Condition and Management of the Vegetation at the Sea Ranch

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Executive Summary

This report evaluates the current condition and management of the vegetation at the Sea Ranch. It contrasts the current vegetation conditions with those reported in an analysis of vegetation completed in 1991. Specific attention in the report is given to (1) Vegetation Management along the Coastal Bluffs, (2) Forest Health, (3) Windthrow, (4) Effectiveness of Vegetation Management Activities, (5) Guidelines for Tree Removal in Forested Areas, and (6) Management of the Timber Production Zone.

The contrast of vegetation conditions in 1991 with the present conditions indicates the mosaic of vegetation types has remained relatively stable. Some grassland areas have been invaded by baccharis and some areas of Bishop pine and Monterey pine have died as a result of extreme weather conditions and changes in local levels of the water table. Windthrow has also accounted for the loss of forest cover in areas of Grand fir.

Monterey cypress trees established along the coastal bluffs have been effective in controlling the erosion of surface soil and sand deposits; however, the undermining of the consolidated rocks beneath the surface deposits continues the natural process of coastal bluff erosion. Monitoring of Monterey cypress along the bluff should be continued to avoid situations where undermined trees will fall into the ocean pulling out large masses of soil.

The health of the redwood/Douglas-fir forest has remained good over the 21 years between the original study and the present. Individual stands of Bishop pine and Monterey pine plantations have not faired as well. Periods of above normal temperature and below normal precipitation have stressed the trees resulting in mortality. Mortality has also been associated with years of above normal precipitation, which raised the level of the water table at some locations. The relatively short life span of these species is also a factor in their declining health.

Windthrow was significant in areas of saturation prone soil that supported Grand fir trees in the interval from 1991 to 2012. Areas of high windthrow potential have been mapped and guidelines for tree removal in these areas have been established.

The vegetation management program of the Sea Ranch has been very effective in maintaining the vegetation. Thinning of pine plantations and fuel management activities in the plantations has been effective both in reducing fire hazard and in sustaining forest health. Hedgerow maintenance and replacement planting activities have been appropriate. Grazing to maintain meadow areas has been effective where applied. Some

meadows that have not been grazed have succeeded to baccharis and lupine. Decisions concerning future grazing of specific meadows should be based on the impact of baccharis and lupine on views and the habitat values of these species. Management of the riparian zones has been very effective in preventing bank erosion. Willows and wax myrtle in some riparian zones on the coastal terrace have expanded since 1991. Pruning back of particular areas of these riparian shrubs will be necessary to maintain views.

Tree removal continues to be an issue at the Sea Ranch. It involves the impacts trees have on views, potential for wind thrown tree falling on structures, fire hazard associated with trees near structures, value of trees for screening, wildlife habitat value, and the maintenance of the landscape character of the Sea Ranch. All of these factors should be considered in decisions to remove trees. In many cases the thinning of tree canopies can provide a balanced compromise. The current permitting procedure for tree removal should be maintained.

A portion of the forestland at the Sea Ranch has been set aside under the California Timber Production Zone program. This program was established to protect timberland from development in order to insure future supplies of timber. A survey of trees growing in the Central Timber Production Zone at the Sea Ranch indicated the potential for a sustained harvest of approximately 2,000,000 board feet of timber every 12 years. It is recommended that a timber harvest plan be prepared for harvesting 30% of the merchantable volume every 10 years. This volume of timber could be harvested using the single tree selection method in perpetuity. The pros and cons of harvesting are discussed in the report.

Specific recommendations for the management of the vegetation at the Sea Ranch are summarized and prioritized in the concluding sections of the report. Management activities are prioritized on the basis human safety and the maintenance of the landscape character of the Sea Ranch. Time periods for prioritization are annual, 3 to 5 years, 5 to 10 years, and 10 to 20 years.

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Introduction

This report examines the condition and management of the vegetation at the Sea Ranch. It specifically address the vegetation along the coastal bluffs and its management, forest health, the problem of windthrow, efficacy of specific vegetation management activities (e.g., hedgerow management and replacement, grazing to control brush succession in meadows), guidelines for tree removal in forested areas, and future management alternatives for that portion of the Sea Ranch within the California Timber Production Zone. Recommendations for future management of the vegetation at the Sea Ranch are presented in the summary of recommendations section of this report.

Background of the Vegetation and its Management

The original vegetation of the Sea Ranch consisted of brushlands and perennial grasslands on the coastal terrace, and conifer forests on the upper slopes. The brushlands were dominated by bush lupine (*Lupinus arboreus*) and baccharis (*Baccharis pilularis*). Several species of perennial grass, such as Pacific hairgrass (*Deschampsia holciformis*), Pacific reedgrass (*Calamagrostis nutkaensis*) and California fescue (*Festuca californica*), were common in the grasslands. Species of sedge (*Carex*) and rush (*Juncus*) occurred in wet areas on the terrace, while arroyo willow (*Salix lasiolepis*) and Pacific wax myrtle (*Myrica californica*) lined the creeks crossing the coastal terrace. The conifer forest above the coastal terrace varied in species composition with areas of pure redwood (*Sequoia semperivens*), mixed redwood and Douglas-fir (*Pseudotsuga menziesii*), stands of nearly pure grand fir (*Abies grandis*), and areas of bishop pine (*Pinus muricata*). Riparian zones within the conifer forests supported red alder (*Alnus rubra*), arroyo willow, and Pacific wax myrtle at lower elevations, while conifer species occurred in the riparian zones at higher elevations. Meadows existed within the conifer forests on the older terraces. These supported perennial grass species, such as purple needle grass (*Nesella pulchra*), Idaho fescue (*Festuca idahoensis*), pine bluegrass (*Poa scabrella*), and California oatgrass (*Danthonia californica*).

The pattern of vegetation observed by the first white settlers had been maintained by Native American burning. Recent research (Hopkinson, 2005; Keeley, 2005) suggests that Native American burning of brush dominated areas as early as 4000 years ago expanded grasslands along the Central California coast. The Native Americans also

burned certain areas of the conifer forests to enhance hunting success and stimulate berry production (Anderson, 2006). Periodic burning of the forest reduced tree density and removed ground fuel accumulations.

Evett (2000) investigated the history of the vegetation on the coastal terraces at the Sea Ranch. He concluded, based on his analysis of phytoliths (microscopic, glass-like remains of plant cells which remain in the soil), that areas of Baywood soil supported grasslands for millennia prior to the arrival Europeans to the area, while the Rohnerville soil supported Bishop pine forests prior to the arrival of the Native Americans. These forests were converted to grasslands by Native American burning.

Early European/American settlement of the Sea Ranch area started in 1845 when Ernst Rufus was given a provisional land grant from the Mexican government. He acquired the land for cattle grazing. Rufus' provisional land grant was subsequently acquired by a German immigrant, William Bihler, and became known as the German Rancho. In addition to the cattle Rufus had introduced to the areas, Bihler brought in horses and hogs. Portions of the coastal terrace grasslands were used for vegetable, orchard and grain production. Logging of the redwoods in the conifer forests started in 1880 along with the harvesting of tanoak (*Lithocarpus densiflora*) bark for tanning leather. Sheep were introduced to what is now the Sea Ranch during the First World War and replaced cattle ranching around 1921.

In 1916 the first hedgerows of Monterey cypress were planted on the coastal terrace to provide windbreaks and to divide the land into 24 "ranchettes" of approximately 200 to 250 acres each. Sheep grazing was the primary use on the grassland areas until the ranch was sold for the development in 1965. During this period the hedgerows were periodically topped to stimulate lateral branching. The tops that were removed were generally dumped over the coastal bluffs to reduce erosion. Monterey cypress trees were also planted at some locations to control the erosion of the bluffs. Grazing of the coastal terrace grasslands and the grasslands in the conifer forest zone resulted in a transition of native perennial grasses to European annual species, although many native grasses still persist today. The stumps of the harvested redwoods sprouted to produce the second growth stands now found in the upland areas.

During the development of the Sea Ranch in the 1960s additional hedgerows and stands of Monterey, bishop and shore pine (*Pinus contorta*) were planted. Due to the elimination of grazing baccharis, lupine, and wax myrtle spread into the grasslands on the coastal terrace. Roads that were built and lots that were opened to accommodate development in the conifer forest resulted in windthrow of trees at certain locations. Along the edge of the coastal bluffs Monterey cypress trees were undercut by wave action and fell into the ocean.

Concern over several aspects of the vegetation by the Sea Ranch Association led to the preparation of a vegetation management report in 1991 (McBride and Gerhard, 1991). This report divided the vegetation into a coastal terrace zone and an upland zone

and addressed issues of vegetation management. These included (1) forest health, (2) maintenance and replanting of hedgerows, (3) wind damage in the conifer forests, (4) crown thinning and tree topping, (5) coastal bluff protection planting, (6) riparian zone maintenance, (7) management of bishop pine stands and (7) invasion of coastal terrace grasslands by shrub species. Various recommendations for vegetation management proposed in the 1991 plan have been adopted. An evaluation of the effectiveness of those management activities and recommendations for future management of the vegetation is presented in this report.

Vegetation Management along the Coastal Bluffs

Vegetation management along the coastal bluffs must address issues of bluff erosion, sand dune stabilization, views to the ocean, bluff trail use, and wind protection. The present vegetation along the bluffs is a mixture of planted conifer species (Monterey cypress, Monterey pine, bishop pine, shore pine) and natural plant communities. These natural communities include coastal brushlands (baccharis, lupine, wax myrtle) and grasslands (Table 1).

Erosion of the coastal bluff is a natural process that depends in large part on the local geology and topography. The bluffs along the margin of the Sea Ranch reach heights of 30 feet or more and have been formed by erosion of the German Rancho Formation (Paleocene), Gualala Formation (Cretaceous), Black Point Basalt (Cretaceous), and Pleistocene alluvial and marine deposits. These formations vary greatly in their resistance to erosion. The poorly consolidated Pleistocene terrace deposits and the soft shales in the Gualala Formation are most easily eroded. The Black Point Basalt is moderately resistant to erosion, while the sandstones and conglomerates of the German Rancho and Gualala Formations are highly resistant, forming the headlands and points along the bluff. Additionally, the numerous faults, which intersect the coastline, create narrow easily erodible zones, regardless of the original rock type.

Konigsmark (1998) reported bluff erosion of more than 2 feet at 12 locations as a result of 1997/98 winter storms. He measured coastal bluff erosion at 32 sites at the Sea Ranch following the 1997/98 winter storms and calculated bluff erosion rates from 1" to 6"/year (Table 2). Nine percent of the sites of bluff erosion during the winter of 1997/98 supported Monterey cypress, 16% coastal shrubs, 16% coastal scrub/grass, and 59% grassland.

Monterey Cypress Coastal Bluff Protection Sites

The planting of Monterey cypress and the dumping of the tops pruned from the hedgerows by the ranchers was effective in protecting portions of the bluffs from erosion. The roots of Monterey cypress trees hold the soil while the branches and foliage protect the soil from direct wave impact during winter storms. The trees do not, however, protect the bluff from being undermined by wave action and falling into the sea below. Konigsmark examined three sites supporting Monterey cypress in his 1998 report. Only at one of these did he observe trees having fallen due to the collapse of the bluffs. Eight coastal bluff sites, examined in the 1991 Sea Ranch Vegetation Management Plan, where Monterey cypress was established to protect the bluffs from erosion were re-examined in 2012 for this report (Table 3, Map 1). The sites showed little change with regard to the stability of the Monterey cypress. Although some trees were perilously close to the edge of the bluffs, they had not been undermined to the point of falling. Some trees had been removed in an effort to avoid their falling and pulling out large volumes of soil and rock from the bluffs. Other trees had been topped to reduce the chance of being toppled by the wind. All trees appeared vigorous and healthy.

A Google Earth image of a portion of the coastal bluff adjacent to Sounding and Solstice show areas of erosion following the 1997/98 winter storms. The eroded areas were identified in the Konigsmark report as having slow to moderate rates of erosion. The erosion occurred in sections of the coastal bluffs supporting grassland (Konigsmark's site Solstice A) and coastal scrub (Konigsmark's site Sounding B). An area of the bluff planted with Monterey cypress separates the two sites. No coastal bluff erosion occurred where the ranchers had planted Monterey cypress. It is concluded that Monterey cypress stands along the bluffs continue to be effective in preventing coastal bluff erosion.

There are some sites where the undermining of the coastal bluffs will eventually lead to the collapse, but it is very difficult to predict when that might occur. Maintaining the existing plantings will protect the softer deposits on the tops of the terrace from being eroded by overland flow, especially if the blanket of Monterey cypress branches and foliage draping down the bluff face is maintained. A report prepared in 2008 (McBride) suggested the removal and replanting of the 53 Monterey cypress stands along the coastal bluffs over a period of 50 years. This proposal is supported by the field observations made for the current report. However, replacement of existing Monterey cypress stands should only take place where older stands have lost their erosion control function. This

function will be lost when trees begin to die or their branches blanketing the upper portions of the bluffs die back.

The softer, unconsolidated deposits on the bluffs above the hard rock currently appear to be protected from erosion at some locations by the exotic species sea fig. Erosion can occur beneath the cover of sea fig and its value for erosion protection is in question. Sea fig is very competitive with native species and capable of replacing large areas of native plants. Efforts should be made to remove sea fig from the coastal bluffs sites and replant with native species. Sea fig should not be planted at new locations at the Sea Ranch.

Sand Dune Erosion Control Sites

Areas of sand dunes occur in a few locations on the coastal terrace adjacent to the coastal bluffs. These dunes have experienced blowouts during high velocity windstorms. Blowouts are areas on the dunes where the wind strips away scant areas of vegetative cover and moves the sand. Blowouts can start a process of inland migration of the dunes. The ranchers were aware of this process and were successful in controlling the spread of the dune into adjacent grassland by planting Monterey cypress and in some cases, where water tables were high, arroyo willow. An example of the "blow-out/dune migration" problem and its can be observed south of 'Walk-on-Beach'. Recently the Monterey cypress trees were removed from this site and bush lupines planted along with additional plantings of arroyo willow in wetter areas. This modification has been successful in continuing to control dune migration.

Aesthetics and Ocean Views

The visual quality of the coastal terrace is enhanced by the presence of the Monterey cypress stands that were planted for coastal bluff protection. These stands provide a visual contrast in both form and color to the grasslands and shrub communities. They visually punctuate the edge of the coastal terrace. At their irregular intervals they break up the monotony of the edge.

However, some Monterey cypress stands along the bluffs block the view of the ocean for some houses at the Sea Ranch. This situation has led to requests for tree removal of certain trees or stands by homeowners. The conflict between preserving the erosion control value of the Monterey cypress stands and providing views for adjacent landowners must be resolved carefully. Resolution of this conflict can be achieved in some locations by the opening of view corridors, crown thinning to provide filtered views of the ocean, or topping of trees. Decisions on the type of treatment, if any, should be based on observations from decks or windows of the particular houses adjacent to the Monterey cypress stands and the erosion potential of the coastal bluffs. Konigsmark's

(1998) report on the rate of erosion and the type of rock at a given location should be an initial guide for making decisions about removal of specific stands. Existing stands that occur on sites with higher rates of erosion should be preserved.

Thinning of lower branches is not a recommended technique for providing views as it leads to top-heavy trees. These are more likely to be toppled in high velocity winds. Topping of existing stands will provide the best solution where the elevation of adjacent houses is high enough to allow home owners to see over trees once they have been topped. Topping of Monterey cypress increases the density of the foliage by stimulating sprouting. The more compact trees offer more resistance to the wind and give better protection to the softer sediments at the top of the coastal bluffs.

Bluff Trail Use and Wind Protection

The bluff trail provides an exceptional opportunity for residents and visitors to the Sea Ranch to enjoy a close proximity to the ocean. The views from the bluff trail are truly outstanding. On the north end of the Sea Ranch, the original Public Access portion of the bluff trail was constructed on the "Commons", but due to coastal bluff erosion in some grassland areas, it has fallen or partially fallen into the ocean. At these locations the trail now crosses out of the public easement onto private common area, and is posted with informational signs to protect private rights to the commons. Fences have been built to prevent trail users from falling off the bluffs where bluff erosion has taken out the existing trail or has come close to the trail. The process of coastal bluff erosion will continue at these sites unless it can be arrested by erosion control planting or engineered structures.

The 1991 Sea Ranch Vegetation Management Report presented plans for gabions and walls to combat the erosion problem. For various reasons the use of gabions was not adopted for the protection of the upper portions of the bluff. They should be reconsidered as appropriate for specific locations where the bluff trail has been lost to erosion. Gabions will be effective only where the erosion of the bluff is due to overland flow or the undermining of the softer material at the top of the bluffs by seepage at the contact between soft and hard rock. Gabions and wall would be problematic and very costly where the bluff trail is being lost due to the undermining of bluffs by ocean waves.

Monterey cypress stands along the bluff trail provide important relief from the wind as one hikes along the trail. They also provide a visual contrast to the grassland. Some Monterey cypress stands along the bluff have grown over the trail in such a fashion as to leave a tunnel-like passage way through the stand. These tunnels add considerable diversity to the experience of hiking along the bluffs. Consideration of these values should be weighed in any decision about removal of the bluff stands of Monterey cypress.

The vigorous growth of Monterey cypress branches requires pruning to prevent some sections of the bluff trail from being physically blocked. Hikers and runners have

created by-pass sections of the bluff trail to avoid these branches. Periodic pruning of these branches every year or so will be required to keep the existing trails open.

Forest Health

The maintenance of a healthy forest was a priority identified in the 1991 Sea Ranch Vegetation Management Plan. Healthy forests function as ecosystems and provide habitat for a variety of animal species. Healthy forest stands have lower windthrow potential and are less hazardous in terms of fire.

Natural forests are not without insects and pathogens. These serve important roles in the maintenance of forest stands to accelerate the demise of trees weakened by stress factors and thus can be important agents in controlling tree density and forest succession. Forest insects assist the mineral cycling process by their mastication of tree leaves, which produces small fragments that are more readily broken down by microbes. Carbon cycling often begins in the heartwood of forest trees long before trees fall to the ground. Heart wood rotting fungi break down cellulose within the heartwood decades before a tree is significantly, structurally- weakened.

These normal roles of insects and pathogens can, however, become serious problems affecting forest productivity and the safety of people using the forest under certain circumstances. Environmental stress factors (such as drought or extended periods of hot weather), competition between individual trees for limited resources, changes in the depth to water table, aging of trees, and mechanical injuries to trees can lead to above normal insect and pathogen activity. Environmental stress alone can be responsible for tree mortality, but it is often a factor that predisposes trees to attacks by insects and

pathogens. Where trees are stressed for prolonged periods of time the overall health of a forest stand may decline and individual tree mortality ensue.

Previous investigations of the coniferous forests at Sea Ranch revealed that the overall health of the forest was good, and pathogens and insect populations were at endemic levels. Recently, small, isolated pockets of mortality of bishop pine, Monterey pine, shore pine, and Monterey cypress have occurred. This mortality could be related to changes in precipitation and temperature during the last two decades. Climatic data at Ft. Ross and Santa Rosa, California have been recorded from 1895 and 1902 respectively. Unfortunately long-term data is not available for the Sea Ranch; however, data from Ft. Ross and Santa Rosa do parallel average annual precipitation data recently collected (2001 to 2011) at the Sea Ranch.

Average annual precipitation is 40.85" at Ft. Ross and 30.34" at Santa Rosa. An average annual precipitation of 40.96" was recorded at the Sea Ranch from 2001 to 2011. At both Ft. Ross and Santa Rosa the annual precipitation was significantly above the long-term average in 1995 and 1996 and significantly below the long-term average from 1988 to 1990 (Table 4). The average maximum monthly temperatures in Santa Rosa were significantly higher from 2001 to 2004. Unfortunately, temperature data for these years was incomplete at Ft. Ross and not available for the Sea Ranch.

The consecutive years of significantly above normal precipitation (1995 and 1996) would have resulted in a raised water table and possibly a shift in below ground flow patterns initiating the decline in Monterey pine trees adjacent to the Moonraker Recreation Center. The consecutive years of significantly below normal precipitation (1989 to 1990) would have stressed trees throughout the Sea Ranch. The above normal temperature from 2001 to 2003 would have also contributed to tree stress and possibly exacerbated insect and pathogen problems.

The aging of trees and forest stands at the Sea Ranch should also be considered as a possible explanation for the recent mortality observed in bishop pine and Monterey pine. Both species are relatively short-lived trees, with average life expectancy of bishop pine from 80 to 100 years and Monterey pine from 80 to 90 years (NRCS, 2009). The oldest Monterey pines planted at the Sea Ranch are approaching 50 years of age and as a result are becoming more susceptible to insect and disease problems. The age of natural stands of bishop pines on the Sea Ranch is unknown, but many of the trees in these stands were present prior to the development of the Sea Ranch. Sholar (2012) has attributed the mortality of bishop pines along the coast of Sonoma and Mendocino counties primarily to trees having reached their life expectancy.

A visual survey from Highway 1 was conducted in 2007 by Lacan and McBride (2007) and was repeated in 2012. In the initial survey, a wide occurrence of branch mortality was observed, but overall tree mortality was low. In the follow up survey in 2012, there were fewer trees exhibiting branch mortality while overall tree mortality remained low. It may be that the higher incidence of forest health problems observed in 2007 were related to significantly higher temperature experienced in northern California

from 2001 to 2004. Tree stress during this period could have predisposed trees to insects and pathogens in the subsequent years. Northern California has not experienced significantly higher than average maximum temperature in recent years.

Several experts on forest health have visited the Sea Ranch in recent years to examine specific areas of tree mortality. They have been helpful in identifying insects and pathogens associated with the death of trees, but have not in all situations been able to identify a specific insect or pathogen responsible for the mortality. Dan Stark, an expert in tree insect and disease problems, was invited to examine all of the previously examined areas on the Sea Ranch where mortality has occurred in recent years. His observations and recommendations concerning forest health are presented in Appendix 1 (Forest Health at the Sea Ranch). Stark's general conclusion on forest health at the Sea Ranch may be summarized as follows:

(1) The overall health of the forest is good.
(2) Trees are generally vigorous and do not exhibit characteristics associated with stress or the presence of insects and pathogens.
(3) Tree age may be an important factor in the mortality of Monterey pine and bishop pine; however, some mortality sites visited exhibited evidence of high water tables that would have stressed the trees.
(4) The presence of Monterey cypress canker suggests periods of above normal temperatures and low fog frequency. We can expect further infections of Monterey cypress by the canker if these conditions reoccur at the Sea Ranch.
(5) Vigilance and quick removal of trees in decline are the best measures for combating forest health problems involving a few trees.

Windthrow

The coastal location of the Sea Ranch exposes the structures and vegetation to high wind velocities, especially during winter storms. Record wind velocities at Pt. Arena, about 25 miles north of the Sea Ranch, have exceeded 100 mph. The force of such winds has toppled trees and broken tree trunks and branches. Severe storms have caused extensive blowdown and tree damage in the Fly Cloud and Pilots Reach areas of the ranch.

A 1999 report identified areas of high windthrow potential at the Sea Ranch (McBride, 1999) using the multiple overlay method developed by McHarg (1966). Surveys of the areas identified as having high windthrow potential revealed a history of windthrow in the forests prior to the development of the Sea Ranch. These areas remain vulnerable because of soil type, topographic position, and tree species. The windthrow problem can be exacerbated where trees are exposed to the direct force of the wind as a result of openings made in the forest for houses, roads, and views to the ocean.

Recommendations for addressing the windthrow problem were submitted in a letter report by the author in 2003 (McBride, 2003). These may be summarized as follows:

1. Designation of sites of high windthrow potential

2. Pre-construction evaluation of windthrow potential
3. Marking of trees for removal prior to construction
4. Marking trees for height and canopy reduction
5. Preparation of a tree removal and individual tree height and canopy reduction plan
6. Approval of the plan by the Sea Ranch Design Committee
7. Inspection and Monitoring

Examination of sites where these recommendations have been applied since 2003 showed they have been effective in protecting structures from wind thrown trees.

One other aspect of the recommendations made in the 2003 report was the suggestion for topping trees to reduce the "wind sail" and thereby reduce the windthrow potential. Although this technique has been effective, it has led to tree mortality, especially in grand fir, Douglas-fir, and bishop pine trees. Therefore it is no longer recommend for either Grand fir or Douglas-fir. Tree topping has not resulted in tree mortality in redwood trees and Monterey cypress trees and should be continued as a means of reducing windthrow in these species.

Crown thinning has been effective and has not led to tree mortality when kept within the prescribed limits (<20% of canopy, evenly distributed). It should be continued as a technique to reduce windthrow and wind breakage in all conifer species at the Sea Ranch.

Permission has been granted for the removal of trees adjacent to houses in areas of high windthrow potential. The permission required that replanting of trees of shorter stature (that will not endanger structures) and shrubs be done to restore that forest habitat in these areas. Some areas where trees were removed have been replanted following the guidelines developed by Roberts and McBride (2005). These guidelines should be followed in the replanting of trees in areas of high windthrow potential. In replanting these areas trees of shorter stature at maturity (e.g., wax myrtle, shore pine, madrone) should be used be used and they should not be planted within a striking distance of a structure should they be toppled in the wind.

Effectiveness of Vegetation Management

Several vegetation management activities were initiated following the 1991 Vegetation Management report. These management activities include tree thinning in the conifer plantations, hedgerow management and replacement, grazing to control brush invasion of meadows, and riparian zone management. These are addressed in the following sections.

Management of Conifer Plantations

A number of plantations of Monterey pine and Bishop pine were planted by the developers of the Sea Ranch to define boundaries between future neighborhoods, screen property from the airport, control erosion, and screen houses from the highway. Ten of these plantations (Map 2: Monterey pine; Map 3: Bishop pine) were examined and their conditions are summarized in Table 5 and Table 6.

Trees in the Monterey pine plantations were generally in poor condition, especially the older trees. One plantation (adjacent to the Moonraker Recreation Center) was completely dead due to a rise in the water table. The fire hazard in these plantations was generally low due to understory maintenance to reduce surface fuel loads and eliminate fire ladders. Regeneration of Monterey pine trees was occurring in all of the surviving plantations.

The Bishop pine plantations examined were in good condition where they had been thinned and surface fuels managed. Those plantations that had not been thinned nor managed for surface fuels exhibited accumulations of surface fuels and developing fuel ladders. The understories of these stands did not show regeneration by Bishop pine, but were supporting native shrubs, sword fern, tanoaks, and grand fir.

Both Monterey pine and Bishop pine are considered to be short-lived species, which become over mature at about 80 to 100 years of age. Over mature trees are subject to limb breakage and are less resistant to insects and pathogens. The conifer plantations at

the Sea Ranch date from the 1960s, putting them at about 50 years of age. One can expect to see increasing problems of windthrow, fire hazard, and tree mortality, as these plantations grow older. Where the conifer plantations have been thinned these problems have been somewhat abated, especially in the Bishop pine plantations. Bishop pine is native to the Sea Ranch and that accounts for the better conditions observed in Bishop pine plantations. Thinning and surface fuel maintenance should be continued in the Bishop pine plantations with an eye toward the eventual succession of these plantations to tanoak and/or fir. Thinning practices should identify and nurture individual tanoaks and fir trees within the Bishop pine plantations that will be replacements for the Bishop pine trees.

Monterey pine is not native to the Sea Ranch and plantations of this species have not faired as well. The current study supports the recommendation for the elimination of Monterey pine plantations that was presented in the 1991. Re-examination of the Monterey pine plantations initially surveyed for the 1991 report support this recommendation because of fire hazard, tree fall hazard, and increasing maintenance costs.

Hedgerow Management

The historic hedgerows planted initially by the ranchers in 1916 and augmented by the developers in the 1960s vary in their condition. The Monterey cypress hedgerows occurring at the Sea Ranch were examined in September 2011 (Table 7; Map 1). These hedgerows are generally in good condition. Limb breakage continues to be a problem in some of the hedgerows, suppressed trees have died, and a few sections of hedgerows exhibited mortality of individual canopy trees and/or sections of adjacent trees (Hedgerows # 1, 2, 3, 10, 16).

Fuel accumulations have resulted from wind breakage of limbs and branches that have fallen to the ground within the hedgerows or may be still attached to trees and in contact with the ground. This latter condition provides a fuel ladder for ground fires to climb into the canopy. Fire hazard associated with each fuel break was ranked as high, moderate, or low. Only three hedgerows were ranked as having high fire hazard (Hedgerows 7, 8, 9), three in the moderate fire hazard class (6, 17, 21), and the remainder were considered to have a low fire hazard. It should be pointed out that fire risk is very low in the western portions of the hedgerows due to fog frequency in the summer. Management of ground fuels and fuel ladder in these sections of the hedgerows should be considered a lower priority than addressing fuel management in other parts of the Sea Ranch.

Natural regeneration of Monterey cypress was not observed within any of the hedgerows and only in areas adjacent to six of the hedgerows (4, 3, 7, 8, 9, 10). Natural establishment of Monterey pine was observed in three of the hedgerows (15, 18, 19).

Monterey cypress trees have been planted along side or in gaps in portions of 13 of the hedgerows (Table 7) as part of the replacement program suggested in the 1991 report. In 2011, these trees ranged in height from 6 to 18 feet, depending on the number of years since they were planted. Where necessary they have been protected by wind screens and all have been watered during the first two or more summers after planting. The methods used by the Sea Ranch in planting and early tree care have been very successful and should be continued.

These replacement plantings were established on the leeward side of the existing windbreaks, with the exception of trees that were planted in existing hedgerow gaps. The hedgerows are protecting the plantings from the full force of the wind. When the trees in the hedgerows are cut down, the replacement trees will be exposed to the wind. It is recommended that the hedgerows adjacent to replacement plantings be pruned up to a height of 20 to 30 feet from the ground to allow passage of the wind beneath the tree canopies, once the replacement trees reach a height of 10 to 20 feet. This will expose the trees to the wind before they grow too tall and will help the new trees to adjust to the wind. As the lateral branches of replacement trees grow under the canopies of the trees in the hedgerows, it will be necessary to remove the trees in the hedgerows to prevent the shading out of the adjacent portions of the canopies of the replacement trees. In time it will be necessary to remove the old hedgerow trees, as individual trees become senescent and present safety hazards.

The Monterey cypress hedgerows were prioritized for replacement based on their general condition. Eight of these were placed in the high priority category (Table 7). It is recommended that a schedule be developed for the replacement of these hedgerows during the next 10 years. Additional planting to extend the sections of partially replanted hedgerows should also be completed within the next 10 years. Five hedgerows were prioritized in medium priority class for replacement because of the condition of the trees in these hedgerows. Replacement of these hedgerows can be delayed for a period of 10 to 20 years. The four hedgerows in the low priority class should be considered for replacement after that time, although the condition of the trees in these hedgerows may dictate earlier replacement.

Three Monterey pine hedgerows occur at the Sea Ranch (Table 8; Map 2). The developers planted these in the 1960s. Only one of these pine hedgerows was present in 2012. Hedgerows A and B have been removed. The third Monterey pine hedgerow (Hedgerow C) is in poor condition with several dead trees and trees leaning out over the road (Horizon Reach). Fire hazard was ranked as low in this hedgerow.

No regeneration of Monterey pine trees was observed in the two remaining Monterey pine hedgerows. It is recommended that the two remaining Monterey pine

hedgerows be replaced with Monterey cypress hedgerows. The Monterey pine trees in the existing hedgerows will be increasingly subject to windthrow and wind breakage as they age. Furthermore, the seeds they produce have a high potential for invading adjacent private property and commons areas on the Sea Ranch. Replacement should be initiated within the next 10 years.

Grazing to control brush invasion of meadows

The grasslands on the coastal terrace at the Sea Ranch were being invaded by shrub species at the time of the 1991 report. Baccharis (*Baccharis pilularis*) was the principle invader on loam and clay soils, while lupines (*Lupinus albiforns*; *L. arboreus*) were invading sandier textured soil. Grazing livestock during the ranching period had kept the grassland free of shrubs. Goat grazing, along with mechanical removal of existing shrubs, was proposed in the 1991 report. Grazing by both goats and sheep and the use of a brush hog for the mechanical removal of existing shrubs was initiated at the Sea Ranch in the 1990s, primarily to maintain the open, meadow character.

Aerial images from 2011 (Google Earth, 2012) of the 50 grassland units on the coastal terrace were examined to determine the extent of shrub cover and assess the efficacy of goat and sheep grazing (Table 9 and Map 4). Ten of the grasslands showed an increase in baccharis cover of 10% or more in the 20 years between the 1991 report and the current assessment. In four of these grasslands baccharis cover had increased over 30% (Grassland # 44, 47, 48, 50).

It was not possible to calculate the increase in cover of lupine because the areas covered by lupine were only generally referenced (e.g., “southeast corner of grassland”) and could not be accurately defined on the 2011 imagery. Field observations suggest that lupine invasion of grasslands has taken place, but is limited to the sandy soils on the coastal terrace. It is not a widespread problem in comparison to the baccharis invasion.

Mature baccharis shrubs can grow to a height of 6 to 8' and block views from houses on the coastal terrace. Baccharis restricts easy movement across the terrace grasslands and results in a different wildlife habitat from the grassland. Mature lupines grow to 3 to 4' in height and are less likely to block views. Lupine stands may restrict easy access to the edge of coastal bluffs, but do not prevent access, as is the case with baccharis. The habitat associated with lupines also varies from the grassland habitat. The succession of grassland areas on the coastal terrace to lupines is not considered a significant problem because of the limited areas of sandy soil on which lupines become established. The large percentage of lupine cover in specific areas observed in preparation of the 1991 report suggest that either these areas were occupied by lupines during the ranching period or succeeded to lupines soon after the development began. In contrast, a much larger area of non-sandy soil exists where baccharis has and potentially will become established.

Reconnaissance of grassland units that have been grazed by goats and sheep show that grazing temporarily halts baccharis invasion and in some cases eliminated the invasion. Grazing usually has a temporary effect because the roots of baccharis remain alive after the tops of the plants are removed mechanically with a brush hog. The sheep and goats graze the regenerating baccharis sprouts, but do not kill the roots. Browsing of these new sprouts does, however, decrease the subsequent amount of sprouting.

New seedlings can become established in treated grasslands because of the abundance of baccharis seed, which blow in from nearby sites. Within a few years baccharis seedlings and sprouts are visible in the most of grazed grasslands. Periodic grazing will be required in the future to maintain grasslands on the coastal terrace. Although some grasslands have not been invaded by baccharis after an initial treatment.

It is recommended that some grassland units be allowed to succeed to baccharis, while other units should be maintained as grasslands. Table 10 identifies those grassland units that are recommended for maintenance by goat and sheep grazing. The table also identifies units that should be allowed to succeed to baccharis and lupine.

The grassland areas in the western portions of several units should be maintained in grass while the eastern portions of these units can be allowed to succeed to baccharis (Table 10). This recommendation is based on the limited views from houses in the eastern portion of these units. The recommendations are based on a general assessment of each grassland unit (both for cost control and for diverse habitat value) and are not based on views from individual houses in the eastern portions of the grasslands. It would be useful to reconsider the recommendations in Table 10 as land management plans are prepared for the different neighborhoods at the Sea Ranch. In any case the long-term cost of grassland maintenance will continue to increase and a decision should be made to allow some grassland units to succeed to baccharis.

An examination of the grasslands in the upland area in the 1991 report indicated that both tree and baccharis invasion was taking place, especially in wetter areas. Re-examination of the areas indicates that tree and shrub invasion has been curtailed if not

halted in grassland that have been managed to reduce fire hazard by mowing, grazing, and tree removal (Table 13; Map 5). Only a small percentage increase in tree and shrub cover has occurred in the five grasslands originally surveyed. Most of the increase in tree and shrub cover in these grasslands is due to the growth of trees and patches of shrubs present in 1991.

Ten additional grasslands were examined in the 1991 on aerial photographs taken in 1990 to determine the density of trees per acre. These densities were compared to the densities present on 1961 photography. An increase in density from 1.4 trees to 7.7 trees per acre was observed. Unfortunately, the records of the locations of the original sample sites could not be found and a comparison with tree density could not be established. Field observations suggest that tree invasion has continued to occur in untreated upland grassland areas at the Sea Ranch. As was noted in the 1991 report, this establishment has been most notable on more moist soils.

One can anticipate further invasion and the succession of some grassland units to conifer forest types in the upland area. Treatment of the grasslands now experiencing invasion should be done for the purpose of reducing fire hazard. That treatment might include tree removal and maintenance of the grassland or thinning and pruning of the trees already established. Choice of treatment should depend on the level of tree invasion and the proximity of houses.

Riparian Zone Management

Riparian zones adjacent to drainages and creeks at the Sea Ranch provide special habitats for plants because of the seasonal or year round high water tables in these zones. Special associations of plants often occupy these riparian areas in response to abundant soil moisture. In some situations the plants may grow directly in the drainage channel.

Plants in the drainage channels, along with plant debris, can block slow the flow of water during periods of heavy rain. Blockage may divert water against stream banks causing erosion. Local areas may be flooded where the trees growing in the stream channels or the debris causes the water to back up and overflow the banks. A balance needs to be struck between the negative aspects of plants and debris in stream channels and the positive effects certain plants have by causing fine sediments to fall out of stream water. Larger woody debris in the creeks improves the habitat. In the 1991 report several riparian zones were characterized as being clogged with living plants and debris. It was recommended in that report that these riparian zones be cleared of debris and periodically monitored to prevent the build up of debris. The California Department of Fish and Game should be contacted to see if a 1600 permit is required for specific debris removal. Their concern is usually with the removal of large woody debris (e.g., logs and root wads), but contacting them in advance would be prudent.

The riparian zones examined in the 1991 report were re-examined in in 2012. The conditions of the riparian zones in the upland areas of the Sea Ranch were good. Little or no evidence of stream channels being blocked by plants and debris was observed

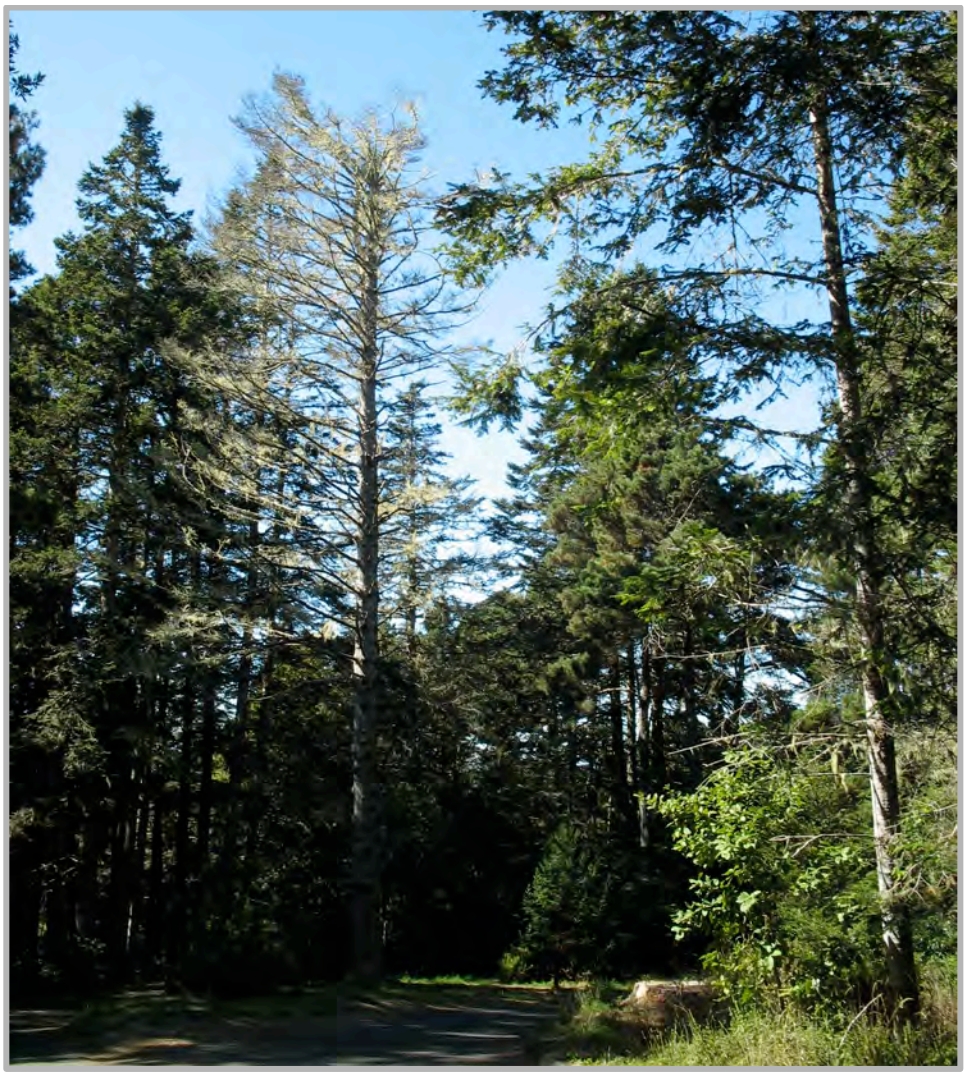
in the upland areas with the exception of site #4 (Table 11; Map 6). At site #4 fallen redwood branches have accumulated in the channel and have the potential of blocking the adjacent culvert. These redwood branches should be removed.

Not all stream channels were examined in the 2012 survey, only those that were initially reported on in the 1991 report. Other stream channels may have developed debris accumulations or may be chocked with living plants. An annual inspection of all culverts prior to the winter rainy season should be continued to insure that the channels above culverts are free of debris that could potentially block the culverts.

Stream channels in the riparian zones on the coastal terrace supported heavy growths of willows and wax myrtle (Table 12; Map 7). They did not have accumulations of plant debris when examined in 2012. Furthermore, the stream channel banks showed no evidence of erosion as some of them had in 1991. The growth of the willows and wax myrtle have effectively reduced water velocity in these channels and eliminated the previous erosion problem.

No treatment of the vegetation in the stream channels on the coastal terrace is recommended except in low lying areas where flooding due to the slowing of water moving through vegetation-clogged drainages could reach adjacent houses. In these situations the willows and wax myrtle occurring in stream channels should be removed. Monitoring of culverts should also be done on an annual basis for the riparian zones on the coastal terrace.

Willows and wax myrtles have expanded from the riparian zone into the adjacent grasslands since the 1991 report. Some riparian zones appeared to be twice as wide as they were in 1991. This expansion into the grassland has increased the habitat for riparian woodland species without significantly decreasing the grassland area on the coastal terrace. The expansion may have, in some cases, reduced the views from nearby houses. It is recommended that this issue be addressed on a house by house basis during the development of neighborhood landscape plans.



Guidelines for Tree Removal in Forested Areas

Tree removal has been an issue in the forested area of the Sea Ranch for many years. Homeowners are concerned about fire hazard and/or the potential windthrow associated with trees adjacent to their homes. Some homeowners wish to have views from their property. Request for permits for the removal of trees often involve the removal of trees from private property as well as trees in commons areas. Removal of trees can reduce fire hazards around structures, prevent the falling of trees onto houses, and provide views. However, tree removal may compromise wildlife habitat values, interrupt wildlife corridors, reduce the privacy of adjacent houses, and expose remaining trees to increased wind velocity and possible windthrow.

Decisions concerning tree removal are handled on a case-by-case basis by the Association's Planning Department and may involve review by the Design Review Committee. Staff of the Planning Department and members of the Design Review Committee have the responsibility of maintaining the integrity of the landscape of the Sea Ranch while insuring the safety of individuals and their property. The forested areas of the Sea Ranch are an integral part of the overall landscape. They contribute to the visual quality, habitat values, and recreational potential of the property. Commons areas were proposed by the planners of the Sea Ranch to maintain these values. The Association should see protection of trees in the commons areas as a first order of responsibility.

Concern over the fire and windthrow hazards associated with the forest is a legitimate concern, but should not be used as a surrogate for opening views. Cal Fire requires a clearing of flammable ground fuels within 30 feet of a structure under the current regulations for the establishment of defensible space around homes in rural areas. In areas of extreme fire hazard rating the clearing must be 100 feet. Trees within these zones are to be pruned to eliminate branches that are growing over the roofs of structures and thinned to eliminate a continuity of crown fuels from adjacent forest areas. Fuel ladders beneath the canopies of trees must also be removed. Under the California Fire Hazard Severity Rating System (Helm, et al, 1973) the forest areas at the Sea Ranch are ranked below the extreme fire hazard level. Thirty feet of clearance of ground fuels and pruning and thinning of trees around structures would be required, but not 100 feet. If any products (e.g., fire wood, timber) are sold from clearance operations permits may be required from Cal Fire depending upon the amount of material.

Proposals for tree removal to avoid tree fall hazards during windstorms were developed in an earlier reports (McBride, 1999; McBride, 2003) and are presented in a previous section of this report titled "Windthrow". These recommendations support the removal of trees that are tall enough to fall onto a structure in areas of high windthrow potential.

In situations where homeowners request permits to open views, the Association Office should proceed with care so that any proposal for tree removal does not compromise forest values on either private property or commons areas. Proposals should be evaluated, in part, as to the impact of the tree removal on adjacent trees. In many cases removal of individual trees has led to wind exposure of adjacent tree resulting in tree desiccation and death or windthrow.

In some situations a filtered view can be obtained by pruning of trees blocking the view. This should be considered a compromise solution that helps to protect the integrity of the forest while providing a partial view. The topping of forest trees to provide views should not be allowed as it leads to the death of most species of trees. It is very important that homeowners realize that the forests in which their homes are located are living plant communities characterized by tree growth. Trees downhill from many lots will in time grow up to diminish or eliminate views of the ocean. Continuously topping or removing trees is not in the best interest of the forest values that are associated with the Sea Ranch.

When new construction is proposed for lots within the forested areas of the Sea Ranch, the site should be evaluated for the potential exposure of trees to high velocity winds as a result of removal of trees to accommodate the building footprint and driveways. It will often be possible to adjust the siting of a structure to both minimize tree removal and prevent the exposure of remaining trees on the site.

The following guidelines are suggested for guiding decisions about tree removal:

1. Tree removal will be permitted where the existing trees present a windthrow hazard to existing and proposed structures. Decisions should be based on conditions identified in "Re-evaluation of the windthrow problem at The Sea Ranch. Report to the Planning Department. The Sea Ranch, CA. (McBride, 2003).

2. Tree removal will be permitted where existing trees are within a 30 feet radius of a structure and the fire hazard associated with individual trees cannot be reduced by pruning and thinning.

3. Proposals for tree removal in order to create views should be carefully evaluated to avoid compromising the integrity of the landscape, causing wind damage to adjacent trees, and reducing the privacy of other homeowners. Where possible a compromise, involving tree pruning to provide filtered views, should be developed.

4. Plans for the construction of new homes or additions to existing structures in forest areas should be evaluated from the standpoint of the removal of trees necessary to accommodate construction. This evaluation must address the potential windthrow of the trees that will remain on the site and the fire hazard associated with the remaining trees. In every case efforts should be made to locate structures on the site to minimize the number of trees that will need to be removed.

Management of the Timber Production Zone

In 1993 the Sea Ranch purchased an area of redwood and Douglas-fir forest classified as a California Timber Production Zone. Timber Production Zone classification of land is intended to set aside productive forestland to prevent its use for other purposes such as development for housing. Land entered into this program is not taxed on the basis of its highest potential value (e.g., subdivision), but at lower rates that insure protection of the forest. Landowners may withdraw from the program at any time, but must pay back taxes on the land if they withdraw before an agreed upon period of time. Forests in the Timber Production Zone program may be harvested. Harvesting is permitted at a variety of level from clear cutting and group selection of small areas to single tree selection.

In 2009 Edwin Tunheim, Consulting Forester, prepared a report to the Sea Ranch on the current timber inventory in the Timber Production Zone and potential alternatives for managing the area. Matt Greene, a consulting forester who worked for Tunheim on the 2009 report, revisited the area to update the forest inventory and address the question of timber harvesting. He also reviewed the potential for placing the area into California's new cap and trade system for the sequestration of carbon. His report can be found in Appendix 2: Upland Forest Area.

In the three years since the 2009 Tunheim report, the forest has grown from 6.4 million board feet to over 7.2 million board feet. Approximately 360,000 board feet of this growth is merchantable. The total merchantable volume in 2012 was 7,297,900 board feet. Most of this volume is redwood (6,015,700 bdft) with smaller amounts of Douglas-fir, Grand fir, and western hemlock being present (1,271,400 bdft). This growth amounts to an increase in volume of 3.5% annually of merchantable timber. The growth rate indicates that the Sea Ranch could harvest 35% of the volume of the stand every 10 years or conservatively 60% of the volume every 20 years on a sustained basis.

Scenarios for harvesting 30%, 40%, or 60% of the existing merchantable volume starting in 2013 are presented in Appendix 2. These would yield approximately 1.7 million, 2.3 million, and 3.4 million board feet of timber respectively. Greene estimated the value of these sales to be between $600,000 and $900,000 for a 30% harvest and potentially from $1,000,000 to $2,000,000 for a 60% harvest. These dollar values would depend on market value of the timber at the time of the sale. Many factors at the local, national, and international level influence the market for timber. An approved timber harvest plan would be required under the California Forest Practice Act before harvesting could take place.

Harvesting the Timber Production Zone is an issue of concern for many people living at the Sea Ranch. The forest serves as habitat for a number of species and the disturbances associated with harvesting would impact people living nearby to the Timber Production Zone. The benefits of harvesting, in addition to the revenues created, include reduced fire hazard, improvement of access to the forest for recreational purpose, improve forest health, and increase in the growth rate of the remaining trees.

Appendix 2 also addresses the possibility of entering the Timber Production Zone into the new California carbon credit program. Currently the program is operating under Version 3.2 of the state's protocol. Version 3.3 is currently being drafted. It will provide more specific instruction for entering forest land into the program and will allow one to calculate the value derived for being in the program. Forest lands must meet specific requirements in order to be considered. The current version of the protocols program specifically state that : "Forest Projects must achieve GHG (green house gas) reductions or removals above and beyond any GHG reductions or removals that would result from engaging in 'Business As Usual' activities. This stipulation would require some management action on the part of the Sea Ranch that would increase carbon sequestration over that now taking place in the Timber Production Zone. Such actions could include a forest thinning operation to increase the growth rate of the forest,

replanting understocked areas of the forest, or weeding operations to reduce competition from shrubs and understory hardwoods. The action or actions proposed in an application for entry into the program would require approval by California Climate Action Reserve staff.

Land entered into the program would have to be committed for 100 years. Several restrictions as to the legal status of the specific property and easements associated with the property might require modifications before a property could be enrolled. Once entered into the program the land owner would receive an annual income based on the carbon cap and trade market and the amount of carbon sequestered by the forest. It is not possible to estimate the potential income from the Timber Production Zone based on carbon sequestration until the Version 3.3 protocol is released.

Matt Greene summarized his report (Appendix 2) with the following recommendations:

- A light selective harvest of 30% is sustainable every 10 to 12 years.
- If a harvest is to occur, particular attention should be paid to the selection criteria of trees that will be harvested. The harvest should remove trees that are dead, dying, diseased, and trees with deformities, which will limit future growth rates. Once these trees have been selected, the remaining forest should be looked at to increase vigor by properly thinning out the clumps, spacing out the residual stand and putting growth on the proper trees. Trees and/or areas with high aesthetical qualities can be retained.
- Reinventory the property every two rotations (unless a carbon project is undertaken which may require additional information).
- Look at developing a carbon sequestration project.
- Check each year to find out what cost share funds are available to conduct fuel hazard reduction projects, thinning and pruning projects, erosion reduction projects, and wildlife habitat improvement projects with help from state and federal funds.
- Begin a planting program to fill in areas that are affected by Sudden Oak Death, wind throw and other disturbances.

It is recommended that a timber harvest plan be prepared for harvesting 30% of the merchantable volume every 10 years following the recommendations in Appendix 2. This is a preferable option to entering the forest into the carbon sequestration cap and trade program because of the uncertainty of the financial returns under that program and the necessity of committing the forest to the program for 100 years.

Summary of Recommendations

1. Vegetation Management along the Coastal Bluffs

Monterey cypress trees planted by the ranchers have successfully retarded coastal bluff erosion for many decades. However, as the trees have aged they are being undermined by coastal bluff erosion at several locations. Many of the trees block views of the ocean and encroach on the bluff trail. The following recommendations address management of Monterey cypress on the bluff:

- Monterey cypress trees on the coastal bluff should be maintained to control coastal bluff erosion, provide wind protection to users of the coastal bluff trail, provide wildlife habitat, and for their scenic value.
- Protect from removal Monterey cypress branches with living foliage that grow down the face of coastal bluff.
- Monitor Monterey cypress trees to determine the degree to which individual trees have been undermined by coastal bluff erosion. Remove trees that appear to be close to falling into the ocean to avoid their pulling out of masses of soil and rock when they fall.
- Gaps created by removal of Monterey cypress to create views should be replanted with lupine, ceanothus, dwarf baccharis, and/or other native species, tolerant species.
- Monterey cypress trees should not be pruned up from the ground to provide filtered views under the crown canopy as this leads to desiccation of remaining canopy and enhances the risk of toppling.
- Monterey cypress may be top pruned to provide views over the tops of the trees and to enhance their stability.

2. Forest Health

Monterey pine, Bishop pine, and Monterey cypress trees have exhibited die back of branches and individual tree mortality in past years. These conditions are associated with the pine trees approaching over maturity, years of below average precipitation and above average temperature, and in the case of Monterey cypress reduced occurrence of summer fog. Maintenance of a healthy forest at the Sea Ranch should be a primary goal

of vegetation management. Recommendations for maintaining healthy forest stands, hedgerows, and individual trees are as follows:

- Remove individual trees in forest stands and hedgerows that exhibit signs of decline (loss of foliage, browning of needles and leaves; signs of fungal pathogens or insect pests) to prevent infection of nearby trees.
- Prune branches showing browning of needles of individual trees
- Thin overstocked plantations of bishop pine to a target of 24' x 24' spacing to reduce stress that can lead to forest pest problems.
- Monitor natural stands of bishop pines that are in decline and remove dead trees which will target structures and roads when they fall.
- Replace Monterey pine plantations and hedgerows with Monterey cypress, Bishop pine, and/or shore pine to avoid the long-term hazards and maintenance costs associated with this species now that is now reaching over maturity.
- Avoid water diversions that may result in higher water tables in bishop pine areas
- Monitor natural stands of Bishop pine that are in decline due to over maturity to avoid trees falling onto roads.
- Be prepared for periodic episodes of tree mortality related to periods of drought, below normal fog occurrence, and high temperatures. These conditions will lead to tree mortality and increased maintenance cost to avoid tree fall problems.

3. Windthrow

High windthrow areas exist on the Sea Ranch. These are related to high wind exposure, soils that are prone to water logging in the winter, and the distribution of grand fir and bishop pine. These areas have been mapped and a policy for removal of trees adjacent to houses in these areas established. Tree fall hazard can be increased where opening in the forest are made for the construction of houses and roads. Care must be taken when siting of houses to avoid increasing the windthrow hazard. The following recommendations are proposed for addressing the windthrow problem:

- Protect structures in high windthrow potential areas by permitting the removal of trees within falling distance of structures and removing such trees from commons areas.
- Require on-site inspection of trees on lots to be developed to determine the potential impacts of wind patterns following construction on the site.

4. Effectiveness of Specific Vegetation Management Activities

- *Conifer plantations management*
  - Maintain the current program of thinning and elimination of fuel ladders in bishop pine plantations to improve the health of individual trees and minimize fire hazard.
  - Replace Monterey pine plantations with Monterey cypress, bishop pine, and/or shore pine.

- *Hedgerow management and replacement*
  - Reduce fire hazard in designated hedgerows by removal of accumulated dead branches on the ground.
  - Continue the replanting program for the replacement of hedgerows
  - Begin pruning up of existing hedgerows to a height of 30 feet once replacement plantings reach heights of 10 to 20 feet to allow the replacement trees to develop wind tolerance. Remove existing trees in hedgerows when they begin to shade out branches of replacement tree or when the present tree fall risk to adjacent properties and roads.

- *Grazing to control brush succession in meadows*
  - Continue grazing goats and sheep on selected meadows.
  - Eliminate some grasslands from the grazing program where views are not an issue, where coastal scrub can provide habitat diversity, and/or where specific grasslands are not included in the fuel management program.

- *Riparian zone management*
  - Annually inspect drainages and creek channels above road culverts prior to the winter storm period to remove any debris capable of blocking the culverts.
  - Installation of metal T-posts to prevent culverts from plugging is recommended where drainages carry large quantities of organic debris
  - Do not remove willows, wax myrtle, sedges, or carex growing in creek channels on the coastal terrace as these plants function to slow down the velocity of water moving in the streams. These plants also filter out sediments. Trees should be removed if flooding becomes a problem in low-lying areas on the coastal terrace trees growing in the channels.
  - Monitor the lateral expansion of riparian thickets of willow and wax myrtle in riparian zones on the coastal terrace in relation to its impact on views. Initiate pruning programs where appropriate.

5. Guidelines for Tree Removal in Forested Areas

- Tree removal will be permitted where the existing trees present a windthrow hazard to existing and proposed structures. Decisions should be based on conditions identified in "Re-evaluation of the windthrow problem at The Sea Ranch. Report to the Planning Department. The Sea Ranch, CA".

- Tree removal will be permitted where existing trees are within 30 feet of a structure and the fire hazard associated with individual trees cannot be reduced by pruning and thinning.

- Proposals for tree removal in order to create views should be carefully evaluated to avoid compromising the integrity of the landscape, causing wind damage to adjacent trees, and reducing the privacy of other homeowners. Where possible a compromise, involving tree pruning to provide filtered views, should be

developed.

- Plans for the construction of new homes or additions to existing structures in forest areas should be evaluated from the standpoint of the minimal removal of trees necessary to accommodate construction. This evaluation must address the potential windthrow of the trees that will remain on the site and the fire hazard associated with the remaining trees. In every case efforts should be made to locate structures on the site to minimize the number of trees that will need to be removed.

6. Management of the Timber Production Zone

- Selectively harvest the 30 % of the merchantable growth of the forest every 10 years
- Retain 20% of the growth for the first two to three entries to build the inventory.
- Check each year to find out what cost share funds are available to conduct fuel hazard reduction projects, thinning and pruning projects, erosion reduction projects, and wildlife habitat improvement projects with help from state and federal funds.
- Begin a planting program to fill in areas that are affected by Sudden Oak Death, wind throw and other disturbances.
- Monitor and address erosion issues as they occur.

Prioritization of Management Recommendations

The management activities recommended in this report have been prioritized on the basis of maintaining safe conditions at the Sea Ranch while ensuring the amenities of the vegetation. The prioritization is also intended to inform the budgeting process of the Sea Ranch Association.

Annual Priorities

Some management activities must take place on an annual basis to insure safety associated with the vegetation and to maintain forest health and control baccharis invasion of grasslands. These include:

1. Monitoring and removal of dead and dying trees to minimize the spread of insects and pathogens and prevent windthrow of trees onto adjacent houses. This activity is proposed for the commons areas. Private property owners should be encouraged to report dead and dying trees on their property and to remove these trees.
2. Monitoring of culverts and removal of debris in drainages above culverts that has the potential of blocking culverts during winter storms.
3. Monitoring and removal of dead tree branches in hedgerows that provide fuel ladders into the canopy.
4. Monitoring and removal of trees on the edge of the coastal bluff that have been undermined by erosion and have the potential of falling into the ocean.
5. Monitor and prune back Monterey cypress branches that have grown into the coastal trail.
6. Monitor sheep and goat grazed grasslands to determine the need for subsequent grazing to control baccharis invasion.

7. Respond to requests by home owners for removal of trees in commons areas. Where decisions are made to remove trees from commons area prompt action is recommended.

Three to Five Year Priorities

1. Grazing of grasslands to control baccharis invasion. Scheduling of grazing should depend upon the amount of baccharis regrowth and new seedling establishment. Decisions should be made within the next three years concerning those grasslands that have been recommended for allowing baccharis to succeed the grass. These should be taken out of the grazing program.
2. Removal of existing hedgerows when the trees planted for replacement have reached 20 feet.
3. Replacement planting of the west end of hedgerow 9.
4. Replacement planting of Monterey pine hedgerows.
5. Remove Monterey pine plantations
6. Thin any currently un-thinned bishop pine plantations to a 12' x 12' spacing
7. Initiate the harvesting process in the Timber Production Zone by preparing a timber harvest plan.
8. Eliminate fuel ladders from bishop pine plantations
9. Conduct a survey of all riparian zones to identify areas of debris accumulation that can potentially cause bank erosion and local flooding. Remove this debris.
10. Evaluate the impact of the expansion of willow and wax myrtle into grasslands on the coastal terrace from the standpoint of the impact on views. Where necessary prune back the willow and wax myrtle.

Five to Ten Year Priorities

1. Replacement planting of hedgerows 6 (partial), 7 (east end), 10 (east end), 12 and 14.
2. Removal of existing hedgerows where the trees planted for replacement have reached 20 feet.
3. Thin all Bishop pine plantation to a 24' x 24' spacing.
4. Complete the first selective harvest in the Timber Protection Zone
5. Initiate the replanting of the Monterey cypress bluff protection stands if any stand exhibits more than 30% tree mortality. These stands should be prioritized at the time on the basis of tree condition and erosion hazard.
6. Continue as necessary the pruning of willows and wax myrtle adjacent to riparian zones on the coastal terrace.

Ten to Twenty Year Priorities

1. Replacement planting of remaining hedgerows

2. Removal of existing hedgerows when the trees planted for replacement have reached 20 feet.
3. Replace sea fig on coastal bluffs with native species.

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Tables

Table 1. Vegetation Types along the coastal bluff at The Sea Ranch

Vegetation Type	Percent of total bluff edge	Number of Units	Average length of units (ft.)
Grassland	73	50	696
Monterey Cypress	13	53	113
Scrub/Grassland	6	15	196
Scrub	4	15	143
Bishop pine/Monterey pine	3	3	120
Willow/Myrtle	1	7	40

Table 2. Erosion rates, bluff-top vegetation, and Monterey cypress lost to coastal erosion in the winter of 1997/98.

Bluff Erosion Site*	Rate of Bluff Erosion**	Bluff-top Vegetation	Monterey Cypress Lost in 1997/98
Leeward	Moderate	Monterey Cypress	yes
Broad Reach A	Moderate to fast	Coastal scrub/grass (Monterey cypress not on immediate edge)	Not adjacent
Broad Reach B	Moderate to fast	Coastal scrub/grass	Not adjacent
Broad Reach C	Moderate to fast	Coastal scrub	Not adjacent
Broad Reach D	Slow	Coastal scrub/grass	Not adjacent
Rock Cod	Moderate to fast	Coastal scrub/grass	Not adjacent
Main Sail A	Moderate to fast	Coastal scrub	Not adjacent
Main Sail B	Moderate	Coastal scrub	Not adjacent
Fish Rock	Slow to moderate	Grassland	Not adjacent
Del Mar Point	Slow to moderate	Grassland/Monterey cypress hedgerow	no
Del Mar Ecological Reserve	No indication of bluff Erosion; cited by Konigsmark for erosion of a trench	Coastal scrub	Not adjacent
Sounding A	Slow to moderate	Grassland	Not adjacent
Sounding B	Slow to moderate	Coastal scrub	Not adjacent
Solstice A	Moderate to slow	Grassland	Not adjacent
Solstice B	Slow to moderate	Grassland	Not adjacent
Solstice C	Moderate	Grassland	Not adjacent
Tide Pool A	Slow to moderate	Grassland	Not adjacent
Tide Pool B	Moderate	Grassland	Not adjacent
Sea Drift	Slow to moderate	Grassland	Not adjacent
Foremast A	Slow to moderate	Grassland	Not adjacent
Foremast B	Moderate	Grassland	Not adjacent
Pelican	Moderate	Grassland	Not adjacent
Sea Pine Reach A	Moderate	Grassland	Not adjacent
Sea Pine reach B	Moderate	Grassland	Not adjacent
Walk-on Beach A	Slow to moderate	Grassland/Coastal scrub	Not adjacent
Walk-on Beach B	unranked	Coastal scrub/ grassland	Not adjacent
Land's End	Slow to moderate	Grassland	Not adjacent
Breaker Reach A	Slow to moderate	Grassland	Not adjacent
Breaker Reach B	Moderate to slow	Grassland	Not adjacent
Green Cove	Slow to moderate	Grassland	Not adjacent
Smuggler's Cove	Slow	Monterey cypress	no
Galleon's Reach	slow	Grassland	Not adjacent

* (Konigsmark, 1998); **(fast =6"/yr; moderate = 3"/yr; slow = 1"/yr)

Table 3. Comparison of coastal bluff protection planting sites in 1991 and 2012

Location number (see Map 8)	Bluff undercut by wave action		Erosion of upper layers of terrace		Evidence of trees having fallen into ocean or onto beach		Current Tree mortality	
	1991	2012	1991	2012	1991	2012	1991	2012
1	no	no	no	yes	yes	yes	no	no
2	yes	yes	no	no	no	no	no	no
3	no	slight	yes	yes	yes	yes	no	yes
4	yes	yes	yes	yes	yes	yes	no	no
5	no	no	yes	yes	no	no	no	no
6	yes (south end)	yes	no	no	no	no	yes	no
7	yes	yes	yes	yes	no	no	yes	yes (south end)
8	no	no	no	no	no	no	no	no

Table 4A. Climatic data from Ft. Ross and Santa Rosa, CA (NOAH, 2012)

Precipitation							
Location	Average Annual Ppt.(")	Standard Deviation	Year				
			1988	1989	1990	1995	1996
Santa Rosa	30.34	9.73	19.23	21.91	19.24	68.56	58.00
Ft. Ross	40.85	13.90	25.01	23.78	23.33	51.24*	***
Temperature							
Location	Average Monthly Maximum Temp. (^{o}F)	Standard Deviation	Year				
			2001	2002	2003	2004	
Santa Rosa	73.96	1.41	76.18	75.42	74.37**	75.57	
Ft. Ross	53.73	1.18	***	***	***	***	

* this precipitation is within one standard deviation of the annual average, but is include here because data was not recorded for 7 days during the rainy season

** average monthly temperature above long term average, but less than one standard deviation above the long term average

*** data incomplete

Table 4B. Sea Ranch and Santa Rosa precipitation data from 2001 to 2011 (Sonoma Water District, 2012)

Annual Precipitation (in):

Year	Sea Ranch	Santa Rosa
2001	49.95	-
2002	37.68	30.72
2003	23.92	29.20
2004	40.53	30.21
2005	36.99	43.41
2006	56.67	34.23
2007	33.80	20.27
2008	30.31	21.59
2009	30.01	23.70
2010	71.43	40.93
2011	39.35	-

Average Annual Precipitation (in):

Period	Sea Ranch	Santa Rosa
2001-2011	40.96	na
2002-2010	40.15	30.47

Table 5. Condition of Monterey pine plantations

Monterey Pine Plantations			
Site (see map 2)	regeneration	tree condition	potential fire hazard/ comments
1	yes along margins	good, some lower branch mortality	low, trees have been pruned up; regeneration starting to form fuel ladder; some portions of stand along highway have been removed
2	yes	poor along water course, considerable mortality	moderate; this plantation is a mixture of Monterey pine and bishop pine; concern about future tree fall hazard; many trees leaning over trail; shore pine east of pubic trail doing very well, much better than Monterey pine
3	yes	poor	only one tree remains in this stand, it is in poor condition, this stand was mostly on a private lot

Table 5. Continued			
Site (see map 2)	Regeneration	Tree condition	Potential fire hazard/ comments
4	yes	trees west of swimming center parking lot have died due to high water table; stand to the south and east in good condition	Fire hazard low; remove regeneration to prevent growth of fuel ladder; thinning of stand south of recreation center would improve future tree health and vigor; pines invading adjacent meadow area
5	yes	younger trees very good, older trees showing lower branch mortality	low understory for the most part well maintained; it appears some thinning of this stand has taken place; power line fire caused the loss of many trees in this stand

Table 6. Condition of bishop pine plantations

Bishop Pine Plantations				
Site (see map 8)	Fuel loading	Ground cover	Spacing	Comments
1	low	understory is grass	appears to be thinned in places	looks good, periodic ground fuel maintenance, no fuel ladder
2	low	grass and coffeeberry on flat; needles on slope	does not appear to have been thinned	should be thinned for fire hazard reduction and future tree health
3	low	mostly grass, wet areas with coffeeberry	does not appear to have been thinned	wetter areas being invaded by grand fir, trees in good condition
4	light	blackberry, some patches of grass and pine needles	8' x 8' at north end 12' x 12' at south end	understory of coffeeberry and tan oak, moist areas support sword fern; grand fir invading understory, fuel ladder is developing with tan oak
5	moderate	understory of coffeeberry and tan oak saplings and young trees	8' x 8' has not been thinned	fuel ladder needs to be eliminated, pruning of lower branches may be required

Table 7. Condition of the Monterey Cypress Hedgerows in 2011

Hedgerow	Mortality	Replacement Planting	Fire Hazard	Natural Regeneration	Comments	Priority for Replacement
1 Leaward	Several patches of mortality where trees have been removed	Replanting in gaps, possibly by homeowners	low	none	Replanted 2010	Unplanted sections on golf course
2 Broad Reach	Past mortality has created several gaps in hedgerow	Replacement plantings in gaps and on north side	low	none	Remaining trees subject to wind damage on golf course and private lots	Replanted on commons; not on private lots and golf course
3 Fish Rock	A few trees tipped over by wind in central section	Gap at west end replanted	low	none	East end on golf course and private lots	West end has been replanted;
4 Helm	A few suppressed trees	Replanted west of Del Mar Point	low	patchy on north side	A few gaps in the original hedgerow	West end replanted
5 Del Mar Center parking lot	Trees at east end of south row are dying, possible root fungus, this area treated with soil inoculant	Replacements planted in gap adjacent to swimming pool, but trees have been topped	low	none	Two hedgerow (north and south); Continue to monitor trees at east end of south row	High for diseased trees at east end of south row
5A Solstice	none	none	low	none within hedgerow	Trees in relatively good condition	low
6 Pelican	Some trees at west end dead and dying	local patches of downed limbs and branches	Moderate Replace-ment planting on west end in gap	none	Lots of natural seed-ling establishment along north edge, but may be on private property	high

Table 7. Continued

Hedgerow	Mortality	Replacement Planting	Fire Hazard	Natural Regeneration	Comments	Priority for Replacement
7 Sea Pine Reach	Several fallen trees and branches on east end	None planted, but wide margin of naturally established trees on west side	high, several large logs within and adjacent to hedgerow as well as occasional dead and dying lower branches	adjacent	none	moderate
8 One-eyed Jacks	several suppressed trees	none	high, patches of dead and downed branches throughout	along margins in places, patchy natural regeneration, could be linked with inter planting for hedgerow replacement	Trees leaning significantly to the southeast	high
9 Cormorant Close	a few suppressed trees	some natural replacement west of Cormorant Close, but no planted replacement	high; large fuel accumula-tions at Cormorant Reach cul de sac and to the west	not within hedgerow	2 fading trees at east end, middle and western portion have private property boundaries up to the edge of hedgerow, property owners are maintaining hedgerows by cleaning up limbs and branches, a few fading trees at east end, may not have been part of original planting, they are adjacent to irrigated lawn	high because of tree fall hazard to adjacent houses
10 Stengel Beach	past mortality has resulted in a number of gaps	planted at west end and in gaps, needs plantings at east end	low	some adjacent to hedgerow, but not in hedgerow	breaking up at west end	high
11 Ohlson Ranch House	a couple of suppressed trees	none	low	none	none	moderate

Table 7. Continued

Hedgerow	Mortality	Replacement Planting	Fire Hazard	Natural Regeneration	Comments	Priority for Replacement
12 Ohlson Recreation Center	a few suppressed trees	replacement has been planted on north side and at southeast end of hedgerow, good condition	low	none	wait until replacement trees are 15-20' tall before removing or pruning up old hedgerow; replacement planting on north side may be more effective than south side; removal of existing hedgerow should be done went branches of replacement trees grow under hedgerow and begin to be shaded out	high
13 Stables and Equestrian Facility	none	hedgerow has been replaced, trees 25' tall, doing very well	low	none	none	very low
14 Albatross Reach	a few suppressed trees	in open section at west end, trees not doing well in gap at west end	low, some patches of dead branches on ground in middle and east end should be cleaned up	none	none	high
15 Mariner's Drive	a few suppressed trees	none	low	Monterey pine seedlings	Monterey pine in middle OK, fairly large gap near west end filling in with Monterey cypress, possibly planted	moderate
16 Whaler's Reach	none	yes, taking place	low	none	wait until replacement trees are 15-20' tall before removing or pruning up old hedgerow	Recently replaced

Table 7. Continued

Hedgerow	Mortality	Replacement Planting	Fire Hazard	Natural Regeneration	Comments	Priority for Replacement
17 Galleon's Reach	a few suppressed trees	replacement planting along south edge and at west end (Hill property)	Moderate, dead branch fuels at east end should be removed	none	Considerable dead limbs of branches hanging from tops of trees, less than 15% live crown	high
18 Horizon Reach	a few suppressed trees	at west end	low, fuel clean up at east end	some Monterey pine	Monterey pine at east end falling apart	low
19 Brigantine's Reach	a few suppressed trees	none	low	Monterey pine	Monterey pine invading windrow in middle section	trees removed on south side and replanted
20 Black Point Reach	several suppressed trees	none	low to medium	none	A few patches of dead branches that need to be cleaned up to reduce fire hazard	moderate
21 Sea Walk Dr.	none	none	moderate	none	Planted by developer, vigorous, healthy at west end, some die back at gap; gap has been replanted	low

Table 8. Condition of Monterey Pine Hedgerows in 2011

Hedgerow	Mortality	Replacement Planting	Fire Hazard	Natural Regeneration	Comments	Priority for Replacement
A		none	low	none	only a small portion of this hedgerow remains at the end of Whaler's Reach; hedgerow appears to have been removed	Recently removed
B	Hedgerow has been removed					
C	Several dead trees at east end of hedgerow, appear to be associated with wet area	none	low	none	only eastern portion of pine hedgerow shown on map still exists	High, remove and replace with Monterey cypress

Table 9. Percent shrub cover in coastal terrace grasslands in 1991 and 2012
Sea Ranch Shrub cover coastal terraces

Unit #	1991		2012			
	Lupine	Baccharis	Lupine	Baccharis	Total	Change in Baccahris
1	50*	0	65	10	75	5
2	50*	5	20	5	25	0
3	8*	1	60	5	65	4
4	1	1	95	0	95	-1
5	20*	0	2	1	3	3
6	50*	12	5	10	15	3
7	50*	10*	1	2	3	-
8	40*	0	1	0	1	0
9	5*	5	0	5	5	0
10	3	1	5	25	30	24
11	0	0	3	1	4	1
12	5	1	0	1	1	0
13	0	0	0	15	15	15
14	30	2	3	3	6	1
15	0	10	1	10	11	0
16	0	1	0	4	4	3
17	78*	0	25	0	25	0
18	25*	1	5	15	20	14
19	40*	0	30	0	30	0
20	0	1	25	1	25	0
21	0	1	0	3	3	2
22	20*	1	4	2	6	1
23	1	1	20	0	20	-1
24	0	1	0	1	1	0
25	0	2	0	1	1	-1
26	0	5	0	15	15	10
27	5	1	0	0	0	-1
28	0	2	0	2	2	0
29	0	0	1	0	1	0
30	0	0	0	2	2	2
31	45*	5	0	0	0	-5
32	25*	2	0	1	1	-1
33	0	2	0	1	1	-1
34	20*	5	0	10	10	5
35	85	0	2	0	2	0
36	65*	2	0	0	0	-2
37	0	3	1	0	0	-3
38	0	5	0	8	8	3
39	0	2	0	3	3	1

Table 9. Continued

Unit #	1991		2012			
	Lupine	Baccharis	Lupine	Baccharis	Total	Change in Baccahris
40	10*	2	10	5	15	3
41	55*	10	1	2	3	-8
42	50	15	0	10	10	-5
43	0	5	5	5	10	0
44	0	10	0	60	60	50
45	40*	0	0	10	10	10
46	0	75	0	70	70	-5
47	0	10	0	60	60	50
48	0	5	0	40	40	35
49	0	15	0	45	45	30
50	0	15	0	85	85	70

* these percentages reported for specific portions of the unit (e.g., “southwest corner of meadow”), not the over all unit

Table 10. Management recommendations for coastal terrace grassland

Unit #	Maintain Grassland	Allow to succeed to baccharis/ lupine	Comments
1	•		Orientation of lots and houses facing ocean; Leave existing areas of lupine
2	•		Orientation of lots and houses facing ocean; Leave existing areas of lupine
3	•		Orientation of lots and houses facing ocean; Leave existing areas of lupine
4		•	Already succeeded to lupine
5	•		Orientation of lots and houses facing ocean; Leave existing areas of lupine
6	•w	•	Allow a portion of eastern half to succeed to baccharis, but keep open views to rocks; Maintain western section in grassland
7	•		Maintain grassland area outside of existing lupine area
8	•		Maintain grassland area outside of existing lupine area
9	•w	•	Orientation of lots and houses does not provide views to ocean from eastern portion of unit, allow this portion to succeed to baccharis; maintain grassland in western portion
10	•w	•	Orientation of lots and houses does not provide views to ocean from eastern portion of unit, allow this portion to succeed to baccharis; maintain grassland in western portion
11	•w	•	Orientation of lots and houses does not provide views to ocean from eastern portion of unit, allow this portion to succeed to baccharis; maintain grassland in western portion
12	•w	•	Maintain grassland west of Leeward Road
13		•	Already 15% baccharis cover, houses block views to ocean

Table 10. Continued

Unit #	Maintain Grassland	Allow to succeed to baccharis/ lupine	Comments
14	•w	•	Orientation of lots and houses does not provide views to ocean from eastern portion of unit, allow this portion to succeed to baccharis; maintain grassland in western portion
15	•w	•	Orientation of lots and houses does not provide views to ocean from eastern portion of unit, allow this portion to succeed to baccharis; maintain grassland in western portion
16		•	No direct views to ocean
17		•	Existing cover by baccharis and lupine
18	•w	•	Orientation of lots and houses does not provide views to ocean from eastern portion of unit, allow this portion to succeed to baccharis; maintain grassland in western portion
19	•w	•	Large cover of baccharis in eastern portion of unit, views blocked by houses; maintain grassland in western portion
20	•		Maintain views
21		•	Views blocked by houses
22	•		Maintain grassland adjacent to bluff trail
23	•		Maintain views from houses
24		•	Views blocked by houses
25	•w	•	Orientation of lots and houses does not provide views to ocean from eastern portion of unit, allow this portion to succeed to baccharis; maintain grassland in western portion
26		•	Limited views of ocean from houses
27	•		Maintain views from houses
28		•	Limited views of ocean from houses
29	•		Maintain views from houses
30	•		Maintain views from houses
31	•w	•	Maintain views from houses and historic setting for Ohlson Ranch House and barn

Table 10. Continued			
Unit #	Maintain Grassland	Allow to succeed to baccharis/ lupine	Comments
32	•w	•	Orientation of lots and houses does not provide views to ocean from eastern portion of unit, allow this portion to succeed to baccharis; maintain grassland in western portion
33	•w	•	Long narrow commons in western portion of unit does not provide views to ocean; maintain grassland in western portion
34	•w	•	Orientation of lots and houses does not provide views to ocean from eastern portion of unit, allow this portion to succeed to baccharis; maintain grassland in western portion
35	•		Maintain views from houses
36		•	Limited views of ocean from houses
37	•		Maintain views from houses and coastal trial grassland setting
38		•	Limited views of ocean from houses
39	•		Maintain views from houses
40	•		Maintain views from houses
41	•w	•	Orientation of lots and houses does not provide views to ocean from eastern portion of unit, allow this portion to succeed to baccharis; maintain grassland in western portion
42	•		Maintain views from houses
43	•w	•	Orientation of lots and houses does not provide views to ocean from eastern portion of unit, allow this portion to succeed to baccharis; maintain grassland in western portion
44	•w	•	Orientation of lots and houses does not provide views to ocean from eastern portion of unit, allow this portion to succeed to baccharis; maintain grassland in western portion
45	•		Maintain views from houses

Table 10. Continued			
Unit #	Maintain Grassland	Allow to succeed to baccharis/ lupine	Comments
46		•	Much of unit has already succeeded to baccharis
47		•	Much of unit has already succeeded to baccharis
48		•	Much of unit has already succeeded to baccharis
49		•	Much of unit has already succeeded to baccharis
50		•	Much of unit has already succeeded to baccharis

Table 11. Characteristics and conditions of riparian zones of the upland area

Site	Species composition	Obstruction	Debris	Comments
1	upper reach- tan oak, Douglas fir, red alder, lower reach - wax myrtle, grand fir	upper reaches no obstructions, lower reaches no obstructions	upper reaches no debris, lower reaches no debris	good condition
2	upper reach - elevation is redwood, grand fir and pacific wax myrtle lower reach - red alder, grand fir, redwood	upper reaches no obstructions lower reaches no obstructions	upper reaches no debris lower reaches no debris	good condition
3	upper reach - Bishop pine, grand fir, coffeeberry, thimbleberry, lower reach – Douglas- fir, thimbleberry, red willow, sword fern	upper reach, no obstructions, lower reach, no obstructions	upper reach, no debris, lower reach, no debris	good condition

Table 11. Continued				
Site	Species composition	Obstruction	Debris	Comments
4	redwood, wax myrtle	no obstructions	a lot of redwood branches and litter in stream channel, did not access upper reach, upper slope appears to be a continuation of the redwood, potential for culvert being plugged by redwood debris	debris should be cleared out
5	upper reach - wax myrtle, Bishop pine, arroyo willow, cattail lower reach,- coffeeberry, tan bark oak, thimbleberry, Bishop pine	upper reach, no obstruction, lower reach no obstruction	upper reach, no debris, lower reach, no obstruction	good condition

Table 12. Characteristics and conditions of riparian zones on the coastal terrace

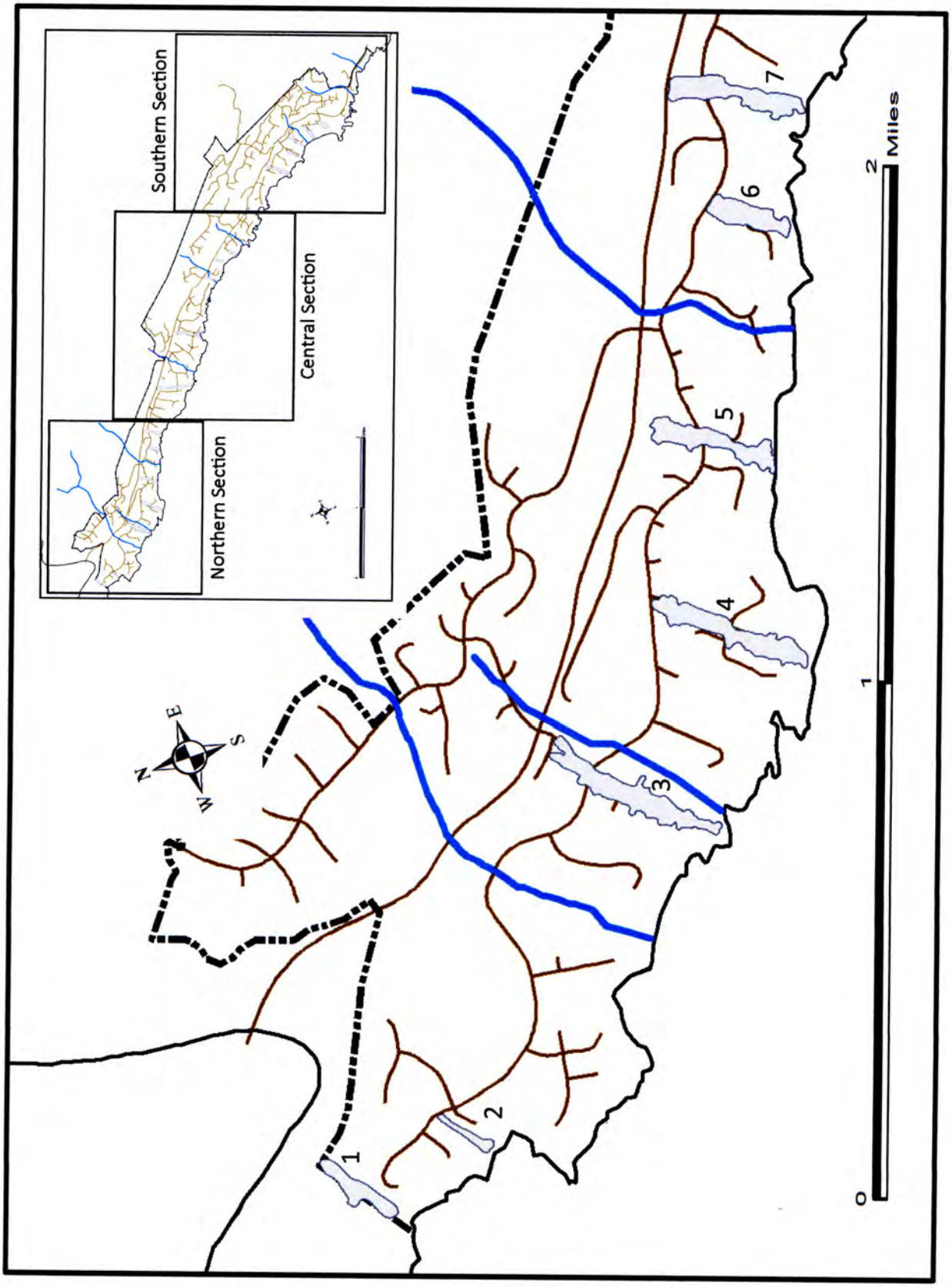
Site	Obstruction	Erosion	Debris	Comments
1	upper section obstructed with wax myrtle, lower section willow, wax myrtle and coffeeberry	no	no	spreading into adjacent grasslands
3	clogged with arroyo willow and some wax myrtle	no	no	spreading into adjacent grasslands
6	clogged with arroyo willow and wax myrtle	no	no	some dying wax myrtle, leave it alone; margins spreading into grassland
9	chocked with arroyo willow on lower terrace, spreading into adjacent grassland	no	no	adjacent to highway 1 supports redwood and grand fir; stream channel open
12	clogged with wax myrtle, willow, blackberry, sword fern	no	no	leave it alone, single Monterey pine cypress in riparian zone; margin of the vegetation has been cut back to improve line of sight to ocean
15	clogged with wax myrtle and coffeeberry	no	no	leave it alone, Douglas-fir invading riparian zone
18	clogged with wax myrtle	no	no	leave it alone

Table 13. Characteristics and conditions of upland grasslands

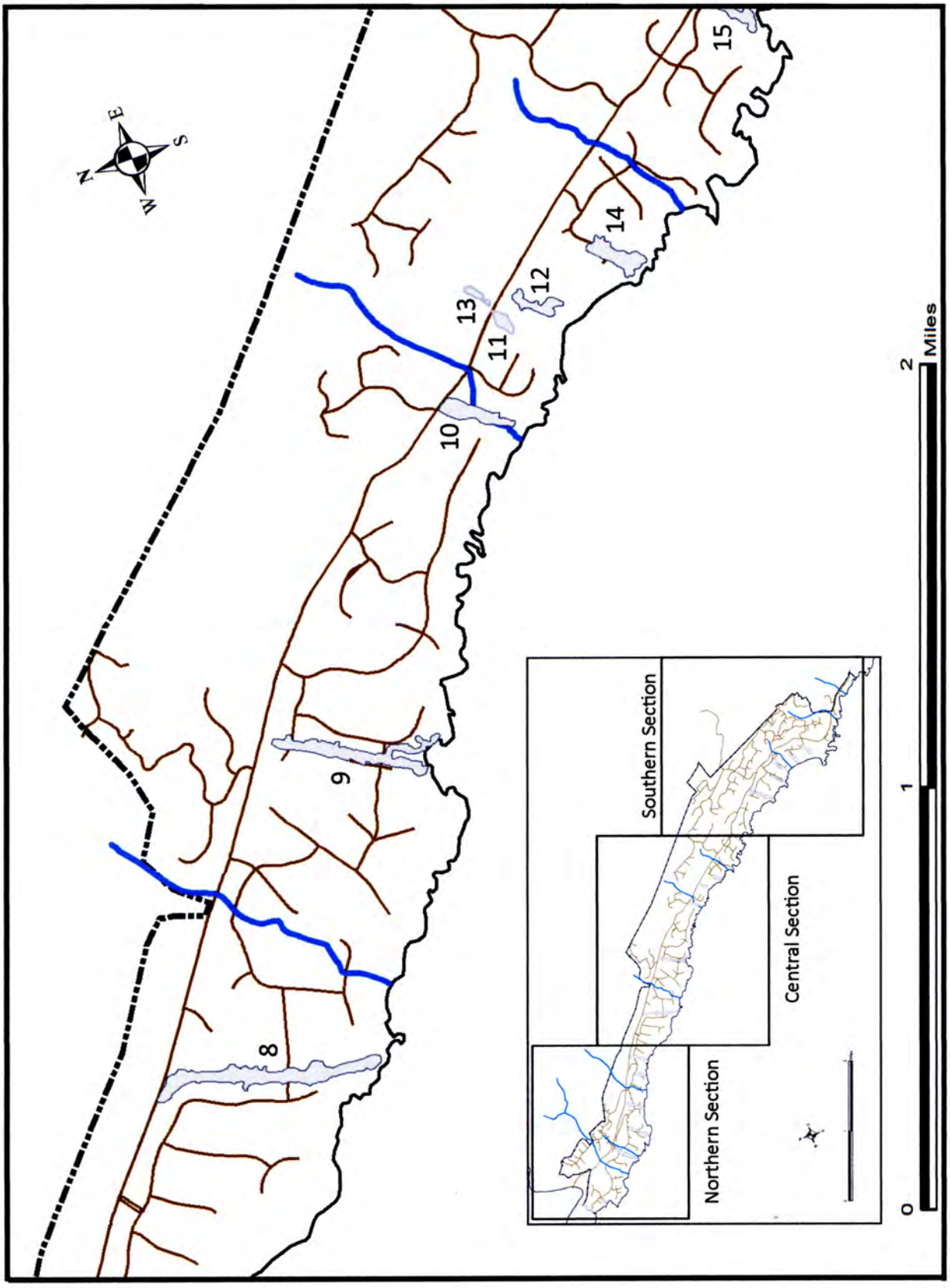
Site	Percent Tree cover	Tree Species	Comments	Recommended Treatment
1	0%	Previous strip of bishop pine along road has been removed	Appears to be stabilized as a grassland	Maintain current treatment to minimize fire hazard
2	5%	Bishop pine, Douglas-fir, wax myrtle	Invasion noted in 1991 report appears to have been arrested, some patches of wax myrtle have expanded	Maintain current treatment to minimize fire hazard
3	5% tree cover, 5% baccharis	Bishop pine, Douglas-fir, baccharis	Individual establishment of trees, expansion of baccharis	Needs more aggressive treatment to prevent spread of both baccharis and trees
4	15% primarily as individual trees with some clumps	Bishop pine, Douglas-fir, some baccharis	Regeneration of conifers and baccharis is under control due to grazing program	Maintain current treatment to minimize fire hazard
5	15% in isolated clumps and individuals that appears on the 1990 aerial photos	Bishop pine, Douglas-fir	Sheep and goat grazing have kept trees from invading this unit	Maintain current treatment to minimize fire hazard

Maps

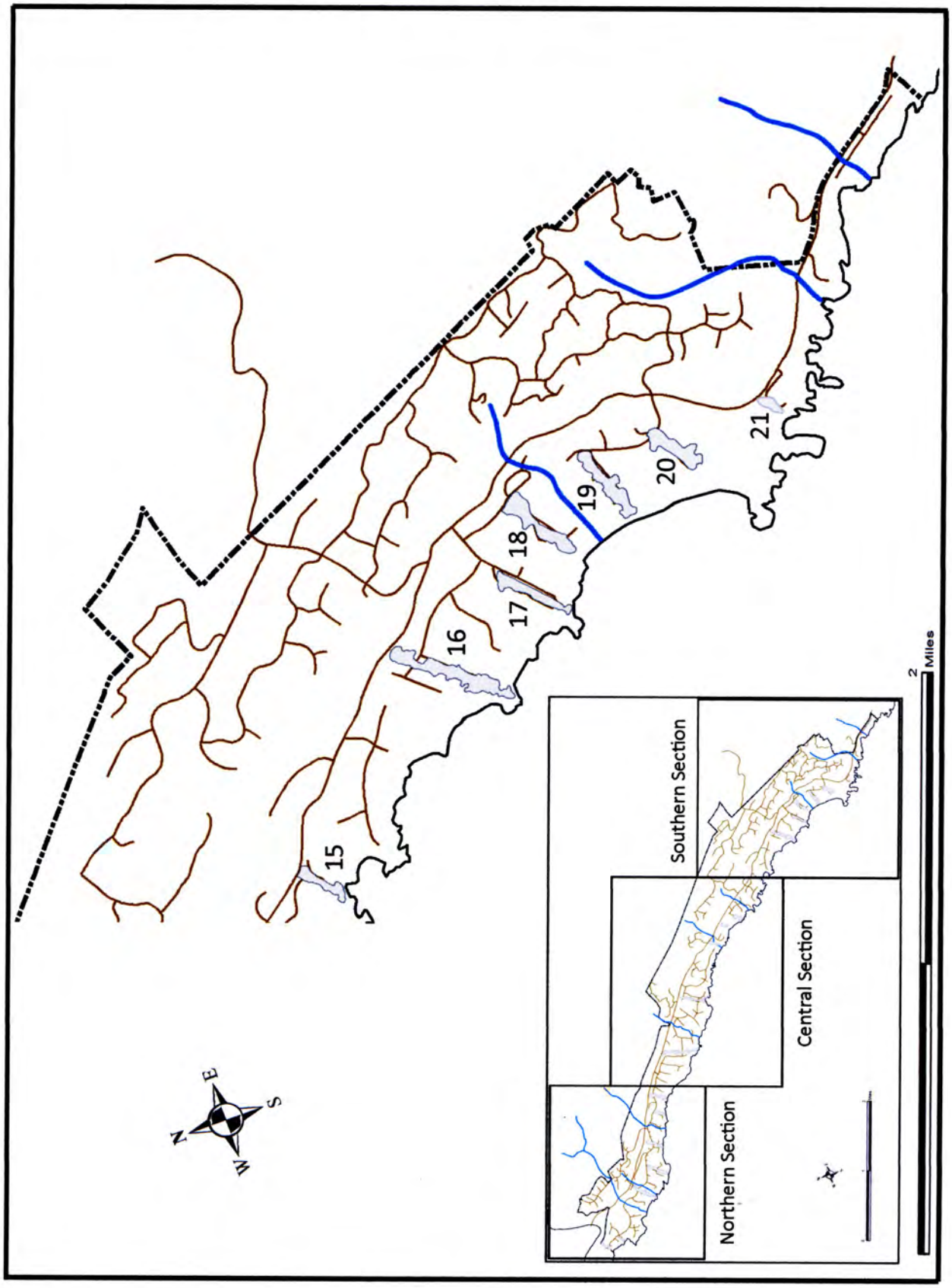
Map 1. Monterey Cypress Hedgerows – Northern section



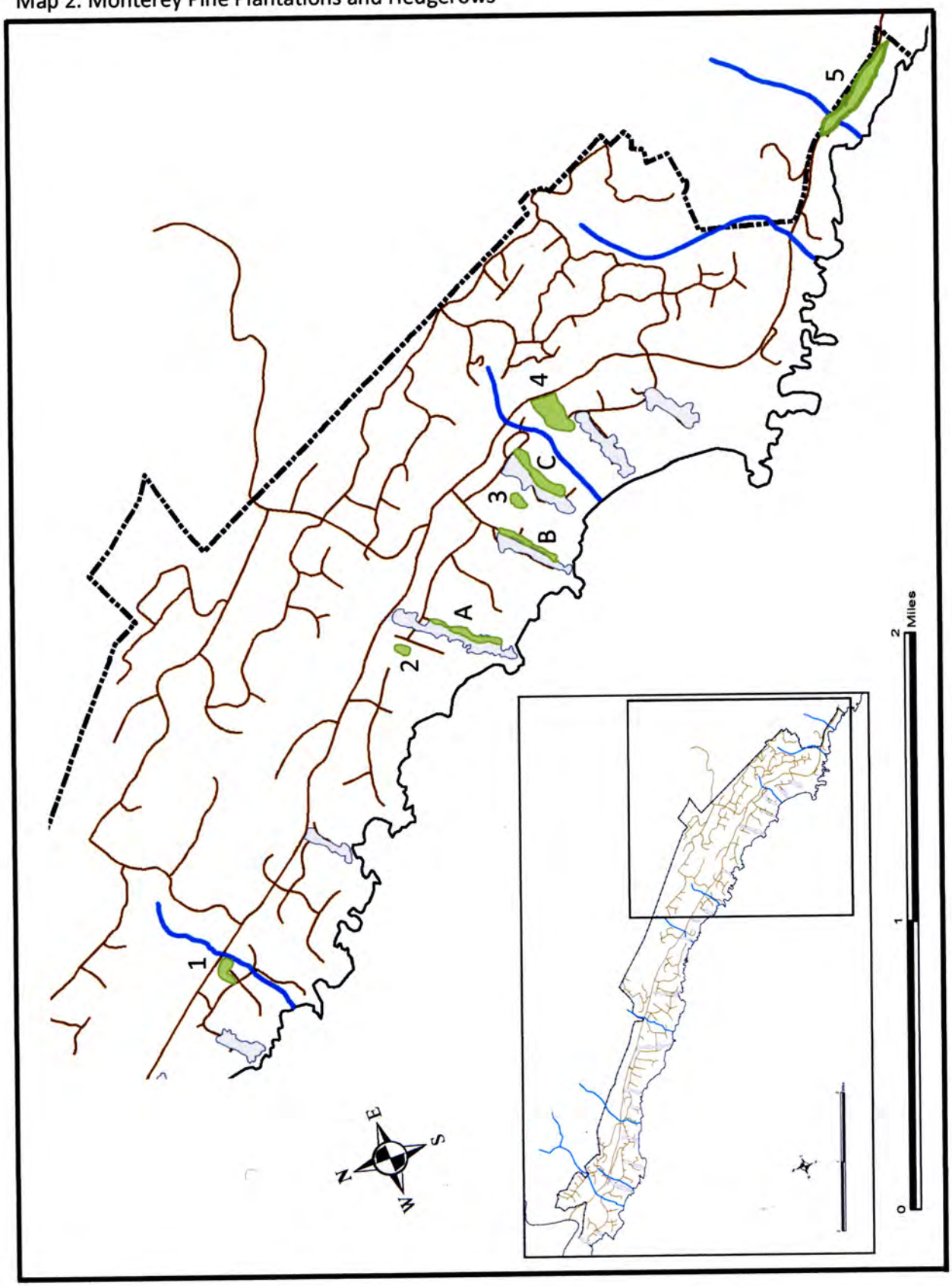
Map 1. Monterey Cypress Hedgerows – Central section



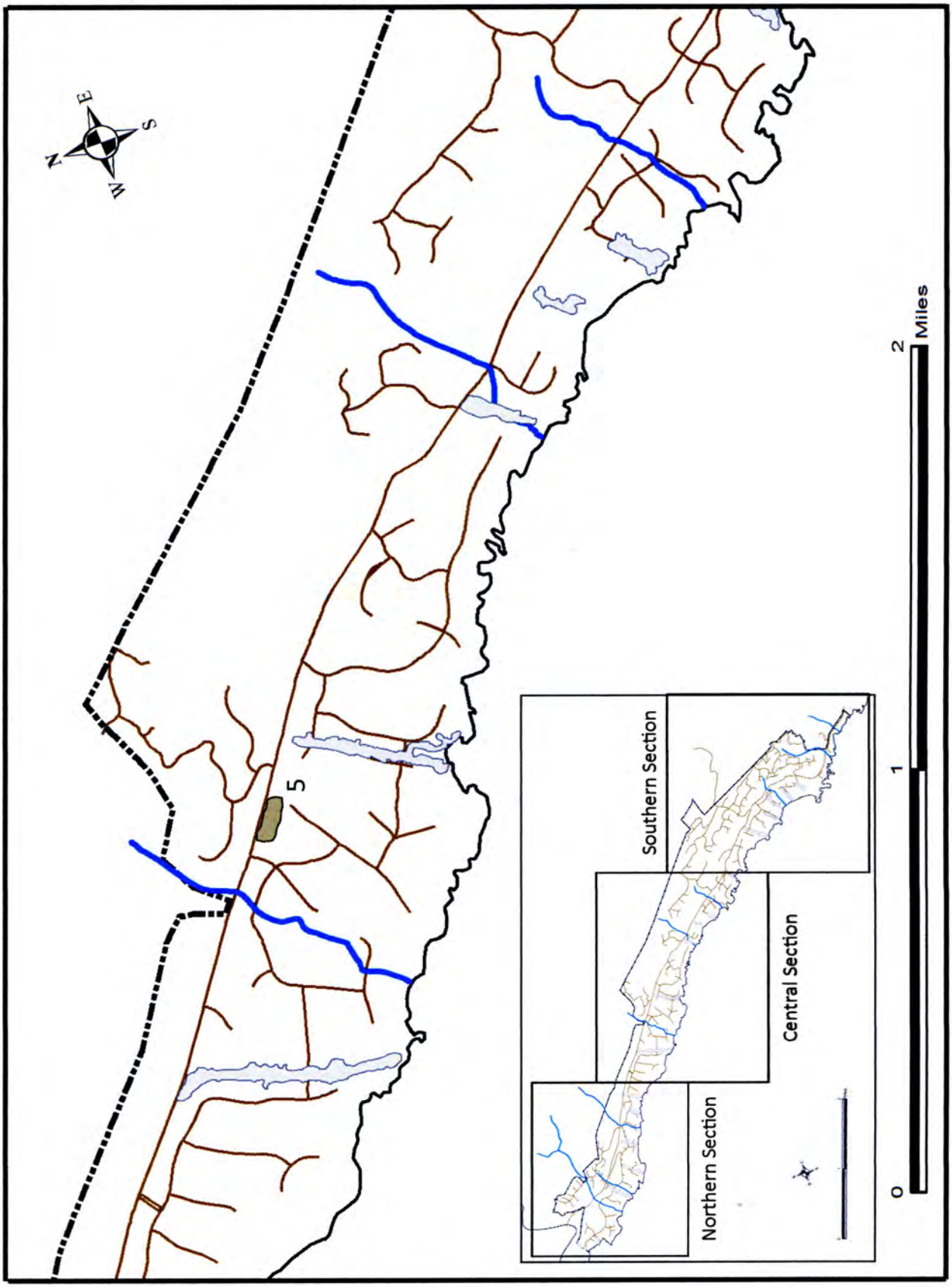
Map 1. Monterey Cypress Hedgerows – Southern section



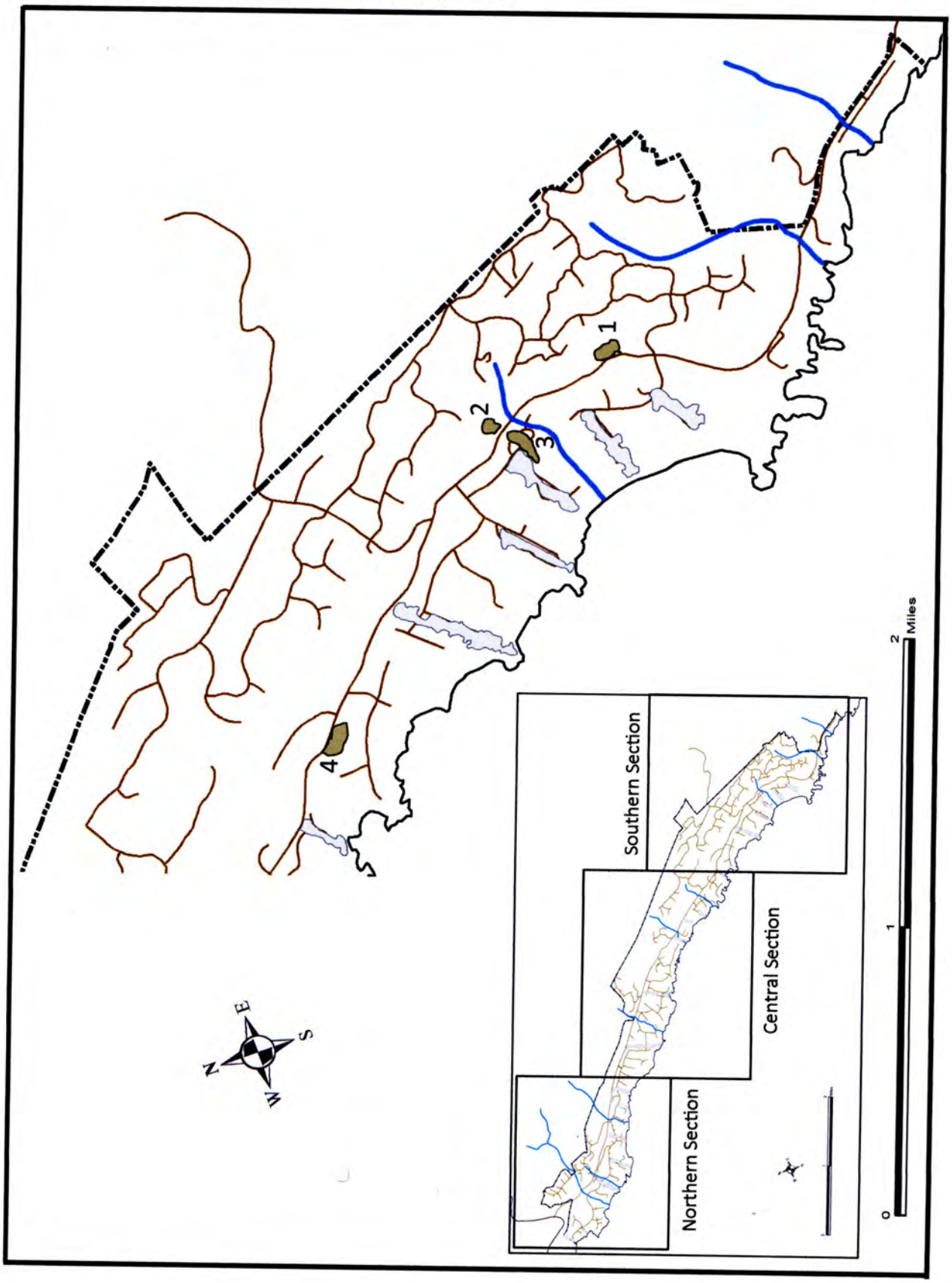
Map 2. Monterey Pine Plantations and Hedgerows



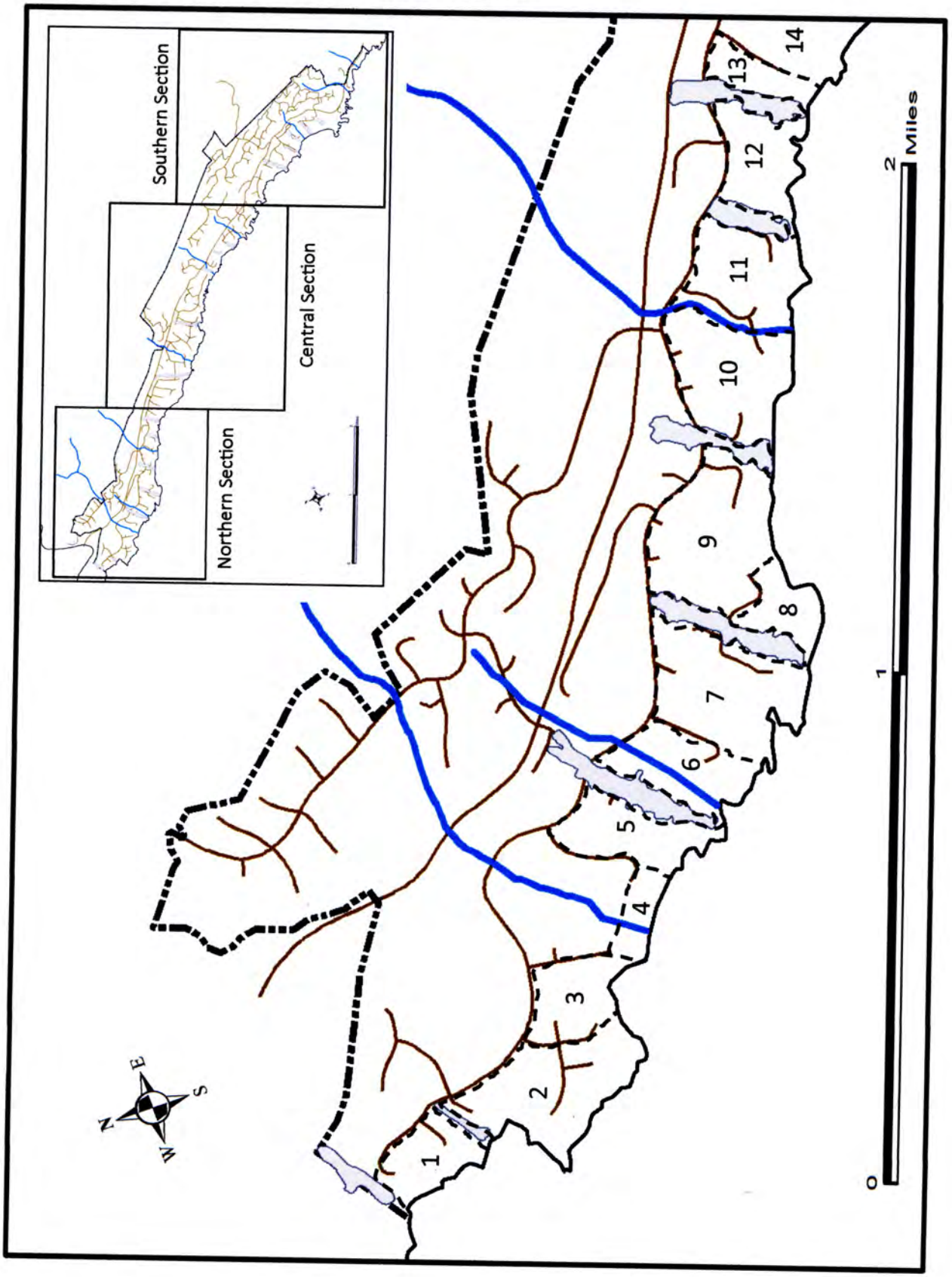
Map 3. Bishop Pine Plantations – Central Section



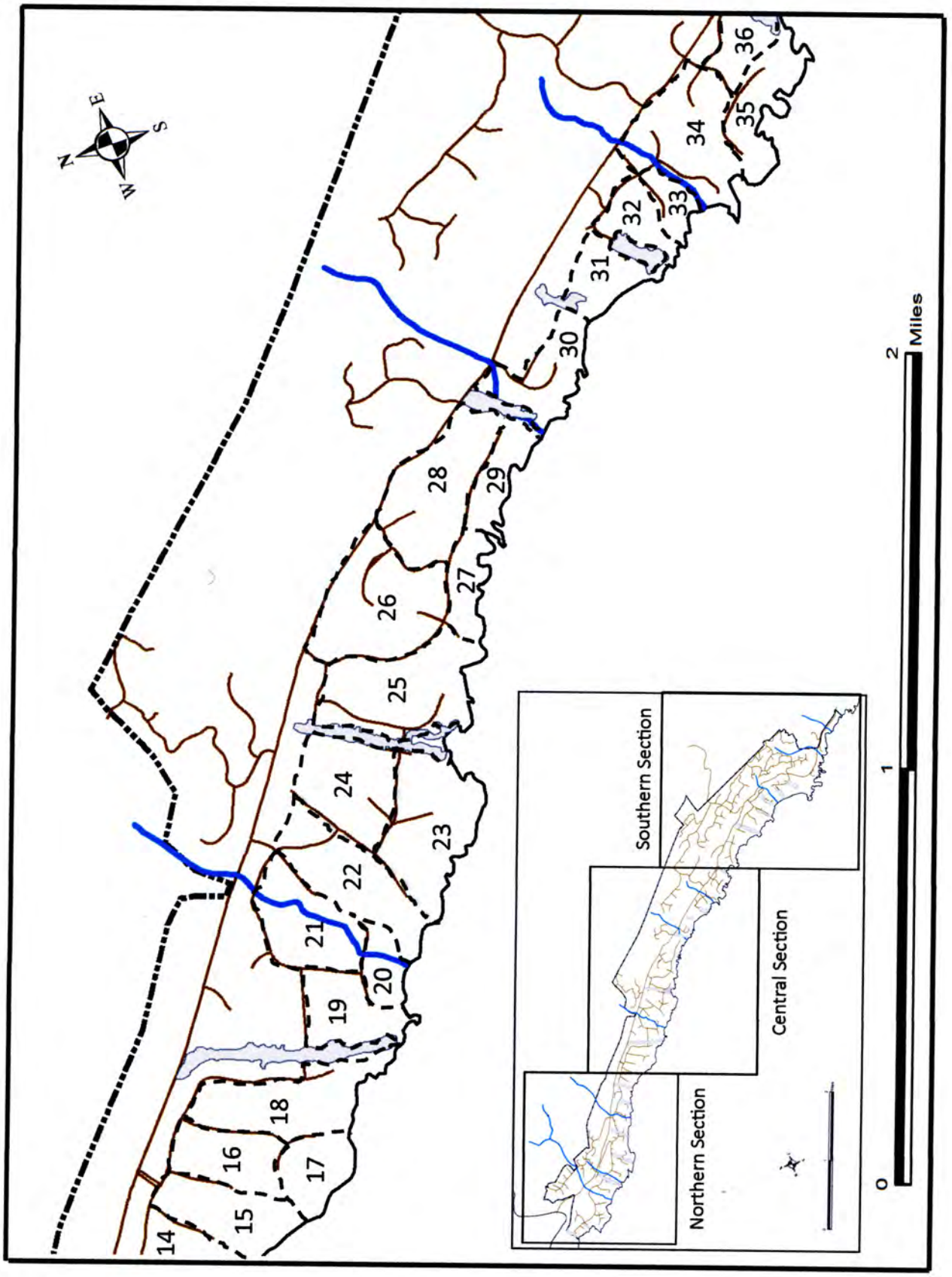
Map 3. Bishop Pine Plantations – Southern section



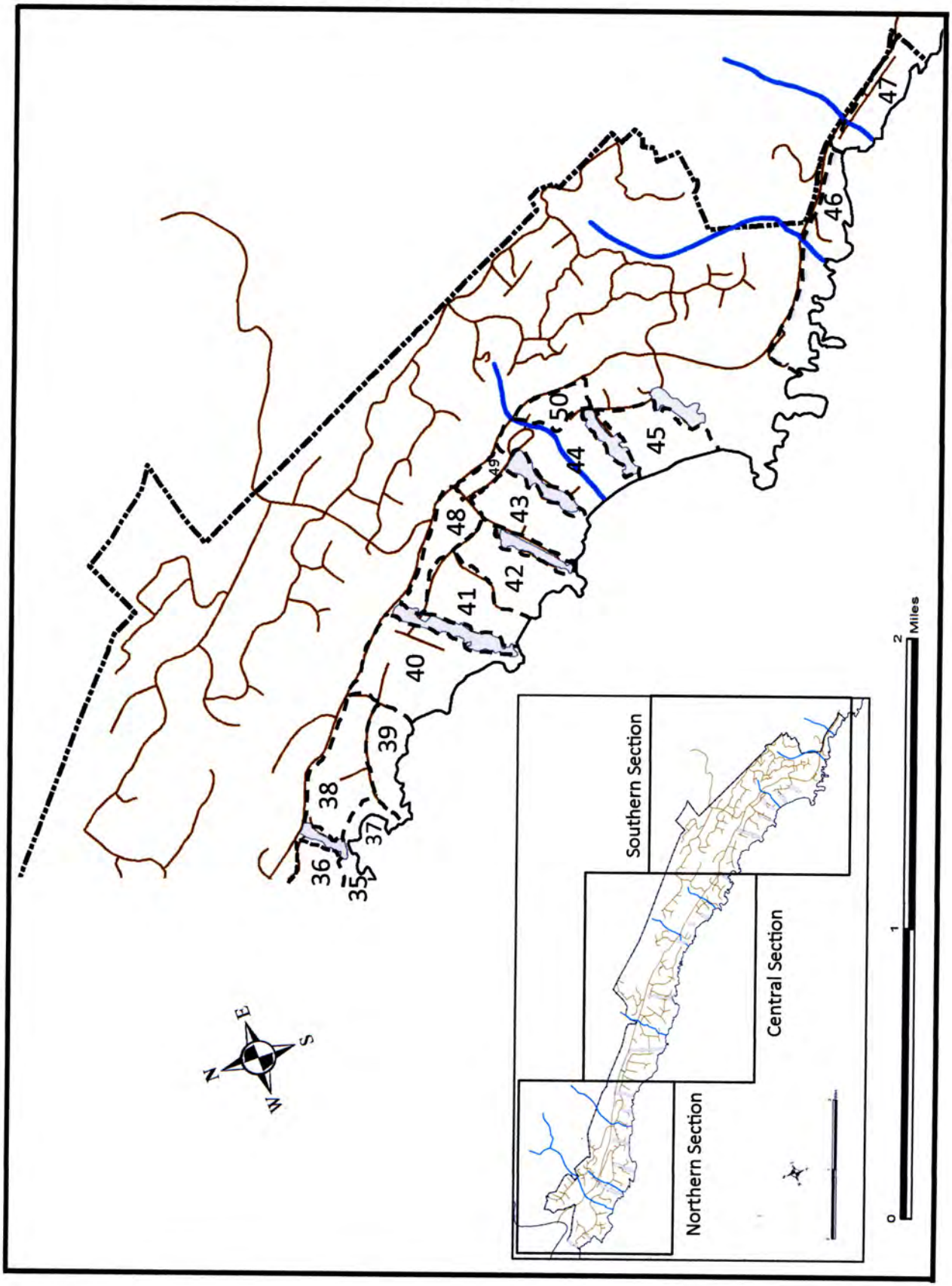
Map 4. Coastal Terrace Grasslands – Northern section



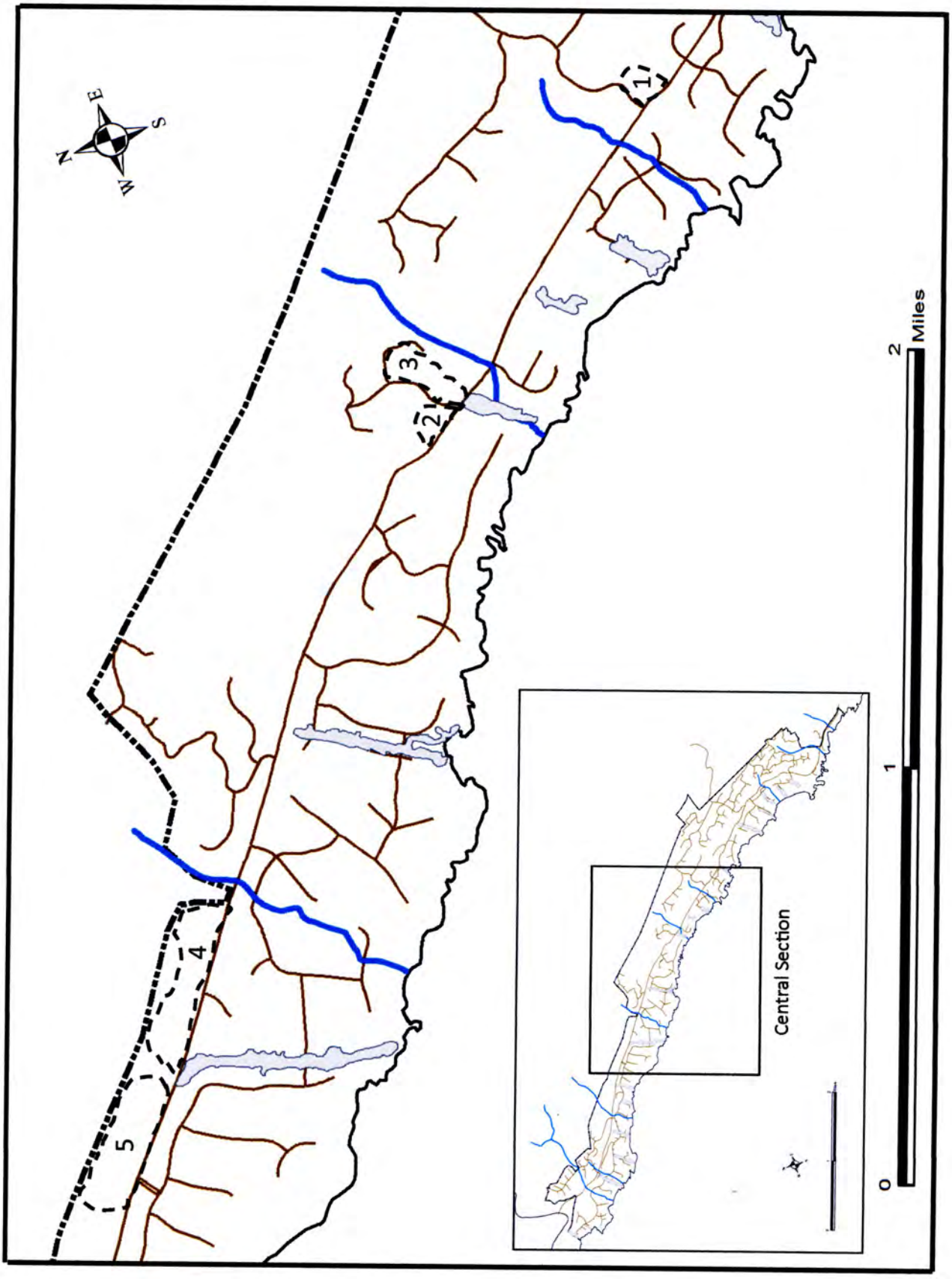
Map 4. Coastal Terrace Grasslands – Central section



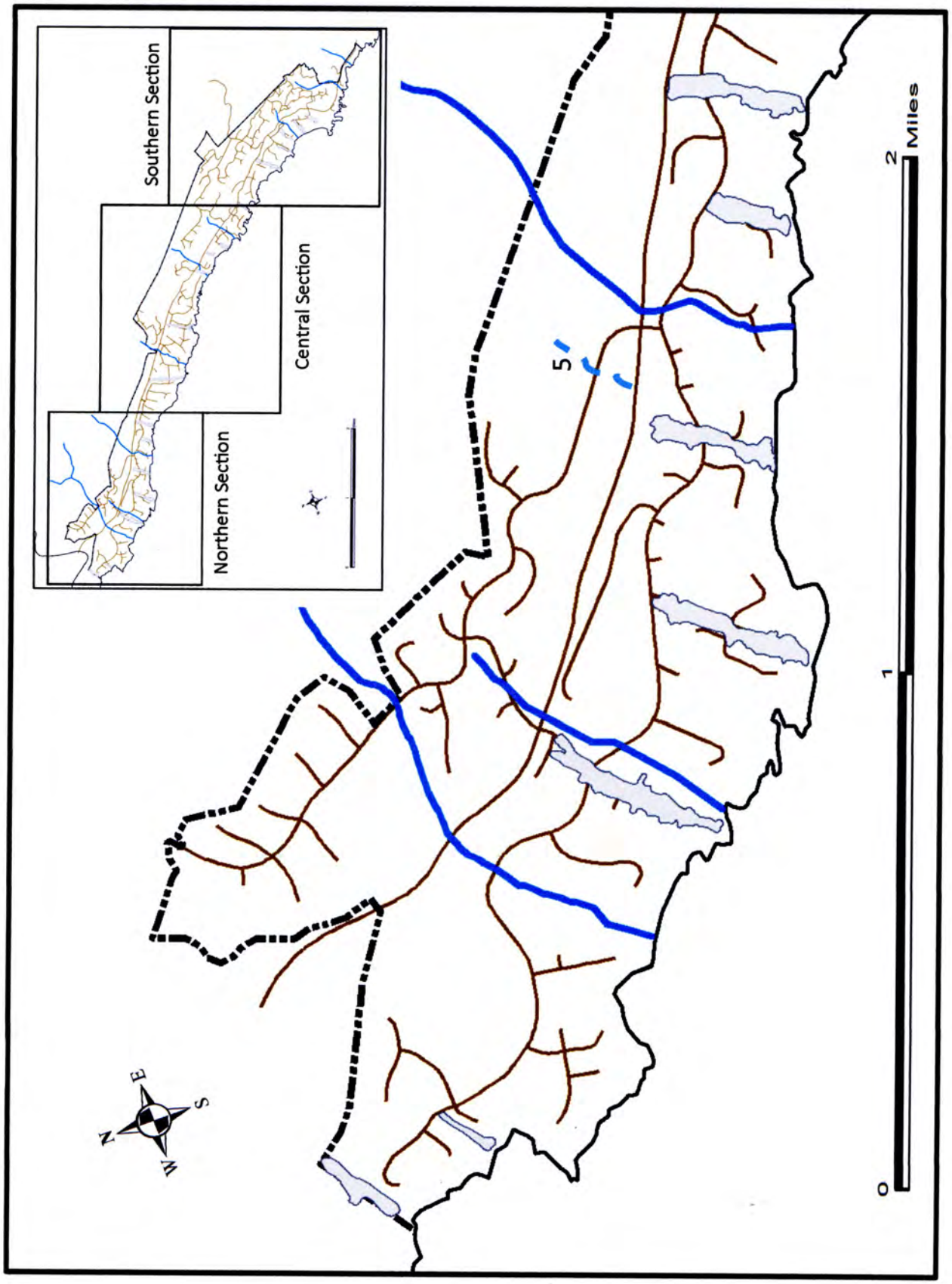
Map 4. Coastal Terrace Grasslands – Southern section



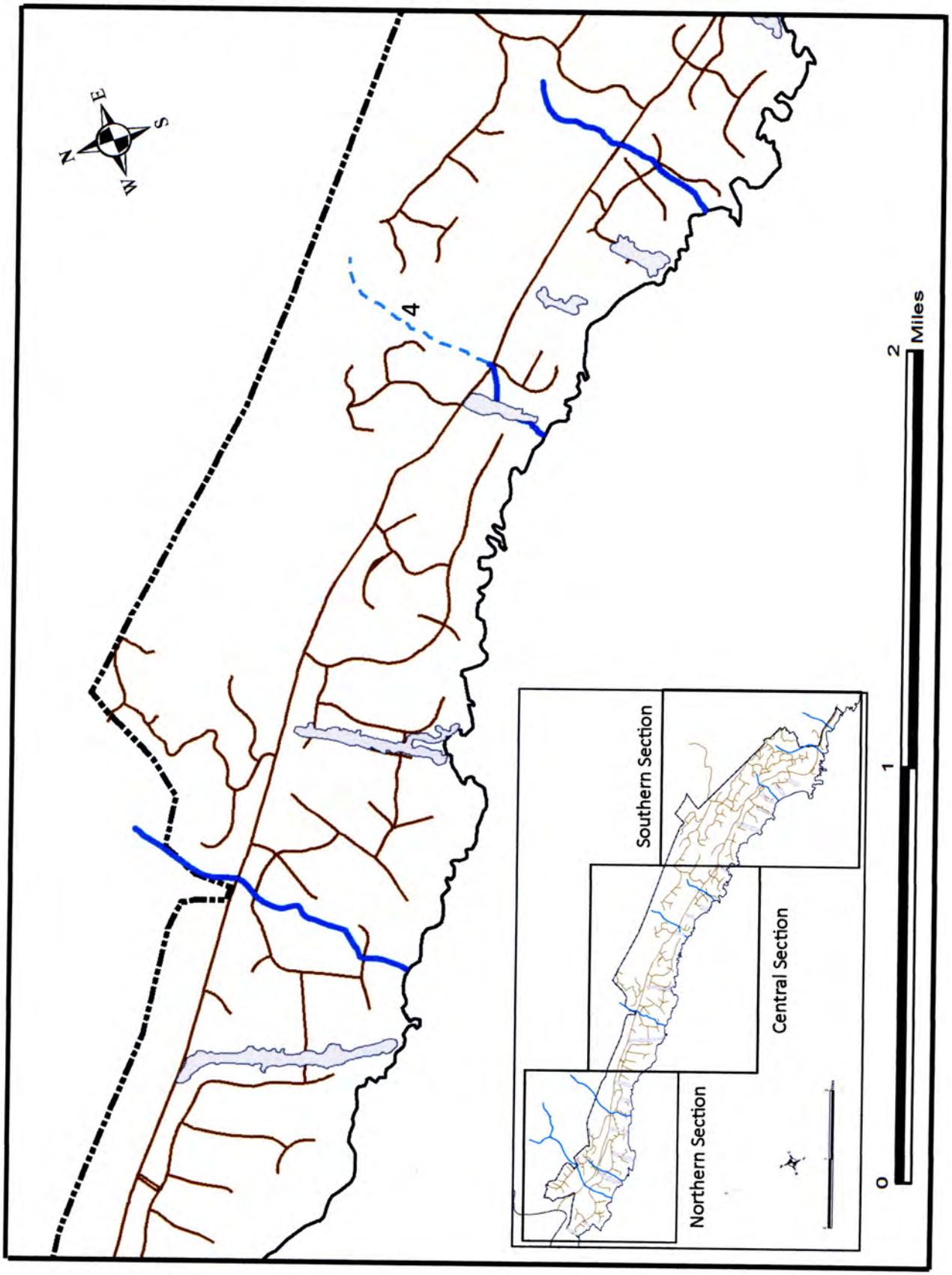
Map 5. Upland Grasslands



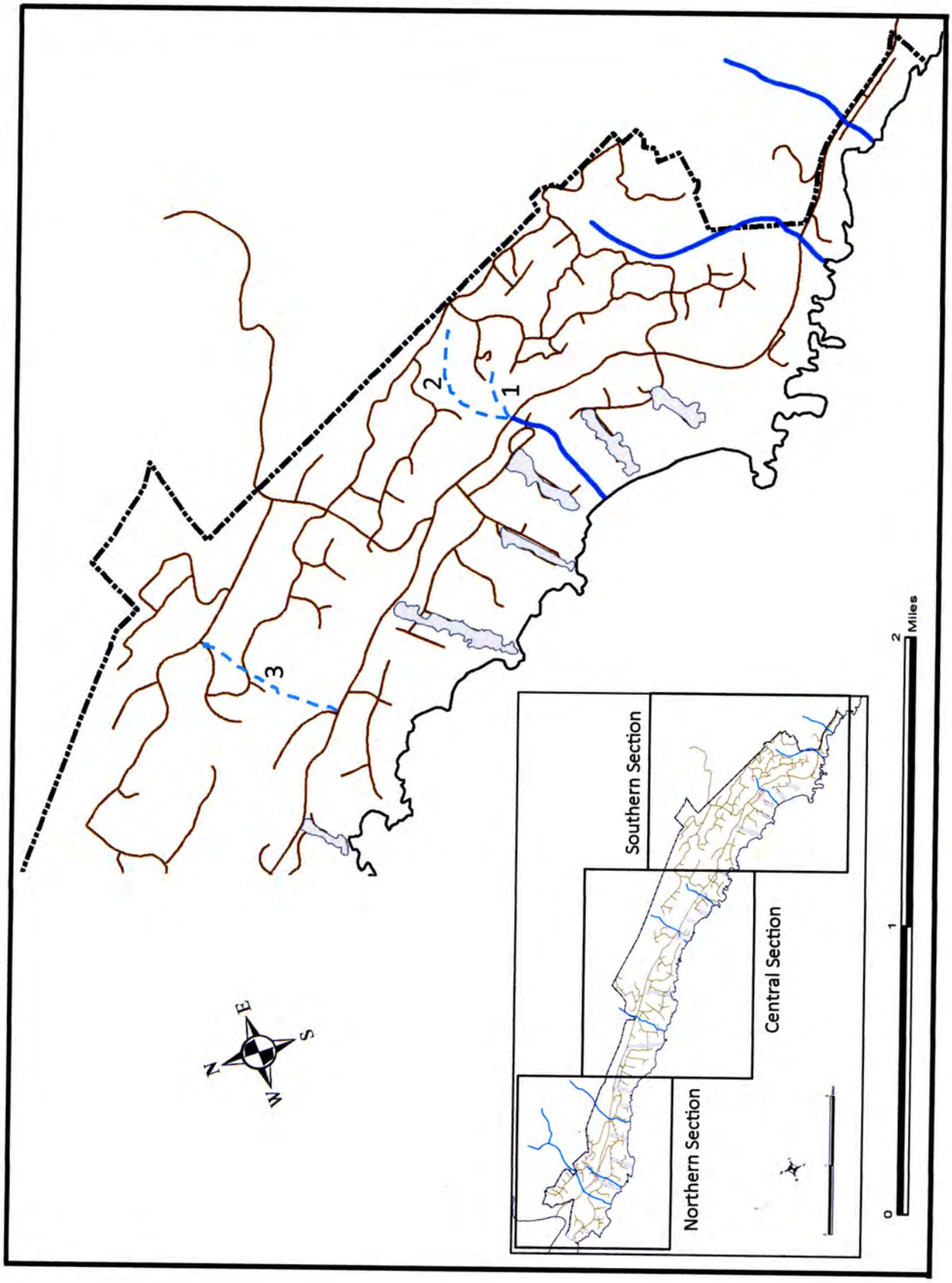
Map 6. Upland Riparian Zones – Northern section



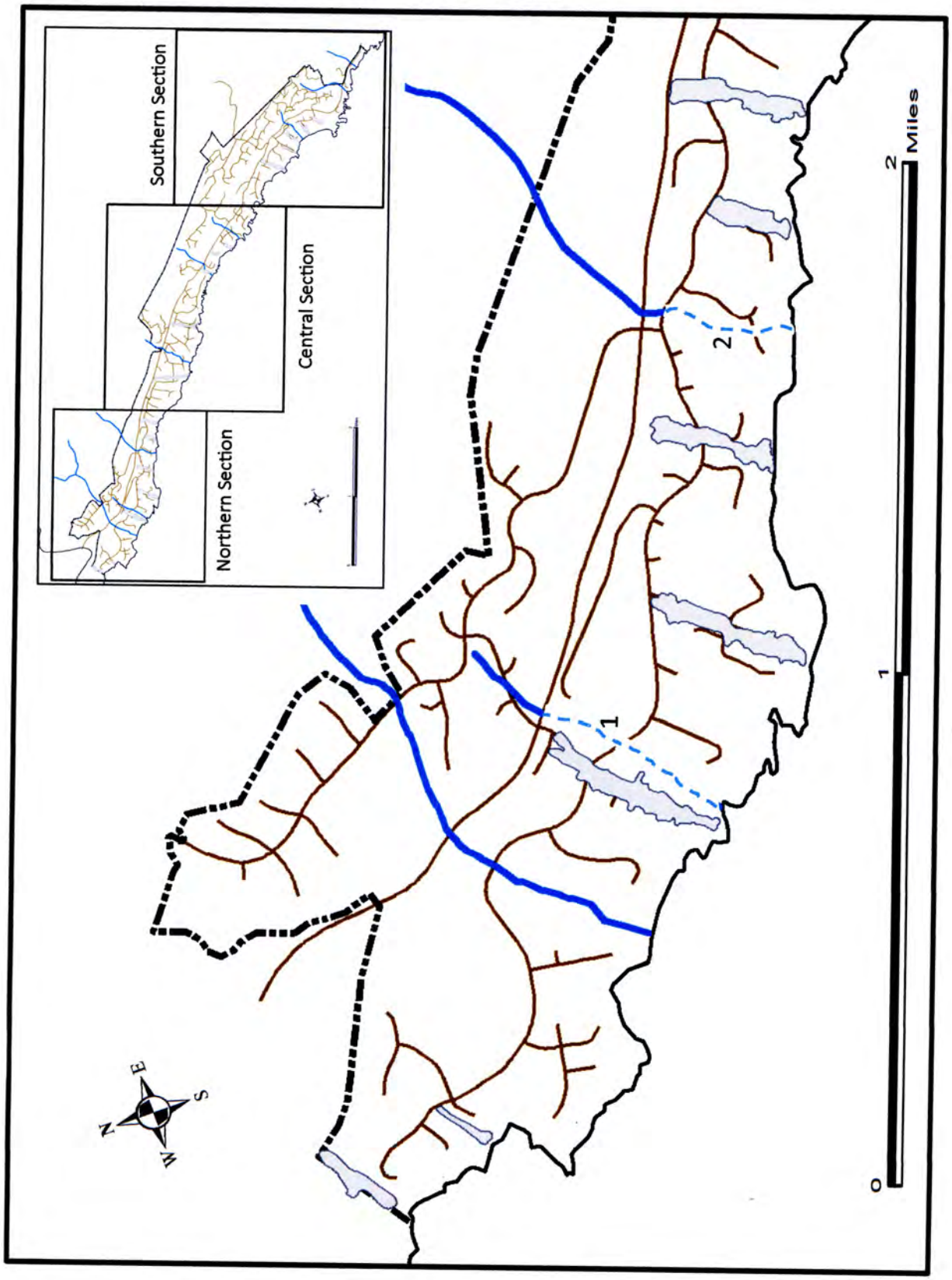
Map 6. Upland Riparian Zones – Central section



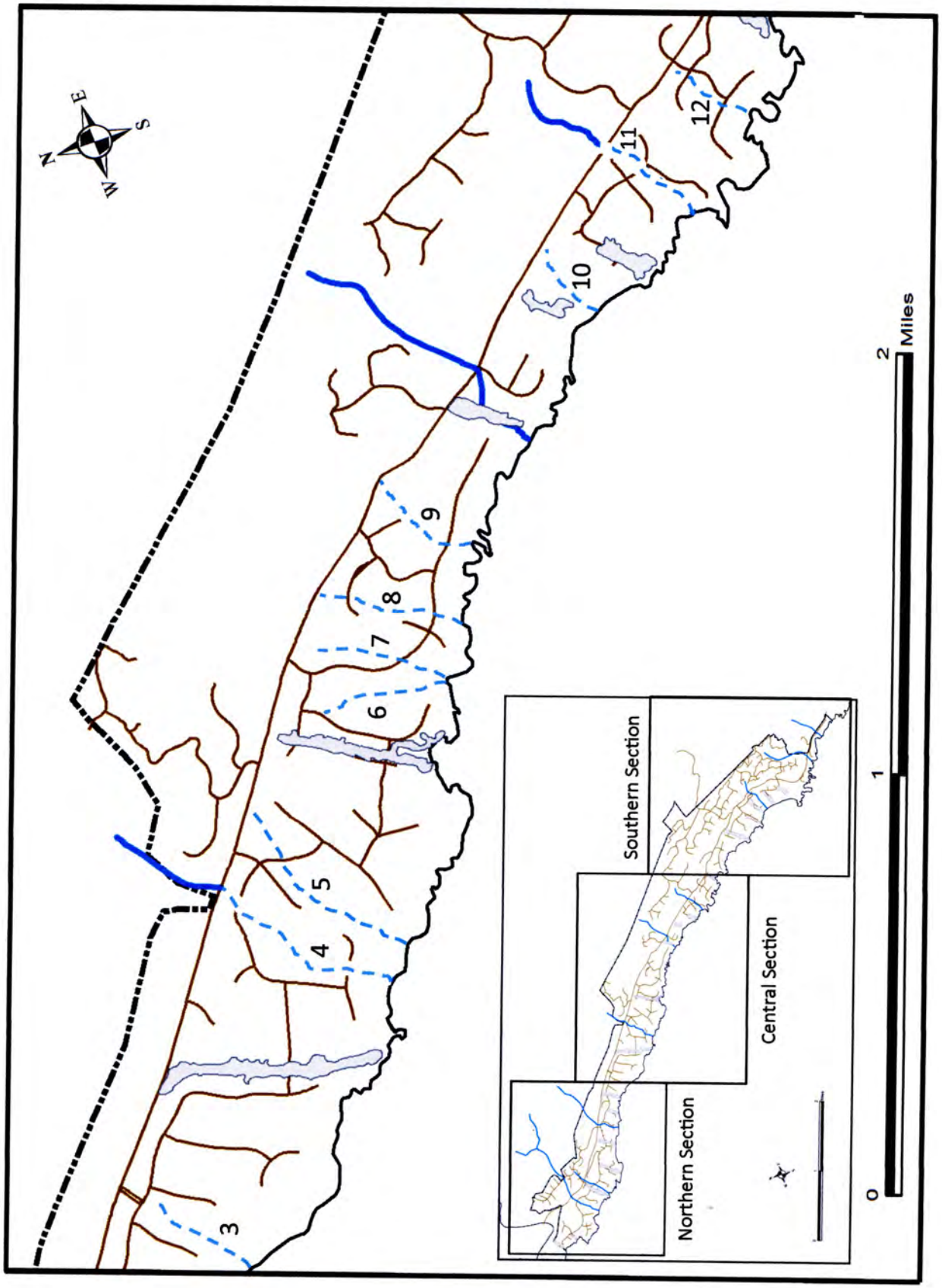
Map 6. Upland Riparian Zones– Southern section



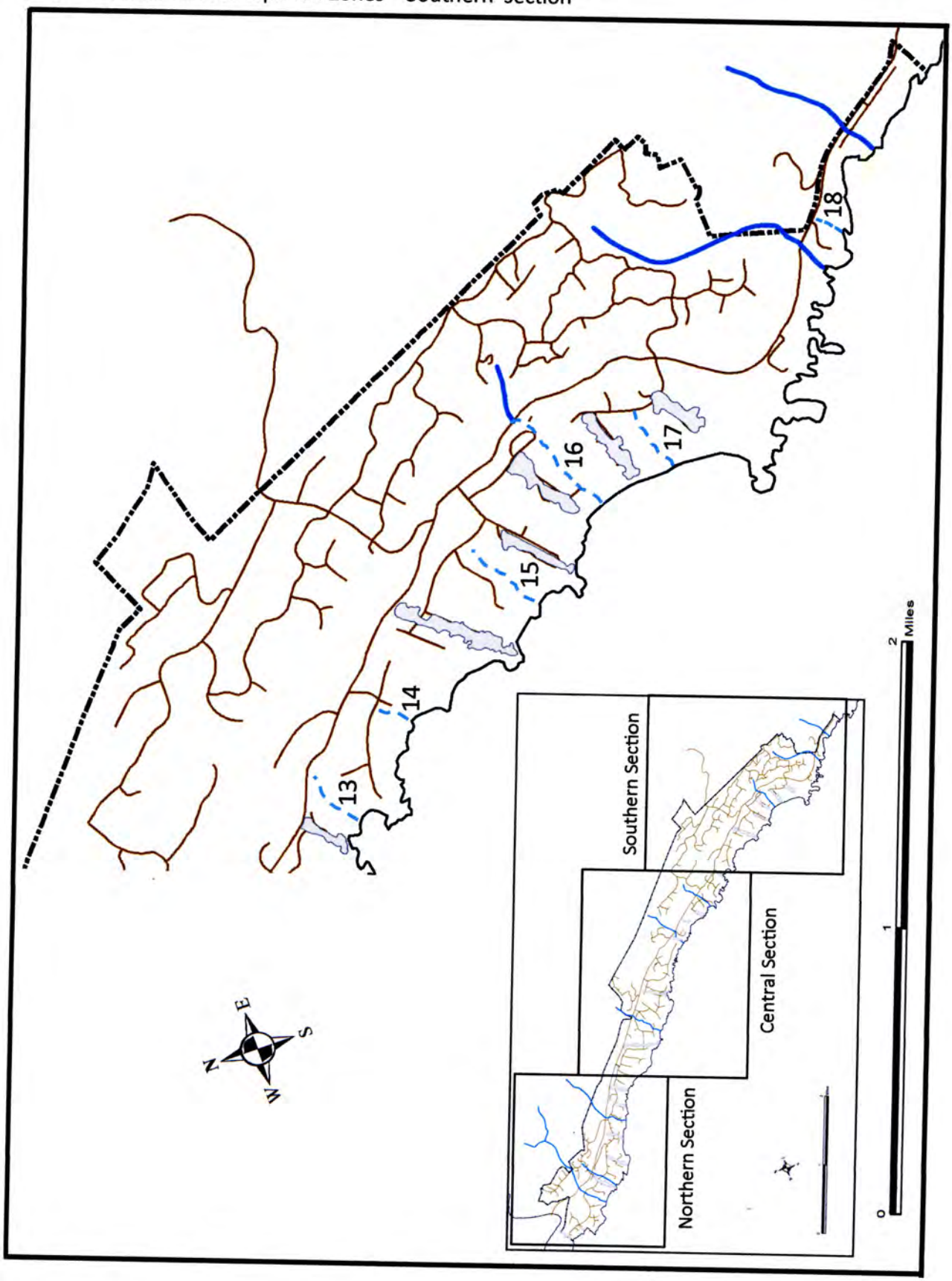
Map 7. Coastal Terrace Riparian Zones – Northern section



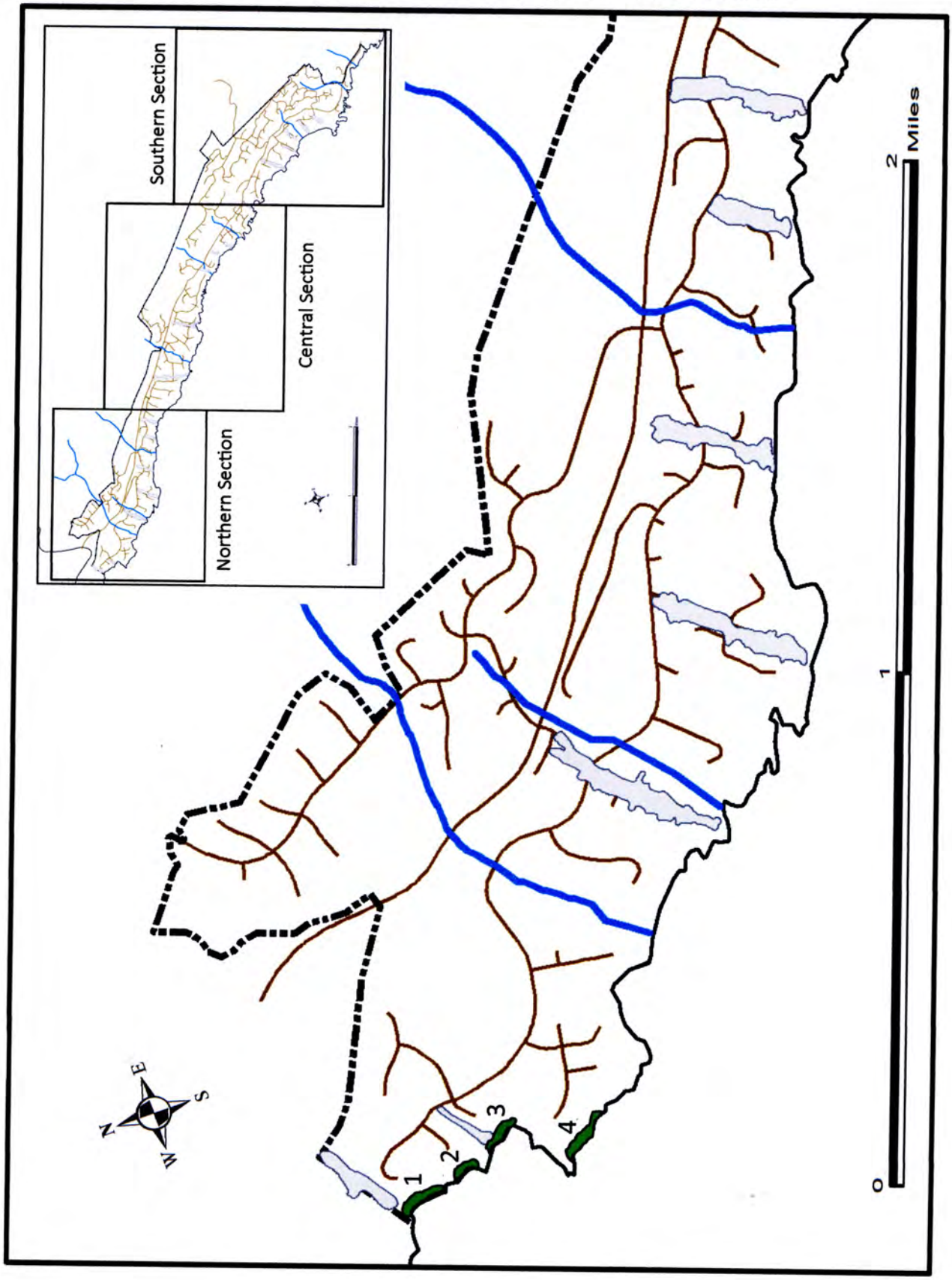
Map 7. Coastal Terrace Riparian Zones – Central section



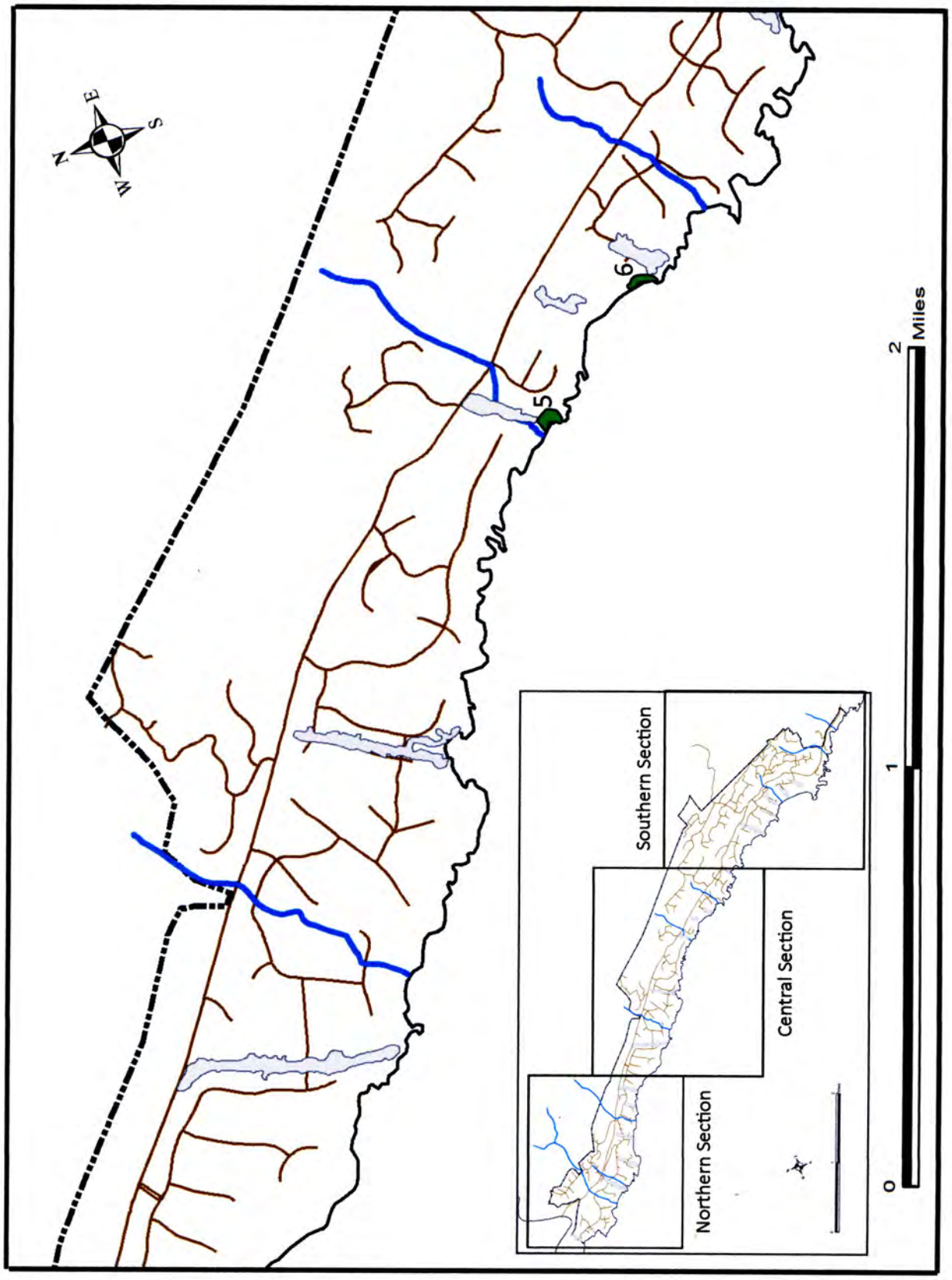
Map 7. Coastal Terrace Riparian Zones – Southern section



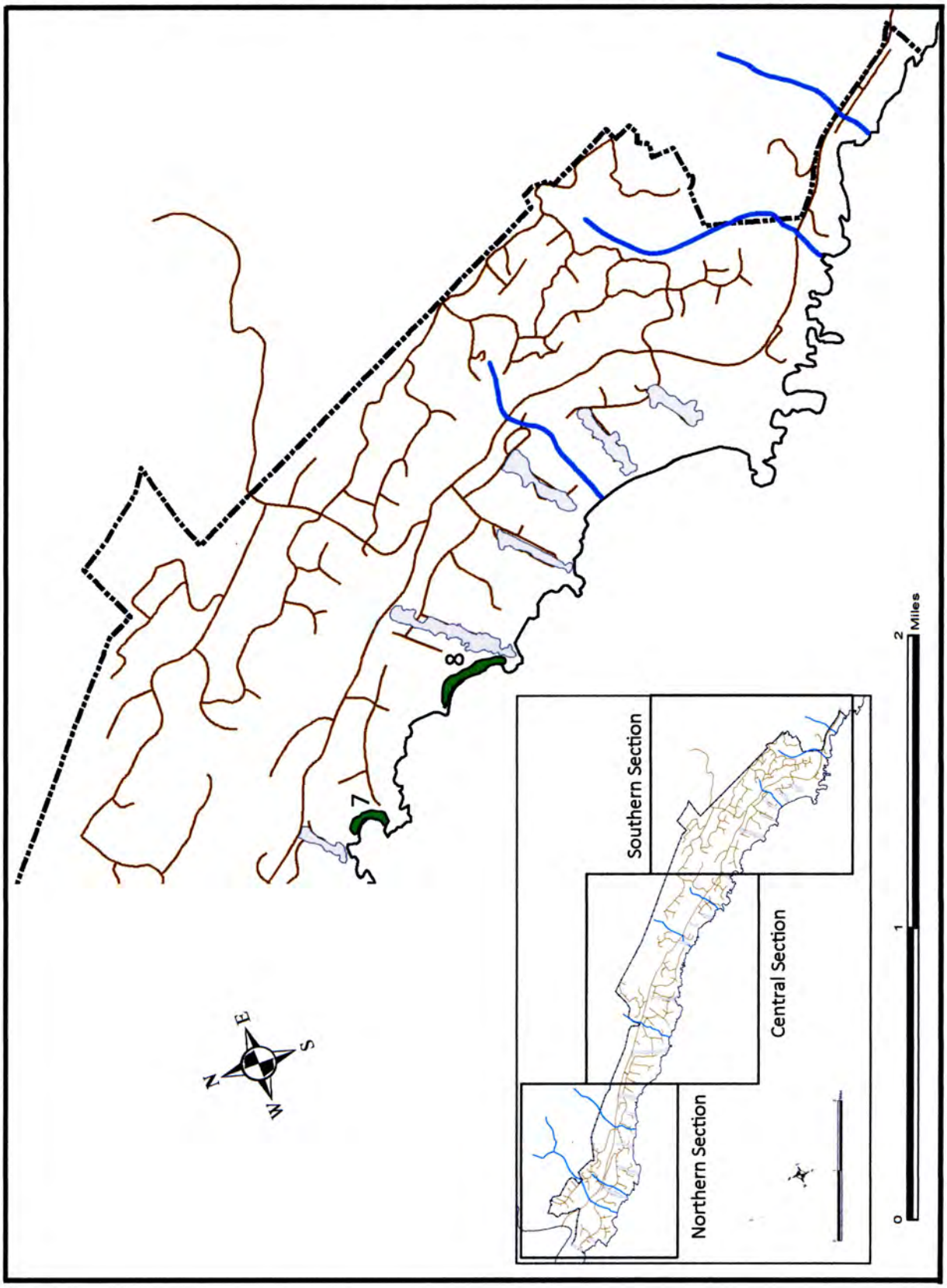
Map 8. Coastal Bluff Protection Plantings of Monterey Cypress – Northern section



Map 8. Coastal Bluff Protection Plantings of Monterey Cypress – Central section



Map 8. Coastal Bluff Protection Plantings of Monterey Cypress – Southern section



Appendices

Appendix 1

Forest Health at the Sea Ranch

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Forest health can be described as the conditions of a forest ecosystem that can sustain complexity while providing for human needs (Sampson et al.1994, *from* Kolb et al. 1994). Furthermore, a healthy forest is one that is resilient, meaning that it can recover from disturbances like wind, fire, or insects and disease, and also from human-caused disturbances. Therefore, forest health management objectives should promote dynamic forest functions, promote resiliency, and also satisfy human needs.

The interactions between a particular host (tree), injurious agent (insect and/or disease), and environment all contribute to forest health and resiliency. Environmental factors like temperature, drought, wind, moisture, and light affect growing conditions of trees (host). These same environmental factors can also affect the development of injurious insects and pathogens (agents). Likewise, host qualities (e.g. tree vigor) can regulate the potential occurrence of a particular agent, and vice versa. In general, host-environment fluctuations regulate agent population levels (Furniss and Carolyn 1977). This is where forest management can play a role. By manipulating particular stand characteristics (e.g. tree density), conditions can be created that can either favor or limit agent activity.

Previous investigations of the coniferous forests at Sea Ranch revealed that the overall health of the forest was good, and pathogens and insect populations were at endemic levels. Recently, small, isolated pockets of mortality of Bishop pine, Monterey pine, and shore pine were assessed to determine possible causes of mortality.

In a plantation of Bishop pines (from State Nursery stock at Davis) off of Sea Ridge Rd, recently dead and dying trees were assessed for insects and diseases. Ambrosia beetles and possibly other deep wood insects colonized all dead trees. This was confirmed by bark dissections on the lower bole where red and/or white powdery frass was present. No evidence of pine engraver galleries was found on the lower bole although colonization was likely higher up evidenced by scaling by birds and by a top down pattern of mortality (Bill Wiemeyer, personal communication). Gall rust was common on limbs and boles on all dead and surrounding living Bishop pines. The base of the needles on the surrounding trees appeared scorched with black sooty mold. Other than brown cubical butt rot and stringy rot on the dead trees (both common decay fungi), no other biotic diseases were confirmed. Forest understory growth of ferns, California buckthorn (*Rhamnus californica*), and grasses indicated that this may be a wet site (soils

were dry to 8" with no current surface water). Grand fir saplings in the understory exhibited 18-24 inches of internodal growth.

A mortality center of native Bishop pines at the end of Top Mast Rd was investigated; however, dead trees had been removed, so causes of mortality could not be verified. This same site was visited several years previously when Bishop pine mortality was first observed. It was estimated that half of the trees had died since then. Surrounding trees were asymptomatic, and there was no indication of a currently spreading mortality center .

Monterey pine sapling mortality had been observed by Sea Ranch personnel in a patch of forest at the end of Navigators Ranch Rd. However, all dead saplings had also been removed from the site. The remaining live saplings exhibited tip wilting most likely caused by root-related stress that can be caused by wet site characteristics, and perhaps wind-related stress. No external symptoms of root disease were present, other than tip wilting. Branch tips and boles (under 2 inches in diameter) were colonized by twig beetles.

Shore pine mortality along the Breaker Meadow Trail off of Breaker reach Rd was also assessed. These trees exhibited similar symptoms of mortality as Bishop pine. Twig beetles massively colonized small branches and tips. Larval mines in the pitch core of tips suggested colonization by tip borers. Colonization by mountain pine beetle or pine engraver could not be verified although exit holes and golf ball fungus were present. Ambrosia beetles and possibly other deep wood insects also colonized dead trees. Upper and lower portions of the boles showed signs of scaling by birds.

Potential disease progression of Monterey cypress was monitored in a windbreak near the Del Mar Center along Leeward Road. Many trees exhibited thin crowns typical of root-related stress. Probable infection appears to be spreading southwestward down the hedgerow. Previous sampling for armillaria root disease could not be confirmed by lab analyses. Prior soil treatments of Vitra © were successful in retarding the progression of the suspect disease, but not restoring the trees to a healthy condition.

No single causal agent could be attributed to mortality at any of the recently investigated sites. Recent studies have indicated a decline in fog frequency in Sonoma County along the Northern California coast that may be contributing to heightened drought sensitivity of coastal endemic plant communities like Bishop pine and Shore pine (Johnstone and Dawson 2010) . Shore pine grows best in the overstory in open patches of full sun. A loss of tree vigor resulting from crowding and shading (Reeb and Shaw 2010) can be exacerbated by drought-related stress and lead to vulnerability to attack by primary tree-killing bark beetles and secondary insects. Further investigation into coastal Bishop pine mortality revealed that most stands are even aged, and populations are at the end of their lifespan of 80-100 years (T. Scholars, personal interview). This seems to be consistent with findings at the Sea Ranch.

Potential injurious agents of Sea Ranch trees

Several tree pathogens and insects occur in the forests at and adjacent to the Sea Ranch and can potentially become forest health problems as individual trees, forest plantations, and native forest stands become older. Climatic conditions as well as management practices (e.g., spread of pathogens via uncleaned tools) can also influence health of individual trees and forest stands. In many cases the health of individual trees can be maintained with attention to water stress during drought years, but otherwise generally avoiding the overwatering of trees. It is also recommended that judicious pruning be used to remove infected branches of individual trees showing symptoms of infection by pathogens or attack by insects. Clippings from branches should be mulched or completely removed from the site to avoid creating potential breeding sites for injurious insects. Tree health in forest plantations and native forest stands can best be served by thinning of plantations to avoid increasing levels of tree stress as the trees grow older. Removal of individual trees showing signs of attack by insects and pathogens is also recommended to reduce forest pest populations. Where these practices have been conducted at the Sea Ranch, especially the thinning of Bishop pine plantations, the remaining trees have avoided many of the pest problems observed in unthinned plantations.

The following paragraphs describe the more common fungal pathogens and insects that can be problems for tree species occurring at the Sea Ranch.

MONTEREY PINE (*Pinus radiata*) and **BISHOP PINE** (*Pinus muricata*) are most vulnerable to pitch canker caused by the fungus *Fusarium circinatum*. Tip wilting, branch dieback (flagging), and bole cankers are the most common symptoms of pitch canker. Abundant resin production usually accompanies dieback (Wood et al. 2003). Trees exhibiting these symptoms should be further evaluated by the U.C. Cooperative Extension Forestry Specialist for positive identification. Gall rust and dwarf mistletoe are also common disease agents at Sea Ranch, and manifest similar symptoms of tip dieback and branch flagging. Infected or weakened Monterey pines are vulnerable to attack most commonly by red turpentine beetles (*Dendroctonus valens*), and weakened Monterey and Bishop pines are both susceptible to colonization by engraver beetles (*Ips* spp.). Other common insects on both pines include cone beetles (*Conopthorus* spp.) that can infest the base or stem of the cones causing immature cones to die, and twig beetles (*Pityophthorus* spp.) that typically colonize shaded out or dying tips and small branches of otherwise healthy trees. The western tip borer (*Eucosma sonomana*) also colonizes Bishop pines and can result in lateral shoot mortality (Wood a et al. 2003). All of the previously mentioned forest beetles (excluding tip borers) are known vectors of pitch canker.

SHORE PINE (*Pinus contorta* var. *contorta*), although less common at Sea Ranch, is susceptible to all of the above mentioned agents including pitch canker. Weakened shore pines are susceptible to attack by red turpentine beetle, pine engravers, shore pine bark beetle (*Pseudohylesinus pini*), and mountain pine beetle (*D. ponderosae*) (Furniss and Carolin 1977; Reeb and Shaw 2010).

DOUGLAS-FIR (*Pseudotsuga menziesii*) is also susceptible to pitch canker, but occurrence is extremely rare. A more common disease on coastal Douglas-firs is

phomopsis canker (*Phomopsis lokoyae* or *Diaporthe lokoyae*). Branch and leader dieback are initial symptoms, and smaller trees up to 3.5 inches in diameter can be killed by this disease (Wood et al. 2003). Dwarf mistletoe also infects Douglas-firs, and causes similar branch and tip dieback. Blackstain root disease (*Leptographium wageneri*) is a particular problem of younger dense stands of Douglas-fir along the coast, but it is also a threat to mature stands as well. Loss of tree vigor, crown deterioration, and mortality are symptoms of the disease, but a "black stain" of the sapwood of infected roots is more characteristic (Wood et al. 2003). Diagnosis of blackstain should be confirmed by the U.C. Cooperative Extension Forestry Specialist. Infected or weakened Douglas-firs are susceptible to attack by the Douglas-fir engraver (*Scolytus unispinosis*) and the Douglas-fir beetle (*D. pseudotsugae*). Douglas-fir is also host to *Hylastes* spp. that can kill weakened saplings by feeding at or below the root collar (Furniss and Carolyn 1977), and is a suspected vector of blackstain root disease (Wood et al. 2003). Just like pines, twig beetles (*P. orarius*) typically colonize shaded out or dying tips and small branches of otherwise healthy trees.

TANOAK (*Notholithocarpus densiflorus*) until recent years has been relatively free of serious injurious agents. In fact, little was known about the insect-disease associates of tanoak presumably because it has been of little economic importance other than as a pest species in most economically important sites like in redwood forests. However, native tanoak stands along coastal central California and southern Oregon have been ravaged by *Phytophthora ramorum*, the causal agent of so called Sudden Oak Death (SOD). Little is known about the spread of SOD although current theories suggest that it may be spread through water splash or wind-driven rain like similar organisms belonging to the same class of water molds. Tanoak is highly susceptible to SOD and efforts should be increased to monitor for SOD infection at Sea Ranch. The most common symptoms in tanoak are "oozing" or bleeding along the lower bole separate from wounds or cracks, and/or dead spots on leaves that are irregular in shape and large compared to the overall size of leaf (suddenoakdeath.org). There are many other similar symptoms that can be caused by other agents, so diagnosis and sampling should be completed by the U.C. Cooperative Extension Forestry Specialist, or contact the Assistant Agricultural Commissioner at the Sonoma County Agricultural Department for further guidance.

MONTEREY CYPRESS (*Cupressus macrocarpus*) is commonly planted in hedgerows as windbreaks throughout Sea Ranch, and for this reason is particularly vulnerable to fungal root diseases. The most common fungal root diseases that affect Monterey cypress are annosum root disease (*Heterobasidion annosum*) and *armillaria* root disease (*Armillaria mellea).* Both root diseases spread root-to-root and *annosum* spores can inoculate the host through wounds or stumps. Hedgerows should continue to be monitored for thinning crowns and loss of tree vigor. Disease identification is tricky as fruiting bodies produced by each fungus can be elusive or rare, and disease confirmation requires lab analysis. If diseased, dead, or asymptomatic Monterey cypresses are removed, stumps should be completely pulverized or treated with borax to minimize infection by annosum root rot. Cypress canker (*Seridium cardinale*) is another potential disease problem for these hedgerows, as well as for Monterey cypresses planted in the upland area. The disease occurs when the cypress canker fungus attacks the living bark or cambium of living trees, progressively killing the outer tissue. Dieback starts at the top

and outer branches of the tree and progresses towards the trunk until the entire tree is killed. Cypress bark moth (*Laspeyresia cupressana*) is a common associate of cypress canker, and branch and bole feeding often produces similar symptoms of swelling and resin flow (Frankie and Koehler 1967). Mortality is more common from cypress canker than from cypress moth. The only other potential pest of Monterey cypress is the cedar bark beetle (*Phloeosinus cupressi)* that typically attacks the bole and large branches of weakened and dying trees. Cedar bark beetles can accelerate the death of trees infected with cedar canker, and may be vectors of cypress canker (Furniss and Carolin 1977).

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Appendix 2

Upland Forest Area

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In 2009 a Forest Management Plan (FMP) was created by Edward A Tunheim Consulting Forester to assess conditions on The Sea Ranch's Central Timber Production Zone (also known as the Central TPZ). That FMP was created with the purpose of doing several things for The Sea Ranch Association (TSRA);

1. The primary purpose of the original FMP was to provide the Association, and its Board with the necessary information and guidelines to make decisions about forest resources and how to manage them.
2. A secondary purpose of the FMP was meant to qualify TSRA for cost share programs from State and Federal sources (CFIP and EQUIP). These funds help with the costs associated with fuel hazard reduction projects, planting projects, thinning and pruning projects, erosion control, and wildlife habitat restoration.
3. Some of the information that was collected during the creation of the FMP was also meant to show where problems existed and how they could be corrected. Issues like erosion problems, dealing with sudden oak death and fire prevention recommendations were made.

The Forest Management Plan collected data on trees, road, trails, fuel breaks, and other biotic and abiotic issues in the summer of 2009. At the heart of the FMP was a forest inventory that looked at the entire Central TPZ. This inventory sampled approximately 3 percent of the Central TPZ to obtain this baseline data. Forty-three 1/5 acre radius plots were installed on a stratified grid. From this inventory 8 forest vegetation types (9 total vegetation types) were inventoried, discussed, and mapped. These 8 forest vegetation types varied by disturbance history, tree age, species composition, tree density, and stand structure.

Current Inventory of the Central TPZ

In 2009 the following was the standing inventory (in net board feet) for the entire Central TPZ:

2009 TOTAL STANDING VOLUME

BY DIAMETER CLASS,

AND SPECIES (NET VOLUMES)

Species	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	476,000	2,091,000	2,6723,100	540,800	5,780,900	5,304,900
Douglas-fir	129,400	277,400	558,800	72,400	1,038,000	908,600
Grand fir	1,900	8,800	119,000	63,000	192,700	198,800
Western Hemlock	0	8,000	0	0	8,000	8,000
Total					7,019,600	6,412,320

During the 2009 inventory, growth rates of the trees in each forest types were measured directly by 10-year growth cores. Approximately 200 trees were measured for growth. The growth rates for each forest type were determined from these measurements. The Central TPZ is growing approximately 260,000 board feet annually. Using these measured growth rates, the 2009 timber inventory was grown to the present (Fall 0f 2012). No new data was collected to make these projections.

The following table shows the current standing inventory of the Central TPZ:

2012 TOTAL STANDING VOLUME

BY DIAMETER CLASS,

AND SPECIES (NET VOLUMES)

Species	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	633,400	2,373,300	3,033,000	609,400	6,649,100	6,015,700
Douglas-fir	171,000	350,500	620,100	80,800	1,222,400	1,051,400
Grand fir	6,000	8,800	140,000	70,000	224,800	218,800
Western Hemlock	-	12,000	-	-	12,000	12,000
Total					8,108,300	7,297,900

The volume table section of this report (pages 85 - 91) has the updated volume tables for each forest type. This information can be updated like this for several years as long as it isn't used for an appraisal. Most timber inventories are updated every 20 years or so. In the future, there are cost shares that are available to assist in an update.

Potential Timber Harvest

The 2009 FMP briefly discussed the issue of a potential timber harvest on the Central TPZ. Prior to its purchase by TSRA, the property was owned by Travelers Insurance and actively harvested. A timber harvest is a viable option for the Central TPZ.

There are several issues to consider when thinking about the topic of a timber harvest. Over the years, timber harvests have occurred adjacent to the Central TPZ, which has been contentious. Any potential of a timber harvest must be very carefully planned. It must also be conducted in a manner, which doesn't detract from its primary uses.

There are a couple of critical decisions that need to be made when considering a harvest; the type of harvest that you want to conduct (which is dictated by your management philosophy), the permitting vehicle you want to utilize, and the

current economic conditions. All forest harvesting must be conducted under the California Forest Practice Rules.

Silviculture

There are two different philosophies of forest management for the redwood region of California; even aged management and uneven aged management. Even aged management is extremely controversial and given previous discussions about neighboring projects, this is not something that TSRA would ever consider.

As was stated in the FMP the goals of TSRA for the Central TPZ are:

1. Provide access and recreation for the benefit of the members of TSRA.
2. Provide good stewardship for the land.
3. Grow and maintain a healthy forest.
4. Create and maintain a forest that is more fire resistant.
5. Maintain the watershed to provide water for municipality purposes.
6. Maintain and upgrade the existing infrastructure to reduce erosion problems.
7. Enhance wildlife habitat and opportunities for viewing on the property.
8. Provide educational opportunities on and about the property to members of TSRA and the general public.
9. Be recognized as a Model Forest, which is an Example of Sustainable Forestry.

Even aged management would conflict with most of these goals. This is not an option that we would recommend for the TSRA to consider other than knowing that even aged management is an option that is legal and does exist.

Uneven aged management is the process of growing, maintaining, and enhancing a multi-aged forest. This is done through selective harvesting. There are many different ways that a selection harvest can be carried out to manage for an uneven aged forest. The management history of a property can play a large role in the development and management of a forest. As the FMP discussed, there have been at least 3 harvests that have occurred on the Central TPZ in the past. The first two harvests were essentially clear cuts that created an even aged forest going forward. On some parts of the property, it appears that there was a timber harvest in the 1970s and then most of the property was harvested in 1990 and 91. This created two and on certain parts of the property three age classes. This multi-age structure much more closely resembles what the original forest would have looked like, pre-European settlement. The main

differences today are that the trees are smaller and there are many more per acre.

Under the Forest Practice Rules, a selection harvest can legally remove up to 60% of the standing inventory (outside of sensitive areas like watercourses and unstable areas). The idea of sustainability is the key to selection harvesting. Selection harvests range in intensity of harvest from as low as 20% of the forest up to 60%. All of these harvests have the potential to be sustainable; the difference is generally the interval between each harvest. The heavier the intensity of harvest the longer the rotation, in order to allow the forest to grow.

Current Forest Growth and Yield

To a large degree the forest will guide you in your decisions. Currently, the forest as a whole is growing 3.8%, which is very good. If you break out the numbers between merchantable and sub-merchantable trees, merchantable trees are growing at 3.5% per year, while sub-merchantable trees are growing at a rate of 8.5%. While these growth rates are good, there is still some room for improvement. As time goes on, these growth rates will slow down as competition increases and the forest matures. What this means is that every year, the forest is growing by 3.5% (merchantable timber) and over a ten year period, by 35%. So, if you wanted to harvest on a ten-year rotation, you could harvest 35% every ten years. If you wanted to harvest every 20 years you could harvest the maximum allowed under a selection harvest of 60%. These examples are somewhat simplified, but give you an idea of what is possible.

There are two vegetation types that are currently under stocked and one that is only growing Bishop Pine. These three vegetation types (Types 5, 7, and 8) are not ready for harvest at this time. These types could use some improvements however to reduce hardwood completion and release conifers.

Because the FMP was only a sampling of the property, certain things only had a cursory inspection. Things like stream classification (to comply with the California Forest Practice Rules), historical and Native American sites, unstable areas, rare, threatened or endangered species presence all have an effect on what can be legally harvested and from which acres. These things aren't fully known at this time, but would be covered in detail when preparing a harvest plan.

In addition to the above sensitive and protected areas (under the Forest Practice Rules) it is generally advisable when dealing with a young forest to retain a certain percentage of growth to increase stocking levels. As can be seen from Appendix 1, each of the forest types vary by species composition and density (which comes across in volume per acre). In order to increase stocking we

would recommend retaining 20% of the volume growth over the rotation period. This will ensure that the forest is always increasing in size, density, and volume per acre over time.

The following tables show what could potentially be harvested under a selection harvest of 30%, 40%, and 60%. These are just examples.

30% Timber Harvest in 2013

BY DIAMETER CLASS,

AND SPECIES (NET VOLUMES)

Species	12-16"	18-24"	26-34"	36-48"	Available Volume
Redwood	-	628,740	604,650	153,570	1,386,960
Douglas-fir	-	65,250	157,530	24,240	247,020
Grand fir	-	6,221	41,566	21,894	69,680
Western Hemlock	-	3,600	-	-	3,600
Total	-	703,811	803,746	199,704	1,707,260

40% Timber Harvest in 2013

BY DIAMETER CLASS,

AND SPECIES (NET VOLUMES)

Species	12-16"	18-24"	26-34"	36-48"	Available Volume
Redwood	-	838,320	806,200	204,760	1,849,280
Douglas-fir	-	87,000	210,040	32,320	329,360
Grand fir	-	8,294	55,421	29,192	92,907
Western Hemlock	-	4,800	-	-	4,800
Total	-	938,414	1,071,661	266,272	2,276,347

60% Timber Harvest in 2013 BY DIAMETER CLASS, AND SPECIES (NET VOLUMES)					
Species	12-16"	18-24"	26-34"	36-48"	Available Volume
Redwood	-	1,257,480	1,209,300	307,140	2,773,920
Douglas-fir	-	130,500	315,060	48,480	494,040
Grand fir	-	12,441	83,131	43,788	139,360
Western Hemlock	-	7,200	-	-	7,200
Total	-	1,407,621	1,607,491	399,408	3,414,520

Note that in all three cases, there should be no intentional harvesting of trees between 12" and 16" dbh. It is recommended that these trees be retained as they are the future and you don't want to be cutting them unless they are damaged, diseased, or have to come out for some logistical or safety reasons. The difference in volume (and also income) between a tree that is 16" dbh and 20" dbh is double. This difference in diameters is about 15 years of growth, so by just waiting a bit, you will double your volume and income. In addition, logging cost go up exponentially when you start harvesting trees between 12" and 16" dbh.

Permitting

The California Forest Practice Rules require a harvest plan be developed for the purpose of commercializing timber. Cal Fire is the lead agency for the purposes of timber harvesting. A multi-agency review is required to meet the functional equivalent of a CEQA review. This includes a public comment period, which is open to all members of the public.

There are two permits available to landowners for timber harvesting; a Timber Harvest Plan (THP) and a Non Industrial Timber Management Plan (NTMP).

A THP is a one-time permit that is good for a 5-year period from the time it is approved. Under the previous ownership, THPs were applied for and used to harvest the Central TPZ. Every time you want to harvest, a new THP must be

created. THPs can be applied for the entire Central TPZ or just a part of the property.

An NTMP is a long term permit that only requires a one-time written permit to be filed with the state. An NTMP doesn't lock you into harvesting in a specific year, it allows you to be flexible and work with market conditions to maximize revenues. It is also good in perpetuity, so each time that you are ready to harvest; you don't have to file a whole new permit. An NTMP also locks you into the current regulations. The other difference between a THP and an NTMP is that an NTMP requires a timber inventory so that projections about future growth of the forest and yields available for harvest can be made (which you already have with the 2009 FMP). Growth and yield projections are not necessary for a THP. This additional growth and yield has already been collected and thus there should be no difference in cost between the two types of plans if a THP were applied for the entire Central TPZ.

With any kind of timber harvest plan, planning must begin at least a year in advance. Surveys for species such as Northern spotted owls, potentially red-legged frogs, various botanical species, and other possible rare, threatened, or endangered species could take a year or more to complete. Please see the FMP for additional discussions about this topic.

Infrastructure

While conducting the timber inventory in 2009, some attention was paid to looking at the infrastructure that was built to log the property previously. Most of the non-pertinent roads and skid trails have been allowed to revegetate or have been built into hiking trails. The property is fairly flat and would be conducive to ground based logging equipment. All of the Central TPZ was harvested with wheel skidders and tractors previously.

Some landings and skid trails would need to be rebuilt in order to log the property in the future. It is not currently known if additional roads and landings would need to be built at this point. This is something that would be explored as part of laying out a harvest plan.

Potential Harvest Strategies

As seen in the tables above, there could potentially be a harvest of between 1.5 million and 3.5 million board feet of timber on the Central TPZ. There are a few ways to think about harvesting the Central TPZ, and some of the decisions would be based on the permitting vehicle.

Economy of scale can be a limiting factor when looking at a timber harvest. To be viable a timber sale must cut 200,000 board feet at a rate of 5,000 board feet per acre. Smaller timber sales will drastically increase logging costs and cut into revenue. This means that in order to harvest an acre of ground, there needs to be a minimum of 17,000 board feet of merchantable trees (18 inches and greater) standing. This eliminates Types 5, 7, & 9 (approximately 90 acres) which do not have enough standing volume to currently harvest. Some of the edges of these areas could be lightly thinned to promote a healthy forest and create openings to plant and enhance.

We would propose retaining about 20 percent of the growth in the stand to build the stocking in the forest and gradually increase the harvest amount until the property is growing at its full potential (which could be several rotations). This practice will keep the forest at a sustainable production level. The maximum harvest given a still high growth rate should not exceed 2,000,000 board feet for each rotation (12 years). As the density and size of the stand increases, the amount available for harvest will also increase.

With approximately 2,000,000 board feet available every 12 years, the property could be all logged in one year (every 12 years) or it could be broken up into smaller units every 3 or 4 years, or even a small harvest every year. There are advantages and disadvantages to all of these options.

A single harvest every 12 years (or more or less depending on the rate of harvest) across the entire property has less annual impact to neighbors (from noise and dust) and to association members that use the Central TPZ for recreation. A lot of times to be safe, it is recommended that forest users stay out of a harvest area for at least the first winter following harvest to allow limbs and other trees to fall or settle to the ground.

A harvest every 3 or 4 years allows equipment to be on the property to maintain erosion control structures, fuel hazard reduction efforts, and stretch out the flow of income over time. A harvest of this nature also allows the landowner to capitalize on market conditions that may come up from time to time (see the discussion on income for additional information on this issue).

A small harvest every year or two allows for a continuous flow of income. Over time this will hit the high points in the market as well as potentially the low points (if the decision is made to harvest during poor market conditions) and maximize a revenue stream. A harvest every year could limit use of the forest for recreation.

Estimating Income

The primary conifer species on the Central TPZ are Redwood and Douglas-fir with lesser amounts of grand fir, Western hemlock, Bishop Pine and Monterey Pine. The hardwood species generally found on the Central TPZ include tanoak, madrone, and bay. Generally conifer trees are cut into logs for lumber. Hardwoods are typically harvested and turned into firewood.

Redwood is generally more highly sought after than other species as there is a premium economically on it. Douglas-fir, grand fir and Western hemlock are currently being sold to international markets. The domestic markets for these species aren't going to recover until the housing market picks up. These species don't carry the same premium as redwood, but currently we are able to sell these species. Bishop pine and Monterey pine are considered commercial species under the Forest Practice Rules, but the market for these products is such that they are a cost to harvest and not a profit.

A 30% harvest has the potential to generate between $600,000 and $900,000. A 60% harvest has the potential to generate between $1,000,000 and $2,000,000. These numbers are for a single logging event in one year. Not included in these estimates are the cost to obtain a harvest plan, the cost to implement a timber sale, and taxes that will have to be paid. A Registered Professional Forester must be retained to prepare a harvest plan.

Pros and Cons of Logging

Logging can be a contentious issue. There are people that just don't believe that trees should be cut for any reason. If done improperly, harm can be done to a forest, to the wildlife that depend on it, and to the people that inhabit it and utilize it. A harvest if conducted must not detract from these uses, and when done properly should enhance all of the uses of the forest.

The Central TPZ is a young forest. If forest management is not continued on the property, the growth rates will decline and the forest will eventually begin to stagnate. The amount of dead, dying, and diseased trees within the forest will continue to increase, as will the hazards associated with leaving them standing. The forest will develop a multi-age structure, but it will take much longer than if actively managed. During this time period, which could last for many decades, the fuel load for fires will continue to build up.

Logging creates slash. Logging slash is the left over limbs, bark, and other debris that is created from trees falling and being yarded. This slash is a short term fuel hazard. Within a year or two of being created, the fuel decomposes

back into the ground and the hazard is greatly reduced. Several things can be done to lessen this impact including the time of year when harvests are conducted, treating the slash by lopping it in contact with the ground, and piling and burning or chipping.

Similarly, logging debris can get hung up in trees and fall out at any time following harvest. Keeping the area clear until the follow spring, allows limbs to be blown out during winter storms.

Noise can be an impact; however this can be limited through allowing harvest activities to only occur during certain hours and days. Log trucks have Jake brakes and the use of them can be restricted to limit excessive noise.

The Central TPZ is a recreation area. For obvious reasons, during logging activities, recreation would have to be limited to those areas that were safe for Association members. Tours can be created to show members the active logging operation, but for the safety of Association members, and the operators, people would need to stay out of active areas.

Logging can accomplish numerous things. As previously stated, it must meet the goals of the Association. Logging can reduce long term fuel hazards by reducing ladder fuels, remove trees that are diseased, dead, or dying (note, not all of these trees need to be removed, but in high use areas, they should be considered), promote high growth rates, and space out the currently overly dense forest. Logging can move a forest towards what the original forests (pre-European settlement) resembled. This is done by putting growth on bigger healthier trees. By maintain a high growth rate this can be accomplished much more quickly than by allowing the forest to do so on its own at a much slower rate.

Logging can improve the visual enjoyment of a forest by highlighting elements that might be hidden, making the forest more transparent or see through, improving the use of the forest for wildlife viewing, and safer for its users by removing hazards. Logging can provide additional benefits to wildlife by creating places to hide, edges (which are the highest use areas in the redwood region), and additional wildlife habitat restoration where there are currently limitations or deficiencies.

One of the most important things that logging can do is install and maintain existing erosion control structures. The 2009 FMP discussed several issues with erosion occurring on the Central TPZ. Logging allows equipment to be on the property and issues to be corrected that might ordinarily be neglected or not seen.

As discussed in the economic discussion above logging also provides a source of income. This income will allow for not only maintenance of the Central TPZ, but also for trail maintenance, fuel hazard reductions and other projects that the Association has wanted to do, but lacked the funding to complete.

Carbon Sequestration

The carbon sequestration concept is still a work in progress. Carbon credits have been sold and more projects are being developed each year. The California Climate Action Reserve has created the current protocol for forest carbon projects (version 3.2) however a key portion of the process is still being developed, which is called cap and trade. Once this is completed, the trade of carbon credits will become much more newsworthy. Version 3.3 is in draft now.

The 2009 FMP briefly discussed Carbon, but because the protocol was still being developed, the issue wasn't covered in much detail. The 2009 inventory did not collect all of the data necessary for a carbon project, because at that time, the necessary information wasn't known. The 2009 inventory will serve as a good starting point, but additional information will need to be collected in order to apply. Some of the additional information that would need to be collected to augment the 2009 inventory include measured amounts of downed wood on the forest floor, measurements of standing dead trees, the depth of the forest floor, and the composition and percent cover of understory species. In addition, more plots may need to be installed to bring the accuracy of the 2009 inventory up to the needs of the protocol. The 2009 inventory was a 3% sample. This number may have to go up to 10% or more in order to meet the protocol standards. In addition, data may have to be collected on other parts of the TSRA that are held in common.

As the current Forest Protocol is written, the concept of additionally is the key to a carbon project. Additionally is defined as: "projects that yield surplus GHG emission reductions and removals that are additional to what would have occurred in the absence of a carbon offset market (i.e. under "Business As Usual")".

Forest Projects must satisfy the following tests to be considered additional:

> *1. Legal Requirement Test. Forest Projects must achieve GHG reductions or removals above and beyond any GHG reductions or removals that would result from compliance with any federal, state, or local law, statute, rule, regulation, or ordinance. Forest Projects must also achieve GHG reductions and removals above and beyond any GHG reductions or removals that would result from compliance with any court order or other legally binding mandates including management plans (such as Timber*

Harvest Plans) that are required for government agency approval of harvest activities.

Deeded encumbrances, such as timber deeds or conservation easements, may effectively control forest carbon, such that there may be multiple Forest Owners within the Project Area. Deeded encumbrances are considered legally binding mandates for the purposes of the legal requirement test, unless they are recorded within a year of the Forest Project's Start Date with clear agreement from all Forest Owners.

Deeded encumbrances may contain terms that do not directly refer to forest carbon, but that nevertheless restrict the effect the ability of any one Forest Owner to change forest carbon stocks. These terms must be interpreted with respect to their effect on forest carbon for the purposes of the legal requirement test and baseline determinations.

Where the terms of deeded encumbrances are not explicit with regards to forest carbon, the following assumptions shall be made:

§ Restrictions or references related to canopy cover, basal area, density, volume, carbon or biomass apply to standing live and dead trees of all species.

§ Carbon in other pools (soil, litter, duff, shrubs, etc.) is assumed to be associated with the other defined terms, such as trees.

§ Terms related to forest (tree) growth apply to growth in all tree species.

2. Performance Test. Forest Projects must achieve GHG reductions or removals above and beyond any GHG reductions or removals that would result from engaging in Business As Usual activities, as defined by the requirements described below (Section 3.1.2).

Source: California Climate Action Reserve, Forest Project Protocol 3.2, August 31, 2010.

The Forest Project Protocol has developed three kinds of projects that meet the current protocol.

1. Improved Forest Management Project
2. Avoided Conversion Project
3. Reforestation Project

A carbon project on The Sea Ranch would be one of two types, either a reforestation project or an improvement project. Reforestation projects must meet the following specifications:

> *1. The project involves tree planting or removal of impediments to natural reforestation, on land that:*
>
> > *a. Has had 10 percent or less tree canopy cover for a minimum of 10 years; or*
> >
> > *b. Has been subject to a Significant Disturbance that has removed at least 20 percent of the Project Area's live biomass in trees.*
>
> *2. No rotational harvesting of reforested trees or any harvesting of pre-existing carbon in live trees occurs during the first 30 years after the project start date unless such harvesting is needed to prevent or reduce an imminent threat of disease. Such harvesting may only occur if the Project Operator provides the Reserve with a written statement from the government agency in charge of forestry regulation in the state where the project is located stipulating that the harvesting is necessary to prevent or mitigate disease.*
>
> *3. The tree planting, or removal of impediments to natural reforestation, does not follow a commercial harvest of healthy live trees that has occurred in the Project Area within the past 10 years, or since the occurrence of a Significant Disturbance, whichever period is shorter.*
>
> *4. The project does not employ broadcast fertilization.*
>
> *5. The project does not take place on land that was part of a previously registered Forest Project, unless the previous Forest Project was terminated due to an Unavoidable Reversal (see Section 7).*

Source: California Climate Action Reserve, Forest Project Protocol 3.2, August 31, 2010.

Although a Reforestation Project is unlikely, there are possible cases where this could come into play. New or diseased windrows could potentially qualify for a carbon project. If Sudden Oak Death or some other disease or a fire were to affect the property, reforestation efforts could potentially qualify.

Improved Forest Management Projects are most likely where TSRA could look into carbon credits in the future. Improved Forest Management Projects include the following:

> *1. The project takes place on land that has greater than 10 percent tree canopy cover.*

2. The project employs natural forest management practices, as defined in Section 3.11.2 of this protocol.

3. The project does not employ broadcast fertilization.

4. The project does not take place on land that was part of a previously registered Forest Project, unless the previous Forest Project was terminated due to an Unavoidable Reversal (see Section 7).

Eligible management activities may include, but are not limited to:

§ Increasing the overall age of the forest by increasing rotation ages.

§ Increasing the forest productivity by thinning diseased and suppressed trees.

§ Managing competing brush and short-lived forest species.

§ Increasing the stocking of trees on understocked areas.

§ Maintaining stocks at a high level.

Source: California Climate Action Reserve, Forest Project Protocol 3.2, August 31, 2010.

A Forest Improvement Project will take some time and additional information to put together, but there is some potential to do a project based on the above information. The key to this type of project is that the project must not be a requirement by law, so planting following a maximum harvest would not qualify, but planting following a light harvest to increase stocking might (baseline levels need to be above a regional standard in order for this to work). Similarly, planting understocked or substantially damaged (from disease or other natural disturbance) lands could also potentially qualify. This should also qualify to areas outside of the Central TPZ, potentially windrows and Commons areas. An inventory of these areas would have to be conducted.

There are a couple of issues with regard to carbon projects that must be considered before proceeding with a project.

1. The project life for carbon offsets is 100 years. This is a long time to agree to a contract that speculates on a commodity. There is no telling what the future holds for this market and it might be best to wait until contracts are developed for 20 or 30 years instead of 100.
2. A project must either be created in conjunction with a Conservation Easement or a long term forest management document. Conservation Easements were briefly discussed in the FMP. These documents are extremely difficult to

create and are fairly expensive to draft and also require additional monitoring and reporting.
3. Once a project is created and begun that includes harvesting, the harvesting must be conducted for the life of the project (100 years).
4. A project must include the entire ownership and not just parts of the property. This would possibly include parts of the Commons and other forested areas on TSRA. An inventory might have to be created for all of the Association held lands.

Version 3.3 of the Forest Protocol should be out within the next year. Public comment has recently closed on this update.

The first step in developing a carbon project should be to look at the regional standards and compare them with the current stocking levels. Following that comparison, any deficiencies in the data will need to be address. Once the deficiencies in data have been addressed, a decision can be made about the size, location, and type of project.

Recommendations

The 2009 Forest Management Plan had 3 pages of management recommendations. These recommendations were created to meet the goals of the Central TPZ and the Association. Those recommendations are still good today and should be implemented. In addition, the following recommendations are suggested to help protect, maintain, and enhance the values of the Upland Forest Area:

The Central TPZ

- Explore the possibility of obtaining an NTMP.
- A light selective harvest of 30% is sustainable every 10 to 12 years.
- Retain 20% of the growth for the first two to three entries to build the inventory.
- If a harvest is to occur, particular attention should be paid to the selection criteria of trees that will be harvested. The harvest should remove trees that are dead, dying, diseased, and trees with deformities, which will limit future growth rates. Once these trees have been selected, the remaining forest should be looked at to increase vigor by properly thinning out the clumps, spacing out the residual stand and putting growth on the proper forest. Trees and/or areas with high aesthetical qualities can be retained.
- Reinventory the property every two rotations (unless a carbon project is undertaken which may require additional information).
- Look at developing a carbon sequestration project.

- Check each year to find out what cost share funds are available to conduct fuel hazard reduction projects, thinning and pruning projects, erosion reduction projects, and wildlife habitat improvement projects with help from state and federal funds.
- Begin a planting program to fill in areas that are affected by Sudden Oak Death, wind throw and other disturbances.

Commons

- Remove trees that pose a significant hazard to existing residences or other structures.
- Monitor trees around residences, along roads, near improvements (i.e. water tanks, power lines) for potential hazard and need for removal or modification.
- Implement and maintain defensible space around structures.
- Create shaded fuel breaks along the main ridge road and all hiking trails. This fuel break should be at a minimum 100 feet in width for the roads and 30 feet for the trails. If economically feasible, the roadside fuel break should 300 feet wide. Trees should be limbed up at least 15 feet. Any snags should be removed from fuel breaks. Clumps of trees less than 10 inches DBH should be thinned out, especially hardwoods.

Note that these were recommendations for the Central TPZ but can also be applied to the Commons and surrounding forests.

Sources of Information

- 2012 California Forest Practice Rules, California Board of Forestry and Fire Protection.

- California Climate Action Reserve, Forest Project Protocol 3.2, August 31, 2010.

- California Climate Action Reserve, Forest Project Protocol 3.3 for Public Comment, June 1, 2012.

- Edward A. Tunheim Consulting Forester, The Central Timber Production Zone, The Sea Ranch, Forest Management Plan 2009.

- McBride, Joe & Gerhard, Deborah, The Sea Ranch Vegetation Management Report 1991.

Volume Tables

2012 FOREST TYPE 1

BOARD FEET PER ACRE BY DIAMETER CLASS, TIMBER TYPE, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	20	1,700	10,300	33,900	10,400	56,300	54,600
Douglas-fir	20	100	-	-	1,400	1,500	1,400
Western Hemlock	20	-	600	-	-	600	600
Total						58,400	56,600

2012 FOREST TYPE 1

TOTAL BOARD FOOT VOLUME BY DIAMETER CLASS, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	20	34,000	206,000	678,000	208,000	1,126,000	1,092,000
Douglas-fir	20	2,000	-	-	28,000	30,000	28,000
Western Hemlock	20	-	12,000	-	-	12,000	12,000
Total						1,168,000	1,132,000

2012 FOREST TYPE 2

BOARD FEET PER ACRE BY DIAMETER CLASS, TIMBER TYPE, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	37	5,000	14,300	24,200	6,700	50,200	45,200
Douglas-fir	37	200	500	-	-	700	500
Total						50,900	45,700

2012 FOREST TYPE 2

TOTAL BOARD FOOT VOLUME BY DIAMETER CLASS, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	37	185,000	529,100	895,400	247,900	1,857,400	1,672,400
Douglas-fir	37	7,400	18,500	-	-	25,900	18,500
Total						1,883,300	1,690,900

2012 FOREST TYPE 3

BOARD FEET PER ACRE BY DIAMETER CLASS, TIMBER TYPE, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	19	3,500	15,900	10,100	-	29,500	26,000
Douglas-fir	19	2,700	1,800	7,100	-	11,600	8,900
Grand fir	19	200	-	-	-	200	-
Total						41,300	34,900

2012 FOREST TYPE 3

TOTAL BOARD FOOT VOLUME BY DIAMETER CLASS, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	19	66,500	302,100	191,900	-	560,500	494,000
Douglas-fir	19	51,300	34,200	134,900	-	220,400	169,100
Grand fir	19	3,800	-	-	-	3,800	-
Total						784,700	663,100

2012 FOREST TYPE 4

BOARD FEET PER ACRE BY DIAMETER CLASS, TIMBER TYPE, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	22	3,200	5,800	6,600	-	15,600	12,400
Douglas-fir	22	1,400	2,400	3,100	2,400	9,300	7,900
Grand fir	22	100	400	-	-	500	400
Total						25,400	20,700

2012 FOREST TYPE 4

TOTAL BOARD FOOT VOLUME BY DIAMETER CLASS, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	22	70,400	127,600	145,200	-	343,200	272,800
Douglas-fir	22	30,800	52,800	68,200	52,800	204,600	173,800
Grand fir	22	2,200	8,800	-	-	11,000	8,800
Total						558,800	455,400

2012 FOREST TYPE 5

BOARD FEET PER ACRE BY DIAMETER CLASS, TIMBER TYPE, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	75	900	3,700	1,000	1,300	6,900	6,000
Douglas-fir	75	700	1,600	900	-	3,200	2,500
Total						10,100	8,500

2012 FOREST TYPE 5

TOTAL BOARD FOOT VOLUME BY DIAMETER CLASS, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	75	67,500	277,500	75,000	97,500	517,500	450,000
Douglas-fir	75	52,500	120,000	67,500	-	240,000	187,500
Total						757,500	637,500

2012 FOREST TYPE 6

BOARD FEET PER ACRE BY DIAMETER CLASS, TIMBER TYPE, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	70	3,000	13,300	1,500	800	18,600	15,600
Douglas-fir	70	300	1,600	4,600	-	6,500	6,200
Grand fir	70	-	-	2,000	1,000	3,000	3,000
Total						28,100	24,800

2012 FOREST TYPE 6

TOTAL BOARD FOOT VOLUME BY DIAMETER CLASS, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	70	210,000	931,000	1,043,000	56,000	2,240,000	2,030,000
Douglas-fir	70	21,000	112,000	322,000	-	455,000	434,000
Grand fir	70	-	-	140,000	70,000	210,000	210,000
Total						2,905,000	2,674,000

2012 FOREST TYPE 7

BOARD FEET PER ACRE BY DIAMETER CLASS, TIMBER TYPE, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	5	-	-	900	-	900	900
Douglas-fir	5	1,200	2,600	5,500	-	9,300	8,100
Total						10,200	9,000

2012 FOREST TYPE 7

TOTAL BOARD FOOT VOLUME BY DIAMETER CLASS, AND SPECIES (NET VOLUMES)

Type	Acres	12-16"	18-24"	26-34"	36-48"	Standing	Merchantable
Redwood	5	-	-	4,500	-	4,500	4,500
Douglas-fir	5	6,000	13,000	27,500	-	46,500	40,500
Total						51,000	45,000

Note: for the purposes of this discussion, all numbers have been rounded to the nearest hundred