	322
47	Maple Creek	30,102
48	Redwood Creek	13,580
50	Lagoons	120
Northern Operating Area Tracts		
Number	**Name**	**Acres**
51	Bald Hills	41,165
56	B-Line	27,714
61	County Line South	6578
66	County Line North	7,833
67	County Line West	1,424
70	Salt Creek	487
71	Hunter - Wilson	21,833
72	Klamath Mouth	276

73	Purchase Unit	10,636
85	Blue Creek North	9,201
86	Blue Creek South	316
87	Moore Tract	4995
88	Tepo Ridge	1,644
90	Morrison Creek	2,910
93	Smith River	19,709
94	Del Norte Golf Course	3,199
95	Fort Dick	1,692
98	ARCO Fee	1,117

3.2 Socio-economic conditions

The population of the region surrounding Green Diamond's land has experienced relatively steady population growth over the past decade. From 2000 to 2019, the region's population grew by approximately 5 percent, compared with the State's growth rate over the same period of 15 percent. Many of the people that live in this region have a strong connection to the land either through outdoor recreation such as hiking, hunting or fishing, or through the resource-based economies of agriculture, forestry or fishing. Many in the community value the aesthetic qualities of living in this rural area and feel a connection to the land for personal and ideological reasons. The commercial forestlands most readily visible from the main population centers around Humboldt Bay are predominantly timberlands owned and managed by Green Diamond.

Lumber and wood products manufacturing have historically been important industries in the region. The Northcoast forest products industry reached a production highpoint during the post-World War II housing boom of the 1950s and early 1960s. The industry dominated the regional economy during that period with employment readily available in the woods operations or in numerous lumber mills. The forest industry has seen a significant decrease in the number of people employed in the industry since that time. However, the current jobs that are available in the forestry and lumber production industries remain a critical component of the local economy. The current employment opportunities provide relatively high paying jobs for the region, and they are a source of primary employment that brings money into the area.

Tourism and the service jobs that support the tourism industry have increased in regional importance during this same time period. The Redwood National and State Park system attracts visitors to the redwood region during the summer months and provides camping and hiking opportunities for tourists and local residents. The ocean and rivers attract numerous outdoorsmen throughout the year including anglers, kayakers, surfers and other water enthusiasts. The cool summer temperatures in the redwood region along the coast are a seasonal draw for residents of the hot inland regions of California. Annual special events also attract people to the region.

Regional unemployment rates tend to be slightly higher than those of California as a whole. This is partially due to the seasonal nature of much of the work available in the region; much of the work available in the forest products industry is seasonal. Work in the woods primarily occurs during the dry period between mid-April through mid-October. Regional timber harvest activities and employment levels are significantly reduced during the rainy winter period. Sawmill operations and related employment is also at lower levels during the winter period when compared to the summer. Employment related to tourism is also largely seasonal.

Green Diamond Resource Company currently employs approximately 170 people as part of its California timberlands operations. The functions of these employees include: secretarial, bookkeeping and accounting; planning and logistics associated with resource management operations; road construction and maintenance; commercial timber harvesting; and mechanical and repair activities. All these activities are conducted over the entire year, with some reduction in workforce during the winter period; consequently, the majority of the 170 jobs are fulltime year-round jobs. Approximately 35 union positions (International Association of Machinists and Aerospace workers) are included in this job count. In addition to work conducted by Green Diamond employees themselves, many of the forest management activities (e.g., professional services, tree planting, pre-commercial thinning, logging, trucking) are contracted directly to other local or regional firms. Contract workers account for approximately 575 workers.

The California Redwood Company (CRC) is a wholly owned subsidiary of Green Diamond. CRC operates the Fairhaven Chip Export Dock in Humboldt County and is dependent on wood chips produced from lumber mills in northern California and southern Oregon. Green Diamond timberlands supply logs to some of these mills. Several of these lumber mills are dependent to some degree on Green Diamond Resource Company timber and employ several hundred people. Green Diamond also operates a log chipping facility at Samoa that can produce hardwood and conifer wood chips that may be delivered to the Fairhaven Chip Export Dock or other facilities. Both the Chip Dock and the Log Chipping facilities hold FSC Chain of Custody certificates.

Further contributions of the Green Diamond lands to local economic conditions include the indirect effect of employee wages on the purchase of goods and services from local businesses, and the contribution of yield taxes on timber purchases, which are distributed to local counties. Green Diamond also has a charitable giving program that includes a college scholarship program, cash donations to local non-profit organizations, staff involvement in local fund-raising events and other donations such as firewood for fund-raising and distribution to low income households.

3.3 Adjacent lands description

Green Diamond's timberlands are set within a larger landscape of federal and state forestlands, large commercial timberland ownerships, small non-industrial timberlands, rural residential parcels and urbanized areas. Six Rivers National Forest and Redwood National and State Parks manage lands adjoining or near Green Diamond lands. Other adjacent ownerships include commercial timberlands managed by Sierra Pacific Industries, Humboldt Redwood Company and other private holdings. The Hoopa Valley Indian Reservation is located east of ownership, and lands administered by the Yurok Tribe or Bureau of Indian Affairs are located along the Lower Klamath River.

Adjacent land use varies by location but generally follows land ownership patterns. The federal and state land management supports multiple uses, including conservation and recreation, and various levels of timber harvesting allowed in designated areas. On adjacent private lands, commercial timber operations and ranching predominate, while other uses include gravel mining, residential development and conservation easements.

The large ownerships of commercial industrial timberlands in the region typically consist of a mosaic of harvested areas and standing timber of various age classes ranging from reproduction to mature timber. The small non-industrial commercial timberlands include a component of intermittent closed-canopy mature stands where land owners elect to manage under a selective harvest or partial harvest regime. Also common in the region is a dendritic pattern of larger and older forest stands generally following riparian corridors resulting from management pursuant to the California FPRs. Other common characteristics of timberlands in the region include:

- Forest ecosystems with conifer stands dominated by coastal redwood and Douglas-fir
- Steep and rugged terrain, several highly unstable bedrock types, and extensive geologic folds and fault lines
- Seasonally intense precipitation
- More than a century of logging, mining, road building and grazing
- A pattern of forest stand structure produced by management pursuant to the California FPRs

Rural residential ownerships, suburban developments and urbanized areas are present mainly along the western edges of the property. From Carlotta in the south to Smith River in the north, rural residential and urban developments of varying density are adjacent or close to Green Diamond property. Some of these communities originally developed as housing for the early mill and woods workers and some are more recent developments. Calville, which is now part of the larger unincorporated community of McKinleyville, was originally developed in the early to mid-1900's as housing for loggers working on adjacent timber lands owned by the Cal-Barrel mill. These timber lands are now part of Green Diamond's McKinleyville and Mather tracts. In areas such as Westhaven, located between Trinidad and McKinleyville, low density rural residential development has slowly encroached into the forest land adjoining Green Diamond's timberland. In the unincorporated areas surrounding the city of Eureka (Cutten and Ridgewood Heights) suburban and urbanized neighborhoods have developed directly adjacent to portions of Green Diamond's McKay tract.

3.4 Management Structure/Systems

Green Diamond Resource Company is a privately held, family-owned business based in Washington. This management plan addresses the forest lands in the coastal regions of Northern California. In 1890, Solomon (Sol) Simpson founded Green Diamond's predecessor, Simpson Logging Company, on Washington's Olympic Peninsula, about 65 miles southwest of Seattle. Today, more than 130 years later, Sol's direct descendants oversee Green Diamond Resource Company's forests with the same commitment to responsible, innovative, long-term forest stewardship that was established by their pioneering ancestor. Green Diamond's corporate headquarters and senior management team are located in Seattle, Washington. The California Timberlands administration offices are located in Korbel, CA with a management office in Orick, CA. Organization charts showing the management structure of the company are provided in Charts 1 and 2 provided in Appendix A.

Green Diamond has a northern and southern operating area with an operations manager who is responsible for implementing timber harvest and road construction operations. The forestry manager is responsible for short to mid-range forest planning and timber harvest plan acquisition. The conservation planning manager is responsible for conducting all biological surveys and monitoring for all the California timberlands. A silviculture investment manager oversees reforestation activities for all California timberlands. A forest inventory systems and planning manager manages our timber inventory, GIS and database information systems. A forest policy and communications manager oversees community affairs, public/media relations, regulatory issues, and state legislative affairs. A log sales and marketing manager oversees log sales and supply agreements. A Planning Manager coordinates mid-range forest planning with harvest plans, operational planning, timber inventory and long-range forest planning. These managers, as well as other administrative managers, report to the Vice President of the California Timberlands division. Day-to-day operations are conducted by supervisors (who report to the managers), resource professionals and technical staff.

3.5 Environmental Setting

3.5.1 Historic Setting

The earliest inhabitants of the north coast are thought to be ancestors of the Karuk, which likely arrived sometime around 5,000 years ago. Local tribal groups represented on or near Green Diamond's ownership include the Tolowa, Yurok, Wiyot, Hupa, Chilula, and Whilkut tribes. Each tribal group had a distinct historical territory and developed subsistence hunting and gathering practices that utilized the territories particular resources.

The historical territory of the Tolowa included the lower reaches of the Smith River and the coastal areas near the Smith River. The Yurok historically occupied the lower reach of the Klamath River from approximately Bluff Creek downstream to the river's mouth, with some settlements along the Trinity River and along the coast south of the Klamath River extending to

Trinidad. The historical center of Wiyot culture is around Humboldt Bay, from Little River south to the Bear River Mountains. The Hupa inhabited the area surrounding the lower reaches of the Trinity River from approximately Salyer to approximately 6 miles above the confluence with the Klamath River. Chilula territory is closely affiliated with the lower reaches of Redwood Creek. The Whilkut people inhabited the higher reaches of Redwood Creek and the Mad River, including the forested area between the two drainages.

Each tribal group developed their own cultural identity and customs. Likewise, each group relied on the resources that were common within their territory. The coastal groups relied more heavily on marine resources, the tribes with major rivers in their territories relied on salmon, and the inland tribes relied on game and acorns. Each of the tribal groups utilized ocean fish, shellfish, sea lions, whale, salmon, sturgeon, acorns, berries, bulbs, grass seed, deer and elk as the staples of their diet to some degree. Many of the North Coast tribes were skilled at basket making and woodworking. The Yurok are especially known for their redwood canoes, which were carved from a single redwood log and were up to 40-feet long. In addition, redwood slabs were used as a building material to construct houses and lodges.

Another cultural practice that was custom to each of the tribal groups in the Northcoast region was the use of fire to manage the landscape. Fires were intentionally set by the tribal groups to burn off the dense woody underbrush that otherwise develops in the redwood region. This practice cleared areas around village sites and improved the gathering of plants for food and basketry.

European explorers first landed in the region in 1775 when a Spanish vessel landed at Trinidad. Following the discovery of Trinidad bay in the late 1700s, Trinidad bay served as a port for fur trading and Chinese trade expeditions. European discovery of Humboldt Bay occurred in 1806 during exploration by the Russian-American Fur Company. There was relatively little European activity in the region until the discovery of gold in Northern California in the Mid 1800's.

The discovery of gold in the Trinity region of Northern California in 1848 caused a population explosion in the region. Dr. Josiah Gregg, a supply company merchant, and his party traveled west on foot from the Trinity mines and reached Humboldt Bay in 1849. In 1850 the entrance to Humboldt Bay was charted, allowing merchant supply ships to travel to the Humboldt Bay region. Settlements were soon founded around the bay and north at Trinidad. Supply routes between the gold mines and the ports at Humboldt and Trinidad bays were explored and developed. In 1853 Fort Humboldt was established on the bay. Settlement rapidly expanded in the region, and by 1856, the city of Eureka was incorporated and included seven sawmills that produced two million board feet of lumber every month.

The early logging began on the lower slopes closest to the bay and larger rivers. Trees were felled and collected in the tributary streams and formed splash dams. Winter flood waters would wash the logs downstream where they would be collected at a mill. By the 1890s railroad lines had been built and extended beyond where splash dams were effective at moving logs to the mills. By the 1940s an extensive system of logging railroads had been constructed. The railroad grades followed the larger rivers and streams with inclines to gain access to ridges or mid-slope areas. Steam-donkey skidding machines pulled logs across the ground several thousand feet or more to the rail lines. Railroad lines and steam-donkey logging extended deep into the forestlands prior to the start of WWII. The clearcut forest was left to regenerate naturally by redwood stump sprouts or seeding. Mobile logging camps followed the rail lines. Timberlands changed ownerships frequently during this period as companies grew and then disbanded and new partnerships were formed.

America's entry into WWII signaled a change in the region's logging. The men that worked in the woods went off to war and the locomotives along with the rails were scrapped for the war effort. The railroad logging era largely ended and there was a brief period of reduced harvest during the war. The economic boom that followed the war was the start of renewed logging activity. Logging truck roads were built to replace the rail lines and tractors were used to skid logs. The ability of log trucks and tractors to push further into forestlands, combined with the growing demand for lumber to supply the mid-century housing boom, resulted in the fairly rapid logging of the lands that currently make up Green Diamond timberlands. By the late 1960s, much of the old-growth timber in Northern California had been logged and the areas that had been logged during the early railroad era had either been logged a second time or supported mature second-growth forests.

In the areas where the earliest railroad logging occurred, the mature second growth forests were clearcut harvested a second time in the 1950s-1980s. A third growth forest was allowed to regenerate naturally, or was planted with seedlings, and mature young-growth forests now exist. In a few areas of the Jacoby Creek tract, these third growth forests have been recently clearcut and have been regenerated through redwood stump sprouts and inter-planting to ensure full site occupancy. A dense vigorous stand of "fourth-growth" advanced regeneration is now growing on these sites.

3.5.2 Current Setting

3.5.2.1 Habitat Conditions

A very detailed description of the regional forest and aquatic habitat conditions on and surrounding Green Diamond's timberlands is presented in the AHCP and FHCP. The following description is a summary of that work and generally follows the AHCP Hydrographic Planning Areas (HPA) framework which includes 11 HPAs assembled in to four HPA Groups (Table 2).

As a broad overview, Green Diamond's California timberlands are generally colder and wetter in the north with more moderate temperatures and less precipitation towards the south. The east-west trend is for cold winters and hot summers in the high elevation interior region and moderate year-round temperatures in the coastal areas. Precipitation shows an east-west trend with increasing precipitation in the high elevation interior region and more moderate precipitation toward the coast. The effect of the summer coastal fog extends 20 to 30 miles inland along major river valleys. Summer temperatures outside the fog zone can be very hot.

Green Diamond's California timberlands occupy the northern extent of the California Coast Physiographic Province and the northwestern extent of the California Klamath Physiographic

Province as defined in the 2011 Revised Northern Spotted Owl (NSO) Recovery Plan. The ownership also occurs primarily within three major Ecological Regions (Ecoregions) as described by the U.S. Forest Service (Miles and Goudey 1997):

Northern California Coast – This Ecoregion is characterized by mountains, hills and valleys of the northern Coast Ranges and portions of the Klamath Mountains that are close enough to the Pacific Ocean for the climate to be greatly modified by the marine influence. The predominant forests include spruce/coastal pine, redwood, Douglas-fir/tanoak, Oregon white oak, tanoak and canyon live oak. Elevations range from sea level to 3,000 feet, and precipitation varies from 20 to 120 inches. The area has a long growing season of 225 to 310 days, with fog very common during summer and winter. This Ecoregion encompasses approximately 81% of the area within the four HPA Groups.

Northern California Coast Ranges – This Ecoregion includes the interior portion of the California Coast Range Mountains that also has a marine influence but to a much smaller degree. Elevations range from just above sea level to 8,000 feet. The growing season is 80 to 250 days, and summer fog is generally limited to low elevations and major watercourses. The predominant plant communities include Douglas-fir/tanoak, Oregon white oak, mixed conifer and white fir. This Ecoregion encompasses about 9% of the area within the four HPA Groups.

Klamath Mountains – This Ecoregion is located between the Southern Cascades and Coast Range Mountains. It is characterized by greater temperature extremes and elevations from 200 to over 9,000 feet. The predominant forest types are Douglas-fir, Douglas-fir/tanoak, Douglas-fir/pine, mixed conifer, white fir, Jeffrey Pine, red fir, canyon live oak and Oregon white oak. This Ecoregion has the shortest growing season of the three, and encompasses about 10% of the area within the four HPA Groups.

Table 2. HPA groups and Ecoregions

HPA Group	HPAs in Group	Ecoregions
Smith River	Smith River	Northern California Coast, Klamath Mountains
Coastal Klamath	Coastal Klamath Blue Creek	Northern California Coast, Northern California Coast Ranges, Klamath Mountains
Korbel	Interior Klamath Redwood Creek Coastal Lagoons Little River North Fork Mad River Mad River	Northern California Coast, Northern California Coast Ranges, Klamath Mountains
Humboldt Bay	Humboldt Bay Eel River	Northern California Coast

Smith River HPA Group
The Smith River HPA group occurs within the Northern California Coast and Klamath Mountains Ecoregions.

Geology
The topography of the Smith River HPA Group is highly variable but generally steep and sharp-featured. The coastal plain is a unique feature of this Group. The Group is bisected by the South Fork Mountain Thrust (The Coast Ranges Thrust), which separates Franciscan Central Belt from the Klamath Mountains and Eastern Franciscan Belt bedrock. Both of these geologic terranes underlie Green Diamond's ownership in the Smith River group. The Franciscan Bedrock is composed of a mixture of sandstone and mudstone and the Klamath Mountains Bedrock is composed of volcanic and ultramafic intrusive rocks.

Climate
This HPA Group is one of California's wettest areas. Average annual rainfall varies from about 60 inches at Point St. George to over 125 inches at higher inland areas. Precipitation increases with elevation and usually greater on the windward (southwest) slopes. About 90% of precipitation occurs between October and April. Average annual snowfall ranges from 28 inches to 126 inches. Marine air masses and cold air drainage from higher elevations primarily influence the climate in this area. The area has a temperate, humid climate with abundant summer fog and occasional drier air masses associated with east winds.

Forest Types
The Smith River HPA is heavily forested, except for the Crescent City Plain which supports significant agricultural and urban development. Redwoods dominate the forested area, with Douglas-fir becoming a more common inland. On western aspects near the coastal plan, Sitka spruce is a major stand component. Dominant hardwoods are red alder, California bay, big-leaf maple and tanoak. Red alder dominates along the riparian zones and north aspects. Western hemlock, western red cedar and grand fir also occur as minor stand components on lower slopes near the coast. Tanoak and madrone are common on drier sites toward the interior.

Aquatic Habitat
Aquatic habitat is being characterized by qualitative descriptions of canopy cover, canopy cover type, instream large woody debris (LWD) density, amount of stream habitat occupied by pools and amount of pool cover provided by LWD. Canopy cover in this group is moderate, generally ranging from 60 to 95%. Canopy cover is generally provided by deciduous species. LWD instream structure is low to moderate. The amount of stream habitat occupied by pools is low. The amount of pool cover provided by LWD is low.

Coastal Klamath HPA Group
The Coastal Klamath HPA Group occurs within the Northern California Coast, Northern California Coast Ranges and Klamath Mountains Ecoregions.

Geology

Generally steep, rugged terrain is the distinguishing landscape characteristic for this HPA group. This HPA Group is bisected by the South Fork Mountain Thrust (the Coast Ranges Thrust), which separates the Franciscan Central Belt from the Klamath Mountains and Eastern Franciscan Belt bedrock. The Central Belt Franciscan Complex is generally described as a complex mixture of meta-sandstone and mudstone, with inclusions of other rock types. Klamath Mountain bedrock in the HPA is composed of Josephine Ophiolite intrusive and extrusive volcanics, which includes partially to completely serpentinized ultramafic rocks, gabbro, diorite, pillow lava and breccia.

Climate
A wide range of climatic conditions occur within this large HPA Group that experiences dry summers with hot daytime temperatures and wet winters with low to moderate temperatures. During the summer, the climate is moderated by coastal fog. Precipitation is very seasonal, with approximately 90% falling between October and March. Annual amounts vary from 20 inches to over 100 inches depending on location. Snow occurs at higher elevations and some areas receive up to 80 inches annually.

Forest Types
Redwood and redwood/Douglas-fir forest dominate, with Sitka spruce occupying a narrow strip along the coast. The redwood/Douglas-fir forests also include grand fir, western red cedar and western hemlock on lower slopes and in riparian zones. Red alder is the most common hardwood in riparian zones. Tanoak is the most common mid- to upper-slope hardwood, with madrone occurring as a minor stand component on drier sites. As distance from the coast increases, the proportion of redwood stands decreases and Douglas-fir and tanoak become more prevalent. Ridge tops and upper south to west slopes in the most inland reaches can support nearly pure Douglas-fir or tanoak/madrone stands. A few isolated small stands of old-growth exist on the HPA in addition to those in state and federal parks within a few miles of the coast.

A distinct ecotone occurs at around 2,500 to 3,000 feet. Redwood and Douglas-fir forest rapidly give way to non-forest landscape dominated by manzanita, with knobcone pine, ponderosa pine and Port-Orford-cedar at the transition and persisting along the bottom of many watercourses. This ecotone results from a band of serpentinaceous soils on the Red Mountain/Rattlesnake Mountain ridge that divides Terwer Creek and Goose Creek in the Smith River HPA.

Aquatic Habitat
Canopy cover in this group is high, generally ranging from 75 to 100%. Canopy cover is generally provided by deciduous species. LWD instream structure is moderate to high. The amount of stream habitat occupied by pools is low. The amount of pool cover provided by LWD is low to moderate.

Korbel HPA Group
The Korbel Group is the largest and most diverse HPA Group, spanning all Ecoregions.

Geology

The Korbel HPA Group is transected by numerous faults, including the Mad River Fault Zone (MRFZ), the Bald Mountain Fault, the Grogan Fault and the South Fork Fault, which separates the Coast Range province from the Klamath Mountains province. Bedrock in this HPA is primarily composed of the Coast Ranges Franciscan Complex with Klamath Mountain bedrock present in limited areas at the eastern margin. The inactive South Fork Fault is the HPA's major structural feature. Franciscan Central Belt and Eastern Belt Bedrock include sandstone, mudstone and mélange, with schist underlying most of the HPA. There are limited occurrences of Wildcat Group equivalent and younger bedrock within the MRFZ and along the coast of the Korbel HPA Group. There are also limited occurrences of volcanic and ultramafic rocks of the Western Jurassic Belt of the Klamath Mountains province in the eastern margin of the Interior Klamath HPA.

Climate

The Korbel HPA Group has a weather pattern typical of most northern California coastal watersheds, with wet winters and dry summers. Summer temperatures are mild, with a commonly occurring marine fog layer. At least 90% of precipitation occurs between October and April. The coastal area receives about 40 inches annually, while interior parts of the watershed receive over 90 inches annually. Although most precipitation falls as rain, snow fall occurs at higher elevations and may persist on the ground for up to four months. The freeze-free period ranges from about 100 to over 300 days.

Forest Types

This HPA Group spans the transition from Sitka spruce and coastal redwood forests along the coastal face to more mesic interior landscapes dominated by Douglas-fir/tanoak forests, with grasslands appearing on some drier ridge tops and south to west aspects. Minor amounts of grand fir, western red cedar and western hemlock occur on lower slopes near the coast and in riparian zones. Red alder is the most common hardwood in riparian areas and northern slopes with tanoak and madrone more common inland or on drier sites. In some areas, Douglas-fir exists as pure or nearly pure stands due to underlying soil characteristics. Higher elevations at the eastern boundary of this HPA Group (4,000 - 4,500 feet) support montane conifer forests dominated by Douglas-fir and white fir with golden chinquapin as a stand component . Oregon white oak is common at the margins of grasslands, with California black oak also found on drier soils.

Aquatic Habitat

The aquatic habitat in this group is the most variable. Canopy cover in this group ranges from low to high, generally ranging from 50 to 100%. Canopy cover is provided by deciduous and conifer species. LWD instream structure is moderate to high. The amount of stream habitat occupied by pools is moderate to high. The amount of pool cover provided by LWD is moderate to high.

The Humboldt Bay HPA Group

This HPA Group exists entirely within the Northern California Coast Ecoregion.

Geology

This HPA Group is entirely within the Coast Ranges province. It is split by numerous fault zones, including the Freshwater Fault, Little Salmon Fault and Russ/False Cape faults. The eastern portion of the Group is underlain by sandstone and mélange associated with the Central belt of the Franciscan Complex. The Freshwater fault delineates the western boundary of the Central belt and separates it from the rocks of the Wildcat formation and the Yager Terrane. The Russ/False Cape fault zone roughly delineates the region southern boundary, separating Pliocene/Pleistocene materials from a strip of Coastal belt rock located just within the southern margin of the region. Most of Green Diamond ownership is underlain by the Wildcat Group geologic units.

Climate
This HPA group is the most heavily influenced by the coastal weather patterns of northern California. Summer temperatures are mild, with a commonly occurring marine fog layer. Typically, most precipitation falls as rain between October and April with snowfall occurring sporadically at higher elevations. The average annual precipitation varies from less than 40 inches near the coast to over 110 inches further inland.

Forest Types
The Humboldt Bay portion of the Group is entirely within the summer fog zone, and all vegetative types reflect a strong coastal influence. Redwood/Douglas-fir forests dominate, Sitka spruce is common near the coast, and minor amounts of grand fir, western red cedar and western hemlock occur on lower slopes and in riparian zones. Red alder dominates many riparian zones, and tanoak is the most common mid to upper slope hardwood.

Above the Eel and Van Duzen river alluvial plains, there is the usual progression of redwood/Douglas-fir forests near the coast to Douglas-fir and Douglas-fir/tanoak forests in the interior. Grand fir, western red cedar and western hemlock occur on lower slopes and in riparian zones. Red alder dominates many riparian zones, and tanoak is the most common mid- to upper-slope hardwood. Other common hardwoods are California laurel (pepperwood), Pacific madrone and California black oak. Extensive prairies are prevalent in this Group's most inland portions, dominating many southern to western slopes and ridge tops.

Aquatic Habitat
Canopy cover in this group is generally high, ranging from 90 to 100%. Canopy cover is provided primarily by deciduous species. LWD instream structure is high. The amount of stream habitat occupied by pools is high. The amount of pool cover provided by LWD is moderate to high.

3.5.2.2 Age Class Distribution

Each HPA group includes a range of forest age classes that reflects the previous management (Table 3). The current age distribution results in part from the timing of initial harvest in the region as discussed above and the more recent harvest entries into the young growth forests. The Humboldt Bay HPA group contains the greatest percentage of young age classes (<30 years) and consequently lower percentages of forests entering the commercially viable age classes (>30 years) due to more recent harvesting of the mature young growth stands. The Coastal

Klamath HPA Group contains the greatest percentage of stands entering the commercially harvestable forest age classes (>30 years).

Table 3. Forest Age Class Percentage by HPA Group

Forest Age Class	Smith River	Coastal Klamath	Korbel	Humboldt Bay
0-9	11.9	8.7	11.2	9.9
10-19	10.6	5.3	12.8	19.4
20-29	13.8	3.6	8.0	20.7
30-39	7.0	19.6	12.6	19.6
40-49	27.2	36.4	11.4	6.9
50-59	17.7	18.2	22.1	4.8
60-69	7.0	3.9	10.5	9.7
70-79	2.5	1.1	4.6	3.7
80+	1.8	2.6	4.0	4.6
Non-Forest	0.6	0.6	2.7	0.8

3.5.2.3 Natural Disturbance Regimes

Historically, old-growth forests in northern California were diverse and ranged from dense closed canopy forests to open patchy forests. These diverse conditions were maintained in part by equally diverse fire regimes of frequent low-severity fire, to a mosaic of mixed-severity fires. Old-growth structure and composition were spatially heterogeneous, varied strongly with topography, aspect and elevation, and were shaped by a complex disturbance regime of fire, wind, flooding, landslides, insects, and disease (Spies, 2005). There is a west to east gradient from the wet coastal redwood zone to the dryer interior mixed conifer zone generally dominated by Douglas-fir on Green Diamond lands. There is also an elevation and aspect gradient from low elevation to high elevation and north slopes to south slopes that is similar to the west to east gradient but on a more localized scale. In general, the wetter coastal, lower elevation or north facing slope areas were subjected to more frequent or lower intensity disturbances and the dryer inland, higher elevation or south facing slope areas were subjected to a more complex mosaic of mixed-severity disturbances.

The primary disturbance events that affect the coastal redwood forest are fire, wind, flooding and landslides. Lorimer (2009) reviewed these factors to clarify how key attributes of redwood forests may have been dependent upon periodic disturbance. Lorimer (2009) found that prior to 1850, old-growth forests of coast redwood appear to have been subjected primarily to frequent disturbances of low to moderate intensity and extent, leading to highly irregular age structures. Small forest canopy gaps were created by these disturbances, and where these gaps were large enough to allow tree regeneration, a small group of same age trees would develop. The resultant stand structure may be described as a mosaic of small to very small even aged groups that create a broadly uneven-aged forest when viewed on a landscape scale.

Large stand replacing events were uncommon in the redwood forest. Stand replacing events probably did occur, but there is currently no significant evidence to support the occurrence of large scale stand replacing events in the redwood forest. The few stand-level case studies on sites susceptible to landslides or repeated flooding (Redwood Creek, Bull Creek) suggest that there can be more than a thousand years between catastrophic events. (Lorimer, 2009)

Fire is commonly recognized as an important disturbance in coast redwood forests, but the nature of historical fire regimes is often uncertain. Evidence from fire scars document that frequent, episodic low intensity surface fires were a dominant fire regime in many coast redwood forests, and that loss of surface fires has occurred over the last century. This loss of surface fire is thought to be in response to loss of Native American ignition sources combined with active fire suppression. (Brown - USDA Forest Service Gen. Tech. Rep. PSW-GTR-194, 2007).

Loss of surface fires from coast redwood forests has led to changes in associated ecosystem patterns and processes. Frequent surface fires typically kill most woody brush and tree regeneration thus promoting an open, low-density stand structure of mature fire resistant trees. With the loss of frequent low intensity surface fires, fire-intolerant species, such as grand fir, western hemlock, and hardwoods, would have more opportunity to become established and would become more abundant. With the loss of surface fire, biomass of shrubs would increase and the diversity and biomass of grass and herbaceous vegetation would decrease.

Progressing inland to the interior mixed conifer zone generally dominated by Douglas-fir on Green Diamond lands, the natural disturbance regime is characterized by the combined effects of insects, disease, and fire. Insects and pathogens, especially those that attack Douglas-fir, contribute to structural and composition heterogeneity. Low levels of mortality from insects and disease results in wide spread snags. Regional droughts impact tree health and vigor and promote beetle infestation and the development of patchy stand openings. Some pathogens result in top killed trees or heart rot in trees, leading to the creation of scattered snags with hard exteriors and decayed or hollow interiors.

The mixed conifer forests of northern California have a historical fire regime that is characterized by fire-return intervals of about 10 to 25 years, depending on aspect, topography, and soil moisture (Spies, 2005). Fires tended to have a mixture of severities, with the most severe fires on upper slopes and the least severe on lower slopes. Also, fires were patchy and relatively small, although size was highly variable. Mean fire sizes typically ranged from about 80 to 160 acres, but fires that burned thousands of acres did occur. Like insects and disease, fire related disturbance results in overall forest heterogeneity.

According to the Redwood National and State Parks Fire Management Plan (2010), fires were set in northwestern California by American Indians to increase acorn production, providing basketry materials and to encourage new growth of grasses and browse favored by deer and elk. Settlers who came into the area after 1850 to develop sheep and cattle ranches also set fires to create pastures for livestock and to encourage growth of browse. When fire suppression became a priority in the 1930s and ranchers came under changing economic pressures due do the depression and WWII, long-term cultural burning practices ended and ecological conditions were fundamentally changed; Douglas-fir forests began replacing the oak-prairie woodlands. The Park is using prescribed burns and selective removal of Douglas-fir stands to restore and maintain oak-prairie woodlands.

Stephens and Fry (2005) hypothesized that the frequent anthropogenic fires ignited in surrounding grasslands or oak savannahs were also responsible for fire in the coast redwood trees. Some prairie fires would naturally extinguish themselves because of the differing fire environments at the coast redwood ecotone and only a subset of those fires burned through the redwood forest. As noted above, this probably resulted in frequent but predominantly low to moderate severity fires in the redwood forests, but some of these same prairie fires likely resulted in some stand replacing fires in the higher elevation Douglas-fir forests.

In summary, except for the low elevation coastal strip, the redwood region was historically highly fragmented by ridges with open prairies, woodlands and Douglas-fir forests separating streams and rivers with old-growth redwood forests. Over time with climatic changes in wet and dry cycles, the ecotones surrounding the ridgelines presumably also increased and decreased with varying amounts of early seral forests.

3.5.3 Desired Future Conditions

Green Diamond will utilize a combination of evenage, unevenage and intermediate timber harvest methods to produce a sustainable yield of forest products while providing for the retention and development of key ecological habitat elements and structure. At a landscape level, Green Diamond lands will be composed of a mosaic of multiple age classes created by evenage regeneration harvest areas set within a network of selectively harvested older stands that typically follow the stream networks. Additional key ecological habitat elements will be retained in the evenage openings and across the landscape. Biodiversity will be maintained through a broad approach that provides structural diversity within harvest units and forest heterogeneity across the landscape.

Green Diamond will plan and implement timber harvests to:

- Create or enhance a mosaic of age classes in a dynamic pattern across future landscapes;
- Provide retention of older forest stands along watercourses within a matrix of regenerating younger forests; and
- Retain key habitat elements within evenage openings.

The selection harvest planned for Riparian Management Zones (RMZs) and unstable areas will provide a dendritic network of older forests with high basal area and dense canopy cover. Approximately 25% of the landscape will be in RMZs and other partial harvest retention areas that will increase from the current average stand age of 44 years to an average of 94 years over the next 50 years. While not considered old-growth, stands of this age in the redwood region develop large trees with cavities, broken tops, debris accumulations and various types of nests built by a variety of birds and mammals.

The evenage harvest areas will create a mosaic of small to large openings that will result in multiple age classes distributed as small patches across the landscape. Approximately 75% of the landscape will be occupied by these small evenage stands. The average evenage opening is expected to be approximately 15 acres and to range in size from less than one acre up to 40 acres. These evenage openings are typically a component of a larger harvest unit that includes a matrix of openings and retention areas. Harvest units (as compared to evenage openings) are expected to average approximately 30 acres and may range from a few acres to over 50 acres.

3.6 Conservation Easements/Land Sales-Purchases

Green Diamond continually assesses the company's land-base to ensure that the ownership fits with our timberland and forest management strategy. Land transactions occur periodically in response to management direction and markets. Land transactions are also constrained by state and local planning and zoning regulations, and by Green Diamond's commitments to long-term forest management under federally-approved habitat conservation plans.

Conversion of Green Diamond timberlands into non-timberland uses is highly constrained under California law. Most of Green Diamond's California Timberlands lie within Timberland Production Zones (TPZ), where conversion to non-forest use is prohibited with only a few, immaterial exceptions. Timberlands may only be removed from TPZ status by approval of a County Board of Supervisors, and also must comply with California's land use planning statutes and California Environmental Quality Act (CEQA). Typically, removal of land from TPZ status is a ten-year process, with immediate removal only allowed under very limited circumstances.

Green Diamond's California Timberlands are held in a configuration of parcels that are typically large acreages matching the manner in which the parcels were acquired and conveyed to Green Diamond. Under California's Subdivision Map Act, the opportunity to subdivide and market land in parcel sizes that are small enough for non-timberland management uses is highly constrained. Accordingly, Green Diamond engages in very little activity to subdivide and market timberlands for non-forest use. In those limited circumstances where Green Diamond does entitle and sell land for non-forest uses, it is in response to comprehensive local land use planning where professional planners, public review, and political accountability ensure that land owned by Green Diamond is properly zoned to meet the needs of the community. Typically, this occurs at the margin of commercial timberlands, or on small isolated parcels where urbanization is in potential conflict with timber management operations and demand for housing or other land uses is accommodated with an update to comprehensive plans that occurs once every decade or two.

In addition to state and local land use laws, Green Diamond has voluntarily constrained its land disposition through its commitment to long-term management under a federally approved habitat conservation plan. Under the AHCP, total area managed under the HCP may not decrease by more than 15 percent of the initial plan-area acreage without a major amendment of the HCP requiring discretionary review by NMFS and USFWS with public review and comment on any proposed action to amend the AHCP. An important exception to this rule is the provision that lands transferred to an owner who is legally bound to manage the lands at or above the standards of the AHCP are not counted as deductions from the AHCP plan area. Lands are not deducted from the AHCP plan area when they are sold to an owner who is legally committed to implement the AHCP on those lands or lands transferred to the U.S. Forest Service for management under the Northwest Forest Plan are not counted as deletions from the AHCP plan area. This means that Green Diamond is strongly incented to engage in conservation sales where timberlands may be sold for purposes of conversion from commercial forestry to greater emphasis on conservation or development rights are sold to perpetuate timberland use.

Some recent land sales and land sales in-progress are described below as examples of recent and ongoing land transactions. These examples also help to illustrate Green Diamond's long-term commitment for forest ownership and the limited instances where forest land conversion may occur.

Yurok Land Sale: In July of 2002 Green Diamond and the Yurok Tribe initiated a land sale project that eventually led to the acquisition of 47,103 acres of Green Diamond timberland by the Tribe or its conservation partner Western Rivers Conservancy. The project required eight separate real estate transactions that closed between September 2009 and February 2017. The sale area included timberlands located north of the Klamath River in the Blue Creek, Bear Creek, Pecwan Creek, and Cappell Creek watersheds. This acquisition project was a significant effort on the part of the Yurok Tribe to purchase lands within their reservation and re-establish their indigenous territory along the Klamath River. The Yurok will apply a sustainable forest management approach and work towards providing traditional subsistence practices on those lands.

City of Arcata: In December of 2011, Green Diamond completed the sale of a 16 acre parcel to the City of Arcata. The sale of this small riparian forest parcel to the City will allow the City to build provide public access trails that will connect to City of Arcata Community Forest. Public ownership of this parcel will also allow the City to enhance the riparian forests and flood control projects that are ongoing in the area. The majority of the parcel will remain as forested land. The City of Arcata owns and manages the City of Arcata Community Forest, an FSC Forest Management certified forest.

Hospice of Humboldt: In September 2013 Green Diamond completed the sale of an approximately 13.5 acre parcel to Hospice of Humboldt near Eureka. This property was used to build the first Hospice inpatient health care facility on the North Coast. A small portion of the land has been developed and the majority of the parcel will be retained as open space. This sale property lies at the edge of urbanization and commercial timberlands.

Humboldt Community Services District (HCSD): In January of 2013, Green Diamond completed the sale of an approximately 22.3 acre parcel to HCSD. The parcel is immediately adjacent to and east of the existing HCSD operations facility which fronts Walnut Drive, a public thoroughfare. Only a small portion of the property acquired by HSCD is suitable for future expansion (i.e. development) with the majority of the property being marinated as open space. This property had been previously planned and zoned for residential development with an allowable density of 1-7 dwelling units per acre. The property is now planned and zoned as Public (P) in conformance with the Humboldt County General Plan.

Moonstone Beach: Green Diamond completed the sale of an approximately 13.9 acres to the Trinidad Coastal Land Trust (TCLT) in 2015. The property was acquired by the TCLT with grant funds from the State Coastal Conservancy and the North American Wetlands Conservation Act (NAWCA).

To improve accessibility of the Humboldt County coastline and mobility for Humboldt County residents, the State Coastal Conservancy (SCC) partnered with Redwood Community Action Agency (RCAA) in 2009 to complete the Humboldt County Coastal Trail Implementation Strategy, which sought to recommend CCT alignments throughout Humboldt County, prioritize recommended trail segments, and aid local jurisdictions and organizations moving CCT segments forward. This Implementation Strategy recommended multiple agencies collaborate to identify a working Little River Trail alignment and crossing opportunity, a cooperative operations and maintenance agreement and potential funding opportunities for the trail and property acquisition. In February 2013 GDRCo provided a willing seller letter for a grant funding opportunity through the North American Wetlands Conservation Act (NAWCA). The Coastal Conservancy facilitated submittal of the NAWCA grant application and has committed to matching the amount funded by NAWCA. In March 2014 NAWCA awarded grant funding in the amount of $40,000 toward the purchase of the GDRCo Moonstone Beach property. With a $40,000 match from the Coastal Conservancy, there was $80,000 available toward acquisition of the GDRCo Moonstone Beach property. GDRCo was asked to consider a charitable contribution of $40,000 to achieve the $120,000 appraised value. This charitable contribution may be applied toward part of the 25% nonfederal match required under the Forest Legacy grant program in conjunction with a conservation easement for GDRCO's McKay Tract property.

University Hill: In December of 2012, Green Diamond completed the sale of a 13,367 acre timberland property to New Island Capital. New Island Capital, after acquiring the property, has initiated a carbon sequestration offset project on the property and is also pursuing a conservation easement on the property with the primary interest in extinguishing development rights.

Berry Summit: In May of 2013, Green Diamond completed the sale of a 2,196 acre timberland property to Finite Carbon. Finite Carbon, after acquiring the property, has registered a carbon sequestration offset project on the property.

Van Cleave Acquisition: Green Diamond Resource Company acquired 346 acres of land and timber on June 29, 2017, from the Marion J. Van Cleave Trust. The property is up on Fickle Hill and straddles the Mad River and Jacoby Creek watersheds. In addition to approximately 290 acres of high site redwood timberland, the Van Cleave property acquisition included two rental houses located adjacent to the county road. Green Diamond obtained all the necessary permits from the planning department to create a legal parcel for each house and has sold both houses. The 290 acres of land and timber was added to Green Diamond's forest inventory system and is managed just like the balance of its FSC certified timberlands.

Sproul Creek Acquisition: Green Diamond Resource Company acquired 9,386 acres of timberland on November 16, 2018, from Boyle Forests, LP, a limited partnership formed by members of the Barnum family. The property is located in Southern Humboldt, approximately three miles from the community of Garberville and U.S. Highway 101. Currently, Sproul Creek is approximately 80% Douglas-fir and 20% redwood. Sproul Creek is within the natural redwood zone which provides an opportunity to increase a more desirable species mix over time favoring redwood. Just prior to the Sproul Creek acquisition, Boyle Forests, LP donated a conservation easement to the Northcoast Regional Land Trust. The conservation easement extinguished development rights on approximately 9,291 acres as well as created a no harvest "Natural Oak Forest Retention Area", which will prevent the conversion of true oak stands within the area.

Willits Woods Acquisition: Green Diamond acquired 18,662 acres of working forest in September, 2022 from Coastal Ridges, LLC. The Willits tract is currently excluded from Green Diamond's FSC Certified lands. This timber tract is located in Mendocino county, California just west of Willits, CA. These productive timberlands have been intensively managed for timber production for more than 60 years with an extensive road network that provides access to most of the property. The primary conifer species are redwood and Douglas-fir, with tanoak the principal hardwood species. The terrain is generally moderate to steep, and elevations range from 600 to 2,500 feet above sea level. The property includes a carbon project known as Willits Woods for which Green Diamond has assumed responsibility. The acquisition included 12 approved Timber Harvesting Plans that covered more than 5,000 acres of harvestable timber. These THPs were approved in compliance with the Coastal Ridges LLC Option (a) to provide for Long Term Sustained Yield as required by the California Forest Practice Rules. This Option (a) document includes silvicultural guidelines that are designed to develop a stand structure characterized by a multi-age and size class of trees. The Willits tract is not covered by Green Diamond's AHCP, FHCP, programmatic WDRs, MATO or other landscape scale management documents.

New Forest Acquisition: Green Diamond completed the purchase of 4,297 acres of California timberland from New Forests in January, 2023. This acquisition area is included in Green Diamond's FSC Certified lands. The timberland acquisition included 4 tracts in Humboldt and Del Norte Counties and a small (41 acre) tract in Trinity County. The 41 acre tract in Trinity County was within the fire perimeter of the 2022 Willow Creek Fire Complex. The primary conifer species within the 4,297 acre acquisition are redwood and Douglas-fir with tanoak and alder the primary hardwoods. A portion of the property includes a carbon project for which Green Diamond has assumed responsibility. The majority of the property is within the area eligible for AHCP/FHCP coverage and has been enrolled in those plans.

Green Diamond recently granted three conservation easements on portions of its timberlands and has proposed three additional conservation easements. Each is described below.

Miracle Mile Conservation Easement: The Miracle Mile conservation easement is located in the Terwer Creek drainage of the lower Klamath Basin. This conservation easement is owned by Save the Redwoods League and it covers approximately 672 acres, with approximately 142 acres of old-growth forest, buffered by 530 acres of younger forest stands less than fifty years old. The Miracle Mile conservation easement area contains some of the best remaining privately owned old-growth forest habitat for marbled murrelets in northern California. The purpose of the easement is to assure that the property will be retained in its natural condition and managed for its habitat, ecosystem and other natural values including its value as breeding habitat for marbled murrelets. The conservation easement prohibits commercial timber harvest on the property, which includes any cutting or removal of trees, whether living or dead, standing or downed.

Big Mynot and E.F. Hunter Conservation Easement: The Big Mynot and E.F. Hunter conservation easement applies to two areas located in the lower Klamath Basin. The Big Mynot area is located on a ridge between two forks of Mynot Creek, and E.F. Hunter is located in the headwaters of the East Fork of Hunter Creek. The Big Mynot and E.F. Hunter easements cover approximately 298 acres. Big Mynot contains approximately 39 acres of old-growth and 94 acres of buffer. The E. F. Hunter stand contains approximately 38 acres of old-growth and 127 acres of buffer. The Big Mynot and E.F. Hunter conservation easement areas contains some of the best remaining privately owned old-growth forest habitat for marbled murrelets in northern California. The purpose of the easement is to assure that the property will be retained in its natural condition and managed for its habitat, ecosystem and other natural values including its value as breeding habitat for marbled murrelets. The conservation easement prohibits commercial timber harvest on the property, which includes any cutting or removal of trees, whether living or dead, standing or downed. This easement is also held by Save the Redwoods League.

The McKay Tract Conservation Initiative/Easement: The McKay Tract is approximately 7,600 acres of timberland located in the coastal region of Humboldt County in close proximity to the City of Eureka. The western margin of the McKay Tract presents a risk of land use conflict where it is a stark interface between urban development and commercial forestry. Green Diamond, working with the County of Humboldt and The Trust for Public Land, developed a multi-phased conservation initiative and easement proposal for this timberland tract. The proposal allows for the potential future development of approximately 377 acres of lands zoned by the County for residential development along the western margin of this tract; the creation of a community forest that would adjoin the residential development area west of Ryan Creek; and a conservation easement for the remainder of the tract that would remove development rights and allow Green Diamond to continue to utilize the land for productive timber harvesting. This proposal meets the needs of the County by providing appropriate lands for growth and development, allows the Company to manage timberlands for timber production and provides a long-term buffer between residential development and commercial timber harvest in the form of a community forest. A 1,002-acre portion (Phase 1) of the McKay Tract was acquired by the County of Humboldt for the creation of a community forest on August 21, 2014.
Green Diamond and The Trust for Public Lands identified an approximately 197-acre portion of the McKay Tract, adjacent to the community forest, which was purchased through grant funding and conveyed to Humboldt County (Phase 2) on June 30, 2020. A conservation easement (Phase 3), covers the majority of the remaining McKay Tract, approximately 5,967 acres, and closed on June 30, 2020. This conservation easement has extinguished development rights in perpetuity and will provide for limited public access along a trail through the conservation easement area.

The Strawberry Rock Conservation Easement (Proposed): In 2016, Green Diamond Resource Company started working with the Trinidad Coastal Land Trust to develop funding sources for a proposed conservation easement for Strawberry Rock. This permanent easement would include 44 acres in the following configuration:

- A public access easement over GDRCo property for the trail from the public road east of US 101 to Strawberry Rock, including a buffer along the trail (19 acres)
- Strawberry Rock and a buffer around the rock (6 acres)
- A stand of mature young-growth timber that is adjacent to the trail and is currently included in an approved timber harvesting plan (24 acres)

Consummation of the conservation easement will be contingent upon available funding and thus far preliminary conversations with potential funders have received favorable responses. Green Diamond also contacted representatives of the Yurok Tribe who are also supportive of permanent protection for Strawberry Rock. Portions of the one approved timber harvesting plan that is adjacent to the proposed trail to Strawberry Rock were harvested in 2020. The one unit that falls within the proposed conservation easement is not scheduled for harvest. However, other harvest units that are over 0.5 miles from Strawberry Rock or the proposed trail are scheduled for harvest. Green Diamond is committed to working with the conservation organizations and the local community to for a successful conclusion.

The Redwood Creek Conservation Easement (Proposed): Green Diamond Resource Company and The Trust for Public Land, in cooperation with Redwood National Park, are proposing a 11,073 acre conservation easement that would be created upstream of Redwood National Park in the Redwood Creek Basin. This easement would prevent any future development or subdivisions and would include the opportunity for a future trail allowing public access extending upstream from the southern park boundary. The area under consideration for the easement would include lands in the Panther Creek, Garrett Creek and Coyote Creek drainages. The future proposed trail would follow Redwood Creek and be located on Green Diamond Resource Company lands. The proposed conservation easement lies within the area outside of the boundaries of Redwood National Park indicated as the “Park Protection Zone” on the map entitled “Proposed Additions, Redwood National Park, California”, numbered 167–80005–D and dated March 1978.

The McKinleyville Conservation Initiative/Easement (Proposed): The McKinleyville Tract is approximately 3,644 acres of timberland located in the coastal region of Humboldt County in close proximity to the community of McKinleyville. Under current conditions, the western margin of the McKinleyville Tract presents a risk of land use conflict where it is a stark interface between urban development and commercial forestry. Green Diamond, working with The Trust for Public Land, has developed a multi-phased conservation initiative and easement proposal for this timberland tract. The proposal would allow for the creation of a community forest that would adjoin the residential development area west of the McKinleyville Tract; and a conservation easement for the remainder of the tract that would remove development rights and allow Green Diamond to continue to utilize the land for productive timber harvesting. Also under consideration as part of this initiative is a conservation easement for an additional 1,517 acres known as the Mather Tract. This proposal meets the needs of the County, Communities of McKinleyville and Fieldbrook, and allows Green Diamond to manage timberlands for timber production while providing separation between residential development and commercial timber harvest in the form of a community forest.

3.6.1 Process to Limit or Compensate for Forest Conversion

Green Diamond engages in very limited land conversion activity since the company's primary goal for its ownership is the sustainable production of forest products. Green Diamond may periodically convert limited acreage forest land to non-forest as described in the following examples:

- Increase acreage of area to support energy or manufacturing facilities and associated log or materials storage.
- Provide for residential development needs as determined by the local jurisdiction through a General Plan Update/Amendment process, effectuated by a change in land use/zoning.
- Establishment of telecommunication lease sites.
- Allow for residential use of properties where continued timber management is significantly constrained by surrounding residential or other non-compatible uses.

Green Diamond, in cooperation with national conservation organizations and local land trusts, is currently seeking to establish a number of conservation easements for its ownership which are primarily intended to extinguish development rights. These are permanent easements which cover areas totaling almost 17,000 acres. Additionally, as part of the proposed McKay Tract Conservation Initiative/Easement, Green Diamond sold approximately 1,000 acres to the County of Humboldt for a community forest. Funding for the acquisition and subsequent transfer was facilitated by the Trust for Public Land (TPL), and there are ongoing discussions regarding selling an additional 100(+/-) acres to the County. These management activities are voluntary agreements which enable clear, substantial, additional, secure, long-term conservation benefits across the forest management unit (FMU).

Green Diamond shall develop a process to track such compensatory activities and forest conversion such that any establishment of conservation easements, contributions to land trusts or other compensatory activities may be added to the account for future use should other forest lands be converted to non-forest use and retained in ownership. The conservation benefits used to offset conversion to non-forest use will lead to equal or greater conservation values than those lost by the conversion. The conversion and resultant compensation will be determined by Green Diamond staff and reported during future audits. There is no time constraint on the land account (i.e., a conservation contribution could be banked indefinitely until needed for compensatory use) as long as the conservation value is equal to or greater than that lost through conversion.

Green Diamond has an evaluation process for identification and analysis of resource values potentially affected by timber harvest activities. This evaluation process is referred to as a Request for Resource Input (RRI). This same process shall be used for evaluating projects which may result in land use conversion. The Manager of Land Management and Business Development Division (LMBD) will initiate the RRI and route the project for internal review to the identified company departments on the form. The respective departmental leads will review and reply to the Manager, LMBD with any identified project issues or resource concerns. This company policy provides assurance that all biological diversity indicators are met, and the conversion does not occur on high conservation value forest areas. A project would not proceed until internal review determines the land conversion conforms to all biological diversity requirements or equal or greater compensatory conservation measures are in place.

Green Diamond tracks ownership additions, deletions, planned and permitted projects via the company's GIS and Timberland Management Information System (TMIS). The GIS also identifies and tracks HCVF and other areas with rare species or habitats to evaluate planned projects and in compliance with FSC Indicator 6.10.b, forest conversion to non-forest land uses shall not occur on HCVF areas within the FMU on lands owned by Green Diamond. In addition, Green Diamond has a system in place to report ownership acres in the FMU for compliance with various HCPs. Green Diamond's GIS and Timberland Management Information System (TMIS) will be used to evaluate the standard for a "very limited portion" of the FMU ensuring that any conversion is a "very limited portion" of the FMU, quantified as less than 2% of the certified forest over a five-year rolling period.

3.7 Regulatory Setting and Compliance Program

Timber harvest-related activities on private lands in California are subject to numerous Federal and State regulations and other applicable guidelines. Key relevant State regulations and guidelines applicable to management activities on Green Diamond's lands in northern California are listed and briefly described below, and more thoroughly described in Section 1.5 of the AHCP FEIS and Sections 1 and 4 of the Forest HCP. In addition, laws that do not directly control timber management but are related are also discussed below and in the AHCP FEIS and Forest HCP.

Federal Laws and Regulations

Endangered Species Act (ESA)

The Federal Endangered Species Act of 1973 is administered by the Secretaries of the Interior and Commerce through the USFWS and NMFS. The ESA was enacted to provide a means for conserving endangered and threatened species and the ecosystems upon which they depend, in order to prevent species extinctions. The ESA has three major components relevant to Green Diamond's forest management plans:

- **Section 7** – Requires federal agencies to ensure, in consultation with the USFWS and the NMFS, that proposed actions are not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat

- **Section 9** – Prohibits "*take"* of listed fish and wildlife species
- **Section 10** – Provides for permit issuance to non-federal entities authorizing the take of listed fish and wildlife species incidental to otherwise lawful activities

In 1992 Simpson Timber Company (the predecessor to Green Diamond) obtained the first Habitat Conservation Plan for the northern spotted owl. This plan was replaced a by the Forest HCP in 2019 that included the norther spotted owl, a Candidate Conservation Agreements for the Pacific fisher and two species of tree voles- red and Sonoma.

Migratory Bird Treaty Act (MBTA)

The MBTA implements various migratory bird protection treaties and conventions between the U.S. and Canada, Japan, Mexico, and the former Soviet Union. Under the MBTA, taking, killing or possessing migratory birds is unlawful as is taking any such birds' parts, nests or eggs. The MBTA defines *take* more narrowly than the ESA and includes only the death or injury of an individual bird from a migratory bird species or their eggs. 50 C.F.R. §10.13 includes a list of MBTA-protected birds.

National Environmental Policy Act (NEPA)

The purpose of NEPA is to ensure that federal agencies consider the environmental impact of their actions and decisions. Although forest management on California's private timberlands is generally not subject to NEPA, Green Diamond's Federal HCPs have been reviewed under NEPA prior to approval. NEPA requires that the federal government use all practicable means to protect environmental values for every federal agency action. To accomplish this goal, NEPA established a review process for analyzing the environmental impacts of proposed federal actions.

Clean Water Act (CWA)

The Clean Water Act of 1977 is the principal Federal legislation designed to protect the quality of the nation's waters. The U.S. Environmental Protection Agency (EPA) is charged with implementing most of the CWA, including Section 303, which contains provisions for establishing and meeting water quality standards. Under the CWA, most forest management activities are considered nonpoint sources when they contribute to water pollution. Such nonpoint sources are not directly regulated under the CWA, but are addressed by best management practices embodied in state law and regulations. The CWA provides for establishment of Total Maximum Daily Loads (TMDLs) where water bodies are not meeting established water quality standards. The CWA includes provisions for states to assume much of the implementation responsibility, which is largely the case in California. Many stream reaches and watersheds in Green Diamond's ownership have been listed as impaired water bodies by the by the federal EPA under Section 303(d) of the CWA, with the implementation program under the North Coast Regional Water Quality Control Board (NCRWQCB). For most of the listed waterbodies, where TMDLs have been prepared and approved, timberland management under

Green Diamond's AHCP has been recognized as satisfying Green Diamond's obligation to address water quality and incorporated into Wastes Discharge Requirement permits approved by the NCRWQCB. An exception is the Elk River drainage. Recognizing the sensitivity of the drainage, a special management plan was created for Elk River. With some modifications this plan was approved by the NCRWQCB in February of 2020.

Some forest management activities are classified as point sources and are directly regulated by an NPDES permit issued pursuant to the CWA. Green Diamond's Crannell forest management and equipment maintenance facility is considered a point source for discharge of stormwater runoff and is managed in compliance with the California general stormwater permit for industrial activities.

California Laws and Regulations:

California Environmental Quality Act (CEQA)

Similar to NEPA, CEQA requires State agencies with discretionary permitting authority to evaluate the environmental effects of a proposed project. If one or more significant impacts are identified, a detailed EIR must be prepared. If no significant impacts are determined or if all of the significant impacts can be mitigated to levels less than significant, a negative declaration is prepared. CEQA also requires that a negative declaration or Draft EIR be prepared if a project has statewide, regional, or area-wide significance, including projects that would substantially affect sensitive habitats. The preparation, review, and approval of Timber Harvesting Plans (THPs) detail activities associated with timber harvesting on State and private lands. The THP process serves as the functional equivalent of an EIR under CEQA.

California Forest Practice Act (FPA)

The goals of the FPA are to:

- Restore, enhance, and maintain the long-term productivity of the state's timberlands, and achieve maximum sustained production of high-quality timber products
- Protect recreation, watershed, wildlife, range and forage, fisheries, regional economic vitality, employment and aesthetic enjoyment

The FPA is implemented through regulations known as the Forest Practice Rules (FPRs), which are applied through THPs reviewed and approved by California Department of Forestry and Fire Protection (CalFire).

The FPRs include standard prescriptions required in every THP, including:

- Protection measures for watercourse zones (minimum buffer sizes, canopy closure requirements, and equipment exclusion)
- Restrictions on construction, use, and maintenance of roads, trails, landings, and watercourse crossings

- Snag Retention requirements and measures providing for retention of late seral elements

Each THP may include site-specific language, restrictions or protection measures that are treated with the same enforcement as if they were approved regulations. The FPRs also require that THPs include a site-specific and area-specific assessment of potential individual and cumulative impacts of timber harvesting on the environment. Any significant impacts remaining after application of the standard FPRs require adoption of other site-specific measures to mitigate or avoid such impacts. Green Diamond receives an average of 50 THPs approvals per year.

Porter-Cologne Water Quality Control Act

The California Porter-Cologne Water Quality Control Act of 1969 authorizes Regional Water Control Boards (RWQCBs) to establish water quality objectives necessary for the reasonable protection of beneficial uses, including preservation and enhancement of fish, wildlife, and other aquatic resources or preserves. The objectives are stated in basin plans. The North Coast Basin Plan, which encompasses Green Diamond's ownership, includes water quality objectives for several pollutants associated with non-point source discharges from timber operations. These include the suspended sediment load and suspended sediment discharge rate of surface waters, turbidity, and the natural receiving water temperatures of intrastate waters. The North Coast Basin Plan regulates certain practices relating to logging and related activities pursuant to the North Coast RWQCB's authority to regulate discharges of pollutants that may affect water quality. Under the FPRs, no THP may be approved if it would result in the violation of an applicable Basin Plan provision.

The State Water Resources Control Board (SWRCB) and regional water boards implement the Federal CWA in California under the oversight of the EPA, Region IX. Direction for implementation of the CWA is provided by the Code of Federal Regulations (40 CFR) and by a variety of EPA guidance documents on specific subjects. The SWRCB and the North Coast RWQCB have the authority and responsibility to ensure compliance with the provisions of the CWA in the north coast region of California.

The NCRWQCB approved a 2010 Waste Discharge Requirement (WDR) for all storm water discharges from Green Diamond's forest roads within the AHCP area based on the road management requirements of the AHCP. In 2012 received a General Waste Discharge Requirement for silvicultural and all other forest management activities that may result in sediment entering the Waters of the State.

California Fish and Game Code and California Endangered Species Act (CESA)

The CESA lists and protects coho salmon that inhabit Green Diamond's timberlands. In 2008, the California Department of Fish & Wildlife (DFW) made a consistency determination under the CESA, finding that Green Diamond activities under the AHCP/CCAA are also compliant with the California's coho salmon protection standards. Following the listing of the northern spotted owl as a candidate under the CEAS in 2011, Green Diamond obtained a “consistency determination” that recognized protection measures under the federal HCP as meeting suitable protection for the owl. This same process occurred in 2019 after the approval of the new Forest HCP. Also in 2019, Green Diamond received approval for Safe Harbor Agreement for the Humboldt Marten by the DFW. The foothill yellow legged frog became a Candidate species in 2018. Using enhanced protection measures model after the AHCP, Green Diamond obtained an “Incidental Take Permit” for this species. The F&G Commission determined this species did not warrant listing, and in April of 2020, cancelled the permit.

Under the California Fish and Game Code, Green Diamond must obtain a permit from DFW for the construction, removal or replacement of stream crossing structures on forest roads. Based on AHCP/CCAA conservation commitments, DFW provided long-term authorization for all stream crossing work on Green Diamond’s California timberlands under a Master Agreement for Timber Operations approved in 2010.

Other Programs

Labor and Employment Laws and Regulations

In addition to laws and regulations pertaining to management of natural resources, Green Diamond also monitors and complies with state and federal laws concerning the management of human resources. In its collective bargaining with logging and road-building employees, Green Diamond complies with the National Labor Relations Act. In its administration of defined benefit and defined contribution retirement plans for employees, Green Diamond complies with ERISA. Confidential employee information is protected under laws such as HIPAA. California wage and hour laws govern fair treatment and compensation for employees through provision of overtime pay, rest periods, meal breaks, and time keeping standards. California health and safety are observed by ensuring that all employees receive appropriate safety training and equipment. Company employees are also protected under Company policies against harassment, discrimination, and violence. All employees regularly receive safety training and training to prevent or report and correct harassment, discrimination, and violence.

Fair Business Practices Laws and Regulations

Green Diamond also maintains awareness of its compliance obligations under federal and state antitrust laws and laws prohibiting other unfair business practices. Green Diamond enforces its own policies on fair business practices and prohibits insider training or conduct in violation of antitrust laws. All Green Diamond employees receive Ethics training at orientation of new employees or through regularly scheduled training sessions on the Company’s Code of Ethics.

Corporate Compliance Program

Green Diamond’s compliance with these and other legal and regulatory obligations is monitored and assured through a Corporate Compliance Program and Green Diamond Code of Ethics. Green Diamond’s Code of Ethics is available to the public at http://www.greendiamond.com/about/Code_of_Ethics.pdf. The Green Diamond Corporate Compliance Program is designed to monitor and maintain compliance with Company values, standards, and policies as well as with external requirements of federal, state, and local law. To maintain an effective compliance program, the Company promotes a culture that emphasizes ethical decisions and actions. As a reminder of the importance of ethics to all compliance efforts, the compliance program and compliance reports are structured around an "ETHICS" acronym:

E nvironment
T imber
H arvest
I ntegrity
C ivility
S afety

Each area of compliance serves one or more of the Company's core values: Profitability, Stewardship, Integrity, Community, and Safety.

"**Environment**" serves the core value of "Stewardship" through regulatory compliance and activities designed to protect the quality of air, soil, and water.

"**Timber Harvest**" serves core values of "Profitability" and "Stewardship" with internal standards, regulatory compliance, and activities that are unique to the sound management and use of commercial forestlands.

"**Integrity**" is a core Company value supported by standards and activities that promote an ethical Company culture, ethical business practices, protection of confidential employee information, and ethical participation in political processes.

"**Civility**" supports a core Company value of "Community" through standards and training that establish and maintain a rewarding work environment free from harassment, discrimination, or violence.

"**Safety**" is a core Company value supported by standards and practices that establish and maintain a safe work environment free from substance abuse, accidents, and injuries.

Oversight for the Corporate Compliance Program is provided by the Company's officers who meet twice each year as the Corporate Compliance Council. The Corporate Compliance Council establishes mandatory compliance standards such as a schedule for third-party compliance audits and schedules for employee training on ethics, fair business practices, safety, and civility. Green Diamond's Vice President, General Counsel is the Corporate Compliance Officer with responsibility for administering the compliance program, preparing compliance reports, and providing advice or assistance in resolving compliance issues.

The Corporate Compliance Council meets twice each year to formally evaluate the performance of the Company's compliance program and various activities that maintain or improve the program. At each semi-annual meeting, the Council is presented with a Corporate Compliance Report. At the fall meeting, the Council receives and reviews a Mid-Year Corporate Compliance Report. At its spring meeting, the Council reviews and approves an Annual Corporate Compliance Report for the prior calendar year. The annual report is then presented to the Company's Board of Directors during the second quarter of each year.

The scope of each report is comprehensive, covering the performance of the compliance program in every respect. Each report is retrospective in summarizing performance, but it is also prospective in describing ongoing corporate compliance issues, projects, and activities.

3.8 International Agreements

Green Diamond monitors and is aware of obligations in international agreements or treaties that may affect Green Diamond. In general, international agreements do not directly impose affirmative conditions on businesses or individuals within states that are members and signatories of international agreements and conventions. However, the intent of these agreements and conventions is often addressed by federal or state laws that do impose affirmative compliance obligations on Green Diamond. Accordingly, Green Diamond's comprehensive Corporate Compliance Program helps to assure that its management of natural resources, human resources, and business and trade practices fulfill the intent of applicable international agreements and conventions.

3.9 Conformance and Conflicts with FSC Principles and Criteria

Green Diamond is committed to managing its California timberlands in conformance with FSC standards and policies. Green Diamond is not aware of any conflicts between the laws and regulations that pertain to Green Diamond's operations in California and the applicable FSC Principles and Criteria (FSC-US Forest Management Standard (v1.0) approved July 8, 2010, as revised). If a situation arises where Green Diamond's compliance with laws and regulations conflicts with FSC principles and criteria, Green Diamond will consult with FSC to resolve the conflict.

Section 4 - Forest Inventory

4.1 Inventory Methods

Green Diamond has maintained timber inventory records for its timber lands for over three decades. A range of strategies have been used to collect timber inventory data and the methods for storing and utilizing the data have changed over time as technology has advanced. The current inventory in general is not stratified. Instead, each stand has an individual estimate of age, site quality, stocking and volume by species. Individual forested stand polygons range in size from less than 1 acre to slightly over 1,230 acres, with an average size of 14.0 acres. Individual stand polygons are delineated to define areas of vegetation that are relatively homogeneous with respect to species composition, stocking, and age.

Logging history has generally been used to delineate stand polygons in younger age classes (<30 years). Stand ages for these polygons are based on an assumption that regeneration was achieved in the year following harvest. Older stands have been delineated primarily by aerial photographic cover typing, Lidar image, and ground recognition. In some cases, stand delineations were obtained from prior owners at the time of acquisition of the land by Green Diamond.

Inventory estimates typically come either from timber cruising conducted by Green Diamond, or from inventory values obtained from prior owners at the time of land acquisition. Approximately 116,000 acres (49% of the net productive acres) have been inventory cruised by Green Diamond in between 2012 and 2022. The stand cruises are validated by Green Diamond's inventory cruising administrator and imported into the growth and yield model system. For stands greater than or equal to 30 years old, 64% of those acres have a recent inventory cruise. The remaining uncruised stands are either within 5 years of harvesting or exist as small isolated patches scattered across the property.

For uncruised stands, or where no suitable inventory was available from a prior owner, there are two primary sources of inventory information: (1) photo-estimates, supported by field verification; or (2) stratification based on age and site, with expansion of cruise averages to uncruised stands within these strata. The latter case was used only for stands for which no information was available other than an estimate of stand age, primary site-species class (redwood or whitewood), and general site-class – 'good' (Site Classes I or II), 'medium' (III), or 'poor' site, (IV or V). The primary goal over the last decade has been to cruise all the large uncruised watersheds greater than 30 years old and we have largely achieved that objective and going forward we will focus on scattered small stands.

In 2005, Green Diamond established a goal to collect and maintain cruise data on the majority of timber stands that are 30 years or older, which resulted in our cruising approximately 4,000 acres per year to 20,000 acres per year starting in 2007. As the majority of stands greater than 30 years old have been cruised, the current level of annual cruising is approximately 8,000 - 10,000 acres, targeting 20, 28, and 36 year-old stands and re-sampling previously-cruised stands at a 10 year interval. These targeted age classes will assist in determining the need to reduce stocking levels (PCT or Thinning), and assist with growth and yield verification.

Green Diamond currently uses the Forest Projection and Planning System (FPS), developed by the Forest Biometrics Research Institute (FBRI), for inventory tracking and growth modeling.

Prior to 2006, Green Diamond used a proprietary growth and yield model to manage legacy cruise data. All stand inventory information was converted to the FPS format in 2006.

All stand inventory data is updated annually for growth using FPS. At the end of each year, we compare our inventory estimates for harvest units (depletion values) with actual production figures for each unit that was harvested (actuals). This comparison has been done annually since 1982. Over that time, total conifer depletion and production differ by less than one percent. This rigorous comparison is required under corporate policies governing financial accounting for depletion and forest management planning. Green Diamond will continue to make such comparisons on an annual basis in order to verify the accuracy of the inventory system.

Green Diamond, in consultation with the FBRI, established 30 new permanent growth plots in 2006-7, to provide better local calibration of the growth model. Each plot is 0.75 acre in size, and they are distributed across the ownership to represent the full range of habitat types, stocking levels, and species compositions. Remeasurement of these plots will be conducted whenever the height growth differential reaches 20 feet. Green Diamond intends to maintain these plots through multiple remeasurement cycles, updating the calibration of the growth model after each set of remeasurements.

Beginning in 2007, all five-year-old stands are surveyed for stocking by species and height class. These are plot-based surveys that can be directly incorporated into FPS. These data constitute the only empirical survey of regeneration on Green Diamond land. Because they effectively integrate the combined effects of planting, natural regeneration, and vegetation management through the first five years after stand establishment, these data are used as the basis for determining the initial species composition and stocking levels for all regenerated stands in the 100-year simulation.

4.2 Option (a)

Green Diamond manages its California timberlands for Long Term Sustained Yield under Maximum Sustained Production (MSP) plans prepared and approved in accordance with the California FPRs under Title 14 CCR 913.11(a). Informally referred to as an “Option (a)” plan, Green Diamond’s most recent Option (a) plan update for the California Timberlands other than the Willits Tract was completed in 2009. The Willits acquisition included an approved Option (a) plan specific to that property. The Option (a) contains confidential proprietary information that is protected from public disclosure under California law. This reference to the Option (a) is explanatory, and the Confidential Option (a) is not intended to be part of the publicly available Management Plan.

Under the Green Diamond Option (a) plans, annual harvest levels are scheduled to balance forest growth and timber harvest over a 100-year period. The Option (a) rule (CCR 913.11 (a)) requires the landowner to demonstrate achievement of MSP by satisfying the following five requirements, paraphrased below from the California Forest Practice Rules:

- Producing the yield of timber products ... while accounting for limits on productivity due to constraints imposed from consideration of other forest values, including but not limited to, recreation, watershed, wildlife, range and forage, fisheries, regional economic vitality, employment and aesthetic enjoyment;
- Balancing growth and harvest over time;
- Realizing growth potential as measured by adequate site occupancy by species to be managed by the landowner;
- Maintaining good stand vigor;
- Making provisions for adequate regeneration.

The results of the California Timberlands Option (a) analysis (excluding the specific Willits Option (a) are summarized in the following sections.

4.3 Forest Growth and Harvest

The Option (a) modeling used spatially explicit simulation of harvesting and growth of individual stand components over more than one rotation for 100 years, based on the GIS mapping of the standing inventory for Green Diamond's California timberlands as of January 1, 2008. The Option (a) modeling used even-aged silvicultural practices (clear-cutting) as the harvest/regeneration method. The MSP modeling resulted in a constant level of harvest for approximately 50 years, followed by an increase to a higher level for the last 50 years, with growth exceeding harvest at all times throughout the period, and with corresponding increase in standing inventory throughout the whole period.

Timber stands 45 years and older are available for regeneration harvest. However, implementation of intermediate treatments such as commercial thinning, as well as state laws that constrain both the size of even-aged management units and the timing of adjacent even-age harvesting operations, can delay the harvest of many stands until they reach the 70-year age class. The anticipated average age of harvest stands as currently modeled is about 50 years as the property approaches full regulation.

Because essentially all Green Diamond's property has been harvested at some time in the past, the progress of timber harvesting across the ownership will reflect the pattern of age classes developed as a result of prior logging activity. Historically, large areas were initially harvested as continuous logging operations resulting in large tracts of evenage young forest; whole watersheds would be harvested in a few years. In contrast, present day harvesting operations occur in smaller patches spread out across multiple watersheds. California FPR constraints will cause the dispersal of activities over time and space within the large blocks of evenage forest created during historic logging activities. This is a product of the California FPRs adjacency harvesting constraints that are applied to even-aged harvesting units resulting in retention of many stands far past planned rotation age. If harvesting of a tract of mature timber is initiated around age 45, the harvesting of much of that tract will be constrained into the following decades, and the harvest of a few stands will be constrained past 70 years of age. This effect has been demonstrated in Green Diamond's growth and yield planning.

4.3.1 Current and projected timber production

For the first 50 years of the simulation, growth exceeds harvest, and timber inventory increases over the period. Annual growth will exceed harvest by a considerable amount over this period due primarily to Green Diamond's forest management investments directed at increasing the stocking and growth of regenerated stands.

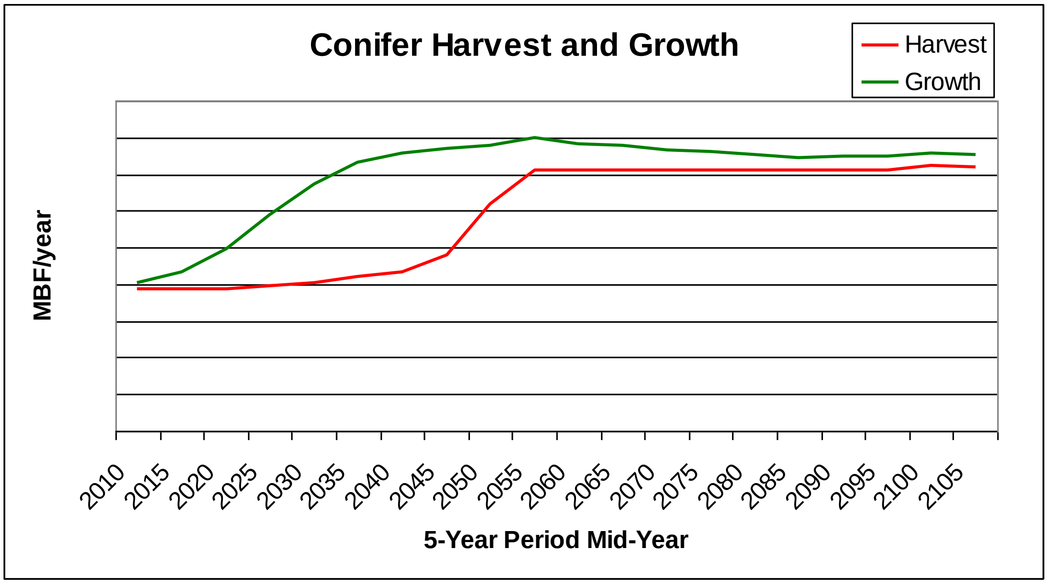


Figure 1. Conifer Harvest and Growth, by 5-Year Periods, 2008-2107

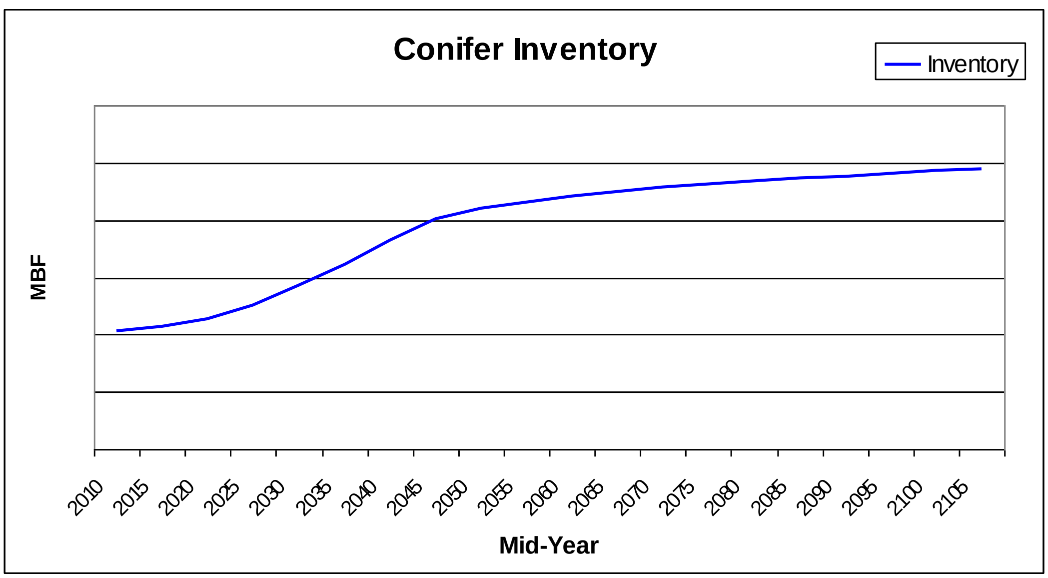


Figure 2. Conifer Inventory, by 5-Year Periods, 2008-2107

By the second half of the simulation, harvest has rapidly increased over the course of a single decade to match growth, with both growth and harvest essentially in balance throughout the last 55 years of the simulation. A perfect balance is not achieved since the FPR and Green Diamond's HCPs limit harvesting in constrained areas and prevents the harvest of all growth in those areas. As a result, growth remains slightly above harvest and the inventory continues to increase slightly through the end of the period. Sustainable management of the even-aged areas combined with selection harvesting in the restricted areas, will allow for growth to exceed harvest levels and inventory to increase indefinitely.

4.3.2 Option A Monitoring

MSP and sustained yield is monitored internally by tracking acres and volume harvested each year. This is also monitored by CalFire. Green Diamond submits an annual confidential report to CalFire that summarizes acres harvested by silvicultural system, and volume harvested, for the previous calendar year.

In 2017 Green Diamond adjusted the Option (A) LTSY to account for a land sale to the Yurok Tribe that reduced the managed timberland acres approximately 16%. The 2009 Option (A) calculated LTSY on 371,808 acres of managed timberlands. After the adjustment in 2017, the option (A) calculated LTSY on 311,744 acres of managed timberland.

4.4 GIS and Data Management

Green Diamond currently uses the Forest Projection and Planning System (FPS), developed by the Forest Biometrics Research Institute (FBRI), for inventory tracking and growth modeling. Long-term harvest scheduling was processed using an in-house computer algorithm prior to 2019 and then transitioned to Remsoft's Woodstock harvest scheduling software. Green Diamond's California Timberlands Division tracks individual stands using an ESRI ArcGIS platform on an underlying Microsoft SQL-Server SDE database.

Section 5 – Operations

5.1 Harvest Planning

Harvest planning occurs over long and short term timeframes and occurs ownership-wide and at the harvest unit level. The Option (a) discussed above is the longest-term harvest planning tool used by Green Diamond and it has a 100-year time horizon and looks at all of the California timberlands (excluding the Willits tract). The California Comprehensive Harvest Forecast (CCHF) (previously known as the Harvest Stand Availability Forecast (HSAF)) model is used to plan for the availability of harvest stands over a 10-year time period and is capable of modeling all of the California lands or sub regions depending on the modeling objectives. The Forest Ops system models harvest units and log production by logging operator for a one to two year time period. THPs are detailed documents that provide specific information needed for the operation of individual harvest units.

5.1.1 California Comprehensive Harvest Forecast (CCHF)

The CCHF model is used to plan for the availability of harvest stands over a 10-year planning horizon. This is a GIS based model that uses a harvest polygon layer and supporting inventory data to identify a potential harvesting pattern that would support a sustained yield of timber over the 10-year planning period. This planning effort is accomplished using GIS data pertaining to evenage harvest date for harvested areas and stand age for potential future harvest areas, as well as timber volume and species composition, watercourse location, road location, wildlife and habitat presence and other site characteristics to identify potential harvest polygons during the 10-year period. The model parameters can be set to account for regulatory constraints governing harvest stand age and adjacency limitations. The Planning Manager, chief foresters and GIS staff work closely together to schedule potential harvest polygons for each year of the planning period that comply with regulatory constraints and attain Green Diamond's sustained yield goals.

The result is a sequence of potential planned harvest polygons across the California ownership for a 10-year period that complies with regulatory constraints and does not exceed the Option (a) sustained yield goals. The actual harvest units that are harvested in any given year tend to be different than the modeled polygons due to market changes that occur, or changes in environmental conditions. This model has been updated every two to five years in the past with a goal to update it annually.

5.1.2 Forest Ops

In 2020, Green Diamond phased in the Forest Ops software system to replace the Log Production Projection System (LPPS). LPPS was developed in house over 20 years ago and was becoming difficult to support in the modern computing environment. The Forest Ops system chosen to replace LPPS serves the same tactical planning purpose. It is a database that is used to schedule monthly and yearly logging operations and forecast harvest production for log sales. This model has a rolling one-to-two-year planning horizon of the current operating year and the next year. The model is updated once or twice monthly as work progresses through the year. It is a detailed model that includes harvest volumes for individual harvest areas, an operations calendar and a list of logging operators. One function of the model is to create a schedule of harvest units by logging operator. The model can also be used to show projected harvest volume by tract, projected harvest volume by species, projected harvest acres, or numerous other harvest planning scenarios.

5.1.3 Timber Harvesting Plans (THPs)

The regulatory requirements for THPs were addressed under the preceding section on California Laws and Regulations. As a planning tool, THPs provide the site specific operational and environmental details needed to implement harvest operations. Silviculture prescriptions and yarding methods are designated for individual harvest units and sub-units, and environmental protection measures are specified. A critical aspect of THPs is that numerous time limits and requirements are put in place upon approval. The earliest possible starting date for evenage harvest units is often specified in the THP and the date for completion of work is also specified. THPs generally have a five-year period where operations may occur and may be extended for two additional years under certain circumstances. Replanting and stocking deadlines are tied to the completion of logging operations in a unit.

THPs are also the primary tool used to implement the programmatic agreements Green Diamond has with regulatory agencies. Each THP includes specific language, restrictions and protection measures that are treated with the same enforcement as if they were regulations. The AHCP, FHCP and marten SHA are implemented in part through operational restrictions incorporated into THPs that are above and beyond what the standard state regulations would require. Other permits or agreements that are implemented through THPs include the DFW MATO, the RWQCB Road Management and Forest Management WDRs, botanical management plans, and wildlife consultations.

5.1.4 Silviculture Methods

Green Diamond's silvicultural practices are designed to enhance the productivity of its timberlands by ensuring both prompt regeneration of harvested areas and promoting vigorous young stand development. Treatments vary by stand age, stand condition, site class and species composition. Green Diamond does not apply all treatments to every site. Table 4 summarizes the treatments that Green Diamond includes as part of its forest management regime.

Table 4. Green Diamond's forest management regime.

Treatment	Stand Age
Site preparation	0 – 1
Planting	0 – 1
Vegetation Management	0 – 10
Pre-commercial thinning	10 – 20
Commercial Thinning	30 and older
Regeneration Harvest	45 and older
Selection Harvest	45 and older

Silvicultural activity involves specific methods used to harvest and regenerate forest stands over time to achieve desired management objectives. Typical management objectives include achieving maximum sustained yield, and the maintenance, alteration or creation of habitat. Examples of even-aged silvicultural methods include seed tree, shelterwood and clearcut; uneven-aged methods include individual (single) tree selection and group selection. Commercial thinning is considered an intermediate silviculture method that is not used to promote regeneration. Salvage is considered a FPR intermediate treatment that is used to harvest trees that are dead, dying, or deteriorating because of damage from fire wind insects or other injurious agents. Rehabilitation is a special prescription that is used to improve the stocking of an under-stocked area and generally results in the development of an evenage forest. Variable retention is also a FPR special prescription described as an approach to harvesting “based on the retention of structural elements or biological legacies (trees, snags, logs, etc.) from the pre-harvest stand for integration into the post-harvest stand to achieve various ecological, social and geomorphic objectives”.

Timber stand regeneration and improvement includes activities necessary to establish, grow, and achieve desired species composition, spacing and rate of growth of young forest stands, including:

- Site preparation, prescribed burning and slash treatment
- Tree planting
- Control of competing vegetation
- Precommercial thinning and pruning
- Commercial thinning
- Regeneration Harvesting

5.1.4.1 Clearcutting

Clearcut harvest involves the commercial harvest of essentially all trees in a designated area to create the desired conditions for the development of a new age class of a species that grow best in full sunlight. Clearcutting provides for timely establishment of regeneration and for vigorous young stand development of redwood and Douglas-fir. It creates a condition where these trees are in a free-to-grow state that is not compromised by competition from retained overstory trees or by the possibility of damage from repeated site disturbance implicit in the application of selection silvicultural systems. Evenage management allows the young dominant and codominant redwood and Douglas-fir trees to grow sufficiently and maintain appropriate form class until the next entry. Clearcut harvesting prevents the selective harvest of only the most highly valued trees from a forest and leaving the low value trees or low quality trees. The growth potential inherent in the use of clearcutting in these forest types was assumed in the calculation of yields for Green Diamond’s Option (a) plan.

Clearcutting is a widely accepted silvicultural method and has proven to be a very effective practice for producing a vigorous young forest. However, this practice has been the focus of criticism from the public and close scrutiny by California resource trust agencies, specifically for the potential to impact water quality and aquatic resources. A review of Green Diamond’s use of this silviculture practice in the Maple Creek Watershed is included in Appendix C. This review provides an analysis of the potential effects of Green Diamond’s operations on the hydrologic cycle, sediment delivery and transport, water temperature and large woody debris recruitment. The paper reviews potential cumulative watershed effects of Green Diamond’s operations at the expected harvesting levels. The analysis takes into account the regulatory restrictions in place on Green Diamond’s AHCP covered lands. This review demonstrates that the implementation of Green Diamond’s management practices and the current regulatory provisions in place avoid, minimize and mitigate potential negative impacts of Green Diamond’s operations on the aquatic system and protect, and in some cases improve, water quality.

Green Diamond plans to practice evenage management throughout its forestlands, using clearcutting as the harvest/regeneration method, with the following general exceptions:

- Areas where buffers along public roads or near non-TPZ adjacent landowners are harvested using the selection or other partial harvesting systems to address visual impact concerns
- Overly steepened or unstable slopes to address slope stability concerns
- RMZs, Habitat Retention Areas (HRAs) or other areas managed principally for the maintenance of fish and wildlife habitat or other resource goals.

There are areas in Green Diamond's forests where past use of partial harvesting practices left standing mature timber over a well-stocked stand of maturing regeneration. These areas will be managed using an even-aged prescription of seed tree removal or shelterwood removal as described below.

Biodiversity will be maintained through a broad approach that provides structural diversity within harvest units and forest heterogeneity across the landscape. Clearcut harvest units will include conservation measures described in the AHCP and the FHCP that are designed to:

- Ensure that existing key habitat elements are retained at the harvest unit level (i.e. snags, live legacy residual trees, key large residual hardwood trees, down old residual logs with rot and defect)
- Provide for the retention of vertical structure at the harvest unit level in the form of conifer and hardwood leave trees where existing key residual habitat elements in the form of RMZs are not present.

Evenage unit tree retention guidelines: In addition to the AHCP RMZ retention standards, Green Diamond will implement the following additional tree retention within evenage harvest units:

- Implement the TREE plan as described below and modified by the Marten SHA.
- If after application of the AHCP RMZ/Geo buffers, other leave tree buffers, and TREE retention, there is less than the equivalent of 10% basal area retention in the unit, retain additional tree clumps, HRAs or scattered trees that are distinct from other retention areas (to the extent feasible) to reach the equivalent of 10% basal area retention for the unit.
- Retention trees will be dispersed throughout evenage units and evenage openings to the extent feasible.
- Retention of tree clumps is preferred over scattered individual trees or large HRAs. A combination of tree retention types (e.g. tree clumps, HRAs, individual trees) may be used based on site specific conditions.
- Tree retention will be located away from RMZs but in sheltered areas to the extent feasible to minimize the risk of blowdown.

- Retention trees will be composed of trees from the mid to upper canopy and are representative of the diversity of species and size classes present, including large and old trees.
- Where present, feasible and safe, retain small conifer trees (generally <12” DBH) as a small tree clump around scattered individual retention trees.
- Consider true oaks for retention, especially if they have legacy elements or structure that give them high wildlife value and all other things considered, fit in with the overall guidelines for tree retention provided here.

These retained trees and habitat elements, in conjunction with those left in RMZs, will provide habitat attributes for terrestrial and aquatic wildlife within even-aged harvesting units.

During the planning and design stage of an even-aged harvest unit, Green Diamond’s RPFs consult with professional biologists to ensure that key resource protection measures and mitigations are applied. This evenage harvesting activity complies with all measures covered under the AHCP and FHCP as well as all other Company programmatic permits and the FPRs. Green Diamond’s goal is to ensure that important key resource values existing at the time of the harvest are identified and protected to provide for a continuity of protection of sensitive habitats and habitat features throughout the harvesting cycles.

Past harvesting practices from the mid-1800s through the mid-1900s involved harvesting all merchantable trees across entire ownerships or watersheds over a very short time period, creating large (several thousand acres or more) tracts of homogenous evenage forest. The historic pre-harvest landscape (pre-1850) consisted of a much more heterogeneous forest that included more complexity in age and stand structure. Prior to 1850, old-growth coast redwood forests appear to have been subjected primarily to frequent small scale disturbances, creating many small gaps and patches that lead to a highly irregular forest structures on a landscape scale. Stand replacing events that affected extensive areas appear to have been uncommon in the redwood forest. Dryer interior mixed conifer forests also naturally developed into a much more structurally diverse and heterogeneous forest type than created by historic harvesting practices.

Clearcutting and opening size: The average acreage of evenage harvest areas within a harvest unit will total 30 acres or less with no evenage harvest acreage exceeding 40 acres within a harvest unit. The total unit size (gross acres) may exceed 40 acres, but the net clearcut acres within a harvest unit will not exceed the limits specified above. Evenage harvest openings (i. e. evenage patches) within harvest units are expected to average approximately 15 acres based on an analysis of our recent harvest units. Green Diamond harvest units typically consist of a matrix of sub-units that include evenage patches separated by retention areas. The retention areas are primarily composed of RMZs where single tree selection or no harvest occurs. A small percentage of retention areas are made up of HRAs, geology areas, Special Treatment Areas and other no harvest or single tree selection areas.

Based on an analysis of the harvest units planned and operated pursuant to the AHCP, the average percentage of each unit that was managed for various retention purposes was 25%. Projecting this onto future harvest units with the additional retention to achieve at least 10% basal area equivalent retention in each unit, the average percentage retention is expected to be approximately 27%. On average, approximately 73% of the area within each proposed harvest unit will be managed using evenage silviculture.

The percentage of each harvest unit that is managed for retention is highly variable but follows two general trends related to elevation and distance from the coast. Harvest units that are closer to the coast tend to have a higher percentage of retention areas than units located further inland. Harvest units located at lower elevations tend to have higher percentage of retention areas than units located at higher elevations. This is a result of the dendritic pattern of the watercourse network on Green Diamond's lands that increases in density closer to the coast and at lower elevations, and the fact that retention areas are focused around the watercourses. Evenage harvest units that are at low elevations close to the coast may have 50% of the proposed harvest area associated with watercourse related retention areas. Conversely, high elevation inland units may not have any watercourse related retention areas.

This evenage management regime will create a mosaic of evenage openings that will develop into multiple age classes distributed as small patches across the landscape. Approximately 73% of the landscape will be occupied by small evenage stands; approximately 27% of the landscape will be in retention areas. The RMZ retention areas will be managed to promote the development of late seral forest characteristics. In addition, retained large old trees, hardwoods and snags provide structural elements needed for the nesting birds, cavity dwellers and roost sites (see TREE plan discussion below).

The timing restrictions of harvesting adjacent evenage harvest units shall conform to the California FPRs. No logical evenage harvest unit adjacent to a harvested even-aged harvest unit may be harvested unless the prior even-aged harvest unit has an approved CalFire report of stocking and the dominant and co-dominant trees average at least five years of age from the time of establishment on site, or the dominant and co-dominate trees average at least five feet tall and at least three years of age from the time of establishment on the site, either by planting or by natural regeneration. If the requirement to achieve adequate stocking is to be met with trees that were present at the time of harvest, there shall be a period not less than five years following the completion of operations before an adjacent even-aged regeneration harvest may occur.

TDWMP and the TREE plan: Green Diamond has had a landscape plan for retaining upland forest structure in even-age harvest units since the early 1990's. Prior to implementation of the NSO HCP in 1992, Green Diamond's staff wildlife biologist Dr. Lowell Diller worked with the forestry staff to develop guidelines for retention of forest structure within clearcut units. At that time, the goal was to retain snags, live culls, and scattered green trees or patches of trees within each unit. The 1992 NSO HCP incorporated very general tree retention guidelines developed during this period.

Following implementation of the NSO HCP, Dr. Diller continued to work closely with the forestry staff to determine what types of habitat elements provided the highest biological value and what distribution would be the most likely to persist on the landscape during and following harvest operations. The time from 1992 to 1999 was a learning period of informal experimentation and trial and error to find out the best combination of retention elements and distribution. Green Diamond also worked closely with Agency staff to develop working guidelines to address their concerns regarding retention of key habitat elements.

In 1999, Green Diamond worked with CDFW (formerly DFG) to adopt a set of working guidelines for tree retention that provided more direction than the general guidelines in the 1992 NSO HCP. These guidelines were referred to as Green Diamond's Terrestrial Deadwood Management Plan (TDWMP) and were based on the site-specific conditions found within Green Diamond's timberlands, the operations that were conducted there and the field experience of the forestry and biological staff. The TDWMP included detailed guidelines for the spatial distribution, type, and amount of retained structure to provide the best long term biological effect.

One of the key concepts that was identified and advanced as part of the development of the 1999 TDWMP was that scattered single retention trees were less likely to persist on the landscape than trees that were grouped. Trees that were grouped and located in a sheltered area were the most likely to persist and provide long term biological benefit. Green Diamond found that single retention trees tended to blow down and were difficult for equipment to work around and retain undamaged, especially in cable yarding areas. Single retention trees also sustained more damage during burning for site preparation. Grouped trees were less likely to blow down and could be avoided during operations and site prep. Retention trees grouped in sheltered areas or adjacent to other watercourse retention areas had the best chance of persisting on the landscape.

Dr. Diller continued to work with the forestry staff to study the implementation of the TDWMP and ensure that it was effectively providing the intended biological benefits. In 2005 the TDWMP was revised to provide additional direction on the retention of hardwoods and high value green wildlife trees. A summary of the TDWMP is provided below.

The key elements of the TDWMP were:

- In evenage harvest units with less than 15% retention area, some form of wildlife green tree retention is required. Retention may be in the form of Habitat Retention Areas (HRAs), tree clumps or scattered trees. Retention rates are 1 or 2 trees per clearcut acre, based on watershed and biologist prescription. Retention of HRAs is preferable in cable yarding areas. Retention of tree clumps is preferable in ground-based yarding areas. Retention of scattered trees is allowed where necessary.
- In evenage harvest units with 15% or more retention area, no additional wildlife green tree retention is required.
- In hardwood dominated stands (>50% hardwood basal area) that will be harvested with ground-based yarding systems, two of the largest hardwood trees will be retained per evenage acre harvested. Where these harvest units have large, scattered Douglas-fir

trees with significant internal decay and structural deformities, these conifers with marginal merchantable value will be retained.

- Retain all non-merchantable snags in harvest units unless they present a clear safety or fire hazard. Merchantable snags will only be felled if they lack evidence of internal rot and have no significant structural deformities.
- Retain a mix of conifers and hardwoods (approximately 50/50 mix where possible).
- Conifer species preference: Douglas-fir, hemlock, white fir, cedar, spruce, redwood. Hardwood species preference: tanoak, Pacific madrone, California laurel, chinquapin.
- The average DBH of retained trees should be equal to or greater than the average DBH of trees in the harvest unit.
- In all harvest units, all large trees (i.e. a conifer >36" dbh or a hardwood > 24" dbh) will be assessed for high value habitat characteristics using the TDWMP scorecard, and trees with a score of 7 or higher are candidates for retention.
- Retain all non-merchantable coarse wood debris in evenage harvest units.

In 2019, the Forest HCP replaced the NSO HCP and the TDWMP has been replaced with the Terrestrial Retention of Ecosystem Elements (TREE) plan. The TREE plan is a refinement of the TDWMP that provides additional direction and guidance on types, amounts and placement of retention elements. It is based on over two decades of scientific studies and operational experience on Green Diamond forest lands. It is designed to address the specific needs of the wildlife present on our lands and is tailored to the silvicultural and operational practices that we use. It is based on scientific study and the biological needs of the species present within our forests and will continue to be studied and updated as new information is developed. A summary of the TREE plan as implemented in each Green Diamond THP is provided below. A copy of the TREE plan is included in Appendix D.

Key features of the TREE plan are:

Conifer Dominated Harvest Areas (>15 mbf conifer per acre) with RMZ/Geo Retention:

- Retain all scorecard trees ≥7 (conifer ≥30" dbh; hardwood ≥18" dbh).
- Retain qualifying evergreen hardwoods at a rate of two trees per clearcut acre where they exist. These trees should be representative of the existing larger hardwoods in the stand, generally 12 inches dbh and larger. The goal is to retain the highest wildlife value hardwood trees with the least merchantable value. Retention may be as scattered trees or tree clumps that are distinct from RMZ/Geo retention areas.
- Hardwood scorecard trees also count towards the two trees per acre hardwood retention standard.

Conifer Dominated Harvest Areas without RMZ/Geo Retention:

- Retain all scorecard trees ≥7 (conifer ≥30" dbh; hardwood ≥18" dbh).
- In one tree per acre retention tracts (standard wildlife retention areas):
    - Retain one conifer per clearcut acre.

    - Retain two qualifying evergreen hardwoods per clearcut acre where they exist. These trees should be representative of the existing larger hardwoods in the stand, generally 12 inches dbh and larger.
- In two tree per acre retention tracts (special wildlife retention areas):
    - Retain one conifer per clearcut acre.
    - Retain two qualifying evergreen hardwoods per clearcut acre where they exist. These trees should be representative of the existing larger hardwoods in the stand, generally 12 inches dbh and larger.
    - If the combined retention of one conifer per acre and retention of all qualifying hardwoods does not equal at least 2 trees per acre, then additional conifers shall be retained to achieve a two tree per acre retention standard.
- The goal is to retain the highest wildlife value trees. Retention may be as scattered trees, tree clumps or HRAs that are distinct from RMZ/Geo retention areas.
- Hardwood or conifer scorecard trees also count towards the respective hardwood or conifer retention standard.

Hardwood Dominated Harvest Areas (<15 mbf conifer per acre and dominated by hardwoods) with RMZ/Geo Retention:

- Retain all scorecard trees ≥7 (conifer ≥30" dbh; hardwood ≥18" dbh).
- Retain qualifying evergreen hardwood trees at a rate of two trees per clearcut acre. These trees should be representative of the existing larger hardwoods in the stand, generally 12 inches dbh and larger. The goal is to retain the highest wildlife value hardwood trees with the least merchantable value. Retention may be as scattered trees or tree clumps that are distinct from RMZ/Geo retention areas.
- Hardwood scorecard trees also count towards the hardwood retention standard.

Hardwood Dominated Harvest Areas without RMZ/Geo Retention:

- Retain all scorecard trees ≥7 (conifer ≥30" dbh; hardwood ≥18" dbh).
- Retain 0.5 acre HRA or tree clumps totaling 0.5 acres.
- In addition, retain qualifying evergreen hardwood trees at a rate of two hardwoods per clearcut acre. These trees should be representative of the existing larger hardwoods in the stand, generally 12 inches dbh and larger. The goal is to retain the highest wildlife value hardwood trees with the least merchantable value. Retention may be as scattered trees or tree clumps that are distinct from RMZ/Geo retention areas.
- Hardwood scorecard trees also count towards the hardwood retention standard.

- Only trees located outside of RMZ/Geo retention areas count towards these retention standards.
- Retain all non-merchantable snags in harvest units unless they present a clear safety or fire hazard. Merchantable snags will only be felled if they lack evidence of internal rot and have no significant structural deformities.
- Conifer species preference for retention: Douglas-fir, hemlock, white fir, cedar, spruce, redwood.
- Hardwood species preference for retention: tanoak, Pacific madrone, California laurel, chinquapin.
- Qualifying evergreen hardwood trees consist of trees that are representative of the existing larger hardwoods in the stand, generally 12 inches dbh and larger. The goal is to retain the highest wildlife value hardwood trees with the least merchantable value. Retention may be as scattered trees or tree clumps that are distinct from RMZ/Geo retention areas.
- The average DBH of retained trees should be equal to or greater than the average DBH of trees in the harvest unit.
- In all harvest units, all large trees (i.e. a conifer ≥30” dbh or a hardwood ≥ 18” dbh) will be assessed for high value habitat characteristics using the TREE scorecard, and trees with a score of 7 or higher will be retained.
- Retain all coarse wood debris in evenage harvest units.

The TREE plan, like the previous TDWMP, specifies retention of snags, coarse woody debris and large trees with high value wildlife habitat characteristics (i.e. scorecard trees) within clearcut openings in addition to the RMZ retention areas. The primary difference between the plans is that the TREE plan places more emphasis on retention of hardwoods as dispersed elements in evenage openings, and reduces the size of “large” trees to be considered as scorecard trees, potentially increasing the number of scorecard trees retained. The following table is provided to compare the two plans.

TDWMP and TREE comparison.

TDWMP		
	<15% retention in evenage unit	≥15% retention in evenage unit
Conifer and hardwood retention	Retain 1 or 2 green trees/CC acre as HRA, tree clumps or scattered trees	No additional green tree retention
Scorecard large tree size: conifer >36" dbh or a hardwood >24" dbh		

TREE Plan					
	Conifer dominated unit (>15 mbf conifer per acre)			Hardwood dominated unit (<15 mbf conifer per acre)	
	With RMZ/Geo Retention	No RMZ/Geo Retention		With RMZ/Geo Retention	No RMZ/Geo Retention
	1 or 2 TPA tract	1 tree per acre tract	2 tree per acre tract	1 or 2 TPA tract	1 or 2 TPA tract
Conifer retention*	No additional retention	Retain 1 conifer per clearcut acre	Retain 1 conifer per clearcut acre	No additional retention	No additional retention
Hardwood retention*	Retain 2 hardwoods per clearcut acre where they exist.	Retain 2 hardwoods per clearcut acre where they exist.	Retain 2 hardwoods per clearcut acre where they exist. If hardwood count is <1 per acre, retain additional conifers to achieve total retention of 2 trees per acre	Retain 2 hardwoods per clearcut acre.	Retain 0.5 acre HRA or tree clumps that total 0.5 acres, and 2 hardwoods per clearcut acre.
*Scorecard trees are retained in all units where they exist. Hardwood or conifer scorecard trees count towards the respective hardwood or conifer retention standard. -Scorecard large tree size: conifer ≥30" dbh; hardwood ≥18" dbh -Hardwood retention trees should be representative of the existing larger hardwoods in the stand, generally 12 inches dbh and larger. The goal is to retain the highest wildlife value hardwood trees with the least merchantable value. Retention may be as scattered trees or tree clumps that are distinct from RMZ/Geo retention areas.					

Culmination of mean annual increment (CMAI): Green Diamond's allowable regeneration age of 45 years does not approach the *culmination of mean annual increment* (CMAI) for redwood or Douglas-fir. However, the actual average age of our evenage harvest units is anticipated to be approximately 59 years over the next 10-year period. This average age approaches CMAI for redwood and Douglas-fir. CMAI for Douglas-fir ranges from 60 years to >150 years of age depending on site classification. Likewise, CMAI for redwood ranges from 50 to >140 years of age depending on site. The best site class has the youngest CMAI. On some of Green Diamond's high site timberlands, or where evenage harvest has been delayed, individual stands will be at or exceed CMAI age at time of harvest. Green Diamond has also initiated a commercial thinning program that will thin several thousand aces per year. The reduced stand density with emphasis on tree spacing, combined with the retention of dominant and codominant trees will also improve growth. (See more detailed discussion below).

5.1.4.2 Seed Tree and Shelterwood Methods

The seed tree and shelterwood silviculture methods are forms of evenage management that involves the harvest of a stand in two or three steps and relies on the retention of seed trees to provide for natural regeneration through seeding. The seed tree method harvests most of a stand in one entry, leaving well distributed seed trees. The shelterwood method typically starts with a preparation step to harvest a portion of the stand and promote the development of full crowned wind-firm leave trees. This is followed by a seed tree step to harvest the remainder of the stand and leave seed trees. Under both methods, the seed trees are harvested after a fully stocked stand of regeneration has become established.

Green Diamond proposes limited use of the seed tree or shelterwood silviculture methods. The preparatory or seed tree step harvest may be used in areas where visual impact is a concern. Over the past ten years, the seed tree removal step has been utilized in limited areas where historic harvesting initiated this method or regeneration. These types of seed tree removal step harvests may continue in the future on a limited basis. Where seed tree removal harvests do occur, the green tree retention standards of the TDWMP and the pending TREE plan that apply to clearcut units also apply to these evenage regeneration units.

5.1.4.3 Commercial Thinning

Commercial thinning is the practice of harvesting selected trees from a young stand to create additional growing space for the remaining crop trees through reduced competition and to promote increased growth on the remaining trees. This allows for the release of the remaining crop trees by providing more light, and in some cases, more nutrients and soil moisture when they are limiting factors. On Green Diamond's forest lands the most significant limiting factor in a young forest is typically sunlight, but increased water also contributes substantially to growth. The trees that are selected for harvest are large enough to have commercial value.

History of Green Diamond's Commercial Thinning Program: Green Diamond's mission is to increase the value of our forests while assuring that we do not adversely impact the public trust resources. One way to increase the value of the forest is to improve the quality of the forest products that are produced. In a managed redwood forest, the highest commercial value wood product is redwood heartwood. The premium for redwood heartwood lumber may be 45% higher than common grades that include sapwood. There is a common understanding that larger diameter trees have more heartwood than smaller trees, however, it was uncertain if there were other important variables that factored into the production of heartwood in a redwood tree. Green Diamond completed a stem analysis study of heartwood production in redwood trees to determine if there was a relationship between heartwood content and environmental variables such as slope and aspect and tree variables such as age, live crown ratio, or log position. The study confirmed that tree diameter had the strongest relationship to redwood heartwood production of all variables considered.

The best way to increase redwood heartwood production in Green Diamond's forests is to control redwood stocking levels and stand density. Commercial thinning can be a very effective management tool to control tree density once timber stands have reached merchantable size. Thinning is not an appropriate treatment for all forest stands. Some stands are too old and the option for an economical commercial thinning has passed. Some stands are overstocked with Douglas-fir that will not respond well to thinning due to poor live crown development. Some stands are understocked with redwood and overstocked with hardwoods. The best opportunity for commercial thinning Green Diamond's forest stands is generally in young stands between 30 and 40 years old. Many of these stands were hand planted with redwood seedlings, and many units were pre-commercial thinned prior to 20 years of age.

Green Diamond began investigations into commercially thinning young, planted redwood forest stands around 2000 when the stands that were planted in the mid- 1960's to mid-1970's were 30 to 40 years of age. These initial thinning trials yielded positive results in terms of being able to economically thin a young stand and leave a healthy vigorously growing forest. However, there were few young stands available at that time to support an economically sustainable thinning program. In the years following this initial thinning trial, Green Diamond has: 1) implemented the FPS growth and yield model which allows for evaluation of diameter growth following partial harvesting; 2) established permanent growth plots that will be used to calibrate the model; 3) conducted stem analysis studies to determine heartwood characteristics of redwood trees; 4) reviewed silviculture systems to ensure that evenage management with commercial thinning will increase long term forest value; 4) continued to assess the age class distribution of our forests.

The culmination of this work has been the re-initiation of Green Diamond's commercial thinning program. In 2011, we commercially thinned approximately 74 acres of 30-year-old redwood forest in the Mad River drainage with positive results in terms of economic return and residual stand density and condition. We also conducted a focused on-the-ground review of thousands of acres of 30 to 45 year old forest to assess these young forests for the suitability of commercial thinning. Based on that review, we determined that we had enough young forests with suitable characteristics to support an economically sustainable commercial thinning program. From 2012 to 2016, we increased the acres thinned each year and expanded the geographic scope of the thinning treatments to include the Klamath operating area. In recent years we have commercially thinned between 2,000 and 4,000 acres per year.   We plan on continuing similar levels of commercial thinning operations in future years as markets and timber stand conditions allow. These operations will be reviewed and analyzed to ensure that this forest management activity is economically viable and results in positive post-harvest stand conditions.

Looking forward, commercial thinning on Green Diamond timberlands will continue to occur in stands that are about 30 to 40 years old that will benefit from this treatment and where the operations are economically viable. The thinned stands are monitored during and after harvest to ensure that the goals of the thinning prescription were met and to determine the appropriate time for the next harvest entry. The next harvest may be a second thinning harvest or a clearcut harvest.

Commercial thinning has other secondary effects to forest management in addition to promoting more heartwood in redwood and overall increased growth on the leave trees. Thinning a stand that is at or near our planned rotation age will also extend the final rotation age for that stand, leading to increased age diversity across the landscape. Thinning in redwood dominated stands will promote stump sprouts from cut redwood trees. Even though Green Diamond's current thinning practices maintain high canopy cover and are not intended to promote conifer regeneration, the redwood stump sprouts that are created as a result of thinning can survive as slow growing, or even suppressed trees in the understory. When the thinned stand is clearcut, some portion of these stump sprouts will likely persist in the harvested unit as older, larger regeneration that is released and provide an extra element of age, size, and habitat diversity in the regenerating stand.

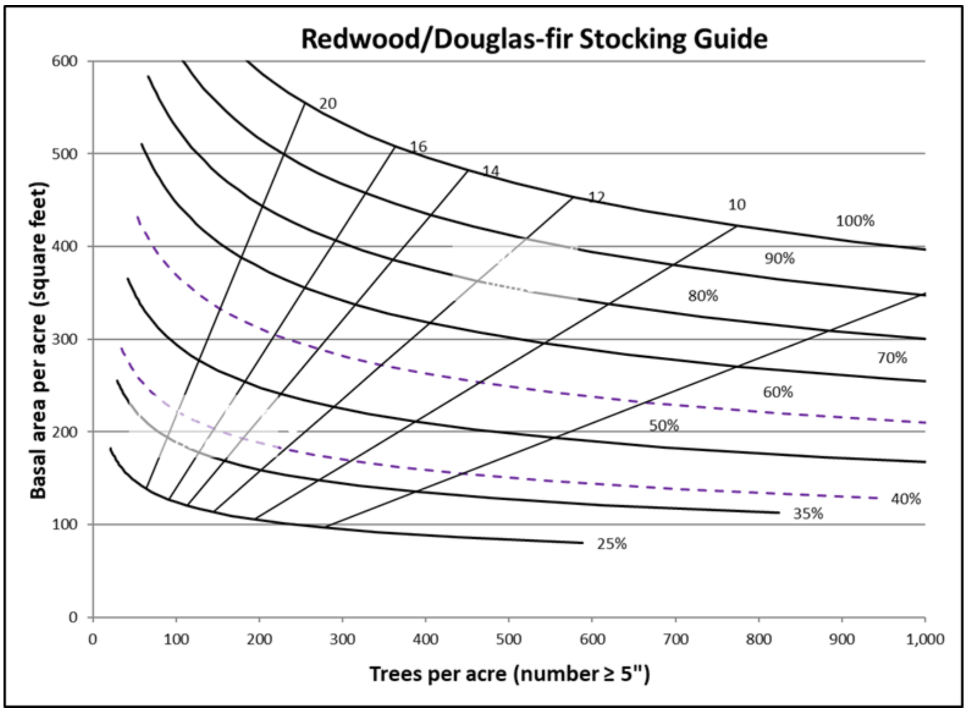
During the planning and design stage of a thinning harvest, Green Diamond's RPFs and professional biologists work together to ensure key resource protection measures and mitigations included in a final clearcut harvest also apply to intermediate thinning harvest. This harvesting activity will comply with all measures covered under the AHCP, FHCP and other programmatic permits and agreements. Green Diamond's goal is to ensure that important key resource values existing at the time of the thinning harvest are identified and protected to provide for a continuity of protection of sensitive habitats and habitat features throughout the harvesting cycles.

When individual timber stands are considered for thinning, an RPF conducts a site-specific analysis of the timber stand to determine if that stand should be thinned prior to rotation harvest. The RPF will assess stand characteristics such as stand age, species mix, trees per acre, basal area per acre, tree sizes, tree damage or defect, etc. to determine if reducing the stand density would be a benefit to the stand prior to planned rotation. One of the tools RPFs use for stand assessment is an ownership specific Redwood/Douglas-fir stocking guide (or density management diagram) that was developed by Green Diamond mensurationist Dr. Dan Opalach (retired). Dr. Opalach utilized decades of Green Diamond inventory data to build the stocking guide based on the Stand Density Index (SDI) work of Reineke (1933).

Reineke devised a measure of density by species that was independent of site index or age. He plotted DBH and TPA on a logarithmic scale for numerous stands of the same species. He used that data to develop a maximum density line for the 14 different species he studied based on actual field measurements of stands. That maximum density line represents the zone of imminent mortality due to competition and was considered maximum or 100% of potential stand density. The slope of the line for all 14 different species he studied was consistent at -

1.605. This allowed him to develop a constant density index for each species that he called Stand Density Index (SDI) based on an average DBH of 10". The maximum Reineke (1933) SDI for Douglas-fir is 600; the maximum SDI for redwood is 1000. Dr. Opalach's work set the max SDI for redwood at 774 based on Green Diamond's inventory data.

The SDI based stocking guide allows an RPF to quickly evaluate whether a stand is fully stocked, overstocked or understocked. It requires only stand basal area (BA) and trees per acre (TPA) to determine stocking levels and provides a guide of how much BA and TPA to retain in a commercial thinning prescription. An example of the Green Diamond stocking guide is provided below. The SDI management zone is generally between 40% to 60% SDI. At that level, a stand would be considered fully stocked for timber management. Young stands that are above 60% SDI are considered overstocked and would be good candidates for commercial thinning to reduce stand density. Stands that are under 40% SDI may be considered understocked for timber management and would not need to be thinned to control density.



There are multiple benefits to commercially thinning a stand other than increased heartwood production as described above. Benefits of reducing stand density by a thinning treatment include:

- Maintaining good diameter growth for the remaining trees.
- Capturing value of damaged or suppressed trees prior to tree mortality.
- Balancing tree growth and stand yield.

- Creating stand conditions that are more resilient to drought years and fire events.
- Reducing overall fuel loading and ladder fuel hazard.
- Creating a financial return prior to final harvest.
- Adjusting species mix prior to final harvest.

Our Commercial thinning prescription is adjusted for site specific stand conditions but follows some general guidelines:

- Consider thinning when stand conditions are over 60% SDI.
- Post-harvest target of about 40% SDI (less than 35% is considered below management zone – not fully utilizing the growing capacity of the site).
- In practice, use the Functional Approach to thinning by considering harvest from all size trees to provide increased growing space for the best growing trees.
- Leave the larger, taller, best growing trees to occupy all the available growing space.
- Harvest the merchantable trees that would otherwise compete with these crop trees.
- Consider tree spacing secondary to leaving a well-stocked stand with vigorous growing trees.
- Rule of thumb is to leave at least 150 to 200 TPA and at least 160 Sq Ft BA/Ac.
- RW is more tolerant of higher density than DF, so multiple RW trees per clump is ok and thin to provide space for individual DF tree canopies.

5.1.4.4 Selection

Selection harvest involves harvesting individual trees or small groups (less than 2.5 acres) of trees from a timber stand with the intention of retaining a stand of young to mature trees and promoting the regeneration of a new age class within the stand. The selection silviculture method is commonly referred to as a unevenage management method. Multiple harvest entries that occur over time are designed to create multiple age classes within the stand, either as an understory component or as patches of regeneration in the small openings. Harvest trees are typically selected from the largest and oldest trees in the stand. The goal is to promote the development of multiple age classes of trees within the stand, generally a new age class for each harvest entry. This system maintains a standing cover of young to mature trees across the harvested area. The period between harvest entries can be highly variable depending on management objectives.

Within Green Diamond's ownership, selection harvest is used where competing resource values take precedence over the higher timber production inherent in evenage management. Selection harvesting is the method used to promote the development of mature stands and individual trees within RMZs, geological sensitive areas and in locations where protection of other resource values is the foremost management factor. As indicated in the preceding clearcutting discussion, selection harvest on Green Diamond's forests is typically included as a subunit of a larger harvest unit that is a matrix of clearcut and selection harvest subunits. On average, approximately 25% of our harvest units are managed under the selection silviculture method. Areas designated for selection harvest are managed under that prescription for long periods to ensure the specific retention that is desired continues to persist on the landscape.

5.1.4.5 Rehabilitation of Under-stocked Areas (Rehab)

The Rehab silviculture method is a special silviculture prescription that is defined under the California FPRs. The purpose of this method is to restore or enhance the productivity of commercial timberlands that are under-stocked with native conifer species. This method may only be applied to stands that do not meet the minimum conifer stocking standards as prescribed in the FPRs prior to harvesting. These minimum standards may be met using the point count system as described in the FPRs or the minimum basal area standards of 85 sq. ft. of basal area per acre for site I lands or 50 sq. ft. of basal area per acre for site II lands or lower.

Green Diamond uses this special silviculture practice on a small percentage of its timberland to harvest hardwood dominated stands that do not meet the minimum state stocking standards. These harvest areas are then planted with native conifers suited to the site. The pre-harvest stands are generally dominated by tanoak and madrone and include scattered conifers, generally Douglas-fir. These stands are the result of historic harvesting where conifers were removed from conifer/hardwood stands and the sites were left to regenerate naturally. The intention is to reestablish the naturally occurring conifer/hardwood forest that existed prior to the historic harvest.

Although this harvest prescription is not subject to the evenage harvest restrictions of the FPRs, Green Diamond's policy is to treat this rehabilitation harvest similar to a clearcut harvest unit. All the tree retention standards of the TREE that apply to clearcut units also apply to rehab units. Green Diamond generally applies the size, separation and timing restrictions of clearcutting to rehab units, with some minor variances allowed for operational flexibility.

5.1.4.6 Salvage

The salvage silviculture method is used to harvest trees that are dead, dying or deteriorating due to damage from fire, wind, insects or other injurious agents. Salvage provides for the economic recovery of trees prior to the total loss of their wood product value. Areas that are harvested under this prescription may be stocked upon completion of harvest or may need to be replanted depending on the extent of the damage in the pre-harvest stand.

Green Diamond occasionally uses this prescription in areas that have been impacted by fire or windstorms. This prescription is also used in areas where bears have stripped the bark off trees and those trees are deteriorating. Bear damage occurs primarily to redwood trees and low levels of damage are common across the landscape in redwood stands. This prescription is generally used where significant damage has been identified in a localized area and where a salvage harvest would improve the overall stand conditions and forest health.

5.1.5 Hazard Abatement

Green Diamond uses hazard abatement treatments as part of its evenage management regime. Hazard abatement treatments may be used where accumulations of slash following timber harvesting create an unacceptable level of dead fuels. Hazard abatement activities are limited by weather conditions, state regulations, staffing, and markets for biomass. Because it is not feasible, desirable, or necessary for Green Diamond to conduct a hazard abatement treatment on every harvest unit, logging slash is often retained on site to naturally break down and decompose. For those harvest units to be treated, Green Diamond may use prescribed burning, machine piling, biomass harvesting, mastication, or a combination of these methods to modify fuel structure for hazard abatement and fire safety purposes. Slash developed on landings from whole-tree yarding and log-processing activities may be piled and burned on or adjacent to these landings.

Hazard abatement treatments occur as soon as possible after the completion of logging operations. Piling of logging slash may occur concurrently or following logging operations. If prescribed burning is required, it is generally scheduled within three years upon completion of timber harvesting. Prescribed burning can be facilitated using two main techniques:

- pile burning where piled logging debris and slash is burned during the winter period under appropriate burning conditions, or
- broadcast burning the harvest unit (excluding RMZs and other resource protection areas)

Currently, pile burning is the most common hazard abatement treatment utilized across the ownership. Piles of slash are typically created by shovel yarding equipment within harvest units or at cable yarder landings where they yard whole trees to the road or landing area. Operators are directed to leave legacy logs (left from past logging operations) and other large coarse woody debris out of the burn piles as they provide beneficial habitat elements for a variety of terrestrial animal species. The timing of prescribed burns is predicated upon temperature, wind, humidity, and fuel moisture conditions that will limit smoke impacts to populated areas and minimize escapes of fire outside the intended burn area. Well piled units and prescribed burning under ideal conditions also allow retention of large woody debris and the finer organic matter concentrated at the soil/litter interface. Ignition patterns are designed to keep fire from spreading into RMZs and equipment exclusion zones. Green Diamond greatly reduced the use of prescribed burning from 2004 to 2018 to comply with regional air quality enforcement, public perception, and Cal Fire initiating a cost recovery policy for nearly any response. Due to a positive shift in regulatory support (from both Regional Air Quality and Cal Fire) and a change in public opinion that supports prescribed burning, Green Diamond has progressively increased annually treated acres following logging operations.

Green Diamond has recently conducted Mastication trials as an alternative to burning for hazard reduction. Masticating slash piles, unpiled scattered and matted slash, and live standing fuels (from tree down to ground cover) have all been tested in specific areas and on segments of fire suppression ridges (Gibson Ridge, Sproul Creek tract). Trials indicated that the use of mastication can treat 2 to 4 acres per day. The high cost per acre, the slow rate of progress, and a short operating period (June - October) limits the use of mastication to very specific locations where the risk of wildfire is exceptionally high.

5.1.6 Biomass Utilization

Biomass harvesting techniques that Green Diamond's contract logging operators developed, refined, and implemented over the past ten years provided a successful and efficient alternative to pile or broadcast burning. In areas where slash and other logging debris is accessible to ground-based equipment and freight logical to co-generation facilities, some of the logging slash is removed from harvest units and landings as a hazard abatement treatment. Specialized harvesting equipment such as shovel logging machines equipped with slash tongs, articulated off highway dump trucks with low ground pressure capabilities, and high-capacity mobile slash grinders have been used to gather up and process previously unused woody material. The resulting chips are loaded into chip vans and delivered to nearby co-generation plants. The biomass that is harvested includes limbs, tops, chunks and slabs. All operational constraints associated with topography, seasonal restrictions, and resource protection and retention of important aquatic and terrestrial wildlife habitat elements are comprehensively followed where these operations occur. In addition, a residual layer of slash is retained throughout the unit to ensure that essential ground cover is present for erosion prevention, and operators are directed to leave larger cull logs and other coarse woody debris scattered across the units.

With the recent loss of markets for biomass fuel for electrical generation as well as fewer biomass facilities in operation than the 2010 era, harvesting and processing of excess logging slash is not currently a viable alternative for hazard abatement on the north coast of California. Green Diamond is pursuing new markets both locally and globally with the intent that biomass harvesting will one day again become cost effective.

5.1.7 Regeneration of Harvested Units

Evenage harvest units are regenerated using a combination of natural and artificial regeneration. Approximately 95% of evenage harvest units are planted or interplanted to ensure full site occupancy of native conifers. Units not planted have an excess of 1000 stems per acre of sprouting redwoods, 3 years following harvest. Tree planting involves hand planting nursery-grown seedlings and redwood clonal planting stock during the first winter following completion of harvesting operations in a unit. In general, the tree species selected for planting are chosen to best fit the site specific conditions of the area harvested. Green Diamond's objective is to get 100% of its regenerated stands in a free-to-grow condition by age ten. Monitoring surveys show that 94% of our timber stands are free-to-grow by age five. Appendix E provides additional information on the free-to-grow concept that is part of Green Diamond's evenage management strategy.

Areas dominated by redwood prior to harvest are planted primarily with redwood reforestation stock. Some areas that are well stocked with redwood stump sprouts are not planted or are only lightly interplanted to supplement the natural regeneration. Redwood planting stock is from clonal cuttings and seedlings native to the region, and is produced by Green Diamond at its containerized nursery in Korbel. Douglas-fir seedlings are grown from improved or native seed at Green Diamond's Korbel nursery or independent contract nurseries in California or Oregon.

Hardwoods are a natural component of the forest across much of Green Diamond's timberlands. Hardwoods are not replanted following regeneration harvest. Natural regeneration is sufficient to ensure a healthy hardwood component in the regenerated areas. Many common hardwood species such as tanoak, madrone and chinquapin vigorously resprout, and other species such as alder rapidly seed in following clearcutting. Excessive hardwood regeneration in evenage harvest areas is treated with herbicides to reduce competition with desired conifer regeneration. The goal is not total elimination of hardwoods from the regenerating forest, but to create an environment where conifer regeneration is free-to-grow, herbicide use is reduced over time, and results in a vigorous healthy young forest by age ten. Additional information on herbicide use is provided below, and Appendix E provides details on the free-to-grow concept that is part of Green Diamond's management strategy.

In hardwood dominated harvest areas where conifer stocking is low due to historic harvesting practices, conifers (either redwood or Douglas-fir depending upon site conditions) are planted to reestablish the natural conifer/hardwood forest. The intent is not to eliminate the hardwood component from the site, but to reestablish a more natural conifer/hardwood forest in place of the hardwood dominated stands created by past harvesting and lack of regeneration. In other locations on the ownership where elevation or growing site dictates, other native tree species such as ponderosa pine or incense-cedar may be selected for planting.

Green Diamond plants redwood in a limited number of evenage regeneration units where redwood has not previously grown on the site. Redwood grows naturally within short distances of these sites which have been carefully selected to have conditions appropriate for the growth of redwood. This regeneration practice is limited to the fringe of the known natural redwood zone. This practice extends the range of redwood upslope to ridge tops and drier sites where redwood has not historically occurred. These planted units also include a significant component of natural native regeneration including Douglas-fir, white fir, hemlock, tanoak, and madrone.

At ages one, two and again at age 4, Green Diamond surveys previously regenerated areas, and if necessary, schedules to plant additional trees. In addition to planting, it is common for natural regeneration to supplement planted seedlings; primarily by redwood sprout clumps but also Douglas-fir, grand fir, western hemlock, Sitka spruce, incense-cedar, pine, and red alder. Natural regeneration can come from a soil seed bank and also from retention trees left within the unit and adjacent stands. This natural process allows for a wide variety of species to establish within evenage harvest units.

5.1.8 Herbicide Use

Historic (pre-1970's) harvesting practices that did not include an effective conifer regeneration program have resulted in hardwood dominated forest stands, above natural levels throughout Green Diamond's ownership. Current harvesting and reforestation practices aim to restore conifer dominance in regeneration units, in addition to retaining and recruiting structural elements which are beneficial to wildlife as described in Appendix C: *Terrestrial Retention of*

Ecosystem Elements (TREE) Plan. To achieve maximum conifer establishment and growth in the shortest period of time, regenerated stands may receive a variety of herbicide treatments after they are planted. Herbicide treatments, where they are used, would generally be initiated within the first three years following harvesting. Trials have shown that we will use less herbicide over an acre, treating a small area around freshly planted seedlings, while providing a competition free growing environment for the planted seedlings. These treatments combined with genetically superior stock matched to the site allows the planted stock to potentially out compete brush in the initial establishment years. This in turn will avoid a higher per acre rate of chemical applied at ages 4 through 6, if needed. Competing brush is reevaluated at stand age 10-12 in which competition from both brush and unwanted conifers is mechanically removed with a chainsaw crews (5.1.9 Pre-Commercial Thinning projects).

5.1.8.1 Herbicides

A list of the herbicides and adjuvants used on Green Diamond's timberlands and methods of application is contained in Appendix F. These products are approved for forestry use and are registered by the California Department of Pesticide Regulation (CDPR) for use in forestry. In addition, the EPA is responsible for regulating the sale, distribution, and use of herbicides under the Federal Insecticide, Fungicide, and Rodenticide Act. Decisions whether to approve (register) an herbicide for sale or distribution are based on a risk/benefit standard that weighs risks to humans and the environment considering economic, social, and ecological costs and benefits from use of the product.

In accordance with the FSC Pesticides Policy (FSC-POL-30-001 V3-0 EN), Green Diamond uses Integrated Pest Management to avoid, or aim to eliminate, the use of herbicides in the FMU, and minimize risk to human health and the environment while maintaining economically viable management. Environmental and Social Risk Assessments (ESRA) have been prepared for all herbicides used as part of Green Diamond's forest management program. Consistent with the objectives of the FSC Pesticide Policy, Green Diamond's IPM plan defines risk management strategies when using chemical pesticides and demonstrates our strategy for reduction in volume and number of chemical pesticides. Please refer to the IPM plan for more information about Green Diamond's vegetation management program.

All herbicides are currently applied on Green Diamond lands by hand application methods. Herbicide use is governed by the manufacturer's label specifications, guidance provided by the EPA and the CDPR, and Green Diamond's own best management practices (BMPs). In addition, site-specific application requires:

(1) a written prescription/recommendation of a Pest Control Adviser (PCA),
(2) a map that identifies site-specific hazards within buffer zones, and when they are needed to avoid or minimize the risk of accidental exposure to potentially sensitive resources,
(3) supervision of a State-certified applicator, and
(4) reporting to the appropriate county agricultural commissioner.

The use of State-certified applicators that are subject to periodic inspections ensures that worker safety is given the highest priority. Green Diamond has very high confidence in the safety aspects of its vegetation management program because, to its knowledge, there have been no incidences of worker exposure to chemicals above and beyond what is acceptable according to the labels on the chemicals prescribed by Green Diamond.

Green Diamond has chosen to use herbicides to control the unwanted competing vegetation that occurs on its timberlands rather than non-chemical management alternatives because such practices are (1) prohibitively expensive and (2) have been shown to be ineffective controlling the problematic species that impact the growth and development of the conifer species during the establishment phase of stand regeneration. As stands are harvested and regenerated with improved planting stock, subsequent vegetation management treatments will result in reduced herbicide use in the next rotation due to the successful control of unwanted species in the current regenerative step.

Whether and how herbicide treatments may occur in an evenage harvest area depends upon the environmental conditions prior to harvest, the type of operations that occur, how the vegetative community responds to post harvest conditions, and the results of hazard abatement treatments in the unit. Following completion of operations in an evenage harvest unit, the unit is evaluated for the need and appropriateness of herbicide treatment under site-specific circumstances. Factors used in that evaluation include:

- The need for treatment based on the
    - species mix of the regenerating commercial trees in relation to other vegetation that may be competing with the regenerating crop trees
    - size of the commercial crop trees in relation to the competing vegetation
    - density of the commercial crop trees in relation to competing vegetation
- Any restrictions placed in the THP because of site-specific circumstances
- Costs and benefits of herbicide treatment under site-specific circumstances
- Aesthetic considerations
- DPR regulations and necessary permits
- Proximity of neighbors
- Existence of and proximity to downstream water supplies
- Non-chemical and no-treatment alternatives
- Nearby harvesting operations
- Any wildlife habitat and botany restrictions

Green Diamond currently applies herbicides to approximately one percent of its California ownership in any given year. This level of treatment is equivalent to 3,000 to 4,000 acres per year but can range as high as 9,000 acres not including the rehabilitation of areas significantly damaged by wildfire (Moore Tract; Slater Fire; 2020). Additionally, 50 to 100 miles of road rights-of-way may be treated annually to control invasive weed species such as Scotch broom and gorse. All herbicides are applied by hand crews; no aerial spraying is used. Methods typically include backpack sprayers and hack and squirt. Specific BMPS have developed to assist in this endeavor; refer to the IPM plan for more details.

Harvest units that are identified as potential candidates for herbicide treatment are placed into project schedules based on expected vegetation problems identified at that time of the evaluation. These schedules are developed for treatment activities for up to three years into the future, depending on the circumstances.

- Units where prescribed burning occurred are assessed for possible pre-emergent treatment and evaluated for needing one or more follow up foliar treatments.
- Broadcast site preparation treatments have been replaced with spot treatments (circles) around planted seedlings. This method has been shown in trials to provide the necessary control and reduce the amount of chemical applied to 10 times less than a standard broadcast application.
- Units with sprouting hardwoods are designated for one or more foliar treatments.
- Units with standing hardwoods are designated for hack and squirt treatments (if not treated prior to harvest).
- Units with grass and herbaceous competition are assessed for feasibility of pre-emergent treatments. These units receive the site preparation spot treatment application.

Units designated for pre-emergent treatment are normally treated within the next year following harvest, during the month of April following planting. Hack and squirt treatments may be conducted pre- or post-harvest and are scheduled to occur concurrently with foliar treatments, where feasible. Whenever possible, hack and squirt treatments of standing tanoak are prioritized over foliar treatment of tanoak stump sprouts to reduce the volume of herbicide used. All harvest units are examined again at two years of age and may be added or deleted from the foliar project schedules at that time. It is common for competing brush species to develop on the site from seed banks in the soil or seed blown in from adjacent areas. The final decision to use herbicide application is made during the growing season prior to the anticipated application date. At five years of age, all harvest units are again examined, and additional herbicide or manual brush cutting treatments are prescribed where needed. If there is doubt as to how the regeneration unit will develop, reassessment at some future date may be prescribed as an alternative to current treatment. Monitoring data is collected and used to prepare summary reports for foresters, supervisors, and managers. The data and reports are used for adaptive management.

Species that compete with commercial crop trees and are targeted by herbicide applications on Green Diamond lands generally include; tanoak, madrone, California bay, red alder, Ceanothus, manzanita, and coyote brush. In limited instances huckleberry, Rubus sp., maple, cascara, poison oak, grass and various herbaceous species such as thistles, cat's ear, dandelion, sorrel, and fireweed are also targeted. Permitted chemical pesticide use for managing competing vegetation is consistent with the FSC Pesticides Policy and is discussed in detail in Green Diamond's Integrated Pest Management (IPM) Plan. A summary of the IPM plan is provided in Section 5.1.8.2.

Green Diamond complies with all herbicide labeling conditions and applies the following BMPs during the ground application of herbicides:

- Adjacent landowners are identified and given prior notification of any application of chemicals. Adjacency is defined as anyone living within 300 feet of the spray area or immediately downstream (within 1000 feet) of the treatment area. Special considerations and cautions are implemented when a domestic water source is identified.
- Routine inspections by Green Diamond personnel will be conducted in addition to any County Agricultural inspections.
- Foliar treatments will not be conducted when wind speeds exceed ten miles per hour on the spray site.
- Standard WLPZ widths as defined in the Forest Practice Rules will be observed for Class I and Class II waters and will not be treated. A minimum untreated 50-foot buffer will be maintained on all flowing water (including Class III watercourses if they contain flowing water at the time of treatment). Brush that is over the channel or directly adjacent to the channel will not be sprayed on Class III watercourses that are dry.
- Unit marking or identification will be sufficient to identify the prescribed treatment area. If the unit marking does not sufficiently identify the prescribed treatment areas and associated areas where treatment is prohibited, the licensed contractor doing the application shall contact Green Diamond prior to application.
- Green Diamond's Botany department will review all proposed applications and rare plants will be protected as described in the associated Timber Harvesting Plan.
- Green Diamond's Wildlife department will review all proposed hack and squirt treatments and survey for sensitive wildlife, as necessary.
- Wildlife habitat will be retained in accordance with Green Diamond's Green Tree Retention Guidelines.
- If a restricted material is prescribed for use, the applicator shall have a copy of the permit and prescription for use on site, when working.
- A copy of Green Diamond's Spill Contingency Plan will be kept on site in case of an accidental spill of any hazardous materials.

Green Diamond restricts hand applications to areas greater than 20 yards from salmonid-bearing streams. This limitation is to remain consistent with the decision of the District Court in *Washington Toxics Coalition v. Environmental Protection Agency*, Case No. C01-0132C pending the Environmental Protection Agency's consultation with the National Marine Fisheries Service under the federal Endangered Species Act.

5.1.8.2 Integrated Pest Management (IPM)

In the context of Green Diamond's forest management practices, Integrated Pest Management (IPM) is an approach to the management of competing vegetation in our evenage harvest units that relies on a combination of common-sense practices. The IPM program applies current information on the life cycles of competing vegetation and how they interact with the environment to manage the unwanted vegetation by the most economical means, and with the least possible hazard to people, property, and the environment. The IPM takes advantage of all appropriate vegetation management options including the judicious use of herbicides.

Green Diamond's IPM program follows a four-tiered approach.

Set Action Thresholds - Before initiating vegetation management, Green Diamond foresters assess harvest units to determine if competing vegetation has exceeded action thresholds, a point at which environmental conditions indicate that action needs to be taken. Action thresholds vary depending on location and environmental conditions and professional judgment is an important element of the assessment. The level at which competing vegetation will become an economic threat is critical to guide vegetation management decisions.

Assess and Identify Target Species - Not all competing vegetation requires control. At low levels, some competing vegetation is innocuous, and may even provide beneficial effects such as ground cover to reduce erosion. Green Diamond's IPM program makes use of forester assessments to check for competing vegetation and identify species accurately, so that appropriate control decisions can be made in conjunction with action thresholds. This assessment and identification reduce the possibility that herbicides will be used when they are not needed or that the wrong kind of herbicide will be used.

Prevention - As a first line of vegetation control, Green Diamond's IPM program works to manage the harvest operations and hazard abatement to minimize the risk of competing vegetation from becoming a threat. Preventative methods can be very effective, cost-efficient, and present little to no risk to people or the environment. These actions include:

- **Reducing broadcast burning.** Green Diamond has found that broadcast burning has the potential to significantly increase the growth of competing vegetation in some watersheds. Green Diamond has significantly reduced its reliance on broadcast burning.
- **Reduce soil disturbance.** Green Diamond has shifted to shovel logging in ground based evenage harvest units and cable logging in many units that would be suitable for traditional tractor operations. This has significantly reduced exposed soil and minimizes competing vegetation.
- **Increased ground cover.** Green Diamond leaves significantly more slash on site than is typical in ground-based harvest units. Increased ground cover minimizes competing vegetation.
- **Planting 2-year-old stock.** Green Diamond plants large, healthy, 2-year-old clonal redwoods where possible. Planting 2-year-old stock accelerates site occupation and reduces the need for subsequent vegetation management treatments.

Control - If assessments, identification, and action thresholds indicate that vegetation management is required, and preventive methods are no longer effective or available, Green Diamond's IPM program then evaluates for the proper control method both for effectiveness and risk. Highly effective treatments with low environmental risks are considered first.

The evaluation for effectiveness includes cost consideration and environmental impact consideration. Most mechanical control methods, such as weed mats or weeding, are cost prohibitive in Green Diamond's forested environment and are not considered highly effective during the first few years at the seedling establishment stage because the treated weed species quickly re-establish themselves and overwhelm the stand of new conifers. Mechanical controls that would involve the use of heavy equipment or hand tools for scarification result in unacceptable levels of disturbance and in many cases encourage the germination of weed species from seed.

Hand application of chemicals to selected, targeted, unwanted weed species is a highly effective method with low environmental risk that is considered first for seedling establishment. This unit-specific approach, with a focus on selecting the right low-risk chemical to control those unwanted species that are impacting conifer development, minimizes risk to non-target species and potentially sensitive sites.

Once monitoring indicates that the seedlings are established and are large enough (sapling stage), a final treatment may be applied to weed species still competing for site resources. At this point manual cutting of the competing vegetation is often the most economical and preferred method of dealing with the competition.

The percentage of harvested acreage treated by herbicides has decreased markedly over the past several years. This reduction is due in part to the use of more effective and highly targeted herbicides that can be applied at an earlier stand age and eliminate the need for a second herbicide treatment. Green Diamond is working towards a future where herbicide treatments are largely phased-out where feasible and only rarely required to produce free-to-grow forest stands in the redwood zone. This future condition will be a result of Green Diamond's commitment to developing improved redwood clonal planting stock with significant gains in growth and performance on all sites capable of supporting redwood forests. Over time, as redwood becomes more uniformly distributed throughout future harvest units in the redwood zone, subsequent regeneration will largely be composed of redwood sprouts and the need for herbicide use for the purpose of releasing planted trees will be reduced. As improved performance of redwood clonal planting stock is realized, planted trees are expected to reach the free-to-grow height earlier than woods run seedlings and thus with less dependence on herbicide treatments to control unwanted vegetative competition.

5.1.9 Precommercial Thinning (PCT)

Precommercial thinning involves thinning dense, young forest trees by mechanical means, including cutting individual trees or mechanically sawing or chipping rows or groups of trees. PCT may occur in redwood sprout dominated units or naturally regenerated conifer stands starting at age nine or 10, and by age 15 to 20 the optimum time for a PCT to occur has generally passed. PCT is undertaken to remedy overstocked conditions in regenerated stands so that the remaining crop trees will achieve optimum diameter growth. Currently, Green Diamond does not remove pre-commercial stems from the site because they are too small to meet current merchantable standards. This operation is performed generally once in the life of a stand and only in those stands with an excess number of trees per acre. Although chainsaws are used to cut the non-crop trees, progress in the development of feller-bunchers may eventually lead to machines capable of executing this operation more efficiently and with less risk of injury to workers.

The pre-commercial thinning treatment, paired with improved reforestation planting stock, will aid in achieving a reduction in herbicide use over time. As stands trend away from hardwood dominance and are planted with improved Douglas-fir seedlings and top performing redwood clonal planting stock, planted trees are expected to achieve free-to-grow status within the first five years, thus reducing the need for herbicide treatment and shifting the density management strategy to manual release (i.e. PCT).

5.2 Harvest Operations

5.2.1 Felling and Bucking Timber

Green Diamond utilizes a combination of hand fallers and mechanical feller-bunching machines depending on site conditions and the season of operations. Trees may be felled and bucked into logs or left tree-length and processed into log lengths at a landing. Log lengths are specified for each harvest unit based on tree species and mill destination. Feller-bunchers are structurally similar to tracked excavators. Using an articulated attachment, they grab, cut, and bunch the trees with others trees or logs for subsequent skidding to the landing. Feller-bunchers that are more complex have “processor heads” to delimb and buck trees into logs. Some of these machines have tracked undercarriages and self-leveling mechanisms so they can operate on moderate to steep slopes and winch assist machines have the ability to safely work on nearly all slopes. Their wide track design and ability to travel on top of forest debris (limbs and chunks) minimize soil disturbance and compaction.

5.2.2 Ground Based Yarding

Ground based yarding traditionally involves using tractors or rubber tired skidders to skid logs to a landing. These machines grasp the log using either powered grapple attachments or wire rope winch lines and drag the logs along a skid trail to a road edge. They typically require constructed skid trails to operate. Green Diamond limits the use of this traditional “tractor” yarding technique to road rights-of-way, partial harvesting units where standing trees prevent shovel logging (as described below) or other unique circumstances where other yarding methods are not feasible.

Green Diamond’s standard method of ground based yarding is shovel logging. Shovel logging is accomplished using a specifically designed hydraulic heel-boom log loader (i.e. a shovel loader) to pick up and swing logs from a harvest unit to the road edge. Shovel yarding machines resemble an excavator equipped with a log loading boom and grapple. These machines are specially designed for working in harvest units and provide more off-road mobility because they have additional horsepower and are mounted on wide-tracked undercarriages with high ground clearance. The shovel machine travels off-road through the harvest unit and systematically picks up felled logs and swings them towards the truck road by lifting the logs and rotating the upper structure of the machine.

Shovel logging machines do not have a blade and do not require the construction of skid trails to move logs. Shovels have wide tracks with low ground pressure that operate on top of the residual slash and over stumps. This provides significant additional resource protection by minimizing soil compaction and ground disturbance. Shovel logging machines may have technologies such as self-leveling cabs, taller grousers (traction blades), or winch assist for safer operations and improved traction on steep slopes. Improved traction increases operator safety and reduces overall ground disturbance by reducing track spin or churning. Green Diamond prefers to use shovel logging wherever feasible rather than tractor or skidder logging; however, shovel yarding is not feasible in commercial thinning units.

5.2.3 Cable Yarding

Cable yarding uses a yarding machine and wire ropes to move logs to from the harvest unit to a truck road or log landing. A yarder has several powered drums filled with wire rope, and a vertical tower or leaning boom that elevates the cables as they leave the machine. There are typically three to eight wire rope guy lines that hold the tower in position. Green Diamond utilizes cable yarding systems where the ground is too steep for traditional shovel logging.

Skyline yarding systems are the primary cable yarding systems used on Green Diamond lands. Harvest units and road locations are carefully designed and engineered by foresters to ensure that the cable yarding systems will operate efficiently and with a minimum of ground disturbance. Skyline logging uses a skyline cable that extends from the top of the tower to an anchor point beyond the edge of the logging area. This anchor is usually a stump or a suitable tree at the perimeter of the logging unit located to provide the necessary skyline elevation. Choker cables are used to attach logs to a drop line that leads to a carriage that rides on the skyline. Certain areas are yarded using a grapple carriage consisting of a large mechanical grapple which clamps around one or more logs in place of chokers. The yarder pulls the carriage to the landing with its mainline. Recent updates to the Forest Practice Rules allow for the use of self-leveling and winch assisted shovels and feller bunchers in certain cable yarding areas. The specialized shovels and feller bunchers are used to arrange felled trees into bundles which creates a safer and more productive work environment for choker setting or grapple yarding.

Depending on the skyline variant used, the yarder lowers the skyline to attach the logs and then raises it for lift, or the carriage can unwind its own skidding line and then lift the logs towards the skyline. Either way, the yarding system typically provides enough lift to suspend the uphill end of logs above the ground. When carefully designed and planned, full suspension of logs across key control points can be accomplished. Green Diamond uses skyline cable yarding systems extensively throughout the ownership, which minimizes overall ground disturbance and mid-slope road building.

5.2.4 Helicopter Yarding

Helicopter yarding typically occurs when steep and/or unstable terrain or lack of road right-of-way prevents road construction for ground based or cable yarding systems. Helicopter yarding utilizes a cable attached to a winch (called a “drop line”) that extends from the bottom of a specially designed helicopter. The helicopter flies from a log landing area to the harvest unit and hovers over the logs to be removed. Chokers are used to attach the logs to the drop line and the helicopter lifts the logs from the harvest area and flies them to the log landing area. The logs are released from the drop line using a remote release mechanism, and the helicopter flies back to the harvest area to pick up more logs. This yarding system requires large landings to safely accommodate log drop zones, log sorting and decking areas, and truck loading areas during peak production hours. Helicopters also require a large separate service landing to allow for a safe zone to land for refueling and maintenance. Helicopter yarding is rarely used on Green Diamond lands because most of the lands are accessible by roads that support standard logging operations.

5.2.5 Cut-to-Length Operations

Cut-to-Length (CTL) operations are conducted using highly specialized machines that includes a felling unit, called a harvester and a yarding unit, called a forwarder. Both these machines have large flotation tires equipped with traction chains and are articulated for maneuverability. After the harvester falls the tree, the specialized cutting head then de-limbs and manufactures logs. The yarding unit (the forwarder) then follows the felling operation using a grapple arm to load the logs on to bunks on the back of the machine and transports the logs to the truck road. The forwarder then unloads the logs and returns to the hillside for another load. When a log truck arrives, the forwarder uses the grapple arm to load the log truck. We use the CTL system in commercial thinning operations and have worked with regulatory agencies and Cal Poly Humboldt analyzing experimental winter operations for potential impacts. Results demonstrate the CTL operations are suitable for winter operations with minimal ground disturbance or soil compaction.

5.3 Roads

5.3.1 Road Construction and Reconstruction

Green Diamond constructs new roads subject to approval under the THP process. New road alignments are designed and engineered by foresters to access harvest units. The roads are designed to facilitate the yarding methods appropriate for the site and to address short and long term transportation needs of the property. Road design specifications are included as part of individual THPs and programmatic agreements (AHCP, roads WDR, MATO). The proposed road alignments are delineated on the ground with flagging and paint prior to construction. Road construction starts with felling and yarding the timber along the road right-of-way. Excavators, dump trucks and tractors are used to build the road prism, excavating or filling hillslope areas to create the desired grade and alignment. Where roads cross watercourses, culverts, bridges, and occasionally fords are installed according to the specifications in the THP. Road construction may include vehicle turnouts and log landings that are wide spots used for yarding and decking logs and loading log trucks. Road construction may also involve surfacing roads with rock, dust treatments (such as lignin or magnesium chloride), pavement, or other surface treatments approved by NMFS and USFWS under the AHCP/CCAA.

Green Diamond road construction falls into three broad categories:

- Permanent roads that are surfaced with rock to provide a stable surface for year-round use and have crossings sized to pass a 100-year flow event.
- Seasonal roads that are native surfaced suitable for dry season use and have crossings sized to pass a 100-year flow event.
- Temporary roads that are planned for a single season of use and either avoid crossing watercourses or utilize temporary crossings sized to pass the flow at the time of use. Temporary roads are abandoned as per the FPRs upon completion of operations.

Road reconstruction is the process of restoring or improving an existing road to be reused for timber harvesting operations. Roads that require reconstruction are generally not usable in their current condition. The reconstruction process usually involves substantial changes to the original road prism. Roads are reconstructed using the same general standards as new road construction.

5.3.2 Road Upgrading, Decommissioning and Maintenance

Road upgrading involves improving road drainage and watercourse crossings that do not meet current road standards. Road upgrading typically includes upgrading culverts to current specifications, installing additional drainage structures, hydrologically disconnecting the road from watercourses, improving road surface drainage, installing critical dips, and stabilizing unstable fill and cut slopes.

Road decommissioning includes removal of all watercourse crossing structures, removal of fill materials, reestablishing a natural watercourse channel at the crossing, shaping the slopes at crossings to the approximate natural slope contours, providing for long term maintenance free road surface drainage, and pulling back excess road fill where there is a significant risk of failure that would deliver to a watercourse. Green Diamond employs two types of decommissioning depending on the intent of future reuse: 1) Temporarily decommissioned roads are those roads that may be used again in the future (typically unused for 20 or more years); and 2) Permanently decommissioned roads are those roads that will not be needed for future management activities and typically includes roads that were constructed on unstable slopes or within or adjacent to riparian zones.

Road maintenance typically includes surface grading, clearing bank slumps, repairing slumping or sliding fills, clearing ditches, repairing or replacing culverts and bridges, adding surface material, dust abatement, and installing or replacing surface drainage structures. Road maintenance may include mechanical control of roadside vegetation. Mechanical control may include grading, hand cutting or pulling, using a brush buster-type mechanical device, burning, steaming, other experimental methods, etc. Herbicide use for control of roadside vegetation is generally used only to control invasive plant species.

5.3.3 Rock Pit Development and Use

Rock pits or borrow pits are locations where rock outcroppings are blasted and the rock is excavated, sorted, stored and sometimes crushed. The resulting rock materials are used as road surface material, road fill, or rip-rap bank stabilization materials. Development of rock pits on Green Diamond lands provides ready access to the material needed to minimize potential erosion associated with roads and watercourse crossing. Activities associated with rock pits include loading trucks with rock, hauling mined rock, and constructing and maintaining rock pit access roads. Rock pit development and use is subject to the conservation measures of the AHCP and FHCP. These areas are also surveyed for rare plants, and archeological investigations are conducted prior to development. Working with our staff geologist we have also identified rock sites with asbestos content and avoid their use to prevent exposure.

5.3.4 Water Drafting and Storage

Water drafting involves the direct drafting of stream flow into a water truck. Storage involves diverting water using gravity fed systems that provide it directly to storage reservoirs or tanks to load water trucks. These trucks then periodically apply this water to roads for dust abatement, road maintenance, construction, and surfacing, or to control prescribed fuel reduction burning or wildfire. This use of water for road watering provides for the development of a firm stable road surface that minimizes the potential for erosion. Development of water drafting sites and the act of drafting water is subject to the conservation measures of the AHCP and MATO. These conservation measures regulate the amount of stream flow that may be diverted from a watercourse and the type of drafting device that is used. Drafting sites are screened to prevent entrapment of aquatic animals during water drafting.

5.4 Chain-of-custody control from stump to log purchaser

Green Diamond uses a trip ticket system to track logs from individual harvest units to the delivery destination of the log purchaser. A trip ticket is generated by the loader operator for each load of logs that leaves a log landing. The trip ticket includes basic information about the load of logs including date, log truck number/driver, loader operator, and also includes a source code that identifies where the logs came from and a destination code for the delivery of the logs. The source code is made up of the Green Diamond THP number, the unit identifier and a number to identify different operators or type of operations that produced that load of logs from the unit. A source code book or database is maintained that links the source code to harvest plan and operator/operations information.

Green Diamond has established accounting systems and reporting procedures to ensure that trip tickets accurately and reliably track the movement of logs from the woods to the purchaser of the logs. Trip tickets are generated by an electronic handheld computer that obtains the source code from the log accounting system and is administered by the Senior Accounting Clerk in the Finance and Accounting Department, who also keeps the source code book up-to-date. A log accounting coordinator in the Green Diamond Finance and Accounting Department tracks the delivery of logs from the harvest units to the various log purchase destinations via the trip tickets. The log accounting coordinator reports back to the Operations Department regarding log deliveries, sort accuracy, log quality and other parameters. The Finance and Accounting Department conducts internal audits and is audited annually by an independent third-party auditor.

5.5 Carbon Projects

Green Diamond's California Timberlands Division currently has three projects approved by the California Air Resources Board (ARB). These projects are designed to reduce Green House Gas (GHG) emissions and provide for enhanced carbon sequestration. Each of the projects is an Improved Forest Management project managed in compliance with the ARB's Compliance Offset Protocols. The Cap-and-Trade Regulation, which appears at sections 95801 to 96022 of Title 17, California Code of Regulations, include offset protocols and provide a set of rules that establish the compliance offset program and the methods for quantifying GHG emission reductions and enhanced sequestration. Each of these projects puts in place forest management practices that result in decreased timber harvest and increased carbon retention in the form of trees retained on the landscape. The increased carbon retention is translated into carbon credits that Green Diamond can sell in various carbon markets. The ARB monitors each of these projects in terms of timber harvest that occurs within the project boundary, carbon credits sold, and maintenance of carbon within eh project area to meet the project commitments.

Humboldt Mixed Forest Improvement Project (CAFR6339; CAR1339):

This project was initiated in 2019 and approved by the California Air Resources Board in 2021. The project area includes 33,218 acres and is composed of about 1,000 timber inventory stands. These stands are spread out from the Klamath River south into the Mad River watershed. Each stand included in the project area was classified in Green Diamond's inventory system as a hardwood dominated "Low Conifer Stocking" stand. These are timber inventory stands that were 45 years or older, had less than 15,000 board feet per acre of conifer volume and were dominated by hardwood trees at the time of the carbon project initiation. On average, the project area is composed of approximately 52% tan oak, 30% Douglas-fir, 3% redwood, 3% alder and 3% madrone. Although the project area is spread out over multiple tracts, about 63% (approx. 21,000 acres) of the project area is within the Bald Hills Tract (Tract 51).

The project area will be managed to maintain forest cover, increase stand age, and increase Douglas-fir stocking relative to tan oak stocking through planned rehabilitation treatments. Annual forest growth from trees in the project area is available for harvest or as carbon credits. Stand improvement will be accomplished by identifying timber stands in the project area for harvest and then replanting the harvested areas with Douglas-fir seedlings to increase the overall occupancy of Douglas-fir. Harvesting is monitored annually to ensure that the carbon stocking baseline is maintained, plus the carbon stocking that makes up any carbon credits sold is maintained. No harvest occurred in the project area during the first reporting period of the project (ending October 31, 2019). A summary of the harvest volume for reporting periods 2, 3 and 4 is provided below.

- 2020 reporting period 2 – harvest about 425 acres in the project area across 45 units; 5,125 mbf or about 35,000 MtCO2e.
- 2021 reporting period 3 – harvested about 310 acres in project area across 24 units; 3,416 mbf or about 22,700 MtCO2e.
- 2022 reporting period 4 – harvested about 303 acres in project area across 28 units; 4,777 mbf or about 32,000 MtCO2e.

Willits Woods Improved Forest Management Project (CAFR5170; CAR1140):

Green Diamond purchased the Willits Woods tract in 2022. The Willits Woods Forest Improved Forest Management Project was initiated by the previous landowner on 12/22/2003 as a voluntary carbon project. It has been successfully verified and is currently an active project under the Air Resources Board. The project area is comprised of 17,682 acres of timberland within the larger 18,662 acre Willits tract. The project area is comprised primarily of well stocked productive forest stands with small areas of brush land, grasslands and rock outcroppings. Primary conifer species are Douglas-fir (26%) and redwood (24%). The principal hardwood species is tanoak (37%) with a mixture of madrone, true oak, California laurel, and other California hardwoods (13%). There has been no commercial harvesting in the tract since 2004. Limited chemical treatment of hardwoods to promote conifer growth was conducted by the previous owner. The reduction in timber harvesting during this period had the combined effect of increasing the overall age of the forest by increasing rotation ages and increasing the stocking of trees on understocked areas of the project area.

Lord Ellis Improved Forest Management Project (CAFR5378; ACR378):

Green Diamond acquired the Lord Ellis project area as part of the larger New Forest Acquisition in 2023. The Lord Ellis project is an improved forest management project under the California Air Resources Board Compliance Offset Program. The project is roughly 1,933 acres in size and has been in existence since 2016. It has been successfully verified and is currently an active project under the Air Resources Board. Logging was first initiated in 1960 to harvest mature Douglas-fir trees and very limited harvest has occurred in the past 20 years. On average, the project area is currently composed of approximately 17% Douglas-fir, 60% Tanoak, and 23% other species (alder, bay laurel, western hemlock, big leaf maple, madrone and others). The elevation range is approximately 750 to 2600 feet. The project area will be managed to increase stocking and extend rotation ages by deferred harvest in the short term and application of harvesting practices that will reduce tanoak occupancy and increase Douglas-Fir occupancy in the long term.

Section 6 - Conservation Planning

Green Diamond has undertaken several watershed- and ownership-level planning efforts to protect terrestrial and aquatic species and supporting habitat that meet or exceed State standard rules and regulations. These planning efforts are designed to address the State of California's mandates of enhancing timberland productivity, and protecting endangered species, timber resources, and related environmental values. The planning efforts also seek to reconcile those mandates with Green Diamond's management objectives and the unique regulatory, environmental and productivity conditions on Green Diamond's ownership. Green Diamond believes that our practice of even-aged management is key to implementation of these other landscape management plans, including the Green Diamond Forest HCP (FHCP, see below), and achievement of maximum sustained production on Green Diamond's lands under Option (a).

6.1 Environmental Limitations

The primary environmental limitation to managing Green Diamond's California timberlands is the protection of numerous listed plant, fish and wildlife species and their habitat. Listed species include state species of special concern, threatened or endangered species under the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA), California Board of Forestry sensitive species, and plants with California rare plant rank. Potential impacts to biological resources are considered as part of the environmental review of Green Diamond's proposed projects. Also, the Final EIS for the AHCP and the FHCP included a thorough analysis of the potential impacts to these species that may result from the implementation of forest management as proposed under the AHCP and FHCP. Complete lists of species are included in AHCP's final EIS (*Table 3.5-3 Plant Species of Special Concern*, and *Table 3.6-1 Wildlife Species of Special Concern*) and FHCP.

Protection of water quality is also a significant environmental limitation or area of concern associated with the management of California forestland. Section 303(d) of the Clean Water Act requires states to develop a list of impaired water bodies where water quality standards are not being met by the existing legally required pollution control mechanisms. The 303(d) list includes the pollutant causing the impairment. Placement of a water body on the 303(d) list triggers the development of a Total Maximum Daily Load (TMDL) that addresses the relevant pollutant for that water body.

The U.S. Environmental Protection Agency (EPA) has adopted a TMDL for sediment, turbidity and/or temperature for the Klamath River, the Trinity River and South Fork Trinity River, Redwood Creek, Mad River, Elk River, Eel River and the Van Duzen River. North Coast Regional Water Quality Control Board staff are in the process of establishing a TMDL for Freshwater Creek. The Klamath TMDL specifically recognizes the Green Diamond AHCP for its measures to address temperature and sediment.

Green Diamond is addressing this issue through Best Management Practices (BMPs) as presented primarily in the AHCP and related Roads WDR and MATO. The AHCP's main focus is on sediment reduction primarily from roads and details a process of road assessment and treatment that involves one of three outcomes: 1) temporary road decommissioning, 2) permanent road decommissioning and 3) road upgrading. The sediment savings from this activity for high and moderate sites from 2007 through 2022 was 1.349 million cubic yards.

6.2 History of Green Diamond Permits, Management Plans and Agreements

On September 17, 1992, the USFWS approved the NSO HCP on Simpson Timber Company California Timberlands and issued an associated Incidental Take Permit. Green Diamond, the successor to Simpson Timber Company, implemented the NSO HCP on all its northern California timberlands from 1992-2019, terminating its implementation upon approval of the FHCP.

The NSO HCP was approved with a 30-year term and a comprehensive review scheduled to occur after the first ten years of implementation. The purpose of the ten-year review was to enable Green Diamond and the USFWS to evaluate the efficacy of the conservation measures in the NSO HCP. Intensive research conducted by Green Diamond during the first ten years of the NSO HCP resulted in creation of sophisticated, site-specific models of habitat utilization and habitat fitness for NSOs on Green Diamond's lands. That research also revealed that the dusky-footed woodrat is the primary prey species for NSOs on Green Diamond's lands, and that spotted owls benefit from habitat that provides a mature timber nesting stand with adjacent young forests where woodrats thrive. The research revealed that certain no-harvest Set Aside areas established by the NSO HCP for spotted owl conservation purposes were seldom used while other sites within and adjacent to Set Asides were more important and contributed to productivity of NSOs. At the end of the ten-year period, USFWS and Green Diamond scientists also recognized a new, significant threat to NSO survival and recovery in the form of the progressive influx of barred owls onto Green Diamond's lands. Under NSO HCP amendments approved by USFWS in 2007, Green Diamond initiated research on NSO and barred owl interactions that demonstrated the need for urgent action to manage barred owls, as recommended in Recovery Actions 22, 26, and 28-30 of the USFWS 2011[1] Revised Recovery Plan for the NSO.

The comprehensive NSO HCP ten-year review identified certain ineffective and inefficient conservation measures and strategies, and other conservation measures and strategies requiring adjustment, addition or improvement. In consultation with the USFWS, Green Diamond considered extending the NSO HCP term and adjusting its NSO conservation measures based on extensive site-specific research done to date. Green Diamond also identified opportunities to build on conservation measures provided in Green Diamond's AHCP to conserve additional terrestrial species that are found on Green Diamond timberlands and may be listed under the ESA in the future. As a result, with USFWS support, Green Diamond chose to prepare the new FHCP that uses valuable information developed in implementing the NSO HCP, establishes an improved NSO conservation program, and provides a conservation program for other terrestrial species.

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[1] USFWS (U.S. Fish and Wildlife Service). 2011. Revised Recovery Plan for the Northern Spotted Owl (*Strix occidentalis caurina*). U.S. Fish and Wildlife Service, Portland, Oregon. xvi + 258 pp.

In 2007, the USFWS and NMFS approved the AHCP for management of Green Diamond's core northern California timberlands. The AHCP targets aquatic species and resource conservation and provides substantial protection of riparian forest stands and geologically unstable areas, resulting in little or no timber harvest in substantial portions of Green Diamond timberlands. By the end of the 50-year AHCP permit (2057), approximately two thirds of the riparian reserve acreage will consist of the dominant and co-dominant trees in the 51-100 year-old age class, with the remaining third over 100 years-old. This provides a well-distributed network of forest habitat trending toward late seral habitat benefiting all aquatic species covered by the AHCP and many other forest species. Accordingly, the AHCP riparian zone management is included in the FHCP conservation program.

For planning and management purposes, the FHCP is the terrestrial species counterpart of the AHCP, with a substantially equivalent term and Plan Area. For Green Diamond, the FHCP is a management tool that builds on and complements the AHCP to conserve covered species in both aquatic and terrestrial forest ecosystems located on Green Diamond's core California timberlands.

Development of Green Diamond's Road Management Waste Discharge Requirements (Road WDR) and Property Wide Programmatic Lake and Streambed Alteration Master Agreement for Timber Operations (MATO) followed the approval of the AHCP in 2007. Both the Road WDR and MATO were approved in 2010. These agreements were necessary to fully implement the non-THP related management components of the AHCP, specifically the road management elements. In 2012, the California Regional Water Quality Control Board, North Coast Region, approved a report of waste discharge (ROWD, Order R1-2012-0087) for Green Diamond's forest management activities on its California Timberlands. The Forest WDR complements the Roads WDR by providing complete, programmatic, ownership-wide waste discharge coverage to Green Diamond for lands under the AHCP.

In addition to implementation of the primary guiding documents of the NSO HCP, AHCP and FHCP, Option (a), the Marten SHA, other Conservation Planning agreements pertaining to aquatic, terrestrial wildlife, botanical resources, water quality and watershed management have developed over time, primarily in response to the THP review process. Green Diamond has taken a proactive approach to work with the responsible agencies reviewing THPs and identify reoccurring resource management issues. Green Diamond is committed to working with these responsible agencies to work out agreements that address their concerns and allow for a streamlined THP review process. A summary of the agreements is provided in the following sections.

6.3 Current Management Permits

Green Diamond currently manages and operates its California commercial timberlands according to the AHCP and the FHCP as briefly summarized below. Both documents are available to the public and have undergone public review as part of the EIS review process.

Aquatic HCP and Consistency Determination

The *Aquatic Habitat Conservation Plan and Candidate Conservation Agreement with Assurances* (AHCP) was prepared to conserve habitat for and mitigate impacts on six aquatic species: Chinook salmon, coho salmon, steelhead (and resident rainbow trout), coastal cutthroat trout, tailed frog and southern torrent salamander.

Green Diamond has implemented an operating conservation program pursuant to the AHCP that is based on the following biological goals and objectives:

- Maintain cool water temperature regimes that are consistent with the requirements of the individual species,
- Minimize and mitigate human-caused sediment inputs,
- Provide for the recruitment of LWD into all stream classifications so as to maintain and allow the development of functional stream habitat conditions,
- Allow for the maintenance or increase of populations of the amphibian Covered Species in the Plan Area through minimization of timber harvest-related impacts on the species,
- Monitor and adapt the Plan as new information becomes available, to provide those habitat conditions needed to meet the general goals that benefit the Covered Species.

The operating conservation program includes specific conservation measures to achieve the goals and objectives. The key conservation measures that affect timber operations include the following categories:

- Riparian Management
- Slope Stability
- Road Management
- Harvest-related Ground Disturbance

The complete list and exact wording of all conservation measures is included in Section 6.2 of the AHCP. Subsequent to the review and approval of the AHCP, the California Department of Fish and Wildlife (DFW), previously California Department of Fish and Game (CDFG) reviewed the AHCP for compliance with California laws and regulations and issued a Consistency Determination that included minor modifications to the AHCP conservation measures. Those modifications have been amended into the AHCP and incorporated as part of the conservation measures. A brief summary of the key conservation measures in these four categories is provided below.

Riparian Management – Key conservation measures include:

- Establishing Riparian Management Zones (RMZs) of specified widths and each with an inner and outer zone along all Class I and II watercourses, as summarized in Table 5;
- Requiring the outer zone of Class I RMZs to be extended, where necessary, to cover the entire floodplain and, depending on slope, an additional 30-50 feet beyond the outer edge of the floodplain;

- Requiring the inner zone of Class I RMZs to start at the outer edge of a Channel Migration Zone (CMZ);

Table 5. Watercourse classes and minimum buffer widths.

Watercourse Class	Further Subdivisions	Total Width per side	Inner Zone Width	Outer Zone Width
Class I	None	150 ft RMZ	50-70 ft	80-100 ft
Class II	II-2	100 ft RMZ	30 ft	70 ft
	II-1	75 ft RMZ	30 ft	45 ft
Class III	IIIA	30 – 50 ft EEZ	NA	NA
	IIIA Modified	30 – 50 ft EEZ plus tree retention	NA	NA
	IIIB	50 ft EEZ plus tree retention	NA	NA

- Establishing Equipment Exclusion Zones (EEZs) of specified widths along Class III watercourses (see Table 5), and designating Class I and II RMZs as EEZs except for the limited circumstances identified in the Plan;
- Allowing only a single harvest entry into Class I and II RMZs over the term of the Permits;
- In Class I and II RMZs, requiring at least 85% overstory canopy closure in the inner zone and 70% in the outer zone, prohibiting the harvest of trees that contribute to maintaining bank stability, requiring the retention of all safe snags, limiting salvage activities, and requiring mulching and seeding of ground disturbances larger than 100 square feet; and
- In Class I RMZs and within the first 200 feet of Class II RMZs adjacent to Class I RMZs, prohibiting harvest of trees that are judged likely to recruit to the watercourse.

For lakes and wetlands larger than one acre on areas covered by the AHCP, GDRCo will apply AHCP Class I protection measures. The AHCP Class I measures are in full conformance to the Pacific Coast Regional indicators under the FSC standard for Category A streams and for lakes and wetlands larger than one acre. For lakes and wetlands smaller than one acre on areas covered by the AHCP, GDRCo will apply AHCP Class II-1 protection measures. The AHCP Class II-1 measures are in full conformance to the Pacific Coast Regional indicators under the FSC standard for Category C streams and for lakes and wetlands smaller than one acre.

Slope Stability – Key conservation measures include:

- Training all RPFs who write THPs for Green Diamond to identify landslides and unstable areas and to understand the Slope Stability Measures and the implications of various timber management scenarios for landslides and other unstable areas.
- Identifying in THPs: a) all steep streamside slopes (SSS) leading to Class I or II watercourses; b) all headwall swales; c) all historically active to active deep-seated landslides; and d) historically active to active shallow rapid landslides;
- In THP areas with identified SSS, establishing an SSS zone of specified widths, each comprised of an inner Riparian Slope-stability Management Zone (RSMZ), an outer RSMZ, and a Slope-stability Management Zone (SMZ);
- In the Coastal Klamath and Blue Creek HPAs, prohibiting harvesting in the inner and outer RSMZs;
- In all HPAs except Coastal Klamath and Blue Creek, prohibiting harvesting in inner RSMZs and requiring 85% overstory canopy retention in outer RSMZs on Plan Area lands with Class I or II-2 watercourses; and requiring 85% overstory canopy retention in inner RSMZs and 75% in outer RSMZs on Plan Area lands with Class II-1 watercourses;
- In all HPAs, limiting harvesting in an SMZ or headwall swale to one entry during the term of the Permits and prohibiting harvesting 25 feet upslope from an active deep-seated landslide; and identifying single tree selection as the initial silvicultural prescription in SMZs and headwall swales;
- In all HPAs, prohibiting harvesting 25 feet upslope of shallow landslides without a geologic review; and
- In all HPAs, requiring Green Diamond to avoid road construction in SSS zones and field verified headwall swales, where feasible, and across active deep-seated landslide toes or scarps or on steep (greater than 50% gradient) areas of dormant slides except as approved by a PG and a RPF with experience in road construction in steep forested terrain.

Road Management – Key conservation measures include:

- Conducting a detailed assessment of road-related sediment sources in each of 58 sub-watershed road work units (RWUs) that encompass the existing road network on Green Diamond’s fee owned lands in the Plan Area, with the order in which the RWUs are assessed based on a ranking of their biological, geomorphic, and road-related features.
- Prescribing and implementing erosion control and erosion prevention measures in connection with the decommissioning or upgrading of roads at each site where treatable sources of erosion are identified, including but not limited to measures such as road surfacing, dispersing runoff into stable vegetated filter areas, armoring with rock rip-rap, end hauling waste material to stable locations, constructing dips and waterbars, mulching, and revegetating disturbed surfaces.
- Prioritizing sites for treatment as “high,” “moderate” or “low” based on (a) projected volume of future sediment delivery; (b) treatment immediacy; and (c) treatment cost-effectiveness;
- Implementing the prescribed treatments at all “high” and “moderate” sites within the term of the Permits;

- Adhering to the time-of-year restrictions identified in the AHCP for road work and use of roads and related facilities in the Plan Area;
- Requiring that log hauling, road decommissioning, road upgrading, road construction, and use of landings cease, regardless of the time of year, if any portion of a road or landing would result in runoff of waterborne sediment in amounts sufficient to cause a visible increase in turbidity in any ditch or road surface that drains into a Class I, II, or III watercourse.
- On fee-owned lands and harvesting-rights areas where Green Diamond has exclusive road-use rights, conducting inspections and implementing repairs and maintenance of mainline roads, roads appurtenant to THPs, secondary roads, and roads not yet decommissioned in accordance with the schedules and standards identified in the Plan;
- Requiring that maintenance and repairs be prioritized based on treatment immediacy, with the goal being to complete all priority tasks prior to the winter period.
- Requiring that, where feasible, new roads be located on or close to ridge tops or on benches where the road prism can be built with the least soil displacement and be constructed in accordance with the standards identified in the Plan;
- Classifying new roads that are designed for a single-use in a THP as temporary and decommissioning such roads upon completion of operations;
- Limiting width of new roads to 16 to 18 feet of running surface for mainline roads and 14 to 16 feet for secondary and temporary roads, with a combination of outsloped and crowned roads plus inside ditches where appropriate and occasional turnouts.
- Limiting the final grade of new roads to no more than 15%, except to avoid unstable slopes, steep slopes, inner gorges, inner gorge crossings, or to access a suitable watercourse crossing location, as measured in minimum 100-foot increments.
- Designing all new permanent watercourse crossing culverts to handle a 100-year return interval flow event without overtopping;
- Conducting emergency inspections of all accessible rocked roads in the affected area if a storm occurs that produces three inches of precipitation or more in a 24-hour period, and prioritizing and scheduling repairs so they are accomplished as soon as possible.
- Requiring that water drafting from Class I or II watercourses, impoundments, and gravity-fed water storage systems conform to the pumping rates and screen design specifications in the Plan;
- Prohibiting the use of herbicide mix trucks in direct drafting of water from any watercourse;
- Prohibiting the establishment of new rock quarries and borrow pits within Class I or II RMZs or the use of an existing rock quarry or borrow pit within 150 feet of a Class I, 100 feet of a Class II-2, or 70 feet of a Class II-1 watercourse;
- Requiring that rock quarrying, rock extraction from borrow pits, and hauling not result in a visible increase in turbidity in watercourses or hydrologically connected facilities that discharge into watercourses; and
- Training foresters, field supervisors, and equipment operators to conduct road decommissioning, road location and design, road construction, road upgrading, and road maintenance in accordance with the measures of the Plan.

Harvest-related Ground Disturbance – Key conservation measures include:

- Adhering to the time-of-year restrictions identified in the AHCP for mechanized site preparation, ground-based yarding, skyline and helicopter yarding, and skid trail construction and reconstruction;
- Requiring that all site preparation operations be designed to limit the amount of ground and forest floor disturbance to that which is required for fuel reduction and reforestation operations;
- Designing prescribed fire operations to produce low intensity burns; limiting fireline construction, reconstruction, and use within RMZs and EEZs; and requiring that firelines not in an RMZ or EEZ have drainage facilities adequate to prevent the delivery of sediments to RMZs or EEZs;
- Implementing erosion control measures in RMZs or EEZs in areas disturbed by felling, bucking, and yarding activities;
- Prohibiting the use of ground-based yarding systems that require constructed skid trails on slopes over 45%, unless greater soil or riparian zone disturbance would be expected from cable yarding;
- Prohibiting the use of ground-based yarding or skidding equipment in RMZs or EEZs adjacent to Class I, II and III watercourses, except for the limited circumstances identified in the Plan; and
- Requiring that field trials of mechanized equipment for silvicultural operations not be conducted unless the Services are provided with documentation that the equipment will not cause compaction or soil displacement measurably greater than the equipment or methods previously used.

Road Management WDR (RMWDR) and the Property Wide Programmatic Lake and Streambed Alteration Master Agreement for Timber Operations (MATO)

Implementation of the AHCP requires an ownership wide approach to managing sediment from the Green Diamond road network. In order to accomplish this ownership management approach, Green Diamond entered into two permitting processes that provide a means to comprehensively manage roads on an ownership wide basis, rather than on a THP basis only. Green Diamond collaborated with DFW and the NCRWQCB to develop a programmatic Master Agreement for Timber Operations (MATO) and a Road Management Waste Discharge Requirements (RMWDR) that apply to the AHCP.

The MATO and RMWDR enable Green Diamond to implement the comprehensive Road Management Plan under the AHCP. There are two key components of the AHCP Road Management Plan:

- Road Implementation Plan and
- Road Maintenance and Inspection Program

The objective of the Road Implementation Plan is to carry out a systematic road upgrading and decommissioning program using the AHCPs road assessment and prioritization system. The AHCP compartmentalizes the Green Diamond ownership into Road Work Units, or groupings of sub-watersheds. These Road Work Units were prioritized using a ranking system that provides the greatest sediment reduction and greatest conservation benefits. Green Diamond will schedule road assessments based on the prioritization of the Road Work Units. The road assessments will identify and prioritize road repairs sites as high and moderate sites. High and moderate sites are identified based on the likelihood of failure and delivery of sediment to a watercourse with high aquatic habitat values. Road upgrading and decommissioning treatments will be planned according to the road assessment results.

The Road Maintenance and Inspection Program requires (1) annual inspections and maintenance of all mainline roads and roads appurtenant to THPs and (2) inspections on a 3-year rotating schedule for secondary roads within Routine Maintenance Areas. The Road Maintenance and Inspection Program will keep upgraded roads at low risk for water quality and biological impacts and will prevent and minimize catastrophic and chronic sediment sources on roads pending upgrading or decommissioning.

The MATO and RMWDR also apply to roads in THP units and appurtenant to THPs. These roads will be assessed following the same AHCP road assessment procedure. Each THP will provide a list of road sites that are identified as imminent risk of failure sites and prioritized for treatment, either upgrading or decommissioning. The THP will also list road sites that will be monitored and list new installation sites. In most instances, road work at sites prioritized for treatment in a THP will be conducted the year the THP is approved, or in the following year, depending on when the THP was approved.

Those THP sites that are not identified for immediate repair will be inspected annually during the life of the inspection period for the THP. Following the inspection period for the THP, the sites will be inspected according to the six-year maintenance schedule identified in the AHCP Road Maintenance and Inspection Program. The MATO and RMWDR provide programmatic regulatory coverage for THP-related sites as well as for non-THP related sites in a comprehensive approach that provides consistency in application of measures and procedures as well as efficiency and flexibility in operations and regulatory reviews.

As part of the MATO and RMWDR, Green Diamond has agreed to develop and submit an Annual Work Plan to DFW by March 1 of each calendar year and to NCRWQCB by March 31 each calendar year. The Annual Work Plan describes all planned road activities for the current operational year. The Annual Work Plan will include specific information for each road repair site including a description of the current site condition, and a detailed work plan for the site. DFW and NCRWQCB will review the planned activities and notify Green Diamond if additional information is needed before commencing operations. A copy of the Annual Work Plan will also be submitted to Cal Fire and made publicly available at the Fortuna office. The Annual Work Plan can be revised/amended at any time with written concurrence from DFW and the NCRWQCB. Such revisions will be submitted to Cal Fire and made available at the Fortuna office.

The AHCP was designed to manage Green Diamond's road network by systematically and efficiently upgrading, decommissioning and maintaining roads to achieve the greatest conservation benefits using a landscape-based approach. Green Diamond has agreed to spend

$2.5 million per year (2002 dollars) for the first 13.5 years of the implementation of the AHCP to accelerate the repair of high- and moderate-priority road sites (based on the revised estimate of future sediment yield). The MATO and RMWDR provide flexibility and a process to identify sites across the landscape that provide the greatest conservation benefits by: (1) fixing sites with the greatest potential sediment savings and maximum benefit to aquatic species and water quality across the entire ownership and (2) establishing a lower priority for repairing those sites with low risk of failure by addressing them at a time when the road is upgraded, decommissioned or the risk of failure of the site becomes elevated.

Forest Management WDR

The Forest Management Waste Discharge Requirements (FMWDR) were adopted by the NCRWQCB in October of 2012. The FMWDR applies to the AHCP covered area. The objective of the FMWDR is to provide Green Diamond with a comprehensive landscape approach to manage sediment from harvest operations. This is similar in concept to the RMWDR and MATO previously discussed. Prior to the adoption of the FMWDR, the NCRWQCB issued general WDRs for individual Green Diamond THPs. The implementation of this landscape WDR will allow Green Diamond THPs within the AHCP covered area to operate under a consistent programmatic permit basis, rather than under separate permits issued THP by THP.

The majority of legacy sediment sources are associated with roads. These sites are addressed as part of Green Diamond's RMWDR. The RMWDR requires systematic treatment of road related sediment sources across Green Diamond's ownership independent of timber harvest plans. Other legacy sediment sources, such as those located up-slope on skid trails, are less conducive to a property wide inventory due to the challenges of evaluating them across a vast acreage. These non-road legacy sediment sources are evaluated, inventoried, and addressed concurrently with timber harvest plans as part of the FMWDR. The inventories are included in each pertinent THP and sites are treated prior to completion of the THP.

In addition to treatment of non-road related sediment sources, the FMWDR included specific conditions for operations on Green Diamond property in Elk River. All THPs in Elk River must adhere to Green Diamond's Elk River Management Plan (ERMP, formerly South Fork Elk River Management Plan) described below In Section 6.5. Green Diamond revised the ERMP in August 2019 to include additional measures to address the recently approved TMDL Action Plan upon further discussions with the Regional Board staff.

The Action Plan for the Upper Elk River TMDL was approved by the State Water Resources Control Board on August 1, 2017, by the California Office of Administrative Law on March 8, 2018, and by the federal EPA on April 4, 2018. On February 6, 2020, the Regional Board adopted a new Order that supersedes the provisions of the FMWDR that apply to the Upper Elk River and establishes revised requirements for Green Diamond's Forest Management Activities conducted within the Upper Elk River Watershed. Green Diamond has challenged this new Order and is currently engaged with the Regional and State Board to resolve the matter. Approved THPs can continue to operate under the existing Elk River plan; however, new THPs will have to adhere to the additional RMZ buffer measures included in the newly approved WDR.

The monitoring and reporting elements of this permit are addressed in Section 7 of this Management Plan.

Marten Safe Harbor Agreement

The *Marten Safe Harbor Agreement (SHA)* was prepared to conserve habitat for and mitigate impacts to the Humboldt marten. One of the key goals under the California State Safe Harbor Agreement Program Act is conserving, protecting, restoring, and enhancing endangered, threatened, and candidate species, is their habitat. The purpose of the Act is to establish a program that will encourage landowners to manage their lands voluntarily to benefit endangered, threatened, or candidate species and not be subject to additional regulatory restrictions as a result of their conservation efforts. The program is designed to increase species populations, create new habitats, and enhance existing habitats and not reduce existing populations or habitat below the baseline established in the agreement.

Key management actions under the SHA as *summarized* below include:

Management Actions

Management Actions are activities conducted on the Enrolled Lands that are reasonably expected to provide a net conservation benefit for the Covered Species within the Enrolled Lands. The Management Actions to be conducted under this Agreement include:

Assisted Dispersal Commitments

- Green Diamond shall provide financial and technical support for a marten assisted dispersal (MAD) feasibility analysis conducted by CDFW.
- Green Diamond shall provide financial and technical support for capture and assisted dispersal of marten based on the recommendations of the MAD feasibility analysis completed under Commitment 1.
- Green Diamond shall provide financial and in-kind technical support to monitor collared martens in recommended release areas.
- Green Diamond's financial commitment to the assisted dispersal project shall include funding of up to a total of $245,000, which may be disbursed over a period of up to five years following the commencement of the assisted dispersal analysis.

Habitat Management Commitments

Green Diamond shall develop a training program to educate employees and contractors on implementation of this Agreement on an annual basis. The training program shall include a summary of marten biology, habitat use and the management actions within this Agreement.

- Green Diamond shall implement measures as currently defined under the federally approved Aquatic Habitat Conservation Plan (AHCP) for Green Diamond Timberlands or as modified through federally approved adaptive management under the AHCP on all Enrolled Lands except those not covered by the AHCP.

- Green Diamond shall implement the TREE Guidelines for Green (Live) Tree and Snag Retention on all Enrolled Lands (Attachment 4) in THPs, Exemptions and hack and squirt projects.
- Green Diamond shall establish a 127,217- acre "Marten Special Management Area" for the Covered Species located between the known occupied marten sites east of the Klamath River that supports an extant population of the Covered Species, and the state and federal parks to the north, west, and south of the MSMA.
- Within the Special Management Area, Green Diamond shall establish a 2,098- acre "Marten Reserve Area" in Del Norte County where the Covered Species are known to occupy an area of serpentine habitat within the Green Diamond Enrolled Lands.
- Within the MSMA and the Moore Tract, Green Diamond shall incorporate into THPs a prescription for retention of downed large woody debris to enhance structural complexity, foraging, denning, resting and escape cover benefitting marten.
- Within the MSMA and the Moore Tract, Green Diamond shall incorporate into THPs a prescription for harvesting practices that creates slash piles to benefit marten occupancy through increased structural complexity, cover, resting and denning habitat.
- When Green Diamond discovers or is made aware of natal or maternal den structures used by marten, as determined by radio telemetry and camera monitoring through its own or cooperative efforts as part of the assisted dispersal project, Green Diamond shall retain these den structures on the landscape and incorporate tree retention around the den structure during and post timber harvest operations.
- When conducting vegetation management activities such as herbicide application and manual treatment of brush with chainsaws, Green Diamond shall conduct the following procedures to protect habitat retained to benefit marten:

Forest HCP and Consistency Determination

The northern spotted owl is listed as threatened under the Federal ESA and California ESA. Since surveys for northern spotted owls were initiated on Green Diamond lands in 1989, over 200 northern spotted owl nest sites or activity centers have been identified throughout its ownership in northern California. Green Diamond currently complies with measures contained in its FHCP and associated Implementation Agreement that provide for the legal incidental take of northern spotted owls in connection with timber harvesting and management operations.

Habitat management and nest site protection measures are implemented primarily through the THP process. Green Diamond uses its FHCP to guide the development of individual THPs. Timber harvesting is planned and implemented to: (1) protect spotted owl nest sites during the nesting and fledging season; (2) maintain suitable foraging, roosting, and nesting habitat on Green Diamond's property; and (3) accelerate the development of replacement habitat following harvesting.

Surveys for spotted owls are conducted as required in the FHCP. Banding and monitoring of spotted owls is conducted to facilitate population estimates and to gather additional demographic information. Green Diamond established 44 dynamic core areas (DCAs) for the protection of NSOs as part of the FHCP. These DCAs are no harvest areas designed to avoid take and promote occupancy and reproduction in the most productive NSO sites on the ownership.

The FHCP and associated ITP was issued by the USFWS on June 13, 2019 and on August 30, 2019, the California Department of Fish and Wildlife found the conservation program to be consistent with the requirements of the CESA under Section 2080.1 of Fish and Game Code.

Green Diamond's FHCP replaced the NSO HCP based on:

- Experience implementing the NSO HCP
- The results of research and monitoring performed pursuant to the NSO HCP
- The opportunity to build on the conservation measures in the AHCP/CCAA to conserve additional terrestrial species

The FHCP establishes a conservation program for the NSO based on the best available scientific data, and a new conservation program for three terrestrial mammals, which could be listed under the ESA in the future (fisher, Sonoma tree vole and red tree vole).

The FHCP conservation measures are designed to be a comprehensive conservation program for the four covered species on Green Diamond timberlands. The FHCP covers the same area managed under the AHCP.

Green Diamond developed an operating conservation program guided by five biological goals with corresponding biological objectives that reflect in biological terms the intended result of the proposed conservation program. The specific biological goals of the FHCP are to:

- **Promote Habitat Mosaic Across the Plan Area:** At the landscape scale, provide for well-distributed, high-quality habitat for the Covered Species with added emphasis on dynamic protection for highly productive NSO nesting sites. The habitat will develop from and be maintained by a mosaic of older Riparian Management Zones (RMZs) and other mature stands interspersed with patches of young growth stands regenerated by timber harvesting.
- **Retain and Recruit Targeted Habitat Elements:** Provide for the retention and recruitment or development of targeted habitat elements necessary for nesting, breeding or denning of NSO, fisher and tree voles.
- **Minimize Harm to Individual NSO, Fisher and Voles:** Minimize disturbance to NSOs during the nesting season, minimize disturbance to fisher in known occupied dens, prevent drowning of fisher through accidental entrapment in water tanks, and minimize direct felling of trees in RMZs bearing active or remnant vole nests. Also, cooperate in fisher capture and relocation/recovery projects provided that individual animals are protected from harm and the animals removed are not essential for sustaining the fisher population in the Plan Area.
- **Barred Owl Research:** Conduct a series of barred owl removal experiments to ensure the maintenance of a well distributed population of NSOs throughout the Plan Area.

Ultimately, this goal will allow attainment of all NSO objectives while still allowing for the persistence of some barred owls in portions of the Plan Area.

- **Compliance, Validation, Monitoring and Adaptation:** Provide resources and structure for accountability and compliance. Gather additional data to refine and validate the NSO and fisher habitat models supporting transition to a landscape conservation plan based on habitat management. Monitor and adapt the Plan as new information becomes available to provide habitat conditions needed to meet the general goals benefitting the Covered Species.

The operating conservation program includes specific conservation measure commitments to achieve the goals and objectives. The key conservation measure commitments that affect timber operations include the following categories:

- Landscape management commitments
- Habitat element commitments
- Covered Species protection commitments

A summary of the key conservation measure commitments in these three categories is provided below.

Landscape management commitments

- Green Diamond will incorporate conservation measures into all THPs that provide long-term retention and recruitment of late seral habitat elements that are beneficial to NSOs, fisher and tree voles.
- Green Diamond will incorporate RMZs into THPs. RMZs will provide a dendritic network of intact forests that will become increasingly older throughout the life of the Plan. Approximately 25% of the Plan Area will be in RMZs that will increase from the current average stand age of 44 years to an average of 94 years. Plan and implement timber harvests to create or enhance habitat heterogeneity in a dynamic pattern across future landscapes; provide retention of older forest stands within a matrix of regenerating younger forests; and retain key habitat components
- Establish a set of 44 Dynamic Core Areas distributed throughout the Plan Area to ensure that there will be areas capable of supporting NSO pairs with high site occupancy and fecundity.

Habitat element commitments

- Plan and implement THPs to include group and individual tree retention in harvest units in conjunction with the TREE plan.
- Green Diamond will retain trees with larger diameters and the highest quality existing structure first, followed by lower biological quality trees. Special consideration for retention is also given to specific conifer and hardwood trees that possess existing structure such as den or nest cavities.

- Green Diamond will make a concerted effort to retain all snags (defined as a standing dead or mostly dead tree) within harvest units unless they constitute a clear safety or fire hazard.
- Green Diamond will retain all non-merchantable Coarse Woody Debris (CWD) within harvest units.

TREE Guidelines for Green (Live) Tree and Snag Retention

A. Candidate Tree Selection:

- Retain large defective residual trees using the TREE's tree retention scorecard
- Retain defective or poorly formed trees, e.g., animal damaged, forked top, broken top, mistletoe broom, etc.
- Retain a mix of conifers and hardwoods (approximately 50/50 mix where possible)
- Retain conifer species preference: Douglas-fir, hemlock, white fir, cedar, spruce, redwood
- Retain hardwood species preference: tanoak, Pacific madrone, California laurel, chinquapin
- Consider protection from wind-throw and site preparation burning when designating HRA and tree clump locations
- Retain trees with the average diameter equal to or greater than the average diameter of trees in the THP area

B. Retention Guidelines – Evaluate the method and level of tree retention needed within each THP unit as follows:

- Conifer Dominated Harvest Areas[2] with RMZ Retention:
    - Retain all scorecard trees ≥7
    - Retain other evergreen hardwoods at a rate of two trees per clearcut acre where they exist

- Conifer Dominated Harvest Areas without RMZ Retention:
    - Retain all scorecard trees ≥7
    - Retain other conifer at a minimum rate of one tree per clearcut acre.
    - Retain other qualifying evergreen hardwoods at a rate of two trees per clearcut acre where they exist. If the unit lacks hardwoods to meet minimum retention standards, require retaining an additional conifer up to two trees per acre if harvest unit is in a one or two tree per clearcut acre retention area.
    - Retention should be a combination of approaches (HRA, tree clumps or scattered trees). HRAs are typically prescribed in cable yarding areas since this type of clumped retention is more practical in these areas. Trees retained in Streamside Management Zones (SMZ) and Class III Tier B areas count toward overall tree retention.

[2]Forest stands with >15,000 board feet of conifer per acre.

- Hardwood Dominated Harvest Areas[3] with RMZ Retention:
    - Require retention of all hardwood dominated areas at a level of at least two trees per clearcut acre regardless of the watershed
    - Retain all scorecard trees ≥7
    - Retain scattered or clumped evergreen hardwood trees at a rate of two trees per clearcut acre and also retain conifer trees scoring ≥7

- Hardwood Dominated Harvest Areas without RMZ Retention:
    - Retain all scorecard trees ≥7
    - Retain ½ acre HRA or clumps totaling 0.5 acres and scattered evergreen hardwood trees at a rate of two trees per clearcut acre

C. Relationship with Snag and RMZ Retention – Live tree retention is in addition to snag and RMZ retention. Green trees retained as described in these retention guidelines will augment structure provided by snag retention and within AHCP areas, i.e., Green Diamond will not include retained snags and trees left within RMZs as part of the count for Wildlife Tree Retention.

D. Live Tree Retention Scoring Criteria Used for Identification of Existing Wildlife Habitat Elements:

- DBH – Conifers ≥30 inches and Hardwoods ≥18 inches (3 points)
- Bole features:
    - Trees with an internal hollow or large cavity (4 points)
    - Trees with a small cavity, internal rot or mistletoe broom (2 points)
    - Trees with crevice cover, i.e., loose or deeply furrowed bark (1 point)
- Crown features – Trees with complex crown, lateral large limbs, epicormic branching (1 point)
- Vole nest factor – Tree containing an active or remnant tree vole nest having canopy connectivity with existing RMZ/Geological retention (2 points) and all others (1 point)
- Unit scarcity factor, i.e., post-harvest density of late seral habitat elements, <1 acre (2 points), >1/acre but <2/acre (1 point), >2/acre (0 points)
- Watershed scarcity factor, i.e., planning watershed factor is determined programmatically and is added to the total score, impaired or special wildlife value (1 point), all others (0 points)

Covered Species protection commitments

- Green Diamond will conduct pre-harvest NSO surveys in all harvest units planned for timber harvest during the period when NSOs may be incubating eggs, brooding nestlings or caring for recently fledged juveniles (1 March – 31 August) and will avoid timber harvest in that unit during that period if nesting NSOs are detected.

[3]Forest stands with <15,000 board feet conifer per acre and dominated by hardwood stems.

- If fisher monitoring or other activities reveal an active den, the site will be protected.
- Green Diamond will ensure all water tanks and pipes used for timberland management in the Plan Area are fisher-proofed to prevent entrapment and/or drowning.
- Green Diamond will cooperate in USFWS- and DFW-approved fisher capture and relocation/reintroduction recovery projects, provided that removal of individual fisher does not compromise the fisher occupancy and population objectives of the FHCP.
- When Green Diamond conducts partial harvesting activities within RMZs and geological areas, it will avoid felling trees containing tree vole nests.

6.4 Other Management Plans and Agreements

Salmon Creek Watershed Management Plan (1993)

This document describes Green Diamond Resource Company's management plan for its timberland ownership within the Salmon Creek watershed in the context of the watershed's relevant physical characteristics, past management activities, and Green Diamond's management objectives. Specifically, this plan summarizes the measures Green Diamond has undertaken to ensure that its operations will mitigate or avoid significant impacts to fisheries, aquatic habitat, and wildlife in this watershed.

The management plan includes measures that are directed toward managing riparian zones to protect and enhance aquatic habitat, minimizing soil disturbance, minimizing movement of sediment into watercourses, and identifying potential off-site mitigation which could aid in reducing overall sediment contribution to the system. Green Diamond has incorporated these policies and procedures into Timber Harvesting Plans where appropriate within the Salmon Creek basin.

The management measures that were included in this 1993 management plan have been incorporated into the AHCP, the Option (a), the MATO and the RMWDRs.

Elk River Management Plan

(*Originally the South Fork Elk River Management Plan, 2006, revised in 2012 and 2019*)

Green Diamond developed the Elk River Management Plan (ERMP) as a sediment reduction strategy for its timberland ownership within the Elk River Watershed. The key goal of this strategy is to design and implement operational procedures and measures specifically aimed at reducing sediment production, transport, and deposition into watercourses. This plan specifically describes the conservation measures Green Diamond will apply to ensure that its operations protect water quality and mitigate or avoid significant impacts to aquatic habitat. These measures were developed in the context of watershed-specific physical characteristics, past management activities, and future Green Diamond management objectives for Elk River. The watershed is significantly influenced by a geologic formation known as the Wildcat Group. This formation incorporates undifferentiated rocks composed of soft siltstones, clay stones and fine sandstones, which, because of their lack of strength and durability, are prone to erosion. This fine grained material becomes easily mobilized and has a high potential to reach fish bearing stream habitat.

The ERMP addresses watershed specific operating procedures in the following five key categories: A) Riparian Prescriptions, B) Geological Prescriptions, C) Harvesting, Yarding and Hauling Prescriptions, D) Road Management and E) Seasonal Restrictions. The conservation measures included in this management plan are consistent with the AHCP, MATO, RMWDR, FMWDR and supplemented with measures from the new Order for Elk River.

McNeil Creek Watershed Management Plan (2007)

The McNeil Creek watershed is a small watershed located approximately 3 miles north of Trinidad that drains directly into the Pacific Ocean. The upper end of the 420-acre watershed is forestland owned and managed by Green Diamond (approximately 369 acres) and the lower portion of the watershed is rural residential ownerships. Green Diamond adopted the watershed management plan to ensure that water quality concerns of downstream landowners were addressed. The key conservation measures included in the plan are: A) Riparian Prescriptions, B) Geological Prescriptions, C) Harvesting, Yarding and Hauling Prescriptions, D) Road Management and E) Seasonal Restrictions. The conservation measures included in this management plan are consistent with the AHCP, MATO, and RMWDR measures, and site-specific measures are included in THPs submitted in this watershed. The term of this Watershed Plan ended on December 31, 2020, and the conservation measures included in the AHCP. MATO, FMWDR and RMWDR in combination with site-specific THP measures are sufficient to address downstream water quality concerns.

Sensitive Plant Conservation Plan (2008)

Green Diamond has worked closely with DFG for many years to identify where sensitive botanical resources exist on Green Diamond property and to implement conservation measures for this resource. This working relationship has led to the development of an efficient ownership-wide Sensitive Plant Conservation Plan (SPCP). The intent of the SPCP is to enable sensitive plant species to persist in their preferred habitats on Green Diamond lands, while providing flexibility to Green Diamond in the management of their lands for timber production.

The SPCP is based on the understanding that the most efficient and effective approach to the long-term conservation of sensitive plants on Green Diamond lands is through adaptive management that is informed by appropriate inventory, monitoring and research. A combination of compatible land management practices, plant protection measures (PPMs), property-wide consultations, and area specific Best Management Practices (BMPs) provide the foundation of the SPCP. Various conservation strategies will continue to be developed, implemented, reviewed, and revised over time with the goal of dividing the ownership into Botanical Management Areas (BMAs). The BMAs are managed under BMPs that rely on known existing conditions within the BMA rather than project by project surveys.

BMAs are areas of the ownership that have similar or unique floristic characteristics, exhibit similar sensitive plant habitat characteristics, and can be managed under consistent BMPs that minimize the risk of adverse impacts to sensitive plant species. The BMPs may utilize a combination of focused surveys, retention of populations, management of reserves, impact avoidance, and compatible management practices (e.g., road use restrictions, timing of impacts, invasive plant removal, habitat enhancement for disturbance associated species, etc.) to reduce the risk of adverse impacts to sensitive species and their associated habitats.

The conservation measures of the SPCP are incorporated into and implemented through THPs. Green Diamond and DFW anticipate continuing to meet on a yearly basis to discuss year-end results and to assess the effectiveness of the SPCP and any BMPs that have been implemented in specific BMAs.

Coastal Lagoons and Little River Botanical Management Plan (2008)

Green Diamond's botanical staff have intensively surveyed the Coastal Lagoons and Little River Hydrological Planning Areas (HPAs) and have found that *Lycopodium clavatum* (running pine) is locally abundant throughout these HPAs, and that other sensitive plant taxa requiring protection measures within the Coastal Lagoons or Little River HPAs have not been encountered. Due to the high density of *L. clavatum* and low occurrence of other rare taxa, these two HPAs provide an ideal pilot Botanical Management Area (BMA) for Green Diamond. This BMA will be managed under its own Botanical Management Plan (BMP) and will likely serve as a template for future BMPs in other areas of the ownership.

The key conservation measures that have been developed for this Botanical Management Plan include:

- RPFs conduct focused surveys for all THPs within the Coastal Lagoons and Little River BMA. The surveys are to identify running pine populations and unique high quality sensitive plant habitat within the project area. Identified running pine populations are protected according to the programmatic *Plant Protection Measures for running pine.*
- Botanical technicians shall survey unique high quality sensitive plant habitat within and outside of THP areas when identified. If plants requiring protection are identified, appropriate protection measures will be implemented.
- A subset of running pine populations will be monitored.

Property wide Programmatic Plant Protection Measures

Green Diamond has developed property wide programmatic plant protection measures (PPMs) for running pine (*Lycopodium clavatum*), Ghost pipe (*Monotropa uniflora*), Howell's montia (*Montia howellii),* seaside bittercress (*Cardamine angulata*), white-flowered rein orchid (*Piperia candida*), and coast fawn lily (*Erythronium revolutum*). The key conservation measures include survey requirements, equipment limitation zones to protect plant populations, documentation and reporting requirements, and monitoring. The conservation measures are incorporated into and implemented through THPs.

When a sensitive plant species is located at any point during timber operations, and neither a property-wide consultation nor a conservation plan has been adopted for the sensitive species encountered, a default mitigation measure of avoidance shall be implemented by placing a 50 foot no-harvest equipment exclusion zone around the outer perimeter of the sensitive plant occurrence until specific mitigation measures can be developed for that species at that site.

Following consultation with DFG the alternative mitigation may be more or less restrictive than the default 50-foot buffer.

Ownership-wide Consultation for Osprey (*Pandion haliaetus*) (2006)

Green Diamond has developed an ownership-wide programmatic consultation with DFW for the osprey. The key conservation measures include survey requirements, equipment limitation zones, habitat retention standards, documentation and reporting requirements, and monitoring. The conservation measures are incorporated into and implemented through THPs.

Fire Plan

Green Diamond updates the fire plan each year. The primary objective of the fire plan is to ensure a safe and effective response by Green Diamond personnel in the event of a wildfire on Green Diamond's timberlands and to facilitate clear communication within the company and with external fire responders. A fire watch list is established and procedures for response to a wildfire are outlined. Contact information for in-house fire response resources, contract response resources and key agency contacts are provided.

6.6 Scientific/Research Permits

Green Diamond Conservation Planning Department employees hold permits that allow for limited incidental take of listed species for the purposes of monitoring and scientific research. These permits are reviewed periodically by the issuing State or federal agency to ensure that the company is in compliance with permit requirements. These permits are necessary for Green Diamond to carry out the research and monitoring that supports the various programmatic agreements and management plans previously discussed.

- ESA Section 10(a)(1)(B) permit for FHCP
- Native Endangered and Threatened Wildlife Species Permit for Northern Spotted Owls in conjunction with population study activities for the purpose of enhancing their survival (USFWS Recovery Permit)
- ESA Section 10 permit for incidental take of listed fish species for purposes of monitoring and scientific research
- CESA Memorandum of Understanding for limited incidental take of coho for purposes of monitoring and scientific research
- CDFW Entity Scientific Collecting Permits
- NSO Federal Banding Permit and CDFW CESA MOU
- Migratory Bird Permit

6.7 Threatened, Endangered and Sensitive Species

Green Diamond has taken a programmatic approach to addressing the biology and conservation of threatened, endangered and sensitive species. Examples of this approach include:

- The FHCP provides a property wide long term conservation program for northern spotted owls.
- The AHCP uses a hydrologic planning unit approach to provide a long term conservation program for six aquatic species: Chinook salmon, coho salmon, steelhead (and resident rainbow trout), coastal cutthroat trout, coastal tailed frog and southern torrent salamander.
- The Marten SHA provides a net conservation by creating and enhancing habitat for Humboldt marten.
- The FHCP establishes a long term conservation program for the NSO, and new conservation programs for three terrestrial mammals: fisher, Sonoma tree vole and red tree vole.
- Osprey are addressed under an Ownership-wide Consultation for Osprey
- Sensitive plant species are addressed under the Sensitive Plant Conservation Plan, the Property-wide Programmatic Plant Protection Measures, and the Coastal Lagoons and Little River Botanical Management Plan.

In addition to this programmatic approach, site specific project assessments for the presence of, and potential impacts to threatened, endangered, candidate, and sensitive species are conducted for each THP. The assessment procedure includes consulting the following State of California lists to identify listed species that should be considered in the assessment:

- DFW State and Federal "Endangered and Threatened Animals of California”.
- DFW "Designated Endangered, Threatened and Rare Plants".
- Board of Forestry Sensitive Species list
- DFW California Natural Diversity Database (CNDDB) "Special Animals"
- Sensitive Natural Communities

After the initial list was composed, additional information on species range and the habitat was gathered by using published listings of Endangered, Threatened or Rare species by region or county, texts and field manuals and local knowledge of pertinent species. This information was used to develop a list of threatened, endangered, candidate, and sensitive species that have the potential to occur on Green Diamond’s timberlands. Property wide surveys and THP specific surveys are used to determine the presence of specific species with a THP area. Specific mitigation measures are developed in the event that a threatened, endangered or sensitive species is found to occur in a THP area.

The details of this process and the site-specific results are provided in each THP. The species that are considered in each THP include:

<u>THREATENED or ENDANGERED SPECIES</u>

- NORTHERN SPOTTED OWL (*Strix occidentalis caurina*)
- MARBLED MURRELET (*Brachyramphus marmoratus*) (Breeding)
-
- COHO SALMON (*Oncorhynchus kisutch*)
- CHINOOK SALMON (*Oncorhynchus tshawytscha*)

- STEELHEAD (*Oncorhynchus mykiss irideus*)
- EULACHON (*Thaleichthys pacificus*)
- TIDEWATER GOBY (*Eucyclogobius newberryi*)
- HUMBOLDT MARTEN (*Martes caurina humboldtensis*)
- GRAY WOLF (*Canis lupus*)
- CALIFORNIA CONDOR (*Gymnogyps californianus*)

BOARD OF FORESTRY SENSITIVE AND SPECIES OF SPECIAL CONCERN

AMPHIBIANS
- SOUTHERN TORRENT SALAMANDER (*Rhyacotriton varigatus*)
- COASTAL TAILED FROG (*Ascaphus truei*)
- NORTHERN RED-LEGGED FROG (*Rana aurora aurora*)
- FOOTHILL YELLOW-LEGGED FROG (*Rana boylii*)
- DEL NORTE SALAMANDER (*Plethodon elongatus*)

REPTILES
- WESTERN POND TURTLE (*Emys marmorata*)

FISH
- COASTAL CUTTHROAT TROUT (*Oncorhynchus clarki clarki*)

BIRDS
- BALD EAGLE (*Haliaeetus leucocephalus*) (Breeding and Wintering)
- GOLDEN EAGLE (*Aquila chrysaetos*) (Breeding and Wintering)
- AMERICAN PEREGRINE FALCON (*Falco peregrinus anatum*)
- GREAT BLUE HERON (*Ardea herodias*) (Rookery Site)
- GREAT EGRET (*Casmerodius albus*) (Rookery Site)
- OSPREY (*Pandion haliaetus*) (Breeding)
- COOPER'S HAWK (*Accipiter cooperii*) (Breeding)
- SHARP-SHINNED HAWK (*Accipiter striatus*) (Breeding)
- NORTHERN GOSHAWK (*Accipiter gentilis*) (Breeding)
- RUFFED GROUSE (*Bonasa umbellus*)
- PURPLE MARTIN (*Progne subis*) (breeding)
- YELLOW WARBLER (*Dendroica petechial*)
- YELLOW-BREASTED CHAT (*Icteria virens*) (breeding)
- BLACK-CAPPED CHICKADEE (*Parus atricapillus*)
- VAUX'S SWIFT (*Chaetura vauxi*)

MAMMALS
- SONOMA TREE VOLE (*Arborimus pomo*)
- RED TREE VOLE (*Arborimus longicaudus*)
- WHITE-FOOTED VOLE (Arborimus albipes)
- FISHER (Pekania pennanti)
- TOWNSEND'S WESTERN BIG-EARED BAT (*Corynorhinus townsendii*)

The following table identifies other threatened, endangered or sensitive species that are considered extremely unlikely to exist within a THP area due to their specific habitat requirements.

Table 6: Threatened, endangered or sensitive species considered extremely unlikely to exist within a THP area

Species (status)	**Scientific name**	**Habitat**
Harlequin duck (Special Concern)	*Histrionicus histrionicus*	Marine waters
Northern harrier (Special Concern)	*Circus cyaneus*	Meadows
Merlin (Special Concern)	*Falco columbarius*	Seldom in heavily wooded areas Grasslands, Coasts
Prairie falcon (Special Concern)	*Falco mexicanus*	Grasslands
Snowy plover (Special Concern)	*Charadrius alexandrinus*	Marine, estuaries
Bank swallow (State Threatened)	*Riparia riparia*	Vertical banks near lowland lakes and streams
Burrowing owl (Special Concern)	*Athene cunicularia*	Grasslands, not in humid NW coastal forests or high Mts.
Short-eared owl (Special Concern)	*Asio flammeus*	Open areas with few trees
Wolverine (Cal. Threatened)	*Gulo gulo*	Habitat poorly known, may occur in Doug-fir/mixed con.
Yellow-billed cuckoo	*Coccyzus americanus*	Riparian woodlands of the lower Eel River
Badger (Special Concern)	*Taxidea taxus*	Not generally found in humid northern coastal forests
Willow Flycatcher (CA endangered)	*Empidonax traillii*	Willow thickets along riparian areas interspersed with open areas.

6.8 High Conservation Value Forest Areas

Green Diamond has conducted a High Conservation Value Forest (HCVF) area assessment and identified nine HCVF categories (Table 7). The HCVF assessment incorporated elements of conservation planning projects that have been undertaken in the past two decades and site specific information developed as part of the THP process. Specific areas have been identified and managed to protect and enhance their ecological values as part of the FHCP, the AHCP, the THP process and other conservation efforts. These areas include Conservation Easement (CE) areas, stands of old-growth forest/marbled murrelet habitat, Riparian Management Zones (RMZs), NSO nest sites and cultural archaeological sites. The HCVF assessment built on those identified conservation areas and identified grasslands, true oak stands, naturally occurring tan oak stands, and an area of unique soils and vegetation with low road density along Rattlesnake Ridge.

High Conservation Values: High Conservation Value Forests are defined as areas that possess one or more of the following High Conservation Values (HCVs):

1. HCV forest areas containing globally, regionally or nationally significant concentrations of biodiversity values (e.g., endemism, endangered species, refugia), including RTE species and their habitats;
2. HCV forest areas containing globally, regionally or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance;
3. HCV forest areas that are in or contain rare, threatened or endangered ecosystems;
4. HCV forest areas that provide basic services of nature in critical situations (e.g., watershed protection, erosion control);
5. HCV forest areas fundamental to meeting basic needs of local communities (e.g., subsistence, health); or,
6. HCV forest areas critical to local communities' traditional cultural identity (areas of cultural, ecological, economic or religious significance identified in cooperation with such local communities).

A total of three HCVF stakeholder meetings were held in the local community as part of the HCVF assessment process. The first two meetings were to present the HCVF concept, Green Diamond's proposal to address the HCVF concept, and to solicit community input on the HCVF assessment process. The third meeting was to present our completed HCVF assessment, including maps of the HCVF areas and management options for those areas, and solicit comments on the process and the results of the process from the stakeholders. Stakeholder participants included representatives from RNSP, SRNF, BLM, DFW, CalFire, HRC, Yurok tribe, City of Arcata, Cal Poly Humboldt, UC Extension office, and Save the Redwoods League. A record of the stakeholder consultation process is kept on file at Green Diamond.

There is overlap in the HCVF areas, especially among RMZs and other categories. For example, a class I RMZ HCVF area may bisect an old-growth forest HCVF area that is located in a Conservation Easement HCVF area. The acres are reported independently for each HCVF category; therefore, the sum of the HCVF acres listed below exceeds the total area of Green Diamond's lands occupied by the HCVF areas.

Table 7. Currently identified High Conservation Value Forest Areas on Green Diamond Resource Company California ownership.

High Conservation Value Forest (HCVF) areas		
HCVF Category	*Acres*	*HCVs*
Conservation Easement areas	972	1, 3
Old-Growth forest and marbled murrelet habitat	659	1, 3
Class I and II RMZs	99,635	1, 4

NSO core areas	3,779	1
Grassland and grass openings	2,499	2
True oak stands	577	2
Mature hardwood (tan oak) stands	694	2
Rattlesnake ridge serpentine habitat	2,098	1, 3
Cultural areas	Not Applicable	5, 6

HCVF Categories and Associated Management Options

Conservation Easement areas: There are two conservation easements (CEs) in the Klamath area centered on old-growth forest stands that provide suitable marbled murrelet habitat. The Miracle Mile CE is located in the Terwer Creek drainage of the lower Klamath Basin. The Big Mynot and East Fork Hunter CE applies to two spatially distinct old growth forest stands occupied by marbled murrelets. The Big Mynot area is located on a ridge between two forks of Mynot Creek, and E.F. Hunter is located in the headwaters of the East Fork of Hunter Creek.

Both of these CEs are held by Save the Redwoods League. The purpose of the easement is to assure that the property will be retained in its natural condition and managed for its habitat, ecosystem and other natural values including its value as habitat for marbled murrelets. These CE areas include old-growth stands and a buffer zone around the old-growth. The 970 acres is divided as follows:

- Miracle Mile: 672 acres (142 acres old-growth, 530 acres buffer);
- The Big Mynot and E.F. Hunter: 298 acres (77 acres old-growth, 221 acres buffer).

Management Options: The CE prohibits commercial timber harvest on the easement property, which includes any cutting or removal of trees, whether living or dead, standing or downed; prohibits subdivision or partitioning of the property, prohibits construction, exploitation of subsurface resources and waste disposal. No industrial, commercial, or residential activities, no signs, no new utilities, no fences, no fertilizers, no herbicides, no pesticides or agricultural chemicals, no alteration of watercourses, no water pollution, no public access, no trails, no off-road vehicles, no disturbances during marbled murrelet breeding season, no grazing, and no use in habitat conservation plans for the purpose of mitigating impacts to marbled murrelets.

The conservation easement provides a right and easement in, on, over, and across the property for the purpose of inspection and monitoring of the property and compliance with the conservation measures, and to conduct forest thinning, brush removal, or other noncommercial forest health activities.

These easement areas do not overlap onto any adjoining ownerships. Green Diamond cooperates with Save the Redwoods league to manage the CE areas according to the terms of the CE. The extent of old-growth forest and marbled murrelet habitat on other ownerships is addressed below.

Sproul Creek Conservation Easement:

Old-growth and marbled murrelet habitat: GDRCo has approximately 659 acres of known old-growth stands within its California ownership. These known old-growth stands are primarily type 1 old-growth, but also include type 2 old-growth that has been partially logged and still retains significant old-growth structure and function. FSC definition of Type 1 old-growth is *"Areas that are three acres and larger that have never been logged and that display old-growth forest characteristics."* Type 2 old-growth is defined as *"20 acres that have been logged, but which retain significant old-growth structure and functions."*

These old-growth stands, with the exception of a 4.8 acre stand along Black Dog Creek in the Mad River watershed, are also considered occupied marbled murrelet habitat.

Management Options: The 659 acres of known old-growth stands are protected from harvesting, road construction and other timber management activities. The management objective is to maintain the area, structure and composition of the old-growth stands and prevent disturbance to marbled murrelets and their habitat. In addition, timber harvest operations proposed within ¼ mile of occupied marbled murrelet habitat are subject to review through consultation with the California Department of Fish and Wildlife and technical assistance from U.S. Fish and Wildlife Service.

Significant areas of old-growth (including old-growth redwood stands) forest are present on Forest Service lands, Redwood National and State Parks (RNSP), and on other private timberlands in the region. There is also old-growth on lands managed by BLM, including the Headwaters Reserve, and the Hoopa Valley Indian Reservation has old-growth forest reserves. There are approximately 39,000 acres of old-growth redwood forest reported within RNSP. This is likely a mix of type 1 and type 2 old-growth forests. Humboldt Redwood Company (HRC) reports that they have 2,200 acres of FSC defined type 1 old-growth forest and 2,500 acres of FSC defined type 2 old-growth forest on their Humboldt county ownership. Six Rivers National Forest (SRNF) has a reported 137,000 acres of old-growth Douglas-fir and mixed conifer forest within its boundaries. This is likely a mix of type 1 and type 2 old-growth forests. The redwood forest old-growth stands within RNSP, BLM Headwaters and HRC are also considered occupied marbled murrelet habitat. Occupied marbled murrelet habitat on adjoining lands that may be affected by management on Green Diamond lands is protected through state or federal consultation.

Class I and II RMZs: An RMZ is a riparian buffer zone on each side of a watercourse that receives special treatments to provide water temperature control, nutrient inputs, channel stability, sediment control, and LWD recruitment. Class I watercourses include all current or historical fish-bearing watercourses and within 100 feet upstream of domestic water supply intakes. Class II watercourses support or provide habitat for non-fish aquatic vertebrates, including seeps and springs. The high conservation values of class I and II RMZs are that they provide and protect habitat for listed anadromous salmonids including steelhead, coho salmon and Chinook salmon.

Green Diamond has identified approximately 99,635 acres of Class I and II RMZ on its forest lands at this time. This is an estimate derived from a combination of GIS modeling and field verified watercourse classifications. Field verified lakes, ponds and springs are included in this classification.

Management Options: RMZ protection measures are prescribed in the AHCP and are implemented through the THP process. The minimum width of Class I RMZs is 150 feet on each side of the watercourse. There is an inner and outer zone within the RMZ with 85% overstory canopy retention in the inner zone (50-70 feet wide depending on slope class) and 70% overstory retention in the remaining outer zone (80 to 100 feet). The RMZ is an equipment exclusion zone and single tree selection silviculture is allowed as long as the canopy retention standards are attained. A detailed description of all Class I RMZ conservation measures is included in section 6.2.1.2 of the AHCP and they are also included in THPs with class I watercourses.

The minimum width of Class II RMZs is 75 or 100 feet on each side of the watercourse depending on the stream order and location of the watercourse. Class II-1 watercourses have a 75 foot RMZ and Class II-2 watercourses have a 100 foot RMZ. There is an inner and outer zone within the RMZ with 85% overstory canopy retention in the inner zone (30 feet wide) and 70% overstory retention in the remaining outer zone (45 to 70 feet). The RMZ is an equipment exclusion zone and single tree selection silviculture is allowed if the canopy retention standards are attained. A detailed description of all Class II RMZ conservation measures is included in section 6.2.1.4 of the AHCP and they are also included in THPs with Class II watercourses.

Class I and II watercourses and riparian zones are also present on Federal and State parks in the region and on other private timberlands in the region. Green Diamond has worked with adjoining landowners, DFW the Yurok and Wiyot tribes, and the Tolowa Dee-ni' Nation on watershed restoration projects designed to improve aquatic habitat conditions.

NSO dynamic core areas: The northern spotted owl, a federally listed threatened species and state listed threatened species, is known to occupy Green Diamond's forestlands, and those forestlands provide extensive habitat for this species. Two decades of research indicates that Green Diamond cannot predict specific locations supporting productive owl nest sites. Only NSOs can select nest sites that provide the right combination of habitat elements that are conducive to production and survival of their young owls. Green Diamond is putting two decades of research into practice through implementation of the FHCP. The FHCP will identify and protect a suite of the more productive NSO nest sites as core areas currently on the ownership. These are referred to as Dynamic Core Areas (DCA) because they can be replaced over time by new, equally or most productive, spatially distributed core areas that are established by NSOs as habitat conditions evolve across the ownership. The concept behind the NSO DCAs is that retention of specific high-quality habitat that includes the most productive owl nesting sites across the landscape as DCAs will contribute to a stable or increasing population of NSOs on the ownership. NSO HCVF habitat is defined as the 44 NSO core areas that are identified and described in the FHCP. The minimum size of the DCAs will be 89 acres unless the site lacks suitable nesting habitat to create a core area of this size. Green Diamond has identified approximately 3,779 acres within the 44 DCAs to be established under the proposed FHCP that will be classified as HCVF areas. The NSO HCVF area will be revised to reflect the changes to the DCAs as they move over time.

Management Options: The NSO core area HCVFs will be precluded from timber harvesting to protect the existing owl sites and to promote development of suitable owl habitat. Each core area will include an NSO activity center that will be managed as a “no-take” site. This will require the retention of at least 233 acres of suitable owl habitat within ½ mile of the activity center. Limited road building and maintenance is allowed within the core areas to permit access to forest areas outside the core area. NSO DCAs may be exchanged over time given criteria defined in the FHCP. Therefore, the NSO HCVF areas will also be dynamic over time, but there will always be a minimum of 44 DCAs maintained as HCVF.

Green Diamond conducts extensive monitoring and reporting for the conservation measures contained in the FHCP as described in the Monitoring Section of this Management Plan.

There is extensive NSO habitat on other landowners around Green Diamond including RNSP, USFS, BLM, SPI, HRC and other small private landowners. Projects on adjacent owners that have the potential to impact NSO habitat are reviewed through consultation with USFWS or through compliance with the FPRs. Green Diamond cooperates with adjacent landowners to share NSO survey data, and participates in a landowner and agency working group that works to improve the region-wide implementation of NSO conservation strategies.

Grassland and Grass Openings: Grassland, prairie and grass dominated openings provide unique habitat elements within Green Diamond’s forested ownership. The nature of the habitat varies from relatively small grassy openings surrounded by conifer forest to relatively large expanses of grassland ridges and swales trending into oak woodlands and conifer forest. Non-forest lands typed as grasslands that were generally twenty acres and larger within Green Diamond’s ownership were considered for classification as grassland HCVF. Areas that are less than twenty acres are considered for inclusion if they are part of larger native grasslands that cross property boundaries or are connected to a true oak HCVF area. This assessment was based on existing vegetation typing. As site specific assessments associated with project planning are developed (e.g. THP layout, timber typing, timber cruising, botanical surveys), this new information will be used to revise and update the grassland HCVF delineations.

Green Diamond has identified approximately 2,499 acres of HCVF grasslands on its forest lands at this time. Some of these grasslands, prairies and grass openings occupy poor soils that will not support forest habitats, or are underlain by unstable Franciscan mélange geology that typically support grassland prairie. Some areas that may have historically supported forest were converted to grassland after historic timber harvesting, and managed for years as grassland for grazing. Grazing in Humboldt County has declined significantly since the 1940’s and many of these grazed grasslands are growing back to forest. It is also thought that Native American burning practices that occurred prior to 1850 promoted or sustained the development of grasslands, prairies and forest openings. Currently, many of the existing prairies and grass openings on Green Diamond’s ownership are slowly developing into forest as trees encroach on the edges of the openings. Prairies and grass opening habitat is also present on Federal and State parks in the region and on other private timberlands in the region.

Management Options: The management objectives for grasslands will be to avoid management activities that would lead to conversion of grassland to non-grassland, and to encourage management activities that promote the retention of existing grasslands. Conversion of grassland to forest by tree planting will not occur. Road building and maintenance is allowed to permit access to forest areas. New roads will be planned to avoid grasslands to the extent feasible. Green Diamond will investigate implementing management practices to reduce forest encroachment into grassland areas and will work cooperatively with adjacent landowners to reduce forest encroachment into grassland areas and promote the retention of grassland habitat. Green Diamond will actively manage these identified grassland HCVF areas to minimize forest encroachment where feasible given legal, economic and environmental considerations.

When grass openings occur within or adjacent to THPs, that unique habitat is specifically surveyed for rare plants. Wet areas within grass openings are provided with equipment exclusion zones or RMZ as appropriate. Where these openings are underlain by unstable geology, the geology conservation measures of the AHCP apply. When proposed operations have the potential to impact sensitive species that utilize this habitat type, surveys are conducted and protection measures are implemented as appropriate.

Redwood National Park (RNP) has approximately 2,500 acres of native grasslands in the Bald Hills area. RNP is using controlled fire and cutting of encroaching trees as management tools to reduce the encroachment of adjoining conifer stands into the grasslands and promote the retention of existing native grassland habitat. As a result of the stakeholder consultation process, Green Diamond and RNP vegetation management staff have initiated conversations regarding possible cooperative management programs to promote retention of the native grassland habitat in the Bald Hills area.

True oak stands: Green Diamond has identified 577 acres of true oak stands as HCVF areas. Forested areas that are dominated by true oaks (primarily white oak or black oak) provide unique habitat elements within Green Diamond's forested ownership. This type of forest habitat is often referred to as oak woodland. The nature of oak woodland habitat varies from relatively small oak patches adjoining grassy openings or intermixed with surrounding conifer forest, to large expanses of oak woodlands typically associated with grass dominated ridges. The oak woodlands are typically present around the margins of the larger grass openings and gradually blend into surrounding conifer forests. For this HCVF analysis, true oak stands are primarily identified as forest stands twenty acres and larger that have recent inventory data indicating the stand is dominated by true oaks (generally 70% or more by basal area) and is composed of larger, mature trees. Often these stands are associated with grass openings. Inventory data, aerial imagery and local knowledge were used to identify the best examples of these true oak stands.

Management Options: Timber harvest is likely to occur around the margins of these stands. As THP units are planned in the vicinity of the identified true oak HCVF, on-the-ground site assessments will occur to ensure that the true oak HCVF areas are correctly identified. The boundaries of the true oak HCVF areas will be revised based on site specific assessments as they occur. The identified true oak HCVF areas will be protected from timber harvest except for harvest prescriptions that promote and protect the true oak conservation value. Road construction to access surrounding forest will be allowed. Maintenance of existing roads in these stands may occur. Green Diamond will actively manage these identified true oak HCVF areas to minimize conifer encroachment where feasible given legal, economic and environmental considerations. The assessment to identify true oak HCVF areas will be reviewed and updated periodically as timber inventory data is revised.

Redwood National Park is using controlled fire and cutting of conifers as management tools to reduce the encroachment of conifers into true oak stands. As a result of the stakeholder consultation process, Green Diamond and RNP vegetation management staff have initiated conversations regarding possible cooperative management programs to promote retention of the true oak/native grassland habitat in the Bald Hills area.

Mature hardwood (tan oak) stands: Forested areas that are dominated by mature tan oaks provide a unique habitat element within Green Diamond's forested ownership. Green Diamond has identified 694 acres of mature hardwood tan oak HCVF areas. Tan oak is a very common tree component of Green Diamond's forestlands, becoming more common to the east and at higher elevations. The majority of these tan oak dominated stands are the result of historic timber harvest. Past management actions created tan oak dominated areas where mixed conifer-hardwood forests previously occurred, and regeneration efforts were poor at establishing conifers on site. The naturally occurring mature tan oak stands identified as this HCVF area differ from the management created tan oak stands by being older and having a predominant component of larger mature trees. These stands are generally located within a matrix of managed mixed conifer-hardwood forests and management related tan oak dominated areas. For this analysis, a naturally occurring mature tan oak stand is identified as a forest stand 20 acres and larger that is dominated by tan oaks and is composed of larger, mature trees. Inventory data along with aerial imagery and local knowledge were used to identify the best examples of these naturally occurring tan oak stands. The assessment to identify naturally occurring tan oak HCVF areas will be reviewed and updated periodically as inventory data is revised and field verification improves knowledge of these areas.

<u>Management Options:</u> Evenage timber harvest is the primary risk for these stands on Green Diamond timberlands. As THP units are planned in the vicinity of the identified tan oak HCVF areas, on-the-ground site assessments will occur to ensure that the tan oak HCVF areas are correctly identified. The boundaries of the tan oak HCVF areas will be revised based on site specific assessments as they occur. The identified naturally occurring tan oak HCVF areas will be protected from timber harvest except for harvest prescriptions that promote and protect the mature tanoak conservation value. Road construction to access surrounding forest will be allowed. Maintenance of existing roads in these stands may occur.

SOD has the potential to negatively affect these stands. Green Diamond monitors its timberlands for signs of new SOD infestations during normal forest management activities. If sites are found, they will be monitored, and appropriate treatments will be designed and implemented if needed. Green Diamond has not conducted timber operations in an area with a confirmed SOD outbreak. If that does occur, Green Diamond will design and implement truck and equipment washing procedures to limit the spread of the infection to non-infected areas.

Green Diamond, in cooperation with CalFire, the UC Cooperative Extension (UCCE) office, the US Forest Service, the Natural Resources Conservation Service (NRCS) and with other affected landowners, formed the Redwood Valley Collaborative (RVC) soon after a SOD infestation was discovered in Redwood Valley. The RVC implemented a treatment program in 2011 designed to limit the spread of the infestation. Technical and financial assistance for this work on the small private lands was provided by UCCE, CAL FIRE, North Coast Land Conservancy, Green Diamond, USFS, and NRCS. Green Diamond is also working with adjacent landowners, UCCE and agencies to address a SOD outbreak in the upper Mad River.

Rattlesnake Ridge Serpentine Habitat: The 2,098-acre Rattlesnake Ridge HCVF area is located in the northeast corner of the Hunter-Wilson and Blue Creek North tracts in the Klamath operating area. There are two overlapping HCVs that occur in this area: Serpentinaceous soils and associated unique vegetation types, and a potential "roadless" area within Green Diamond's ownership.

There is a band of serpentine soils in the Rattlesnake Ridge area that is dominated by a unique chaparral vegetation type composed of sparse stunted trees and dominated by dense areas of manzanita and other evergreen shrubs. The serpentine soils have high concentrations of heavy metals such as magnesium, high pH, poor water holding capacity and few available nutrients. These harsh growing conditions have resulted in the development of a unique plant community. This vegetation type starts at around 2,500 to 3,000 feet of elevation on the west side of Rattlesnake Ridge and extends past Green Diamond's eastern property line. Redwood and Douglas-fir forest are present to the west of this area, with a transition zone to this shrub dominated landscape. Knobcone pine, Jeffery pine, ponderosa pine and Port-Orford-cedar are present in the transition zone, along the lower slopes of some watercourses and at very low densities throughout the area.

Within this HCVF area, there are approximately 1,500 contiguous acres with a very low density of roads. There is an existing low-standard jeep trail along the top of Rattlesnake Ridge that divides the area, and a system of logging roads to the west along the approximate boundary of the shrub dominated area and commercial timberlands. Between the logging roads and the property line to the east, the only mapped road is the low standard jeep trail. Road development in this area has been very limited due to the vegetation type and the remote location. Other low standard trails may be present in this area, but they have not been identified at this point. Further investigations will need to be conducted to determine if unmapped roads are present in this area.

The assessment to identify this HCVF area was based on timber typing information, aerial imagery and local knowledge. Green Diamond is in the process of updating inventory information in this area and the new inventory information will be used to refine the HCVF area boundaries.

Management Options: The management objectives for this HCVF area will be to avoid management activities that would lead to conversion of this vegetation type to a different vegetation type, and to encourage management activities that promote the retention of this vegetation type. Vegetation type conversion by site preparation and tree planting will not occur. Roads will be planned to avoid this HCVF area to the extent feasible. The existing trails may be maintained.

Cultural Sites: Green Diamond maintains confidential records of survey reports, maps and site records that document all known Native American archaeological sites on the property. Green Diamond consults with the North Coastal Information Center and Northeast Information Center (the regional state clearinghouses for all archaeological and historic site records and surveys) to conduct a property wide update of the records every 5 years.

Management Options: The management objective for these HCVF areas is to avoid impacts. Known cultural sites that have the potential to be impacted as a result of Green Diamond's operations are addressed in project specific confidential archaeological reports. Local tribal representatives are contacted during the preparation of the archaeological report, and when cultural sites are known to be in the project area or are discovered in the project area, their input is specifically requested. Cultural sites are also reviewed by Cal Fire archeologists as part of the THP approval process. If operational restrictions are needed to protect a cultural site, those restrictions are made part of the THP and are enforceable through the THP inspection and completion process. All information regarding cultural sites is kept confidential.

Redwood National Park has identified an area with a high concentration of bear grass located along a common property boundary. Bear grass is used in Native American cultural for basket making and this identified area could be used as a bear grass collecting area. As a result of the stakeholder consultation process, Green Diamond and RNP vegetation management staff have reviewed the area on the ground and are reviewing a possible cooperative management program to promote the retention of bear grass where it is known to exist along common property boundaries. A portion of this area was included in a Green Diamond harvest operation in 2017 and the remainder of the mapped area on the Green Diamond lands is included in an area planned for harvest in 2024. Little to no bear grass was identified in this area during the field review and surveys conducted for these THPs. Redwood National Park has also conducted forest thinning projects in the vicinity of this area.

6.9 Representative Sample Areas

Green Diamond conducted a Representative Sample Area (RSA) assessment to document the existing ecosystems on the ownership and assess the adequacy of their representation and protection in the surrounding ecoregions. A two-stage assessment process was used, beginning with a systematic GAP analysis. The GAP analysis was used to identify potential areas that are underrepresented, inadequately protected or have large "gaps" between protected areas and may therefore need designation as RSAs to protect or promote biodiversity. The analysis was a quantitative, comparative process that used publicly available information to look at the level of protection provided to ecosystems both on Green Diamond's property and on surrounding lands in the region. If potential “gaps” in ecosystem protection were identified, a closer look was taken using site specific knowledge and data to determine if additional protection levels were warranted. The GAP analysis was followed by a more qualitative RSA assessment that integrated site specific local knowledge and information developed during stakeholder meetings.

The result of the RSA assessment was the establishment of the following four categories of RSA areas:

- Douglas-fir /Western Hemlock SAF cover type (Smith River area) (241 acres)
- Old growth stands (659 acres)
- Grasslands in the Bald Hills area (364 acres)
- Rattlesnake ridge serpentine habitat area (2,098 acres)

The rationale for the designation of each RSA category is provided below, followed by a detailed description of the GAP Analysis process.

Douglas-fir **/Western Hemlock SAF cover type (Smith River area):** Approximately 241 acres of Douglas-fir/western hemlock cover type in the RMZ HCVF areas of the Smith River tract has been identified as RSAs that will be provided GAP level 2 protection. This RSA category was identified using the GAP analysis process. The areas that were selected represent the larger concentrations of Douglas-fir/western hemlock cover type located in the RMZ HCVF area of the Smith River tract. All the protection measures of the RMZ HCVF area will apply to this RSA, and in addition, these areas will be excluded from active commercial timber management. The location and boundaries of these RSA areas will be verified on-the-ground by professional foresters as timber harvest plans are planned and designed. Timber harvest units will either avoid these RSA areas, or if a unit overlaps an RSA, the RSA will be designated a “No Harvest” area, and all RMZ conservation measures shall apply to the RSA in addition to the “No Harvest” designation. The mapped boundary of the RSA will be refined over time as additional field work is conducted in the areas adjoining the RSAs.

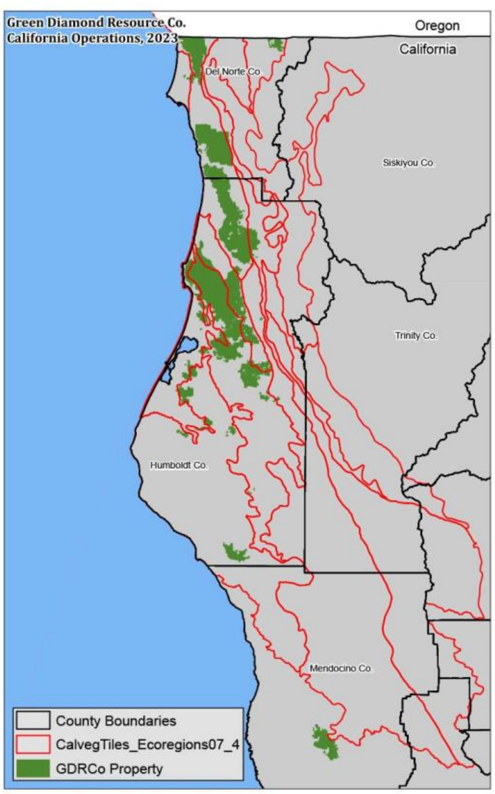
Old Growth Stands: The 659 acres of old growth stands identified as HCVF areas will also be designated as RSAs. Although significant areas of old growth are permanently protected in State and National parks in Northern California, there are relatively few old growth stands located on private timberlands in these ecoregions. The limited amount of old growth timber stands located on private land, and the location of Green Diamond’s old growth stands make RSA designation appropriate. Timber harvest is excluded from these areas as described in the HCVF area discussion.

Grasslands in the Bald Hills area: Approximately 364 acres of native grassland HCVF area have also been identified as RSAs in the Bald Hills area. Redwood National Park is investing significant resources to maintain and promote the development of the natural grasslands in the Bald Hills area. We discussed the location of these areas with Park staff during HCVF stakeholder meetings and have committed working with the Park towards similar goals for management of the grasslands in this area. Designating these native grassland areas as RSAs acknowledges the regional significance identified by RNP personnel. Conservation measures that will be applied to these areas are described in the HCVF section of the Management Plan.

Rattlesnake ridge serpentine habitat area: The 2,098 acres of HCVF serpentine habitat area along Rattlesnake Ridge has also been identified as an RSA. Although this habitat type is regionally abundant on federal lands in this ecoregion, this habitat type is uncommon on commercial timberlands to the west and has regional significance due to the habitat it provides for the Coastal (or Humboldt) Marten. This animal is currently being considered for listing by the Fish and Wildlife Service. Green Diamond track-plate and camera survey efforts have documented this animal in the designated HCVF/RSA area. Based on the survey work, the HCVF/RSA area is one of the westernmost habitat areas in the range of the marten. The conservation measures that will be applied to this area are described in the HCVF section of the Management Plan.

GAP Analysis: The GAP analysis used data from the USFS California Vegetation (CALVEG) Project and the USGS GAP Analysis Program's Protected Areas Database of the United States (PADUS) version 1.2. The Society of American Foresters (SAF) cover type classification system was used to identify vegetation types at the ecoregion level. CALVEG Project ecoregion mapping was used to define the ecoregions that encompass Green Diamond's California ownership (Figure 4).

Figure 4: CALVEG Ecoregions relative to Green Diamond property



Six ecoregions encompass Green Diamond's ownership. Twenty SAF cover types were identified that overlap Green Diamond's ownership and the other ownerships within the ecoregions (Table 8). SAF cover type data for the ecoregions to be analyzed was extracted from the CALVEG project data files. This cover type data within the six ecoregions was intersected with four GAP protection status values (Table 9). The GAP status values for Green Diamond property were based on the protection levels provided to different areas. The GAP status assigned to Green Diamond's HCVF areas are shown in Table 10. Non-HCVF areas were assigned a GAP status of 4. Off property GAP status was acquired from PADUS.

Table 8. SAF Cover Types used in the GAP Analysis

Calif. coastal conifers	Pacific Douglas-fir
California black oak	Pacific ponderosa pine - Douglas-fir
California coast live oak	Port Orford-cedar
Canyon live oak	Red alder
Cottonwood - willow	Red fir
Douglas-fir - western hemlock	Redwood
Hard chaparral	Sierra Nevada mixed conifer
Jeffrey pine	Sitka spruce
Knobcone pine	Western white pine
Oregon white oak	White fir

Table 9: GAP Status Levels and Descriptions

Level	Description
1	An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, and intensity) are allowed to proceed without interference or are mimicked through management. (concept: Wilderness Designation, Ecological Reserve, etc.)
2	An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive use or management practices that degrade the quality of existing natural communities. (concept – Park or Natural Area)
3	An area having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type or localized intense type. It also confers protection to federally listed endangered and threatened species throughout the area. (concept: public or private forest with timber extraction subject to a conservation easement)
4	Lack of irrevocable easement or mandate to prevent conversion of natural habitat types to anthropogenic habitat types. Allows for intensive use throughout the tract. Also includes those tracts for which the existence of such restrictions or sufficient information to establish a higher status is unknown. (concept: unrestricted forest lands)

Table 10: On-Property GAP Status Values

HCVF Type	GAP Status
Conservation Easement Areas	2
Old Growth	2
Grassland	3
RMZs	3
NSO Core Areas	3
Serpentine Soils (Rattlesnake Ridge)	4
Tan Oak	4
True Oak	4

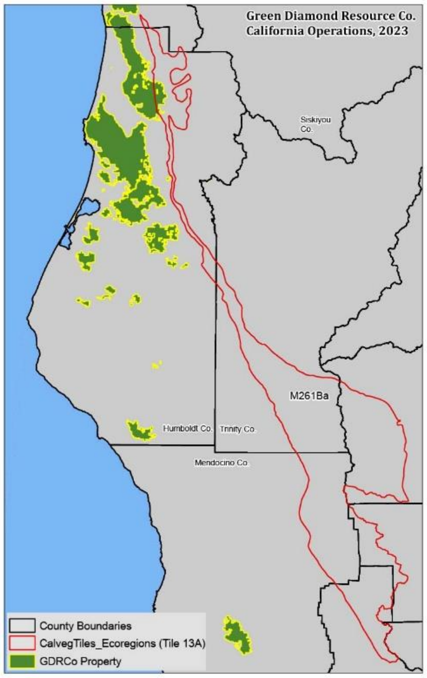
Results: The complete GAP analysis is on file at Green Diamond's Korbel office and is available for review upon request. The results indicate that at the ecoregion level, the vegetation types present on Green Diamond lands are also found on the surrounding lands in the ecoregion and are well protected to conserve biodiversity. There are no vegetation types on Green Diamond lands that are unique to any of the ecoregions. The GAP analysis did reveal that there are three vegetation types with potential gaps in protection at the ecoregion level: red alder, Jeffery pine and Douglas-fir/western hemlock (Table 11).

Table 11: Vegetation types with no GAP level one or two protection in an ecoregion.

	Red Alder		Jeffery Pine		Douglas-fir/western hemlock	
Ecoregion	GAP 1 or 2 Acres	Total Acres	GAP 1 or 2 Acres	Total Acres	GAP 1 or 2 Acres	Total Acres
1A	4,615	13,887	0	0	0	270
1B	4,058	19,740	182	286	0	1,368
2A	574	4,827	6,241	13,452	0	0
11A	195	5,157	0	0	0	0
12A	0	0	0	0	0	0
13A	0	1,286	5,354	6,937	0	0
Totals	9,442	44,897	11,777	20,675	0	1,638

Red alder: The red alder vegetation type is present in five out of the six ecoregions (Table 11). In one of the ecoregions that the red alder vegetation type is present, (13A), no areas were identified that provided GAP level one or two protection. This ecoregion is located primarily in a dryer inland region (Figures 5) with a very small amount of this vegetation type and a small percentage of Green Diamond ownership. The remaining four ecoregions have a more coastal influence with substantial acreage of red alder vegetation. There is approximately 9,440 acres of red alder type with GAP level one or two protection in these four ecoregions. Given the high level of protection provided to 21% of this vegetation type and greater than five occurrences across multiple ecoregions both on and off Green Diamond property, no Representative Sample Area was designated on Green Diamond lands to provide additional protection for the red alder vegetation type.

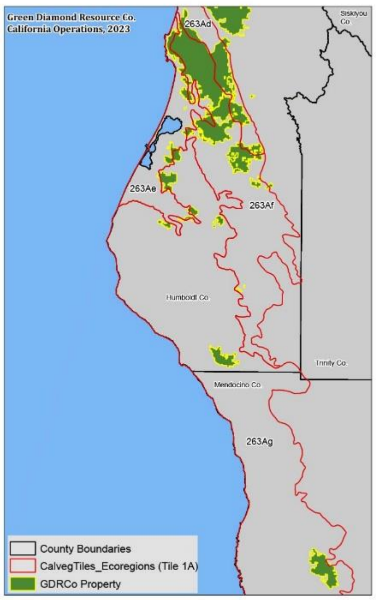
Figure 5: Ecoregions 13A.

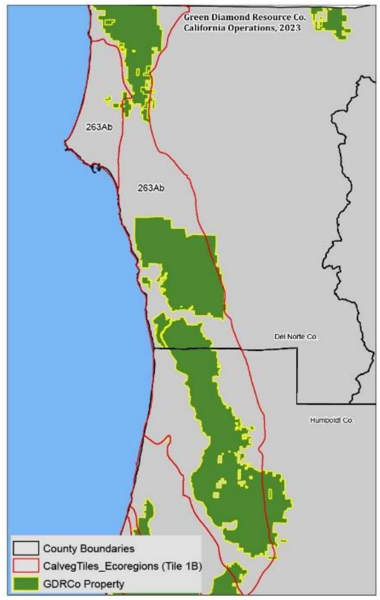


Jeffery pine: The Jeffery pine vegetation type is present in three out of the six ecoregions (Table 11). In the three ecoregions, there is approximately 11,777 acres (44%) of the Jeffery pine vegetation type with GAP level one or two protection and greater than five occurrences of this vegetation type. This GAP analysis and follow up investigation indicate that the eastern edge of Green Diamond's ownership is along the western edge of the general range of Jeffery pine in this region. Given the high level of protection provided to a substantial acreage of this vegetation type across multiple ecoregions, no Representative Sample Area was designated on Green Diamond lands to provide additional protection for the Jeffery pine vegetation type. The occurrence of Jeffery Pine on Green Diamond's ownership is in one of the HCVF areas and this designation also requires that the high conservation values for the area be maintained.

Douglas-fir/western hemlock: The Douglas-fir/western hemlock vegetation type is present in ecoregions 1A and 1B (Figures 6 and 7) and absent from the remaining four ecoregions (Table 11). No Douglas-fir/western hemlock vegetation type was identified within areas with an identified GAP level one or two protection. Within ecoregion 1A, approximately 59 acres of this vegetation type was identified on Green Diamond property in the Wiggins tract. A site-specific assessment of the area identified in the GAP analysis as Douglas-fir/western hemlock cover type was conducted by Green Diamond's forestry staff using field verification, timber inventory data, GIS data and local knowledge. This site-specific assessment indicated that there is no Douglas-fir/western hemlock cover type in this area. The vegetation is more correctly classified as the Douglas-fir vegetation type. Green Diamond's vegetation classification determination was reviewed by an independent third-party professional forester familiar with these vegetation types. The independent reviewer confirmed Green Diamond's conclusion that Douglas-fir/western hemlock cover type is not present in this area. There are significant areas of GAP level one or two protected pacific Douglas-fir in this and other ecoregions.

Figures 6 and 7: Ecoregions 1A and 1B.





Ecoregion 1B stretches along the coast from southern Oregon south to the Redwood Creek watershed. Approximately 1,370 acres of the Douglas-fir/western hemlock type was identified in California in this ecoregion, with approximately 930 acres of this type located in Green Diamond's Smith River tract. Although no areas receiving GAP level one or two protections were identified, 425 acres were identified on Green Diamond's lands that are within areas receiving GAP level 3 protection, primarily within RMZ HCVF areas. Although the RMZ conservation measures combined with the HCVF designation protections provide significant protection to the Douglas-fir/western hemlock types located with RMZ HCVF areas, additional protection will be provided to the larger concentrations of this cover type within the RMZ HCVF areas of the Smith River tract. Approximately 241 acres of Douglas-fir/western hemlock cover type in the Smith River tract have been identified as RSAs that will be provided GAP level 2 protection as no harvest zones.

Our conclusion from the current GAP analysis is that other than the Douglas-fir/western hemlock type in the Smith River tract, vegetation types within the ecoregions are adequately represented and protected for the maintenance of biodiversity. The public stakeholder meetings conducted as part of the HCVF process also facilitated identification of important ecosystems and protection status within Green Diamond's ownership and the neighboring ecoregions. Green Diamond will continue to monitor its ownership and the adjacent lands within the ecoregion as new information is developed and available to determine if future GAP analyses are warranted to gain better insight to representation and protection of biological resources.

In early 2022, Green Diamond conducted a review of the original GAP analysis conducted to identify RSAs within the FMU. The first level of review was to examine the data used in the original analysis. We used data from the USFS California Vegetation (CALVEG) Project and the USGS GAP Analysis Program's Protected Areas Database of the United States (PADUS) version 1.2. Our review was conducted prior to the release of PAD – US 3.0 (https://doi.org/10.5066/P9Q9LQ4B). A note exists on the USGS site regarding changes to PAD-US data; "We strongly discourage comparing two PAD-US versions to look for changes in protection status as many changes reflect improvements to agency and organization GIS systems and data, rather than actual changes in protected area acquisition on the ground." The USGS goes on to state that individual agencies and field offices are the best sources for time specific management practices. Based on this information, our knowledge of public lands and other protected areas within the ecoregions represented by the FMU, and our regular contact with these stakeholders, we concluded that protective status remained unchanged or increased since the last analysis. The Society of American Foresters (SAF) cover type classification system was used to identify vegetation types at the ecoregion level. We concluded that these data were still valid for the process of identifying RSAs within the FMU, and there was no need to conduct a new analysis based on different or new vegetation type data. Next, we examined Green Diamond's ownership with respect to ecoregion mapping. CALVEG Project ecoregion mapping was used to define the ecoregions that encompass Green Diamond's California ownership. There were no substantive changes in the FMU at review that warranted a new analysis based on ownership changes at the ecoregion scale. Therefore, the ecoregion mapping and SAF cover types used in the GAP analysis remained valid, and there was no change in representation at the ecoregion scale.
Given that: 1) the data used in the original analysis remained valid; 2) there were no substantive changes in the FMU that resulted in new vegetation cover types or ecoregions, and; 3) protective status of areas within the FMU remained unchanged, a new GAP analysis to identify or refine RSAs was not conducted in 2022. Green Diamond will continue to annually monitor acquisitions of new timberlands with respect to HCVF areas through FRIS data and the RRI process for THP development. In addition, future changes to the FMU that result in different vegetation types, ecoregions, and adjacent lands may warrant a new GAP analysis and review of designated RSAs.

6.10 Rare Ecological Communities (including plant communities)

Green Diamond has identified eight rare ecological communities following the assessment described below. The sites are mapped in GIS and are available to foresters, biologists and land managers so that impacts to these communities can be avoided or minimized during forest management activities.

An assessment for the presence of rare ecological communities within the FMU was conducted by comparing the list of Natural Communities[4] provided by CNDDB to plant species found within the FMU. Special attention was paid to determining whether any of the high priority vegetation types (S1-S3) were present or potentially present. Project level floristic surveys provide a record of all species found to be present, but plant community types are not necessarily reported as they are classified in the Manual of California Vegetation[5]. Therefore, expert knowledge and the presence of the dominant species that characterize the vegetation types were used to indicate presence or potential presence of each of the vegetation types on the FMU. In addition, expert knowledge was used to identify areas on the FMU which contain ecological communities that are very unique and rare within the FMU. Nearly three hundred high priority vegetation types were identified as present or potentially present within the FMU.

The vast majority of the high priority vegetation types that are present or potentially present are conifer and hardwood forest types. In most cases it is highly unlikely that there are any high-quality occurrences of these forest types on the FMU due to prior timber harvests, roads and other related impacts. However, the old growth stands, and true oak stands previously identified as HCVF and RSA will also be designated as rare ecological communities. In addition, since there are several grasslands associated high priority vegetation types, those grasslands that are HCVF will also be designated as rare ecological communities. Within the FMU, serpentine associated plant communities are rare and there are several rare plant taxa that may occur there, so the Rattlesnake Mountain Serpentine habitat that is identified as HCVF and RSA is also designated as a rare ecological community.

The process for assessing the presence and condition of rare ecological communities within the FMU yielded eight new rare ecological communities. Four of which were not previously identified and for which there are high-quality occurrences. Three of these are unique, montane wetland habitats in which rare plant taxa are known to occur. The fourth, Mt. Andy, is a unique geologic feature.

Christmas Prairie Lake rare ecological community (2 acres)
Rare Vegetation Community types present**:**
Vaccinium cespitosum (*Vaccinium cespitosum* (Dwarf bilberry meadows and mats) Alliance)
Sphagnum Bog

Rare Species present: *Carex arcta, Sanguisorba officinalis*
Other interesting species: *Calamagrostis sp., sphagnum, Carex vesicaria, Carex echinata, Carex aquatilis, Gentiana sceptrum, Dulichium arundinaceum, Vaccinium caespitosum, Spiraea douglasii*
Possible Dominant Species: *Calamagrostis sp., Carex species, Vaccinium caespitosum, Spiraea douglasii*

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[4] https://www.wildlife.ca.gov/Data/VegCAMP/Natural-Communities/List
[5] Sawyer, Keeler-Wolf, Evens. A Manual of California Vegetation, second edition. California Native Plant Society Press, 2009

Notes from surveys at Christmas Prairie Lake 2011-2012
Only a small portion of the area delineated as the rare vegetation community has been surveyed. The northern region of Christmas Prairie Lake contains flat lakeside meadows that are vernally inundated. These areas receive full sun and have a thin layer of peat upon which Sphagnum and other wetland and riparian species grow. Tufted *Calamagrostis* sp., sedges and rushes dominate the saturated soils nearest the lake while *Vaccinium caespitosum* and more prairie-associated species grow further upslope. There was no tree canopy cover over this area. Shrub cover was about 20% and the density was moderate. *Vaccinium caespitosum* and *Spiraea douglasii* were the dominant shrubs of the lakeside. Overall herbaceous cover was 90%. *Juncus* spp., *Carex* spp., and various grasses were the most abundant herbaceous plants with small amounts of *Senecio integerrimus* var. major, *Gentiana sceptrum* and *Eleocharis pachycarpa*. *Sanguisorba officinalis* and possibly some *Carex arcta* were found growing in this area

The western and southwestern margins of Christmas Prairie Lake had a mix of shrubs such as *Salix* sp., *Spiraea douglasii* and *Gaultheria shallon*, with patches of *Carex* spp. that were a mix of *Carex aquatilis*, *Carex vesicaria* and *Carex echinata*. *Carex arcta* was observed at the southern region of the lake margin. Unlike the northern region, these regions had coniferous forest that reached up to the margins of the lake on the west and southwestern sides.

Management Options: The conservation measures for this rare ecological community are specified under the riparian management measures of the FMP identified in section 6.3 Current Management Permits – Riparian Management and Section 6.8 High Conservation Value Forest Areas – Class I and II RMZs. Additional site-specific protection measures for rare plants will be identified during the THP process and through direct consultation with the California Department of Fish and Wildlife (also see FMP Section 6.5 Other Management Plans and Agreements – Sensitive Plant Conservation Plan (2008), Coastal Lagoons and Little River Botanical Management Plan (2008), and Property wide Programmatic Plant Protection Measures).

Snow Camp Lake rare ecological community (31 acres)
Rare Vegetation Community types present**:**
Abies concolor–Pseudotsuga menziesii (Abies concolor - Pseudotsuga menziesii / Corylus cornuta)
Calocedrus decurrens (Calocedrus decurrens - Abies concolor / Senecio triangularis)
Camassia quamash (Camassia quamash (Small camas meadows) Alliance)
Carex (aquatilis, lenticularis) (Carex aquatilis)
Sphagnum Bog

Rare Species present: *Carex arcta, Sanguisorba officinalis, Bensoniella oregona, Lycopodium clavatum, Platanthera stricta, Cornus canadensis, Erythronium revolutum*).
Other interesting species: *Calocedrus decurrens, Abies concolor, Spiraea douglasii, Vaccinium caespitosum*, sphagnum, *Gaultheria ovatifolia, Prunus emarginata, Camassia quamash (Camassia leichtlinii* ssp. *suksdorfii), Polygonum bistortoides, Caltha leptosepala, Carex aquatilis, Carex vesicaria, Carex echinata, Fritillaria affinis, Clintonia uniflora, Calamagrostis sp*.
Possible Dominant Species: *Spiraea douglasii, Vaccinium caespitosum, Carex sp., Abies concolor, Calocedrus decurrens, Salix* sp.

<u>Notes from surveys at Snow Camp Lake 2009-2012</u>
The immediate area that surrounded Snow Camp Lake alternated between marshy areas and drier, forested areas, where the trees seemed to be encroaching on the lakeshore from the forest. The trees were young and even-aged. The long branches of the trees in the overstory significantly added to the understory. Overstory canopy ranged from 0-95%. The trees were open to moderately spaced. Dominant overstory trees were: *Pseudotsuga menziesii var. menziesii* at 60% and *Abies concolor* at 40%. Dominant understory trees were: *Pseudotsuga menziesii* var. *menziesii* at 55%, *Abies concolor* at 30%, *Calocedrus decurrens* at 10%, and *Chrysolepis chrysophylla* var. *chrysophylla* at less than 5%. Shrub cover averaged less than 5%. Dominant shrubs were: *Rubus ursinus* at 75%, and young *Chrysolepis chrysophylla* var. c*hrysophylla* and *Rosa* sp. at 5% each. Overall herbaceous cover averaged 35%. Dominant herbaceous species were: *Circaea alpina* ssp. *pacifica* at 30%, *Pteridium aquilinum* var. *pubescens* at 10%, and *Hydrophyllum tenuipes*, *Smilacina stellata, Lupinus* sp., and *Tiarella trifoliata* var. *unifoliata* at 5% each. The herbaceous layer was very diverse. The soil at both the marshy areas and the drier areas was loam.

In-between the drier, forested areas were marshy areas. Few trees were present in the marshy areas. Overstory canopy ranged from 0-10% and averaged 5%. Dominant overstory trees were: *Abies concolor* at 50%, *Pseudotsuga menziesii var. menziesii* at 40%, and *Calocedrus decurrens* at 10%. Dominant understory trees were: *Calocedrus decurren*s at 80% and *Alnus rubra* at 20%. Shrub cover averaged 30%. Dominant shrubs were: *Spiraea douglasii* at 75%, *Vaccinium caespitosum* at 10%, *Rubus ursinus* at 5%, and *Amelanchier utahensis* at less than 5%. Overall herbaceous cover averaged 95%. Dominant herbaceous species were: *Juncus effusus* at 20%, *Caltha leptosepala* var. *biflora* and *Carex* spp. at 15% each, and *Xerophyllum tenax* and *Pteridium aquilinum* var. *pubescens* at 5% each. The dominant *Carex* species was *Carex aquatilis*, but several other unknown *Carex* species were present.

Directly south of Snow Camp Lake, a wide, saturated to inundated marshy area was present that tapered closer to Snow Camp creek's banks, farther south. The vegetation was diverse. The overstory was mostly open (ranging from 0-5%) as few trees were present in this area. Dominant overstory trees were: *Pseudotsuga menziesii* var. *menziesii* at 75%, *Abies concolor* at 10%, and *Calocedrus decurrens* at 5%. *Alnus rubra* was the dominant understory species. Shrub cover averaged 5%. Dominant shrubs were: *Salix* sp. at 75%, and *Ribes lobbii* at 5%. Overall herbaceous cover averaged 90%. Dominant herbaceous species were: *Juncus effusus* at 45%, *Aster* sp. at 15%, *Caltha leptosepala* var. *biflora* at 10%, and *Corallorhiza maculata*, *Tiarella trifoliata* var. *unifoliata*, *Dicentra formosa*, and *Hydrophyllum tenuipes* at 5% each. *Bensoniella oregona* was also dominant in the herbaceous layer at less than 5%. The soil in this area was silty.

The north side of the lake has an open area that is dominated by shrubs and hummocks of *Xerophyllum tenax* just up from the shore. The immediate lake margin is dominated by *Carex* spp. The east side of the lake has coniferous forest that comes very close to the lakeside. The south side has a creek that drains from the lake and spreads out into a wet meadow dominated by herbaceous species intermixed with woody debris. The west side has some forested area that is directly adjacent to the lake, but also a wide, open meadow that stretches from the west to the banks of the lake. This open, wet meadow is dominated by *Carex* spp., *Calamagrostis* sp., *Vaccinium caespitosum* and *Spirarea douglasii*. The shrubs form patchy thickets and the sedges and grass form dense hummocks along the shore.

Management Options: The conservation measures for this rare ecological community are specified under the riparian management measures of the FMP identified in section 6.3 Current Management Permits – Riparian Management and Section 6.8 High Conservation Value Forest Areas – Class I and II RMZs. Additional site-specific protection measures for rare plants will be identified during the THP process and through direct consultation with the California Department of Fish and Wildlife (also see FMP Section 6.5 Other Management Plans and Agreements – Sensitive Plant Conservation Plan (2008), Coastal Lagoons and Little River Botanical Management Plan (2008), and Property wide Programmatic Plant Protection Measures).

Roddiscraft Sphagnum Bog rare ecological community (6 acres)
Rare Vegetation Community types present:
Sphagnum Bog
Camassia quamash (*Camassia quamash* (Small camas meadows) Alliance)

Rare Species: *Cornus canadensis, Erythronium revolutum*
Other interesting species: *Calamagrostis sp., Carex vesicaria, Carex echinata, Carex luzulina, Gaultheria ovatifolia, Taxus brevifolia, Polygonum bistortoides, Camassia quamash (Camassia leichtlinii ssp. suksdorfii), Lilium pardalinum*, sphagnum
Possible Dominant Species: *Calamagrostis sp., Carex sp., Gaultheria shallon, Pseudotsuga menziesii var. menziesii*

Notes from survey at Roddiscraft 2009
From the Roddi-Snow Camp THP: There was a very large wet meadow along the west side of the unit. The outer portions of the meadow are seasonally dry. To the northeast, the meadow turned into a pond, and then into a narrower wet meadow with a creek. This is the headwaters of one of the tributaries to Pardee Creek. Herbaceous cover was 100% in the meadow itself, and less as the meadow transitioned into forest. There were only a few *Taxus brevifolia*, *Alnus rubra*, and *Pseudotsuga menziesii* var. *menziesii* within the meadow. Overstory canopy over the meadow ranged from 0-45%. Shrub density was open, averaging 15%. Dominant shrubs were: *Gaultheria shallon* at 75%, *Rubus ursinus* at 10%, and *Vaccinium parvifolium* and *Gaultheria ovatifolia* at 5% each. The most dominant herbaceous species were: *Calamagrostis* sp. at 25%, and *Carex* spp. at 20%. Also dominant, but less abundant were *Senecio triangularis* at approximately 7%, and *Cornus canadensis*, and *Tiarella trifoliata* var. *unifoliata* at 5% each. Two species of Anemone were also present, *Anemone deltoidea* and *Anemone oregana*. Together they made up approximately 5% of the herbaceous layer. Some of the dominant *Carex* species within the meadow included: *Carex vesicaria*, *Carex luzulina* var. *ablata*, and *Carex echinata*.

Management Options: The conservation measures for this rare ecological community are specified under the riparian management measures of the FMP identified in section 6.3 Current Management Permits – Riparian Management and Section 6.8 High Conservation Value Forest Areas – Class I and II RMZs. Additional site-specific protection measures for rare plants will be identified during the THP process and through direct consultation with the California Department of Fish and Wildlife (also see FMP Section 6.5 Other Management Plans and Agreements – Sensitive Plant Conservation Plan (2008), Coastal Lagoons and Little River Botanical Management Plan (2008), and Property wide Programmatic Plant Protection Measures).

Mt. Andy rare ecological community (81 acres)
Rare Vegetation Community types present:
Quercus garryana shrub (*Quercus garryana* (Brewer oak scrub) Alliance)
*likely others but this area has been poorly surveyed

Rare species**:** *Gilia capitata* ssp. *pacifica*, *Piperia* sp.
Other interesting species: *Minuartia* sp., *Quercus chrysolepis*, *Ceanothus cordulatus*, *Quercus garryana* var. *breweri* (shrub type), *Eriogonum nudum*, *Eriophyllum lanatum*, *Clarkia amoena* (not *whitneyii*), *Garry fremontii*
Dominant Types: The area directly on top of Mt. Andy can be characterized as being dominated by a mix of *Quercus garryana* var. *breweri* and *Quercus chrysolepis* with herbaceous associates of *Clarkia amoena*, *Eriogonum nudum*, *Minuartia* sp. and *Eriophyllum lanatum*.

Notes from survey at Mt. Andy 2013
The area of Mt Andy that was surveyed was largely barren and composed of flaky and crumbly rock that was referred to as chert. There was patchy, intermittent cover of *Quercus garryana* var. *breweri* and *Quercus chrysolepis* with occasional *Ceanothus cordulatus, Arctostaphylos* sp. and *Garrya fremontii*. There were only a couple, small Douglas-fir and incense cedar trees. Small, scattered herbaceous cover was evenly distributed across the barrens and consisted of *Clarkia amoena*, *Eriogonum nudum*, *Minuartia* sp. and *Eriophyllum lanatum*. The majority of the mountain consisted of a very steep slope carved with numerous swales and ravines through a barren landscape. The actual area that was capable of being surveyed was very little in comparison to the rest of the mountain and consisted mostly of just the narrow ridgeline at the summit.

Management Options: Timber harvest is likely to occur around the margins of this area. As THP units are planned in the vicinity of the identified rare community, on-the-ground site assessments will occur to ensure that the rare community is correctly identified. The boundaries will be revised based on site specific assessments as they occur. The management objectives for this area will be to avoid management activities that would lead to conversion of this community type and to encourage management activities that promote the retention of this vegetation type. Vegetation type conversion by site preparation and tree planting will not occur. Roads will be planned to avoid this area to the extent feasible. Road construction to access surrounding forest will be allowed. Maintenance of existing roads in this area may occur.

Old Growth stands:
The 659 acres of old growth stands identified as HCVF and RSA will also be designated as rare ecological communities. Although significant areas of old growth are permanently protected in State and National parks in Northern California, there are relatively few old growth stands located on private timberlands in these ecoregions. The limited amount of old growth timber

stands located on private land, and the location of Green Diamond's old growth stands make designation as a rare ecological community appropriate. Timber harvest is excluded from these areas as described in the HCVF area discussion.

True Oak stands:
Green Diamond has identified 577 acres of true oak stands as HCVF areas. Forested areas that are dominated by true oaks (primarily white oak or black oak) provide unique habitat elements within Green Diamond's forested ownership. This type of forest habitat is often referred to as oak woodland. The nature of oak woodland habitat varies from relatively small oak patches adjoining grassy openings or intermixed with surrounding conifer forest, to large expanses of oak woodlands typically associated with grass dominated ridges. The oak woodlands are typically present around the margins of the larger grass openings and gradually blend into surrounding conifer forests. For this HCVF analysis, true oak stands are primarily identified as forest stands twenty acres and larger that have recent inventory data indicating the stand is dominated by true oaks (generally 70% or more by basal area) and is composed of larger, mature trees. Often these stands are associated with grass openings. Inventory data, aerial imagery and local knowledge were used to identify the best examples of these true oak stands. Management options for this community type are described in the HCVF discussion of the FMP.

Grasslands:
Grassland, prairie and grass dominated openings provide unique habitat elements within Green Diamond's forested ownership. The nature of the habitat varies from relatively small grassy openings surrounded by conifer forest to relatively large expanses of grassland ridges and swales trending into oak woodlands and conifer forest. Non-forest lands typed as grasslands that were generally twenty acres and larger within Green Diamond's ownership were considered for classification as grassland HCVF. Areas that are less than twenty acres are considered for inclusion if they are part of larger native grasslands that cross property boundaries or are connected to a true oak HCVF area. This assessment was based on existing vegetation typing. As site specific assessments associated with project planning are developed (e.g. THP layout, timber typing, timber cruising, botanical surveys), this new information will be used to revise and update the grassland HCVF delineations. The conservation measures that will be applied to this area are described in the HCVF section of the FMP.

Rattlesnake Mountain Serpentine Habitat:
The 2,098 acres of HCVF serpentine habitat area along Rattlesnake Ridge has also been identified as an RSA. Although this habitat type is regionally abundant on federal lands in this ecoregion, this habitat type is uncommon on commercial timberlands to the west and has regional significance due to the habitat it provides for the Coastal (or Humboldt) Marten. This animal is currently being considered for listing by the Fish and Wildlife Service. Green Diamond track-plate and camera survey efforts have documented this animal in the designated HCVF/RSA area. Based on the survey work, the HCVF/RSA area is one of the westernmost habitat areas in the range of the marten. The conservation measures that will be applied to this area are described in the HCVF section of the FMP.

6.11 Riparian Canopy Experiment

The AHCP includes a provision for an experimental investigation of management prescriptions that might yield benefits to the covered species – coho and Chinook salmon, steelhead, rainbow and cutthroat trout, tailed frogs and torrent salamanders. Green Diamond has been in the process of developing a watershed level experiment since shortly after the approval of our AHCP in conjunction with numerous collaborators including Humboldt State University, Oregon State University, USGS, U.S. Forest Service and others. The conceptual framework for the experiment is focused on the response of stream systems to modifications of the riparian canopy that would increase the amount of solar radiation reaching the stream. The fundamental premise is that increases in sunlight will increase primary productivity in the stream ecosystem. Field experiments have been designed and implemented to test effects of modifications to the riparian canopy on aquatic species and their habitat.

The objectives of these studies are to evaluate the response in terms of growth and abundance of selected key aquatic organisms including juvenile salmonids, a headwater amphibians, macro-invertebrates and algae to manipulations of canopy openings. In particular, the experiment will be sensitive to impacts on water quality, large woody debris recruitment and non-fish aquatic species. The outcome of these investigation may trigger the adaptive management provision of Green Diamond's AHCP leading to riparian management prescription changes.

The experiment is being conducted at both the stream reach and watershed level in multiple sub-basin watersheds of the Lower Klamath River).

Pilot Project: SF Ah Pah Creek

A pilot study was initiated on a single stream reach with several objectives. We evaluated the feasibility of marking and removing riparian trees as part of a timber harvest operation to achieve an approximate 50% overstory canopy cover post-harvest. We also monitored the treated reach to determine if there was any evidence of bank erosion or measured increases in turbidity/suspended sediments or any biologically significant increases in water temperature in the treatment or downstream reaches relative to the water entering the upstream portion of the treatment reach. Although the primary objectives were related to the physical variables, prior to conducting the treatment (i.e., felling of riparian canopy trees), we also captured and marked juvenile cutthroat and steelhead trout and coastal giant salamanders to test field methodologies and to provide an opportunity to record movements and growth. The data collected on the physical variables with potential for negative impacts were evaluated from this pilot treatment to ensure that treatment of additional stream reaches was warranted and unlikely to produce negative biological impacts.

The pilot study was located on Green Diamond's ownership in the South Fork (SF) Ah Pah Creek sub-basin. The single riparian treatment was conducted on an approved Timber Harvesting Plan (GDRCo # 56-1302; CalFire # 1-13-106HUM, Unit B) in SF Ah Pah Creek. The RMZ along the west side of SF Ah Pah Creek in Unit B was marked by a forester to achieve approximately 50% overstory canopy after the trees were felled and yarded out of the RMZ. Trees marked for harvest included alder, maple, bay, tanoak, hazelnut, and cascara. The marked trees with commercial value were yarded out of the RMZ, wherever feasible. The stream reach immediately upstream of the treated RMZ serves as a control for all the physical variables recorded in and immediately downstream of the treated reach. A 100-m reach immediately above and below the treated reach serve as biological control areas for recording movement and growth response of marked juvenile cutthroat and steelhead trout and coastal giant salamanders.

Felling of the harvest unit was completed on 3/31/2015 and yarding was completed by 4/3/2016. Monitoring associated with the Pilot Project in SF Ah Pah Creek is complete and a final report is being prepared.

Class I Riparian Canopy Experiment: Upper Tectah Creek

The watershed level riparian canopy experiment is located on Green Diamond's ownership in Tectah Creek, tributary to the Lower Klamath River Basin. The riparian treatment areas were incorporated into a Timber Harvesting Plan (GDRCo # 56-1601; CalFire # 1-16-091HUM) along Class I stream segments in Upper Tectah Creek. The target overstory canopy retention level post-harvest within the treatment reaches is 50%. Based on information learned from the pilot project in SF Ah Pah Creek, canopy will be removed along both sides of the stream in each treatment reach to ensure adequate solar radiation reaches the stream to observe a treatment response. Trees marked for harvest included alder, maple, tanoak, madrone, Douglas-fir, redwood, and hemlock. The marked trees with commercial value will be yarded out of the RMZs, wherever feasible. Stream reaches immediately upstream of the experimental RMZs serves as the control for each harvest unit and the stream reach immediately downstream of the treated RMZs serves as the downstream response for each harvest unit. Monitoring associated with this experiment is primarily being conducted in conjunction with a research project by David Roon (PhD candidate from Oregon State University), who's dissertation research also includes studying the riparian thinning restoration being conducted along Middle Fork Lost Man Creek in Redwood National Park.

The objectives of the study are to 1) determine how changes in canopy cover and light associated with riparian thinning will affect thermal regimes within the stream network, 2) determine how stream food web structure shifts to changing riparian canopy conditions associated with the experimental thinning treatments, 3) determine if thermal or trophic pathways are responsible for driving potential changes in growth, production, and bioenergetics for cutthroat trout, and 4) evaluate cumulative watershed effects associated with riparian thinning for aquatic ecosystems using a food web system dynamics model.

Pre-treatment data collection for the project began in 2015 and 2016. Felling and yarding activities of the harvest units occurred in 2017. Post-harvest data collection began late summer of 2017 and continued into the fall of 2018 concluding the data collection effort by the PhD candidate. Green Diamond has continued to collect summer water temperature data and hemispherical photography at all the sites through 2020 for further post-harvest data analysis. Dave Roon has prepared preliminary drafts of chapters of dissertation and is on track to be completed with the project by the end of the 2020 fall term.

Class II Riparian Canopy Experiment: Lower Klamath River tributaries

Concerns about the effects of forest management activities on riparian function have led to aspects of the California FPRs, specifying regulations for operations within RMZs and development of the riparian requirements in the Green Diamond's AHCP. However, the effectiveness of the RMZs at maintaining or restoring key riparian and aquatic functions in Class II watercourses have not been thoroughly examined.

The title of this project is "Effectiveness of Class II Watercourse and Lake Protection Zone (WLPZ) Forest Practice Rules (FPRs) and Aquatic Habitat Conservation Plan (AHCP) Riparian Prescriptions at Maintaining or Restoring Canopy Closure, Stream Water Temperature, Primary Productivity, and Terrestrial Habitat." It is a collaborative project with Oregon State University, CalFire, CDFW and Green Diamond that is being funded by the Effectiveness Monitoring Committee of the California Board of Forestry, CalFire and Green Diamond. This project is evaluating whether the current Class II riparian requirements/regulations are effective at maintaining, protecting, and restoring (a) canopy closure, (b) stream water temperature, and (c) primary productivity. This study is also examining what stream and riparian forest characteristics are important for determining the effectiveness of the RMZs. A Before-After Control-Impact (BACI) study design is being utilized in several sub-basins on Green Diamond's Lower Klamath River property. Eighteen Class II-2 (Class II-L) stream reaches were selected to evaluate RMZ stand structure, canopy closure, upstream/downstream water temperature, and primary productivity response under varying riparian prescriptions. RMZ prescriptions include, (a) ASP Coastal Anadromy Zone Class II-L Prescription - 30 foot core zone; 70 foot inner zone with 80 percent overstory canopy cover, (b) GDRC Class II-2 Prescription - 30 foot inner zone with 85 percent overstory canopy; 70 foot outer zone with 70 percent overstory canopy cover, and (c) alternative prescription resembling pre-ASP prescription - 100 foot zone with 50 percent overstory canopy.

Pre-treatment data collection for the project began in 2019 and 2020. Falling and yarding activities of the harvest units began in 2020 and will continue throughout the summer. Post-harvest data collection will continue into the spring of 2023.

6.12 Conservation Partnerships

The Lower Klamath Restoration Partnership (LKRP), formed in 1995, is composed of The Yurok Tribe and they provide personnel, administration, planning, and logistical support. Green Diamond provides access to their Lower Klamath land holdings, heavy equipment support, materials and supplies, and financial and logistical support. The California Coastal Conservancy facilitated the formation of the Lower Klamath River Restoration Program, by providing funding for both planning and project implementation.

It is the goal of the LKRP to restore aquatic habitat conditions within Lower Klamath River tributaries to a level that supports viable, self-sustaining populations of native salmonids. This goal will be accomplished through treatment of road networks and upslope sediment sources, improvement of instream and riparian habitats, and through interaction with public and private landowners to implement improved long-term land management practices in the sub-basin.

Specific goals of the LKRP include:

· **Protect and restore existing healthy areas first**. Protection of key healthy areas is much more certain and less expensive than the restoration of degraded areas. In addition, relatively healthy areas provide the source populations for recovery in other locations. On the other end of the spectrum are watersheds that have undergone extreme habitat degradation. These watersheds could absorb large amounts of money and effort with little chance of recovery in the foreseeable future. Restoration in these areas should be postponed until protection and restoration efforts are completed in areas that are more productive.

· **Improve stream/riparian habitat in priority watersheds**. A corollary to protection of “the best,” is restoration of “adjunct” habitats that historically supported healthy fish populations but are currently lightly to moderately degraded. Efforts to improve watershed and aquatic conditions in these areas will likely aid fish populations in the long term.

· **Provide jobs training and quality employment opportunities**. Implementation of watershed restoration activities will provide long-term stable employment opportunities for qualified tribal applicants. Many of the potential long-term restoration activities, such as road decommissioning, would involve technical skills requiring specialized training.

Numerous restoration projects have been completed on Green Diamond’s lands since the initiation of the LKRP. The types of projects have included assessments to identify and prioritize restoration areas, in-stream restoration work and upslope restoration work. The projects have occurred in Terwer, Hunter, McGarvey, Tectah, Ah-Pah and Blue Creek. More than $9.2 million has been invested in this restoration work since 1995. The primary funding sources have been DFG (now CDFW) and USFWS, however Green Diamond has contributed over $1.3 million in cash and in-kind services toward the completion of these projects.

Examples of recent projects include:

- **U900 Lower Klamath River Road Decommissioning and Erosion Prevention Project** - Remove 17 major stream crossings, landslides and ditch relief culverts with the potential of delivering over 10,699 $yrds^3$ of sediment above prime spawning grounds.
- **H100 Lower Klamath River Road Decommissioning and Erosion Prevention Project** - Remove 53 major stream crossings, landslides and ditch relief culverts with the potential of delivering over 25,717 $yrds^3$ of sediment above prime spawning grounds.
- **East Fork Hunter Creek Phase I Stream and riparian enhancement** - Planted 2,075 coastal redwood and 635 Douglas-fir saplings in riparian habitats, conducted pre-project topographic surveys and photo-monitoring, install 16 constructed wood jams (CWJs).
- **Lower Terwer Creek/Lower Arrow Mills Bioengineering** - Construct an engineered log jam and augment a previously constructed wood jam, planted the project area with native willow cuttings to help prevent bank erosion.

- **Upper Tectah Creek Restoration Logging** - Worked with Green Diamond forester to harvest whole trees (i.e., with rootwads) from a timber harvest unit in upper Tectah Creek. Harvested 231 whole trees for restoration projects LWD in the Lower Klamath basin.
- **Lower Terwer Creek Cattle Exclusion** - Constructed cattle exclusion fence to keep cattle from impacting riparian habitat.

Section 7 – Monitoring, Research, Reporting and Adaptive Management Program

Green Diamond has an extensive monitoring, research and reporting program that includes timber inventory and related issues, biological resources, environmental impacts, social issues and economic/business management issues. The majority of our biological and environmental monitoring is conducted to comply with our permits and agreements. Monitoring and reporting that is tied to our permits and agreements is typically summarized in periodic reports that are submitted to state and federal agencies for review. These monitoring and reporting documents are available to the public on Green Diamond's internet site. The monitoring and reporting that is internally driven, such as inventory information, economic or business management information, and social issues, includes a combination of confidential information and information that is made available to the public. The public information is available on Green Diamond's internet site. The confidential information is made available on a limited basis to Green Diamond management and auditors.

A summary of Green Diamond's monitoring, research and reporting is provided below and a list of monitoring and reporting subjects by department and permit or agreement is provided at the end of this section. Copies of the most recent public monitoring and reporting documents can be found at: www.greendiamond.com.

<u>AHCP</u>

The monitoring component of the AHCP evaluates the success of the conservation program in achieving the biological goals and objectives of the AHCP. Over time, better ways to manage watersheds that may further benefit aquatic species and their habitats may emerge. The monitoring and adaptive management programs were developed to incorporate new information into practice as it becomes available.

Current AHCP monitoring measures include:

1. **Rapid Response Monitoring:** Provides early warning signals to ensure that the biological goals and objectives of the AHCP will be met.
    - Annual property-wide water temperature monitoring in Class I and Class II watercourses
    - Tailed frog monitoring
    - Southern torrent salamander monitoring
    - Implementation and effectiveness monitoring of road management measures

- Road maintenance assessments

2. **Response Monitoring:** Monitors the effectiveness of the conservation measures in achieving the biological goals and objectives of the AHCP.
    - Class I channel monitoring

3. **Long-term Trend Monitoring/Research:** Have the potential to provide feedback for adaptive management, but in some circumstances, decades may be required before that can occur.
    - Steep streamside slope delineation study
    - Steep streamside slope assessment
    - Mass wasting assessment
    - Long-term habitat assessments
    - Large woody debris monitoring
    - Summer juvenile population estimates
    - Out-migrant trapping
    - Turbidity threshold sampling

4. **Experimental Watersheds Program:** Watersheds, judged to be representative of the different geologic and physiographic provinces across the AHCP area have designated for additional monitoring and research on the interactions between forestry management and riparian and aquatic ecosystems.
    - Little River (Little River Hydrographic Planning Area (HPA))
    - South Fork Winchuck River (Smith River HPA)
    - Upper Tectah Creek, Little Surpur Creek and Ah Pah Creek (Coastal Klamath HPA)

AHCP monitoring is reported in the AHCP Biennial Report submitted every two years to NMFS, USFWS, CDFW and NCRQCB. The items addressed in the Biennial Report are listed in Table 12 at the end of this section.

MATO and RMWDR

The MATO and RMWDR enable Green Diamond to implement the comprehensive Road Management Plan described in the AHCP. A discussion of the AHCP, the MATO and the RMWDR is provided in Section 6.3 of this Management Plan. A fundamental component of the MATO and RMWDR monitoring and reporting programs is a sediment source inventory of all road-related sediment sources tracked for treatment as part of AHCP section 6.2.3.1. The sediment source inventory is maintained as a database by Green Diamond. An Annual Work Plan is produced each year that summarizes the road upgrading work planned for the year. The annual work plan is submitted to CDFW and NCRWQCB for review and approval. The annual work plan forms the basis for other monitoring and reporting.

The monitoring and reporting required by the MATO includes:

- monthly water drafting reports that summarize the monitoring of water drafting operations,
- an Annual Report that summarizes the completions and inspections for the annual work plan projects and summarizes the monthly water drafting reports, and
- a four-year status report to assess the effectiveness of the MATO's conservation measures on protected species.

The monitoring and reporting required by the RMWDR includes:

- the submission of monthly post-winter monitoring reports to summarize the progress of post-winter inspections at road work sites.
- an Annual Report that summarizes the inspections and work completed as part of the annual work plan.

FMWDR

A discussion of the FMWDR is provided in Section 6.3 of this Management Plan. The FMWDR builds on the work outlined in the AHCP, MATO and RMWDR and incorporates the monitoring and reporting included in those documents. The FMWDR includes a monitoring and reporting program to ensure that Green Diamond complies with FMWDR, to track activities covered under the FMWDR, and to evaluate the effectiveness of the FMWDR in protecting and restoring the beneficial uses of water. The FMWDR requires that non-road related sediment source treatment sites that are part of a THP are inspected or monitored twice after treatment to evaluate the implementation and effectiveness of the completed treatment. The results of these inspections are reported to NCRWQCB as part of an annual summary provided for each THP. A copy of the AHCP post-harvest report form is included as part of the final certification notice for the THP.

The FMWDR also includes monitoring and reporting requirements specific to the Elk River drainage. Monitoring specific to the Elk River watershed includes:

- Master inventory of all sediment sources.
- Inventory of road related sites after completion of master inventory treatment sites,
- South Fork Elk River sediment reduction effectiveness monitoring,
- Landslide monitoring, and
- Water quality trend monitoring

Reporting specific to the Elk River includes:

- Annual update to the master inventory
- Annual report of Elk River sediment reduction effectiveness monitoring
- Annual Harvest Reports
- Annual summary of water quality trend monitoring
- Summary of landslide monitoring

Option A

The Option A is Green Diamond's sustained yield planning document required by the California Forest Practice Rules. Green Diamond maintains confidential timber inventory, timber harvest records and timber growth records that are used for internal monitoring and reporting. A confidential Annual Forest Inventory Report is produced each year. The confidential information is made available on a limited basis to management and auditors. Specific to the Option A document, Green Diamond submits an annual confidential report to CalFire that summarizes acres harvested by silvicultural system, and volume harvested, for the previous calendar year that documents our compliance with the sustained yield document.

Sensitive Plant Conservation Plan

Green Diamond's close work with CDFW and commitment to identify and protect the sensitive botanical resources that exist on Green Diamond property has led to the development of the ownership-wide Sensitive Plant Conservation Plan (SPCP). The intent of the SPCP is to enable sensitive plant species to persist in their preferred habitats on Green Diamond lands, while providing flexibility to Green Diamond in the management of their lands for timber production. The SPCP is based on the understanding that the most efficient and effective approach to the long-term conservation of sensitive plants on Green Diamond lands is through adaptive management that is informed by appropriate inventory, monitoring and research. The inventory, monitoring and research efforts that are conducted as part of the SPCP is summarized in the Annual Year-end Summary Report for the Botanical Season and provided to CDFW.

NSO Core Areas

Green Diamond conducts extensive monitoring and reporting on NSOs and NSO habitat for the conservation measures contained in the FHCP. This monitoring and reporting began in 1992 with the NSO HCP and has continued with implementation of the FHCP.

Marten Safe Harbor Agreement

The monitoring plan for the Marten SHA is located as Attachment 2 in the Marten SHA on Green Diamond's website and can be referenced here:
https://www.greendiamond.com/downloads/Safe_Harbor_Agreement_for_Humboldt_Marten.pdf
The results of monitoring under the Marten SHA can be found in annual reports that are submitted to CDFW and are posted on Green Diamond's website here:
https://www.greendiamond.com/downloads/2022_Marten_Safe_Harbor_Agreement_Annual_Report.pdf

Forest Habitat Conservation Plan

The FHCP includes an extensive monitoring program that is described in Section 5 of the plan that can be referenced here:
https://www.greendiamond.com/downloads/Forest_Habitat_Conservation_Plan.pdf

The results of various other monitoring programs will be reported in annual reports that are submitted to the USFWS and CDFW.

Illness and Injury Prevention Program

Green Diamond has developed and implemented an Injury and Illness Prevention Program as required under California law. The IIPP includes record keeping, monitoring and reporting. Green Diamond's Human Resources and Safety Manager is responsible for coordinating and monitoring compliance with the IIPP. The Human Resources and Safety Manager maintains a safety training database to track compliance with training requirements and provides monthly, quarterly and annual summaries of safety statistics and IIPP compliance.

Annual Plan/Budget

Green Diamond's Finance and Accounting Department produces a comprehensive confidential annual plan that includes budget and production information by department. The annual plan is monitored by the accounting department and confidential monthly updates are provided to managers to ensure that each department is on track to attain production goals and is operating within budget. The annual plan, monthly updates as well as quarterly and annual review documents are all confidential internal documents that are provided to managers and auditors on a limited basis.

High Conservation Value Forest (HCVF) Monitoring

Green Diamond has identified nine categories of HVCF as discussed in Section 6.7 of this Management Plan. The monitoring associated with each HCVF category is summarized below:

Conservation Easement (CE) areas – These areas are identified as fully protected areas in FRIS, Green Diamond's GIS. FRIS will be used to monitor these areas to ensure that no Green Diamond projects are proposed in the CE areas. Save the Redwoods League has been designated as the easement holder and are responsible for all other monitoring. Green Diamond will report annually on the status of the CE areas and will summarize any monitoring reports provided by Save the Redwoods League.

Old-growth - These areas are identified as fully protected areas in FRIS. FRIS will be used to monitor these areas to ensure that no Green Diamond projects are proposed in the old-growth areas. Green Diamond will report annually on the status of the old growth areas

Class I and II RMZs - Implementation of RMZ conservation measures is accomplished and monitored through the THP process. RMZ effectiveness monitoring is addressed as part of the overall AHCP monitoring program. The ACHP Biennial Report summarizes the both the implementation of RMZ conservation measures on approved AHCP THPs and the effectiveness of the conservation measures.

NSO core areas - Green Diamond conducts extensive monitoring and reporting on NSOs and NSO habitat for the conservation measures contained in the FHCP.

True oak stands and naturally occurring tan oak stands – The cover types that have the criteria to qualify as one of these HCVF areas are identified in FRIS. As new and updated inventory information is added to FRIS, that data will be analyzed to determine if additional HCVF areas that meet these criteria are present. As new areas are identified, they will be added to the FRIS HCVF layer. Foresters and other project managers will check the FRIS HCVF layer as part of their project planning process to determine if the proposed project is adjacent to an identified true oak or tan oak HCVF area. These areas will be "ground-truthed" by foresters as THPs are planned and fieldwork is conducted in the vicinity of these identified stands. Site specific stand conditions will be used to identify these HCVF areas in the field and to design projects that protect the conservation values of the areas. The site-specific field information will be used to update the FRIS HCVF mapping for these areas. FRIS data will be used to monitor these areas annually and Green Diamond will provide an annual summary report on any changes to these stands.

Rattlesnake Ridge serpentine soils area – The non-timber cover types in the Rattlesnake Ridge area have been identified in FRIS as HCVF areas. Foresters and other project managers will check the FRIS HCVF layer as part of their project planning process. The identification of these non-timber cover types was based on timber typing using color aerial photography. Changes in this cover type that occur due to new or updated inventory data, vegetation typing, or site-specific assessments related to project planning will be monitored and reported annually.

Grass openings – Grass cover types have been identified in FRIS as HCVF areas. Foresters and other project managers will check the FRIS HCVF layer as part of their project planning process. The identification of grass cover type was done using color aerial photography. Changes in grass cover types will be monitored and reported as updated aerial imagery is acquired. Changes that result from planned projects or natural disturbance will be reported annually.

Cultural Sites - Cultural sites that have the potential to be impacted as a result of Green Diamond's operations are addressed in project specific confidential archaeological reports. Local tribal representatives are contacted during the preparation of the archaeological report, and when cultural sites are known to be in the project area or are discovered in the project area, their input is specifically requested. If operational restrictions are needed to protect a cultural site, those restrictions are made part of the THP and are enforceable through the THP inspection and completion process. Operations at these sites are monitored by RPFs during operations, and at the completion of operations, CalFire inspects the sites to ensure that all protection measures were implemented and to assess effectiveness. If a protection measure was not implemented as required in the THP, CalFire would likely issue a notice of violation for that THP. In that event, the violation would be monitored and reported as indicated below. All other information regarding cultural sites is kept confidential.

Social Impact Monitoring

Green Diamond has developed a stakeholder consultation program as described in Section 14 of this management plan. Stakeholder outreach, stakeholder comments and management consideration of stakeholder comments are tracked and monitored by the Forest Policy and Communications Department. An Annual Summary of Social Impact monitoring will be provided on Green Diamond's internet site.

Herbicide Monitoring

Green Diamond's use of herbicides is addressed in Section 5.1.8 of this Management Plan. Green Diamond monitors the acres treated, chemicals used, amounts used, application method and reason for use of applications. According to the California Department of Pesticide Regulation (DPR), California's pesticide use reporting program is the most comprehensive in the world. California regulations require full reporting of agricultural pesticide use to the DPR, who can then provide the public with comprehensive pesticide use data. Under the DPR program, all agricultural pesticide use must be reported monthly to county agricultural commissioners, who in turn, report the data to DPR. Green Diamond complies with DPR regulatory program and Green Diamond's herbicide application contractors report all agricultural herbicide use to the appropriate County Agricultural Commissioner. Pesticide use will be reported in an annual summary of pesticide and other chemical use report and will be made available on Green Diamond's internet site.

Other Monitoring and Reporting

Green Diamond monitors and reports on a variety of other business related and social issues including:

- Number of employees tracked and reported monthly,
- Summary results of 5-year post-planting stocking surveys are summarized and reported when available,
- Charitable giving, including community donations and scholarships are tracked and reported with annual summaries.
- Money spent in the local community on good and services.

The following table lists the monitoring and reporting described above by department and relevant permit or agreement and the reporting document.

Adaptive Management

Monitoring and adaptive management form a key component of Green Diamond's science-based approach to management. Extensive assessment and monitoring of the Company's resources has been conducted throughout the company and the ownership, and much of the Company's management practices summarized in this plan are based on the results of these studies.

The monitoring and adaptive management program provide the framework needed to ensure that Green Diamond's objectives are met, and if necessary, to fine-tune specific measures through adaptive management. Adaptive management has two key features: 1) a direct feedback loop between science and management, and 2) the use of management strategies as a scientific experiment. The majority of the monitoring and adaptive management program described in this Management Plan is designed to provide a feedback loop between science and management. There is a detailed adaptive management plan included in section 6.2.6 of the AHCP that incorporates both of these features. First, there are measurable thresholds associated with specific monitoring projects, which if exceeded, trigger corrective action to provide the direct link between science and management. Second, the implementation of specific management measures in selected watersheds will be designed to work in concert with monitoring projects as a scientific experiment.

Table 12: Green Diamond Monitoring and Reporting Program: Ongoing monitoring and reporting by department, permit or agreement and reporting document.
(Underlined documents are available at: www.greendiamond.com)

Conservation Planning Department

Permit or Agreement: AHCP

Reporting document: AHCP Biennial Report to NMFS and USFWS

- Summary of AHCP Conservation Measures for Approved AHCP THPs
- Summary of Post-harvest Information for Completed THPs
- Summary of Land Transactions and AHCP Plan Area Adjustments
- Summary of AHCP Employee and Contractor training programs
- Summary of the number of sites, volume of sediment savings and total costs of treating high and moderate priority sites
- Annual inspections and maintenance of all mainline and appurtenant roads
- Steep Streamside Slopes (SSS) Delineation Plan
- SSS Assessment Plan
- Mass Wasting Assessment Plan
- AHCP related road plan and monitoring requirements budget
- Property-wide Water Temperature Monitoring
- Class II Before-After-Control-Impact (BACI) Water Temperatures
- Road Maintenance Assessments
- Tailed Frog Monitoring
- Southern Torrent Salamander Monitoring
- Class I Channel Monitoring
- Long-Term Fish Habitat Assessment
- Stream channel Large Woody Debris (LWD) Monitoring
- Summer Juvenile Fish Population Estimates
- Out-migrating Salmonid Smolt Trapping
- Experimental Watersheds monitoring projects
- Adaptive Management Changes

- Changed Circumstances reporting (Significant changes in forestland ecosystems)
- ACHP Minor Modifications

Permit or Agreement: Road Management WDR and MATO

Reporting document: Annual Work Plan to NCRWQCB and DFW

- Summary of planned activity at road work sites

Reporting document: Annual Work Report to NCRWQCB and DFW

- Summary of completions and inspections for Annual Work Plan projects
- Summary of monthly water drafting reports

Permit or Agreement: Road Management WDR

Reporting document: Monthly Post-winter Monitoring Reports to NCRWQCB

- Post treatment monitoring of road related sediment source sites

Permit or Agreement: MATO

Reporting document: Monthly Water Drafting Operations Report to DFW

- Water Drafting Operations

Reporting document: Four-year MATO Status Report to DFW

- Effectiveness of MATO in protecting fish and wildlife resources
- (first report available 2015)

Permit or Agreement: Forest Management WDR

Reporting document: Elk River - Master Inventory of Sediment Sources & Road Related Sites after Completion of Treatments Annual Report to NCRWQCB

Reporting document: Elk River - Sediment Reduction Effectiveness Monitoring Annual Report to NCRWQCB

Reporting document: Elk River - Water Quality Trend Monitoring Annual Report to NCRWQCB

Reporting document: Elk River - Landslide Monitoring to NCRWQCB

Permit or Agreement: Programmatic Consultation for Osprey

Reporting document: Osprey Monitoring Results to DFW

- Summary of osprey nest site monitoring

Permit or Agreement: Marten SHA

Reporting document: Marten SHA Annual Report to DFW

- Monitoring & Research Commitments
- Habitat Management Commitments

Permit or Agreement: FHCP

Reporting document: FHCP Annual Report to USFWS

- NSO THP surveys
- NSO THP Pre-harvest Conservation Measures
- NSO THP Post-harvest Conservation Measures
- NSO Habitat Class Monitoring (forest age classes)

- NSO Population Monitoring
- NSO Set-aside Monitoring
- NSO Special Management Area Monitoring
- Barred Owl Monitoring
- NSO Site occupancy/ status
- NSO Banding
- NSO Reproductive success
- NSO Juvenile dispersal
- NSO Turnover rates
- NSO Density
- NSO Demography
- NSO and West Nile Virus
- Annual Results of THP surveys for NSOs

Permit or Agreement: Sensitive Plant Conservation Plan

Reporting document: <u>Annual Year-end Summary Report for the Botanical Season</u> to DFW

- Summary of botanical survey season
- Sensitive species found
- Uncommon species found
- Coastal Lagoons and Little River Botanical Management Plan Status Report
- Monitoring Report for Howell's montia in Salmon Creek
- Annual Surveys for Southern Operations
- Annual Surveys for Northern operations
- Cumulative vascular plant species list for all surveys – 2001 to-date

Permit or Agreement: FSC Certification

Reporting document: <u>Annual Summary of HCVF Monitoring</u>

- Summary of previous years HCVF related monitoring

Operations/Forestry Departments

Permit or Agreement: Forest Management WDR

Reporting document: Annual THP Summaries to NCRWQCB

- Status of timber harvesting
- Status of sediment source sites and treatments
- Status of site preparation activities
- Disclosure of newly developed sediment sites

Reporting document: AHCP Post-harvest Report Forms to NCRWQCB as synthesized and considered in the <u>AHCP Biennial Report</u> to NMFS and USFWS (copies of the forms are also included in an Appendix to the report)

- Monitoring of completed harvest operations

Silviculture Investment Department

Permit or Agreement: FSC Certification

Reporting document: Pesticide Use Report

- Summary of pesticide and other chemical use.

Permit or Agreement: Not Applicable

Reporting document: Summary of 5 year stocking surveys (internal document)

- Summary of stocking surveys for harvest units 5 years post-planting

Timberlands Inventory Department

Permit or Agreement: Option A

Reporting document: Annual Harvest Summary Report to CalFire

Confidential Document

- Summary of harvest volume, harvest acres and silvicultural systems used

Reporting document: Annual Forest Inventory Report

Internal Confidential Document

- Acreage Changes
- Land Acquisitions and Disposals
- Annual Timber Harvest Volume
- Annual Timber Inventory Volume Depletions
- Annual Timber Inventory Growth
- Forest Inventory Accomplishments
- Inventory Methodologies
- Land Base Ownership by Acreage
- Acres by Age Class and Species
- Volume by Age Class and Species
- Low Conifer Stocking Acres by Age Class and Species
- Low Conifer Stocking Volume by Age Class and Species
- Encumbered Leave Areas by Age Group and Cover Type
- Net Timber Producing Acres by Site Class
- Intensive Forest Management (IFM) Activity Summary (Planting, Spraying, Burning, Biomass)
- Historical Inventory versus Cutout
- Historical Timber Inventory Cruising Activity
- Historical IFM Treatments

Human Resources Department

Permit or Agreement: Not Applicable

Reporting document: Annual Employee Summary Report section of Socio-economic Report (internal document)

- Number of employees per month

Permit or Agreement: Illness and Injury Prevention Program

Reporting document: Annual Safety Summary Report section of Socio-economic Report (internal documents)

- Summary of safety training courses

Finance Department

Reporting document: Annual plan and monthly updates

(Internal *Confidential* Documents)

- Budget and production information by department

Forest Policy and Communications Department

Permit or Agreement: FSC Certification

Reporting document: Annual Social Impact Monitoring

- Summary and analysis of previous years stakeholder outreach, input and management consideration in order to identify trends

Permit or Agreement: FSC Certification

Reporting document: Annual Socio-economic Summary Report (internal document)

- Money spent in the local community on goods and services.
- Charitable giving, community donations, scholarships, matching grant funds
- Number of employees per month
- Summary of safety training courses
- Summary of Stakeholder Consultation

Section 8 - Cultural Resources

8.1 Archaeology Protocols

Green Diamond has enacted protocols and procedures for protecting archeological resources associated with timber harvesting, road upgrading and road decommissioning activities. The California FPRs have extensive requirements pertaining to cultural and historic resource surveying and protections. Green Diamond's protocols and procedures for operations that are part of a THP are consistent with the FPRs. A similar set of protocols and procedures has been established for road related projects that are proposed outside of the THP process as part of the MATO.

Green Diamond maintains confidential records of survey reports, maps and site records that document all known archaeological and historic sites and survey areas on the property. Green Diamond consults with the North Coastal Information Center and Northeast Information Center (the regional state clearinghouses for all archaeological and historic site records and surveys) to conduct a property wide update of the database every 5 years. The information provided by the Information Center is confidential and only made available to professional archeologists or trained professionals working on THP projects.

Green Diamond consults with the Native American Heritage Commission (NAHC) and local tribal representatives as part of the planning phase of all THPs. A similar consultation process is followed for MATO projects. Site specific surveys are conducted for all project areas by a professional archaeologist or a person with archaeological training as specified in the FPRs. Surveys are documented in reports and the reports are filed with the appropriate archaeological Information Center. If a proposed project has the potential to impact historical or cultural resources, mitigation measures are developed to reduce the impact to a less than significant level. If a site is identified during operations, those operations are suspended until the site can be assessed and protection measures developed where needed.

Every effort will be made to keep archeological and historical sites on Green Diamond lands confidential. The one exception to this will be notification to Green Diamond security staff on the location of significant sites. This will allow security to evaluate any unusual behavior around these sites during their normal patrolling activity. There are various State and Federal statutes and guidelines that disallow any person, except as otherwise permitted by law, who is involved in timber operations or MATO activities to excavate, collect artifacts from, vandalize or loot archeological or historical sites located within the operating area. The appropriate authorities will be notified of anyone found engaged in these activities on Green Diamond property.

8.2 Tribal Consultations

In addition to the tribal consultations conducted as part of the THP or MATO activities described above, Green Diamond has worked extensively with the Yurok Tribe on restoration projects located on Green Diamond property within the reservation boundary. Road decommissioning, riparian restoration and erosion control are examples of projects that have been completed in cooperation with the tribe.

Section 9 - Aesthetic Values

Timber Management Visual Impact Policy

Green Diamond has adopted a policy to ensure that potential visual impacts are consistently considered when preparing timber harvest plans. The primary areas where visual impacts may be of concern are the Highway 101 corridor where there are Coastal Commission Special Treatment Areas, and the Highway 299 corridor. Other situations where potential visual impacts are considered include where a THP is in close proximity to a housing development or urban center.

Potential visual impacts are assessed using three distinct zones:

- Foreground or near view (0 - 0.5 mile).
- Middle ground or middle view (0.5 – 3.5 miles)
- Background or far view (3.5 miles+).

Green Diamond is primarily concerned with the near and middle view zones when considering visual impacts.

When it is determined that visual impacts are an issue, some landscape principles to consider are:

- How management practices will appear on the landscape and the extent to which they "fit".
- Generally, landscapes that appear "natural", intact, and without signs of modification are preferred.

- Where modifications are present, those that blend in are more acceptable.
- Keep discordance to a minimum, mimic the natural.
- Make modifications complimentary rather than in contrast to the existing lines, form, colors, and textures as they appear on the landscape.

Some of the factors that may be manipulated to influence the level of visual impact associated with a THP include: size, shape, edge, distribution of leave trees, and scale. Five silvicultural prescriptions that can be used to manipulate these factors have been identified as possible tools to allow for commercial timber harvest while minimizing visual effects.

- Alternative Prescription – A harvest that would be similar to selection or group selection but with a goal of evenage management and/or larger than FPR defined small group openings.
- Seed Tree Seed Step – A two-step harvest prescription where in the first step, sufficient seed trees would be retained to visually buffer the harvest units, and as a second step those seed trees would be harvested when the regeneration is advanced to a point they would allow a removal harvest with little visual impact.
- Modified Clearcut – The standard clearcut prescription would be used, but the units would be smaller and designed to be screened, and extended adjacency periods would be used.
- Commercial Thinning – A standard commercial thinning prescription could be used to reduce visual impacts.
- Shelterwood Preparatory Step – This prescription would be similar to the seed tree seed step except that more leave trees would be retained after the first harvest and the residual trees may be removed in two subsequent harvests.

Every THP is assessed for visual impacts. Where there is a potential for visual impacts to occur, site specific mitigation measures are considered, including modified silvicultural practices.

Section 10 - Public Access and Recreational Uses

10.1 Allowed uses

Nearly all access and allowed use of Green Diamond's lands is related to timber management. Some limited recreational and public service activities are authorized by permit to individuals and/or organized groups. Authorized recreational uses within the ownership are coordinated with forest management activities for safety reasons and to reduce conflicts. Authorized recreational users are informed about seasonal operating areas and seasonal restrictions and requested to stay away from active operations. Examples of non-forest management uses that are allowed on Green Diamond's forest land include law enforcement and fire fighter training exercises, Coast Guard and search and rescue training exercises; recreational hunting, a hunting club or authorized guided hunts; rifle range use by a gun club; fishing by employees or authorized permit holders; organized mountain bike events; and trail rides within designated areas by a permitted motorcycle club and a horse club. In 2017 Green Diamond agreed to a request by the Redwood Coast Mountain Bike Association to construct and maintain a series of mountain bike trails. The mountain bike trails are open to association members only. The public response to the trails has been very positive with the association reporting significant growth in membership to access the trail network. Green Diamond has continued to work with the association to expand the trail network and investigate new trails in other areas of the ownership.

10.2 Trespass and Unauthorized Use

Green Diamond timberlands are not open to the general public. Access is restricted by locked gates and the boundaries are posted for no trespassing. Due to the close proximity of some lands to population centers, some unauthorized use and recreational activities occur in the form of walking or jogging, mountain bike and motorcycle riding, poaching, and horseback riding. These non-permitted uses are considered trespass and violators are asked to leave or be cited. Trespassers who cause damage to Green Diamond property are cited and fined when caught.

Other illegal unauthorized uses of Green Diamond's lands occur such as trash dumping, cultivation of marijuana and manufacturing of methamphetamines. Green Diamond has adopted a policy that addresses illegal and unauthorized activities on our timberlands and works closely with law enforcement to prevent this activity and train our employees on how to respond when this activity is observed on Green Diamond land. The primary focus of the policy is the safety of our employees and to prevent interaction between Green Diamond employees and trespassers involved in the cultivation or manufacture of illegal drugs. An equally important focus is the protection of our forests from unauthorized and potentially destructive uses.

Section 11 - Non-timber Forest Products

Non-timber forest products include burls, stumps, boughs and greenery. Such products are collected, harvested and transported on Green Diamond timberlands on a very limited basis. When these activities occur, they would comply with all applicable laws and regulations, and with all Green Diamond HCPs and programmatic agreements. These activities are conducted by third parties subject to Green Diamond's use permits with conditions that protect sensitive habitats.

Green Diamond leases out multiple sites to communication companies for communications towers. The towers support antenna arrays for cell phone communications and radio transmission. These sites are located on ridge tops and generally require minimal disturbance to install and maintain. Access roads to these sites are the same roads used for forest management activities.

Section 12 - Invasive species program

Green Diamond has developed and implemented an invasive species program to prevent or control invasive, exotic and noxious weed species that have the potential to negatively impact the native flora and fauna on the ownership. This program assesses the risk of each threat, prioritizes them based on their distribution, abundance and potential threat, and as warranted, develops and implements a strategy to prevent or control the invasive species. The specific elements of the plan include the following:

a. A determination of the extent (i.e., distribution and abundance) of invasive, exotic and noxious weed species and the degree of threat to native species and ecosystems on Green Diamond's ownership;
b. Implementation of management practices that minimize the risk of invasive establishment, growth, and spread;
c. Implementation of eradication or control programs for those established invasive that represent a substantial threat to native species on the ownership and,
d. A monitoring program of control measures and management practices to assess their effectiveness in preventing or controlling negative impacts from invasive species.

The goal of the invasive species program is to provide control measures for all those species capable of threatening native biodiversity or sound and sustainable forest management. The control measures are designed to be commensurate with the potential impact/threat and may involve direct removal of the invasive species or include preventative measures to reduce the potential for spreading of the threat. A process of early detection and monitoring the effectiveness of our program has been developed for the most serious threats.

12.1 List of Invasive, exotic and noxious weed species

The first step in this program was to compile a complete list of all the recognized invasive, exotic and noxious weed species that occur on Green Diamond's timberlands including the aquatic system and non-forest habitats such as prairies (Table 1).

Table 1. List of invasive, exotic or noxious weed species documented on Green Diamond's ownership.

List of Invasive Species		
	Scientific Name	Common Name
Vertebrates		
	Strix varia	Barred owl
	Micropterus salmoides	Largemouth bass
	Micropterus dolomieu	Small mouth bass
	Lepomis macrochirus	Blue gill sunfish
	Gambusia affinis	Mosquito fish
	Lithobates catesbeianus	American bullfrog
Invertebrates		
	Potamopyrgus antipodarum	New Zealand Mud Snails
	Cipangopaludina chinensis	Chinese Mysterysnail

Micro-organisms and Pathogens		
	Phytophthora ramorum	Sudden oak death
	Phytopthora lateralis	Port-Orford-Cedar root disease
	Batrachochytrium dendrobatidis	Chytridiomycosis - chytrid fungus
Plants		
	Acacia dealbata	silver wattle
	Agrostis stolonifera	carpet bent; creeping bent; redtop bent
	Aira caryophyllea	silver hairgrass; shivergrass
	Anthoxanthum odoratum	sweet vernal grass; vanilla grass
	Avena fatua	wild oats
	Bellis perennis	English daisy
	Brassica rapa	turnip; field mustard
	Briza maxima	big quakinggrass; rattlesnake grass
	Bromus diandrus	ripgut brome; great brome; ripgut grass
	Bromus hordaceus	soft brome; soft chess; lopgrass
	Bromus tectorum	cheatgrass; downy brome
	Buddleja davidii	butterfly bush; summer lilac
	Centaurea stoebe subsp. micranthos	spotted knapweed
	Cirsium arvense	Canada thistle
	Cirsium vulgare	bull thistle
	Conium maculatum	poison-hemlock
	Cortaderia jubata	jubatagrass; pampasgrass; pink pampasgrass
	Cotoneaster pannosus	silverleaf cotoneaster; velvet cotoneaster
	Crepis capillaris	hawksbeard; smooth hawksbeard
	Crocosmia x crocosmiiflora	montbretia
	Cynosurus echinatus	annual dogtail; bristly dogtail grass; hedgehog dogtail grass

	Cytisus scoparius	Scotch broom; English broom; common broom
	Dactylis glomerata	orchard grass
	Digitalis purpurea	foxglove
	Dipsacus fullonum	common teasel; wild teasel; card thistle
	Erica lusitanica	Spanish heath, Portuguese heath
	Erodium cicutarium	filaree; redstem filaree; redstem stork's bill
	Festuca arundinacea	alta fescue; coarse fescue; rescue; reed fescue; tall fescue; Kentucky fescue; numerous cultivars exist.
	Festuca perennis	Italian rye grass
	Foeniculum vulgare	fennel; sweet fennel; sweet anise
	Genista monspessulana	French broom; soft broom; canary broom
	Geranium dissectum	cutleaf geranium
	Hedera helix, H. canariensis	English ivy and Algerian ivy
	Holcus lanatus	common velvet grass; Yorkshire fog
	Hypericum perforatum	St. John's Wort; klamathweed; tipton weed; goatweed
	Hypochaeris glabra	smooth catsear
	Hypochaeris radicata	common cat's-ear; rough cat's-ear; false dandelion
	Ilex aquifolium	English holly
	Isatis tinctoria	dyer's woad
	Leucanthemum vulgare	ox-eye daisy; dog daisy; margriet; marguerite daisy; moon daisy; white daisy; yellow daisy;
	Linaria genistifolia ssp. dalmatica	Dalmatian toadflax, broad-leaved toadflax
	Medicago polymorpha	burr medic; California burclover
	Mentha pulegium	pennyroyal; European pennyroyal

	Myosotis latifolia	common forget-me-not; wood forget-me-not; broadleaf forget-me-not
	Oxalis pes-caprae	buttercup oxalis, Bermuda buttercup
	Parentucellia viscosa	yellow glandweed; sticky parentucellia; broadleaved glandweed
	Picris echioides	bristly ox-tongue; bugloss; bugloss-picris
	Plantago lanceolata	buckhorn plantain; English plantain; buck plantain; black-jacks; narrowleaf plantain; lanceleaf plantain; ribbed plantain; ribgrass; ribwort
	Poa pratensis	Kentucky bluegrass; smooth meadowgrass
	Ranunculus repens	creeping buttercup
	Raphanus sativus	wild radish
	Rubus armeniacus	Himalayan blackberry
	Rubus laciniatus	cutleaf blackberry
	Rumex acetosella	sheep sorrel
	Rumex crispus	curly dock
	Senecio jacobaea	tansy ragwort; stinking willie; stavewort; kettle-dock; felonweed; Fairies' horse; tansy butterweed; staggerwort

12.2 Ranking, action plan and monitoring program

From the table above, we compiled a second list that categorizes the species in terms of their relative threat of impact on native species that occur on Green Diamond's ownership (Table 2). Threat Category 1 includes species that we believe pose the greatest threat to native species on Green Diamond's property. Threat Category 2 includes species that we believe have a moderate threat to native species on Green Diamond's property.

Table 2. Ranking of species with the greatest threat (Category 1) and moderate threat (Category 2) to native species on Green Diamond's ownership along with a brief synopsis of the action plan to minimize or eliminate the threat and the monitoring plan. Additional details are provided below for those species with the greatest threat to the native flora and fauna.

Species (Threat Category)	Impact to native species on GDRCo	Action Plan	Monitoring
Barred owl (1)	Recognized as one of the primary threats to the federally listed northern spotted owl and may threaten other native species. Barred owls have been dramatically increasing regionally and on GDRCo ownership in the last decade.	Phase one of the barred owl experiment was completed in 2014 and results were published in Diller et al. 2014 and 2016. Additional experiments on spotted owl/barred owl interactions are being implemented under the FHCP.	We survey for barred owls as part of our regular spotted owls surveys along with having a network of survey points specifically designed for detecting barred owls.
Sudden oak death (1)	Currently there are 14 California counties with Sudden Oak Death (SOD) infested forests. To date, it is estimated that more than a million oaks and tanoaks have been killed by SOD in California, and at least another million trees are currently infected. A confirmed outbreak of SOD was identified on GDRCo in 2010 on 120 acres in the Redwood Creek Drainage. An outbreak has also been observed in the Mad River drainage.	The Redwood Creek infested area is low on the slopes and located on multiple landowners on both sides of Redwood Creek. Green Diamond, in cooperation CalFire, the UC Cooperative Extension (UCCE) office, the US Forest Service, the Natural Resources Conservation Service and with the other affected landowners, formed the Redwood Valley Collaborative (RVC) soon after the infestation was discovered. The RVC implemented treatment programs in 2011, 2012 and 2013 designed to limit the spread of the infestation in Redwood Valley. The site in the Mad River was similar – low on the slope and on multiple owners and has	Green Diamond monitors its timberlands for signs of new SOD infestations during normal forest management activities. If new sites are found they will be monitored and appropriate treatments will be designed and implemented if needed. Green Diamond has not conducted timber operations in an area with a confirmed SOD outbreak. If that does occur, Green Diamond will implement appropriate procedures to limit the spread of the infection to non-infected areas.

		been treated in cooperation with CalFire and the UCCE office.	
Port-Orford cedar root disease (1)	*Phytopthora lateralis* is the cause of Port Orford cedar (POC) root disease, a fungal infection that affects POC trees in Green Diamond forests. The origin of the disease is not known, however it is wide spread in the Pacific Northwest. This disease affects the fine roots of a tree first and spreads up to the trunk, eventually killing the infected tree.	Green Diamond foresters are aware of infected areas on Green Diamond's ownership and monitor the ownership for signs of new infections. Green Diamond restricts wet weather access into infected areas to minimize the spread of the disease.	Green Diamond monitors its timberlands for signs of new POC infestations during normal forest management activities.
Chytridiomycosis - chytrid fungus (1)	This pathogen is attributed to population declines of amphibian populations worldwide and has been documented in several watersheds in north coastal California.	Currently implement approved decontamination protocol to minimize and mitigate the potential to spread of this disease. Further monitoring is anticipated in cooperation with research currently being conducted by Dr. Vance Vredenburgat at San Francisco State University.	Surveillance monitoring, via laboratory testing for chytrid DNA, was conducted in 2010 to assess occupancy in tailed frog populations across GDRCo's ownership. Visual surveillance monitoring is also conducted annually in conjunction with established amphibian monitoring projects. In 2013, 2014 and

			2015, we worked cooperatively with a graduate student from San Francisco State University investigating the distribution of chytrid in Coastal Redwood forests. In addition, Green Diamond has added eDNA sampling for chytrid as part of the ten-year occupancy surveys conducted property-wide for tailed frogs.
Spotted knapweed (1)	USDA Class A noxious weed. Detected in 2013 along bank of lower Mad River.	County of Humboldt Department of Agriculture tasked with eradication. GDRCo botany staff trained in identification.	Annual monitoring, hand removal and reporting.
Gorse (1)	Limited known areas; present in 1% of surveyed areas. Co-occurs along roadsides and other disturbed sites where some rare native plants also occur.	Roadside herbicide application	Monitor in conjunction with botanical surveys
New Zealand Mud Snails (2)	Recognized as a threat to aquatic ecosystems, this invertebrate is easily spread and where established can impact native species at multiple trophic levels.	Staff working in aquatic system are trained on the identification and known distribution of this species in north coastal California. Staff are required to follow the state decontamination protocol and necessary	Visual surveillance monitoring is conducted annually in conjunction with established aquatic monitoring projects. In 2013, we cooperated with a Dr. Darren Ward from Humboldt State

		facilities and equipment are provided. Staff are also required to document any observations of this species when conducting monitoring work. Any new observations are reported to the appropriate agency representative.	University investigating the distribution of New Zealand Mud Snails in the Big Lagoon watershed. He found that populations of New Zealand Mud Snails have not expanded their distribution upstream into Maple Creek other than Big Lagoon and the downstream end of Maple Creek proximate to the lagoon. Results suggest that low specific conductivity and environmental calcium are likely limiting New Zealand Mud Snail distribution within watersheds.
American bullfrog (2)	Recognized as a threat because it predates on native species and has been attributed to population declines of the foothill yellow-legged frog, red-legged frog, and western pond turtle populations.	Staff working in aquatic systems are trained on the identification and known distribution of this species in north coastal California. Observations during field surveys are recorded and the potential for eradication is assessed on a case-by-case basis. Opportunities for state involvement in eradicating established populations have been discussed but current methods are ineffective	Visual surveillance monitoring is conducted annually in conjunction with all field surveys. Removal efforts have been underway in the Korbel gravel ponds from 2018 to present.

		or impractical where this species occurs.	
Largemouth bass (2)	Recognized as a threat because it predates on native aquatic species and has been attributed to population declines of lentic-amphibian species of special concern.	Staff working in aquatic systems are trained on the identification and known distribution of this species in north coastal California. Observations during field surveys are recorded the potential for eradication is assessed on a case-by-case basis. Opportunities for state involvement in eradicating established populations have been discussed; management options have been considered.	Visual surveillance monitoring is conducted annually in conjunction with all field surveys. In 2017, CDFW and CAL POLY HUMBOLDT initiated biological sampling in the Big Lagoon Mill Pond to obtain estimates of abundance for centrarchids and to develop potential management options for this waterbody. Green Diamond has been encouraging fishing and removal of largemouth bass from the mill pond.
Smallmouth bass (2)	Recognized as a threat because it predates on native aquatic species and has been attributed to population declines of lentic-amphibian species of special concern.	Staff working in aquatic systems are trained on the identification and known distribution of this species in north coastal California. Observations during field surveys are recorded the potential for eradication is assessed on a case-by-case basis. Opportunities for state involvement in	Visual surveillance monitoring is conducted annually in conjunction with all field surveys.

		eradicating established populations have been discussed; management options have been considered.	
Blue gill sunfish (2)	Recognized as a threat because it predates on native aquatic species and has been attributed to population declines of lentic-amphibian species of special concern.	Staff working in aquatic systems are trained on the identification and known distribution of this species in north coastal California. Observations during field surveys are recorded the potential for eradication is assessed on a case-by-case basis. Opportunities for state involvement in eradicating established populations have been discussed; management options have been considered.	Visual surveillance monitoring is conducted annually in conjunction with all field surveys.
Mosquito fish (2)	Recognized as a threat because it predates on native aquatic species and has been attributed to population declines of lentic-amphibian species of special concern.	Staff working in aquatic systems are trained on the identification and known distribution of this species in north coastal California. Observations during field surveys are recorded the potential for eradication is assessed on a case-by-case basis. Opportunities for state involvement in eradicating established populations have been	Visual surveillance monitoring is conducted annually in conjunction with all field surveys.

		discussed but current methods are ineffective or impractical where this species occurs.	
English holly (2)	Locally abundant - present in 15% of surveyed areas. The rare sedge, *Carex leptalea*, is infested with several noxious weed species including *Ilex aquifolium* (English holly).	Hand removal at *C. leptalea* sites	Monitor in conjunction with botanical surveys
Jubatagrass (2)	Widespread - present in 50% of surveyed areas. Co-occurs with *C. leptalea* and along roadsides and other disturbed sites where some rare native plants also occur.	Hand removal at *C. leptalea* sites; Roadside and in unit herbicide treatment.	Monitor in conjunction with botanical and regeneration unit surveys
Scotch broom (2)	Present in 15% of surveyed areas. Co-occurs with *C. leptalea* and along roadsides and other disturbed sites where some rare native plants also occur.	Roadside herbicide application	Monitor in conjunction with botanical and regeneration unit surveys
French broom (2)	Widespread - present in 60% of surveyed areas. Co-occurs with *C.*	Roadside herbicide application	Monitor in conjunction with botanical and

	leptalea and along roadsides and other disturbed sites where some rare native plants also occur.		regeneration unit surveys
Spanish heath (2)	Limited known areas; present in 1% of surveyed areas. Co-occurs with *C. leptalea* and along roadsides and other disturbed sites where some rare native plants also occur.	Hand removal at *C. leptalea* sites	Monitor in conjunction with botanical surveys

12.3 Full description of the threat, action plan and monitoring for Threat Category 1 invasive species

For the invasive, exotic or noxious weed species that represent the greatest threat to native species or to productive and sustainable forest management, we have provided a more detailed description of the threat, action plan and monitoring.

A. Barred owl

Due to their slightly larger size and apparently more aggressive behavior (Van Lanen et al. 2011[6]), barred owls were recognized as a potential threat to spotted owl populations as early as 1990 when the US Fish and Wildlife Service listed the northern spotted owl (NSO) as a threatened species (USFWS 1990[7]). In a critical review of all available information on the status of the species, Courtney et al. (2004[8]) reported that barred owls were believed to be a greater threat than previously anticipated. Barred owls are considered habitat and prey generalists

[6] Van Lanen, N. J., A. B. Franklin, K. P. Huyvaert, R. F. Reiser and P. C. Carlson. 2011. Who hits and hoots at whom? Potential for interference competition between barred and northern spotted owls. Biological Conservation 144: 2194–2201.

[7] USFWS (U.S. Fish and Wildlife Service). 1990. The 1990 status review: northern spotted owl: *Strix occidentalis caurina*. U.S. Fish and Wildlife Service, Portland, Oregon. 95 pp.

[8] Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004.

(Mazur and James 2000[9], Hamer et al. 2001[10]). However, their similarity in size, overlapping diet and broader range of habitat use compared to spotted owls supports current hypotheses and competition theory predictions that they will substantially compete for resources (Hamer et al. 2001[11]; 2007; Gutiérrez et al. 2007[12]). Barred owls also have comparatively smaller home ranges (Hamer 1988[13]), and potentially greater reproductive output, and are known to become numerically superior in favorable habitats (Wiens et al. 2011[14]). Occasional hybridization between the two species is well documented (Hamer et al. 1994[15]; Kelly and Forsman 2004[16]), but not considered to be a serious threat to spotted owl populations.

Barred owls may negatively affect spotted owl survey detectability, site occupancy, reproduction, and survival. A negative effect of barred owls on detectability of spotted owls was reported by several studies (Dugger et al. 2009[17]; Olson et al. 2005[18]; Crozier et al. 2006[19]; and Wiens et al. 2011[20]). Kelly et al. (2003[21]) found that spotted owl occupancy was significantly lower in territories where barred owls were detected within 0.8 km of the territory center.

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[9] Mazur, K.M., and P. C. James. 2000. Barred owl (*Strix varia*). In A. Poole (editor), The Birds of North America Online, No. 508. Cornell Lab of Ornithology, Ithaca, New York.

[10] Hamer, T.E., D. L. Hays, C.M. Senger, and E.D. Forsman. 2001. Diets of northern barred owls and northern spotted owls in an area of sympatry. Journal of Raptor Research 35(3):221-227.

[11] Hamer, T.E., D. L. Hays, C.M. Senger, and E.D. Forsman. 2001. Diets of northern barred owls and northern spotted owls in an area of sympatry. Journal of Raptor Research 35(3):221-227.

[12] Gutiérrez, R.J., M. Cody, S. Courtney and A.B. Franklin. 2007. The invasion of barred owls and its potential effect on the spotted owl: a conservation conundrum. Biological Invasions 9:181–196.

[13] Hamer, T.E. 1988. Home range size of the northern barred owl and northern spotted owl in western Washington. M.S. Thesis. Western Washington University, Bellingham, Washington.

[14] Wiens, J. D., R. G. Anthony and E. D. Forsman. 2011. Barred owl occupancy surveys within the range of the northern spotted owl. Journal of Wildlife Management 75(3):531–538.

[15] Hamer, T. E., E. D. Forsman, A.D. Fuchs, and M.L. Walters. 1994. Hybridization between barred and spotted owls. Auk 111(2):487-492.

[16] Kelly, E.G. and E.D. Forsman. 2004. Recent records of hybridization between barred owls (*Strix varia*) and northern spotted owls (*S. occidentalis caurina*). Auk 121:806-810.

[17] Dugger, K.M., R.G. Anthony and E.D. Forsman. 2009. Estimating northern spotted owl detection probabilites: updating the USFWS Northern Spotted Owl Survey Protocol. Final Report. Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon.

[18] Olson, G.S., R.G. Anthony, E.D. Forsman, S.H. Ackers, P.J. Loschl, J.A. Reid, K.M Dugger, E.M. Glenn, and W.J. Ripple. 2005. Modeling of site occupancy dynamics for northern spotted owls, with emphasis on the effects of barred owls. Journal of Wildlife Management 69(3):918-932.

[19] Crozier, M. L., M. E. Seamans, R. J. Gutierrez, P. L. Loschl, R. B. Horn, S. G. Sovern, and E. D. Forsman. 2006. Does the presence of barred owls suppress the calling behavior of spotted owls? Condor 108:760-769.

[20] Wiens, J. D., R. G. Anthony and E. D. Forsman. 2011. Barred owl occupancy surveys within the range of the northern spotted owl. Journal of Wildlife Management 75(3):531–538.

[21] Kelly, E.G., E.D. Forsman, and R.G. Anthony. 2003. Are barred owls replacing spotted owls? The Condor 105:45-53.

Pearson and Livezey (2003[22]) and Gremel (2005)[23] also reported relationships between barred owl presence and reduced site occupancy by spotted owls. In a related study, Olson et al. (2004) found the presence of barred owls negatively affected reproductive success in spotted owls.

Substantial evidence suggests that barred owls are contributing to the population decline of the northern spotted owl (USFWS 2011[24]; Van Lanen et al. 2011[25]) and lacking some form of intervention, some researchers have hypothesized that barred owls likely will replace or seriously influence spotted owls throughout all or major portions of their range (Gutierrez et al. 2004) and reduce the likelihood that the species will be recovered (USFWS 2011a).

Although barred owls were documented on Green Diamond's ownership as early as 1989, it has only been since around 2000 that they increased on the ownership to population densities associated with negative impacts on NSOs. An analysis of spotted owl demographics indicated that the presence of barred owls was negatively correlated with fecundity and apparent survival of spotted owls on Green Diamond's study area. The apparent decline in spotted owls coincided with a sharp increase in barred owl numbers, and at this time, the most feasible hypothesis for the decline in the spotted owl population on Green Diamond's ownership with analytical support is the recent and rapid increase in barred owl numbers.

To address this serious threat, a pilot barred owl removal experiment was initiated in 2009 within Green Diamond's spotted owl demographic study area. The experiment was set up with a BACI (before-after-control-impact) design to utilize the extensive data set from that long-term spotted owl demography study. To account for geographic differences in the history of timber harvesting, physiographic patterns and density of barred owl and NSO sites, the relatively linear Green Diamond study area was divided into roughly equivalent-sized paired 'southern' (Salmon Creek Tract treatment versus Ryan Creek Track control), 'middle' (Mad River/Korbel/Little River/Maple Creek Tracts treatment versus Lower Redwood Creek Tract control and 'northern' (Klamath River North Wilson/Hunter/Terwer Tracks treatment versus Klamath River South Bald Hill/County Line Tracts control) areas.

Green Diamond staff conducted standardized surveys using recorded calls for both barred owls and spotted owls in treatment and control areas. In control areas, the surveys were used to estimate barred owl occupancy rates, while in the treatment areas; all barred owls detected during surveys were removed. However, barred owls were not taken if they potentially had dependent nestlings or fledglings as required by the collecting permit authorizations. The field

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[22] Livezey, K. B. 2010. Killing barred owls to help spotted owls I: a global perspective. Northwestern Naturalist 91:107–133.

[23] Gremel, S. 2005. Factors controlling distribution and demography of northern spotted owls in a reserved landscape. M.S. thesis, University of Washington, Seattle. 49 pp.

[24] USFWS (U.S. Fish and Wildlife Service). 2011. Revised Recovery Plan for the Northern Spotted Owl (*Strix occidentalis caurina*). U.S. Fish and Wildlife Service, Portland, Oregon. xvi + 258 pp.

[25] Van Lanen, N. J., A. B. Franklin, K. P. Huyvaert, R. F. Reiser and P. C. Carlson. 2011. Who hits and hoots at whom? Potential for interference competition between barred and northern spotted owls. Biological Conservation 144: 2194–2201.

work for this pilot experiment was completed in 2014 and the results were presented in two peer-reviewed manuscripts that were published in 2014 and 2016 (Diller et al. 2014[26] and 2016[27]).

Green Diamond's long-term NSO demographic study provided almost 2 decades of pretreatment data from which to estimate the demographic response of NSO to barred owl removal. The fundamental premise of our classic BACI experiment was to determine if trends in any of the NSO demographic parameters changed between treated and untreated areas following treatment (barred owl removal). Specifically, we estimated occupancy parameters (rates of site occupancy, extinction and colonization), fecundity, survival and rate of population change pre and post treatment to determine if the relationship among any of these demographic parameters changed post treatment relative to pretreatment. Based on the theoretical underpinnings of a BACI experiment, any statistically significant post treatment changes in the parameters of interest can be attributed to the treatment effect (barred owl removal).

Some of the most important demographic results were that barred owls caused more than a four-fold increase in the estimate of NSO site extinction (i.e., probability that a NSO site will be abandoned), but following barred owl removal, the extinction rate in the treated areas returned to normal levels and NSO site occupancy was greater in treated than untreated areas. Furthermore, apparent survival and the rate of population change (lambda) were both in decline prior to removal, but these demographic parameters showed significant increases following removal. Mean apparent survival was 0.859 and 0.822 for treated and untreated areas, respectively. Probably the most dramatic result was that prior to treatment, mean lambda was declining 3.6% for all areas, but post treatment, mean lambda was 1.029 (2.9% annual increase) and 0.87 for treated and untreated areas, respectively. Mean fecundity did not show a significant increase following treatment due to high annual variation, but the greater number of occupied spotted owl sites on the treated areas resulted in greater productivity in the treated areas based on empirical counts of fledged young. The primary conclusion from this initial experiment was that lethal removal of barred owls allowed the recovery of the NSO population in the treated portions of the study area (Diller et al. 2016).

B. Sudden oak death

Phytophthora ramorum is the cause of both Sudden Oak Death (SOD), a forest disease that has resulted in widespread dieback of tanoak trees and many true oak species in California and Oregon forests, and Ramorum blight, which affects the leaves and twigs of numerous other plants in forests including redwood and Douglas-fir. Currently there are 14 California counties with SOD infested forests, as well as one county in southwest Oregon. To date, it is estimated that more than a million oaks and tanoaks have been killed by SOD in California, and at least

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[26] Diller, Lowell V.,

[27] Diller, Lowell V.,

another million trees are currently infected. SOD was first found in Humboldt County in 2002 near Redway. The current status of SOD in the state is that the known infected areas have expanding infestations, but there has been minimal spread to new areas in the last few years.

In 2010, a confirmed outbreak of SOD was identified on Green Diamond timberlands in the Redwood Creek Drainage. Approximately 120 acres of Green Diamond lands are currently known to be infested. The infected area on Green diamond lands consists of 35- to 45-year-old coastal redwood forest. Green Diamond has not conducted harvest operations in the area since the discovery of the occurrence and there are no regularly used truck roads that pass through the area.

The infested area is low on the slopes and located on multiple landowners on both sides of Redwood Creek. Green Diamond, in cooperation CalFire, the UC Cooperative Extension (UCCE) office, the US Forest Service, the Natural Resources Conservation Service and with the other affected landowners, formed the Redwood Valley Collaborative (RVC) soon after the infestation was discovered. The RVC implemented a treatment program in 2011 designed to limit the spread of the infestation in Redwood Valley. Technical and financial assistance for this work on the small private lands was provided by UCCE, CAL FIRE, North Coast Land Conservancy, Green Diamond, USFS, and NRCS. On Green Diamond property, the treatment consisted of killing all infected tanoaks and bay laurel trees using a hack and squirt applied herbicide. The site continues to be monitored and additional treatments were designed and implemented in 2012 and 2013 in an effort to limit the spread of the infection. However, the infection continues to spread in this area.

In May of 2012, Agriculture Deputy Secretary Kathleen Merrigan presented USDA's prestigious Two Chiefs' Partnership Award to representatives of the Redwood Valley Collaborative for their work in reducing the threat of Sudden Oak Death (SOD) disease in the Redwood Valley. The Two Chiefs' Partnership Award is a national award that is presented annually to recognize people and teams that work collaboratively to support conservation and forest stewardship. Award winners are selected by the Chiefs of the US Forest Service and Natural Resources Conservation Service.

A new outbreak was discovered in August of 2020 on Green Diamond property within the Cal Trans right of way in Del Norte County above State Route 197. This outbreak was discovered by the UC Extension Forester and has been confirmed by California Department of Food and Agriculture. The discovery is of particular concern as it is the first in Del Norte County and is the European strain of the disease. Green Diamond, Cal Trans, CAL FIRE and UC Extension are working together to implement a treatment plan.

Green Diamond monitors its timberlands for signs of new SOD infestations during normal forest management activities. If new sites are found, they will be monitored, and appropriate treatments will be designed and implemented if needed. Green Diamond has not conducted timber operations in an area with a confirmed SOD outbreak. If that does occur, Green Diamond will consult with the appropriate agencies and design and implement the necessary procedures to minimize the spread of the infection to non-infected areas.

C. Port-Orford-Cedar root disease

Phytopthora lateralis is the cause of Port-Orford cedar (POC) root disease, a fungal infection that affects POC trees in Green Diamond forests. The origin of the disease is not known, however it is widespread in the Pacific Northwest. This disease affects the fine roots of a tree first and spreads up to the trunk, eventually killing the infected tree. Spread of the disease is primarily through movement of infected soils from infected areas to non-infected areas via wheels and tracks of vehicles and equipment. The disease can also be spread on the feet of livestock and wild game, by flowing surface water, and tree to tree through overlapping root systems.

Green Diamond foresters are aware of infected areas on Green Diamond's ownership and monitor the ownership for signs of new infections. Green Diamond restricts wet weather access into infected areas to minimize the spread of the disease.

D. Chytridiomycosis - chytrid fungus

Chytridiomycosis is an infectious disease of amphibians that is caused by the aquatic chytrid fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*). Globally, *Bd* has been documented in all three orders of amphibians, and the pathogen has been attributed to worldwide amphibian population declines and the extinction of at least 200 species of frogs. Recent studies have documented the pathogen in the western United States, including northern California and the Pacific Northwest. Though it is currently unknown where the pathogen originated, two hypotheses have been proposed for its recent spread. The first hypothesis is that it is a novel pathogen that has been transmitted to new host species and new geographical areas by humans and other biological vectors. The second hypothesis suggests that it is an endemic pathogen which amphibians have become more sensitive to over recent decades due to environmental changes.

Bd infects the keratin-containing layers of skin in affected amphibians. In tadpoles, only the mouthparts are keratinized and susceptible to *Bd* infection. Infection in tadpoles can lead to mouthpart depigmentation and defects. Therefore, visual inspection of tadpole mouthparts in the field has been used as a possible indicator of *Bd* infection for certain species. Direct morality of infected tadpoles is rare but severe effects from *Bd* infection are well documented in individuals during and after metamorphosis. At this transitional life history stage the frog's external skin layer becomes keratinized, allowing the fungus to encyst in skin cells over the entire body, impairing electrolyte transmission and osmoregulation and ultimately leading to death if the infection intensity is high enough. One method of detecting *Bd* in amphibians is through laboratory testing for chytrid DNA from skin or buccal swabs of animals.

In 2008, sampling for *Bd* presence in coastal tailed frogs was conducted in Black Dog Creek and Jiggs Creek on Green Diamond property. This sampling was conducted as part of a region wide assessment of *Bd* infection for the species and has since been published in the primary scientific literature. Based on the laboratory analyses, *Bd* was not detected in any swabs of animals sampled at Green Diamond sites. However, visual inspections of coastal tailed frog tadpole mouthparts in 2008 and 2009 documented pigment loss of keratinized tissues at several study sites across Green Diamond property. Therefore, in 2010 Green Diamond collected swab samples from 18 coastal tailed frog monitoring sites and had them analyzed by a laboratory for presence of *Bd* DNA. Despite visual evidence suggesting *Bd* infections this pathogen was not detected at any sites. Since 2010, visual inspection of captured amphibians has occurred to document any symptoms possibly resulting from *Bd* infection. Since that time no symptoms have been documented to warrant further testing.

In early 2013, a request to collect *Bd* samples from amphibians on Green Diamond property was made by a graduate student in the laboratory of Dr. Vance Vredenburg at San Francisco State University (SFSU). The objective of the proposed study is to document the current distribution of *Bd* in all amphibians throughout the range of coast redwoods. Green Diamond has worked cooperatively with this study and assisted with the collection of samples from two sites not previously sampled. Preliminary laboratory results from these samples indicated *Bd* infection of tailed frogs in Bald Mountain Creek. These results are the first positive detection of *Bd* on Green Diamond property. Further sampling and testing by SFSU for *Bd* at other sites on Green Diamond property was conducted in 2015 and results are pending.

Approximately every ten years Green Diamond conducts property wide larval *Ascaphus truei* occupancy surveys. During the 2019 surveys, eDNA sampling was employed to test for larval occupancy presence on streams that did not have detections via traditional survey methods (e.g., rubble rousing). Additionally, these water samples were tested for the presence of the chytrid fungus. Out of 73 sites sampled, chytrid was detected at only 4 sites (~5%).

Green Diamond currently implements an approved decontamination protocol to minimize and mitigate the potential spread of *Bd* within and among watersheds. Decontamination follows the California Department of Fish and Wildlife Northern Region's 2011 Decontamination Protocol for Field Activities. All gear that has been in contact with water or animals (e.g. boots, waders, nets) at a given site is decontaminated before proceeding to another site that is not directly connected within the watershed to the original site. Decontamination is conducted in all such instances regardless of if it is known that *Bd* is present or not. Proper decontamination involves completely soaking all gear in a Sparquat 256 solution (7 ounces Sparquat:1 gallon water) for at least 10 minutes. Treated field gear is then rinsed in fresh water before being used at a new site. Decontamination solutions are replaced after one week of use or after being significantly contaminated with organic debris.

E. Noxious weed species

Numerous exotic noxious weed plant species are present throughout Green Diamond's timberlands. In general, these are pioneer species that invade disturbed sites after harvesting, road construction or fires. Most of these species require disturbance and open canopy conditions to persist on the landscape. Green Diamond is currently in the process of developing a weed management strategy as part of the updates to the Integrated Pest Management Plan. Updates to the strategy and planning process include incorporating efforts from the botany group to identify new infestations of invasive species such gorse, spotted knapweed, jubatagrass, yellow star-thistle, etc. as part of the botanical surveys. The intent is to catch new infestations early and mobilize a rapid response for eradication. Newly infested areas and areas with known rare plant populations, or other special status natural resources at risk of displacement from invasive plants, will be prioritized for treatment.

An evaluation of the existing distribution and threat from invasion of jubatagrass, and other invasive plant species, on roadsides and in forested areas will be included in the weed management strategy, with a focus on identifying and treating high priority areas first. Examples of high priority areas include newly infested roads and regeneration units where early detection and rapid response may be effective; special status native plant areas including both unique populations (i.e. rare plants) as well as vegetation types (i.e. native grasslands); and any regeneration units recently planted and at risk of infestation from jubatagrass or other invasive plant species. The synthesizing of work between the botany group and the IFM group will improve our ability to plan and prioritize implementation of invasive plant control strategies throughout the FMU.

Invasive species are also monitored by Green Diamond's IFM Department during routine regeneration inspections. Over the course of stand establishment, each harvested unit is visited four times. The first inspection occurs immediately following harvest and documents the presence of invasive plants in the vicinity that have the potential to affect regeneration. This observation is recorded as a vegetation management recommendation that is placed in the IFM unit file and the site is entered into a programmatic vegetation management system and scheduled for either reassessment or treatment.

The second inspection takes place during planting operations. Planting supervisors report significant occurrences of invasive plants to the IFM Forester. If the occurrence has not been previously noted, it is added to the reassessment/treatment schedule. The third inspection takes place the second year following planting when stocking data is collected for the state required stocking report. If an occurrence is noted that has not been previously noted, it is added to the reassessment/treatment schedule. The last inspection occurs at age five. At this time, the regenerated timber stand is generally of sufficient height to dominate the site until the next rotation. If follow-up treatment is required to ensure a free to grow condition, it is scheduled in the vegetation management system.

In addition to the programmatic inspections, IFM personnel continuously monitor invasive species occurrences during their travels throughout the ownership. This provides for identification of populations outside of regeneration units and along road systems that have the potential to spread and infest other areas. This information is used to schedule periodic treatment projects to reduce these populations. As of August 2023, a total of 66 miles of roadside Scotch broom (*Cytisus scoparius*) has been treated in both the Klamath and Korbel operating areas.

Establishment and spread of invasive species are prevented beginning at the harvesting stage. Minimization of disturbance by cable and shovel logging methods reduces exposed disturbed soil available for invasion by wind borne seed and reduces the germination potential of seed banks that exist on the site. During construction and rehabilitation projects, weed free straw is used for erosion control. The limited use of broadcast burning also minimizes exposure of bare soil and reduces suitable habitat for invasive species and seed bank germination. Prompt regeneration and treatment of infestations noted during monitoring is used to establish closed canopy conditions that inhibit further growth and spread of the invasive species.

F. Gorse (Ulex europaeus)

Gorse is slow in spreading and establishing, but when it does, it completely displaces native plant species and presents a fire hazard. Gorse populations exist at four known locations on the ownership. These populations are monitored regularly by the IFM department. Three locations (Smith River, Mather tract and Wiggins Ranch) are relatively small, and the plants are grubbed out by hand or sprayed with triclopyr when they are found. The larger location (Mad River) is periodically treated with triclopyr around the perimeter and along roads to stem the spread of seed. To date, approximately 20 miles of forest road has been treated in an effort to control populations of gorse. The timber in this area is dominant and inhibits the development of the gorse, although the population still exists in the understory. Future timber harvest plans in this area will include the requirement to wash equipment prior to transport from the site to prevent the transport of seed to other locations.

G. Spotted knapweed (Centaurea stoebe subsp. micranthos)

Spotted knapweed is currently not as widespread in California as it is in other states, such as Oregon, Washington, Montana and Idaho, thus infestations are a high priority for eradication. It is a biennial to short-lived perennial that is found primarily in disturbed sites. It crowds out native species and can invade undisturbed native grasslands. Spotted knapweed establishes and dominates on dry, disturbed sites, especially along roads. In September of 2013 the County Department of Agriculture contacted GDRCo to notify us of a reported occurrence of this species on company property along the gravel bar of the Mad River. Agriculture inspectors and GDRCo botanists went out to the site and identified three locations between the Mad River hatchery and the historic Sweasey dam site. In 2014, the site was surveyed, and no plants were detected. The gravel bars along the river were surveyed to the south of the site and no other populations were detected in these regions either. The site was surveyed in 2015 and one population was detected and removed; the gravel bars along the river were surveyed to the south of the site again and no additional plants were detected. In 2016 the botany crew removed approximately 100 spotted knapweed plants and disposed of them offsite. The total number of plants eradicated had increased from approximately 30 the previous year. Plants have been removed every year since with some variability in the number of plants found. Thirty plants were removed in 2017, 50 in 2018 and only four were observed and removed in 2019. Additionally, there is a previously undetected infestation of yellow star thistle (*Centaurea solstitialis*). There are several known infestations of yellow star thistle throughout the watershed, though this species has never been recorded at this particular location. It is assumed that the low water conditions and higher than average temperatures associated with the drought cycle which peaked in 2016 may have contributed to increased suitability for invasive species infestations. The infestation of yellow star thistle was first detected in 2016 and has been observed in subsequent years. Due to the riparian nature of the habitat, there is no plan to use herbicides in treating known sites. Monitoring, reporting and hand removal will be applied towards the control of this infestation.

Section 13 - Employees

13.1 Training

Green Diamond is committed to providing appropriate training opportunities for our employees. These opportunities include personal and professional development, but the primary focus of our training is on safety, followed by training to ensure that our environmental standards are understood and implemented properly.

13.1.1 Safety and Compliance

There is nothing more important to Green Diamond than the health and safety of our employees. It is a core value of our company, and we are committed to creating and maintaining a safe and healthful work environment. Furthermore, in California, every employer has a legal obligation to provide and maintain a safe and healthy workplace for employees, according to the California Occupational Safety and Health Act of 1973. California law requires that every employer has a written and effective Injury and Illness Prevention Program (IIPP).

Green Diamond has developed and implemented an Injury and Illness Prevention Program. Green Diamond's objective is that our Injury and Illness Prevention Program will reduce the number of injuries and illnesses to an absolute minimum, not merely in keeping with, but surpassing, the best experience of operations like ours. It is the intent of Green Diamond to comply with all laws relating to occupational safety and health. We require the active participation and assistance of all our employees. The success of our program depends on the proper attitude toward injury and illness prevention on the part of management, supervisors and employees. Through the cooperative efforts of all employees, we strive to make Green Diamond Resource Company the safest company in our industry.

The IIPP program is designed to provide workplace protection for Green Diamond employees and to reduce losses resulting from accidents and injuries. The IIPP consists of the following elements:

- Responsibility
- Compliance
- Communication
- Hazard Assessment
- Accident/Exposure Investigations
- Hazard Correction
- Training and Instruction
- Recordkeeping

The Vice President (VP) of Green Diamond's California Timberlands Division is the IIPP Administrator. Although the VP is not involved in the procedural details of the IIPP, he is responsible for the end results. Operations managers and supervisors are responsible for implementation of the IIPP and to carry out the intent of the federal, state, local, and company safety regulations. The Safety and Human Resources Manager supports the Vice President and the operations managers by coordinating and monitoring compliance with the IIPP. The Safety and Human Resources Manager's responsibilities include the following:

- Coordinate the IIPP and ensuring that it is properly maintained and regularly updated
- Review/prepare mandated written safety policies and programs
- Inform management of new laws and regulations as they pertain to safety
- Perform/participate in accident investigations as needed
- Coordinate, participate in, and document outside safety audits as needed
- Provide assistance with the Corporate Compliance Training Program as it relates to safety
- Assist Operations Managers with developing in-house compliance training

The Safety and Human Resources manager maintains a safety training database to track compliance with training requirements as well as an extensive library of safety documents and training materials.

13.1.2 Environmental training

Green Diamond's Conservation Planning Staff plans and conducts an annual training program for forestry staff, operations staff and contract loggers. The training program includes a review of conservation measures included in the FHCP and the AHCP including any amendments or revisions. The training program also provides a review of Green Diamond's other conservation measures such as botanical protections, raptor and birds of prey identification and protection, road construction techniques and crossing design. The objectives of the training are to build a company-wide understanding of the company's conservation measures and ensure uniform and consistent implementation of the conservation measures.

Section 14 - Stakeholder Consultation

This Management Plan is based on the extensive input that was collected from diverse sources and stakeholders during the development of Green Diamond's numerous management documents. Stakeholders include the company owners, company employees, the scientific community, and the local community including company contractors, reviewing agencies, local government officials and the general public. Green Diamond has decades of experience working with State and Federal Agencies, scientists and public stakeholders in the development of the NSO HCP, FHCP, AHCP, Option A, RMWDR/MATO, FMWDR and other guiding documents. This stakeholder consultation continues with the implementation of new permits and agreements.

Individual harvest plans are subject to a thorough stakeholder consultation process. The THP document is a public document that goes through a public review process guided by CEQA. Other landowners within 300 feet of the proposed operations are officially noticed of the THP and invited to comment. Landowners within 1,000 feet downstream of the proposed plan are contacted and asked about potential domestic water intakes that could be affected by the proposed harvest. Local Native American representatives are contacted and invited to participate in the THP preparation and review process. If Native American archaeological sites are known to occur within the project area, Native American tribal representatives are notified and informed of the site and of the proposed protection measures for the site and asked to provide input. Green Diamond foresters personally contact adjacent landowners and discuss the proposed plan during the early phases of plan development to ensure that neighbor's concerns are addressed to the extent feasible. All aspects of the THP are reviewed by multiple public agencies in the office and in the field. At least one public meeting occurs where the plan is reviewed, and public comment is taken. All Green Diamond THPs are now posted on the CalFire web site for public review. The review process for THPs is a very structured public process that ensures a thorough public review of every proposed plan.

Direct Interaction with the Local Community

Green Diamond Resource Company staff interacts with stakeholders in the community on a variety of levels:

- Since 1998 the company has held an annual Day in the Forest tour for members of the community.
- The company has contributed significantly to the annual Forestry Institute for Teachers.
- The company has participated in the Redwood Region Logging Conference, making presentations in classrooms and leading tours with grade school and high school students. Many employees have served on the board, and several have served as President.
- Provide field learning opportunities for Cal Poly Humboldt students by providing property tours to active operations.
- Employees are invited to present to various Cal Poly Humboldt classes as guest presenters, present lectures and serve on advisory committees.
- Conduct tours for numerous school and community groups.
- Administered the Mark E Reed Scholarship program for local students.

Employee Involvement with Local Non-profit organizations

Employees throughout the company serve on a variety of groups and boards within the community including:

- California Forestry Association, California Forest Soils Council, California Chamber of Commerce, Buckeye Conservancy, Humboldt County Farm Bureau, Humboldt County Forestry Review Committee, CASA, The Wildlife Society, Humboldt County Hospice, Eureka Chamber of Commerce, Cal Poly Humboldt Advancement Foundation Board, The Forest Foundation, etc.

Recent membership in other local organizations include:

- Eureka Chamber of Commerce, Trinidad Chamber of Commerce, Blue Lake Chamber of Commerce, McKinleyville Chamber of Commerce, Crescent City Chamber of Commerce, Orick Chamber of Commerce, Western Forestry and Conservation Association, etc.

Documenting Employee Interactions with Stakeholders

To document employee interactions with stakeholders, a spreadsheet has been developed for employees to record forest management or business-related interactions and input from stakeholders. This spreadsheet is available on Microsoft Teams for employees to document their interactions with stakeholders. Green Diamond's Community Affairs and Communications Representative conducts an initial review of the input before action items are brought to the management team.

Consideration of Stakeholder Input

Managers will review the summary of stakeholder input for significant issues or trends and consider those issues that need potential follow-up action. "Consideration of stakeholder input" will be a regular agenda item at a monthly manager's meeting to ensure time for consideration. Examples of possible follow-up actions include the development of new company policies or revisions of existing policies to address significant concerns, the Vice President or Community Affairs and Communications Representative meeting with community members to discuss issues of concern, or foresters interacting with concerned community members about specific issues as they arise.

Interactions with Local Elected/Appointed Officials

Green Diamond representatives frequently attend Humboldt County Board of Supervisors and Planning Commission meetings. Company representatives also meet with individual elected officials on a frequent basis, including members of the state assembly and senate, and congress. To provide a structured and measurable target for interaction and feedback from elected officials, the following program has been initiated:

- Attend at least one meeting of Humboldt County and Del Norte County Board of Supervisors every 6 months
- Meet with each member of the Humboldt County and Del Norte County Board of Supervisors annually
- Meet with the Congressional representative for Humboldt/Del Norte County annually
- Meet with the State Senate representative for Humboldt/Del Norte County annually
- Meet with the State Assembly representative for Humboldt/Del Norte County annually

General Public Input and Input Regarding the Forest Management Plan

To inform the public and seek local public input on Green Diamond forest management and community activities, a meeting is conducted with the public each year.

Additional public input opportunities will be provided through the Green Diamond internet site. This site includes the Forest Management Plan and monitoring data and an option for public input.

Monitoring Traditional and Social Media

Green Diamond will continue to monitor local, regional and state-wide papers in addition to web sites and blogs for stories of local interest and stories of broader coverage. This media monitoring provides stories that may directly involve Green Diamond and trends that involve broader forestry issues.

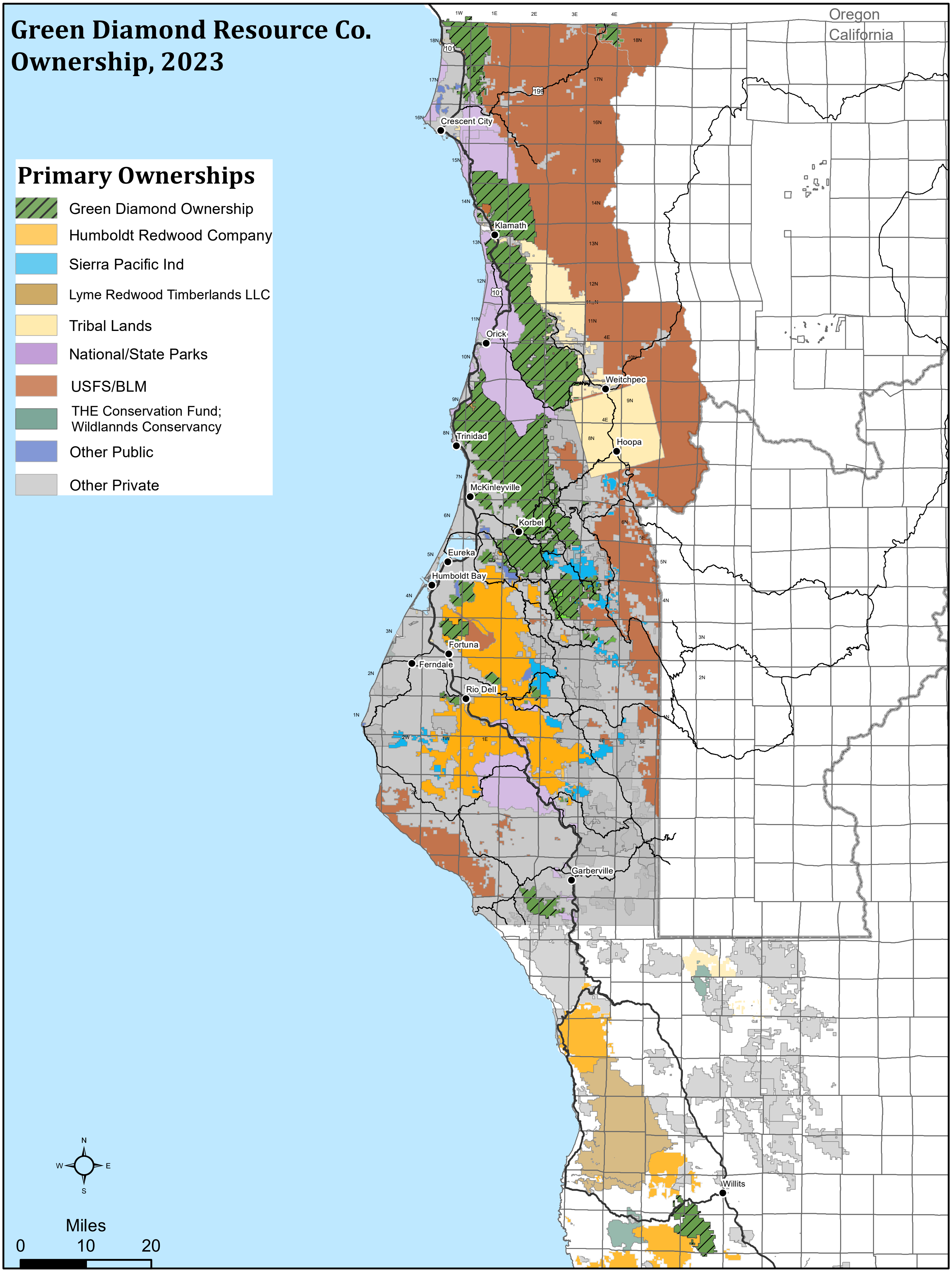
Interactions with Native American Communities

In addition to the Native American contact process associated with THPs, the company will also initiate an outreach program to improve the communications between tribal representatives and Green Diamond staff. The appropriate Native American tribal representatives included on the CalFire Native American contacts list will be contacted by Green Diamond with a goal of identifying issues that the groups may have. This contact will also help to establish a line of communication with the Native American communities to address issues as they arise and will provide a mechanism for open communication.

The CalFire Native American contacts list can be found at:

http://calfire.ca.gov/resource_mgt/archaeology-native_american_contacts.php

Maps and Attachments



Green Diamond Resource Co. Ownership, 2023
Primary Ownerships
Green Diamond Ownership
Humboldt Redwood Company
Sierra Pacific Ind
Lyme Redwood Timberlands LLC
Tribal Lands
National/State Parks
USFS/BLM
THE Conservation Fund; Wildlannds Conservancy
Other Public
Other Private
Oregon
California
Crescent City
Klamath
Orick
Weitchpec
Trinidad
Hoopa
McKinleyville
Korbel
Eureka
Humboldt Bay
Fortuna
Ferndale
Rio Dell
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Willits
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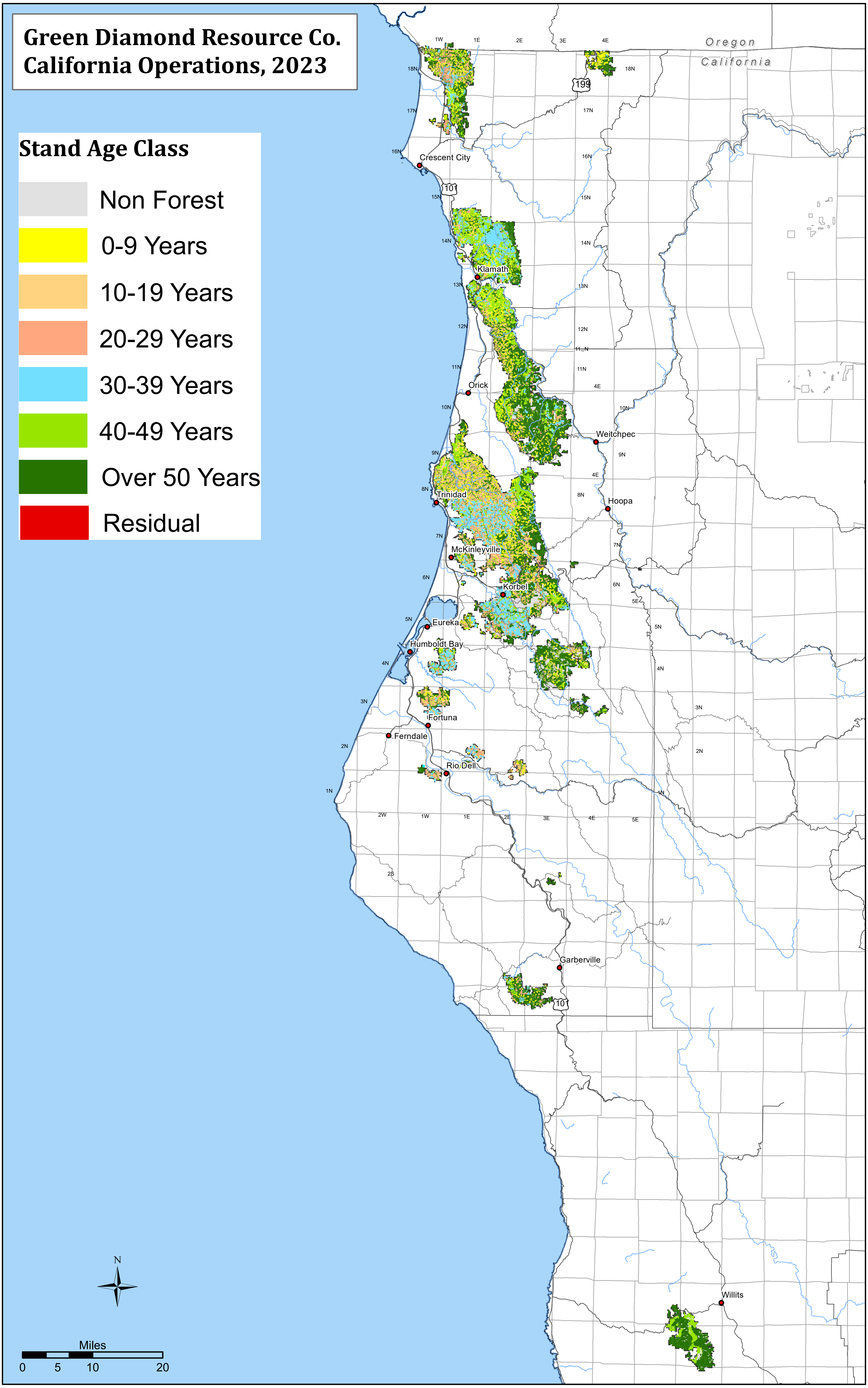
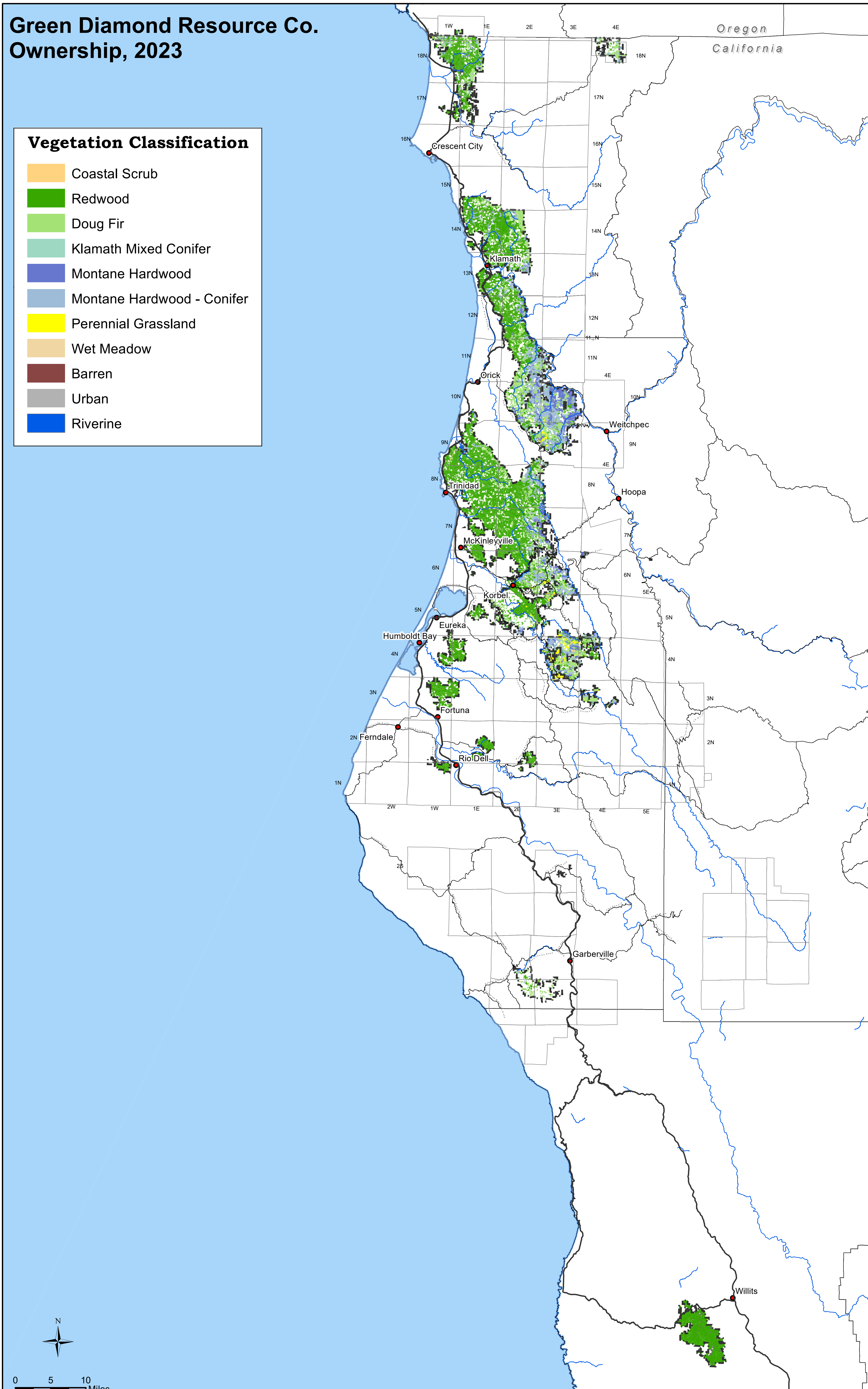
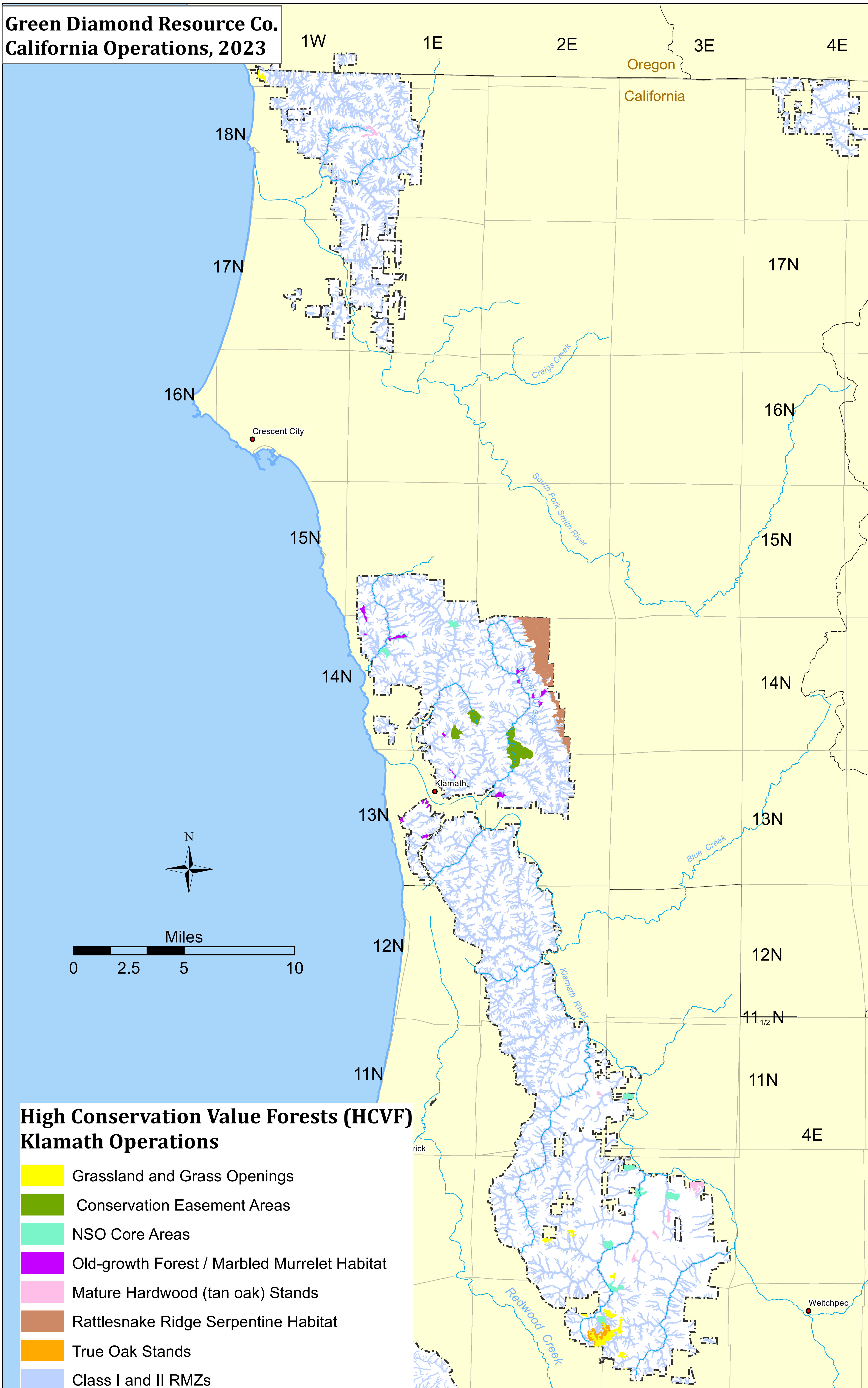
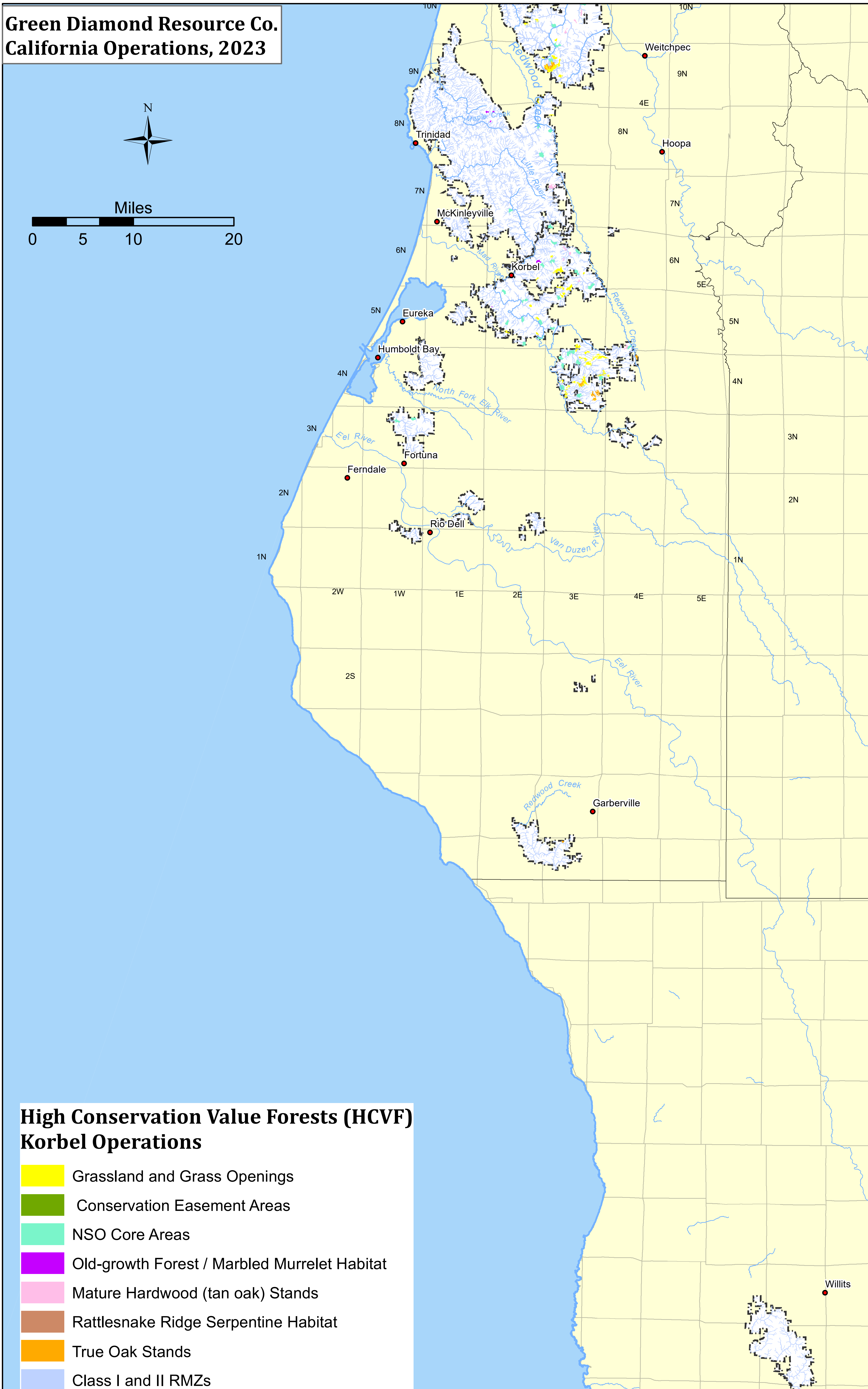


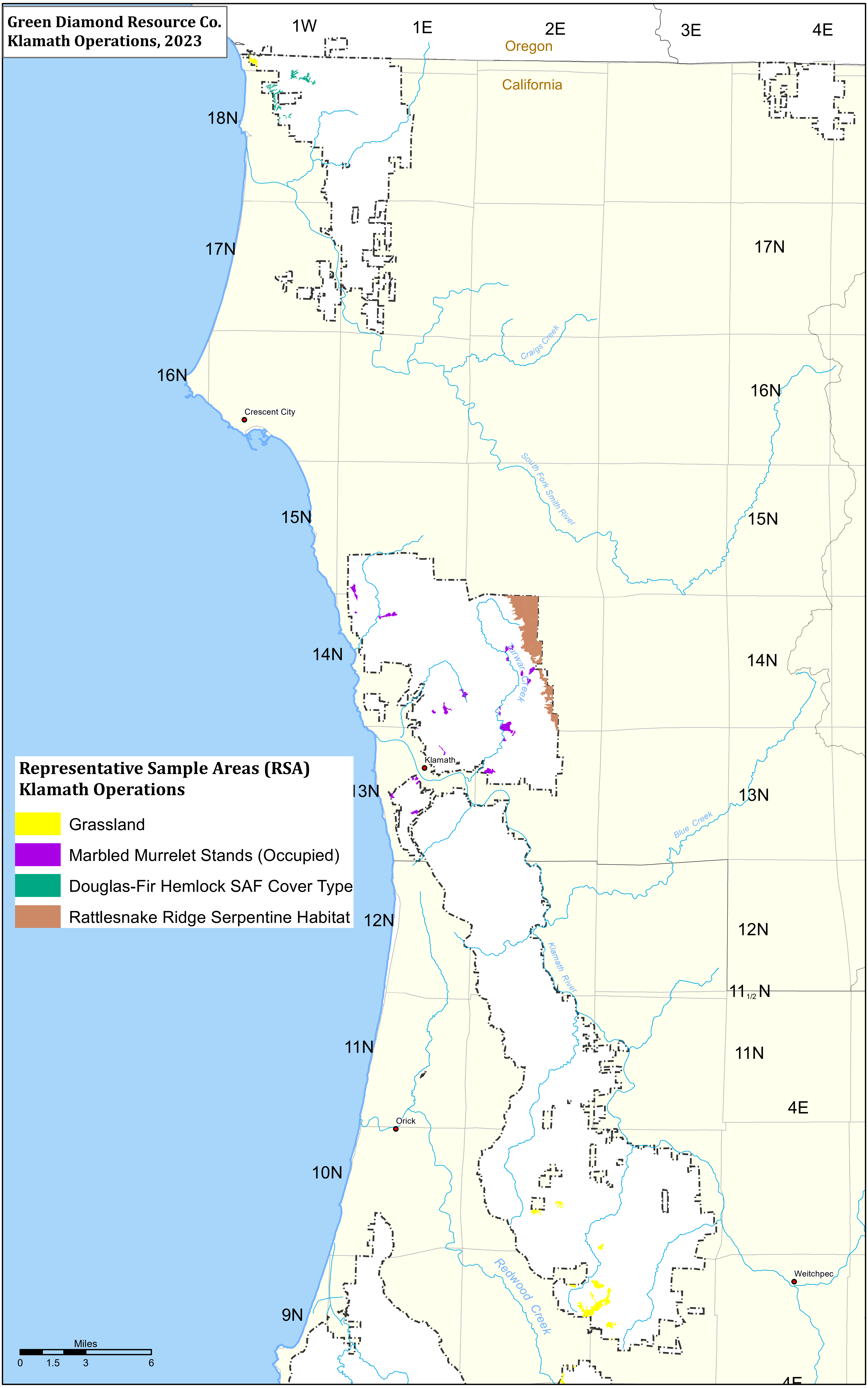
Green Diamond Resource Co.
California Operations, 2023
Stand Age Class
Non Forest
0-9 Years
10-19 Years
20-29 Years
30-39 Years
40-49 Years
Over 50 Years
Residual
Oregon
California
Crescent City
Klamath
Orick
Weitchpec
Hoopa
Trinidad
McKinleyville
Korbel
Eureka
Humboldt Bay
Fortuna
Ferndale
Rio Dell
Garberville
Willits
199
101
N
Miles
0
5
10
20


Green Diamond Resource Co.
Ownership, 2023
Vegetation Classification
Coastal Scrub
Redwood
Doug Fir
Klamath Mixed Conifer
Montane Hardwood
Montane Hardwood - Conifer
Perennial Grassland
Wet Meadow
Barren
Urban
Riverine
Oregon
California
Crescent City
Klamath
Orick
Weitchpec
Hoopa
Trinidad
McKinleyville
Korbel
Eureka
Humboldt Bay
Fortuna
Ferndale
Rio Dell
Garberville
Willits
N
0
5
10
Miles

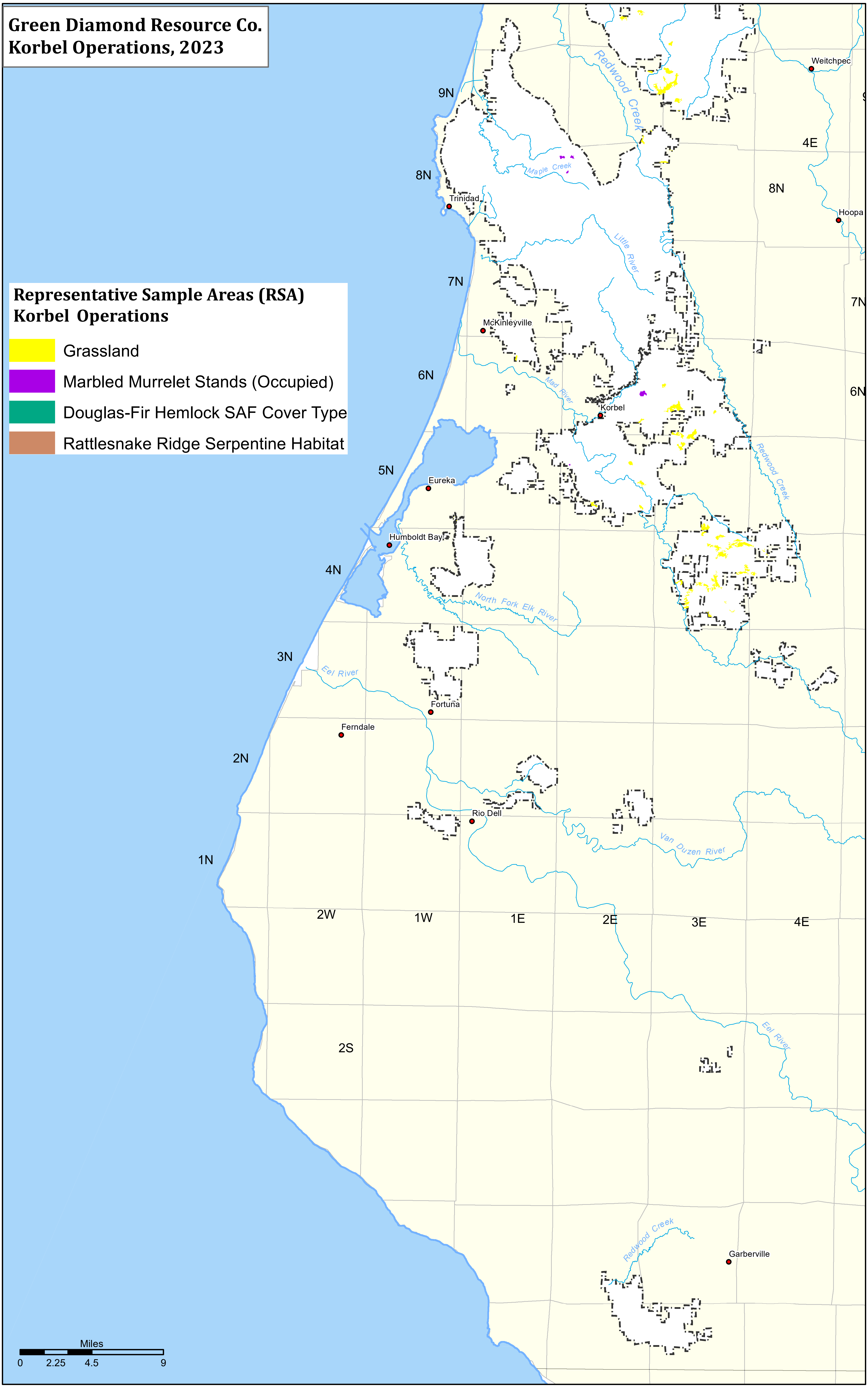


Green Diamond Resource Co.
California Operations, 2023
1W
1E
2E
3E
4E
Oregon
California
18N
17N
16N
15N
14N
13N
12N
11 1/2 N
11N
4E
Crescent City
Klamath
Weitchpec
Craigs Creek
South Fork Smith River
Blue Creek
Klamath River
Redwood Creek
N
Miles
0
2.5
5
10
High Conservation Value Forests (HCVF)
Klamath Operations
Grassland and Grass Openings
Conservation Easement Areas
NSO Core Areas
Old-growth Forest / Marbled Murrelet Habitat
Mature Hardwood (tan oak) Stands
Rattlesnake Ridge Serpentine Habitat
True Oak Stands
Class I and II RMZs


Green Diamond Resource Co.
California Operations, 2023
N
Miles
0 5 10 20
Weitchpec
Trinidad
Hoopa
McKinleyville
Korbel
Eureka
Humboldt Bay
Fortuna
Ferndale
Rio Dell
Garberville
Willits
Redwood Creek
Maple Creek
Little River
Mad River
North Fork Elk River
Eel River
Van Duzen River
10N
9N
8N
7N
6N
5N
4N
3N
2N
1N
2S
2W
1W
1E
2E
3E
4E
5E
High Conservation Value Forests (HCVF)
Korbel Operations
Grassland and Grass Openings
Conservation Easement Areas
NSO Core Areas
Old-growth Forest / Marbled Murrelet Habitat
Mature Hardwood (tan oak) Stands
Rattlesnake Ridge Serpentine Habitat
True Oak Stands
Class I and II RMZs



Green Diamond Resource Co.
Klamath Operations, 2023
1W
1E
2E
3E
4E
Oregon
California
18N
17N
16N
15N
14N
13N
12N
11 1/2 N
11N
10N
9N
Crescent City
Craigs Creek
South Fork Smith River
Blue Creek
Turwar Creek
Klamath
Klamath River
Orick
Redwood Creek
Weitchpec
Representative Sample Areas (RSA)
Klamath Operations
Grassland
Marbled Murrelet Stands (Occupied)
Douglas-Fir Hemlock SAF Cover Type
Rattlesnake Ridge Serpentine Habitat
Miles
0
1.5
3
6


Green Diamond Resource Co.
Korbel Operations, 2023
Representative Sample Areas (RSA)
Korbel Operations
Grassland
Marbled Murrelet Stands (Occupied)
Douglas-Fir Hemlock SAF Cover Type
Rattlesnake Ridge Serpentine Habitat
Weitchpec
Hoopa
Trinidad
McKinleyville
Korbel
Eureka
Humboldt Bay
Fortuna
Ferndale
Rio Dell
Garberville
Redwood Creek
Maple Creek
Little River
Mad River
North Fork Elk River
Eel River
Van Duzen River
9N
8N
7N
6N
5N
4N
3N
2N
1N
2S
4E
7N
6N
2W
1W
1E
2E
3E
4E
Miles
0
2.25
4.5
9

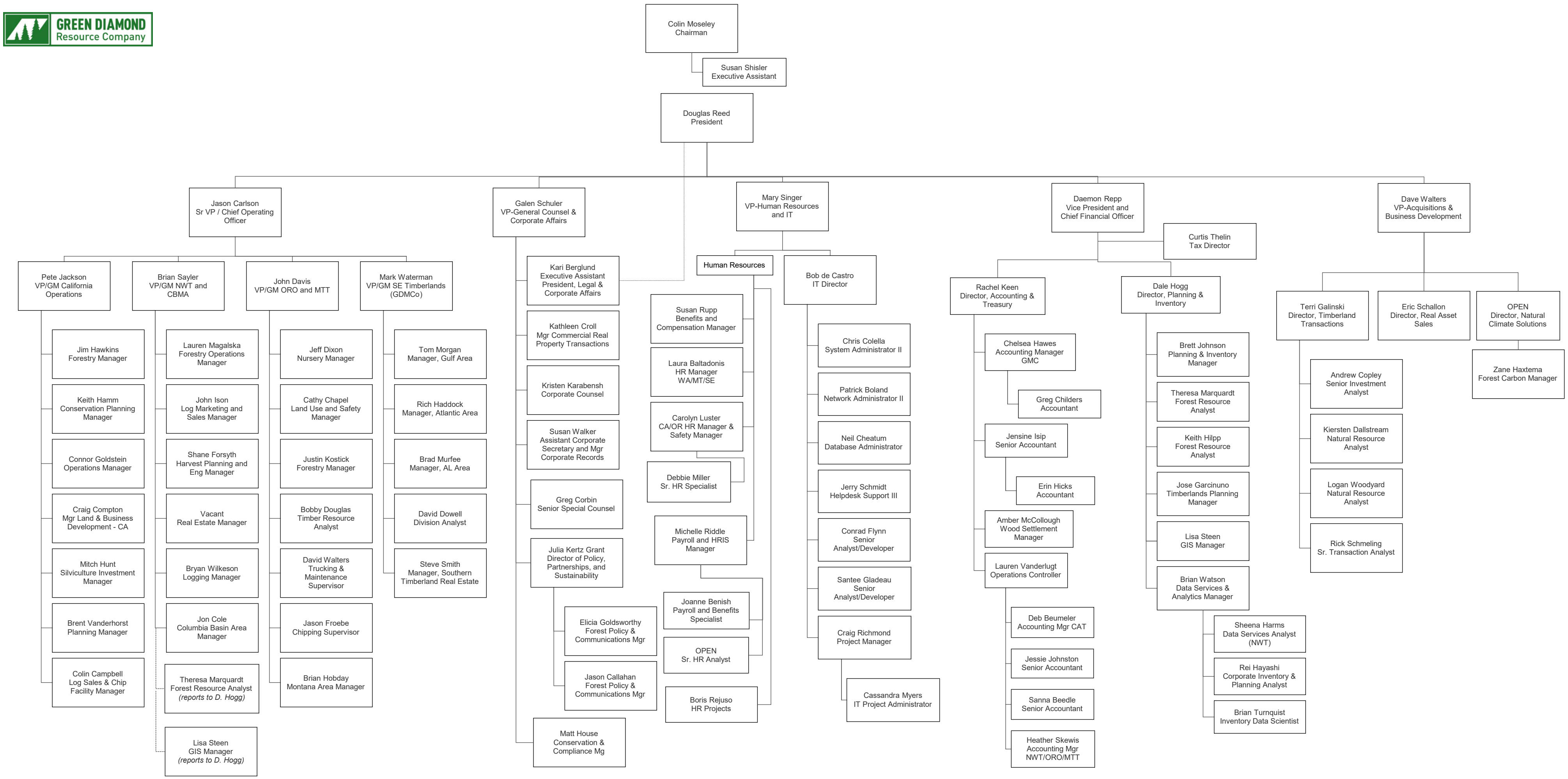
Appendix A: Green Diamond's California Timberlands Organization Charts

GREEN DIAMOND
Resource Company

- Pete Jackson, VP/GM California Operations
  - Keith Hamm, Conservation Planning Manager
    - Desiree Early Dorvall, Sr. Terrestrial Wildlife Biologist
      - OPEN (2), Wildlife Biologist II
      - Fehring, Roos, Hannon, Wildlife Field Technician
      - Maddie Cameron, Wildlife Biologist I
      - Morris, Marquez, Bentz, Lucchesi, Wildlife Biologist III - Coordinators
    - David Lamphear, Sr. Geospatial Scientist
    - Matt Nannizzi, Aquatic Biologist Supervisor
      - Pat Righter, Aquatic Biologist III, Fish/Herpt Coordinator
      - Mel Reneski, Aquatic Biologist II - Hydrology Coordinator
      - Matt Kluber, Aquatic Biologist III, Herpetology
      - Mike Zontos, Aquatic Biologist III Fisheries
      - Erin Phillips, Aquatic Biologist I Fisheries
      - Simon Boycott, Reed Hamilton, Aquatic Biologist I Hydrology
      - Jordan Spence, Aquatic Biologist I, Herpetology
    - Woody Woodward, Senior Geologist
      - Rob Raibley, Geologist I
    - Pat McNeil, Game Mgmt Administrator
    - Gabe Cashman, Botany Supervisor
      - Macy Budeslich, Botanist II Coordinator
      - Alexandria Shedlock, Botanist I
  - Mitch Hunt, Silviculture Investment Manager
    - Tony Whitehead, Silviculture Forester
      - Alex Beauchene, IFM Forester II
      - Bryce McCurry, IFM Forester I
    - Jeromy Couch, Silviculture Forester
      - Samuel Chavez, IFM Forester II
      - Brian Kelly, IFM Forester I
    - Reid Cody, Silviculture Forester
      - Cameron Ziesak, IFM Forester II
      - Nigel Smith, Sierra Cosper, IFM Forester I
    - Scott Whittington, Research Coordinator
    - Christopher Keyser, Tissue Culture Coordinator
      - Isadora Mack, Tissue Culture Technician II
      - Severin, Kirwin, Bangs, Tissue Culture Technician I
    - Chris Hale, Silviculture Forester
    - Brad Henderson, Nursery Coordinator
      - Maura Rasmussen, Nursery Technician I
  - Jim Hawkins, Forestry Manager
    - Kameron Crocker, Chief Forester (KO)
      - Loren Camper, Sr. RPF Forester
      - Kegerreis, OPEN, Mahoney-Moyer, Reg. Prof. Foresters
      - Sonnette Russell, Forester IV
      - Isley Jones, Forester III
      - Matt Lewis, Forester II
      - Clinton Kafka, Forester I
    - Tom Dols, Chief Forester (KL)
      - Chad Freeman, Sr. RPF Forester
      - Hurst, Dobosh, Coulter, MacAdam, Registered Prof. Foresters
      - Allie Fletcher, Forester IV
      - Sarah McGee, Forester II
      - Chris Villarruel, Miranda Tanforan, Forester I
    - Jeremy Drakeford, Chief Forester (KO)
      - Zach Mohrmann, Robert East, Sr. RPF Foresters
      - Skyler Twohig, Chris Kirk, Reg. Prof. Foresters
      - Nathanael Pope, Forester IV
      - Isabell Berger, Samantha Hayman, Ashton McComas, Forester I
    - Seth Smith, Land Surveyor
      - Tristan Cole, Forester IV
  - Connor Goldstein, Operations Manager
    - Linda Herron, Sr. Operations Coordinator
    - Mike Newman, Roads Superintendent
      - Jeff Hackney, Road Maintenance Supervisor
      - Gaird Rigden, Roads Operations Administrator
      - Danny Mayo, Roads Operations Administrator
      - Nalani Ludington, Forest Operations Coordinator
        - Lily Pendley, OPEN, Forest Operations Tech II
        - Haley Weaver, Forest Operations Tech II
    - Mike Carroll, Logging Superintendent, Korbel
      - Kevin Nichols, Logging Supervisor
      - Chad Kroeker, Shop Supervisor
      - Dave Circe, Contract Fall/Buck Administrator
      - Kyle Durrett, Logging Operations Administrator
    - Joel Rink, Logging & Roads Superintendent (KL)
      - Chad Humphreys, Logging Operations Administrator
      - Ted Connelly, Logging Operations Administrator
      - OPEN, Logging Operations Administrator
      - Mersadies Campbell, Logging Operations Administrator
      - Will Devenport, Logging Operations Administrator
    - Nia Tikoo, Transportation Coordinator
  - Brent Vanderhorst, Planning Manager
  - Craig Compton, Mgr Land & Business Development - CA
    - OPEN, Administrative Forester
    - Elizabeth Phillips, Real Property & Transaction Administrator
    - Theresa Taylor, Environmental Administrator
    - Todd Fulton, Security Patrol
  - Colin Campbell, Log Sales and Chip Facility Manager
    - Kent Aultman, Sr. Chip Dock Supervisor
      - Mike Mixer, Chip Dock Lead
  - Elizabeth "Lizzie" Ebert, Timber Resource Analyst
  - Elicia Goldsworthy, Forest Policy & Communications Mgr *(reports to J. Grant)*
    - Brita Goldstein, Community Affairs & Communications Rep
  - Brian Watson, Data Services & Analytics Mgr *(reports to D. Hogg)*
  - Jose "Pepe" Garcinuno, Planning & Inventory Mgr *(reports to D. Hogg)*
    - Aidan Stephens, Inventory Supervisor
      - Winkler, Russell, Inventory Forester I
    - Andrea Begnoche, GIS Mapping Technician III
    - Miles Eggleston, GIS Mapping Technician
  - Carolyn Luster, CA/OR HR Mgr & Safety Mgr *(reports to M. Singer)*
    - Debbie Miller, Sr. HR Specialist
  - Deb Beumeler, Accounting Manager *(reports to S. Steers)*
    - Lori Durrett, Senior Accounting Associate
    - Glenda d/Usseau, Senior Acctng Assoc *(reports to A. McCollough)*

CAT
July 2023

GREEN DIAMOND
Resource Company



corporate
July 2023

Appendix B: Evenage Management Discussion

Review of Green Diamond Resource Company's Timber Harvest Operations and Forest Management Activities As They Relate to Rate of Harvest and Cumulative Watershed Effects

Matthew House, M. S., *Aquatic Biologist*
Ryan Bourque, M. S., *Aquatic Monitoring Supervisor*
David Lamphear, *Research GIS Analyst*

Green Diamond Resource Company

June 2012

Historically, unregulated timber operations have been shown to negatively impact water quality and aquatic species and their habitats. Modern regulated timber harvesting and best management practices have been designed to eliminate, reduce or mitigate these negative impacts, but concerns remain that some negative impacts still occur and additional mitigations are required to more fully protect aquatic resources. Green Diamond Resource Company (Green Diamond) developed and employs a variety of management practices designed to avoid, minimize and mitigate the impacts of Green Diamond's operations on the aquatic system. These management practices are regulated by the California Forest Practice Act and Forest Practice Rules (CFPRs), Green Diamond's Aquatic Habitat Conservation Plan (AHCP) approved by the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS), the Consistency Determination and the Master Agreement for Timber Operations (MATO) approved by the California Department of Fish and Game (CDFG), the Road Management Waste Discharge Requirements (RMWDRs) approved by the Regional Water Board and the Forest Management Waste Discharge Requirements (FMWDRs) pending approval by the Regional Water Board.

Collectively Green Diamond's timber and forest management operations include all the activities described in the Project Description for the FMWDRs. These activities include those necessary to grow and harvest trees (road construction, road reconstruction, timber harvest and transport, silviculture and timber stand regeneration and improvement), and others designed to mitigate potential or avoid negative impacts and improve aquatic resources (road maintenance, road upgrading and decommissioning, instream and riparian restoration projects). These activities also include all the management practices and measures incorporated into Green Diamond's operations as part of the NEPA and CEQA reviews that produced the EIS and IS/MND to accompany approval.

This paper provides a review of the potential effects of Green Diamond's operations on the hydrologic cycle, sediment delivery and transport, water temperature and large woody debris recruitment. We review potential cumulative watershed effects of Green Diamond's operations at the expected harvesting levels utilized during the development of the documents described above (which remain current). Our analysis takes into account all current regulatory restrictions as described in the FMWDRs project description and, as addressed in the CEQA and NEPA documents accompanying the permits and approvals summarized above. Our review demonstrates that the implementation of Green Diamond's management practices and the current regulatory provisions in place—that establish and control the rate of Green Diamond's timber harvesting—avoid, minimize and mitigate potential negative impacts of Green Diamond's operations on the aquatic system and protect, and in some cases improve, water quality. This review confirms that there are no new impacts that have not previously been addressed by and considered in the Final Environmental Impact Statement for approval of the AHCP, the CDFG Consistency Determination for the AHCP, and the IS/MND prepared to support the MATO approved by CDFG and the RMWDR approved by the Regional Water Board.

I. Forest Management Effects on the Aquatic System and Green Diamond's Conservation Strategies to Minimize, Mitigate or Avoid Impacts on Water Quality and Aquatic Species

The potential effects of forest management on the aquatic system include altered hydrologic cycle, solar insulation and stream temperature, habitat complexity, large wood delivery and accumulation, sediment yield, and channel morphology (Bilby and Ward 1991, Chamberlin et al. 1991, Everest et al. 1987, Gregory et al. 1987, Ice et al. 2004, MacDonald et al. 1991, Naiman et al. 1998, Rice et al. 2004). The scale and magnitude of these environmental effects depend on factors such as the extent and intensity of the harvest and logging methods that can be modified with management practices tailored to avoid, minimize and mitigate potential negative impacts of timber management activities. However, other factors such as geology, topography, watershed size, and the timing and magnitude of large, infrequent storm events (Hicks et al. 1991) are inherent characteristics of a watershed or stochastic events that sometimes complicate the application of best management practices and may make the potential impacts more difficult to predict and properly mitigate or avoid. Understanding the effects of forest management activities on natural processes of Green Diamond watersheds aids in developing specific management practices to protect and improve the aquatic resources. Green Diamond developed and employs a variety of management practices designed to avoid, minimize and mitigate the potential impacts of Green Diamond's operations on the aquatic system.

A. Forest Management Effects on the Hydrologic Cycle and Green Diamond's Conservation Strategies to Minimize, Mitigate or Avoid Those Impacts on Water Quality and Aquatic Species

1. Potential Forest Management Effects on the Hydrologic Cycle

Timber harvesting can alter the hydrologic process within a watershed. The primary effects of timber harvest on surface water hydrology pertain to annual water yield, low flows, and peak flows. Annual water yield generally increases following timber harvest with the greatest increase occurring during the fall period. However increases in water yield tend to diminish with forest regrowth over time. Timber harvesting typically increases summer low flows but this effect also diminishes with regrowth. The hydrologic processes affecting peak flows include evaportransportation, interception, fog drip, snow accumulation and melt rates, and soil compaction. Timber harvest typically increases peak flows but the increases are generally only detectable for events with return periods of 5 years or less. At Caspar Creek in northern California, increases in peak flow magnitude were about 27% for two-year storm recurrence interval events. The effect of timber harvest on peak flows generally diminishes with increasing watershed size and increasing time since harvest. Timber harvest activities that compact or disturb the soil can reduce the infiltration capacity of soils and alter the process of subsurface water movement. Compacted soils found on roads and landings are relatively impermeable and water runs off them quickly. Reduced soil infiltration capacity and the interception of surface flow caused by roads may lead to increases in surface runoff, peak stream flows, and sediment inputs to watercourses.

The effects of timber harvest on annual water yield, peak flow magnitude and timing, and summer low flows on aquatic species and habitat characteristics are difficult to assess. The life-cycles of salmonids have adapted to temporal variations in flow conditions by timing the phases of their life cycles to take advantage of seasonal discharge characteristics. Increased runoff in the early part of the rainy season may, in some cases, benefit salmonids by reducing water temperatures, improving water quality, and providing more flow for immigrating adult spawners. However, a harvest-related increase in peak flows may increase the number of times that channel substrates are mobilized by storm events and potentially impact developing eggs and alevins in redds. Channel-forming flows may occur more frequently as a result of an increase in peaks flows; however, the effects are generally confined to low gradient channel reaches that are less than approximately 2% gradient and with streambed and banks that are composed of gravel and finer material. Increased peak flows may also affect the survival of over-wintering juvenile salmonids by displacing them out of preferred habitats. These flow increases could also have beneficial effects by increasing available aquatic habitat. Short-term increases in summer low flows will also increase the amount of aquatic habitat. However, these hydrologic effects are temporary and diminish with regrowth of forest vegetation.

In addition to the summary above, see Appendix A for a more detailed description of timber harvest impacts on the hydrologic cycle.

2. Green Diamond's Conservation Strategies for Minimization of Altered Hydrology

The conservation measures that limit or avoid the effects of altered hydrology and associated impacts to water quality are Harvest Rate, Unit Size and Distribution

Measures; Riparian Management Measures; Slope Stability Measures; and Road Management Measures.

a) *Harvest Rates, Unit Size and Distribution Measures*

The hydrology of a watershed is controlled by many complex interacting factors. Increases in runoff and peak flows could result from harvesting activity and road construction (either from individual harvesting activities or from the combined effects of multiple harvesting operations in a watershed that are temporally or spatially related). Green Diamond's AHCP measures augment existing California FPRs that constrain the timing, location, and intensity of timber harvesting operations, and thus limit the hydrologic effects that might result from such operations. Four CFPR Sections are the primary sources of these constraints: those dealing with canopy retention along watercourses (14 CCR 916 et seq.), those restricting the size and spacing of even-age management harvest units (14 CCR 913.1(a)(3) and (4)(a)), and those limiting harvest rotation age (14 CCR 913.1(a)(1) and 913.11 et seq.).

Green Diamond utilizes a combination of even-age and uneven-age timber harvest methods. At a landscape level, Green Diamond's ownership within the AHCP area is composed of a mosaic of multiple age classes created by small even-age regeneration harvest areas set within a dendritic network of selectively harvested older stands that coincides with the watercourse network.

Before AHCP implementation (prior to 2007) the defined watercourse protection zone widths under the California FPRs, in concert with provisions of the Northern Spotted Owl HCP, resulted in approximately 12% (48,800 acres) of Green Diamond's ownership within the AHCP area in riparian buffers and habitat retention areas (HRAs). These riparian and other HRAs ranged in retention standards from no-cut to a minimum 70% post-harvest canopy retention.

Under the AHCP provisions, approximately 25% of a watershed is retained in RMZs and other partial or no harvest retention areas. The selection harvest and no harvest areas within these RMZs and unstable areas consist of older forests with high basal area and dense canopy cover. Over the life of the AHCP the current average stand age for these RMZ and unstable areas will increase from approximately 42 years (in 2010) to an average of approximately 92 years (in 2060). The even-age harvest areas create a mosaic of small openings that result in multiple age classes distributed as small patches across a watershed. Over the life of the AHCP, 75% of Green Diamond's ownership within the AHCP area will be occupied by these small even-age stands. The average opening created by even-age timber harvest under the AHCP has been calculated to be 15.0 acres in the Maple Creek watershed (discussed further below), which has been subjected to the most intensive harvesting on Green Diamond's ownership in the last decade. These small harvest unit openings will produce a mosaic of even-age 0-20 year old stands that average approximately 30 acres and include a matrix of riparian and in unit retention areas.

The potential for even-age management to alter hydrologic regimes is further constrained by the current FPRs that place strict limits on:

- The size of even-age management units, which can be no more than 20 acres for non-shovel yarded ground-based systems, 30 acres for aerial, cable or shovel yarding systems, and 40 acres when justified according to specified criteria (14 CCR 913.1 (a) (2);

- The distance between even-age management units, which must be "separated by a logical logging unit that is at least as large as the area being harvested or 20 acres, whichever is less, and must be separated by at least 300 feet in all directions" (14 CCR 913.1 (a) (3); and

- The timing of the harvest of contiguous even-age management units, which cannot occur unless regenerating stand in a previously harvested, adjacent clearcut unit is at least five years of age or five feet tall, and three years of age from the time of establishment on the site. (14 CCR 913 (a) (4) (A) (The net effect of this rule is that four to seven years must elapse between initiation of timber harvesting operations on adjacent even-age management units, depending on how long it takes to complete timber harvesting operations and reforestation efforts and the growth rate of subsequent regeneration on the site.)

Green Diamond's Maximum Sustained Production Plan, approved pursuant to the provisions of 14 CCR 913.11(a) (both previous and current Option A documents), also constrain the harvesting rate, limiting even-age harvests to the 50 year (45-55) and older age classes. This provision further limits the frequency with which the hydrologic characteristics of any site can be altered. Even though intermediate treatments such as pre-commercial thinning and commercial thinning may result in transitory and minor changes in the hydrologic regime, this constraint on rotation age ensures that many decades of hydrologic recovery follow any even-age timber harvesting operation. Also, restrictions on the size and spacing of even-age management harvest units, described above, effectively constrain the rotation age on many harvesting units well past the 50 year age class, with some stands reaching to 70 years of age or more before harvest, thus lengthening the cycle of disturbance significantly.

Long-term planning of timber harvesting operations in large tracts of mature timber in compliance with these temporal and spatial constraints becomes a complex challenge. The terrain typical of north coast forests, the need to consider road placement, appropriate harvesting systems, lumber markets, and other operational constraints, as well as varying stand ages and species compositions add complexity to the planning and further constrain Green Diamond's harvest schedule, meaning that it is not even possible to harvest at the pace that the minimum acreage, timing and spacing constraints would, in theory, allow. Even with the most optimistic operational assumptions, Green Diamond's planning efforts have demonstrated that the net effect of these constraints is that large tracts (~ 2000 acres) of relatively homogeneous rotation-aged timber cannot be completely harvested in less than 25 years, even assuming a steady demand for forest products. Larger tracts typically encompass a range of both mature and younger age-classes that will extend this hypothetical harvest rate period to near rotation age length.

Accordingly, existing regulatory requirements and Green Diamond's planning regime significantly limit the potential for increased runoff and peak flows and limit the risk that significant aquatic resource impacts could result from them.

A Case Study: Maple Creek. Green Diamond evaluated the rate of harvest in Maple Creek (tributary to Big Lagoon) to illustrate how these current operational and management provisions work to limit the rate in which a watershed can be harvested. Green Diamond purchased the Maple Creek property from Louisiana Pacific in 1998. Green Diamond owns 29,035 acres in the approximately 30,000 acre watershed. The first intensive old-growth harvesting began in the southern portions of the watershed early in the 1930s and continued in a northerly direction until the 1980s. Early logging was done by steam donkey and hauled to the mill by railroad. Most of the present main haul roads incorporate these old railroad grades. Logging operations were interrupted by the catastrophic fire of 1945 that burned over 60% of the watershed. Most of the railroad trestles burned making much of the area inaccessible. Railroad grades were replaced by truck roads and logs were skidded by tractor instead of steam donkeys. Most of the area burned in the 1945 fire was salvaged and then aerially seeded with conifers. This led to the vast acreage of overstocked pole size stands of Douglas-fir and redwood that currently exist in the drainage. In the 1950s an old-growth sawmill was built near the mouth of Maple Creek to process logs salvaged from the fire. Some second-growth harvesting, consisting of both clearcut and commercial thinning, began in the southern sub-watersheds of Beach Creek and M-Line Creek in the early 1980's, as these sub-watersheds were not burned in the 1945 fire. However, it wasn't until 1999, following the purchase of the LP property by Green Diamond, that even-age second growth harvesting began in the majority of the watershed.

Figure 1 shows the annual rate of harvest over the last 13 years and the projected harvest rate for the next 10 years on Green Diamond's ownership in Maple Creek. The rate of harvest includes all harvesting methods incorporated into THPs such as acres of clearcut, selection, no harvest, commercial thinning, rehabilitation, and sanitation-salvage. By the end of the 23 year period (year 2021) approximately 17,356 acres (59.8 %) of Green Diamond's ownership in the Maple Creek watershed will be incorporated into a THP for even-age harvesting. Over this same time period, approximately 5,940 acres (25.5%) will be in RMZs and other partial or no harvest retention areas within these THPs.

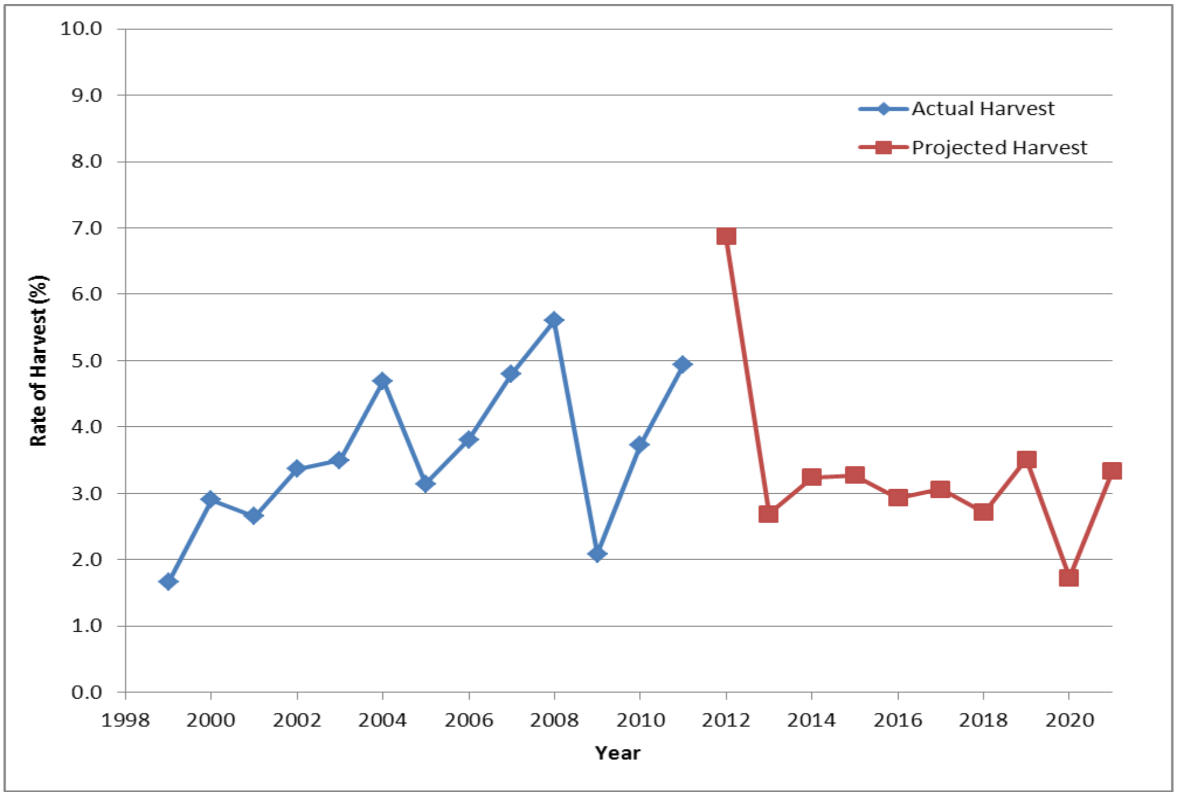


Figure 1. The actual and projected annual rate of harvest of Green Diamond's Maple Creek ownership from 1999 through 2021. The reported rates of harvest incorporate all harvesting methods from THPs including areas retained in RMZs and other partial or no harvest areas.

b) Riparian Management Measures

The riparian measures specify no salvage in the inner zone of Class I and II watercourses and salvage in outer zone if non-functional criteria are met. This conservation measure maintains in-channel LWD and allows for further recruitment of downed LWD from the RMZ which will increase overwintering habitat for juvenile salmonids. The increased pool habitat will help avoid displacement or minimize the effects of displacement of juvenile salmonids caused by peak flows. The LWD in headwater streams function primarily to create suitable riffle habitat through the storing and sorting of sediment and to dissipate hydraulic energy during peak flows.

The riparian conservation measures were also designed to increase LWD recruitment through enhanced widths and canopy retention standards. On Class I watercourses and the first 200 feet of a Class II watercourse where it enters a Class I watercourse, no trees that are judged likely to recruit are harvested. Over time, this conservation measure will increase the amount of LWD in streams, which will help sort and store sediment in streams and ultimately increase overwintering habitat for juvenile salmonids.

c) Slope Stability Measures

Most past road related failures on steep streamside slopes were generally attributed to perched road fill loosely sidecast on steep slopes or concentrated road runoff discharging onto the fill. The slope stability conservation measures for SSS zones avoid building new roads or substantial upgrading on these features without the evaluation of a registered geologist. Upgrading or decommissioning of roads on SSS's address areas with perched unstable fill and sites with concentrated road runoff on fill material.

A benefit of tree retention with regard to slope stability on deep-seated landslides, headwall swales, and SMZs is the maintenance of forest canopy, which preserves some measure of rainfall interception and evapotranspiration. Although these benefits of tree retention cannot be readily modeled across Green Diamond's ownership within the AHCP area, such maintenance of rainfall interception and evapotranspiration is expected to contribute to acceptable slope stability conditions in some locations through partially mitigating high pore water pressures that may be management related.

d) Road Management Measures

Through the road upgrading and decommissioning program, the Green Diamond road network is being progressively hydrologically disconnected from the watercourses. Inboard ditches collect surface runoff and intercept subsurface flows, then quickly route the water (and sediment) to streams, if hydrologically connected, thereby potentially producing higher and early peak flows. Through the use of decreased cross-drain and rolling dip spacing, and outsloping, as specified in the AHCP Road Management Plan, the amount of concentrated surface runoff at any point will decrease. The ditch water is dispersed onto the forest floor where it can infiltrate and reduce the effects of increased peak flow caused by the road network.

Both the road management and decommissioning measures in the AHCP, MATO and RMWDRs reduce the impacts of any operations-related altered hydrology by reducing the magnitude of peak flows and reducing the volume of sediment available for runoff during such events.

e) Harvest-related Ground Disturbance Measures

Timber harvest activities that compact or disturb the soil can reduce the infiltration capacity of soils and alter the process of subsurface water movement. Soil compaction can increase surface runoff and increase the rate which runoff reaches the watercourses as compared to subsurface flow. Site preparation measures are designed with seasonal operating limitations and minimized use of tractor-and-brushrake piling which can cause soil compaction during saturated soil conditions. There are also seasonal limitations for ground-based yarding operations with tractors, skidders, and forwarders which are intended to minimize soil compaction and risk of sediment delivery to watercourses. In addition, Green Diamond has also emphasized the use of shovel logging equipment which has very limited ground disturbance. There are many attributes of shovel logging equipment and the practice that minimizes impacts including:

- Do not have blades and do not require the construction of skid trails for the movement of logs.

- Are equipped with wide surface area – low ground pressure tracks.

- Have high undercarriages allowing them to work on top of the residual slash and stumps – thus providing for less potential for ground disturbance and soil displacement than conventional tractor logging.

- Limited to operating on topography averaging less than 35% in slope.

- Roads and landing areas associated with specific shovel harvesting areas are, by design, located on mild slopes requiring significantly less cutting and filling and often are designated as temporary. These temporary roads and landings are commonly drained and slash packed with the shovel equipment – nearly removing the footprint of the roadway.

- Landings associated with shovel logging are often not "constructed" but designated as areas along the temporary roadways where logs are decked (roadside decking) on top of the slash and existing mild topography – often eliminating the need for the actual construction of landings altogether.

The AHCP's harvest-related ground disturbance measures reduce the impacts of any operations-related to altered hydrology by minimizing soil compaction which can increase the magnitude of peak flows and the volume of sediment available for runoff during such events.

Altogether, these measures work to minimize impacts to aquatic resources that could result from harvest-related increases in runoff and peak flows. They reduce runoff, sediment transport and reduce the impacts of altered hydrology.

B. Forest Management Effects on the Sediment Inputs and Green Diamond's Conservation Strategies to Minimize, Mitigate or Avoid Those Impacts on Water Quality and Aquatic Species

1. Potential Forest Management Effects on Sediment Inputs

The frequency and magnitude of landslides is governed by a number of natural factors, including; hillslope gradient, level of soil saturation, composition of dominant soil and rock types, degree of weathering, and occurrence of climatic or geologic events. Landslides also have the potential to be substantially influenced by the type and level of management activities. Landslides are usually episodic events and tend to contribute significant quantities of course and fine sediments and organic debris to stream channels. Forest management practices can affect slope stability and increase the risk of landslides by changing vegetative cover, hillslope shape, and water flow above and below the ground surface. Different forest management operations have distinct effects on the factors that control slope stability. Roads, skid trails and harvesting trees are the major components of forest management operations that can influence slope stability. Roads and skid trails may result in unstable cut and fill slopes and divert or concentrate surface and subsurface flow. In addition, road and skid trail crossings can plug, causing fill washouts or gullies, if the flow is diverted down the road and adjacent hillslopes. Roads have long been identified as the dominant source of sediment inputs to watercourses caused by forest management activities. Harvesting trees can increase the rate of landsliding by reducing the root strength of the soil and increasing the pore water pressure by reducing interception of precipitation and evapotranspiration of soil water.

Deep-seated landslides also have the potential to produce large amounts of both coarse and fine sediments. Natural mechanisms that may trigger deep-seated landslides include intense rainfall, earthquake shaking, and erosion of landslide toes by streams. Forest management activities can potentially increase the occurrence or rate of movement of deep-seated landslides; however the accelerated rates of movement are very small (i.e. measured in millimeters).

In addition to the summary above, see Appendix A for a more detailed description of timber harvest impacts on sediment inputs and transport.

2. Green Diamond's Conservation Strategies for Sediment Input Reductions

The conservation measures that contribute to minimizing sediment input and associated reduction in impacts to water quality are Riparian Management Measures, Harvest-related Ground Disturbance Measures, Slope Stability Measures, and Road Management Measures.

a) Surface Erosion (non-road related)

Sediment production from surface erosion of hillslopes is assumed to be most important with regard to the sediment budget on slopes that are adjacent to watercourses, although erosion does occur higher on the hillslope within harvest units. Eroded sediment can be delivered to watercourses through gullies or rills or through sheet transport processes. The AHCP's riparian prescriptions and harvest-related ground disturbance prescriptions were designed to reduce non-road related surface erosion and contribute to decreased sediment delivery to the watercourses.

(1) Riparian Management Measures

The minimum width of RMZs on Class I (fish bearing) watercourses is 150 feet with 85% overstory canopy retention in the inner zone (50-70 feet depending on slope class) and 70% overstory retention in the remaining outer zone. Class II watercourses have a minimum RMZ width of 75-100 feet with 85% overstory canopy retention in the inner zone (30 feet) and 70% on the remaining outer zone. Modified Tier A, Class III watercourses (established in areas with highly erodible soils) have an EEZ width of 30 feet with 15 square feet of basal area of hardwoods, and all channel zone trees retained. Tier B, Class III watercourses have an EEZ width of 50 feet with 100% hardwood retention and one conifer per 50 feet of stream length. These retention standards, with the inherently associated understory retention, ensure that there is almost no loss in total forest canopy in the inner RMZ along Class I and II watercourses and greatly increased canopy along Class III watercourses relative to the CFPRs. This canopy coverage impedes surface erosion in these critical areas, where eroded sediment would have relatively short transport distances to reach watercourses.

In addition to the canopy requirements, general RMZ conservation measures such as the limitations on equipment in the RMZs (EEZs), seeding and mulching of areas of ground disturbance larger than 100 square feet in Class I and II RMZs, and limitations on site preparation in RMZs and EEZs also contribute to mitigating the effects of timber harvest on erosion processes on hillslopes that are adjacent to watercourses by preventing and remediating harvest related exposure of bare mineral surface soil.

Retention of trees that are judged to be critical to maintaining bank stability along Class I, II, III (Modified Tier A and Tier B) watercourses and retention of trees with roots that act as control points in Modified Tier A and Tier B Class III watercourses contribute to mitigating accelerated bank erosion and down-cutting by maintaining a live root network that increases total cohesion in the surface soil.

Other RMZ conservation measures, such as retention of trees that are likely to recruit and restrictions on salvage logging, may also contribute to mitigating the effects of management related increased sediment loads to the aquatic system to the extent that those trees and that downed wood do actually recruit to fish bearing watercourses.

(2) Harvest-related Ground Disturbance Measures

The AHCP's Harvest-Related Ground Disturbance measures are specifically designed to minimize management related surface erosion. In particular, there are time period restrictions on silvicultural and logging activities when operations conducted during those time periods have a greater risk of sediment delivery to watercourses. Harvesting activities generally result in some level of ground disturbance. The time period restrictions allow those harvest activities with relatively low ground disturbance (and associated low risk of surface erosion), such as shovel logging (not requiring constructed skid trails) and skyline and helicopter yarding, to be conducted during the winter period. Those harvest activities that can create more ground disturbance (e.g. skid trail construction, mechanized site preparation) are limited to the summer period only, with some activities (e.g. ground based yarding with tractors, skidders or forwarders) extending into the early spring or late fall, as well, if certain favorable climatic conditions occur. There are also specific areas (Salmon Creek and N.F. Elk River) with erodible soils where winter yarding is excluded.

Harvest related ground disturbances and exposure of bare mineral soil within harvest units are also minimized by way of carefully designed site preparation methods, limiting use of ground based yarding equipment that require constructed skid roads to slopes less than 45% (with some exceptions), preferential use of cable yarding systems versus ground based yarding systems, and water-barring of cable corridors where necessary. Evaluation of existing skid trails that have the potential to divert a watercourse and cause gully erosion or surface erosion are evaluated on a site-specific basis for repair during THP layout. All of these harvest related ground disturbance conservation measures contribute directly to minimizing management related surface erosion potential within harvest units by reducing harvest related ground disturbance and exposure of bare mineral soil.

b) Mass Wasting (non-road related)

Sediment production from mass wasting is most significant in riparian management zones (RMZs), steep streamside slopes (SSSs), headwall swales, and active deep-seated landslides. These areas, with the exception of RMZs, are collectively referred to as Mass Wasting Prescription Zones (MWPZs) and are subject to specific slope stability conservation measures that are intended to reduce landslide occurrences and sediment production from non-road related landslides. Most of the MWPZ's are applied in conjunction with the riparian prescriptions to provide additional protection to reduce management related landsliding.

(1) Slope Stability and Riparian Management Measures

The AHCP's Slope Stability Measures require tree retention in MWPZs, which are areas identified as having relatively high landslide-related sediment delivery rates and are sensitive to management activities. In Streamside Management Zones (SMZs), single tree selection harvest is the most intensive silvicultural prescription permissible without geologic review. The Riparian Streamside Management Zones (RSMZs) are no cut in the Blue Creek HPA. For the rest of the HPAs, the inner RSMZ band for Class I and Class II-2 is no cut and 85% canopy retention on the outer band. The total width of the SSS's, which includes the RSMZ and SMZ, varies depending on HPA location. SSSs along Class I watercourses are a maximum slope distance of 150 feet in the Smith River HPA, 425 feet in the Coastal Klamath HPA, and 200 feet in all other HPAs. SSSs along Class II-2 watercourses are a maximum slope distance of 100 feet in the Smith River HPA, 195 feet in the Coastal Klamath HPA and 200 feet in all other HPAs. SSSs along Class II-1 watercourses are a maximum slope distance of 135 feet in the Coastal Klamath HPA and 75 feet in all other HPAs. The initial default SSS prescriptions for slope gradients and slope distances are scheduled to be revised based on the results of further data collection. The initial default prescriptions for the Coastal Klamath HPA have been refined based on the results of the SSS delineation study for this HPA. Data collection is currently under way for the remaining HPAs.

EEZs along Tier B, Class III watercourses require retention of all hardwoods and an average of one conifer per 50 of stream length, plus all trees that are judged to be critical to bank and channel stability. EEZs along Tier A, Class III channels in areas with highly erodible soils receive Modified Tier B protections that require retention of 15 square feet of basal area of hardwood and all channel zone trees. In high-risk headwall swales that are field verified, selection harvest is the most intensive silvicultural prescription permissible. Active deep-seated landslides are prescribed limited operating areas of 100% tree retention above their scarps and on the lower portions of their toes. Also, road construction and reconstruction is limited in MWPZs.

Tree retention in the MWPZs is expected to maintain a network of live roots that preserves total soil cohesion and contribute to acceptable slope stability conditions in these areas. Another benefit of tree retention with regard to slope stability is the maintenance of forest canopy, which preserves some measure of rainfall interception and evapotranspiration. Although these benefits of tree retention cannot be modeled in a simple and practical manner across Green Diamond's ownership within the AHCP area, such maintenance of rainfall interception and evapotranspiration is expected to contribute to acceptable slope stability conditions in some locations through partially mitigating high pore water pressures that may be management related.

The riparian and slope stability conservation measures for Class I and II watercourses that require 85%-100% canopy retention in the inner RMZ and prohibit harvesting of trees that are likely to recruit, as well as the conservation measures for Tier B Class-III watercourses that require retention of hardwood trees and trees that are judged to be critical to maintaining bank stability and that act as stream control points, ensures that removal of trees and reduction of root reinforcement of soil shear strength is minimized. In addition, Modified Tier A Class III protections, applied in areas with highly erodible soils, require retention of 15 square feet of basal area of hardwood and all channel zone trees. Collectively these riparian and slope stability measures provide root strength to mitigate management related sediment inputs associated with stream bank instabilities.

Limiting road construction and reconstruction in MWPZs is intended to avoid and reduce the undercutting and overburdening of sensitive hillslopes and also avoid unnatural concentration of storm runoff to these slopes. Additional benefits of road related conservation measures pertaining to road cut and road fill failures as well as watercourse crossing failures are discussed below.

The AHCP's Slope Stability Measures are intended to reduce management related landslide occurrences and contribute to decreased sediment delivery, which is intended to mitigate the possible effects of management related sediment input to watercourses and the impacts on water quality.

The default slope stability prescriptions in the AHCP are based on a presumption that: (a) harvest-related activities on any unstable features (as defined in the AHCP) poses a certain level of environmental risk (e.g., causing movement of the unstable area and delivery of sediment to watercourses); and (b) applying the default prescription to harvesting activities on that feature provides a sufficient level of risk avoidance or mitigation of such impacts on water quality. The AHCP also provides for the development of site-specific alternatives based upon unique site conditions that would minimize the risk of sediment delivery and provide a level of protection to water quality that equals or exceeds that provided by the default prescription. In other words, the alternatives would be designed to achieve the same conservation objective as the default. Therefore, applying the alternative will achieve protection and conservation benefits that are equal to or better than that provided by the default prescriptions.

c) Road Related Surface Erosion and Mass Wasting

Road related erosion and mass wasting is known to be a significant contributor to the sediment budget in most managed watersheds. Eroded sediment can be delivered to watercourses through gullies or rills or through sheet transport processes from roads or through mass wasting.

(1) Road Management Measures

There are two key components of the AHCP Road Management Plan: (1) the Road Implementation Plan and (2) the Road Maintenance and Inspection Program. The objective of the Road Implementation Plan (AHCP Section 6.2.3.2) is to carry out a systematic road upgrading and decommissioning program using the Plan's road assessment and prioritization system (AHCP Section 6.2.3.1). The strategy under the AHCP differs from the past approach of conducting road work, which was on a THP-by-THP basis. The AHCP approach compartmentalizes the Green Diamond ownership into Road Work Units, or groupings of sub-watersheds. These Road Work Units were prioritized for potential upgrading and decommissioning based on a priority ranking system of providing the greatest sediment reduction and conservation benefits to aquatic resources. The intent of the AHCP is to conduct scheduled road assessments and road treatments by prioritized Road Work Units, as well as THPs, as necessary to comply with State regulations.

The Road Maintenance and Inspection Program (AHCP Section 6.2.3.9) requires: (1) annual inspections and maintenance of all mainline and appurtenant roads to THPs; and, (2) on a 3-year rotating schedule of secondary roads within Routine Maintenance Areas. The inspections are conducted in accordance with the process outlined in AHCP Section 6.2.3.9.5.

The objectives of the Road Maintenance and Inspection Program and their related responsibilities placed on Green Diamond are distinct from those of the road upgrading program (contained in the Road Implementation Plan). The objectives of the Road Maintenance and Inspection Program depend on whether or not the road being maintained and inspected has been upgraded under the AHCP. For all roads that have been upgraded under the Road Implementation Plan, the Road Maintenance and Inspection Program is designed to keep these upgraded roads in a "low risk" category.

In contrast, for roads that have not yet been upgraded or decommissioned under the Road Implementation Plan, the objectives of the Road Maintenance and Inspection Program are to minimize the risk of significant road failures and to control significant chronic sources of sediment discharges from these roads until the point at which the entire road can be upgraded or decommissioned according to the prioritization schedule in AHCP Section 6.2.3.1.1.

The AHCP was designed to manage Green Diamond's road network by systematically and efficiently upgrading, decommissioning and maintaining roads using a landscape-based approach. Green Diamond has agreed to spend $2.5 million per year (2002 dollars) for the first 15 years of the implementation of the AHCP to accelerate the repair of high- and moderate-priority road sites. The RMWDRs and MATO provide programmatic regulatory coverage for THP-related sites as well as for non-THP sites in a comprehensive approach that provide the greatest conservation benefits by: (1) fixing sites with the greatest potential sediment savings; and, (2) deferring improvements on those sites with low risk of failure until the road is upgraded, decommissioned or the risk of failure of the site is elevated.

The AHCP, RMWDRs and MATO contain a site identification, prioritization and rating system that is designed to determine which sites have the highest probability for risk of failure. The Agreement and RMWDRs provide the regulatory authorization for repair of all categories of road sites (upgrading, decommissioning, and maintenance) across the landscape through a proactive approach that provides significantly more environmental protection and biological benefits than is possible under the typical THP/1600/General WDR process. These authorizations greatly reduce the probability of catastrophic road crossing failures that would, in turn, cause significant sediment delivery to streams.

The AHCP, RMWDRs and MATO include performance and prescriptive measures required to protect fish and wildlife resources, as well as other public trust resources. These conservation measures address: crossing types; time of operation; permanent crossings; temporary crossings; fish passage; culvert crossings; fords; water drafting, flow bypass and drafting site maintenance; erosion and sediment control; bank stabilization; road decommissioning; obstruction and sediment removal; vegetation removal and control; deposition and disposal of materials; equipment use, petroleum and other pollution control; and geology.

In the respective sections below, we summarize ongoing monitoring data from the Maple Creek watershed (Figure 2) to evaluate the potential negative effects of the current rate of harvest in this basin where Green Diamond has been implementing contemporary management practices.

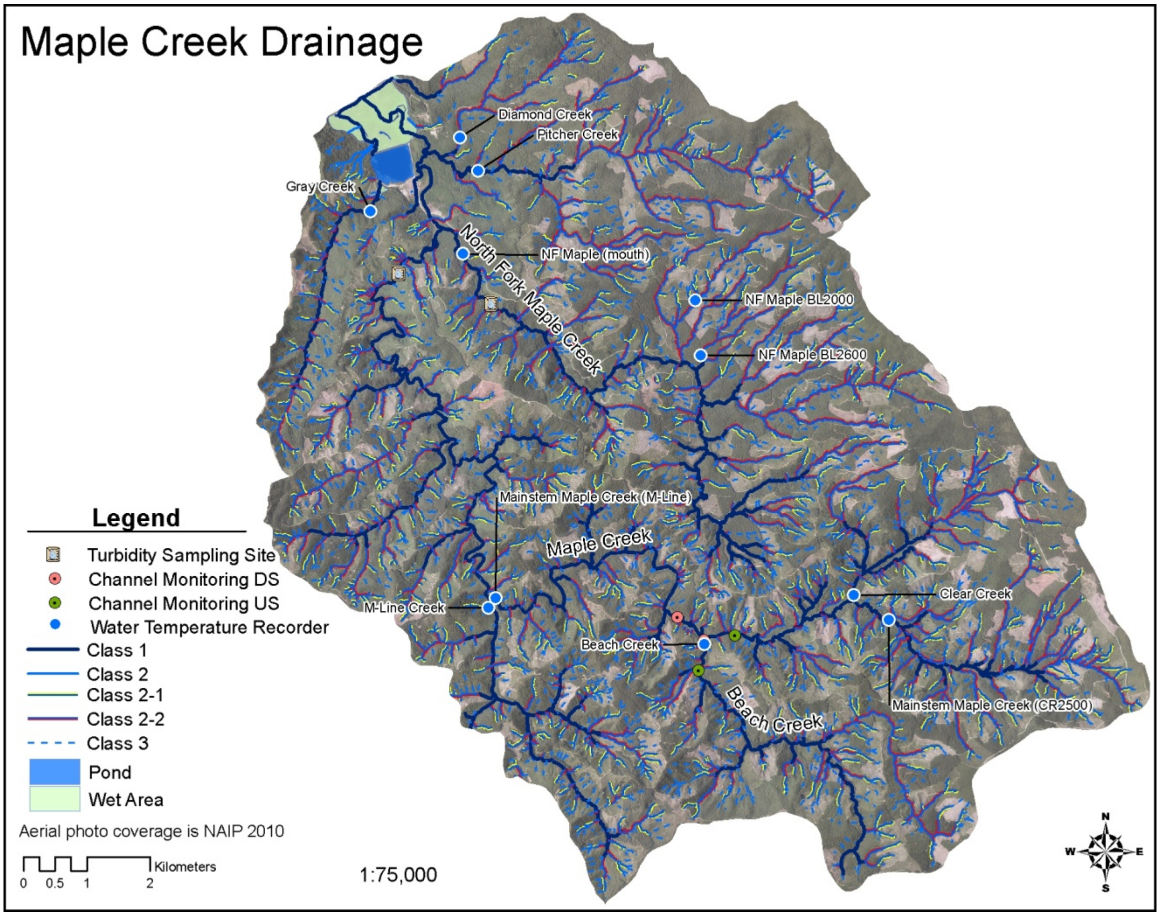
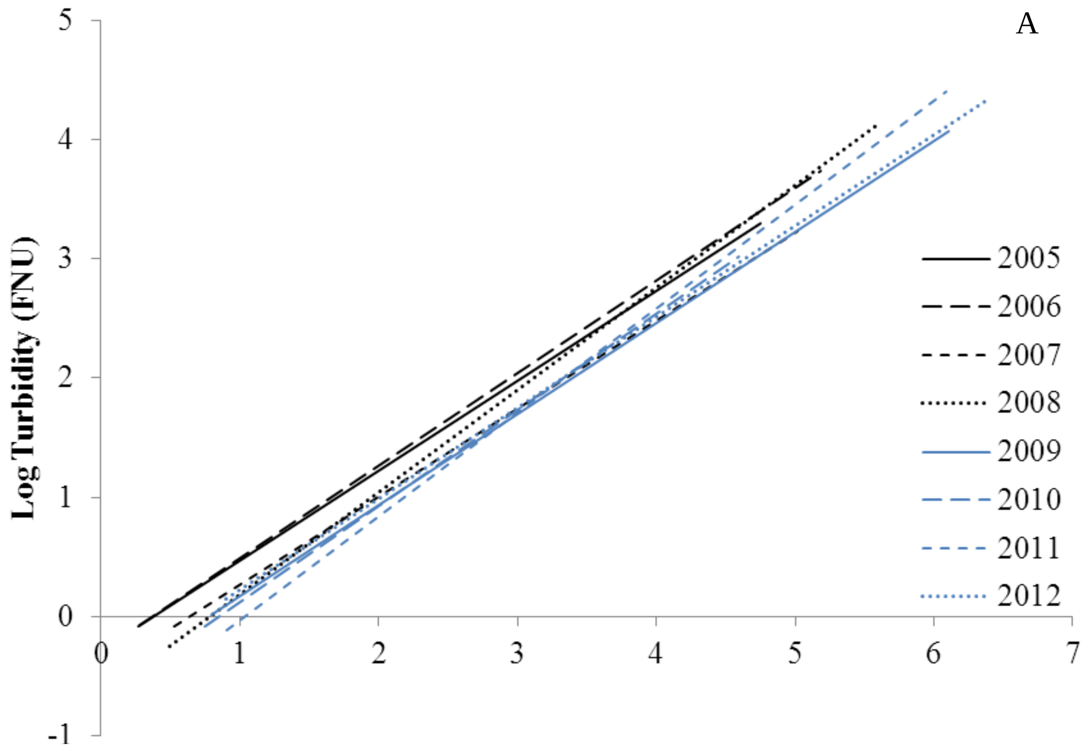


Figure 2. Map of the Maple Creek watershed and Green Diamond's turbidity monitoring, water temperature monitoring, and channel monitoring locations.

The Road Management Measures in the AHCP, RMWDRs and MATO reduce road related sediment production and delivery to watercourses. Turbidity threshold sampling (TTS) data collected from 2005-2012 at two sites in Maple Creek watershed (Figure 2) indicate that stream turbidity has generally decreased over time. This change is evident from assessment of the annual relationship between stage and turbidity (Figure 3). Assuming a constant slope, an increase in the y-intercept would suggest an increase in the overall turbidity levels in the watershed across all ranges of water depths (or stream flows), whereas, a decrease in the y-intercept would suggest a decrease in the overall turbidity levels in the watershed across all ranges of water depths (or stream flows). Assuming a constant y-intercept, an increase in the slope over time would suggest that turbidity levels are higher for a certain water depth (or stream flow), whereas, a decrease in slope would suggest that turbidity levels are lower for a certain water depth (or stream flow). Over the past seven years of monitoring, the slopes of these relationships have remained constant at mainstem Maple Creek (MSM linear regression: t-value = 0.9935, p = 0.3588, R^2 = 0.1423) and North Fork Maple Creek (NFM linear regression: t-value = 1.5226 , p = 0.1787, R^2 = 0.2787) but the y-intercepts of these relationships have decreased significantly at both sites (MSM linear regression: t-value = -2.7786, p = 0.0321, R^2 = 0.5627 and NFM linear regression: t-value = -2.6362 , p = 0.0387, R^2 = 0.5367). The constant slope suggests that road management has not negatively impacted turbidity. In fact, the change in the regression intercept translates into a decrease in turbidity across the range of stages (discharges) at each site. We evaluated the current rate of harvest above each turbidity station to assess the observed changes in turbidity (Figure 4). The rate of harvest was lagged by one year in an attempt to align the potential impact of harvesting with the expected response from the turbidity monitoring. The decrease in turbidity appears to be independent from the rate of harvest in each sub-basin. This decrease is likely attributable to the collective suite of sediment minimization measures described above and implemented by Green Diamond in conjunction with the AHCP.



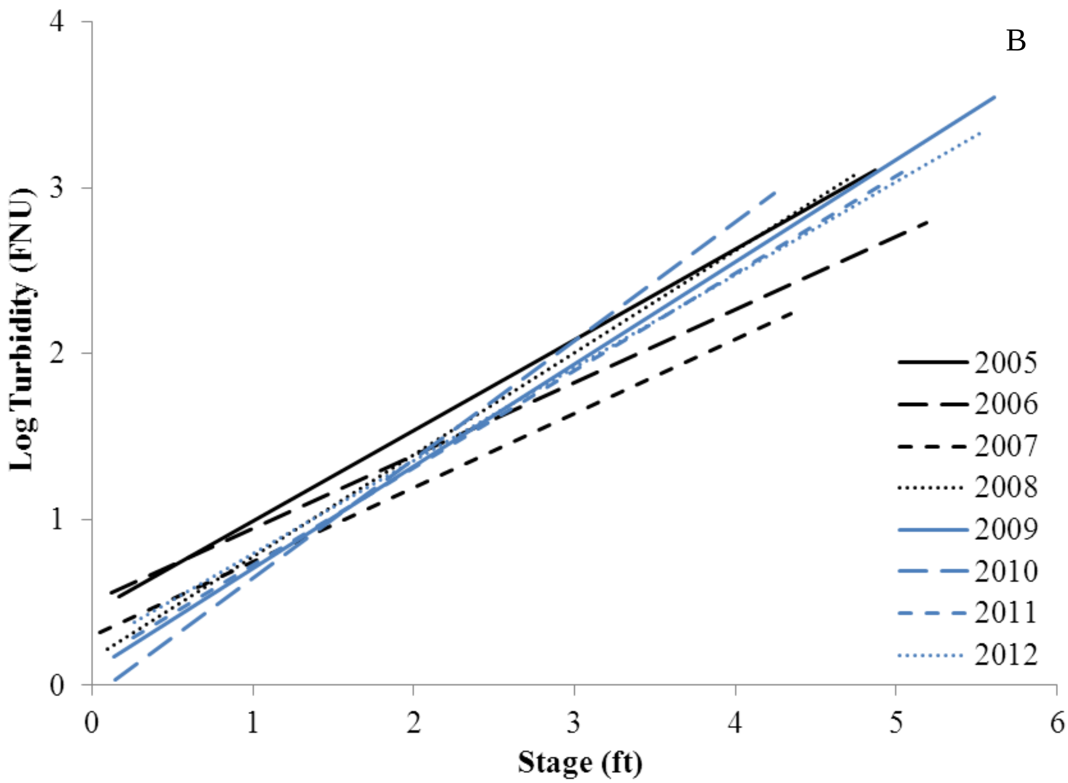


Figure 3. Comparison of stage-turbidity relationship from 2005-2012 in mainstem Maple Creek (A) and North Fork Maple Creek (B).

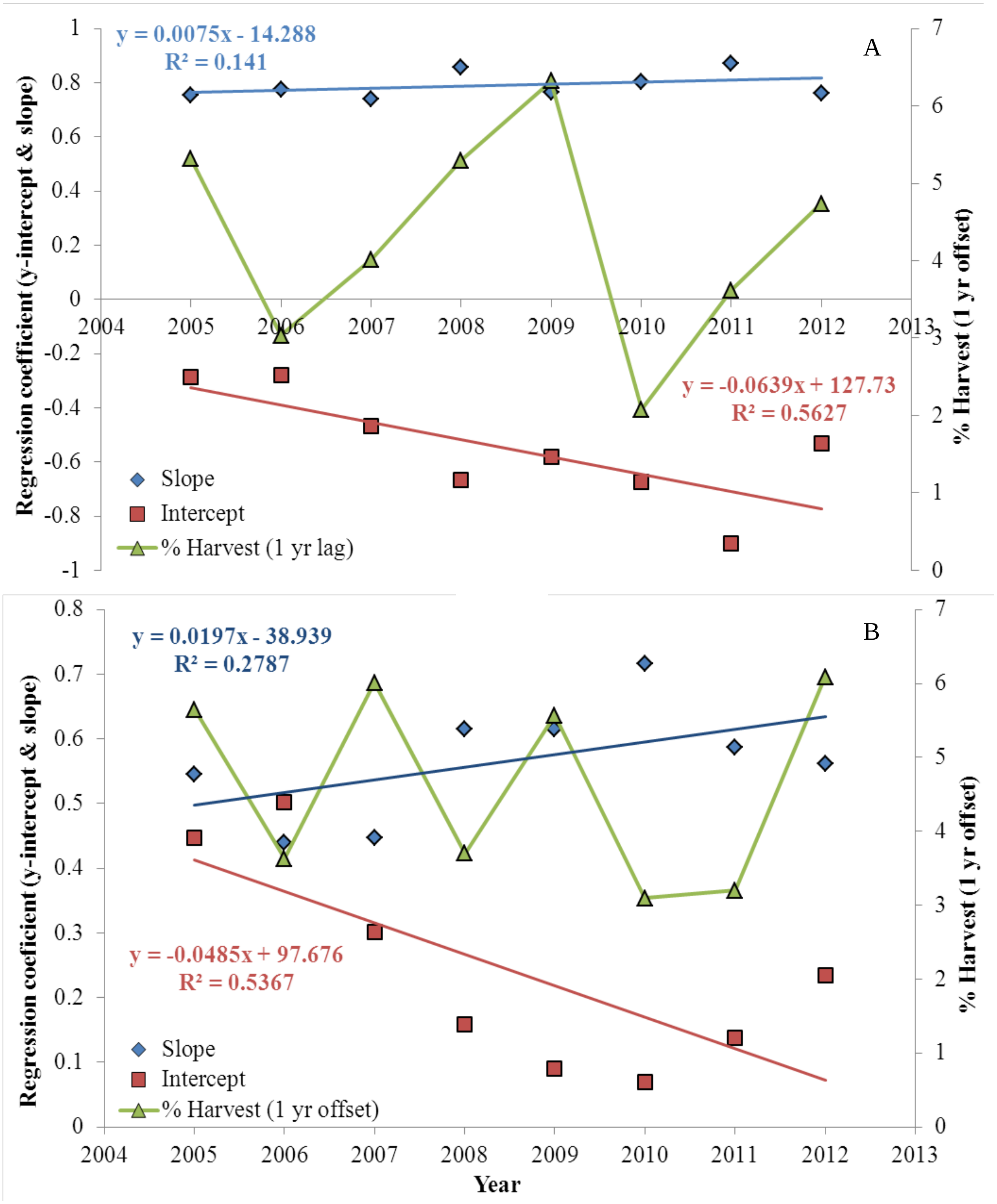


Figure 4. Relationships between stage-turbidity linear regression coefficients [slope = blue diamonds; y-intercept = red squares] and percent harvest [green triangles] from 2005-2012 in the mainstem Maple Creek (A) and North Fork Maple Creek (B). The rate of harvest was lagged by one year in an attempt to align the potential impact of harvesting with the expected response.

C. Forest Management Effects on the Altered Water Temperature and Green Diamond's Conservation Strategies to Minimize, Mitigate or Avoid Those Impacts on Water Quality and Aquatic Species

1. Potential Forest Management Effects on Altered Water Temperature

Stream temperature is controlled by multiple factors such as solar and thermal radiation, riparian shading, air temperature, wind velocity, relative humidity, tributary inflow, groundwater inflow, and hyporheic flow. Timber harvest can affect water temperature in streams in three principal ways: (1) increased incoming solar radiation and decreased incoming thermal radiation through the removal of canopy cover; (2) increased sediment inputs that results in wider and shallower channels; and (3) modification of hydrologic processes that regulate the timing and quantity of stream flow. Incoming solar radiation appears to be the dominant factor at the site level; however, modeling studies of the cumulative effects of large scale timber harvest emphasize that it is a complex set of factors, rather than a single factor such as shade, that governs stream temperature dynamics. Increases in water temperatures during summer can have negative impacts on the aquatic system. However increased light levels and increased autotrophic production can also have a positive effect through an increase in food production and higher growth rates if water temperature increases are not significant.

In addition to the summary above, see Appendix A for a more detailed description of timber harvest impacts on altered water temperature.

2. Green Diamond's Conservation Strategies for Minimization of Altered Water Temperature

The AHCP's Riparian Management and Slope Stability Measures minimize, mitigate and avoid the impacts of Green Diamond's operations associated with altered water temperature.

a) Riparian Management Measures

The minimum width of RMZs on Class I (fish bearing) watercourses is 150 feet with 85% overstory canopy retention in the inner zone (50-70 feet depending on slope class) and 70% overstory retention in the remaining outer zone. Class II watercourses have a minimum buffer width of 75-100 feet with 85% overstory canopy retention in the 30 foot inner zone and 70% on the remaining outer zone. These retention standards ensure that there is almost no loss in canopy in the critical inner zone. There is an immediate net reduction of canopy cover of approximately 15-20% following timber harvest in the outer zone, which will be replaced within 5-10 years by recovery of the remaining tree crowns.

As a result, there should be little or no measurable change in water temperature as a result of canopy reduction following timber harvest.

Although the sample size is still small, Green Diamond has direct experimental data to support the conclusion that the riparian conservation measures will prevent impacts to water temperature. A Before-After-Control-Impact (BACI) experimental design was used to assess the influence of clearcut timber harvest on water temperature in small Class II watercourses where the influence of reduction of canopy has the greatest potential to impact water temperature (see AHCP Appendix C, Class II Temperature Assessments). The riparian protection measures were based on past California FPRs and Green Diamond's NSO HCP guidelines, which included 50-75 foot buffers with 70% total (overstory and understory) canopy retention. Two of the treated streams showed minor (0.5-1.0 ºC) increases in water temperature within the limits of the harvest unit relative to the controls during the warmest time of day in the warmest 14-day period of the summer and two of the treated streams showed minor decreases (-1.3-1.4 ºC). The decreases in temperature were likely the result of increased ground water inputs following harvesting of the adjacent stand. Considering the small magnitude of change under the most extreme annual conditions, the opposite direction of the response, and the fact that riparian protection measures are substantially more restrictive under the AHCP than the time the study was conducted, Green Diamond believes there should be no measurable change in water temperature in Class I or larger Class II watercourses due to minor reductions in canopy following timber harvest. Even if there continues to be minor positive and negative changes in water temperature in the smaller Class II watercourses, the limited time and area of the impacts should result in no biological effects.

Temperature data collected in the Maple Creek watershed were also analyzed to determine if changes have occurred in response to the current rate of harvest in this basin. Eleven monitoring sites were evaluated; eight sites located in Class I watercourses and three in Class II watercourses (Figure 2). To determine if water temperatures changed over time, the maximum seven-day moving average (M7DMA) water temperature was calculated each year for each monitoring site and linear regressions were used to assess the direction and significance of changes to M7DMA water temperatures at each site. Two sites showed a significant decrease in M7DMA water temperature and the other nine sites (82%) showed no significant change (Table 1). However, many of these sites demonstrated a slight decrease or generally had consistent water temperatures over time. Diamond Creek and Gray Creek were the two sites where M7DMA water temperatures decreased (Figure 5A). These decreases in water temperature were likely due to the close proximity of these sites to the coast. The persistent coastal fog in this area likely reduces the potential for heating from solar radiation. The lack of any increase to M7DMA water temperatures in the Maple Creek watershed provides evidence to relieve concerns about altered water temperatures related to past and planned rates of harvest.

Several sites (e.g., Beach Creek, Clear Creek, Mainstem Maple Creek [M-line], Mainstem Maple Creek [CR2500], NF Maple Creek [BL2000], and NF Maple Creek [mouth]) experienced a warming period from 2003-2006. The potential influence of harvest rate and air temperature during this time was assessed by plotting these two variables against time and looking for associations with annual changes in water temperature (Figure 5). Maximum August air temperature appears to be partially associated with the observed water temperatures and harvest rate showed minimal and seeming coincidental associations at only two sites. For example, the highest M7DMA water temperature at Clear Creek in 2006 coincided with an increased harvest rate; however, there was no response from the higher rate of harvest that occurred in 2010. These results further suggest that harvest rate is not significantly associated with the observed changes in water temperatures in Maple Creek.

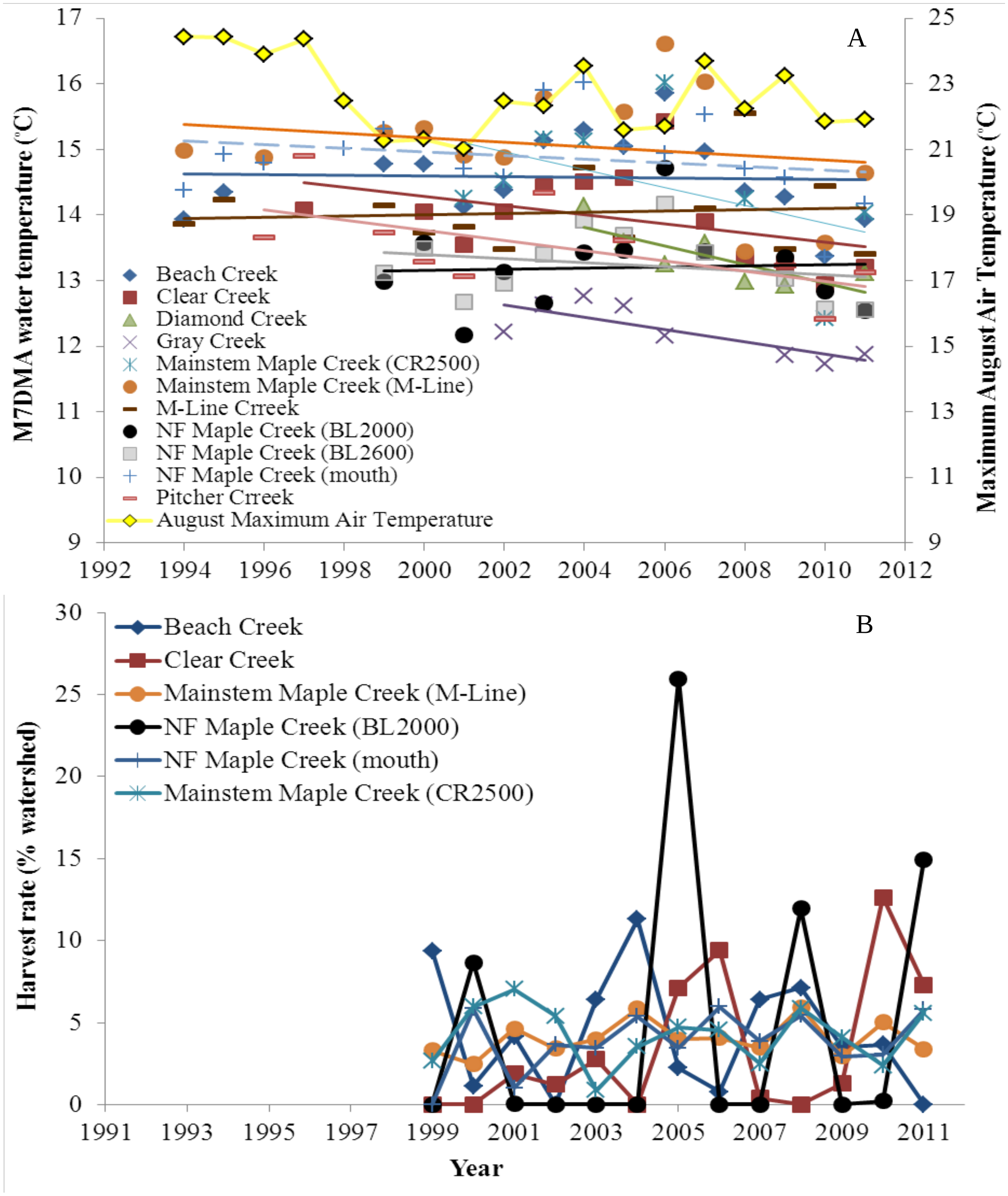


Figure 5. Change in maximum seven-day moving average (M7DMA) water temperatures [primary y-axis] at sites monitored in the Maple Creek watershed and maximum August air temperature [secondary y-axis] from the midpoint of the basin from 1994-2011 (A) and harvest rate history at a subset of these sites from 1999-2011 (B). For purposes of comparing water temperature and rate of harvest, the x-axis for the harvest rate was advanced by one year to align the potential impact of harvesting with the expected response from the water temperature monitoring.

Table 1. Summary of linear regression results assessing the change in maximum seven-day moving average (M7DMA) water temperatures over time.

SiteName	N	Slope	R-squared	t-value	P-value
Beach Creek	15	-0.0056	0.002	-0.1629	0.8731
Clear Creek	13	-0.0695	0.1764	-1.5351	0.153
Diamond Creek	7	-0.14	0.6207	-2.8605	0.0354
Gray Creek	8	-0.0944	0.63	-3.1959	0.0187
Mainstem Maple Creek (CR2500)	8	-0.1367	0.2339	-1.3536	0.2246
Mainstem Maple Creek (M-Line)	13	-0.0347	0.0424	-0.6975	0.4999
NF Maple (mouth)	17	-0.0278	0.0542	-0.9271	0.3685
NF Maple BL2000	12	0.0083	0.0026	0.1602	0.8759
NF Maple BL2600	12	-0.0311	0.0556	-0.767	0.4608
M-Line Creek	13	0.0098	0.0082	0.3014	0.7687
Pitcher Creek	10	-0.0784	0.3768	-2.1995	0.059

b) Slope Stability and Road Management Measures

Green Diamond's qualitative assessment (review of past air photographs and identifying physical indicators of past conditions such as historical terraces and location of riparian vegetation) of Class I watercourses indicate that streams generally reached peaks in aggradation during the 1960's and 1970's. Since that time, most channels have dramatically downcut and narrowed. More recently, changes in channel morphology has been more subtle, and it is expected that this trend will continue with periodic adjustments due to the severity of winter storms. With the slope stability and road management measures that are designed to minimize management related sediment inputs, Green Diamond believes that sediment inputs will be reduced relative to past practices. Given that water temperatures are generally favorable throughout Green Diamond's ownership even with past sediment inputs, Green Diamond believes that future sediment minimization measures described in the AHCP, RMWDRs and MATO will further reduce the likelihood that aggradation of channels will result in elevated water temperatures.

A preliminary assessment of channel monitoring data collected in the Maple Creek watershed (Figure 2) support the effectiveness of current management measures to minimize sediment inputs and reduce the likelihood of elevated water temperatures. A comparison of channel monitoring long-profile data collected from 2002-2011 along two reaches in the Maple Creek watershed were conducted. To determine if the longitudinal profiles of these streams changed over time, profiles were analyzed using linear regression to calculate regression coefficients (i.e. slope and y-intercept) and these coefficients were subsequently regressed to assess the direction and significance of changes to the long profiles over time. An increase in the y-intercept would suggest aggradation (i.e. increased sediment inputs over time), whereas, a decrease in the y-intercept would suggest channel down cutting. Interpretation of channel morphology changes with respect to the slope depend on whether the changes occur at the upstream or downstream end of the long profile. A decrease in slope at the downstream end of the channel would suggest downstream channel aggradation is occurring, whereas, a decrease in slope at the upstream end of the channel would suggest upstream channel down cutting is occurring.

No significant change in slope occurred at either Maple Creek (linear regression: t-value = -1.231, p = 0.258, R^2 = 0.178) or Beach Creek (linear regression: t-value = 2.66, p = 0.057, R^2 = 0.639) (Figure 6). A significant decrease in the y-intercept was found at Maple Creek (linear regression: t-value = -6.185, p = 0.0005, R^2 = 0.845) but no change occurred at Beach Creek (linear regression: t-value = -1.58, p = 0.189, R^2 = 0.385). The significant decrease in y-intercept along Maple Creek suggests that sediment inputs have reduced sufficiently to allow for the channel to down cut. The slight increase in slope at Beach Creek that occurred in 2007 was likely influenced by the enlargement of the large wood debris accumulation (Figure 6), especially considering that the change was only apparent upstream from the debris accumulation. This wood accumulation likely reduced the movement of sediments downstream and caused the upper portion of the monitoring reach to aggrade but has since remained constant. Overall, there is no apparent influence from the current rate of harvest (% area harvested) on the observed changes to channel profiles in these two basins (Figure 7).

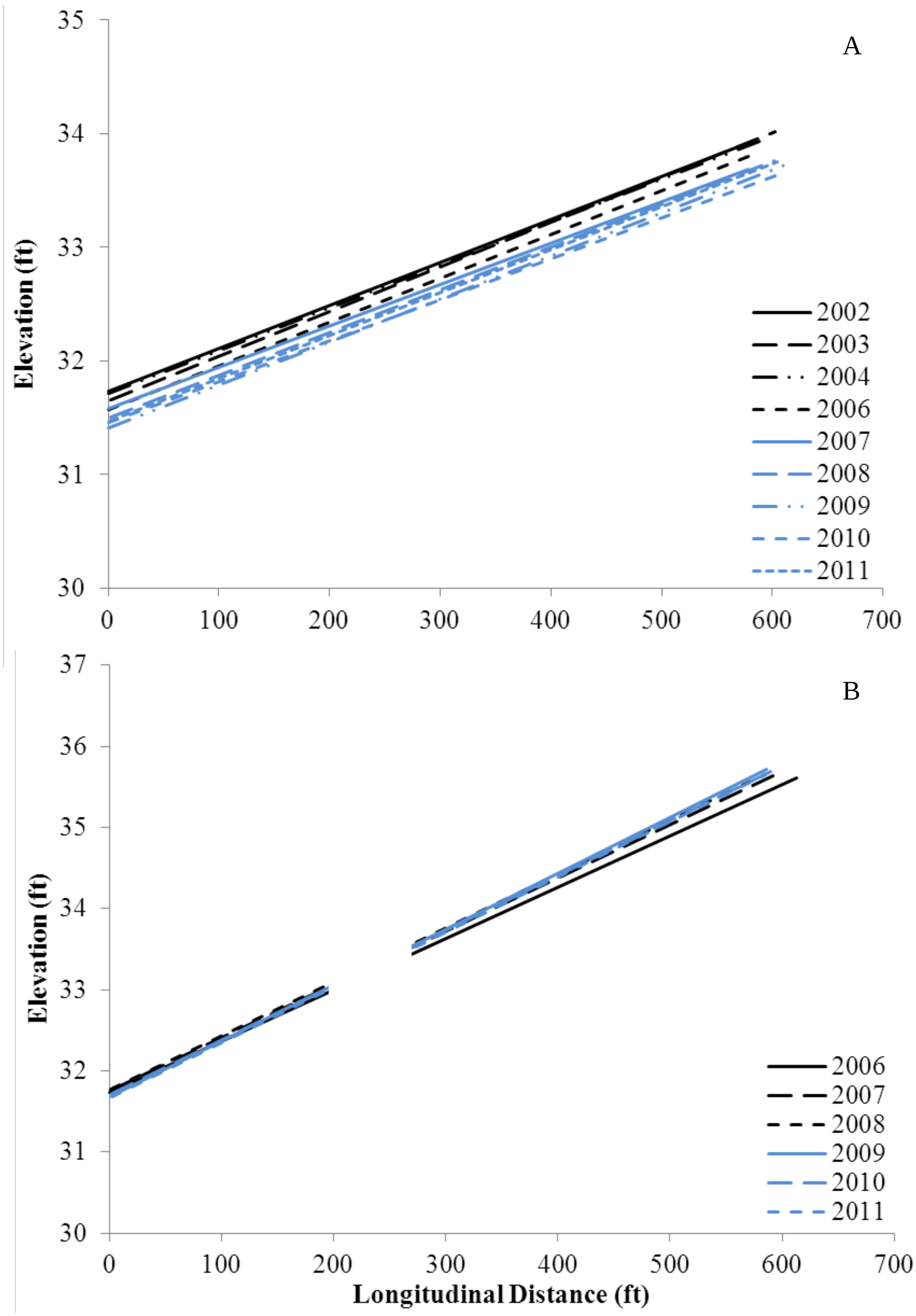


Figure 6. Comparison of channel monitoring long-profile trend lines collected at Maple Creek (A) and Beach Creek (B) from 2002-2011 by Green Diamond. Gap in the data for Beach Creek (from 210-280 ft.) resulted from a segment that could not be effectively measured due to a large woody debris accumulation.

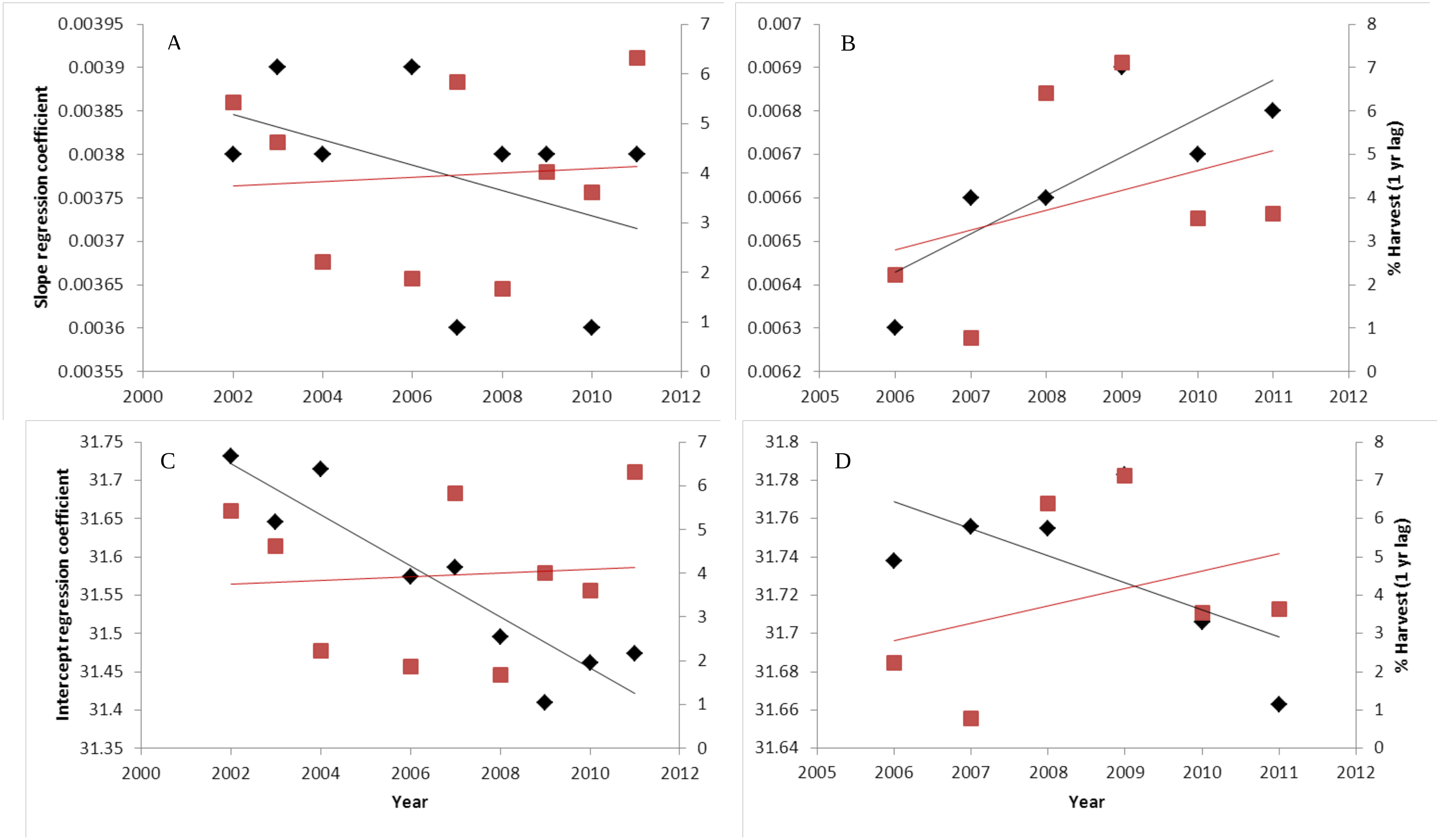


Figure 7. Change in long profile linear regression coefficients (i.e. y-intercept and slope) over time for Maple Creek (A & C) and Beach Creek (B & D). Regression coefficient trends (black lines), with annual data points (black diamonds), and harvest rate trends (red-lines), with annual data points (red squares), are shown. The rate of harvest was lagged by one year in an attempt to align the potential impact of harvesting with the expected response.

D. Forest Management Effects on Large Woody Debris Recruitment and Green Diamond's Conservation Strategies to Minimize, Mitigate or Avoid Those Impacts on Water Quality and Aquatic Species

1. Potential Forest Management Effects on Large Woody Debris Recruitment

Large woody debris (LWD) influences stream channel morphology and is an important component to forming pools and instream cover. Historical practices such as splash damming, stream cleaning, and intensive logging in watercourses and riparian zones resulted in extensive removal of LWD and potential recruitable LWD from watercourses. These historical practices have resulted in the loss of important habitat features and impacted aquatic species. Timber harvesting and the presence of, or the construction of roads in riparian areas may result in a decline in the recruitment of LWD and a resulting reduction of in-channel LWD. Timber harvest in riparian zones removes trees that could potentially become in-channel LWD. Roads in riparian zones may reduce potential LWD by the presence of the road surface eliminating tree production and also by intercepting trees that fall toward the channel.

In addition to the summary above, see Appendix A for a more detailed description of timber harvest impacts on large woody debris recruitment.

2. Green Diamond's Conservation Strategies for Large Woody Debris Recruitment

The AHCP's Riparian Management measures and certain Slope Stability measures minimize and mitigate impacts associated with loss of LWD. Maintenance of riparian management zones (RMZs) provides several biological and watershed functions. In addition to functions such as maintaining the riparian microclimate and providing nutrient inputs, one of the most important functions of the RMZs is to provide for the recruitment of LWD.

a) Riparian Management Measures

The minimum width of RMZs on Class I (fish bearing) watercourses is 150 feet with 85% overstory canopy retention in the inner zone (50-70 feet depending on slope class) and 70% overstory retention in the remaining outer zone. However, probably the most important measure relative to the potential recruitment of LWD is that no trees are harvested that are judged likely to recruit. There are a variety of criteria used to make this judgment including, but not restricted to, distance from the stream, direction of the lean, intercepting trees and potential for being undercut by the stream.

Most of the trees that are harvested from RMZs are those on the outer edge of the riparian buffer. These same trees also have the lowest potential to be functional in the stream since only the upper portion of the tree would reach the stream. Excluding geologic processes, the riparian conservation measures ensure that all the trees with the greatest potential for significant LWD function (e.g. LWD recruited by fluvial processes, windthrow or tree mortality with sufficient size and proximity to the stream that it can influence fluvial processes and provide cover for fish) are retained. The small proportion (<10%) of trees that are harvested within the RMZs not only have a very low probability of contributing significant LWD to the stream, but by removing some trees, the surrounding trees will have increased growth with even greater potential functionality in larger Class I watercourses. Therefore, Green Diamond concludes that the riparian conservation measures for Class I watercourses will provide for fully functional LWD recruitment rates and may actually enhance LWD recruitment compared to natural rates from no cut buffers.

LWD performs many similar functions in Class II watercourses, but also has some unique functions in Class II watercourses, particularly in the smaller headwater streams. The piece size that is functional tends to decrease as the stream and associated hydraulic energy of the stream decreases. In addition, pool habitat is more likely to be formed by bedrock and boulders in small confined channels. Finally, there is little evidence for a reduction of LWD in most Class II watercourses in Green Diamond’s ownership . Instead, past logging practices may have resulted in an overabundance of LWD in many of these smaller streams. As a result, LWD recruitment is less of a conservation priority in these streams and much of the benefit of the Class II RMZ is thought to be for the maintenance of microclimate and bank stability. Even so, it is still important that there are adequate sources of LWD for these channels into the future with the Class II protections. The minimum width of RMZs on Class II watercourses is 75-100 feet with 85% overstory canopy retention in the 30 foot inner zone and 70% overstory retention in the remaining outer zone.

As part of the riparian conservation measures, there is only a single entry into RMZs to harvest trees during the term of the AHCP for both Class I and II watercourses. Only a small proportion of the trees within RMZs are harvested (85% retention in inner zone and 70% in the outer), and those remaining will continue to age and grow larger following removal of the adjacent stands. Based on the age of RMZs at the time the AHCP was being developed, over one third of the stands comprising the RMZs will be greater than 100 years old and the remainder will be between 51-100 years by the end of the permit period. At age 100 in a typical RMZ in the redwood zone, there will be approximately 120 trees per acre, with 12% of the trees > 36” DBH. A few trees will exceed 48” DBH and the tallest trees in the stand will be about 170 feet tall. Under exceptional conditions (little competition, very good soils, abundant light, water and nutrients) a 100 year old redwood can exceed 5 - 6 feet in diameter. In the more interior Douglas-fir/hardwood zone, diameter growth will not be quite as rapid, but there will be approximately 130 trees per acre, with 6% of the trees > 36” DBH. An occasional tree will exceed 48” DBH and the tallest trees in the stand will be about 180 feet tall.

b) Slope Stability Measures

Most of the Slope Stability Measures are designed to minimize management induced sediment inputs into Plan Area watercourses; however, geologic processes can be important mechanisms to provide LWD into streams, and in some situations, it may be the predominate mechanism by which LWD reaches streams. In particular, shallow rapid landslides have the potential to deliver large amounts of LWD when they form in steep streamside slopes or inner gorges. In addition, debris torrents from small headwater Class II and III watercourses can be an important source of LWD when they empty directly into Class I or large Class II watercourses. This latter phenomenon has not been frequently observed within most of the Green Diamond's ownership, but there are isolated areas where debris torrents are sufficiently common to be a potential important source of LWD.

The slope stability management zones (SMZs) occur outside of RMZs in areas (inner gorges and steep streamside slopes, headwall swales and toes of deep-seated landslides) that have been determined to be prone to shallow rapid landslides. As noted above, the primary objective of the SMZ is to minimize the likelihood of management-induced landslides. However, landslides do occur in these areas with or without management activities, and the SMZ conservation measures ensure that when a landslide does occur, it has the potential to deliver large amounts of LWD to the stream.

II. Cumulative Watershed Effects and Rate of Harvest

The ability to make generalizations about the effects of forest harvest on aquatic systems is difficult because there are a number of confounding issues that have generated a wide variety of responses. Issues such as the timing and magnitude of peak flow generating events, watershed characteristics, the type and condition of roads, forest species composition, types of harvest systems, forest practices, and time since harvest can influence the observed responses reported in the literature. Separating harvest effects from road effects is similarly problematic since those activities studied in paired watersheds typically occurred coincidently or were closely coupled.

The ability to make inferences from the various paired watershed studies to Green Diamond's ownership is another limitation at multiple levels. First, how applicable are the results observed from different watershed studies to a particular watershed or ownership of interest, such as Green Diamond's ownership within the AHCP area? The answer is that the results are probably applicable for certain metrics such as water temperature where the different variables are more readily predicted and modeled, but less applicable for metrics such as sediment input which is strongly influenced by local geology, topography and storm history. The second and probably most important question on the limitation of inference is whether the findings from the historical paired watershed studies are germane when evaluating the effects, including cumulative effects of contemporary forest practices? Given the substantial changes in every aspect of contemporary forest management, attempting to draw inferences from paired watershed studies that included substantial areas of historical logging is clearly inappropriate.

Historical logging practices involved harvesting all merchantable trees across entire ownerships and watersheds over a very short period of time with little or no constraints resulting in more roads built than necessary, roads built in poor locations, tractor logging on steep slopes, construction of tree falling layouts, vast skid trail networks, hot and intense broadcast burning, inadequate or no protection or retention of riparian zones, and little or no concern for proper design and location of stream crossings. These practices were utilized on Green Diamond's property primarily in the 1950's through early 1970's when contemporary environmental protections were non-existent or inadequate. Due to the lack of a consistent approach to landscape planning and regulation, large watersheds were roaded and harvested over a relatively short period of time which exposed large areas to soil compaction, erosion and longer term environmental legacy impacts.

It wasn't until the Z'berg-Nejedly Forest Practice Act of 1973 was established that a system for regulating timber harvest activities in California began. Although the California Forest Practice Rules (FPRs) have many different objectives, a primary one has always been to minimize and avoid significant adverse impacts on aquatic resources. Over time the FPRs have been altered to provide additional protections for aquatic species such as Federal and State listed fish species based on the increasing knowledge made available in the literature regarding impacts of harvesting activities on aquatic systems as described above. The net effect of these various studies has been the establishment of management practices with a central focus on streams that includes riparian buffers along fish bearing watercourses (Class I) and non-fish bearing watercourse that support other aquatic life (Class II) and the establishment of equipment exclusion zones on watercourses that do not support aquatic life (Class III). In addition to providing buffers and equipment exclusion zones on watercourses, the general provisions that have evolved to be associated with forest Best Management Practices (BMP), in virtually every state, include properly designing, locating and maintaining roads and watercourse crossings; minimizing soil compaction and soil disturbance; and avoiding or providing buffers on unstable topography. Although the specific measures vary between states, the mitigation principles are the same; to protect aquatic resources.

In California, there has been a significant paradigm shift as to the classification and the protections provided for Class I and Class II watercourses. In 1990 many streams, both Class I and Class II watercourses, qualified for shade exemptions where no overstory canopy retention was required during timber harvest operations. The exemptions were authorized in coastal climates where water temperature increases were not expected to be significant. The exemptions focused solely on water temperature effects and did not consider the many other benefits that riparian zones provide. In 1992, Green Diamond (then Simpson Timber Co.) began operating under the NSO HCP. This HCP established higher canopy retention standards than the CFPRs for Class I and II watercourses. In 1994 when the southern torrent salamander was petitioned to be listed under CESA, there was a significant California forest industry-wide upslope migration of Class II riparian retention along watercourses that would otherwise had been designated as Class IIIs with equipment exclusions zones. During this time period there were amphibian training programs for foresters to help them recognize the specific habitats that these salamanders occupied so appropriate classifications would be made and protections provided to the watercourses. Also beginning in 2000, the specific criteria of what qualifies a particular stream as a Class II watercourse evolved significantly in addition to the riparian buffer width and retention requirements. Before this time period watercourses were designated as Class II when either salamanders were detected or the gravel substrate that provided habitat for the animals were present. The criteria that were developed and are currently utilized by Green Diamond today include the presence of perennial flow, aquatic obligate plants, aquatic obligate amphibians, aquatic macro-invertebrates, season of classification and drainage area.

The most recent enhancement to Class II watercourses on Green Diamond's ownership occurred in 2007 with the implementation of the Aquatic HCP. The buffer width and overstory retention standards were again increased relative to the CFPRs and Green Diamond's NSO HCP. These changes in Class II watercourse classification and riparian retentions standards have resulted in significant additional watercourse buffers across the landscape, extending retention in many cases to ridge tops.

Historical paired watershed studies were extremely valuable in understanding the fundamental effects of timber harvest on water quality, water quantity and watershed processes and were instrumental in guiding the development of current forest practices and protections to avoid, minimize and mitigate forest management impacts. However the use of these studies to evaluate the effects of present day forest practices on aquatic resources is inappropriate. A majority of the existing research was conducted in the 1970s, 1980s, and early 1990s during a time when forest practices were non-existent or vastly different from current practices. In addition, the harvesting practices used historically not only varied with time locally, but even regionally. This is still a very important consideration when evaluating and comparing contemporary watershed studies because specific protection measures such as watercourse buffers still widely vary from state to state. Also the types of equipment utilized to yard and transport logs during initial harvest entries were much larger than the equipment needed and used today. Significant advances in yarding and road construction techniques and technology have minimized soil compaction, ground disturbance, surface runoff and sediment delivery to watercourses.

An example of the advances in management practices can be found in Williams et al. (2000), who conducted a retrospective study of harvesting impacts where BMPs were applied and compared those results to a study by Hewlett (1979) where no BMPs were applied in the B.F. Grant Memorial Forest in the Piedmont. Hewlett (1979) reported that the majority of the sediment increases observed originated from roads and channel disturbances. Williams et al. (2000) similarly monitored sediment and other water quality parameters following timber harvesting operations that utilized state BMPs. They estimated that the BMPs reduced sediment yield increases tenfold compared to those that utilized no BMPs.

There have been other recent retrospective studies that have evaluated the impacts of harvesting that utilize more contemporary harvesting practices. For example Litschert and MacDonald (2009) evaluated the frequency and stream connectivity of sediment rills and plums originating from harvest units that ranged in age from 2 to 18 years old in the Sierra Nevada and southern Cascades. After assessing approximately 200 harvest units, they found 19 erosional features within the harvest units but only 6 were connected to watercourses. Sixteen out of the 19 erosional features that were found and 5 out of the 6 features that were connected to watercourses originated from skid trails. They concluded that new harvest practices rarely initiated large amounts of runoff and surface erosion but suggested that sediment delivery from timber harvest can be further reduced by proper construction and post-harvest treatment of skid trails.

CalFire et al. (2011) conducted a rapid assessment of sediment delivery sources from recent clearcut timber harvesting activities in the Battle Creek Watershed in the Sierra Nevada's. They evaluated 135 sites that had a high risk of potential sediment delivery to watercourses and observed no significant direct water quality impacts related to clearcutting. They found that the riparian buffers were effective in filtering sediment from adjacent clearcut areas; however, there was one instance where less than 1 cubic yard of sediment delivered to a watercourse due to an encroachment of a tractor into an equipment exclusion zone resulting in a violation of the FPRs. They noted that road crossings, tractor crossings and roads and landings adjacent to watercourses had the greatest probability of sediment delivery but could be further minimized with proper implementation of mitigation measures.

It has been well documented that forest roads can cause significant increases in erosion rates within a watershed (Haupt 1959, Gibbons and Salo 1973, Beschta 1978, Rice et al. 1979, Cederholm et al. 1980, Reid and Dunne 1984, Furniss et al. 1991, Sidle et al. 1985; Montgomery 1994; Veldhuisen and Russell 1999; Sidle and Wu 2001; Brardinoni et al. 2002). Gibbons and Salo (1973) concluded that the sediment contribution per unit area from forest roads is usually greater than that contributed from all other timber harvesting activities combined. MacDonald et al. (2004) found that erosion rates from roads can be one or more orders of magnitude higher than erosion rates from skid trials and non-compacted areas in harvest units.

Although roads have been shown to play a significant role in affecting water quality, Klein et al. (2012) found that roads did not significantly influence observed turbidity levels in managed watersheds. Their results indicated that harvest rate and drainage area explained much of the observed variation. However their analysis and conclusions were potentially flawed in a variety of critical ways.

1. Their analysis included only a single year of turbidity data (WY 2005) so they were not able to evaluate the inherent annual variability of turbidity within and between watersheds.
2. They used an equivalent clearcut area disturbance index based on "high' and "low" harvest using three, 5-year increments and found that the years 1990-1994 preceding the turbidity data record explained most of the turbidity differences between sites. They assert that this result substantiates a rate of harvest impact; however, Green Diamond believes the authors are associating impacts of historical practices to the impacts of contemporary practices.

3. They also speculate that the link to the period 10-15 years preceding the WY2005 turbidity record was due to a lag effect for root decay and subsequent harvest-related landslide occurrences; however, there was no landslide inventory information presented for their study watersheds to substantiate this claim. They only reference a study (e.g. Reid, 2012) that evaluated harvest-related landslide rates from harvest practices that occurred in the late 1980s and early 1990s (which included clearcutting, broadcast burning and later treatment with herbicides) to support this assumption.

Klein et al. (2012) also assert that there are no regulations in place to control rates of harvest. This statement is simply not true in California. As described above there are several provisions in the CFPRs that control the timing, location and intensity of timber harvest (See 14 CCR 913.1(a)(1), (a)(3), and (4)(a)). In addition the combined application of Green Diamond's management measures will result in approximately 25% of a watershed in RMZs and other partial harvest retention areas that will consist of older forests with high basal area and dense canopy cover.

While harvesting practices that are used today still can cause significant adverse impacts to aquatic resources if poorly implemented, there are rules and regulations in place to avoid, minimize and mitigate the impacts and to ensure the measures are implemented. The California FPRs are among the most restrictive in the United States. Beyond that, Green Diamond has been operating under HCPs that have consistently provided more protections that the standard CFPRs. The most recent being the Aquatic HCP, beginning in 2007, that requires additional mitigation measures and provides further aquatic resource protections. The measures in the Plan were developed for Green Diamond's ownership taking into account existing habitat and watershed conditions and were designed to address the specific activities that Green Diamond employs to conduct its management while minimizing and mitigate the impacts of those activities on aquatic species and their habitats and to protect water quality.

Green Diamond also considers and analyzes cumulative watershed effects (CWEs) when designing and conducting its timber harvest operations. In general, CWEs can be categorized as incremental changes that induce changes in watershed processes that alone are not overwhelming, yet if combined, the impacts on stream channels and habitat for aquatic species are detrimental. The assessment of CWE's is problematic because many resources can be affected, the resources can be affected in many different ways, and various spatial and temporal scales can be used in the analysis (MacDonald 2000). In addition, identification of CWEs is difficult due to both the technical complexities of designing statistically valid field studies, and because few research efforts have been sustained for extended time periods which have considered the significant changes in forest practices over time.

Current methods for evaluating CWE's range from low cost, simple and qualitative checklists to high cost, complex, quantitative, and physical based models (MacDonald 2000). Whichever method is utilized they each have positive and negative aspects. For example the checklist approach works well to: 1) identify which issues should be investigated, 2) ensure the range of issues are considered, and 3) provide a simple method to address the issue of cumulative watershed effects (MacDonald 2000). However the checklist approach typically only includes a qualitative approach to the assessments, lacks repeatability, and contains limited documentation. The model based approach provides a mechanism to: 1) include causal actions, 2) include external factors, 3) estimate on-site changes, 4) route the changes spatially and temporally, and 5) evaluate the impact on the resource of concern at different locations (MacDonald 2000). A disadvantage of the model based approach is it often uses a single watershed scale disturbance index to represent the aggregate impacts from multiple sources. Examples of the single disturbance index include the equivalent clearcut area and equivalent roaded area. It is highly unlikely that any method which relies on a single metric can adequately assess multiple, unrelated impact mechanisms over different spatial and temporal scales. Additionally, the models generally lack validation and typically do not relate the predicated physical changes to a biological impact or other designated beneficial use (MacDonald 2000).

The complexities and uncertainties involved in conducting a CWE analysis do not obviate the need to perform the analysis to meet CEQA requirements. CalFire utilizes the checklist approach to guide RPFs in conducting a cumulative effects assessment when developing a THP. Green Diamond similarly utilizes this process when developing THPs; however, there are additional actions that Green Diamond has taken to manage and assess CWEs; and these are by, 1) minimizing on-site impacts through implementation of state-of-the-art management practices so that off-site impacts are effectively eliminated and, 2) monitoring and adaptive management. A specific activity typically has the largest effect at the local scale and the impact can more easily be detected at that same scale (MacDonald 2000). Similarly if the local impacts can be minimized, then the potential for CWEs at a larger scale should also be reduced. The measures that Green Diamond implements through its existing landscape management plans (e.g. NSO HCP, AHCP, RMWDRs, MATO) and those plans that are currently in development (e.g. FMWDRs and Forest HCP) collectively minimize the adverse effects of its operations at the local scale as well as the watershed scale.

Although decades have passed since the historical landscape impacts occurred and the majority of the sites are no longer sediment producing sources, there still remain legacy road sites, stream crossing sites and stream diversions on the landscape that need to be identified and repaired to ensure they no longer produce sediment. Green Diamond has observed that the majority of current sediment producing sites across the ownership are associated with roads. This fact was the driving force in developing the AHCP and obtaining the RMWDS and MATO that specifically target sediment sources associated with road construction, road upgrading and road decommissioning, and road maintenance on a landscape basis. The AHCP similarly addresses other non-road related legacy features such as diverted skid trails which if left unmitigated could add to sediment production across the landscape.

While there has been a rapid succession of enhanced environmental protections within the last 10-15 years, the realization and expression of the benefits from these landscape plans will require time. Green Diamond has also acknowledged that over time there still may be better ways to manage watersheds that may further benefit aquatic species and their habitats and has developed mechanisms to incorporate this new information into practice as it becomes available. This process was built into the AHCP by way of the Effectiveness Monitoring and Adaptive Management Programs.

Monitoring and adaptive management are used to evaluate the overall effectiveness of the AHCP and to fine-tune specific measures as needed. The effectiveness monitoring program measures the success of the conservation measures in relation to the AHCP's biological goals and objectives. The monitoring projects and programs in the AHCP fall into four categories: Rapid Response Monitoring, Response Monitoring, Long-term Trend Monitoring and Research, and Experimental Watersheds Program. The first three categories are based on the minimum time frame over which feedback for adaptive management is likely to occur. The time scales are a product of the specific variables or processes being measured as well as the available monitoring protocols currently used. The last category provides a unique spatial scale for individual experimental projects and for the development of new or refined monitoring or research approaches.

The Rapid Response and Response Monitoring projects form the backbone of the adaptive management process. Each project has (or will establish) measurable thresholds which, when exceeded, initiate a series of steps for identifying appropriate management responses. To provide the ability to respond rapidly to early signs of potential problems while providing assurances that negative monitoring results will be adequately addressed, a two-stage "yellow light, red light" process is employed. The yellow light threshold serves as an early warning system to identify and rapidly address a potential problem. As such, the yellow light thresholds can typically be exceeded by a single negative monitoring result (i.e., summer water temperatures). The red light threshold is usually triggered by multiple negative monitoring responses (a series of yellow light triggers) and indicates a more serious condition than the yellow light threshold. The intent is to provide a timely review of monitoring data to allow for corrective actions to occur, if necessary, prior to the next season.

The Rapid Response Monitoring projects and programs provide the early warning signals necessary to ensure that the biological goals and objectives of the AHCP will be met. The current Rapid Response Monitoring projects include: 1) annual property-wide water temperature monitoring in Class I and Class II watercourses; 2) paired water temperature monitoring in sites on Class II watercourse; 3) tailed frog monitoring; 4) southern torrent salamander monitoring; 5) implementation and effectiveness monitoring of the Road Management Measures; and 6) road maintenance assessments. While trends which occur over longer time scales will also be monitored through these projects, they are distinguished from the response and trend monitoring projects by their potential to provide rapid feedback for adaptive management. The yellow light threshold for these projects can typically be triggered in less than one year, although the annual analysis of results will be necessary to identify the yellow light condition. The red light threshold will generally take two to three years to be triggered. See Figures 8 and 9 for the spatial distribution of the Rapid Response Monitoring projects.

The Response Monitoring projects, like the Rapid Response projects, monitor the effectiveness of the conservation measures in achieving specific biological goals and objectives of the AHCP. These monitoring projects are distinguished from the Rapid Response projects by the greater lag time required for feedback to the adaptive management process. The Response Monitoring projects are focused on the effects of cumulative sediment inputs on stream channels. The current Response Monitoring projects include: 1) Class I channel monitoring; and 2) Class III sediment monitoring. Natural variability in stream channel dimensions, combined with the potential time lag between sediment inputs and changes in the response variables of these projects, make it difficult to determine appropriate thresholds for adaptive management at this time. When yellow and/or red light thresholds are determined, they are expected to require more than three years of results to be triggered in most cases. See Figure 8 for the spatial distribution of the Response Monitoring projects.

The Long-term Trend Monitoring/Research projects are those monitoring projects for which no thresholds for adaptive management are set. For some projects, this reflects the multitude of factors which affect the response variables, in others, the long time scales required to distinguish the ‘noise’ from the underlying relationships. Research projects are designed to reveal relationships between habitat conditions and long-term persistence of the AHCP’s Covered Species. Each of these projects has the potential to provide feedback for adaptive management, but in some circumstances, decades may be required before that can occur. The current Long-term Trend Monitoring projects include: 1) steep streamside slope delineation study; 2) steep streamside slope assessment; 3) mass wasting assessment; 4) long-term habitat assessments; 5) LWD monitoring; 6) summer juvenile population estimates; 7) outmigrant trapping; and 8) turbidity threshold sampling. See Figure 10 for the spatial distribution of the Long-term Trend Monitoring projects.

While the majority of the AHCP’s monitoring projects are conducted throughout the AHCP Area, four experimental watersheds judged to be representative of the different geologic and physiographic provinces across the AHCP Area were specifically designated where additional monitoring and research on the interactions between forestry management and riparian and aquatic ecosystems will be conducted. Those watersheds are the Little River (Little River HPA), South Fork Winchuck River (Smith River HPA), Ryan Creek (Humboldt Bay HPA), and Ah Pah Creek (Coastal Klamath HPA).

The AHCP’s monitoring program is intended to increase the understanding of watershed processes and the effects of forest management activities on the habitats and populations of the Plan’s Covered Species, and adapt the AHCP’s conservation measures in response to this new information. The adaptive management measures become applicable through the triggering of a “Yellow or Red Light” condition determined through on-going monitoring, the slope stability monitoring, or through the outcome of a designed experiment in one or more of the Experimental Watersheds.

The overall benefits of the monitoring and adaptive management program are to: 1) continuously validate that the habitat and populations of the fish and amphibian species are in good condition where they currently exist; 2) document the trend in recovery in areas that have been impacted from past management activities or natural disturbances; 3) modify or augment existing conservation measures where fine-tuning is necessary; and 4) re-allocate resources to make the conservation measures more efficient and effective.

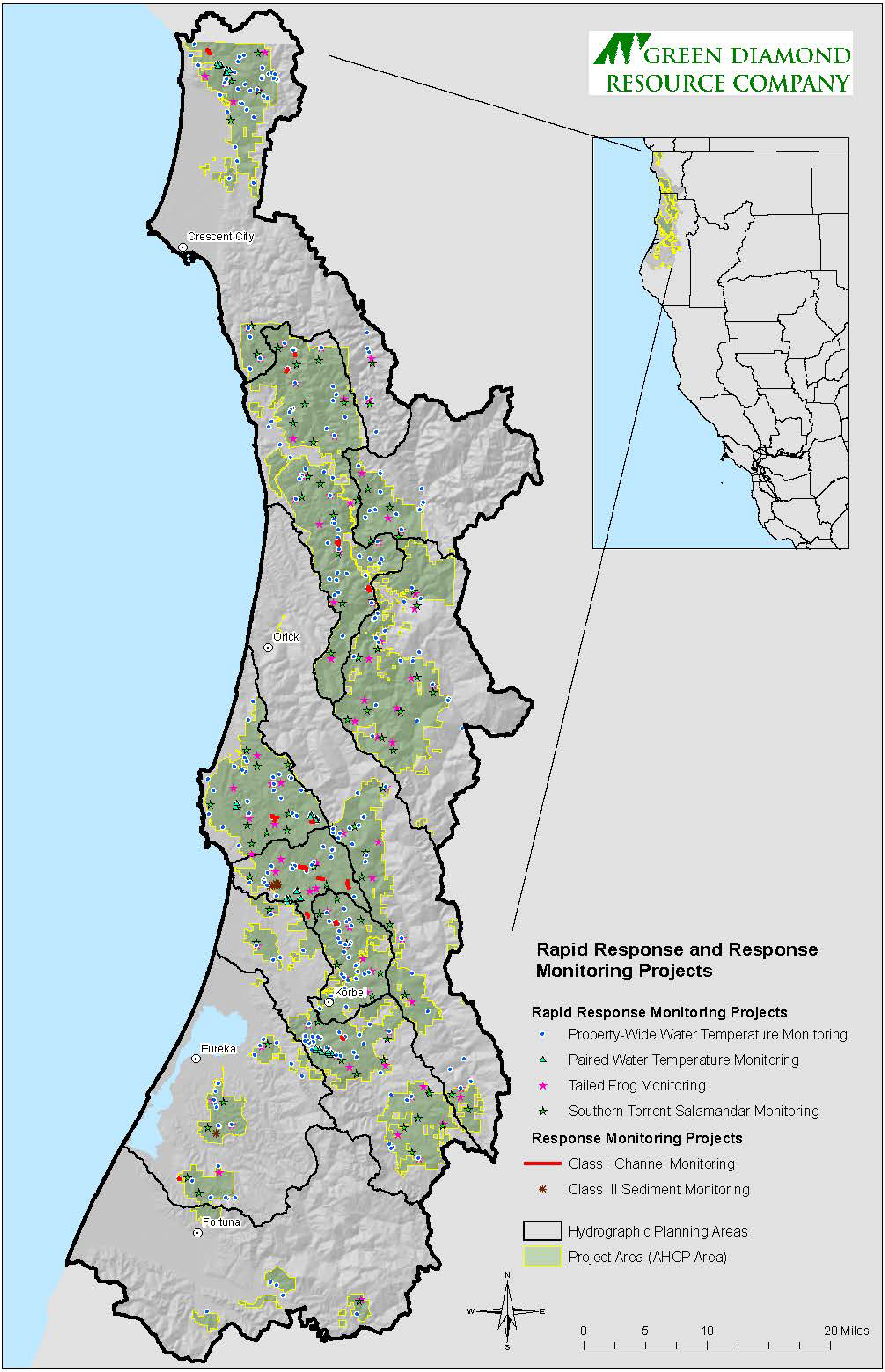


Figure 8. Map showing the locations of rapid response and response monitoring conducted by Green Diamond in the AHCP area.

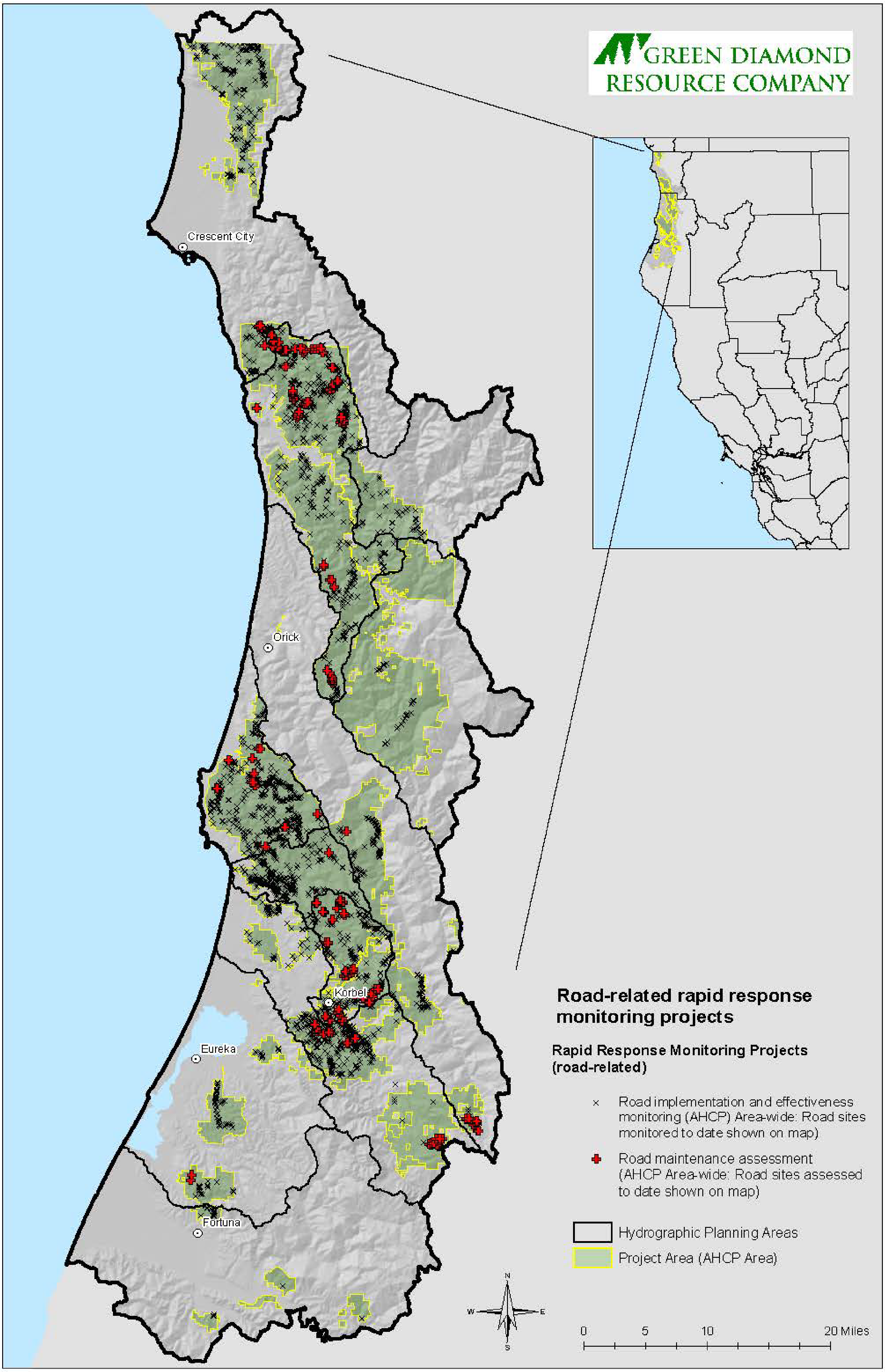


Figure 9. Map showing the locations of road-related rapid response monitoring projects conducted by Green Diamond in the AHCP area.

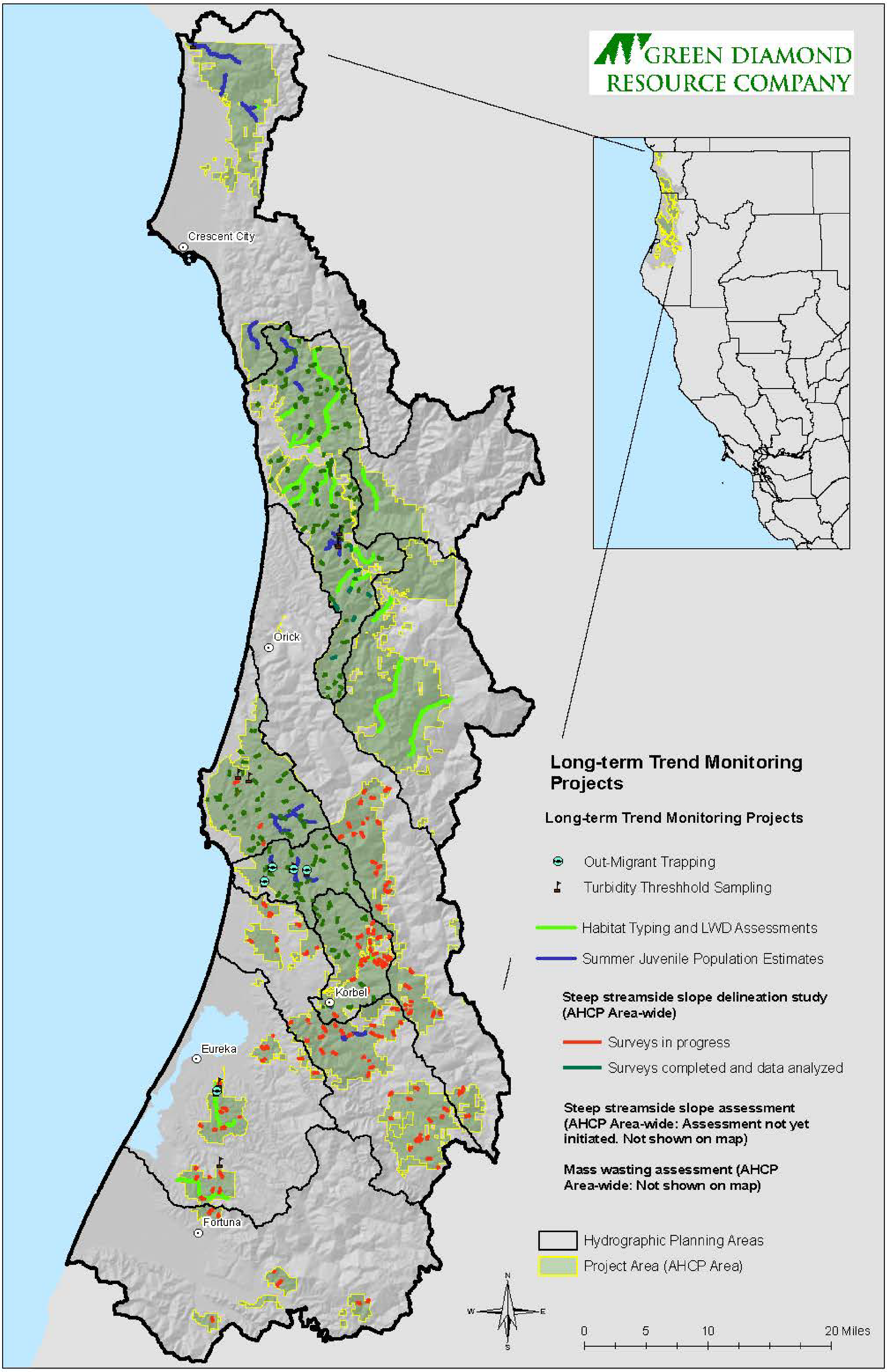


Figure 10. Map showing the locations of long-term trend monitoring projects conducted by Green Diamond in the AHCP area.

III. Summary

There have been more than 2000 articles published on watershed-scale studies since 1970 (Ice and Stednick, 2004). Despite the immense body of literature, much of the work was conducted during a period when forest practices were unregulated or had minimal mitigation measures. However invaluable lessons were learned from this rich history of watershed research. They have increased our understanding of how streams and forest ecosystems function and how to improve forest management practices to minimize their impacts to the aquatic system. As described above, the scale and magnitude of these environmental effects depend on the extent and intensity of the harvest, logging methods, geology, topography, watershed size, and the timing and magnitude of large, infrequent storm events. Green Diamond also acknowledges that some effects of timber management are unavoidable even when using the most cautious harvesting and road management techniques. However, based on an assessment of current aquatic habitat conditions across Green Diamond's ownership within the AHCP area and an understanding of the potential effects of forest management, Green Diamond has developed and employs a suite of state-of-the-art aquatic conservation measures to minimize individual impacts of our operations on the aquatic system. These management practices are regulated by the CFPRs, Green Diamond's AHCP approved by the NMFS and USFWS, the Consistency Determination and the MATO approved by CDFG, the RMWDRs approved by the Regional Water Board and the FMWDRs pending approval by the Regional Water Board. Green Diamond also has monitoring and adaptive management provisions in place to validate that the prescriptions are working and provides a mechanism to modify the measures to improve their effectiveness. The potential environmental effects of Green Diamond's timber harvesting operations at the harvest levels reflected in Green Diamond's Maximum Sustained Production Plan were taken into account in the FEIS and IS/MND for the AHCP/CCAA, MATO and RMWDRs and those documents concluded that Green Diamond's operations at these levels will not result in significant environmental impacts as such impacts are avoided or minimized or mitigated to a level of insignificance. In this paper, Green Diamond has confirmed that the implementation of the management practices and the current provisions in place that control the rate of Green Diamond's timber harvesting operations avoid, minimize and mitigate the impacts of Green Diamond's operations on the aquatic system and protects water quality. "New" watershed studies are underway for Caspar Creek in California, Hinkle Creek in Oregon, Trask Watershed in Washington, Mica Creek in Idaho and the Alto Watersheds in Texas that are evaluating the effects, including cumulative effects, of contemporary timber harvest practices on the aquatic system. These and Green Diamond's ongoing monitoring will invariably continue to shape Green Diamond's science-based adaptive approach to landscape management.

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Appendix A

Potential Effects of Forest Management on Water Quality and Aquatic Species

I. Potential Forest Management Effects on the Hydrologic Cycle

The basic components of the hydrologic cycle are precipitation, infiltration, evaporation, transpiration, storage and runoff. In the Pacific Northwest, where annual precipitation is highly seasonal, the timing, quantity and quality of rain and snowfall have great influence on water quality. Timber harvest temporarily reduces or eliminates leaves and stems at a stand and catchment level. The surface area of this vegetation normally intercepts precipitation for short-term storage that is either evaporated or released as drip. The loss of forest vegetation also reduces the amount of water extracted from the soil by root systems via evapotranspiration and increases soil moisture and pieziometric head. This was demonstrated by Keppeler and Brown (1998) after harvest of second growth redwood forest. The effect of any reduction in evapotranspiration is typically short lived (3-5 years), as rapid regrowth of vegetation may consume more water than pre-timber harvest amounts (Harr 1977). This is likely to be true in redwood forests as well, in part owing to the stump-sprouting habit of redwood. The commercial timberlands within Green Diamond’s ownership within the AHCP area are rain-dominated. However, some watersheds in this area have upper sections within the transition zone between rain and snow. Along these hillslopes the forest canopy intercepts snowfall, redistributes the snow, shades the snowpack and acts as a windbreak. In these transient areas the snow is generally wet and sticks to the forest canopy longer than colder, drier snow. In transitional areas snow usually reaches the ground in clumps under trees or as snow melt so that snow pack in forested areas tends to vary in distribution and depth compared to logged hillslopes (Berris and Harr 1987).

Snow melt from hillslopes in coastal watersheds is usually the result of warmer rainfall or latent heat in air moisture rather than from solar radiation. Snow packs in transitional areas may accumulate and melt several times during the wet season. When the forest canopy has been removed more of the snow pack is directly exposed to rainfall, warm air and direct sunlight.

A. Surface Water Hydrology

The primary effects of timber harvest on surface water hydrology pertain to annual water yield, low flows, and peak flows.

Paired watershed experiments to measure changes in flow following timber harvest have been conducted in Oregon and Northern California. Annual water yield generally increases following timber harvest (Bosch and Hewlett 1982, Harr 1983, Stednick 1996). The magnitude of the increase depends on the climate regime, forest type, harvest type, and amount of harvest (Bosch and Hewlett 1982, Stednick 1996). Clearcutting and patch-cutting increased annual water yields up to 6 mm for each percentage of basin harvested in rain dominated catchments, while selective cutting increased annual water yields up to 3 mm for each percentage of basal area removed (Moore and Wondzell 2005). Increases in water yield are not detectible by measuring streamflow when less than 20% of the catchment is harvested (Bosch and Hewlett 1982, Stednick 1996). In studies that evaluated seasonal variation in water yields, most of the increased yields (by volume) occurred in the wetter fall-winter period (Harr, 1983, Keppeler and Ziemer 1990) whereas the larger proportional change occurred in the dryer summer period. Increases in water yield tend to diminish with forest regrowth over time (Harr et al. 1979, Hibbert 1967, Keppeler and Ziemer 1990).

Summer low flows in rain-dominated watersheds were typically augmented following logging. At Caspar Creek in northern California, the low flow increases were greatest in the first year after harvest and diminished irregularly thereafter (Keppeler and Ziemer 1990). At the Alsea Watershed in the Coast Range of Oregon, summer low flows slightly increased (though not statistically significant) for the first 5 years after harvest in Needle Branch, then slightly decreased for the next 3 years; however, low flows in Flynn Creek were reduced for the full three years post-logging (Harr 1977).

An exception to the low flow increases occurred at the Bull Run Municipal Watershed in the northern Oregon Cascades, where patch-cutting 25% of the catchment area initially increased the number of annual low flow days in two of the catchments (Harr 1982). Harr hypothesized that the reduced number of low flow days was caused by the reduced inception of fog drip following harvest. About 5 years after harvest the summer flow increases were detected by Ingwersen (1985).

The effects of harvesting on peak flows have been extensively studied (e.g. Beschta et al. 2000, Harr 1980, Jones and Grant 1996, Lewis 1997, Moore and Wondzell 2005, Reid and Lewis 2007, Ziemer and Lisle 1998). The hydrologic processes affecting peak flows include evaportransportation, interception, fog drip, snow accumulation and melt rates, and soil compaction (Grant et al. 2008).

In relatively small watersheds (about 150 to 1200 ac), peak flow magnitude following harvest tends to increase, with the largest increases occurring in smaller runoff events (less than one-year) (Beschta et al. 2000, Ziemer 1998). For one-year recurrence interval events, peak flow magnitude increased 13-16%; these increases were 6-9% for five-year recurrence interval events (Beschta et al. 2000). At Caspar Creek in northern California, increases in peak flow magnitude were about 27% for two-year storm recurrence interval events in 100% clearcut tributaries (Ziemer 1998). The effect of timber harvest on peak flows generally diminishes with increasing watershed size, increasing time since harvest and with increasing flow magnitude (Beschta et al. 2000, Thomas and Megahan 1998, Ziemer 1998).

Timber harvest activities that compact or disturb the soil can reduce the infiltration capacity of soils and alter the process of subsurface water movement. Compacted soils found on roads and landings are relatively impermeable and water runs off them quickly. Inboard ditches along truck roads not only collect and concentrate surface runoff, but also intercept subsurface flow and bring it to the surface (Furniss et al. 1991). Reduced evapotranspiration, reduced soil infiltration capacity, and the interception of surface flow may lead to increases in surface runoff, peak stream flows, and sediment inputs to watercourses.

Water and sediment from roads can enter stream channels by many mechanisms (Furniss et. al. 2000):

- Inboard ditches that deliver road drainage to stream channels at truck road watercourse crossings,
- Inboard ditches that deliver flow to culverts, road drainage dips or water bars with sufficient discharge to create a gully or generate a sediment plume that extends to a stream channel,
- Improperly spaced or located road drainage structures that discharge sufficient water to create a gully or generate a sediment plume that extends to a stream channel, and
- Roads located close enough to a stream that fill slope erosion or fill failures result in sediment discharge into the stream channel.

Research conducted at the plot and reach scale have shown evidence of the effects of roads on peak flows (Luce 2002, Wemple et al. 1996). However research conducted at the watershed scale have examined the effects of roads on peak flows when coupled with timber harvesting. Some paired watershed studies have shown that roads did not have a significant effect on peak flows (Lewis et al. 2001, Ziemer 1981). While other have shown a significant increase in peak flow when roads occupy at least 12% of a watershed (Harr et al. 1975). Because of the difficulty in decoupling the effects of roads with harvesting at the watershed scale in paired watershed studies, modeling efforts have been used to predict changes in peak flows due to roads. A modeling effort in Washington suggests that the increase in peak flow is approximately equal to that of forest harvest however the magnitude of the change is very different on a per unit area basis (Bowling and Lettenmaier 2001). Roads increased the magnitude of the mean annual flood 11-12% per 2% of the area disturbed, whereas forest harvest increased the magnitude 8-15% per 35-66% area disturbed; however, both of these increases in peak flows decreased with increasing return interval (Bowling and Lettenmaier 2001).

The effects of timber harvest on annual water yield, peak flow magnitude and timing, and summer low flows on aquatic species and habitat characteristics are difficult to assess. The life-cycles of salmonid species have adapted to temporal variations in flow conditions by timing the phases of their life cycles to take advantage of seasonal discharge characteristics (Sullivan et. al. 1987). Increased runoff in the early part of the rainy season may, in some cases, benefit salmonids by reducing water temperatures, improving water quality, and providing more flow for immigrating adult spawners. However, a harvest-related increase in peak flows may increase the number of times that channel substrates are mobilized by storm events and potentially damage developing eggs and alevins in redds (Hicks et al. 1991). Channel forming flows may occur more frequently as a result of an increase in peaks flows; however, the effects should be confined to channels with gradients that are less than approximately 0.02 and with streambed and banks that are composed of gravel and finer material (Grant et al. 2008). Increased peak flows may also affect the survival of over-wintering juvenile salmonids by displacing them out of preferred habitats. These flow increases could also have beneficial effects by increasing available aquatic habitat. Short-term increases in summer low flows may improve survival of juveniles (Hicks et. al. 1991) and increase the amount of aquatic habitat. However, these hydrologic effects are temporary and diminish with regrowth of forest vegetation.

II. Potential Forest Management Effects on the Sediment Inputs and Transport

Timber harvest and the associated construction and use of the road system have the potential to increase sediment inputs. Increased sediment inputs from such activities can impair water quality through increased turbidity levels.

Hillslope erosion, sediment delivery to streams, and sediment transport and sorting within streams are natural dynamic processes. Steep, geologically young, coastal mountains are especially prone to high natural rates of erosion. However, excessive inputs of sediment (both coarse and fine) from a combination of anthropogenic and natural sources can overload a stream's ability to store and transport sediment which can be detrimental to water quality.

A. Sediment Sources and Erosional Processes

Sediment of varying size from the smallest fines to large boulders can be generated from a variety of different sources involving different erosion processes. One such process, surface erosion, tends to generate smaller particles sizes, and is a two-part process in which particles are first detached and then transported downslope. The two hydrologic processes that transport surface erosion are channelized erosion by constricted flows (rilling and gullying) and sheet erosion in which soil movement is non-channelized (rolling and sliding) (Swanston 1991). Increases in channelized and non-channelized erosion occur when the infiltration capacities of soils are reduced by management activities, large storm events or fires. Chamberlin et al. (1991) reported that the potential for surface erosion is directly related to the amount of bare soil exposed to rainfall and runoff. A study in Redwood National Park indicated that higher erosion rates tended to occur where rill erosion was more common, which was associated with tractor-harvest, and to a lesser extent, cable yarding, on schist soils (Marron et al. 1995).

In general, surface erosion does not account for a large portion of the total sediment budget in a watershed. Hagans and Weaver (1987) analyzed the data used by Marron et al. (1995), as well as data on percent bare soil following harvest and data on sediment delivery to streams from surface erosion processes on logged areas, including skid trails, for the lower Redwood Creek basin for the period c. 1954-1980, and concluded that only 4% of erosion was caused by sheet and rill erosion. Rice and Datzman (1981) conducted detailed surveys in northern California of 102 harvested plots averaging about 11 acres in size over a range of geologic and slope conditions. In aggregate, they found that two-thirds of the observed erosion was associated with roads, landings or skid trails. Surface erosion in the form of rills and gullies not associated with roads, landings or skid trails (i.e. harvested areas) accounted for about five percent of total erosion.

Mass wasting is another process that has the potential to produce large amounts of both coarse and fine sediment. In steep mountainous terrain, mass soil movement is a major type of hillslope erosion and sediment source in watersheds (Sidle and Ochiai 2006, Swanston 1991). The frequency and magnitude of mass soil movements is governed by a number of factors, including; hillslope gradient, level of soil saturation, composition of dominant soil and rock types, degree of weathering, type and level of management activities, and occurrence of climatic or geologic events.

Mass soil movements are usually episodic events and tend to contribute significant quantities of sediment and organic debris to stream channels over time intervals ranging from minutes to decades (Swanston 1991). The resultant sediment and organic debris may have a profound effect on a stream channel including large increases in coarse and fine sediments, shifts of existing bed-load, and increases in woody debris that can lead to partial or complete stream blockages.

Forest management practices can affect slope stability and increase the risk of mass wasting by changing vegetative cover, hillslope shape, and water flow above and below the ground surface. Different forest management operations have distinct effects on the factors that control slope stability. For two of the major components of forest management operations—road construction (and to a lesser extent skid trail construction) and harvesting trees—the potential consequences with respect to shallow landslide processes and slope stability are relatively well known. Road and skid trail construction may:

1. Create cut slopes and fill slopes too steep to be stable,
2. Result in deposition of sidecast material (spoils) that overburdens and/or oversteepens slopes, and
3. Divert and/or concentrate both surface and subsurface runoff.

While dominate factors affecting slope stability due to harvesting trees include:

1. Root strength deterioration: reducing effective soil cohesion by disrupting networks of interlocking roots from living trees in the "window" of reduced root reinforcement between 3 and 15 years after harvesting (Sidle and Ochiai 2006), and
2. Increase pore water pressure by reducing interception of precipitation and evapotranspiration of soil water. This is significant because greater soil moisture reduces the amount of precipitation from a given storm event required to cause soil moisture levels to reach a critical level.

The actual influence of specific forest management activities on slope stability, however, depends on the design and construction of the road network, density of residual trees and under-story vegetation, rate and type of revegetation, topography, material strengths, patterns of surface and subsurface flow, and patterns of water inflow (Sidle and Ochiai 2006, Yoshinori and Osamu 1984). Landslide rates associated with roads are generally much greater than landslide rates associated with timber harvest alone (Sidle and Ochiai 2006). However, separating the effects of timber harvest activities from the associated yarding, construction, maintenance and use of skid roads and the forest road system may be difficult. Further, the results vary between watersheds. Most studies indicate that the sediment inputs from timber harvesting alone are less than those of the associated road network (Sidle and Ochiai 2006, Raines and Kelsey 1991, Best et al. 1995).

Deep-seated landslides also have the potential to produce large amounts of both coarse and fine sediments. Natural mechanisms that may trigger deep-seated landslides include intense rainfall, earthquake shaking, and erosion of landslide toes by streams. It is generally acknowledged that deep-seated landslides (earthflows and rockslides) may be destabilized by undercutting of the landslide toe (e.g. by streambank erosion or excavation of road cuts), by adding significant mass to the landslide body (e.g. disposing of spoils from grading or excavation projects), or by significantly altering the groundwater conditions in a landslide (e.g. clearcutting, road building, diversion of road drainage into head scarps or lateral scarps) (Keaton and Beckwith 1996, Swanston 1981). However the effect of hydrologic changes associated with reduced evapotranspiration, reduced canopy interception, and elevated pore pressure on deep-seated landslides is not well understood. Elevated pore pressures as a result of timber harvesting may result in accelerated movement of deep-seated landslides due to prolonged exposure to such pore pressures (Sidle and Ochiai 2006). However, pore pressures appear to be affected only during moderate rain storms preceded by dry conditions (Sidle 2005).

The relatively few regional empirical landslide studies have produced varying conclusions on the effect of timber harvesting on earthflow stability (i.e. deep-seeded landslides). Short-term increases in ground displacement following clearcutting have been documented on several active earthflows in the Coast Range and Cascades of Oregon (Pyles et al. 1987; Swanson et al. 1988; Swanston 1981). In contrast, work by Pyles et al. (1987) on the Lookout Creek earthflow in central Oregon concluded that timber harvesting was unlikely to induce a large increase in movement, primarily because the slide was well drained. In either case, accelerated movement due to timber harvesting was not significant (i.e. measured in millimeters). Ongoing studies by Green Diamond indicate that movement of large deep-seated landslides may be influenced by timber harvest activities in some cases. However, overall average rates of movement are typically very slow (0.5 to 1.9 feet per year) making the accelerated movement due to harvest activities nearly imperceptible.

In summary, previous studies suggest that forest management activities can potentially increase the occurrence or rate of movement of deep-seated landslides. Recognition of active landslides and avoidance of management practices that are known to increase risks of movement can reduce the overall risk of erosion associated with deep landslides. Site-specific conditions pertaining to individual slides will always be important in development of site-specific forest management plans; nevertheless, substantial uncertainty is likely to remain regarding predicted effects of management on slide activity. Deep-seated landslides are relatively common, naturally occurring geologic features in northern California that will continue to generate substantial quantities of sediment delivered to streams, regardless of management influences.

The preceding discussion indicates that erosion from roads, including landslides (mass wasting), gullying caused by improper drainage, and rainsplash and sheetwash erosion on road and cutslope surfaces, are generally the most significant component of erosion related to forest harvest activities. Timber harvesting operations have historically relied on an extensive network of unpaved roads and necessitated building new roads to access portions of timberlands being harvested. Roads are recognized as a significant source of sediment inputs to watersheds (as described above; see also Gibbons and Salo 1973, Weaver and Hagans 1994). Sediment input from roads can occur through both surface erosion and mass wasting.

Research has shown that road construction for timber harvesting can cause significant increases in erosion rates within a watershed (Haupt 1959, Gibbons and Salo 1973, Beschta 1978, Rice et al. 1979, Cederholm et al. 1980, Reid and Dunne 1984, Furniss et al. 1991). Roads can affect watersheds by modifying natural drainage patterns and by accelerating erosion and sedimentation, potentially altering channel stability and morphology. If proper construction techniques and maintenance practices are not followed, sediment increases following road construction can be severe and long lasting. Gibbons and Salo (1973) concluded that the sediment contribution per unit area from forest roads is usually greater than that contributed from all other timber harvesting activities combined.

Forest road systems and their associated stream crossings in steep coastal watersheds have the potential to be a major cause of mass soil movements (e.g. Best et. al. 1995, Sidle et al. 1985). Road inventories conducted in the Pacific Northwest have reported that erosion from older roads may contribute 40 to 70 percent of the total sediment delivered to the system (Best et al. 1995, Durgin et al. 1988, McCashion and Rice 1983, Raines and Kelsey 1991, Rice and Lewis 1991, Swanson and Dryness 1975).

The actual increases in hillslope failures due to roads that are observed in any given watershed are affected by variables such as hillslope gradient, soil type, soil saturation, bedrock type and structure, management levels (usage) and road placement, design, and construction. The literature suggests that road placement is the single most important factor, because it affects how much the other variables will contribute to slope failures (Anderson 1971, Larse 1971, Swanston 1971, Swanston and Swanson 1976, Weaver and Hagans 1994).

B. Sediment Transport Processes

There are three modes of sediment transport in stream channels: bedload, intermittent suspended load, and suspended load. Although each of these processes corresponds to a generally consistent size range of sediment, the processes occur over a physical continuum, and there is substantial overlap among these modes of sediment transport. Depending on the intensity (i.e. velocity) of stream flow, the sediment transported in one mode may be transported in another mode. Many textbooks provide a description of sediment transport mechanics (e.g. Richards 1982, Raudkivi 1990, and Yang 1996).

The typical size of material transported primarily as bedload in upland streams is gravel (2 mm to 64 mm diameter) and cobble (64 mm to 256 mm diameter). Larger material (boulders) are also transported as bedload, however, sediment particles of this size move relatively slowly and are more likely to form nodes of stability in stream channels (i.e. boulder steps or transverse bars, Grant et al. 1990).

Bedload is transported by sliding, rolling, or skipping along the streambed. Bedload particles are rarely found in the water column far above the bed. Bedload sediment is typically routed through mountain channel systems slowly, with average annual transport distances from tracer studies of about 300 ft., ranging from about 60 to 1500 ft. (NCASI 1999). The volume of bedload sediment deposits is typically large in comparison with the annual transport rate.

Bedload sediment is broken and abraded as it collides with other sediment clasts on the bed or in transport; this gradual process of breakage and declining size is known as attrition. The attrition process converts a portion of the bedload to suspended load as larger sediment clasts produce smaller sediment particles. The attrition rate is usually estimated as a function of transport distance in the channel network. The magnitude of attrition varies, but as much as half of bedload material may be converted to suspended sediment over transport distances of about 20 km (Collins and Dunne 1989). Where bedrock is extremely weak (e.g. Wildcat Group rocks near Humboldt Bay), however, the attrition rate may be much higher, and where bedrock is relatively strong, the attrition rate much lower.

Intermittent suspended load (also called “saltation load” by Raudkivi (1990)) is typically comprised of fine gravel and coarse sand. It is transported partly in contact with streambed, and partly in suspension, depending on flow intensity and local channel morphology. These sediment sizes are often found in sorted deposits in the lee of channel obstructions or in pools, and are typically finer than typical median grain size on the surface of point bars and alternate bars. Intermittent suspended load is transported through channel systems more quickly, provided it is not deposited underneath coarse armor layers of bed and bar deposits. The typical annual velocity of intermittent suspended load is between that of bedload and suspended load, and is on the order of 1000’s of feet to miles.

Sand, silt and clay sizes (< 2 mm diameter) comprise the suspended sediment load in most upland stream systems. The sand fraction (> 0.06 mm and < 2 mm) is often a major constituent of the intermittent suspended load and a substantial constituent of the bedload. In many low-gradient rivers, sand is the dominant component of the bedload. Such conditions are found at the mouths of several coastal watersheds in northern California.

Suspended load is transported in suspension in the water column in relatively low-intensity flows. It typically is transported through the channel system rapidly; sediment velocity for suspended load is nearly equal to water velocity. If suspended sediment is present in or on the margins of channels it will be entrained rapidly with increasing stream discharge. This suspended sediment can be subsequently deposited in low-velocity areas downstream as stream discharge declines. Sediment of this type is rarely deposited in large quantities within the streambed in upland channel networks except in low-velocity environments such as unusually low gradient or hydraulically rough reaches, channel margins, side channels, and behind flow obstructions.

Suspended load transport in many northern California streams (e.g. Caspar Creek, Lewis 1998) is correlated with turbidity (an optical characteristic of water quantifying its clarity or cloudiness). Hence, the supply of suspended load sediment size fractions is the chief control on stream turbidity, a measure of water quality used by the California Regional Water Quality Control Board in its Basin Plan for northern coastal California. The silt and clay fraction in the suspended load strongly influences turbidity; hence control of sediment sources rich in silt and clay will provide the greatest reduction in turbidity.

The relationship between sediment inputs to a channel network and sediment transport capacity of the channel network will have a strong influence on channel sedimentation status (e.g. Buffington and Montgomery 1999, Montgomery and Buffington 1993,). For example, channel systems that are said to be “transport-limited” have a high sediment supply such that supply is greater than the streams sediment transport capacity. The channel bed in transport-limited channels is expected to be relatively fine, typically composed of finer gravel and sand with little armoring of the bed surface. Transport-limited channels may be found where there are abundant sediment inputs (e.g. recent concentrated inputs from landslides) or where channel slope declines rapidly (e.g. where a relatively steep confined channel reaches a broad valley with lower channel gradient). In contrast “supply-limited” systems have a high sediment transport capacity relative to sediment supply. The channel bed of supply-limited systems is expected to be relatively coarse, with frequent armoring of bed deposits and frequent bedrock exposures. Although conditions are variable, depending on channel and valley morphology and watershed erosion history, many of the smaller, steeper upland streams important for anadromous fish would be expected to be supply-limited. This expectation is conditioned largely on the high degree of confinement, moderately high slopes, and moderate to intense storm runoff typical of such streams (i.e. factors suggestive of high sediment transport capacity).

The timing and frequency of coarse sediment inputs into stream channels tend to be dominated by mass wasting processes. With the exception of channel erosion, bank erosion and soil creep, mass wasting processes typically generate sediment inputs that are relatively concentrated near the point of entry to the channel network. Landslide deposits in channels typically include abundant coarse and fine sediment and LWD. Deposits may fill existing channels and induce erosion along stream banks. The transport and downstream routing of such coarse sediment budgets have been investigated both in model and field studies of upland rivers (Benda and Dunne 1997a, 1997b, Lisle et al. 1997 and Lisle et al. 2001). While it is generally agreed that the local effect is greatest at the point of entry, consistent theoretical statements regarding the magnitude and timing of effects downstream and the governing processes are elusive. Regardless of the specific mechanism, the greatest short-term effects with respect to coarse sediment are localized, with only gradual (over a period of years to decades) translocation of effects (typically increased depth of gravel deposits and changes in size distribution of bed material).

III. Potential Forest Management Effects on Altered Water Temperature

Stream temperature is controlled by multiple factors such as solar and thermal radiation, riparian shading, air temperature, wind velocity, relative humidity, tributary inflow, groundwater inflow, and hyporheic flow. Removal of the riparian canopy can result in elevated summer water temperatures, often in direct proportion to the increase in incident solar radiation that reaches the water surface (Chamberlin et al. 1991). For a given exposure from solar radiation, water temperature increases directly proportional to the surface area of the stream and inversely proportional to stream discharge (Sullivan et al. 1990). Exposed channels will also radiate heat more rapidly at night. In addition, increased sediment inputs that results in aggradation will result in a wider and shallower channel that gains and loses heat more rapidly. Therefore, reduction of riparian vegetation and aggradation of a channel act synergistically to cause greater daily and seasonal fluctuations in water temperatures.

While the increases in summer water temperatures can be large after removal of riparian vegetation, the changes in winter water temperatures are usually less dramatic. Generally, the removal of riparian vegetation resulted in increases of winter water temperatures in low elevation coastal watersheds due to increases of solar energy (Beschta et al. 1987). Conversely, in northern latitudes and at higher elevations decreases in winter water temperatures may occur due to the loss of insulation from riparian vegetation, leading to an increase in radiative cooling from the watershed.

Changes in water temperatures from the removal of riparian vegetation may benefit or negatively impact salmonid populations. Among the potential benefits of canopy removal is an increase in primary and secondary production that would increase the amount of available food. Studies have reported increases in biomass and production of salmonid populations after riparian harvest (e.g. Hawkins et al. 1983, Johnson et al 1986, and Wilzbach et al. 2005). Increased water temperatures during winter months are usually less dramatic than summer increases; however these slight increases may have a great effect on salmonids. Studies conducted on Carnation Creek in British Columbia revealed that slight increases in winter water temperatures resulted in accelerated development of coho embryos, thus an earlier emergence of juveniles (Hartman et al. 1987, Holtby 1988). The earlier emergence resulted in a longer growing season for the juvenile coho salmon, but also increased their risk to downstream displacement during late-winter storms.

Increased water temperatures can also have negative impacts on the salmonids (Beschta et al. 1987). Potential impacts to salmonids from increased stream temperatures include (Hallock et al. 1970, Hughes and Davis 1986, Reeves et al. 1987, Spence et. al. 1996):

- reduction in growth efficiency,
- increased disease susceptibility,
- changes in age of smotification,
- loss of rearing habitat, and
- shifts in the competitive advantage of salmonids over non-salmonid species.

There is a potential secondary negative impact of increased water temperatures that is related to levels of dissolved oxygen in the water. During summer months, low flows and increased water temperatures accelerate respiration and reduce the solubility of oxygen. The reduction of available oxygen may reduce growth rates of individual fish and may limit the production capability of an entire watershed.

Incoming solar radiation appears to be the dominant factor at the site level (Johnson 2004), however modeling studies of the cumulative effects of large scale timber harvest emphasize that it is a complex set of factors, rather than a single factor such as shade, that governs stream temperature dynamics (Bartholow 2000, Sridhar et al. 2004).

IV. Potential Forest Management Effects on Large Woody Debris Recruitment

Historically, the mainstems of watersheds were utilized to transport logs downstream to processing mills. Thus, extensive clearing of debris jams occurred on most coastal watersheds (Sedell and Froggatt 1984). Splash damming was another management technique to transport logs downstream that tended to dislodge established large woody debris (LWD) from stream channels. These channel clearing activities directly removed salmonid habitat from watersheds and also reduced the probability of additional LWD retention within the channel.

In-channel salvage logging and the clearing of LWD from streams in the Pacific Northwest began shortly after the 1964 Flood. Much of this activity was sponsored by the federal government as a measure to protect bridges and to reduce cases of property liability in court (Maser and Sedell 1994). Removal of LWD from stream channels also occurred during the 1970s and 1980s when state and federal agencies spent over six million dollars annually in efforts to remove debris jams and improve fish habitat (Maser and Sedell 1994). Many of the large debris jams were probably barriers to fish migration and required modification. However, these stream clearing programs often went too far and now fisheries managers have spent the past 20 years reintroducing LWD to streams along the Pacific Northwest. Currently, some fisheries biologists consider the placement of LWD restoration structures in streams as an interim, short-term measure until large conifers are reestablished in riparian zones to provide a source of LWD.

Decades of timber harvesting in the riparian zone has altered the species composition and age classes of trees along stream channels. The removal of valuable conifer species has led to the predominance of early successional species such as alders and willows. Short-rotation harvesting has decreased the numbers of large trees available as potential LWD. Woody debris from second-growth forests has a shorter residence time in stream channels than debris from uncut watersheds (Grette 1985). Managed riparian zones of predominately red alder may have a greater input rate of wood to the stream channel than conifers in an uncut riparian zone, but the reduced longevity of alder debris results in reduced cover and fewer pools than in uncut watersheds (Grette 1985).

In-channel LWD is recognized as a vital component of stream habitats. The physical processes associated with LWD include sediment sorting and storage, retention of organic debris, and modification of water quality (Bisson et al. 1987). In headwater streams, LWD is also known to dissipate hydraulic energy, store and sort sediment, and create habitat complexity (Chesney 2000, Gomi and Sidle 2003, May and Gresswell 2003, O'Connor and Harr 1994). The biological functions associated with LWD structures include important rearing habitats, protective cover from predators and elevated stream flow, retention of gravels for salmonid redds, and regulation of organic material for the instream community of aquatic invertebrates (Bisson et al. 1987, Murphy et al. 1986). Decreased supply of LWD can result in (Hicks et. al. 1991):

- reduction of cover,
- loss of pool habitats,
- loss of high velocity refugia,
- reduction of gravel storage, and
- loss of hydraulic complexity.

These changes in salmonid habitat quality can lead to increased predator vulnerability, reduction of winter survival, reduction in carrying capacity, lower spawning habitat availability, reduction in food productivity and loss of species diversity.

Current timber harvesting and the presence of or construction of roads in riparian areas may result in a decline in the recruitment of LWD and a resulting reduction of in-channel LWD. Timber harvest in riparian zones removes trees that could potentially become in-channel LWD. Roads in riparian zones may reduce potential LWD by the presence of the road surface eliminating tree production and also by intercepting trees that fall toward the channel. The decline of recruitment of potential LWD from riparian zones can be expected to reduce LWD recruitment to streams for decades following timber harvest of riparian areas. High in the watershed, the potential impacts would be primarily localized, but in larger streams lower in the watershed, LWD can be transported during higher flow events and the impacts may be cumulative. A decline in pool density, pool depth, instream cover, gravel retention, and sediment sorting are likely to result if LWD recruitment is reduced. These habitat changes may reduce the growth, survival, and total production of aquatic species (Murphy et al. 1986, Steele and Stacy 1994).

V. Appendix A References

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Appendix C: Terrestrial Retention of Ecosystem Elements (TREE) Plan

Terrestrial Retention of Ecosystem Elements (TREE)

Green Diamond Resource Company
September 12, 2014

Introduction and Background

Green Diamond Resource Company has had a landscape plan for retaining upland forest structure since the implementation of its Northern Spotted Owl Habitat Conservation Plan in 1992. Since that time, field experience related to the efficacy of leaving upland structure has resulted in the evolution of the guidelines and criteria that govern the spatial distribution, type, and amount of retained structure. Implementation of Green Diamond's Aquatic Habitat Conservation Plan (AHCP) in 2007 resulted in additional refinement to the amount and distribution of retained terrestrial habitat. The TREE is focused on habitat areas and habitat elements that are essential to specific behaviors of vertebrate species that reside on Green Diamond's ownership. It discusses the amount, spatial arrangement and types of habitat or habitat elements retained across this dynamic landscape.

The vital role of trees with decay, snags and downed coarse woody debris (CWD) in forest ecosystems has been well documented and Green Diamond recognizes the critical importance of sustaining these elements in the forests that it manages. In addition to the role that these habitat elements play in the ecology of many fungal, nonvascular plant, and invertebrate species, a variety of wildlife species are directly dependent on snags or CWD for nest/den/rest sites and as primary sites for foraging. The primary cavity excavators (woodpeckers) are particularly well known for their connection to snags, but other species (e.g. owls, fishers and others) have vital links through secondary use of snags, CWD and decaying live trees.

Although decaying wood is a vital element in all forest ecosystems, its average abundance varies among forest types and the temporal and spatial distribution of snags and CWD can vary substantially within the same forest type. In addition to the total quantity of dead wood, the size distribution may be important to certain species. All sizes of snags and CWD are likely to be utilized by certain species, but the larger size are more likely to be limiting simply because it takes longer to generate the larger size classes once they are lost from a landscape. Along with considerations of quantity and size class distributions, there is the additional factor that not all tree species have equal potential value as snags or CWD. Trees that are prone to heart rot are generally more valuable as snags and CWD. Such tree species tend to be selected by most primary and secondary cavity users because, during the decay process, they tend to be hard on the outside and soft (decayed) on the inside. Snags that decay from the inside out are suitable for cavity excavation and support a complex detrital-dependent community of species (fungi, saprophytes and invertebrates). In addition, trees that are prone to heart rot are more likely to develop internal cavities while living, which is the only mechanism by which hollow logs are produced. Some species of trees that are resistant to internal rot may have limited value to many of the dead wood-dependent species, but they have the potential to provide long lasting structural forest elements. The high natural variability between and within forest types along with the many other considerations discussed above has made it virtually impossible to establish critical thresholds for the maintenance of snags and CWD.

Throughout Green Diamond's ownership there are differences in the amounts of dead wood even though much of the pattern was produced through management activities rather than natural processes. In spite of the anthropogenic impacts on the distribution of dead wood, there is a sequence of biotic communities (ecocline) as one moves from west to east. In the more coastal areas, forest stands are predominately redwood with relatively few hardwoods other than red alder, which occur primarily in the riparian areas. Since redwood is highly resistant to heart rot, it decomposes very slowly and often contributes large amounts of dead wood in a stand. In addition, because of their longevity, large redwoods develop many structural deformities (e.g. fire scars, broken tops, basal hollows and etc.) that provide an important source of long-lasting structural cover and diversity within the forest. However, the decay resistance of redwood may also have a negative aspect for dead wood associated species. Due to the resistance to heart rot, redwood is likely to produce snags that are difficult to excavate for use by primary and secondary cavity nester. Similarly, redwood logs decompose from the outside inward so they lack the quality of having a hard outer bark with decomposing moist heartwood that is prime habitat for a variety of small mammals, herptiles and invertebrates. Douglas fir and numerous hardwood species become a more dominant component of stands at greater distances inland from the coast. In addition, Douglas fir and many hardwood species are more susceptible to heart rot and produce high quality snags and logs for use by dead wood associated species.

Corresponding with this vegetational west-east transition is a change in the vertebrate species associated with snags and logs. Green Diamond has documented a west-east distributional gradient for fishers, spotted owls and red tree voles. (The pattern associated with the voles is probably more related to direct utilization of Douglas fir for food rather than an association with decadent trees.) Anecdotal observations indicate that the same pattern holds for pileated woodpeckers and other woodpecker species such as the acorn woodpecker. Although Green Diamond's management goals include maintaining dead wood throughout its ownership, the greatest emphasis is placed on those regions where it will have the greatest benefit for the most species. In addition, there are adjacent public lands that can provide an abundance of this wildlife structure in portions of Green Diamond's ownership (e.g. state and national parks or Forest Service late successional reserves), which can partially provide for dead wood values at a landscape level of analysis.

While snags and CWD are important components of forest ecosystems, living trees with decay, hollow living trees, trees with natural cavities, and remnant or legacy trees also play a key role in forest ecosystems. Similar to snag development, structures on living trees often take many decades or centuries to develop and are typically dependent upon natural stochastic events such as lightning, fire, severe storms and natural pathogens. It is important to identify and focus retention on these structures since they are living and will likely persist on the landscape for many years. Living trees with decay are also likely candidates to develop into snags. The living trees with existing structure are prime candidates for retention in harvest units, but other live trees that have low economic value and can be minor stand components should be strongly considered for retention. Examples of these conifer species are hemlock, cedar and grand fir. Hemlock and cedar are known to harbor or develop structures important to wildlife such as mistletoe brooms and complex limb formations. These species are commonly subordinate species in the overstory canopy and will contribute additional vertical diversity to the canopy. A variety of hardwood species within forest stands also contribute to increased wildlife species diversity, and they accommodate essential behaviors of many species. Our data indicates that hardwoods are important stand components of nest groves for spotted owls and data on fishers shows that females frequently select tanoak trees with cavities as their natal and maternal den sites. We also suspect that the positive relationship of successful nest sites of spotted owls with hardwoods is related to increased prey diversity at the nest stand level or the increased canopy diversity from hardwood species contributes to survival of fledged owlets by providing "hiding" or escape cover. A downy owlet is often more difficult to sight within the branches and foliage of evergreen hardwoods relative to exposed lateral branches of conifer trees.

Regardless of the tree species involved, it is important to consider live trees, snags or downed woody debris that have critical or vital conservation value. Primary consideration should be given to live trees, snags and coarse woody debris that currently provide or are most likely to be become critical habitat elements on the landscape. The concept of a "critical habitat element" refers to something that is relatively rare on a managed landscape, takes a long time to develop (greater than a single rotation) and is linked to some behavior (reproduction, foraging) of a vertebrate species in such a way that the loss of the habitat element would likely result in a substantial population reduction of the species on the landscape. This concept is incorporated in the attached live tree retention scorecard, which has been adopted as part of this plan to assist foresters and wildlife biologists in selecting the trees that have the greatest benefit to a variety of wildlife species.

***Wildlife species positively influenced by retention of green wildlife trees, snags and coarse woody debris*:**

The following are some examples of vertebrate species believed to be dependent on or strongly associated with critical habitat elements found on managed timberlands. Included with each species is the critical habitat element it is known to use. The species are ranked with their approximate relative dependence on these habitat elements.

1. Marbled murrelet – large conifers with large lateral branches (Note: This habitat element on managed lands is not likely to be suitable for maintaining a population of murrelets. All the studies to date indicated that a contiguous stand of old growth is necessary to support murrelets.)
2. Spotted owl – large trees with cavities and structural deformities
3. Fisher – large trees with cavities, internal hollows and mistletoe brooms, downed hollow logs and hardwoods (tanoak) with cavities
4. Several bat species (e.g. Townsend's bat) – large trees with basal hollows and loose bark with crevices
5. Pileated woodpecker – large live trees and snags with heart rot
6. Tree vole – medium to large trees with structural deformities and "candelabra" tops
7. Bald eagle – large trees above the surrounding canopy with large lateral limbs or structural deformities
8. Peregrine falcon – large green trees or snags with broken tops or fire scar-formed depressions or platforms
9. Vaux's swift – large fire scarred trees or snags with internal hollows
10. Purple martin – large trees or snags with cavities that are located in open areas
11. Osprey – large trees or snags above the surrounding canopy with broken tops or large lateral branches
12. Marten – large trees with cavities, snags, large hollow logs, brush piles

Guidelines for green tree retention

The guidelines for green tree retention are based on standards initially developed under Green Diamond's 1992 spotted owl HCP. Although these retention guidelines were initially developed specifically to accelerate the development of future habitat for spotted owls, it is these same trees that will likely contribute to the development of future snags.

The following guidelines apply to clear-cut harvesting of even-age young growth stands. Harvesting using other silvicultural methods not described in this document or in other types of stands will require the site-specific considerations of company wildlife biologists, operational managers and foresters to determine appropriate retention standards. Despite the following guidelines, it is important to remember that the goal is to retain critical habitat elements and promote the development of future spotted owl or other wildlife habitat within a managed landscape, which may best be achieved utilizing a flexible and adaptive approach.

Criteria for establishing the need for green tree retention in harvest units:

The original tree retention guidelines were established prior to Green Diamond's Aquatic Habitat Conservation Plan, but this document now serves as the foundation for habitat retention across the ownership. It is essential to understand the provisions of Green Diamond's aquatic HCP (AHCP) to predict the influence of this plan on habitat for owls and other terrestrial species. The AHCP provides riparian management zones and protection of geologically unstable areas that will create riparian reserves since only a single light selection harvest (variable 0-30% canopy removal) will be allowed during the life of the AHCP (2007-2057). Modeling of future landscapes using forest inventory data and GIS as well as implementation of the AHCP demonstrated that approximately 25% of the landscape will be retained in Riparian Management Zones (RMZs) and other geological instabilities (landslides, headwall swales, steep streamside slopes). The largest retention zones occur along Class I watercourses that are fish-bearing, but the greatest quantity of retention across the landscape occurs adjacent to Class II watercourses that typically originate as headwater streams. These watercourses provide habitat for aquatic vertebrates such as torrent salamanders and tailed frogs but are not fish bearing. The density of these headwater streams is quite high within the north coastal zone, and these stream retention areas often extend to near the ridge tops. Some Class II zones are associated with seeps or springs that do not form well-defined channels and therefore are not considered watercourses; however, these areas warrant the same level of canopy retention and protection zones that further contribute to retained forest habitat across the landscape. There is additional scattered tree retention along ephemeral class III watercourses under the AHCP that will function as dispersed vertical structure within the managed landscape. The amount of tree retention will be evaluated at three spatial scales: The ownership (landscape); the watershed; and the THP harvest unit. Evaluation of terrestrial habitat retention at each level is described below.

- **Ownership** – The baseline for determining whether an individual THP unit warrants retention is guided by the amount of forest habitat that is essentially set aside in a no harvest or in a partial harvest scenario by agreements entered into by the company and other parties. The ownership level of retention is based upon two landscape level planning documents: The AHCP and the NSO HCP. Under the AHCP, the amount of forest retention within riparian zones and other mitigated areas is estimated to be approximately 25%. This estimate will likely increase over time because additional watercourses (primarily Class IIs with substantial protection zones and canopy cover) are discovered each time a THP is developed in the field. This prediction is relative to what is known from the best available hydrological information. Also, retention of forest habitat around newly discovered geological zones will change over time. At the end of the AHCP term in 2057, an estimated ≥25% of the landscape will be in forest stands 65-140 years of age. Projections of spotted owl habitat under the NSO HCP are expected to increase and then plateau as the forests on GDRCo reach a regulated state under the CA Forest Practice Rules.

- **Watershed** – This is an appropriate scale for addressing tree retention because it generally coincides with cumulative effects analyses conducted for THPs, and it allows for consideration of unique habitat areas. The goal is to retain at least 1 tree per clearcut acre harvested in areas (3rd-4th order watersheds of typically 10,000-20,000 acres) that currently have existing structure available for potential green wildlife tree value. In areas that have special wildlife value or in areas where past harvesting has already eliminated most of the snags and potential green wildlife trees the goal is to retain at least 2 trees per clearcut acre harvested. Areas that have special wildlife value are regions that are known to support high densities of owls or have other sensitive wildlife species dependent on residual structure and dead wood. The specific areas that meet this criterion should be determined in consultation with the company's biological staff. For example, although the Little River Watershed contains significant stands of healthy well-formed trees, the thinning history of most of the stands has resulted in a general lack of snags, or trees with deformities, cavities, or forked/ platformed tops and hardwoods.

- **THP Unit** – After initial reconnaissance and during the course of layout, each RPF will determine the amount of RMZ or other partial harvest system occurring within each THP unit. Based upon these field assessments, the RPF will designate tree retention for each unit guided by the landscape and watershed factors discussed above. When a THP unit includes any acreage of RMZ or other partial harvest system, additional green tree retention in the form of scattered trees, tree clumps or an HRA will not be required (excluding hardwood areas and trees scoring ≥7 – see below). However, individual trees are always retained when they possess higher wildlife value (≥7) as determined from the Live Tree Retention Scorecard regardless of the acreage in RMZ or other partial harvest. In addition, existing evergreen hardwoods that do not meet the minimum score ("7") should also be retained at the watershed level of 1 or 2 trees per clearcut acre. Preference is given to the largest diameter trees and species such as tanoak and madrone, Also, any low economic value conifers "standing slash" should be retained.

  When a THP unit does not include RMZ or other partial harvest system, additional tree retention will be required at 1 or 2 trees per clearcut acre. In these circumstances, incorporate some form of green tree retention (HRA's, tree clumps or scattered trees).Trees included in the retention tally should be representative of the stand being harvested, but smaller diameter hardwoods with well-formed crowns should also be considered for retention. Any existing scorecard trees (≥7) should be the first candidates for retention followed by lower scoring hardwood and conifer trees.

***Types of green tree retention*:**

- Habitat retention areas (HRAs) are groups of trees ½ acre or more in size that are within a THP unit. Trees that are within the normal boundaries of a RMZ or special treatment area are not included as an HRA. However, areas extending beyond the required boundaries for a RMZ or special treatment area can be used as HRAs. Ideally, HRAs will include a portion of the harvest unit that tends to have trees with greater wildlife value, but lower economic value. HRAs are not considered no-cut areas, but the target for post-harvest overstory canopy cover is 70%. Harvesting in HRAs should be done with the objective of retaining the trees with the greatest future wildlife value. When possible, HRA's should encompass a critical habitat element or unique habitat feature (e.g. large snags, decadent hardwoods) within the THP unit. These "biological anchors" are often unique elements that can be rare within the managed landscape and contribute substantially to overall stand diversity. In addition, placement of HRA's should take into consideration use by wildlife (i.e., placement away from roads) as well as operational constraints.

- Individual or clumped retention (groups of 10-20 trees) Smaller groups of trees outside of RMZs including individual trees or tree clumps (10-20 trees) may also be retained in harvest units to achieve wildlife green tree retention standards. Also, hardwoods in SSS zones are counted towards the desired retention level for these species. Individual trees should be selected due to their high wildlife value, while tree clumps should be small groups of trees associated with one or more trees of high potential wildlife value. Retention of individual trees or tree clumps should be considered to promote dispersed vertical structure and snag recruitment. Particular attention is given for additional retention in stands predominately composed of hardwoods where the greatest wildlife benefit can be achieved.

Placement of green tree retention:

- Preference is always given to HRAs in cable units because of operational constraints, burning and wind throw. For the same reasons, HRAs are best placed low within the unit, or added on to the top or side of a Class III watercourse. The latter case is particularly well suited for situations where there already may be some concerns related to instability associated with the upper portion of a geological area. Even if an HRA has been designated, individual wind-firm trees with high wildlife value should always be considered for retention except when precluded by safety or operational constraints.
- Well-dispersed individual trees or tree clumps should be given preference in ground-based units. However, concerns related to wind throw or the location of suitable trees with high wildlife potential may necessitate delineating an HRA instead of dispersed individual trees or tree clumps.

Guidelines for snag retention

Green Diamond's goal is to make a concerted effort to retain all snags (defined as a standing dead or mostly dead tree) throughout its ownership unless it constitutes a clear safety or fire hazard. When situations arise where snags must be felled because they represent a fire or safety hazard, a discussion of options will occur between the responsible parties (Operations, Forestry, IFM and Wildlife) prior to the felling of the snag. When the snag must be felled, it will be left on site as CWD. Also, anything classified as a snag is not counted in the tree retention tally

Snag recruitment

The active recruitment of snags into a forest system where they are currently lacking typically involves intentional introduction of decay pathogens into trees or the mechanical disfigurement of living trees. The former is often costly and limited in scope due to the time, effort and potential controversy involved with such activities. The introduction of pathogens (inoculation) into trees will result in the "natural" development of heart rot and the subsequent use by woodpeckers, invertebrates, and secondary cavity users, Equipment can be used to create cavities or trees with snag-like qualities, but the use of chainsaws or larger equipment (log loaders) is also costly and is limited to confined areas or areas with suitable access. In addition, artificial cavities and snags will not develop into hollow trees and logs over the long-term in the absence of natural decay mechanisms. Creation of snags and cavities by mechanical means is difficult to replicate over large areas and the usefulness of these techniques requires further investigation. Another consideration for creation of snags or structures on trees is to allow some intentional burning within tree clumps, HRAs or RMZs. The one-time burning of trees or habitat areas may result in the creation of snags, but repeated low intensity burning is necessary to create hollows, cavities and other structural deformities. Basal hollows on redwoods and some hardwood species provide the best example from repeated low intensity fires that create and maintain this type of structure. The extensive RMZ networks and other upland tree retention areas such as HRAs would be suitable for exploring the efficacy of these techniques on GDRCo's managed landscape because these retained trees will not be harvested within the life of the permit and will be available for voluntary efforts to actively accelerate the formation of wildlife structure. In the absence of proactive snag creation GDRCo will be contributing to the accelerated process of potential snag development by retaining 2 trees per clearcut acre harvested in harvest units lacking partial harvest systems, through application of the tree retention score card and in areas dominated by hardwoods. This retention standard does not include trees retained within the RMZ's or existing retained snags.

Guidelines for coarse woody debris retention

Certain wildlife species have been shown to have a strong connection with downed CWD. In certain cases, (e.g. Oregon slender salamander) a species may have an obligate association with CWD. Studies to date on Green Diamond's ownership have shown little direct association between any wildlife species and CWD. The only exception is that Pacific fishers show a weak association with areas having a higher density of fir logs. There are no amphibian species in this area that are closely tied to CWD and unlike studies in other parts of its range, spotted owls within Green Diamond's ownership do not show an association with CWD. In spite of this, we believe that CWD plays an important role in the overall structural diversity of stands and may have important indirect benefits to a variety of species.

Our general policy is to retain all non-merchantable CWD within stands. Future recruitment of CWD will result directly from the natural tree mortality (stem exclusion, disease, animal damage and etc.) within developing stands as well as the retention of existing snags and green wildlife trees. Merchantable redwood logs without internal rot may be removed outside of watercourses, because we do not believe these logs provide critical wildlife habitat. Broadcast burning occasionally results in the loss of CWD, but Green Diamond always strives to have light intensity burns that only consume the smaller (<2 inches) material. For the same reasons that trees and snags with large hollows are considered critical conservation elements on the managed landscape, in general, large woody debris with hollows or large cavities have relatively greater value to wildlife compared to pieces without cavities or with small cavities. In areas where biomass harvesting is planned, the same guidelines will apply for retention of CWD. The definition of merchantability is different for biomass harvesting and large logs that would not be suitable for lumber or lumber products could be suitable for biomass harvesting.

***Hardwood areas*:**

On broad ridges such as Wiregrass and Bald Mountain Ridge in the Korbel Operating Area, or Williams Ridge in the Klamath Operating Area, there are stands with few or no watercourses. When these stands are harvested, the only structure left behind tends to be what is designated as HRAs or individual tree clumps. In some instances, mechanical feller-bunchers are being used to harvest the smaller hardwood and conifer component on gentle ground. Hardwoods greater than 28 inches at the base are typically not taken by the feller-buncher and have to be manually felled. Our regular guidelines call for leaving two trees per acre that are equal to the average stem diameter in the stand. In predominantly hardwood stands, the average stem diameter is often quite small so that many of the trees retained will be small and have little wildlife value. Given their high wildlife value, the maximum benefit for wildlife can be achieved through the retention of the larger residual hardwood trees that often occur throughout these stands.

To provide for beneficial future habitat structural elements in hardwood dominated stands (areas understocked with conifers), two of the largest hardwood trees (especially if they have structural deformities that provide high wildlife value) will be retained per clearcut or rehabilitation acre harvested <u>regardless</u> of the amount of RMZ or partial harvest present in the unit. If possible, these larger residuals should be well distributed throughout each harvest unit. If the area to be harvested is lacking in large residual hardwoods, then the largest hardwoods present in the stand should be selected for retention at a rate of 2 trees per clearcut acre. The RPF should choose the hardwoods with the best crown characteristics and those that are most likely to remain standing post-harvest. To make the retention successful over the long term, small group retention can be considered over individual tree retention. In addition to the scattered or clumped retention, an HRA will be designated in these areas. Where possible, HRAs should be located around a residual large hardwood or decadent conifer. Often, hardwood rehabilitation plans have large scattered fir trees with significant internal decay and structural deformities. All of these conifers with marginal merchantable value (e.g. broken top, long basal fire scar, evidence of internal rot and "grouse ladders") should be marked for retention. The scattered hardwood retention is focused at providing dispersed den and rest tree opportunities for ambulatory species such as the fisher. The scattered retention could provide future nesting opportunities for spotted owls, but this species is more capable of accessing clumped retention within the managed landscape. The combination of clumped and scattered retention is likely to have the greatest benefit to a variety of species

Pre-Commercial Thinning

In areas scheduled for pre-commercial thinning (PCT) and lacking any previous hardwood retention under the 1992 NSO HCP or TREE (previously the Terrestrial Dead Wood Management Plan, TDWMP), the general prescription is to retain at least two unthinned evergreen hardwood sprout clumps per acre. These unthinned clumps will serve as future candidates for retention and habitat elements within the stand. If other existing larger evergreen hardwoods are present those shall be retained as first priority. Any hardwoods retained under either the HCP or TDWMP shall not be cut down during the PCT treatment.

Commercial Thinning:

To date, Green Diamond has conducted commercial thinning on relatively few acres. As second and third growth stands mature, commercial thinning harvests may increase over time. In general, commercial thinning and selection have the potential to remove decadent trees and hardwoods that could function as nest trees or roost sites for owls as the stand matures. In addition, heavy thinning reduces the overall canopy closure in the short term, which may inhibit owls from using the area for nesting and roosting. In commercial thinning harvests, the age class typically targeted is the 30-45 yr old forest. The timing of commercial thinning coincides with the stage of forest development at which Green Diamond biologists hypothesized that owls would begin colonizing young forests. If thinning is conducted on a large scale (ownership or watershed) it may inhibit owls from colonizing and reproducing due to the short time period between thinning harvests, stand recovery (crown closure) and clearcut rotation. Given the target rotation age for forests on Green Diamond ownership, it is likely that commercial thinning and clearcut harvesting will occur within a time frame of 10-15 years. Our own studies indicate that owls are less likely to reproduce in forests that were commercially thinned and where decadent/deformed trees and hardwoods were removed (Little River area). The resultant stands of clean, straight conifers offers few nesting opportunities for spotted owls and roosting opportunities are diminished due to the delimbing effect on retention trees. In this area, thinning within the limits of the California Forest Practice Rules does not significantly increase abundance of the owls' primary prey species, the dusky-footed woodrat and may further inhibit use by spotted owls.

Thinning is generally conducted over larger areas and has the ability to disrupt larger areas of the home ranges of species such as owls and fishers. Removal of a large percentage of the hardwoods in a stand may negatively affect fishers, a species which Green Diamond biologists found to be positively associated with hardwoods. Alternatively, many young stands in the 30-45 yr age class have a high stem count and are currently marginally suitable for owls due to the lack of flight space under or within the tree canopy. In this instance, thinning may increase the suitability of the forest for spotted owls. By reducing the stem density and increasing canopy lift, thinning may promote the development of owl habitat.

The general assumption is that thinning will be conducted in stands with a relatively high conifer to hardwood ratio. In these stands it will be important to maintain the evergreen hardwood component where it exists (species such as tanoak, madrone, chinquapin). In general, the harvest of these species should be limited or avoided in order to promote species diversity and structural diversity within the forest. All decadent and residual conifers with deformities or structures likely to be used by wildlife should be retained during the thinning harvest so that they are present for use by wildlife before the clearcut harvest. In addition, these decadent conifers and hardwoods should be retained so that foresters have the option of designating these trees for retention at the time of clearcut harvest to meet requirements under the TREE. Removal of hardwoods and decadent/deformed conifers during the thinning will limit the opportunities available to future foresters and wildlife biologists. In addition, commercial thinnings should be designed so that the basal area removed is not uniform throughout the unit. This practice will create areas with varying stand density and vertical diversity, and it will also create options for establishment of future HRAs and/or tree clumps. No-harvest HRA areas can be designated during the commercial thinning harvest so that these areas are available during the clearcut rotation. The rationale behind this uneven application of thinning is to create a stand more typical of a forest developing under a natural disturbance pattern. The general goal is that thinning be conducted in a manner to promote forest development and suitability for wildlife species such as spotted owls and fishers.

Directions for use of Live Tree Retention Scorecard

To provide foresters and wildlife biologists with more specific guidance, the attached Live Tree Retention Scorecard provides a system for ranking of the relative value of habitat elements that should be preferentially retained. The rankings are not absolutes, because the forester needs to also consider the ability to protect the structure during operations and site preparation, the likelihood that it will be destroyed by natural processes (e.g. wind throw) and safety.

A mix of conifers and hardwoods is normally preferred, but preference should be given to evergreen hardwoods if the stand is predominately composed of conifers.

During the course of normal THP layout, foresters will traverse a large percentage of the ground in each THP unit. As large trees are encountered, they will be evaluated per the scorecard. Each tree meeting the diameter criteria will be evaluated for the presence of other tree elements and assigned values when elements present meet the definitions and descriptions provided. Trees with a score ≥7 should be noted on a field map and marked for retention per the criteria on the scorecard. Trees not meeting the diameter threshold but exhibiting the described habitat elements should be considered as prime candidates for meeting the green tree retention guidelines if large trees are not available.

Training

Green Diamond Resource Company biologists provide annual training to company Forestry and Operations departments regarding the requirements and proper implementation of the Northern Spotted Owl Habitat Conservation Plan and company guidelines such as the TREE. This training is also provided to contractual foresters, operators and timber fallers, although complete attendance cannot be guaranteed for contractual workers. The training consists of a "classroom" review to ensure consistent application of the plans.

Live Tree Retention Scorecard Used for Identification of Existing Wildlife Structure

	Tree elements					Unit Scarcity Factor[a]	Planning Watershed Factor[b]	Total score
	DBH[d]	Bole features[c]			Crown features[c]			
	conifer >30" hardwood >18"	internal hollow or large cavity	small cavity, internal rot or mistletoe broom	crevice cover (loose or deeply furrowed bark)	complex crown, lateral large limbs, epicormic branching	Post-harvest LSE density: =<1 ac, add 2 pts >1/ac, <2/ac, add 1 pt =>2/ac, add no pts	Impaired or special wildlife value, add 1 point. All others, add no points	
Wildlife score	3	4	2	1	1			

[a] Unit scarcity factor is determined at the unit level based on the number of residuals post harvest (conifers and hardwoods are to be evaluated separately) and is added to the total score. Estimate is based on entire unit acres (including RMZs).
[b] Planning watershed factor is determined programmatically and is added to the total score.
[c] See Definitions and descriptions.
[d] Trees not meeting the diameter threshold but exhibiting the described habitat elements should be considered as prime candidates for meeting the green tree retention guidelines if large trees are not available.

Trees with a score equal to or greater than 7 will be retained except under very rare circumstances where operational constraints prohibit retention as justified by Forestry and Wildlife. Trees with scores less than 7 can be harvested. Maximum obtainable score for combined tree elements is 11. The maximum score for each tree element column is depicted in the gray shaded box. For example, a tree with a complex crown and large lateral limbs would receive only 1 point for Crown Features.

Note: Trees not meeting the minimum retention score but exhibiting high potential defect (standing slash) or high harvesting costs so as to negate their value should also be considered as prime candidates for meeting green tree retention guidelines if high-scoring trees are not available.

Late Seral Habitat Elements – Definitions and Descriptions

The following information is intended to provide guidance for foresters and biologists assessing the relative value of wildlife trees in harvest units. The terms listed here should provide a common language for describing the various late seral habitat structures encountered in California north coast forests. These definitions and descriptions are not perfect, and if interpreted too narrowly may exclude some trees of obvious wildlife value or if interpreted too broadly may include some trees of little wildlife value. These descriptions should be used to obtain a general impression of the types of structures that may be visible in the field during THP development and review.

I. Trees and Snags

A. Residual tree (Legacy tree): A tree that existed in a stand prior to the most recent harvest entry.

Description: Structure and appearance varies substantially depending on residual tree age, species, and harvest history of the stand. For conifers, including redwood, the residual tree will almost always exhibit a greater diameter than the regenerated trees in the stand. If the residual has a live top it will likely project well above the surrounding canopy.

Two types of residual tree may be recognized:

1. Old-growth residual (Legacy tree): A residual tree at least two centuries old; minimum age varies by species

Description: Usually has a much greater diameter than the second-growth trees in the stand (for redwood, dbh is typically well over 4 feet for site class I, II, or III conditions) and often relatively tall (at "true" site potential height for site class). In addition to large size, old-growth residual trees usually exhibit one to several readily observable features of "old-growth" including broken top, large reiterations and large-diameter limbs, thick bark that may have deep furrows, fire scars or basal cavity, other cavities, possibly well-developed duff layers, moss, or lichen accumulations on horizontal limbs or platforms. Crown architecture visible from the air may include emergent crown (where the surrounding stand is relatively young), irregular or flat-topped shape (as opposed to conical top), obvious dead or spike top (note these may also occur in large second-growth trees), multiple leaders due to large reiterations (which may give the crown the appearance of a cluster of tall young trees).

2. "Mature" residual ("Bastard-growth"; Legacy tree): A residual that was probably less than 100 years old at the time of the initial harvest. The age at present is around 100 to 200 years old.

Description: Usually at or above the maximum dbh of the second-growth trees in the stand. Other characteristics (height and defect) vary depending on age, age relative to other trees in the stand, fire history, and whether damage to the residual occurred during the initial entry. Typically, "mature" residuals show a much smaller dbh than an old-growth residual for the site class and exhibit fewer of the structural features listed above for old-growth residuals. From the air, the crown of a "mature" residual tree may emerge above the surrounding canopy (where the surrounding stand is relatively young) or may not be particularly evident if the surrounding stand is mature second-growth. If the "mature" residual grew for an extended period above a regenerating stand, it may exhibit a relatively broad crown and high degree of taper, but otherwise be relatively free of physically induced defect.

B. Snag: A standing dead tree.

Description: Snags vary tremendously in appearance and function for wildlife depending on species, size, and decay class.

C. Green Wildlife Tree: A standing live tree with important, existing wildlife structure.

Description: A conifer or hardwood tree with existing habitat elements (II. and III. described below) that result in a score ≥7 based on evaluation from the score card.

D. Green Tree: A standing live tree

Description: A conifer or hardwood tree lacking existing habitat structure and possessing few elements that contribute to a score of ≤7 based upon evaluation from the score card. It is common for trees with low economic value but some wildlife value to be retained (e.g. hardwoods, hemlock, and cedar). These trees with low economic value but some existing wildlife structure should always be considered as prime candidates for retention even where there is no requirement for retention.

II. Bole Features

A. Large cavity: A cavity (or void within a tree bole or large limb) with a relatively small entrance suitable for use by a variety of wildlife species, such as spotted owl, wood rats, Pacific fisher, or American marten, or colonies of Vaux's swift, purple martin, or bats. The small entrance precludes the entry of larger predators into the cavity. Cavities with larger entrances (classified as hollows, see below) may also be used by these species.

Description: A large cavity is generally several feet deep and at least 8 to 12 inches in diameter with an entrance size ranging from about 2.5 to 6 inches diameter. Entrance height is often at least 15 feet above the ground, but lower entrances may also be used. In practice, interior dimensions will usually just be a guess based on entrance size and appearance, as well as the characteristics of the tree, plus any observations of wildlife use of the cavity.

B. Hollow: A large cavity with an entrance or opening greater than 6 inches diameter.

Description: Hollows have similar interior dimensions as large cavities and may be used by the same suite of species for cover; however, the larger entrance size of a hollow may not prevent larger predators from entering the hollow.

C. Basal hollow (Goose pen): A large hollow at ground level typically created by fire that destroys the cambium on a portion of the bole's circumference. Repeated fires play an important role in maintaining and enlarging basal hollows.

Description: A basal hollow is a hollow that extends at least a third of the tree's diameter into the bole and is generally several feet in height. It should be capable of providing shelter to small or medium-sized wildlife.

D. Small cavity: A cavity suitable for use by a variety of small to medium-sized wildlife species, such as small to large woodpeckers, secondary cavity-nesting birds, wood ducks, individual or small numbers of bats, northern flying squirrel, Douglas squirrel, and small owls.

Description: A small cavity is generally between about 7 inches and a few feet deep and between about 4 and 8 inches in diameter with an entrance size ranging from about 1.5 to 3 inches in diameter. Entrance height is often at least 10 feet above the ground, but lower entrances may also be used. Interior dimensions will usually be a guess based on entrance size and appearance, characteristics of the tree, plus observations of wildlife.

E. Internal decay (Heart rot): Widespread or localized heart rot fungus infection within the bole of a tree. Decayed, softened wood encompasses at least enough volume to allow excavation of a small cavity.

Description: Decayed wood in old scars may be visible at ground level or with binoculars well above the ground. Good indicators of internal decay include fungal fruiting bodies, such as conk, cavity entrances, and sloughing wood and bark. In practice, it may be difficult to discern the extent of internal decay in some cases.

F. Crack (Fissure): A longitudinal gap in the bole of a tree caused either by physical damage (including wind, lighting, or fire) or by growth of two trees or leaders into each other where the gap provides cover for wildlife.

Description: Cracks must be sufficiently deep relative to their width to provide partial cover for foraging birds or complete cover for nesting birds, roosting bats, or small- to medium sized mammals. Longitudinal indentations in which the deepest portions are visible from outside the tree are not considered cracks unless they are capable of providing cover for foraging or roosting small vertebrates.

G. Furrowed bark: A relatively deep linear indentation in the bark of a tree capable of providing cover for roosting bats or foraging bole-gleaners.

Description: Furrowed bark occurs where an underlying defect (crack, old lightning or fire scar, narrow strip of removed cambium) or the line of contact between two trees growing into each other has been covered by bark. The furrow is sufficiently deep and narrow to be capable of providing cover for small vertebrates. Furrowed bark should not be used to describe the bark of a large or fast-growing redwood tree on which the bark has developed a ropey or braided look, but does not provide cover for foraging or roosting small vertebrates.

H. Loose bark: A discrete, large piece of bark that has separated from the underlying tree bole but remains attached to the tree.

Description: "Loose bark" refers to a portion of a tree's bark that provides cover for roosting bats, nesting birds, or possibly foraging bole gleaners. Typically, such bark pieces provide relatively tight, stable cover for small animals. The distance of separation from the underlying tree should be 2 inches or less and should not be so loose that the bark piece flaps in the wind. As a general rule, loose bark is attached along at least one edge at least 1 foot long. Although some bear-stripped trees may meet the definition of "loose bark", most bear-stripped trees have bark that has been pulled away from the bole along most of the strip's edges, flaps against the underlying wood in the wind, and only provides a small amount of cover at one end of the strip. Such bear-stripped bark should not be scored as "loose bark".

I. Ledge (Platform): A relatively horizontal portion of a tree limb, exposed old cavity, or cluster of epicormic branches on the bole of a tree.

Description: A ledge or platform must be of sufficient size and have adequate cover to provide a nesting or resting opportunity for a moderately large wildlife species, such as Pacific fisher or peregrine falcon.

III. Crown Features (features contributing to a "complex crown")

A. Dead top (Spike): A dead tree leader.

Description: "Dead top" refers to dead leaders that are evidenced by leaf die-back along at least the top one-fifth of the tree height or with a minimum diameter at the lowest extent of leaf die-back of about 12 inches.

B. Broken top: A tree with the original leader broken off.

Description: "Broken top" refers to broken-topped trees with a minimum diameter at the original break of about 12 inches.

C. Reiteration (Reiterated top, Bayonet, "Schoolmarm", Candelabra): A sprouted leader or limb that exhibits apical dominance.

Description: Reiterations vary greatly depending on relative age and position on tree. All reiterations include some vertical growth that gives them the appearance of a "tree-on-a-tree". Old reiterations may exhibit a high degree of decadence and may themselves have additional reiterations. A tree should be scored for reiteration only if the reiteration provides opportunities for resting, denning, or nesting, or includes a substrate or epiphytes providing foraging opportunities for vertebrate wildlife.

D. Forked top: A split in a tree's leader.

Description: A tree should only be scored for a forked top if the structure provides an opportunity for resting or nesting for vertebrate wildlife, or if defect associated with the fork suggests that other structures may be present (such as internal rot or cavity).

E. Mistletoe broom (Witch's broom): A compact spray of branches infected with mistletoe.

Description: A tree should be scored for mistletoe broom if the structure is large and solid enough to provide an opportunity for resting or nesting of vertebrate wildlife, or if smaller brooms occur in multiple locations within the tree.

F. Large limb (Platform limb): A relatively horizontal limb of sufficient girth for vertebrate wildlife to use the structure for resting or nesting (but not including bird perches).

Description: A tree should be scored for large limbs if the limbs are distinctly larger than typical for similar size trees with good growth form. Generally, such trees in a stand of merchantable age will have at least two branches at least 12 inches in diameter.

A. Candidate Tree Selection:

- Retain large defective residual trees using the TREE's tree retention scorecard
- Retain defective or poorly formed trees, e.g., animal damaged, forked top, broken top, mistletoe broom, etc.
- Retain a mix of conifers and hardwoods (approximately 50/50 mix where possible
- Conifer species preference: Douglas-fir, hemlock, white fir, cedar, spruce, redwood

Hardwood species preference: tanoak, Pacific madrone, California laurel, chinquapin

Consider protection from windthrow and site preparation burning when designating HRA and tree clump locations

- Retain trees with the average diameter equal to or greater than the average diameter of trees in the THP area

B. Retention Guidelines – Evaluate the method and level of tree retention needed within each THP unit as follows:

Conifer Dominated Harvest Areas[1] with RMZ Retention:

Retain all scorecard trees ≥7

Retain other evergreen hardwoods at a rate of two trees per clearcut acre where they exist

Conifer Dominated Harvest Areas without RMZ Retention:

Retain all scorecard trees ≥7

Retain other conifer at a minimum rate of one tree per clearcut acre.

Retain other qualifying evergreen hardwoods at a rate of two trees per clearcut acre where they exist. If the unit is lacking in hardwoods to meet minimum retention standards, additional conifer must be retained up to two trees per acre if harvest unit is located in a one or two tree per clearcut acre retention area.

Retention should be a combination of approaches (HRA, tree clumps or scattered trees). HRAs are typically prescribed in cable yarding areas since this type of clumped retention is more practical in these areas. Trees retained in Streamside Management Zones (SMZ) and Class III Tier B areas can be counted toward overall tree retention.

Hardwood Dominated Harvest Areas[2] with RMZ Retention:

Require retention of all hardwood dominated areas at a level of at least two trees per clearcut acre regardless of the watershed

Retain all scorecard trees ≥7

Retain scattered or clumped evergreen hardwood trees at a rate of two trees per clearcut acre and also retain conifer trees scoring ≥7

Hardwood Dominated Harvest Areas without RMZ Retention:

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[1]Forest stands with >15,000 board feet of conifer per acre.

[2]Forest stands with <15,000 board feet conifer per acre and dominated by hardwood stems.

Retain all scorecard trees ≥7

Retain ½ acre HRA or clumps totaling 0.5 acres and scattered evergreen hardwood trees at a rate of two trees per clearcut acre

C. Relationship with Snag and RMZ Retention – Live tree retention is in addition to snag and RMZ retention. Green trees retained as described in these retention guidelines will augment structure provided by snag retention and within AHCP areas, i.e., Green Diamond will not include retained snags and trees left within RMZs as part of the count for Wildlife Tree Retention.

D. Live Tree Retention Scoring Criteria Used for Identification of Existing Wildlife Habitat Elements:

Dbh – Conifers ≥30 inches and Hardwoods ≥18 inches (3 points)

Bole features:

Trees with an internal hollow or large cavity (4 points)

Trees with a small cavity, internal rot or mistletoe broom (2 points)

Trees with crevice cover, i.e., loose or deeply furrowed bark (1 point)

Crown features – Trees with complex crown, lateral large limbs, epicormic branching (1 point)

Vole nest factor – Tree containing an active or remnant tree vole nest having canopy connectivity with existing RMZ/Geological retention (2 points) and all others (1 point)

Unit scarcity factor (i.e., post-harvest density of late seral habitat elements) <1 acre (2 points), >1/acre but <2/acre (1 point), >2/acre (0 points)

Watershed scarcity factor (planning watershed factor is determined programmatically and is added to the total score), impaired or special wildlife value (1 point), all others (0 points).

Appendix D: Vigorous Young-Stand Development on Green Diamond's California Timberlands

Vigorous Young-Stand Development
On Green Diamond's California Timberlands

Dan Opalach, Ph.D., RPF #2459
Timberlands Investment Manager
Green Diamond Resource Company

Background

To become certified under the FSC-US Forest Management Standard ("Standard"), Green Diamond must demonstrate that its use of even-aged silviculture is consistent with the following indicator which is contained in Appendix C of the Standard (Forest Stewardship Council 2010):

Indicator 6.3.g.1.b *Even-aged silviculture may be employed where: 1) native species require openings for regeneration or vigorous young-stand development, or 2) it restores the native species composition, or 3) it is needed to restore structural diversity in a landscape lacking openings while maintaining connectivity of older intact forests.*

Indicator 6.3.g.1.b ("Indicator"), as written, contains a number of "or" clauses. Thus, to show consistency with the Indicator it is sufficient to show that Green Diamond's use of even-aged silviculture is consistent with at least one of the "or" clauses. The focus of this paper is to demonstrate that the native species that Green Diamond relies upon for its reforestation program <u>require openings for vigorous young-stand development</u>.

The Standard defines even-aged silviculture as follows (see page 78):

Even-aged silviculture: *Silvicultural systems in which stands of trees of roughly the same age and size are grown and harvested simultaneously. Even-aged systems may involve intermediate entries that remove some trees before the final, or "regeneration" harvest, when a new even-aged class of trees is established. A regeneration harvest is designed to remove all or most of the trees within a defined age/size class, or to convert a stand containing trees having a variety of ages, sizes, or species to a more uniform stand. The timing of the regeneration harvest is termed the "rotation age" of the timber stand. Even-aged silvicultural systems include clearcut, seed-tree, shelterwood, two-age silviculture, and variable retention systems. Even-aged management units may contain more than one age/size class of trees on the site at any one time for silvicultural reasons or environmental enhancement. For instance, a variable retention system typically retains 10-25% of the vegetative cover present before harvest on site and intermixed with the new even-aged stand, to maintain structures and functions important for wildlife. Classic shelterwood and seed tree cuts retain mature trees from the harvested stand during the establishment of the next crop of trees, but these are taken out during a "removal" harvest to leave one age/size class for future management.*

This definition of even-aged silviculture encompasses several sections from California's Forest Practice Rules ("FPRs"). First, the FPRs describe the various regeneration methods used in even-aged management including clearcutting, seed tree, and shelterwood methods (14 CCR 913.1). Second, the FPRs list the intermediate treatments (commercial thinning and sanitation salvage) that can be employed to manage crop tree density in an even-aged stand (14 CCR 913.3). Finally, the FPRs define variable retention as an approach to harvesting "based on the retention of structural elements or biological legacies (trees, snags, logs, etc.) from the pre-harvest stand for integration into the post-harvest stand to achieve various ecological, social and geomorphic objectives" (14 CCR 913.4(d)). To be clear, the FPRs do not "lump" variable retention into the even-aged management methods. Rather it is in a separate section of the rules labeled Special Prescriptions.

Green Diamond's approach to even-aged management has evolved considerably over the years. Back in 1990 harvest units[1] averaged 60 acres in size and watercourse and lake protection zones ("WLPZs") only encumbered 3% of Green Diamond's timberland. Timber Harvesting Plans ("THPs") were only 22 pages in length and Green Diamond had one biologist on its staff.

In 2012, over 20 years later, harvest units average 29 acres size. THPs routinely exceed 200 pages in length and we have over 40 biologists, botanists, and geologists on staff. WLPZs, habitat retention areas, unstable geologic features, and other areas that cannot be clearcut encompass 25% of Green Diamond's ownership. A typical THP, nowadays, results in a landscape that has lots of structure upon the completion of timber operations (see Figure 1).

[1] A harvest unit is comprised of clearcut patches and adjacent watercourse buffers and/or habitat retention areas.

Figure 1. WLPZs occupy significant portions of the landscape in some areas. This image shows the buffers associated with Class II watercourses in the Little River watershed. WLPZs are principally managed using uneven-aged silviculture. This image was taken from Pollnow Peak in May 2001.

Given the widespread occurrence of areas that need to be managed for values other than timber it is important to note that Green Diamond uses both uneven-aged and even-aged regeneration methods on its California timberlands. A recent examination of THPs approved since the implementation of Green Diamond's Aquatic Habitat Conservation Plan (July 2007) showed that 75% of Green Diamond's timberlands are currently managed using even-aged silviculture and 25% are managed using uneven-aged silviculture or no harvest prescriptions. Uneven-aged prescriptions are used in areas such as WLPZs, habitat retention areas, or geologically unstable areas.

Green Diamond's Intensive Forest Management Program

For decades Green Diamond has managed its California timberlands such that the large majority of the stands that exist today are even-aged. That said, the way in which we manage our even-aged stands has evolved considerably over the years. Prior to the mid-1960s Green Diamond relied on natural regeneration to restock cut over timberlands. In areas that contained a lot of redwood, this approach worked quite well given redwood's ability to sprout from stumps. But most harvest units did not contain enough redwood trees to solely rely on stump sprouts for stocking purposes, nor was the frequency and distribution of natural regeneration that germinated from seed sufficient to achieve acceptable stocking over most stand and site conditions.

Recognizing that significant improvements in forest productivity could be achieved by investing in silvicultural treatments, the company hired its first silviculturist, Jim Rydelius, in 1965 (Rydelius, personal communication). At first Jim used aerial seeding to supplement natural regeneration but he soon convinced the company to invest in a containerized nursery (in Korbel, California) to produce seedlings so he could use artificial regeneration, where needed, to restock harvest units. Over time Jim started redwood and Douglas-fir tree improvement programs which featured the installation of numerous test sites to evaluate the performance of plus trees and their progeny. Eventually Jim built a tissue culture lab at the Korbel containerized nursery to clone redwood plus trees. The lab is still in operation and produces approximately 750,000 redwood clonal plantlets annually for our reforestation program.

Our Intensive Forest Management ("IFM") program was initiated in 1974 to improve the survival, growth, and development of seedlings and stump sprouts. At that time treatments consisted of prescribed burning, reforestation, scarification, aerial applications of herbicides, pre-commercial thinning, and forest fertilization. These are largely discretionary investments and therefore subject to curtailments during difficult economic periods. For example, pre-commercial thinning, scarification, and forest fertilization treatments were temporarily halted in the early '80s due to the severe recession that was occurring in the United States.

Green Diamond's IFM program has evolved considerably over the years. This evolution is the result of research (both in-house and at universities), new laws, rules, and regulations, effectiveness monitoring, social pressures, markets for products, financial analyses, biotic influences, and other factors. These days Green Diamond's IFM foresters focus on:

- ***Site Preparation and Hazard Abatement*****—**Biomass harvesting is the primary method for reducing the fire hazard associated with logging slash. Our contractor picks up the logging slash and grinds it into hog fuel which is then delivered to the wood-burning power plants in the region. The slash on approximately 1,000 acres is treated annually using this method.[2] In addition to biomass harvesting Green Diamond also relies on pile burning to eliminate accumulations of logging slash. Pile burning is the preferred method in those areas that are not economical to conduct biomass harvesting operations. Going forward we expect to treat approximately 1,000 acres annually using this practice. Many of these acres are located in our Klamath Operations area, which is geographically isolated from the

[2] Cal Fire Forest Practice Inspectors routinely conduct inspections of active biomass operations. In a recent Notice of Fire Hazard Inspection a Cal Fire forester noted that "the work performed by this company is a significant benefit to the prevention of damaging wildfires" (McCray 2010).

wood-burning power plants. Lastly, if we have no alternative, we will use a broadcast burn to remove the slash from a problematic harvest unit. It must be emphasized that broadcast burning is our treatment of last resort. We would much rather conduct a biomass harvesting operation or burn piles than conduct a broadcast burn.

- ***Reforestation***—90% of the clearcut acres harvested by Green Diamond require artificial regeneration to rapidly restock the site with desirable conifer species. At a minimum, the California Forest Practice Rules ("FPRs") require that 55% of the plots in a regeneration survey are stocked. In order to ensure compliance with the stocking provisions of the FPRs as soon as possible, Green Diamond's IFM foresters predominately plant large, healthy, 2-year-old nursery stock at densities sufficient to ensure that regeneration surveys indicate that 75% of the plots are stocked.[3] Planting 2-year-old stock accelerates site occupation (Smith 1962) and reduces the need for subsequent vegetation management treatments. The quantities of trees that are planted on any given site depend on the frequency and distribution of redwood stump sprouts and other naturally occurring conifer seedlings. If a site has an abundance of sprouting redwood stumps it may not be necessary to plant any trees to achieve Green Diamond's stocking objectives. On the other hand, if the site has no redwood stump sprouts and seedling survival may be problematic, our foresters will plant up to 450 trees per acre to achieve our stocking objectives.

- ***Vegetation management***—Herbicides are no longer applied aerially. Instead all herbicide applications are ground based. The most common prescription calls for workers to carry 3- to 5-gallon backpack sprayers and then systematically walk through units and apply herbicides <u>directly</u> to the foliage of problematic brush species. WLPZ buffers, habitat retention areas, and other protected sites are not treated. A small percentage of the acreage we plant (about 17%) is treated with a pre-emergent herbicide which is <u>broadcast</u> over the harvest unit. It should be noted that herbicides are not applied programmatically. Additionally, Green Diamond's foresters periodically take water samples to make sure the Best Management Practices ("BMPs") we use are appropriately guarding against chemicals getting into watercourses.

  Each area to be considered for treatment is inspected by an IFM forester to make sure the unit contains hardwood and/or brush species that are impacting the growth and development of potential crop trees. It's noteworthy that only about 50% of our redwood harvest units require a vegetation management treatment. Thanks to stump sprouts and rapid artificial regeneration where needed, many units achieve full stocking and free-to-grow status without the need for a vegetation management treatment. In addition to herbicides Green Diamond may,

[3] On high elevation Douglas-fir sites and mixed conifer sites we use 1-year-old planting stock. It is very difficult for Green Diamond to plan for harvesting operations in these areas given current market conditions. When we do harvest, however, we want to get the units restocked as soon as possible so we use 1-year-old seedlings produced at our containerized nursery in Korbel.

on occasion, control unwanted vegetation with chainsaws or other hand tools. Such manual treatments are primarily used in those situations where the harvest unit has a hardwood or brush component that is too big to spray. Such treatment may also be combined with a pre-commercial thinning of the conifers to space out the crop trees.

The percentage of harvested acreage treated by herbicides has decreased markedly over the past several years. This reduction is due to the use of imazapyr which (1) can be applied at an earlier stand age and (2) is more effective than a tank mix of 2,4-D and triclopyr (the herbicides it replaced) and thus eliminates the need for a second treatment.

Green Diamond envisions a future where herbicide treatments are needed a lot less to produce free-to-grow redwood stands. This future condition is the result of Green Diamond's commitment to plant high quality redwood clonal stock and seedlings on all sites that are capable of supporting redwood over the long-term. With redwood uniformly distributed throughout the harvest units of the future, much of the regeneration will be composed of redwood sprouts that will out-compete the brush and hardwood species typically found in north coast forests. The primary treatments needed in the future to produce high quality timber stands dominated by redwood will be precommercial thinning and commercial thinning. These thinnings will ensure that the growth potential of each unit is allocated to an optimal number of trees.

The IFM program discussed above usually results in well stocked, free-to-grow stands by age five. In fact, monitoring surveys[4] show that 88% of our redwood stands are free-to-grow by age five. Very few stands require additional treatments (beyond age five) to achieve free-to-grow status by age ten. Green Diamond's objective is to get 100% of its redwood stands in a free-to-grow condition by age ten. Vistas packed with trees are commonplace along Green Diamond's forest roads (see Figure 2).

[4] Green Diamond monitors every young stand at age 5. IFM foresters establish transects through each stand and measure the trees on 10 1/100-acre plots. These surveys help the IFM forester (1) assess the effectiveness of IFM treatments, (2) determine the need for additional treatments, and (3) estimate stand attributes for the company's inventory database.

Figure 2. This is a young stand on the BM-1300. Forest stands in this area are typically free-to-grow by age five and well stocked with redwood clones, Douglas-fir seedlings, and other coniferous species.

Recently Green Diamond surveyed 17 ten-year-old stands to obtain additional data to help calibrate the growth and yield model that is used to update the forest inventory and prepare long-term management plans.[5] The model Green Diamond uses is called FPS which is the acronym for the Forest Projection and Planning System. FPS is discussed in detail below. The diameter distribution from one of the ten-year-old stands is shown in Figure 3.

[5] The monitoring data that is collected on five-year-old stands does not include DBH information, only tree heights. To calibrate the FPS model we needed a data set that included DBH and height measurements on all trees. A decision was made to collect the data on ten-year-old stands because such stands would have a substantial number of trees that would be tall enough to have measureable breast height diameters.

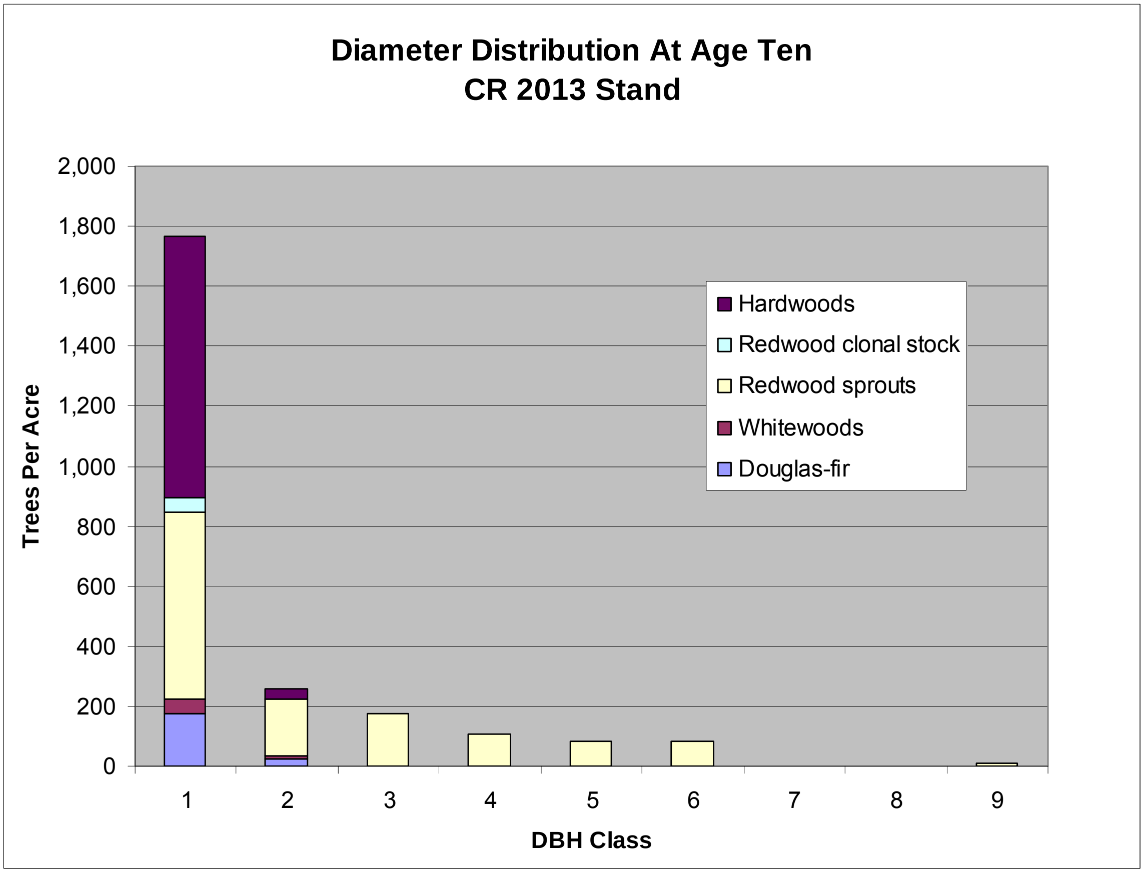

Figure 3. This chart shows the diameter distribution for a ten-year-old stand (covertype ID 821903) in the Little River tract just off the CR 2013 road.

The stand shown in Figure 3 is estimated to have 2,482 stems per acre with a diameter at breast height ("DBH") of 1 inch or greater. Over half of these stems are redwood sprouts (1,271 per acre) and 906 are hardwoods, primarily tanoak. The balance of the stocking is Douglas-fir, whitewoods (grand fir and western hemlock), and redwood clonal stock. It is noteworthy that this stand received <u>two</u> vegetation management treatments and still contains a significant number of hardwood stems in the 1 inch DBH class. In order to maximize the board foot yields from this stand at rotation age, Green Diamond pre-commercial thinned ("PCT") this unit in 2011. Unthinned, FPS estimates that the yield for this stand at age 50 will be about 41 MBF/acre. With the PCT treatment, FPS estimates that the yield will be 50% greater.

The plot data from the 17 ten-year-old stands show that the average density for this sample is 1,249 trees per acre (all species) over 1 inch in DBH. We are in the fortunate position of having exceptionally well stocked stands to manage for timber and other resources for decades to come based on the results obtained from our IFM program over the years. These data also demonstrate that Green Diamond's stands contain a wide variety of tree species and should not be characterized as "monocultures".

Growth and Yield Modeling

Green Diamond currently uses the Forest Projection and Planning System ("FPS"), developed by the Forest Biometrics Research Institute ("FBRI"), for inventory tracking and growth modeling. Green Diamond's California Timberlands Division has been a member of the FBRI since January, 2005.[6] FPS has been implemented for Green Diamond with a certified calibration library developed for us by Dr. James Arney, President and founder of the FBRI. The main features of this library that distinguish it from the standard FPS California Redwood Library are:

- Redwood is the index species, rather than Douglas-fir.
- Inclusion of old-growth redwood, old-growth Douglas-fir, and other old-growth whitewoods as separate species, which have been calibrated for zero growth.
- Inclusion of several generic species, notably 'other whitewoods' and 'other hardwoods', for compatibility with our legacy data.
- The default taper equations for redwood and Douglas-fir have been modified by Dr. Arney to duplicate the board-foot tree volumes as specified by the volume equations published in the Co-op Redwood Yield Research Project, Research Note No. 9. These were the same volume equations on which our proprietary growth and yield models were based.

When Green Diamond converted from the legacy proprietary growth and yield model to FPS in 2006, the company converted all legacy cruise data (some dating as far back as 1976) to FPS format, then grew all those cruised stands to December 31, 2005, using FPS. The resulting cruised inventory differed by only -0.1% (conifer and hardwood) from the inventory as grown using the legacy proprietary growth and yield models. The cruised conifer inventory decreased by 1.9% while the cruised hardwood inventory increased by 12.0%.

Uncruised stands were converted to FPS as they were represented in the legacy inventory system at the time of conversion, *i.e.*, as they were on December 31, 2005. These stands, as well as the cruised stands, are updated annually for growth using FPS. At the end of each year, we compare our inventory estimates (depletion) with production figures for each unit that was harvested. This comparison has been done annually since 1982. Over that time, total conifer depletion and production differ by less than one percent. This rigorous comparison is required under corporate policies governing financial accounting for depletion and forest management planning. Green Diamond will continue to make such comparisons on an annual basis in order to verify the accuracy of the inventory system.

As a further verification of the growth rates in the FPS library, Green Diamond provided FBRI with our legacy permanent-plot data, which had been the basis for calibration of our proprietary model. Approximately 500 1/5-acre plots were established across the

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[6] Green Diamond's Northwest Division, headquartered in Shelton, Washington, is also a member of FBRI. Additionally, Dr. Dan Opalach, Green Diamond's Timberlands Investment Manager, was elected to FBRI's Board of Directors in November 2010. Dr. Opalach is still on the Board and is serving as its Chairman.

ownership between 1969 and 1976 and remeasured every four years until 2005. FBRI used FPS to simulate the growth of these plots from their earliest measurements and compared the simulated to actual growth of individual trees. FBRI concluded that the current FBRI library did an excellent job of simulating actual growth, and that modifications to the library were not needed based on Green Diamond's legacy permanent plot data. FBRI also conducted comparisons of growth as projected by our legacy growth and yield model and by FPS, and found close agreement between the two.

In order to provide a better local calibration going forward, especially with respect to effects of clumpiness, Green Diamond, in consultation with FBRI, established 30 new permanent plots in 2006 and 2007, each 0.75 acre in size, distributed across the ownership and representing the full range of habitat types, stocking levels, and species compositions. Later in 2007, we began stem-mapping the plots, completing this process in 2008. Remeasurement of these plots will be conducted, as recommended by FBRI, when the height growth differential reaches 20 feet. Green Diamond intends to maintain these plots through multiple remeasurement cycles, updating the calibration of the FPS library after each set of remeasurements.

Long-Term Sustained Yield Based on Even-Aged Management

Green Diamond's even-aged management practices lead to increases in conifer harvest and growth (see Figure 4) and conifer inventory (see Figure 5) over the next 100 years. If Green Diamond were to implement selection management, harvest levels would decline precipitously (see Figure 6).

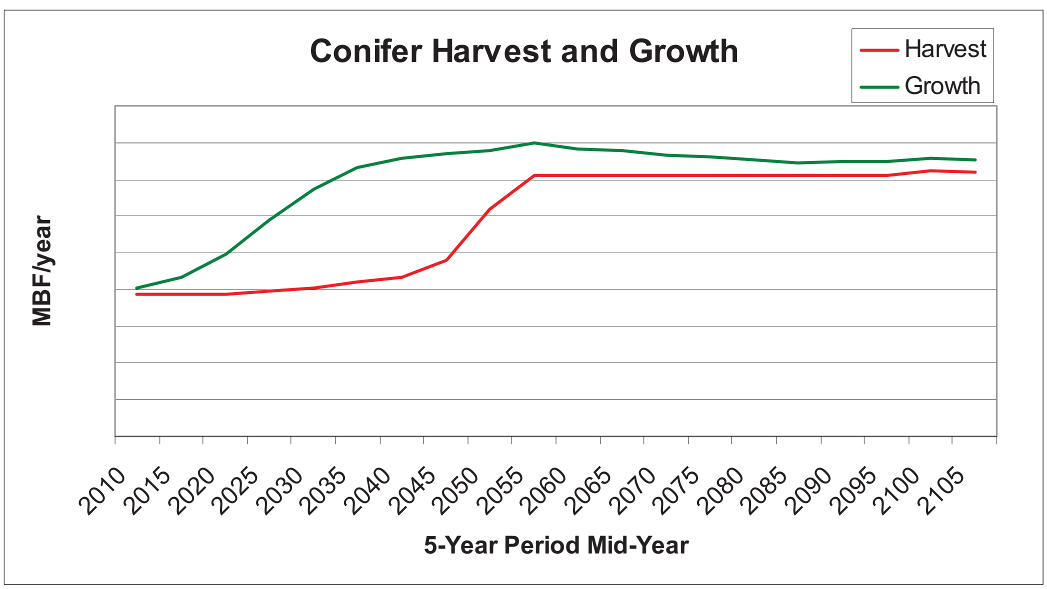

Figure 4. Conifer Harvest and Growth by 5-Year Periods, 2008-2107, as shown in Green Diamond's current Option (a) document which was approved in 2009. The Option (a) document is attached to every THP and is used to demonstrate compliance with certain sections in California's Forest Practice Rules.

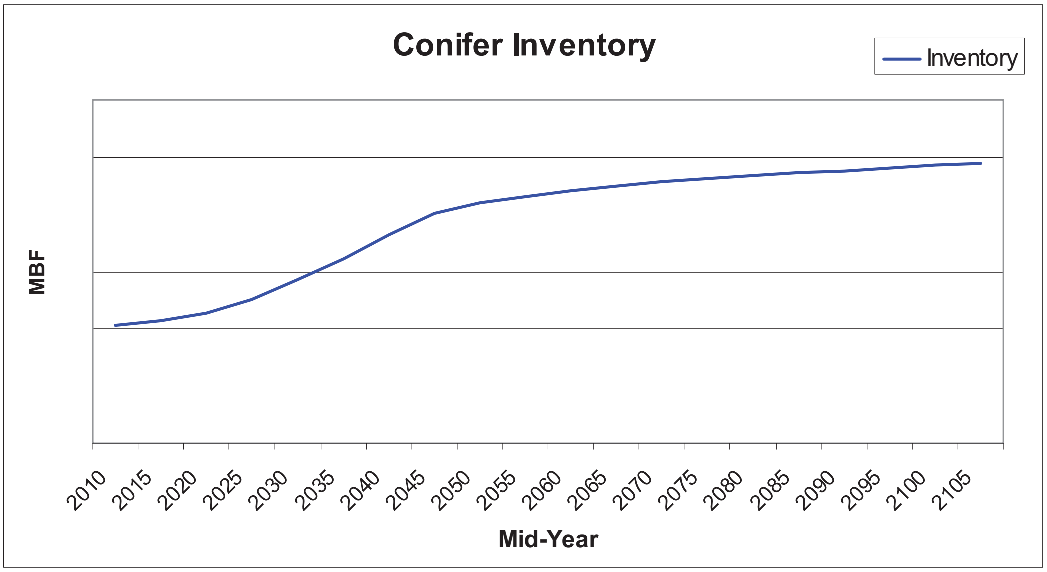

Figure 5. Conifer Inventory by 5-Year Periods, 2008-2107, as shown in Green Diamond's current Option (a) document.

Regime	Years 1 - 15 Avg Annual Harvest MMNLS	Years 16+ Avg Annual Harvest MMNLS
Clearcut	150	322
Commercial Thinning/Clear	212	281
Seed Tree	145	317
Variable Retention	143	310
Shelterwood	141	306
Selection	118	83

Figure 6. Selection management of Green Diamond's timberlands would result in reduced harvest levels. This analysis utilized the FPS long-term planning module to evaluate each of the regimes.

Review of the Literature

Redwood sprout regeneration is hampered by an overstory. Fritz (1951) was probably the first author to comment on this characteristic of redwood. To better appreciate the impact of an overstory on regeneration it will be instructive to compare the reproduction obtained with uneven-aged management and the reproduction obtained with even-aged management. Helms and Hipkin (1996) reported on the growth of redwood for ten years following treatment under various uneven-aged silvicultural methods. They reported that there were 209 trees (mostly stump sprouts) that grew into the two inch diameter class on 287 1/10-acre permanent plots.[7] That's equivalent to 7 trees per acre over the ten-year period. That's a very small amount compared to the average of 539 trees per acre that exceeded two inches in diameter on the 17 ten-year-old stands that Green Diamond recently surveyed (see above).

Lindquist (1996) also compared the redwood regeneration with no canopy versus a range of overstory levels from three studies on the Jackson State Demonstration Forest. A portion of his Table 4 is reproduced below:

Table 4. Average values for dominant and codominant trees at Whiskey Springs (20 years old) and Caspar Creek (19 years old).			
Treatment	Age (years)	Ave. Diameter (inches)	Ave. Height (feet)
Caspar Creek Clearcut	19	10.9	51.9
75% Overstory Removal Whiskey Springs	20	3.1	26.3
50% Overstory Removal Whiskey Springs	20	1.4	12.2

Lindquist summed up Table 4 by saying "*statistical analysis is not necessary to see differences at Whiskey Springs and Caspar Creek*." The data in the table show that the regeneration growing in the clearcut areas at Caspar Creek have diameters three times bigger and two times taller than the best regeneration growing in an understory at Whiskey Springs.

Results from other studies are consistent with those reported above. Adams et al. (1996) compared the growth rates of regeneration in uniform (single-tree) and group (1/4- to 4-acre clearcuts) selection silvicultural systems and found that the uniform system "*seems to lack the ability to assure the rapid growth of regeneration afforded under the group selection* (small clearcut) *system*." Barrett (1988) established treatment plots in stands

[7] A small number of these permanent plots were from uncut control areas (<10%). The paper did not contain enough information to sum up the ingrowth on the treated plots only. Hence the per acre figures shown above most likely understate the ingrowth on treated plots by a small amount. It's unfortunate that the Helms and Hipkin study site did not contain 100% overstory removal treatment blocks.

subjected to various levels of overstory removal and concluded "*the harvest system that provides the greatest sprout growth is the clearcut system*." Finally, O'Hara and Berrill (2009) said that "*redwood coppice systems require relatively severe overstory treatments to provide sufficient light for sprout vigor and growth*."

Several authors have reported that redwood seedlings do much better in full sunlight including Roy (1965), Boe (1975), and Olson et al. (1990). Green Diamond tested this relationship and verified that redwood seedlings grown in areas that had been clearcut outperform those grown in shaded environments (Figure 7).

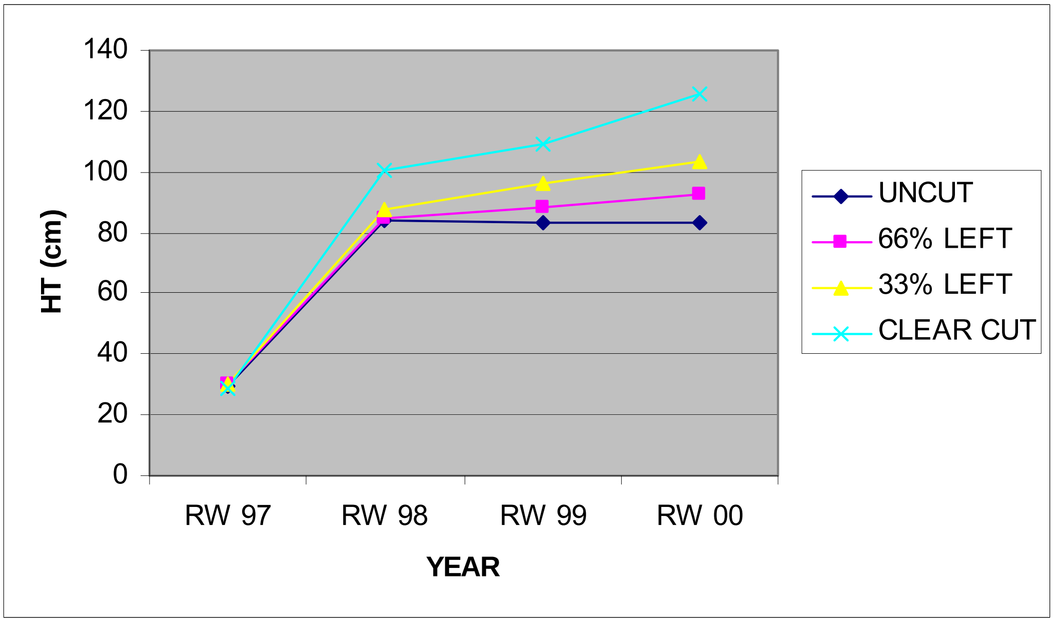

Figure 7. Results from a study on Green Diamond's timberlands by Dr. Bill Bigg. Redwood seedlings in the open grew substantially better than those in partial shade or uncut environments.

Olson et al. (1990) provide a physiological explanation as to why redwood grows so well in the open even though most researchers classify redwood as a tolerant species:

"Juvenile growth of redwood is best in full sunlight. Although redwood seedlings can endure heavy shade, growth there is slow. Photosynthetic capacity in redwood is remarkably high at low light intensities and keeps increasing as light intensity increases, much like more intolerant species."

FSC released a document that contains guidance with respect to interpreting Indicator 6.3.g.1.b (Forest Stewardship Council 2011). Most importantly it provides a definition for the term "vigorous":

Vigorous: *as used in the Indicator is intended to include consideration of fiber production, including economic and social considerations, but not to imply maximization of fiber production. Vigorous young stand development implies conditions where native tree species have access to the necessary light, water, and nutrients to grow sufficiently and maintain appropriate form class until the next entry. These conditions will vary by species and location.*

The weight of the literature indicates a substantial amount of sunlight is needed for redwood stands to develop vigorously. Although it's possible for redwoods to regenerate and survive in a stand that was partially harvested, such trees do not grow sufficiently to sustain long-term forest production at levels that approach those obtained by even-aged management. Perhaps the only outstanding question, therefore, from FSC's perspective, pertains to opening size. That is, what size clearcuts are needed to ensure that Green Diamond's young stands, which include redwood sprouts, natural regeneration, and artificial regeneration, develop over time in a manner that meets Green Diamond's objectives that include financial, social, environmental, and stewardship goals.

FSC Draft Guidance

FSC has prepared a document that provides applicants and auditors with guidance on how to achieve conformance with Part 1 of the Indicator (Forest Stewardship Council 2011):

Conformance with Part 1 of the Indicator should include:

1. *Consideration of regional silvicultural practices involving the same native species. In areas where ownerships of similar scale, commercial capacity, and site conditions are actively and successfully employing uneven-aged management for the species in question, the manager provides written and robust justification that even-aged management is required for regeneration or vigorous young-stand development. This justification includes comparisons of tree establishment and growth under even-aged and uneven-aged management.*
2. *Best available information and research on seedling/sprout survival, establishment, and growth of a young stand of native tree species.*
3. *Data from on-site, or local and equivalent, field trials measuring the relationship between management regimes (opening sizes) and survivorship and growth. These field trials may be ongoing and should be used to provide periodic feedback to management decisions. In the absence of valid and applicable data from off-site studies, on-site field trials are generally expected to be included as evidence.*
4. *Written documentation supporting conformance with the Indicator.*

Items 1, 2, and 4 were essentially covered in this paper. Item 3, however, would require that Green Diamond install field trials on its property to obtain the needed data. Such trials should be conducted with the assistance of a university professor who has expertise in the design and conduct of forest growth and yield experiments. Green Diamond is prepared to initiate this long-term study in 2013 with the objective of measuring the relationship between opening sizes and survivorship and growth of redwood sprouts and artificial regeneration.

Conclusion

Green Diamond has a long history of managing redwood and Douglas-fir using even-aged silviculture on the North Coast of California. Over the years, we have assembled a wealth of data, conducted analyses using growth models, and surveyed the literature regarding the survival, growth, and development of redwood and Douglas-fir in this region. Based on this information Green Diamond has concluded that redwood and the other species it manages require openings for vigorous young-stand development. The size of such openings could be determined by installing field trials on Green Diamond's timberlands in cooperation with a university researcher. Green Diamond is prepared to initiate such a research effort in 2013.

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Appendix E: Forest Chemicals and Methods of Application Currently Used by Green Diamond as Part of its Forest Management Activities

Forest Chemicals and Methods of Application Currently Used by Green Diamond as Part of Its Forest Management Activities

Chemical Trade Name	Application Type	Active Ingredient	Buffer Required?
Arsenal, Polaris AC, Polaris, Alliagre, Imazapyr 4SL	Applied by direct injection or hack & squirt to remove competing hardwoods and brush	Imazapyr	No
Chopper, Chopper Gen2, Polaris SP	Foliar applications; applied by hand. Used to control perennial broadleaf weeds.	Imazapyr	No
Garlon 4, Element 4 Tahoe 4	Foliar applications; applied by hand, aerially, and roadside. Used to control broadleaf weeds and brush.	Triclopyr BEE	Yes
Oust XP, Spyder, Sulfoment XP, SFM 75	Pre-emergent; applied by hand. Used for non-selective weed control. Applied to soils at extremely low rates and has moderate to low persistence. Also a foliar herbicide for Rubus sp.	Sulfometuron methyl	No
Transline	Pre-emergent/foliar; applied by hand. Used for broadleaf weed control.	Clopyralid	No
Moract, COC, Herbimax (adjuvant)	Foliar applications.	Crop Oil	No
Hasten	Foliar applications.	Oil + non-ionic surfactant	No
MOC, MSO (adjuvant)	Foliar applications.	Methylated seed oil	No
Colorfast Purple Dye	Added to herbicide mixes to track application coverage.	Proprietary	No

Appendix F: Response of Wildlife and Aquatic Resources to Even-Aged Management in Coastal Northern California

Response of Wildlife and Aquatic Resources to Even-Aged Management in Coastal Northern California

Lowell Diller, Ph.D., TWS Certified Wildlife Biologist

To achieve compliance with the FSC-US national standard, even-aged silviculture may not be employed unless certain conditions are met. Specifically, as described in Indicator 6.3.g.1.b, even-aged silviculture may be employed where: 1) native species require openings for regeneration or vigorous young-stand development, or 2) it restores the native species composition, or 3) it is needed to restore structural diversity in a landscape lacking openings while maintaining connectivity of older intact forests. To clarify "Part 3" of the indicator, the following draft guidance language was developed:

> *Where assessments (see below) indicate the historical existence of a distribution of openings within all or a portion of the assessment area and a current landscape lacking representative openings, managers can use even-aged silviculture to re-create openings in those areas. The resulting distribution of openings should be guided by considerations of historical natural disturbance regimes and maintenance of functional wildlife habitat for native species or maintenance of ecosystems of conservation concern, including HCVF. The intent is largely, but not exclusively, about restoration of habitat diversity to historical conditions.*
>
> *Conformance with Part 3 of the Indicator should include:*
>
> 1. *Assessments of natural disturbance regimes and associated distribution of openings at the watershed or planning unit level. Generally, the spatial scale of assessments should be within 10,000 – 20,000 acres.*
>
> 2. *Justification for the scale and configuration of the assessments. This should include consideration of the purpose of restoration and goals of restoring habitat heterogeneity (e.g. the suite of target species that benefit from habitat openings). Departures from the 10,000 – 20,000 acre size range are justified by ecological conditions or historic events.*
>
> 3. *A review of the assessment by independent qualified experts (e.g. wildlife biologists or landscape ecologists who are not biased because of past or present affiliations with the land owner/manager or other interested stakeholders) to confirm the findings. The adequacy of the assessment should be based upon the quality of input into the assessment, and may include expert opinion and literature.*

From an ecological prospective, Indicator 6.3.g.1.b Part 3 indicates that the prohibition of even-aged silviculture was established at least in part, because of the potential for even-aged silviculture to not mimic the pattern, form or frequency of historical disturbance regimes and thereby reduce the native species composition. Potentially this could occur because even-aged silviculture may create more, larger or less structurally diverse openings relative to historical openings. This would create a forested landscape lacking continuity, structural diversity and eliminate connectivity of older intact forests.

The following discussion addresses how Green Diamond Resource Company, California Operations has maintained native biodiversity, and how its primarily an even-aged management system compares to historical disturbance regimes. However, before launching into this discussion, it is essential to establish the extent to which Green Diamond has investigated and monitored the various terrestrial and aquatic resources that occur within its ownership.

Green Diamond has been engaged in numerous research and monitoring projects on their timberlands in coastal northern California for over two decades. The northern spotted owl (*Strix occidentalis caurina*) was the focus of the first studies initiated in 1990 on Green Diamond's (originally Simpson Timber Company) ownership. Intensive studies on spotted owls has continued with annual property-wide surveys, mark-recapture demography studies, two master's theses on habitat associations and a telemetry study to quantify nighttime activity. Since 2007, this work has been expanded to monitor the expansion of the barred owl (*Strix varia*) and its the interactions with spotted owl. Collectively, this work has resulted in the single largest mark-recapture dataset on spotted owls in existence (>1,800 captures and >4,000 capture/recapture events) and the data has been included in nine peer-reviewed scientific papers and reports.

Following the spotted owl, the terrestrial species most intensively studied on Green Diamond's ownership has been the dusky-footed woodrat (*Neotoma fuscipes*) with two master's theses on abundance and habitat associations, a study on their population response to commercial thinning versus clearcutting and property-wide population monitoring since 2004. Similar levels of work have been directed on the fisher (*Martes pennanti*) with two master's theses (habitat associations and population density) and four property-wide surveys. Other terrestrial wildlife species with extensive studies include the marbled murrelet (*Brachyramphus marmoratus*), black bear (*Ursus americanus*) red and Sonoma tree voles (*Arborimus longicaudus* and *A. pomo*) and Del Norte salamander (*Plethodon elongates*). Finally, species with less extensive monitoring include bald and golden eagles
Research and monitoring also has been conducted on aquatic systems since 1993. The initial focus was on coho and Chinook salmon (*Oncorhynchus kisutch* and *O. tshawytscha*), steelhead (*O. mykiss*), cutthroat trout (*O. clarki*) with annual monitoring of juvenile populations in key watersheds throughout the ownership. Monitoring of outmigrant smolt populations was added on selected streams in 1999. Among herptiles, the southern torrent salamander (*Rhyacotriton variegatus*) and coastal tailed frog (*Ascaphus truei*) were also extensively and intensively studied and monitored since 1993. Other herptiles less extensively monitored were the western pond turtle (*Clemmys marmorata*), northern red-legged frog (*Rana aurora aurora*) and foothill yellow-legged frog (Rana boylii). Green Diamond has also conducted extensive assessment and

monitoring of aquatic habitat and water quality on key fish bearing streams since 1993. In addition, since 2001, Green Diamond has done complete floristic surveys as part of all timber harvest plans. There has also been extensive forestry related research on Green Diamond's ownership, but that work is covered in a separate discussion.

In addition to all the studies directly supported by Green Diamond or conducted "in-house" with the company's large biological staff, the company has engaged in over 15 cooperative studies with various academic and federal scientists. Examples of these cooperative studies of terrestrial wildlife species include the following:

- Marten (*Martes americana*) distribution and habitat associations (USDA Forest Service, Pacific SW Research Station and Department of Wildlife, Oregon State University)
- Mountain lion (*Puma concolor*) habitat and movements (Department of Wildlife, Humboldt State University, Department of Wildlife, University of Idaho)
- Use of residual structure by forest bats (USDA Forest Service, Pacific SW Research Station)
- Passerine abundance and composition in forest stands (Department of Wildlife, Humboldt State University)
- Olive-sided flycatcher (*Contopus cooperi*) habitat associations (Department of Wildlife, Humboldt State University)
- Varied thrush (*Ixoreus* naevius) nesting ecology (Department of Wildlife, Humboldt State University)
- Water economy in two species of plethodontid salamanders (Department of Wildlife, Humboldt State University)

Incidental to other designed surveys and as part of timber harvest assessments, Green Diamond's biological and trained forestry staff have also collected property-wide data for the past 20+ years on the distribution and relative abundance of a variety of species. Data were collected for wildlife species such as the peregrine falcon (*Falco peregrinus*), bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), osprey (*Pandion haliaetus*), northern goshawk (*Accipiter gentilis*), Cooper's hawk (*Accipiter cooperii*), sharp-shinned hawk (*Accipiter striatus*), flammulated owl (*Otus flammeolus*), Vaux's swift (*Chaetura vauxi*), great blue heron (*Ardea herodias*) rookeries and a variety of amphibian and reptile species. In summary, we believe this property is unprecedented in terms of the number and extent of the studies and monitoring on a large industrial ownership. In addition to the conservation plans described below, the studies and monitoring have lead to over 30 scientific publications and master's theses. Possibly only a few experimental forests such as the 16,000 acre H. J. Andrews Experiment Forest in the Oregon Cascades have been more intensively studied.

Collectively, most of the studies and monitoring have either been used for the development of, or as part of long term monitoring for multiple conservation plans. The first plan was a habitat conservation plan (HCP) for northern spotted owls developed with the US Fish and Wildlife Service and implemented in 1992. This was followed in 2005 with a Deadwood Management Plan that was developed in cooperation with California Department of Fish and Game. In 2007, a second HCP covering six listed or sensitive aquatic species with dual jurisdictions was developed with and approved by the US Fish and Wildlife Service and National Marine Fisheries Service. The floristic surveys led to a Sensitive Plant Conservation Plan in 2005 that was developed in cooperation with California Department of Fish and Game, and in 2009, the department also approved an incidental take permit for the Trinity bristle snail that includes special conservation measures and monitoring. Finally, a new forest HCP (FHCP) is near completion with an anticipated signing in 2013. The FHCP will include updated conservation measures for the spotted owl including management of the barred owl threat and it will also cover the fisher and two species of tree voles.

All of these studies along with published scientific reports have allowed us to characterize species into the following basic tiers on Green Diamond's ownership:

1. *Compatible with or dependent on even-aged timber management:*
   Species in this category include those that select early seral stages or require openings, and therefore readily utilize stands regenerated from even-aged management. This group also includes species that select mid successional (pole to mature stands) forests, but they are compatible with even-aged management because they have the ability to readily recolonize managed forests (e.g., Cooper's and sharp-shinned hawks and many Passerine birds)

2. *Generally believed to be incompatible with even-aged timber management, but able to be sustained with special harvest prescriptions or mitigation:*
   Species in this group include those that either because of special habitat requirements or limited ability to recolonize areas have the potential to be reduced or completely eliminated from a managed landscape.

3. *Incompatible with timber management with no known mitigation possible:*
   This group currently only includes the marbled murrelet which is only known to persist in unmanaged old growth forests.

Species that belong in the first category require no special attention during timber harvest planning and may actually be more abundant in an even-aged management system. For example, bird species such as the olive-sided flycatcher and purple martin require openings for their perches or roosts and benefit by the openings created by even-aged management. Passerine birds benefitting from even-aged management is not an anomaly, a graduate study on Green Diamond's ownership documented that landbirds had the greatest diversity and abundance in stands <20 years relative to mature second growth and old growth stands in Redwood National Park (Hazard and George 1999). This result was consistent with a regional study that showed bird abundance and richness increased with increased levels of disturbance in highly productive west-side systems in the Pacific Northwest (McWethy et al. 2009). However, McWethy et al. (2009) showed the reverse pattern relative to disturbance and bird abundance and richness in less productive east-side systems, which illustrate the need to evaluate disturbance on a site-specific basis.

We do not have site-specific data on overall small mammal response to even-aged management, but there have been several studies done on the dusky-footed woodrats, the primary prey for the northern spotted owl and fisher in this region. This important prey species was found to be most abundant in young stands <20yrs (Hamm 1995 and Hughes 2005), which relates to the significance of habitat heterogeneity as described in more detail below.

It is the second category of species for which Green Diamond's management must be most critically assessed relative to the FSC even-aged management indicator noted above. Probably the most telling assessment of Green Diamond's success relative to this group is simply the distribution and abundance of these species that are generally not associated with managed forests. Despite the fact that the landscape consists mostly of second and third growth forests, the summation of the extensive studies and monitoring have demonstrated a high diversity and abundance of wildlife and fish that occur on Green Diamond's ownership in California. Possibly the most noteworthy are spotted owls and fishers because these are species that are generally thought to be associated with old growth or late seral forests (USFWS 1990; Courtney et al. 2004; Powell and Zielinski, 1994; Carroll et al., 1999; Zielinski et al., 2004). The estimated density of spotted owls is the highest reported in the scientific literature (Diller and Thome 1999) and fisher densities were estimated to be equivalent to the highest reported in North America (Thompson 2008). Tree voles also are generally believed to be associated with mature and old growth forests (Meiselman and Doyle 1996; Dunk and Hawley 2009), but their unique adaptations and life history characteristics have thwarted attempts to characterize their population dynamics. We have documented that tree voles can be locally abundant (Thompson and Diller 2002) and analysis of spotted owl food habits indicated that tree voles were well distributed, but highly variable across Green Diamond's ownership (unpublished report).

In addition to the well-known mature and old growth associated wildlife species described above, there are lesser known amphibian species purported to be associated with late seral and old growth coniferous forests in the Pacific Northwest. The Del Norte salamander, a terrestrial species associated with rocky substrates and two headwater amphibian species, the southern torrent salamander and coastal tailed frog, have all been described as being primarily associated with mature and old growth forests (Carey, 1989; Welsh, 1990; Welsh and Lind, 1991; Bury and Corn 1988; Corn and Bury 1989). All of these amphibian species have been shown to be well distributed and abundant on Green Diamond's ownership (Diller and Wallace 1994; Diller and Wallace 1996; and Diller and

Wallace 1999). All of the salmonid species that occur in the region (i.e., coho and Chinook salmon, steelhead and cutthroat trout) are also thought to be sensitive to even-aged timber harvest and most abundant in streams in undisturbed mature and old growth forests. The numerous fish surveys on Green Diamond's ownership revealed that all the historical salmonid streams continue to support populations of these fishes and several of the streams have runs of the federally and state listed coho salmon that are equivalent to some of the best runs anywhere in California (Green Diamond, Aquatic Habitat Conservation Plan 2011 Biennial Report).

This abundance of wildlife and fish raises the obvious question of why this would occur on Green Diamond's ownership when so many other studies have demonstrated that these same species are rare or absent from managed forests and in particular those that are managed using even-aged silviculture. To answer this apparent contradiction, we need to examine what these purported late seral or old growth associated species require that is typically missing or in limited supply in forests managed using even-aged silviculture. A key conclusion from our own studies along with numerous studies on other landscapes indicates the importance of late seral habitat elements for the terrestrial species such as spotted owls and fishers. These late seral elements include large diameter snags and green wildlife trees with cavities and other types of decadence. These same green wildlife trees and snags eventually are recruited as downed logs and coarse woody debris, which are also important to some late seral wildlife species. In addition to late seral habitat elements, structural complexity in terms of the stand layers (i.e., shrub, intermediate canopy and overstory canopy) and the diversity of tree species is important. In particular, conifer stands with a mix of hardwood species tend to be important to selected species of wildlife.

With repeated rotations using even-aged management, it seems likely that the late seral habitat elements and stand diversity would be lost or severely reduced. The fact that this has generally not occurred on Green Diamond's ownership is partly due to the logging history and partly due to current conservation planning efforts. One key factor that led to the initial retention of older habitat elements on Green Diamond's land was the change of merchantability standards over the years. When the original harvesting of the old growth stands occurred, numerous individual trees exhibited undesirable defects such as large fire scares, extensive rot indicators and overall decadency. At the time of original harvest, these trees had little or no economic value and therefore were left on the landscape. In addition, individual or groups of old growth trees were left on the landscape due to the feasibility or cost of extraction using older harvesting equipment. Finally, many large old growth trees were left on the landscape simply because they were too dangerous or difficult to fall. These and other factors led to the retention of individual "legacy trees" across the landscape, which numerous studies have shown to provide critical structure for many species of wildlife. Having demonstrated the value of this legacy or residual structure, Green Diamond has developed multiple conservation plans that target this structure for retention. This started with the spotted owl HCP in 1992 and was followed by the development of the Terrestrial Deadwood Management Plan in 1999. This plan for retention and recruitment of late seral habitat elements (large green wildlife trees and snags) has been revised to better conserve habitat elements for fishers and tree voles and will be included as a conservation element of the FHCP. The approval of the aquatic HCP (AHCP) in 2007 was particularly important, because it will result in preserving approximately 25% of the ownership in riparian and geologic reserves that will develop into late seral stands.

The fact that Green Diamond's managed stands are not simplified "monocultures", but tend to contain a diversity of conifer and hardwood species is mostly an attribute of the tree species richness that occurs in this area. In particular, there are a variety of evergreen hardwood species such as tanoak, (*Lithocarpus densiflorus*), California bay (*Umbellularia californica*), and Pacific madrone (*Arbutus menziesii*) that exhibit coppice growth making them virtually impossible to eliminate from conifer stands. The result is that stands developing from even-aged silviculture tend to show high structural and species diversity in a manner similar to the attributes of late seral forests. The managed stands on Green Diamond's ownership simply do not show the typical monoculture look of many plantations associated with even-aged silviculture in other regions in the Northwest. Finally, the mild climate, abundant rain and rich soils in coastal California lead to very high primary productivity and stands that are only 30-40 years old can already show attributes of a mature forest stand.

In addition to the important structural characteristics of forest stands on Green Diamond's ownership, there is an important species, the dusky-footed woodrat, which could be termed a "keystone species" because it has a large impact on the abundance of important late seral species in the region. As noted before, the dusky-footed woodrat tends to be associated with early seral shrub and pole-staged stands and they can reach high densities (i.e., represent a high amount of total biomass) in these stands (Sakai and Noon 1993, Hamm 1995, and Hughes 2005). To sustain a mosaic of early seral stands within a forest environment, it is necessary to create openings through some form of stand-replacing disturbance. Historically, this was produced by natural disturbance events, primarily fire, which has been replaced largely by even-aged management.

As noted earlier, the northern spotted owl and fisher have adapted to take advantage of this abundant prey species. The northern spotted owl was listed in 1990 primarily due to loss of old growth habitat on which it was assumed to depend (USFWS 1990). Throughout much of its range in Washington and Oregon, the owl roosts and nests in older forests and feeds primarily on flying squirrels that are also found most abundantly in older forests (Courtney et al. 2004). In areas where spotted owls feed primarily on flying squirrels, suitable habitat requires relatively large tracts of old forests. However, as noted above, the highest reported densities of northern spotted owls occurred in what was described as "highly fragmented" forests on Green Diamond's ownership in coastal California (Diller and Thome 1999). Similar high owl densities were reported in forests with a history of even-aged management to the east in the Hoopa Reservation (Higley, pers. comm.) and Willow Creek Study Area (Franklin et al. 1990). Initially, this appeared to be a contradiction with the studies previously done in Oregon and Washington, but it was soon discovered that the dusky-footed woodrat was responsible for this apparent contradiction.

Understanding the difference in the primary prey of the northern spotted owl provided a logical explanation for why forest landscapes with frequent openings leading to apparent forest fragmentation might be unsuitable for spotted owls in one region and beneficial in another. The spotted owl still roosts and nests in older forests in coastal California, but its primary prey is found in young forests. Long-term demographic studies of spotted owls using mark-recapture data have shown that a mosaic of young and older forests (termed “habitat heterogeneity”) is critical to maintaining spotted owls in this portion of their range (Franklin et al. 2000; Diller et al. 2010; M. Higley, pers. comm.). Given that fire has largely been eliminated from managed forests in the redwood region, creating openings through even-aged management is a critical element of maintaining habitat for spotted owls.

Although it is now well established that habitat heterogeneity is beneficial where the northern spotted owl’s range overlaps the range of the dusky-footed woodrat (Klamath Province in southern Oregon southward along the California coast), there has been little work on the effects of selection harvesting versus even age management in this region. However, Green Diamond acquired a large tract of timberlands in the Little River Drainage that had been subjected to extensive thinnings for approximately 20 years. This provided the opportunity for a retrospective study on the impact of thinning versus clearcut harvesting on woodrat abundance. The study involved trapping woodrats in young stands regenerating from clearcuts and stands with various levels of thinning. The conclusion was that woodrats did not colonize stands until they reached a level of thinning that was equivalent to clearcutting standards in California (Hamm and Diller, 2009).

The key to providing woodrat habitat appears to be having sufficient sunlight to promote the growth of early seral plant species that are fed on by woodrats. Under lower light levels associated with thinnings, the unpalatable shade tolerant shrub species such as salal (*Gaultheria shallon*), evergreen huckleberry (*Vaccinium ovatum*) and Pacific rhododendron (*Rhododendron macrophyllum*)) persist. In this portion of their range, our data indicate that spotted owls are not only compatible with even-age management as practiced by Green Diamond, but high quality habitat capable of maintaining a viable population only occurs in areas where creation of openings through even-aged management maintains habitat heterogeneity (Diller et al. 2010). This phenomenon may change in more southern portions of the spotted owl’s range in coastal California (e.g., southern Humboldt and Mendocino Counties), which has a warmer and dryer climate. Although there have been no published studies, anecdotal observations on managed timberlands in Mendocino County indicate the woodrats are found in thinned stands (R. Douglas, pers. comm.), but this observation has not been confirmed with any designed studies.

Historically, stand-replacing wildfires presumably were the primary mechanism that maintained varying amounts of early seral stands that supported a variety of early seral-associated species such as the dusky-footed woodrat in coastal California. While it may not apply to the redwood region in California, it was estimated that over the last 3,000 years in the Oregon coastal forests, the proportion of old growth forests at the province scale varied from 25-75%, but the variation increased at the smaller watershed scale from 0-100% (Wimberly et al. 2000).

We are unaware of any estimates of the historical levels of old growth versus early seral stands in coastal California, but pre-European natural disturbance in redwood forests was characterized as frequent but predominantly of low to moderate severity and extent, and resulting in uneven-aged forest (Lorimer et al. 2009). However, the fire history and ecology of the redwoods does not accurately characterize the impact of fire and other disturbance factors in the coastal redwood region, because the predominately redwood forests generally only occur in the fog influenced low elevation areas near the coast and in the stream and river valleys. The higher elevation ridges that parallel the river valleys and interdigitate with and fragment the redwood forests give way to predominately Douglas-fir and hardwoods. On many of the south-facing slopes generally above 2,000 feet, the conifer forests are replaced by oak-prairie woodlands. These non-redwood ridges that are typically oriented northwest to southeast experience the seasonal extremes more typical of interior locations. From north to south in coastal California, the extent of these oak-prairie woodlands increases and their proximity to the coast decreases. In the northern portion of Green Diamond’s ownership in Del Norte County the non-redwood ridges reach to within 5-8 miles of the coast (Figure 1), but south of the Eel River Drainage, prairie ridges extend all the way to the river valleys and the coast (Figure 2).

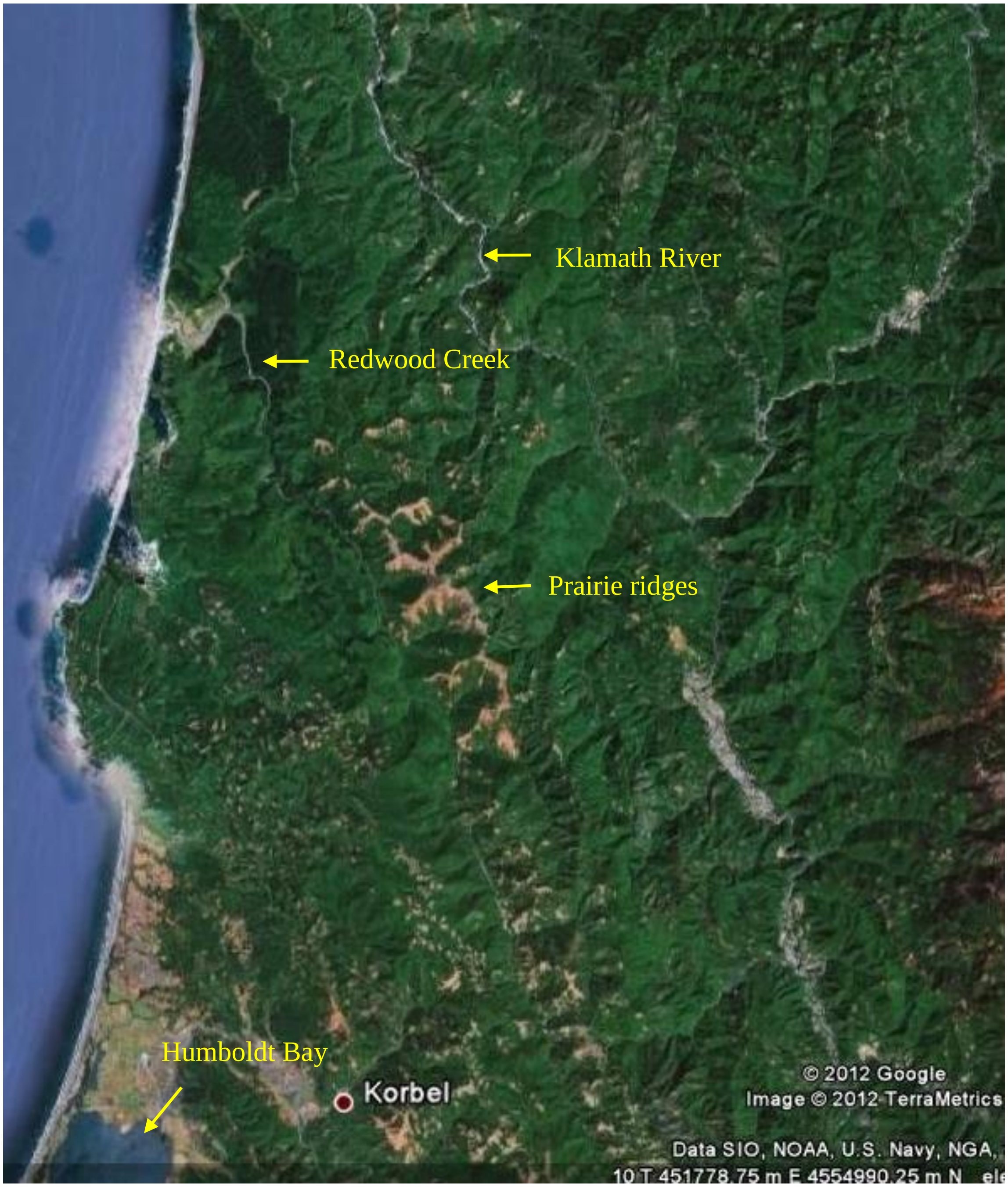

Figure 1. Google Earth view of the landscape from Humboldt Bay north to the Lower Klamath River. Note the prairies and oak woodlands along the ridge east of Redwood Creek.

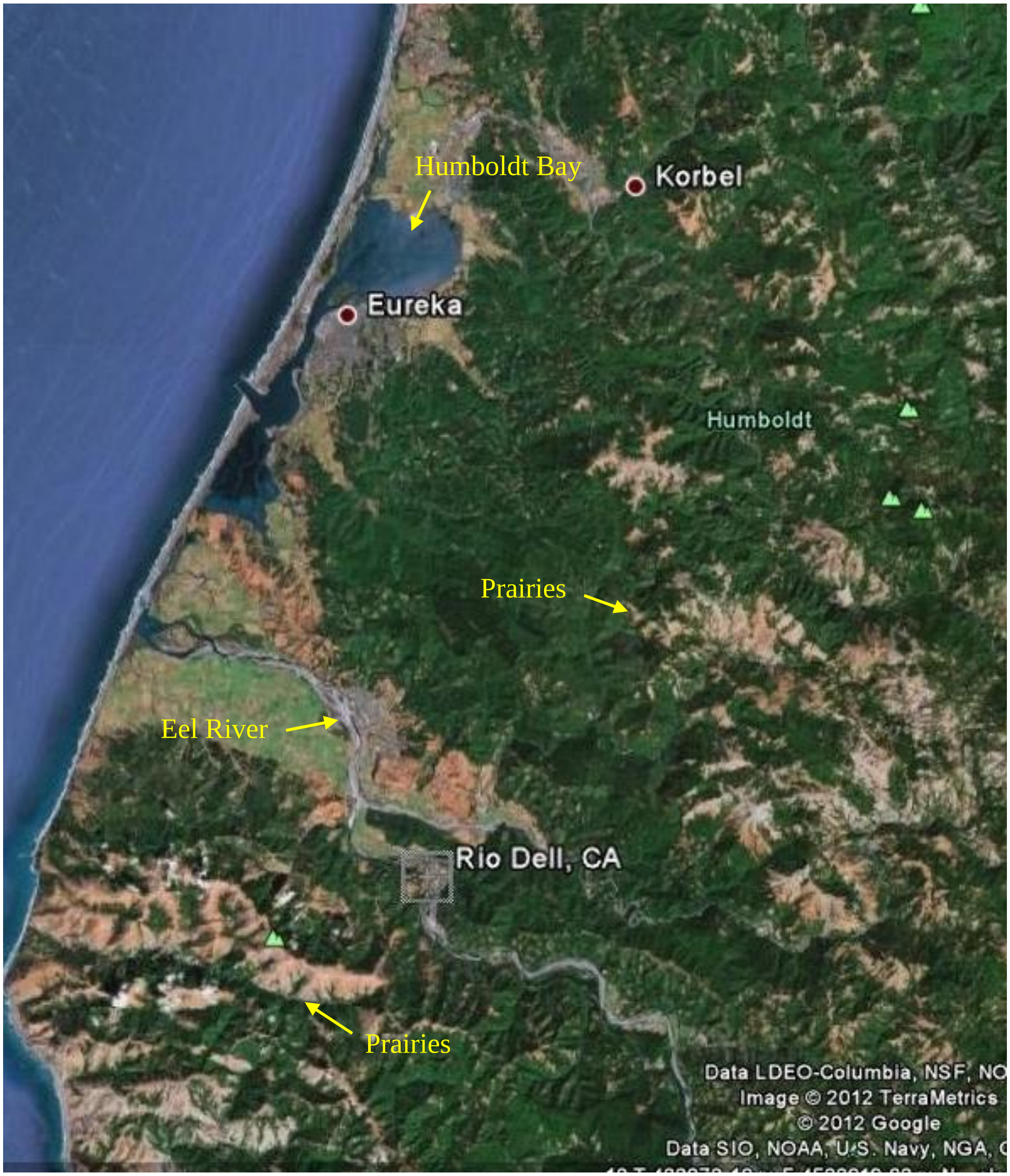

Figure 2. Google Earth view of the landscape from Humboldt Bay south to the Lower Eel River Drainage. Note the extensive prairies and oak woodlands throughout the area including ridges that extend to the coast southwest of the Eel River Drainage.

The coastal prairies that occur primarily on the ridges and south-facing slopes in the redwood region are part of the California coast grassland that was ranked as one of the most endangered ecosystems in America (Noss and Peters 1995). It is generally believed that fire was the primary mechanism to create and maintain the oak-prairie woodlands. According to the Redwood National and State Parks Fire Management Plan (2010), fires were set in northwestern California by American Indians to increase acorn production, providing basketry materials and to encourage new growth of grasses and browse favored by deer and elk. European settlers that came into the area after 1850 also set fires to create pastures for livestock and to encourage growth of browse for elk. When fire suppression became a national policy and priority in the 1930s, ecological conditions were fundamentally changed and Douglas-fir forests began replacing the oak-prairie woodlands. Although we are unaware of any regional quantification, anecdotal observations by numerous foresters and biologists have noted substantial changes in recent decades in the amount of openings associated with prairies and oak woodlands. Redwood National and State Parks is using prescribed burns and selective removal of Douglas-fir stands in an attempt to restore and maintain this vital ecosystem.

Stephens and Fry (2005) hypothesized that the frequent anthropogenic fires ignited in surrounding grasslands or oak savannahs were also responsible for fire in the coast redwood trees. Some prairie fires would naturally extinguish themselves because of the differing fire environments at the coast redwood ecotone and only a subset of those fires burned through the redwood forest. As noted above, this probably resulted in frequent but predominantly low to moderate severity fires in the redwood forests, but some these same prairie fires likely resulted in some stand replacing fires in the higher elevation Douglas-fir forests. These fires likely created a highly dynamic ecotone between prairies, Douglas-firs and redwood forests, which would have been the primary source of early seral forests. Over time with climatic changes in wet and dry cycles, the ecotones surrounding the ridgelines presumably also waxed and waned with varying amounts of early seral forests. With the exclusion of wild fire from this ecosystem, not only are natural openings associated with prairies and oak woodlands being lost, but of equal importance, the process that generated early seral forests has been lost.

In summary, except for the low elevation coastal strip, the redwood region was historically highly fragmented by a high density of ridges with open prairies, woodlands and Douglas-fir forests separating stream and river with old growth redwood forests. Presumably, it was in these highly dynamic areas associated with ridges and south-facing slopes where spotted owls evolved this relationship with dusky-footed woodrats and selection for areas with high habitat heterogeneity. Although fishers tend to utilize a more diverse prey base than spotted owls, coastal California is the only region in which woodrats constitute a major portion of the fisher’s diet (K. Slauson, unpublished report). Similar to the spotted owl, there is a high density of fishers on Green Diamond’s ownership, which is likely at least partially due to their relationship with woodrats in this historically structurally diverse region.

As noted above, the value of habitat heterogeneity is not limited to the structurally diverse redwood region, but extends inland to the western portion of the Klamath Province. This illustrates that the adaptations shown by purported late seral associated species such as the northern spotted owl and fisher occur over a much larger scale than the redwood region. We know from Green Diamond's mark-recapture study over the last 22 years that juvenile spotted owls readily disperse to and from Green Diamond's ownership to the Eel River drainage to the south, north into southern Oregon and to the Hoopa and Willow Creek study areas to the east. Clearly, the local breeding population of spotted owls extends over millions of acres. A study of the genetic structure of spotted owls confirmed genetic exchange throughout coastal California and the Klamath Province including haplotypes from the California spotted owl in individuals on Green Diamond's ownership (Haig et al. 2004). This would suggest that spotted owls in this region are not adapted to local conditions, but exist as a population that encompasses millions of acres in southern Oregon and northern California.

We do not have the extensive mark-recapture data for fishers, but presumably their abilities to disperse are much more limited than a bird that can readily fly over ground barriers such as large rivers and non-forest habitats. However, we have documented a fisher moving from Hoopa to Green Diamond land. Presumably, there are no barriers for genetic exchange within the coastal redwood region and western Klamath Province and a locally adapted population of fishers would encompass all the coastal river drainages from southern Oregon to the Eel River.

Spotted owls and fishers are two species with large home ranges that would be unlikely to have unique adaptations associated with redwood forests, but are there less vagile species that may be uniquely adapted to redwood forests? Although the possibility exists for some uniquely adapted undiscovered non-vertebrate species, there are no known vertebrate species or sub-species that are unique to redwood forests. The purported Humboldt marten subspecies (*Martes americana humboldtensis*) is the closest to being considered a redwood forest specialist, but the genetic data do not support it being distinct from coastal martens in Oregon and the historical range of the subspecies extends into the western Klamath Province. This lack of species uniquely adapted to the redwood forests provides strong evidence for the dynamic and structurally diverse nature of the redwood region and indicates that conservation assessments should include the entire redwood region and adjacent western Klamath Province.

Although there are no data available to quantify the extent to which historical disturbance events such as wildfire created and maintained prairie openings and early seral stands, we can reasonably assume that these historical openings and early seral forests varied dramatically both spatially and temporally. The high variability in natural systems illustrates the arbitrary nature of our current definitions of silvicultural systems. Various types of timber harvesting characterized as uneven-aged silviculture from single tree selection to the maximum opening size for group selection are assumed to provide a diversity of tree sizes and ages for various forest wildlife species. Above an arbitrary opening size, the silvicultural prescription is characterized as "even-aged" and the concern is that a diversity of trees of different size and age will not have available wildlife. However, this is a function of the mobility of the wildlife species in question and not the arbitrary limits on the size of openings. For example, spotted owls and fishers have large home ranges and can move about rapidly so that Green Diamond's ownership with its small maximum clearcut size and a very high density of watercourses with substantial riparian retention would not be perceived as "even-aged." In contrast, from the perspective of a Trinity bristle snail, single tree selection may essentially create an "even-aged" home range. Although Green Diamond's predominate silvicultural prescription is defined by California's forest practice rules as even-aged, we believe that it is effectively uneven-aged at the landscape level relative to most of the species of conservation concern. For those species with more limited vagility and sensitivity to timber harvest such as some of the amphibian species, the extensive riparian reserves have been demonstrated to meet their habitat needs.

At the landscape level, we believe Green Diamond's application of even-aged silviculture actually provides for greater habitat and structural diversity than application of an uneven-aged silvicultural prescription such as individual tree selection. The two pictures below of recent timber harvesting illustrate this point. The picture on the left (Figure 3.A) is of an "uneven-aged" selection harvest, which if applied extensively across the landscape would result in within stand diversity, but very little stand diversity at the landscape level. This same landscape would be perpetuated indefinitely with repeated entries at intervals of approximately 10-15 years. In contrast, the "even-aged" harvesting on the right (Figure 3.B) may result in little diversity in tree ages at a small scale (<10-20 acres), but at the landscape level, the small clearcuts, riparian reserves and retention of tree clumps within harvest units will provide for much greater overall diversity.

Figure 3. Picture of a selection harvest (A) in a second growth redwood forest near Humboldt Bay and a mosaic of even-aged harvest units (B) in the Little River watershed.

The current application of even-aged harvesting has been evolving on Green Diamond's ownership over just the last 20+ years, and as a consequence, we do not have examples of how this silvicultural management will look in the future at the end of a typical rotation within a given sub-basin. The picture of even-aged silviculture (Figure 3.B) may give the impression that the future landscape will be dominated by young seral stages. However, the future managed landscapes created on Green Diamond's ownerships can be predicted by areas of current focused harvesting (Figure 4). At the initiation of the next rotation in approximately 30 years, this sub-basin will be covered by stands regenerated from former harvest units that will be mostly 30-50 years old. Within these stands will be a complex matrix of extensive riparian areas and retention areas (approximately 25%) that will be 80-100 years old. At that point in the future, this particular sub-basin will be a continuously forested area with stands of variable age, while other sub-basins across the ownership will be in the active harvesting stage as pictured below(Figure 4). This process will be repeated across time and space with harvest units continuing to be harvested at the appropriate site-specific rotation age, but the riparian and retention areas will continue to age relative to the harvest units.

Figure 4. LiDAR imagery of the vegetation layer in the Maple Creek watershed. Extensive even-age timber harvesting was initiated in this area in 1999 and it is currently the sub-basin within Green Diamond's ownership with the highest rate of harvest.

The synthesis of the studies of various wildlife species on Green Diamond's ownership also demonstrates the importance of fundamental ecological processes. Natural disturbances of various types (i.e., fires of different intensities, windstorms, floods, disease outbreaks, etc.) have always been part of all forest ecosystems and these disturbances have produced a variety of different seral stages and stand conditions within forested landscapes on both temporal and spatial scales. Species are adapted for these variable conditions in different ways so that there have always been "winners" and "losers" depending on stochastic natural disturbance regimes. This same ecological principle applies equally to human managed systems in that disturbing a forest, or attempting to hold it static, results in some species that benefit (i.e., become more numerous and widespread) and others that are disadvantaged or even locally extirpated. This means there is no single "right way" to manage forests to benefit all terrestrial and aquatic species and natural biodiversity within a region is only maintained through diversity of forest conditions.

The regional relationship between spotted owls, fishers and woodrats also illustrates the importance of site-specific research and monitoring to establish the most appropriate silvicultural system in any given region to maintain selected species of conservation concern. However, we also need to address the larger context of the biodiversity within the entire north coastal region of California. A major portion of Green Diamond's ownership is situated between Redwood National and State Parks on the west and US Forest Service land on the east. Both of these public land bases have substantial areas of old growth and the management plans for both areas will lead to additional old growth in the future. With the possible exception of a rare major stand-replacing wildfire, potentially these areas will be losing much of their openings necessary to create habitat heterogeneity (seral stage diversity), and along with it, some of their biodiversity. Although the old growth along the coast will likely be poor habitat for spotted owls and fishers, it will continue to play a vital role in providing habitat for species of critical conservation concerns such as the marbled murrelet, which as noted above, is not compatible with any type of forest management. The old growth forests of the parks and Forest Service may also play a key role in the recovery of coastal (Humboldt) martens, which may not be able to persist on a managed landscape that has high densities of fishers, a strong competitor/predator of the marten.

Therefore it is our conclusion that when the region is considered in its entirety, Green Diamond with its unique version of even-aged silviculture will maintain a vital link that is required to maintain the native biodiversity of the region. Openings and early seral forests that were historically maintained on ridges and south-facing slopes within the redwood region will gradually be lost, but they will be replaced by a dynamic mosaic of openings on Green Diamond's ownership. While this will represent a westward shift in some areas in the pattern of openings and early seral forests relative to historical patterns, Green Diamond will help maintain the native biodiversity of the region through its application of even-aged management. In essence, the process of frequent fires associated with prairies that maintained openings and early seral forests has been lost and has been replaced by even-aged management that retains high amounts of late seral elements. We therefore strongly believe that the application of our management practices meet the requirement of (as described in Indicator 6.3.g.1.b Part 3) "restores the native species composition" for both vegetation and wildlife, and "is needed to restore structural diversity in a landscape lacking openings while maintaining connectivity of older intact forests."

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