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LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

December 30, 2015

Director Scott Glenn
Office of Environmental Quality Control
Department of Health, State of Hawai'i
235 S. Beretania Street, Room 702
Honolulu, Hawai'i 96813

Dear Director Glenn:

With this letter, the Department of Land and Natural Resources Division of Forestry and Wildlife hereby transmits the draft environmental assessment and anticipated finding of no significant impact (DEA-AFONSI) for the Kōke'e Timber Management Area Forest Management Plan Implementation in the Waimea District on the island of Kaua'i for publication in the next available edition of the Environmental Notice. A list of the TMKs affected is attached to this letter.

Enclosed please find a completed OEQC Publication Form and one copy of the DEA-AFONSI, an Adobe Acrobat PDF file of the same, and an electronic copy of the publication form in MS Word. Simultaneous with this letter, we have submitted by electronic mail to your office a .PDF copy of the DEA-AFONSI and the summary of the action and a list of TMKs as text files.

If there are any questions, please contact Sheri S. Mann, Forestry Program Manager, at 808-587-4172 or Sheri.S.Mann@hawaii.gov.

Sincerely,

Suzanne D. Case
Chairperson

Enclosures

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OFC. OF ENVIRONMENTAL QUALITY CONTROL

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July 2015 Revision

AGENCY ACTION SECTION 343-5(b), HRS PUBLICATION FORM

Project Name: Kōke'e Timber Management Area Forest Management Plan Implementation
HRS §343-5 Trigger(s): Use of State or County lands of funds, Use in the Conservation District
Island: Kaua'i
District: Waimea
TMK: See attached list
Permits: BLNR approval; NPDES general permit
Proposing/Determination Agency: DLNR, Division of Forestry and Wildlife
1151 Punchbowl Street, Room 325
Honolulu, HI 96813
Sheri Mann, Forestry Program Manager, 587-4172

Accepting Authority:
(for EIS submittals only)
Consultant: Anden Consulting
2812-B Kalihi Street
Honolulu, HI 96819
Christen Mitchell, 808-222-7877

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Status (check one only):

_x_DEA-AFNSI — Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of DEA, a completed OEQC publication form, along with an electronic word processing summary and a PDF copy (you may send both summary and PDF to oeqchawaii@doh.hawaii.gov); a 30-day comment period ensues upon publication in the periodic bulletin.

__FEA-FONSI — Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of the FEA, an OEQC publication form, along with an electronic word processing summary and a PDF copy (send both summary and PDF to oeqchawaii@doh.hawaii.gov); no comment period ensues upon publication in the periodic bulletin.

__FEA-EISPN — Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of the FEA, an OEQC publication form, along with an electronic word processing summary and PDF copy (you may send both summary and PDF to oeqchawaii@doh.hawaii.gov); a 30-day consultation period ensues upon publication in the periodic bulletin.

__Act 172-12 EISPN — Submit the proposing agency notice of determination on agency letterhead, an OEQC publication form, and an electronic word processing summary (you may send the summary to oeqchawaii@doh.hawaii.gov). NO environmental assessment is required and a 30-day consultation period upon publication in the periodic bulletin.

__DEIS — The proposing agency simultaneously transmits to both the OEQC and the accepting authority, a hard copy of the DEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the DEIS (you may send both the summary and PDF to oeqchawaii@doh.hawaii.gov); a 45-day comment period ensues upon publication in the periodic bulletin.

__FEIS — The proposing agency simultaneously transmits to both the OEQC and the accepting authority, a hard copy of the FEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the FEIS (you may send both the summary and PDF to oeqchawaii@doh.hawaii.gov); no comment period ensues upon publication in the periodic bulletin.

__ Section 11-200-23 Determination — The accepting authority simultaneously transmits its determination of acceptance or nonacceptance (pursuant to Section 11-200-23, HAR) of the FEIS to both OEQC and the proposing agency. No comment period ensues upon publication in the periodic bulletin.

__Section 11-200-27 Determination

The accepting authority simultaneously transmits its notice to both the proposing agency and the OEQC that it has reviewed (pursuant to Section 11-200-27, HAR) the previously accepted FEIS and determines that a supplemental EIS is not required. No EA is required and no comment period ensues upon publication in the periodic bulletin.

__Withdrawal (explain)

Summary (Provide proposed action and purpose/need in less than 200 words. Please keep the summary brief and on this one page):

The Department of Land and Natural Resources (DLNR) Division of Forestry and Wildlife (DOFAW) proposes the implementation of the Kōkeʻe Timber Management Area (KTMA) Forest Management Plan ("KTMA Plan"). The project area encompasses part of the Puʻu ka Pele and Nā-Pali Kona Forest Reserves and Kōkeʻe and Waimea Canyon State Parks. The KTMA Plan provides for sustainable commercial management of existing non-native timber plantation areas (approximately 10% of the total area), for limited selective harvest of non-native tree species outside of the non-native timber plantation areas, and the removal of native and non-native trees for purposes of road, trail, and fence maintenance, hazard reduction, or for the salvage of dead or dying trees.

The objectives of the KTMA Plan were developed with the intention of balancing the sustainable harvest of timber resources with existing resource management goals for the area, including fire hazard mitigation, rare species protection, restoration of native habitat and continuation of recreational opportunities.

Primary anticipated impacts of KTMA Plan implementation includes disruption to existing recreational activities, impacts on traffic, and the potential for erosion. Strict adherence to the State's *Best Management Practices for Maintaining Water Quality in Hawaiʻi* (BMPs) will minimize impacts to the

DRAFT
ENVIRONMENTAL ASSESSMENT

Kōkeʻe Timber Management Area

Forest Management Plan Implementation

DECEMBER 2015

Prepared for
Division of Forestry and Wildlife
Department of Land and Natural Resources

Prepared by
Anden Consulting

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1. SUMMARY

Project Name	Kōke‘e Timber Management Area Forest Management Plan Implementation
Project Location	Kōke‘e Timber Management Area: portion of Pu‘u ka Pele Forest Reserve portion of Nā-Pali Kona Forest Reserve Waimea Canyon State Park Kōke‘e State Park Island of Kaua‘i Waimea District
Land Use	Forest Reserve and State Park Affected TMK parcels listed in Appendix A Conservation District
Proposing Agency	Department of Land and Natural Resources Division of Forestry and Wildlife
Anticipated Determination	Finding of No Significant Impact

<u>Summary of Action</u>
The Department of Land and Natural Resources (DLNR) Division of Forestry and Wildlife (DOFAW) proposes the implementation of the Kōke‘e Timber Management Area (KTMA) Forest Management Plan (“KTMA Plan”). Specifically, the KTMA Plan provides for sustainable commercial management of existing non-native timber plantation areas, for limited selective harvest of non-native tree species outside of the non-native timber plantation areas, and the removal of native and non-native trees for purposes of road, trail, and fence maintenance, hazard reduction, or for the salvage of dead or dying trees.

The objectives of the KTMA Plan were developed with the intention of balancing the sustainable harvest of timber resources with existing resource management goals for the area, including fire hazard mitigation, rare species protection, restoration of native habitat and continuation of recreational opportunities. The project area encompasses part of the Pu‘u ka Pele and Nā-Pali Kona Forest Reserves and Kōke‘e and Waimea Canyon State Parks.

Under full implementation of the KTMA Plan, commercial harvest of timber (involving harvest, replanting, timber stand management and road repair) would be anticipated to occur in a small portion of the KTMA (approximately 10% of the total area). In the remainder of the area, primary timber

management activities would be thinning existing tree stands, hazard tree removal, and tree removal related to maintenance of existing roads, trails, and fences. Commercial harvest could occur on a very limited scale, involving specific identified trees.

Primary anticipated impacts of KTMA Plan implementation includes disruption to existing recreational activities, impacts on traffic, and the potential for erosion. Strict adherence to the State's *Best Management Practices for Maintaining Water Quality in Hawaiʻi* (BMPs) will minimize impacts to the physical environment.

2. PROJECT DESCRIPTION

2.1 BACKGROUND INFORMATION

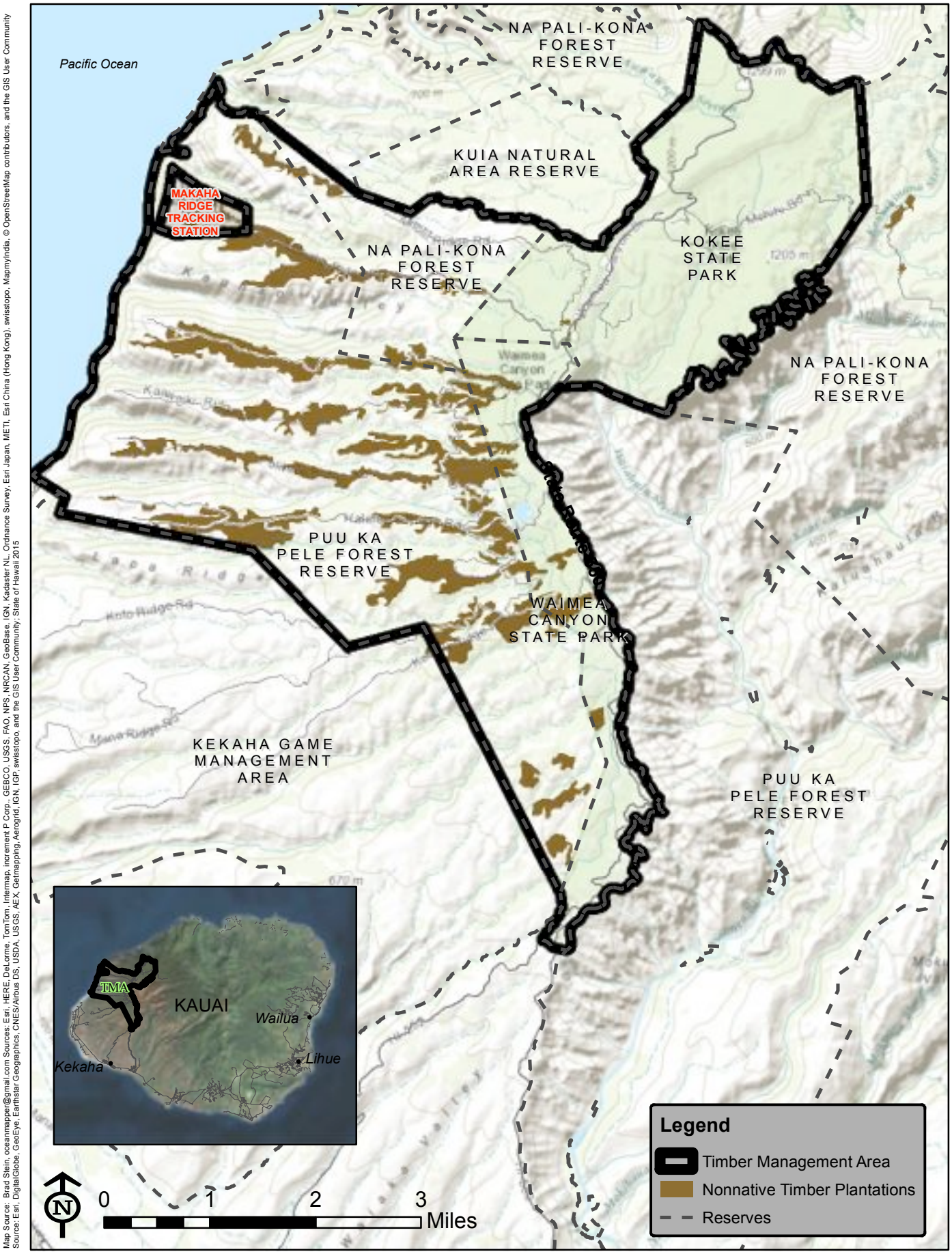
Location

The KTMA is located on the west side of Kauaʻi, along and adjacent to State Route 550 (Kōkeʻe Road), starting approximately 5 miles north of Waimea (Figure 1). It is comprised of a portion of Puʻu ka Pele Forest Reserve west of Kōkeʻe and Waimea Canyon State Park (appx. 9,400 acres), a portion of Nā-Pali Kona Forest Reserve south of Miloliʻi ridge (appx. 1,500 acres), Waimea Canyon State Park, and Kōkeʻe State Park (appx. 6,200 acres). Altogether, the KTMA totals approximately 17,092 acres.

Land Use

Components of the Puʻu ka Pele Forest Reserve were established in 1918 and 1938 to retain its wild scenic beauty for the benefit of the public and to reduce erosion and damage of the steep cliffs by controlling ungulate populations. The Nā-Pali Kona Forest Reserve portion was established in 1907 to protect the water supply for adjacent agricultural lands. Waimea Canyon State Park and Kōkeʻe State Park were initially part of these forest reserves, withdrawn in 1919 and 1922 for recreational use, and officially established as State Parks in 1952.

Reforestation efforts in the KTMA were initiated in an attempt to slow down soil erosion, improve watershed cover, and provide fuelwood. Species planted were not necessarily selected on the basis of wood quality or merchantability, but on the basis of adaptability and rapid growth. Early plantings were primarily in gullies and areas bordering croplands, where sugar and pineapple could not be grown. The Civilian Conservation Corps programs of the late 1930s, with a large labor force, concentrated on planting the steeper slopes and rugged mountain ridges. Trees of many species – both native and exotic – were planted until World War II stopped operations by sugar plantation and government personnel, with *Eucalyptus robusta* heavily favored, but also including *E. paniculata*, *E. saligna*, blackwood acacia (*Acacia melanoxylon*), sugi pine (*Cryptomeria japonica*), silk oak (*Grevillea robusta*), and brushbox (*Lophostemon confertus*) (Honda 1967). During the late 1950s and 1960s, tree planting continued on the lower eroded slopes of the area, primarily with *Eucalyptus saligna* and pine trees *(Pinus taeda* and *P. elliottii*). Reforestation efforts in the 1960s tried to capitalize on the potential for sawtimber production, leading to additional plantings in areas where native forest was of particularly poor quality. Due to limited funding, staffing, and other higher priorities, these non-native timber stands were not managed as commercial products; they were not thinned at early growth stages or harvested at peak value.



Map Source: Brad Stein, oceanmapper@gmail.com Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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Figure 1. KTMA: Location.

The primary concentration of non-native timber plantation stands is located within the Puʻu ka Pele Forest Reserve section west of Kōkeʻe Road. Additional small non-native timber plantation stands are located within the Nā-Pali Kona Forest Reserve (appx. 100 acres) and in the State Parks (approximately 165 acres). The non-native timber plantation stands are located primarily on ridgetops, within an elevation range of 1,000 to 3,500 ft, and average rainfall from 30 to 55 inches. Timber stands are scattered in numerous areas throughout the KTMA and are accessible in most cases by unimproved roads.

Table 2-1. KTMA Acreage.

Designation	**Total Acreage**	**KTMA Acreage**	**Approximate acreage of non-native timber plantation stands (including acreage associated with roads)**
Puʻu ka Pele Forest Reserve	23,600	9,405	2,110
Nā-Pali Kona Forest Reserve	23,019	1,505	95
Waimea Canyon State Park	1,837	1,837	160
Kōkeʻe State Park	4,345	4,345	5
TOTAL:	52,801	17,092	2,370

The Puʻu ka Pele Forest Reserve is currently managed as a multi-use area, with the current principal objective to manage the lands for sustainable game hunting opportunities, to provide native and non-native timber resources for commercial and non-commercial use, to manage rare native biological resources, and to maintain existing infrastructure. The current management objective of the Nā-Pali Kona Forest Reserve (which includes the Alakaʻi Wilderness Preserve) is to maintain highest quality native ecosystems habitat for threatened, endangered, and rare plants and animals and the associated healthy watershed. Waimea Canyon State Park and Kōkeʻe State Park are managed for recreation, preservation, and education.

The forest resources within the KTMA are primarily managed for watershed protection, recreational use, and protection of biodiversity. The majority of the KTMA is located within the Resource subzone of the Conservation District, with a small portion located in the Protective subzone (Figure 2).

Kōkeʻe Timber Management Area Establishment

In 1998, a Hawaiʻi Forestry and Communities Initiative (HFCI) timber survey crew conducted an inventory of publicly held non-native timber resources on the island of Kauaʻi to provide accurate forest type maps, volume estimates of commercial timber resources, and an assessment of timber losses sustained due to hurricane damage. The primary concentration of non-native timber was located within the Puʻu ka Pele Forest Reserve, with additional timber stands in Nā-Pali Kona Forest Reserve, Waimea Canyon State Park, Kōkeʻe State Park and the Līhuʻe-Kōloa Forest Reserve. The resulting timber plantation map contained 178 timber stands, totaling 2,386 acres, excluding clearings. Total wood volume exceeded 4,300,000 cubic feet.

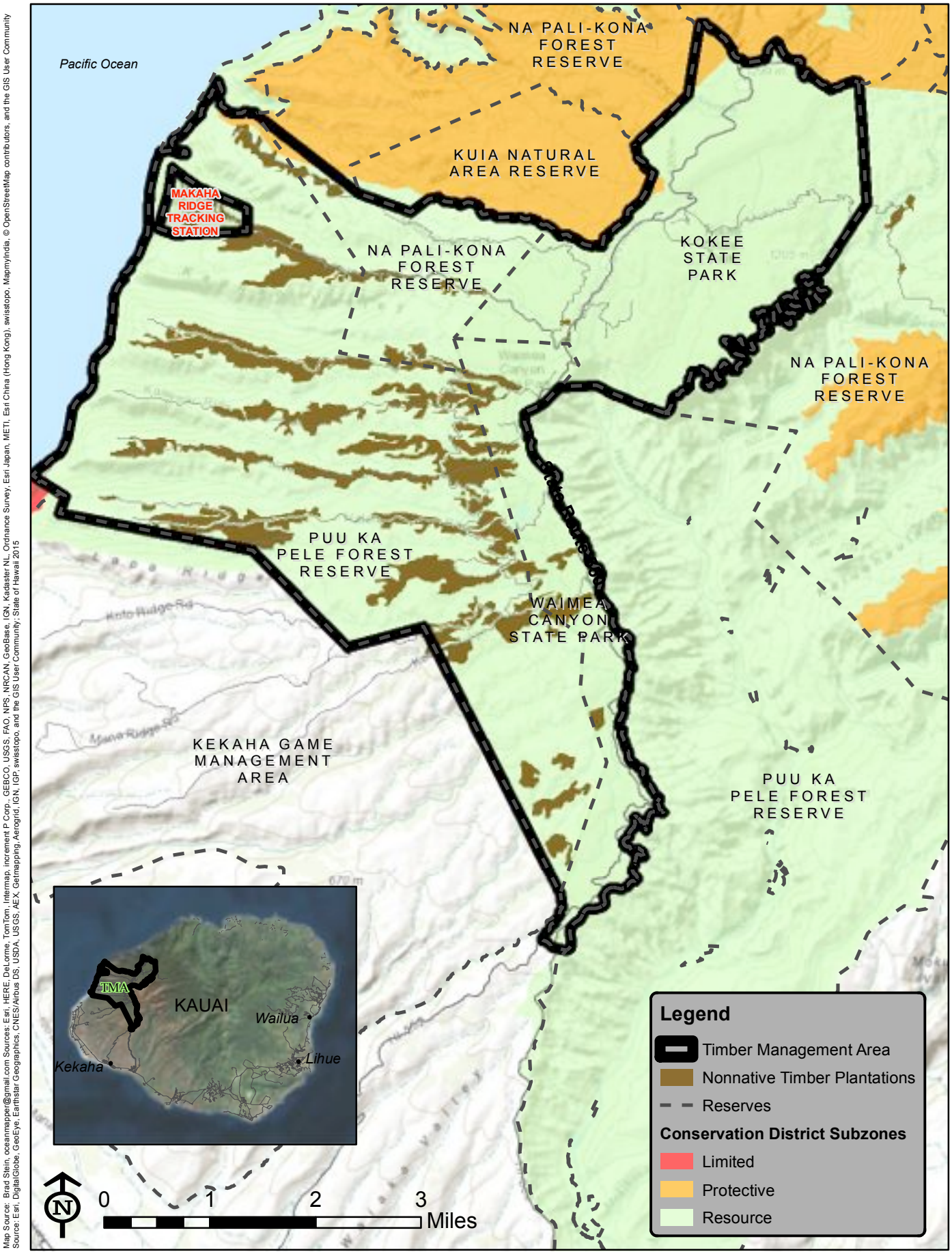

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Figure 2. KTMA: Conservation District Subzones.

The data indicated that the non-native timber plantation stands within the Puʻu ka Pele Forest Reserve and the smaller adjacent stands within Nā-Pali Kona Forest Reserve, Waimea Canyon State Park and Kōkeʻe State Park represented a readily accessible timber resource. Around the same time, DOFAW received inquiries from the private sector for access to specific timber resources within the KTMA, including harvest of non-native brushbox and salvage of downed native trees.

Pursuant to HRS §183-16.5, the harvest of trees on public lands requires a management plan approved by the Board of Land and Natural Resources, compliance with HRS Chapter 195D, and compliance with HRS Chapter 343. The Kōkeʻe Timber Management Area was established in 2005, and the Board approved a management plan that specifically provided for the harvest of trees from land within the KTMA (attached as Appendix C). The KTMA Plan proposed three principal methods of forest management for the KTMA:

1. Sustainable commercial management of non-native timber plantation areas, where harvesting would be followed by replanting of either native or non-native species.
2. Selective harvest of non-native or invasive species outside of the non-native timber plantation areas, where harvesting would be followed by replanting of native species.
3. Removal of native and non-native trees for the purpose of road, trail and fence maintenance, hazard reduction, or the salvage of dead or dying trees.

<u>2012 Fire</u>
In 2012, over 3,000 acres of forest burned within the KTMA in three separate wildfires. Much of the burned area consisted of non-native timber plantation stands (eucalypts and pine) on the ridgetops and were considered severely burned with little remaining live vegetation. As a result, the burnt areas were closed to the public for an extended period of time due to safety issues: fire weakened timber, exposed rock and soils, downed trees, and intense re-growth of invasive species. Post-fire mitigation under a 2013 Emergency Proclamation issued by Governor Abercrombie involved soil stabilization through aerial seeding of bare ground, road clearing and repair, small-scale hazard tree removal along roadways, large-scale biomass removal, and reforestation within the KTMA, taking place from 2012 into 2015.

2.2 PURPOSE AND NEED

The KTMA management plan was completed in 2005. For a variety of reasons, including the economic downturn, staff furloughs, and other forestry priorities, the corresponding environmental assessment was never completed. The 2012 fire dramatically illustrated the fuel load and fire potential contained in the non-native timber plantation stands and increased the priority of completing the environmental assessment for the KTMA Plan, to facilitate future timber management activities to reduce the fire threat.

The KTMA Plan expresses the following goals:

- initiate active long-term commercial forestry operations on Kauaʻi;
- reduce the fire potential contained within the non-native timber plantations;
- restore native plant communities where partial/remnant native plants exist within areas

degraded or dominated by non-native species;
- promote tree removal or harvest methods in support of hazard reduction;
- increase existing limits on salvage operations for dead or dying trees;
- promote the use of forests or forest products for cultural or educational purposes;
- stimulate economic activity and growth in the timber processing sectors of both Kauaʻi and the State; and
- provide DLNR with an opportunity to supplement annual budgets through timber sales revenues, effectively increasing funding available for resource management activities.

Historically, the economics of forestry operations in Hawaiʻi have been variable. Some planted species have not succeeded, many timber plantations have not been effectively managed to maximize timber value, local processing opportunities have been limited, and the remote location and relatively small (compared to mainland forests) timber resources increase costs of harvest. These challenges remain, but DOFAW believes it important to provide the *opportunity* for sustainable commercial harvest of appropriate forest resources.

2.3 PROJECT DESCRIPTION

Full implementation of the KTMA Plan outlines three principal methods of timber management, correlated to specific areas within the KTMA:
1. sustainable commercial management of existing non-native timber plantation areas;
2. selective harvest of existing non-native or invasive species outside the existing timber plantation areas; and
3. removal of native and non-native trees for purposes of road, trail, and fence maintenance, hazard reduction, or for the salvage of dead or dying trees.

Table 2-2. Timber Management within the KTMA.

Activity	**Approximate Acreage Involved**	**Estimated Maximum Annual Harvest (acres)**	**Primary Timber Species**	**Mechanism**
Commercial harvest of non-native timber plantations	1,967	500	Eucalyptus, pine	Request for Proposals and land license
Selective harvest	17,000	10-30	Brushbox, monterey pine, silk oak, formosan koa	Commercial harvest permit
Road, trail and fence maintenance	100	<10	All	Staff or by contract
Hazard reduction	17,000	<1	All	Staff or by contract

Salvage of dead or dying trees	17,000	<1	koa, other	By permit

Sustainable commercial management of existing non-native timber plantation areas

The KTMA contains approximately 1,967 acres of non-native timber plantation stands[1] (Figure 3). In general, commercial harvest of the non-native timber plantation stands would involve the following activities: (1) improvements or repair of existing forest road infrastructure, (2) harvesting of timber, (3) replanting of harvested areas, (4) management of planted areas, and (5) transport of harvested timber from KTMA.

The surveyed timber stands within the non-native timber plantations represent a readily accessible resource due to comprehensive existing road networks. Approximately 40 miles of unimproved access roads interconnect within the KTMA. These roads can be utilized for timber harvest purposes, and no new permanent roads are necessary. However, slopes exceeding 25% are common in KTMA, so operation of vehicles and heavy equipment would be restricted by slick road conditions during rainy periods.

Improvements to the existing roads, such as clearing, grading, application of gravel, and installation or reconstruction of water bars, dips, culverts and other drainage features, may be required to accommodate harvesting activities and mitigate erosion potential and to repair or restore the existing roads after harvesting activities are complete. Temporary skid trails, used to move logsfrom the forest to the landing area, and landings, where logs are loaded into trucks for transportation, would be allowed as necessary, with locations mapped and determined in advance after collaboration with DOFAW. All roads would be required to be restored to their original usable condition, and all temporary skid trails and landings would be required to be revegetated after use.

The non-native timber plantation stands are composed primarily of eucalyptus (appx. 1,100 acres) and pine (appx. 700 acres) species. The stands range in size from less than one acre to 92 acres. *Eucalyptus saligna* and *E. microcorys* appear to be well suited to the growing conditions found in the KTMA; *E. robusta* has not grown as well, likely because of the relatively dry climate condition. Eucalyptus stands in the KTMA were heavily damaged by Hurricane Iniki, with most species sustaining volume losses of 20% or more; eucalyptus species also suffered heavy damage during the forest fires of 2012 as in general, these species burn with high fire intensity. Rapid growth rates, high yields, and straight form of these trees make eucalypts usable in a wide variety of processing opportunities including veneer, plywood, and as biofuel, but the estimated commercial value of the existing stands is unknown.

[1] This number reflects the 2,002 acres identified in the 1998 Timber Inventory, minus the acreage (35) located within Pacific Missile Range Facility. The acreage reported in the KTMA Plan (2,370 acres) reflects the inclusion of acreage associated with the access roads that run through or adjacent to the non-native timber plantation stands.

Figure 1a. Non-native timber resources represented by primary overstory species - West Kauai.

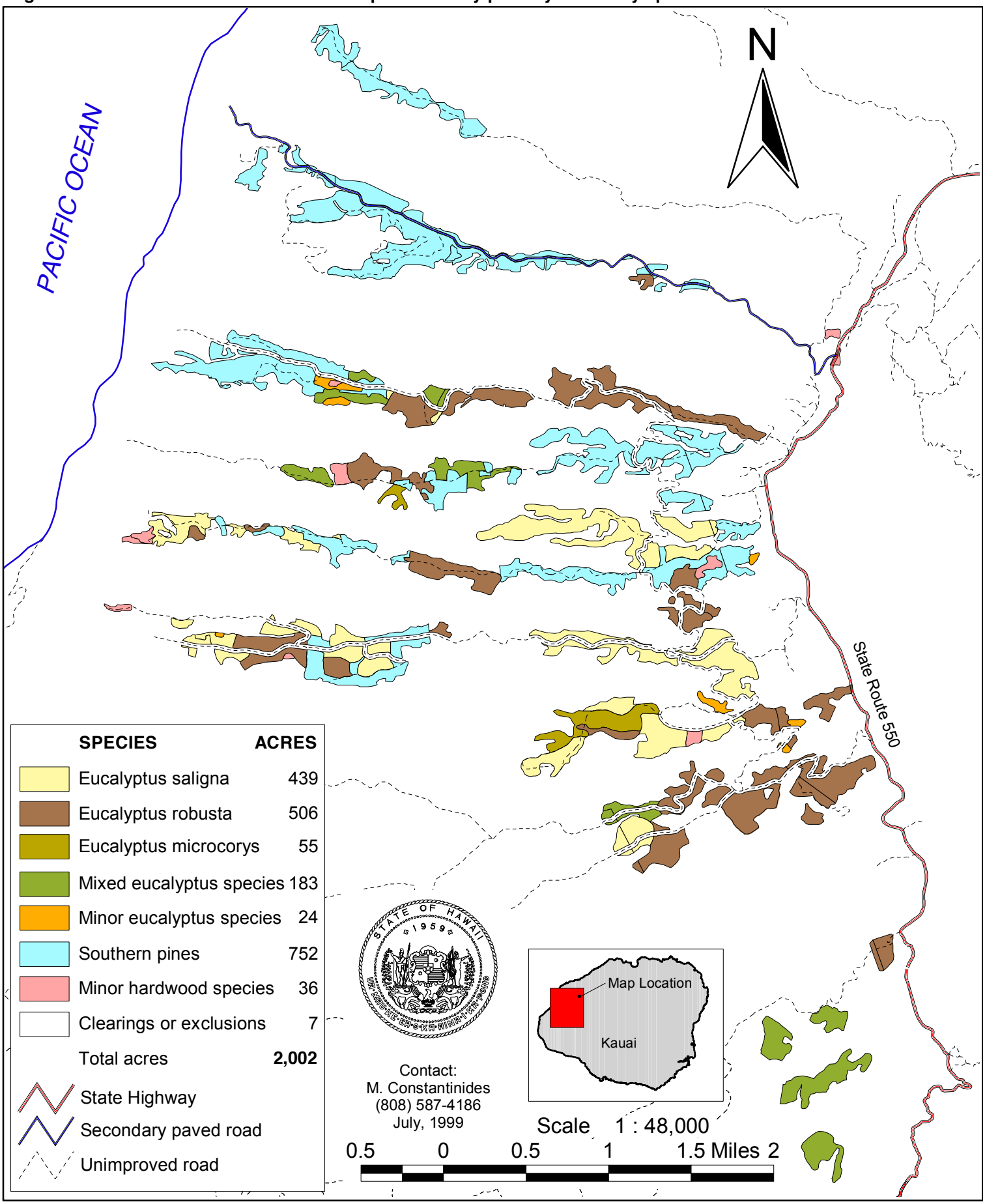

Figure 3. West Kauai Non-Native Timber Resources: Primary Tree Species

Southern pines were initially planted for erosion control on the lower ridges, on a smaller scale than the eucalypts. These pines have proven to be resistant to wind and fire damage, suffering minor losses from Hurricane Iniki and minor long-term damage from the 2012 fire. At present, the size and value of the commercial market for pine is unknown. Certification for use as dimensional lumber could increase the value of the existing pine stands and may be explored by DOFAW in the future.

Timber harvest involves several steps: (1) felling, or cutting, the trees; (2) bucking the cut tree, which involves removing the branches and if necessary, cutting the tree into logs; (3) extracting the logs from the fell site in the forest to a landing area, using ground-based mechanical systems; and (4) loading the cut logs for transport.

Best management practices to be incorporated during harvesting include:

1. careful felling of trees to minimize the impact to the surrounding environment;
2. avoidance of road ditches as skid trails;
3. use of water bars for skid trails on steep slopes;
4. servicing equipment involving fuel, lubricants, or coolants in places where the materials cannot enter streams; and collecting used oil and other liquids for proper disposal (not poured on the ground); and
5. mulching or seeding erosion-prone areas upon completion of logging.

In general, DOFAW will not prescribe a specific management regime for harvesting timber within the KTMA non-native timber plantations stands (clear-cutting vs. thinning vs. selective harvest of specific trees). However, DOFAW may identify specific trees or tree stands to be left standing for visual buffers, wildlife habitat or other reasons.

In addition, timber felling will not be allowed between June 1 and September 15 due to potential impacts to the Hawaiian hoary bat, or ʻōpeʻapeʻa (*Lasiurus cinereus semotus*). However, this restriction may be lifted upon additional surveys and the implementation of additional mitigation actions, if the U.S. Fish and Wildlife Service (USFWS) and DOFAW Wildlife staff concur that the proposed mitigation actions will adequately reduce the possibility of take during ongoing harvesting activities. Other project activities, including loading and transporting timber, road maintenance, site preparation, and replanting, may still occur within the KTMA during the “no-harvest” period.

Timber harvesting creates a fair amount of woody debris, also called slash, composed of treetops, branches, and leaves left behind after the cut logs are removed. Slash may be used in areas of soft-ground to create a track for vehicles, mitigating erosion and ground damage, it may be left to compost in place, or it may be chipped and incorporated into site planting preparation as mulch or made available to the public for use as mulch or firewood. In general, the following options for slash treatment are recommended, listed in preferential order:

1. lop all logging debris such that it lies within 12 inches of the ground surface and away from stumps;
2. scatter logging debris with a bulldozer;
3. pile all logging debris in designated windrows or piles.

Slash may not be pushed into valleys or drainages. Additional requirements may be established for eucalyptus logging debris based on the anticipated volume, due to the potential for self-combustion.

After harvest, regrowth from stumps (coppicing) and from seed fall may interfere with replanting activities. Herbicides may be utilized, following all applicable state and federal regulations and label restrictions, to prevent weedy regrowth. Mechanical crushing or manual clearance of existing vegetation may also be incorporated. Use of fire for site preparation for replanting will not be permitted under any circumstances.

In general, planting of seedlings will occur within six months of the harvest to minimize the potential for soil erosion or the establishment of invasive weed species in the area. Species selection will depend largely on site conditions (primarily rainfall and elevation), adjacent forest characteristics, seedling availability, specific qualities of a species (e.g., growth rate, disease resistance, wood characteristics, ease of removal, available markets), and management goals. DOFAW intends to encourage the planting of native species to the extent possible, but recognizes that native species may not thrive in many locations. Historically, many of the non-native timber stands were planted because existing native vegetation was not growing well, and soils been further altered by the presence of pines and eucalypts. Due to the need to get vegetation established quickly, to stabilize soils and minimize erosion, non-native species are likely to be used for replanting efforts, especially below 2,400 ft in elevation. All non-native species proposed for planting will be evaluated for potential invasiveness using the Hawaiʻi Weed Risk Assessment and other relevant information.

Best management practices to be incorporated during site preparation and replanting include:

1. avoiding excessive soil compaction during mechanical site preparation,
2. utilizing the minimum preparation necessary to control competing vegetation and establish a desirable timber stand,
3. ensuring that windrows, disking, bedding, and planting with furrow type mechanical planters follow contours, and
4. planting trees on contour.

After seedlings are planted, timber stand management is necessary to enhance planting success. Timber stand management includes manual application of commercial fertilizers to encourage seedling survival and forest re-establishment, weed control to reduce competition, side branch pruning of young tree stands, and thinning of young stands to improve stand health as the trees age. In addition, insect and disease monitoring may be conducted for known problems to tree seedlings, such as *Phytophthora cinnamomi* (root rot disease) and for insect damage such as by the black twig borer (*Xylosandrus compactus*).

Best management practices to be incorporated during timber stand management include:

1. choosing pesticides or herbicides suitable for use on the target species and registered for the intended use by the U.S. Environmental Protection Agency (EPA),
2. following all label directions,
3. considering site factors, application conditions and techniques, and products available, in addition to cost and effectiveness when selecting pesticide or herbicide options, and

4. incorporation of protocols for transportation, storage, use, and disposal of chemicals, to minimize opportunities for spills or contamination.

Cut timber would need to be transported from the KTMA. Truck traffic volume will depend largely on harvesting activity and the size of the truck used for transport (smaller trucks would require more trips). DOFAW estimates a maximum of ten trucks per day, regularly spaced, would enter the KTMA empty and leave the KTMA carrying a fully loaded container of timber. The ultimate destination of the timber would depend on market interest; possibilities include transportation to the Green Energy Agricultural Biomass-to-Energy facility in Kōloa, transportation to Nāwiliwili for further processing off-island, and transportation to various locations on island for processing or use on Kauaʻi.

Selective harvest of existing non-native species outside the existing timber plantation areas
Other non-native tree species found in minor quantities in the KTMA include brushbox on 7 acres, monterey pine (*Pinus radiata*) on 2 acres, paperbark (*Melaleuca quinquenervia*) on less than one acre, Formosan koa (*Acacia confusa*) on 8 acres, ironwood (*Casuarina equisetifolia*) on 8 acres, and silk oak on 16 acres. No detailed volume or distribution data are available for these species due to their scattered occurrences. These species either presently exist in small stands (brushbox, monterey pine) or are considered invasive. There is limited market interest in these species, based on the periodic inquiries received by DOFAW.

The harvest process for these species would be similar to that of the commercial harvest of the non-native timber plantation stands, but on a significantly reduced scale. These species may be harvested selectively (identifying and marking each individual tree to be harvested) or in small patches. Any invasive species would be harvested with a primary goal of control, removal, and conversion to native species. Total acreage harvested would necessarily be limited to existing stands.

The same best management practices identified above would be incorporated where appropriate into selective harvest activities. Instead of issuing a Request for Proposal (RFP) and associated land license, requests to selectively harvest non-native trees outside the non-native timber plantation stands will be processed using the existing commercial harvest permit process.

Removal of native and non-native trees where necessary for hazard reduction, road, trail and fence maintenance, or the salvage of dead or dying trees.
Koa and other native species, as well as non-native trees, may be harvested within the KTMA where necessary for hazard reduction, road, trail and fence maintenance, or for salvage of dead and dying trees. DOFAW defines dying trees as those with less than 15% remaining live crown area comprised of healthy leaves.

Hazard reduction and road, trail and fence maintenance would be concentrated along existing access-ways (roads and trails), along existing fencelines, and in publicly used areas (e.g., picnic shelters, lookouts). Tree removal associated with hazard reduction could also occur in other areas of the KTMA as necessary to respond to and mitigate the effects of a fire, windstorm, or disease outbreak or as a fire prevention measure. Clearing hazard trees reduces risk of tree fall, limits flash flooding potential, and suppresses fire potential by reducing fuel loads and clearing firebreaks. Fuel reduction thinning

Maintenance activities ensure roads and trails are passable for management, recreational uses, and emergency response and protect the integrity of existing conservation fences.

Tree removal for hazard reduction, fence and roadway maintenance will be done internally by DOFAW or Division of State Parks staff or by contract managed by DOFAW or the Division of State Parks. Currently, cut timber is left in place to decompose or for the public to collect as firewood or other use, and wood resources of high-value trees have been donated to public schools for craftwork curriculum. Salvage harvest of dead or dying trees will continue to be regulated by commercial harvest or special use permit, identifying the specific tree to be harvested. The same best management practices identified during the discussion on commercial harvest within the non-native timber plantations will be incorporated as appropriate into all maintenance and salvage harvest harvest activities.

Timing and Process

After acceptance of the Final Environmental Assessment (EA), the State will periodically solicit proposals for commercial harvest of the non-native timber plantation stands. Market interest in this timber is currently unknown. Because of the non-contiguous nature of these plantation stands, logistical issues involving access and movement of equipment to Kauaʻi from other islands or the mainland, the uncertainty of the timber markets, and the high cost of transporting the timber from the KTMA, it is possible that there will be no bidders.

If there are bidders, selecting a contractor and awarding a land license could be completed approximately six months after opening of the proposals. Harvesting activities could begin as early as two months after award of the license, depending on the time of year and the ability of the selected contractor to complete required pre-harvest planning.

Licenses are anticipated to have terms of 15 to 30 years with clear milestones, so that the State can easily terminate a license for inaction or violations of the license terms. DOFAW's goal is to provide long-term assurances for potential contractors, recognizing the expensive start-up costs associated with commercial timber harvest of this area, yet at the same time, prevent successful bidders from tying up wood resources and not making use of the valuable commodity. Because of uncertainty regarding market interest, actual timing of harvest of a particular area or of specific timber species is unknown.

DOFAW will require all proposals for harvesting within KTMA to include at minimum:

- a proposed stumpage fee,
- identification of areas and species to be harvested,
- anticipated markets for harvested timber,
- detailed information about the harvest methods (including planned management of slash),
- site preparation methods,
- replanting plans (including species selection criteria, planting method, minimum survival rates),
- timber stand improvement methods,
- preliminary transportation plan, including planned access routes, skid trails, and landing areas,
- timeline,

- invasive species prevention and mitigation protocols (staging, equipment cleaning, etc.), and
- any planned mitigation measures and site-specific best management practices.

If there are no bidders and no land license is awarded, DOFAW may explore other options to reduce fuel loads within the non-native timber plantations, including contracting for thinning and tree removal in specified areas within the KTMA.

Permit applications, if any, for commercial harvest of non-native trees outside the non-native timber plantation areas and for salvage harvest of dead or dying trees will be processed and evaluated upon receipt. Contracts for tree removal for hazard reduction or maintenance purposes will be developed as needed, in conformance with State procurement laws and regulations.

3. SCOPING AND PUBLIC PARTICIPATION

The 2005 KTMA Plan was presented to the Board of Land and Natural Resources (BLNR) for adoption in January 2005 and finalized internally in 2007. Contents of the 2005 KTMA Plan were incorporated in the Kōkeʻe and Waimea Canyon State Parks Master Plan, which was finalized in 2014 after 10 years of work and discussion. The planning process for the Master Plan included a community-outreach effort and the involvement of the Kōkeʻe State Park Advisory Council.

Beginning in 2013, DOFAW sent letters to federal, state and county agencies, community organizations, businesses, and interested individuals about planned logging and biomass removal operations to be conducted as part of the post-fire mitigation response from the 2012 fire. The logging occurred between February and April 2015, covering approximately 1,000 acres of burnt forest, to remove dead and dying trees, to thin and remove coppice re-growth, and to reduce the fuel load. In addition to a site visit for interested reporters, DOFAW held several public meetings before and during the salvage operations to share information and receive community concerns.

Potential adverse impacts raised during scoping include: traffic impacts caused by timber hauling; damage to highways and roads due to timber hauling activities; public safety; impacts on recreational activities; air quality, runoff, noise, and other impacts from equipment operations and activities associated with on-site timber processing and removal; effects on endangered species and habitat; soil exposure and erosion; visual impacts of harvesting activities; and loss of water retention due to the absence or reduction of vegetative cover.

4. ALTERNATIVES CONSIDERED

4.1 ACTIONS CONSIDERED BUT ELIMINATED

Early in the alternatives development process (during formulation and revision of the KTMA Plan), DOFAW considered the following actions. These actions were ultimately eliminated from further consideration for the reasons provided.

Commercial harvest of existing native forest.
Due to the value of native forest for watershed and habitat purposes, commercial harvest of existing native forest stands was not seriously considered, despite the commercial value of native species such as koa for specialized woodworking.

Non-commercial removal of non-native timber plantation areas and restoration of native forest.
Widespread removal of non-native timber species on a non-commercial basis followed by reforestation with native species was considered but eliminated due to high cost, small likelihood of success, and potential for increased erosion and for establishment of other invasive plants. Labor costs involved to remove non-native timber species and replant native species would be high due to lack of specialized equipment on-island. The limited availability of native seedlings and the low potential for successful establishment in the lower elevations would complicate native reforestation efforts, increase the acreage of bare ground, and ultimately could result in increased erosion or increased colonization by invasive plant species. Transportation costs to remove timber resources from the mountain are extremely high, while allowing cut logs to remain on site and letting natural regeneration occur would increase the overall fuel load, increasing fire risk and contributing to hotter fires when fire does occur. It would also waste timber resources, the commercial value of which (when used for energy production or for wood products) could be used to defray the cost of forest management.

4.2 NO ACTION ALTERNATIVE

The no-action would entail a continuation of the current management activities. Current management of the KTMA includes basic maintenance of dirt roads for recreational access and use, clearing hazard trees along roadways, wildland fire response and suppression, limited pilot projects of small-scale removal of invasive plant species and replanting of native species, post-2012 fire mitigation activities, and selective harvest of identified dead or dying trees by commercial harvest or special use permit. More intensive forest management would not be anticipated to occur because funding for forest management is limited and dependent on government appropriations, and DOFAW has limited staff and equipment on-hand.

Implementation of the KTMA Plan differs from current management by allowing for sustainable commercial harvest of the non-native timber plantation stands, allowing for selective commercial harvest of non-native trees in forest areas outside the timber plantation stands, and improving productive salvage of timber resources from dead, dying or hazard trees. Benefits of implementing the KTMA Plan versus the no-action alternative include a reduction in fuel loads, the creation of a revenue source for forest management, and improved opportunities for economic use of forest timber resources.

5. SUMMARY DESCRIPTION OF THE NATURAL ENVIRONMENT, POTENTIAL IMPACTS, AND MITIGATION MEASURES

This section describes existing conditions of the natural environment, potential impacts of the project, and mitigation measures to minimize impacts.

5.1 CLIMATE AND TOPOGRAPHY

The climate of the KTMA varies with elevation and topography. The island of Kaua‘i is a remnant of a huge shield volcano, and despite time and natural weathering, the shape of the shield volcano remains the island's dominant feature with Mt. Wai‘ale‘ale and its peaks of Kawaikini (5,243 ft) and Wai‘ale‘ale 5,148 ft). Numerous ridges and valleys, becoming more pronounced toward the coast, characterize the landscape of the KTMA. The steep windward slopes of Mt. Wai‘ale‘ale force moisture-laden wind upward, and changes in temperature and pressure cause rapid condensation, cloud formation and heavy rain. This effect produces an average annual rainfall of 433 inches on Mt. Wai‘ale‘ale.

Rainfall decreases with the change in elevation; in the roughly 8 miles between Mt. Wai‘ale‘ale and Kanaloahuluhulu Meadow in Kōke‘e State Park (3,600 ft), the rainfall contour drops from 433 inches to 60 inches (Figure 4). The median annual rainfall within the KTMA ranges from 120 inches at the 4,000 ft elevation, decreasing to 30 inches annually at the 1,000 ft elevation. Average rainfall along the ridge tops containing majority of the non-native timber plantation stands ranges from approximately 30-55 inches annually (Giambelluca et al. 1986). During Kona wind conditions, fog belts commonly develop in two localized regions: (1) starting at the 5 mile marker on Kōke‘e Road and extending just base Waimea Canyon Lookout, and (2) starting approximately at the 12.5 mile marker and extending to the intersection of Kōke‘e Road and Halemanu Road.

At the higher elevations in the Kōke‘e area (3,600 ft and above), the average recorded temperature ranges from 46°F (February) to 71° F (August), and frost formation is common during the cooler months. As elevation decreases, the average recorded temperature warms; the mean annual temperature at the 1,800 ft elevation is approximately 77° F.

Potential impacts and mitigation measures
Full implementation of the KTMA Plan is not anticipated to have any negative impacts on regional climate or the existing topography. Part of the KTMA, particularly the area containing the majority of the existing non-native timber plantation stands, is considered to be a low rainfall zone where wildfire is a constant threat. Typically, fire risk increases in forested areas with increased human activity, and in general, the presence of too much slash resulting from timber management activities may increase fire hazards through increased fuel loads or self-combustibility. Mitigation measures include restricting smoking and open fires within the KTMA by any licensee or permittee, requiring the development and implementation of a DOFAW-approved fire response plan as part of a harvest plan, and implementing site-specific and species-specific procedures to manage slash. Commercial harvest of the non-native timber plantations and hazard tree reduction activities would have a secondary benefit of reducing fuel loads and maintaining the road network for use during fire response and emergencies.

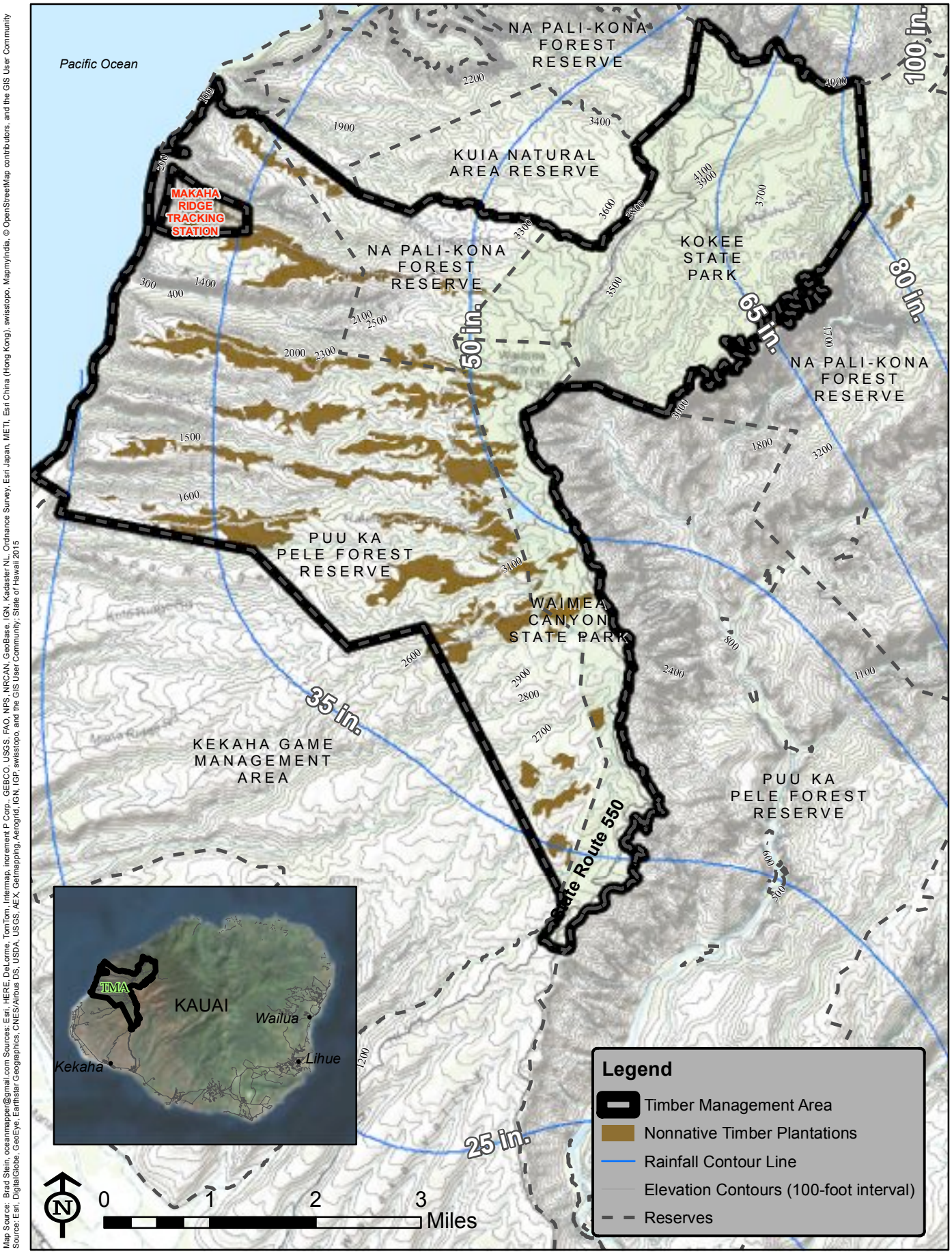

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Figure 4. KTMA: Elevation and Rainfall.

5.2 SOILS

Information on soils comes primarily from the Soil Survey of Kauaʻi, conducted by the US Department of Agriculture, Natural Resources Conservation Service (NRCS), and the University of Hawaiʻi, Agriculture Experiment Station (Foote et al. 1972).

The NRCS Soil Survey classifies the soil types within the KTMA as mostly ash-derived silty loams from the Mahana and Oli series, basalt derived clay loams from the Niu, Kokee, Kunuweia and Puu Opae series, or rough broken land and rock outcrop (Figure 5). This complex landscape of soil types provides evidence of the island's volcanic origin and the natural forces that shape the terrain. These soils are classified as well-drained. The erosion hazard of these soils ranges from slight to severe, depending on the slope (with more severe erosion in steeper areas). Slopes range widely within the KTMA, and slopes exceeding 25% are common.

Potential impacts and mitigation measures
Portions of the KTMA are characterized by steep lands, broken by many drainage channels, where soil depth is variable, runoff is rapid and erosion is active. Some of the existing soil erosion in the KTMA can be attributed to vegetation loss caused by feral ungulates; some of the erosion can be attributed to natural processes. Management objectives for the long-term management of the KTMA necessitate the protection of soil resources on site. Impacts to soils include potential for soil erosion and the generation of dirt and dust during harvesting activities. Effects would not be widespread throughout the KTMA, but would be localized in the specific areas being harvested or undergoing reforestation and would be temporary. The proposed action involves the use of heavy equipment for harvesting, road maintenance, site preparation, and replanting activities. Timber harvesting operations also require the construction of temporary skid trails and landings. Additional soil disturbance is possible during tree felling, while logs are skidded to landings, decked, and loaded, and when preparing a site for replanting (which involves crushing or removing existing vegetation). Heavy rainfall could also cause some erosion of soils within disturbed areas of land. No grading or grubbing is anticipated, and no permanent new roads will be established. Greater impacts could be anticipated with harvest of the non-native timber plantation areas; impacts associated with selective harvest or tree removal associated with hazard reduction, maintenance, or salvage would be anticipated to be smaller and localized around the tree or feature (e.g., road or trail) site.

All forest management activities would be required to comply with the measures listed in the State's BMPs (attached as Appendix D) and the Hawaiʻi Watershed Guidance (DBEDT 2010). Developed in 1996 and 2010 respectively, the practices outlined in these documents would be incorporated to minimize the impact of forestry practices on water quality from the following actions: roads, timber harvesting, chemical management, stream-side management, fencing, wildlife damage control, fireline construction, prescribed burn, and reforestation.

Specific best management practices to be incorporated to minimize the potential for soil movement, erosion, and compaction would include proper engineering in the design and location of skid trails and landings, maintenance of active and inactive roads sufficient to maintain a stable surface and keep the drainage system operational, avoiding the use of heavy equipment in the steeper and more erosion-

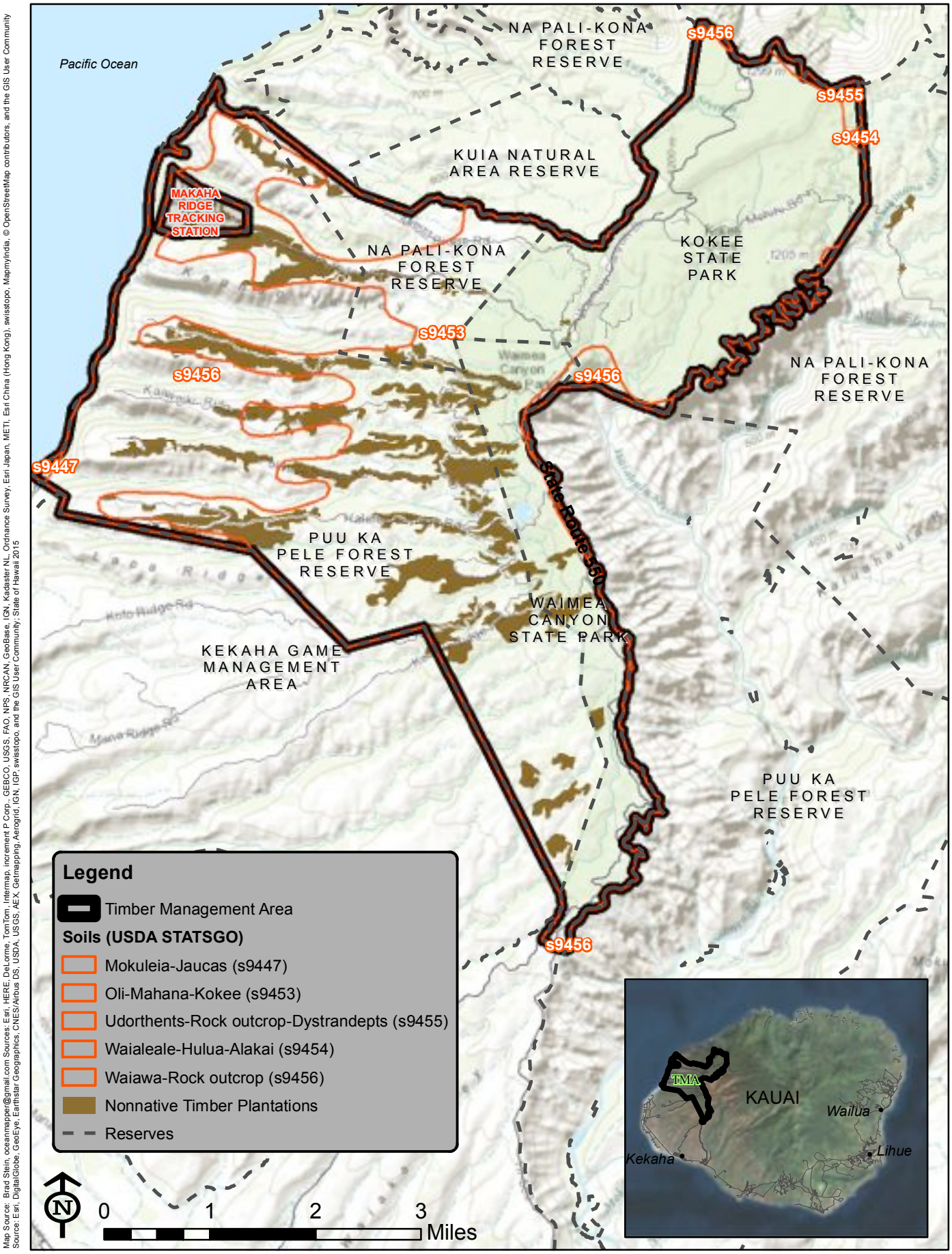

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Figure 5. KTMA: Soils.

prone portion of the project area, phasing harvesting to reduce exposed ground areas, avoiding earthwork in inclement weather or periods of excessively wet soil conditions, using vegetative buffers for erosion control and soil stabilization, and revegetating of bare areas with vegetative cover as an interim measure between harvest and replanting.

5.3 HYDROLOGY AND WATER RESOURCES

The KTMA has extensive tree and ground cover making the area a functional watershed. Three aquifer systems underlie the KTMA:
* Hanalei acquifer sector/Nāpali system
* Waimea aquifer sector/Waimea System
* Waimea aquifer sector/Kekaha system (RM Towill 2014).

All three are characterized as (1) high level (fresh water not in contact with sea water); (2) unconfined (the water surface is in the upper surface of a saturated aquifer), and (3) dike-contained (aquifers are confined in basaltic dike compartments) and have been assigned a groundwater status code 21111, which indicates that the groundwater has potential for development, is a source of drinking water, has a low salinity content, is irreplaceable, and has high vulnerability to contamination (RM Towill 2014).

Many perennial and intermittent streams are found within the KTMA (Figure 6). Surface water runoff from Nā-Pali Kona Forest Reserve, Alakaʻi Wilderness Preserve, and Kōkeʻe State Park are the principal contributors to the Waimea River watershed. Three primary streams originate from the Kōkeʻe State Park area: Halemanu, Kōke'e and Po'omau streams. Some flow from Kōkeʻe stream is diverted near Camp Sloggett into a small surface water pond, then piped to metal tanks, to be used when well water is not available.

The Kōkeʻe ditch, completed in 1926, intercepts flow from 6 streams (including Poʻomau stream) at peak altitude of 3,400 ft. The system consists of a 21 mile collection and conveyance system, including tunnels, channels, underground pipes, reservoirs, and ditches, and was built to provide the water needs of the sugar operations in the lowlands surrounding Waimea and Kekaha. Most of the infrastructure is located within Waimea Canyon and Kōkeʻe State Park and is now used to transport water to the Kekaha Agricultural Park and to the Mānā Plain for irrigation.

Seasonal stream flows also occur in the valley drainages on the westward facing slopes of KTMA during incidents of heavy rain. Many of these flows are intermittent or ephemeral. Spring sources occur throughout the KTMA, with flows reflecting rainfall levels. The Kōkeʻe Air Force Station has developed one such spring as a potable water source (shared with the restroom at Kalalau Lookout). Other small and privately operated water sources utilizing wells and surface water are located in the Kōkeʻe, Halemanu, and Puʻu ka Pele Camp lot areas.

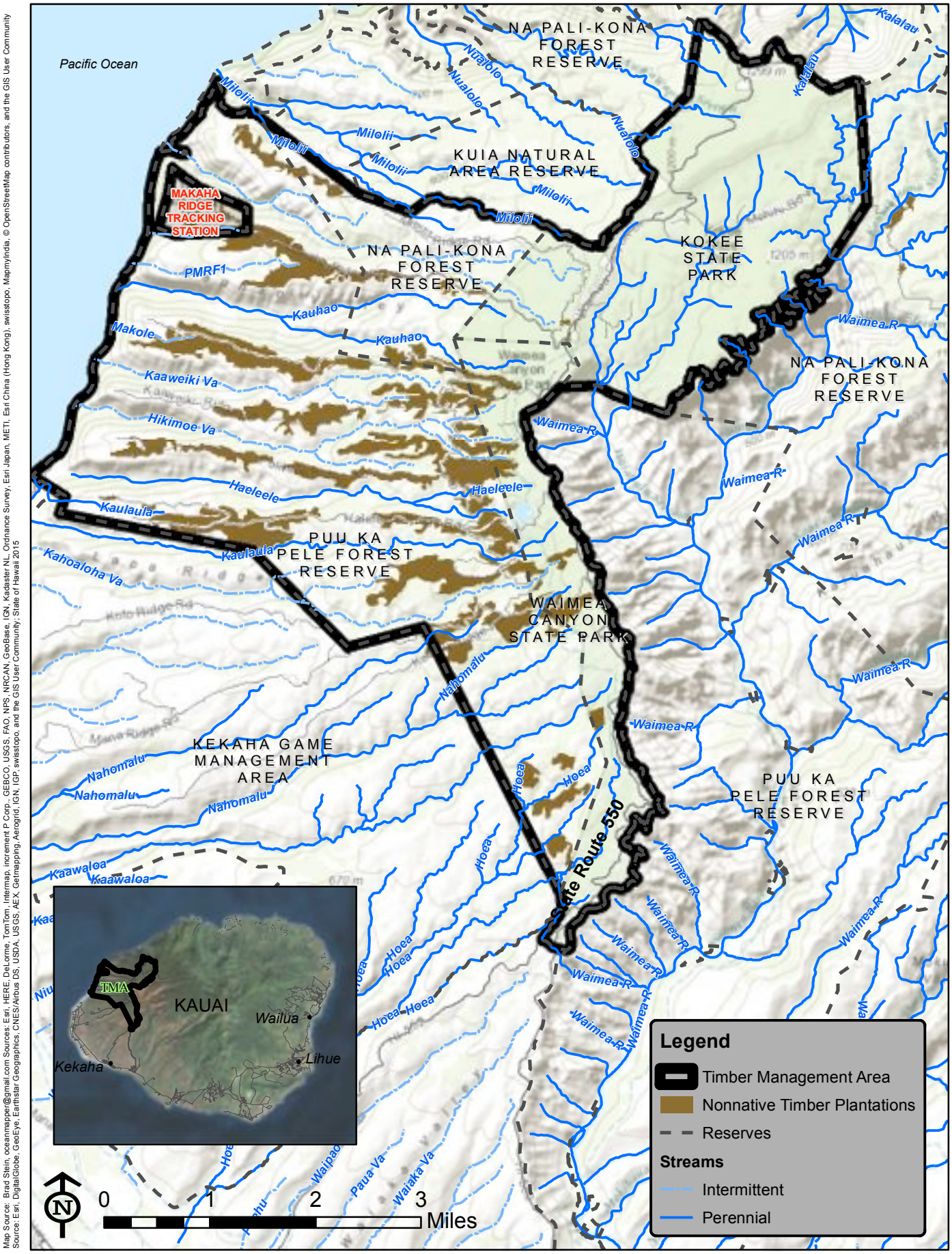

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Figure 6. KTMA: Streams.

Coastal waters, especially in nearshore marine waters (within 300 m of shoreline), can be viewed as an extension of the watershed, largely influenced by streams and groundwater resources on the adjacent land. A small portion of the State's marine waters were assessed in 2014 using available water quality data (DOH 2014). Segments with data closest to the KTMA include Hāʻena Beach Park, Kēʻē Beach Park, Pacific Missile Range Facility/Barking Sands Beach, and Polihale State Park; all exceeded State turbidity standards. Segments adjacent to KTMA, currently with insufficient data, include Hanakāpīʻai Beach, Kalalau Beach, Kepuhi Beach, Tunnels Beach, Miloliʻi, Nuʻalolo, and Nā-Pali Coast State Park.

Potential impacts and mitigation measures
Impacts to hydrology and water resources include the potential for water quality degradation from sediment, nutrients, pesticides and debris from harvesting activities and post-harvest timber management. The area immediately around the non-native timber plantation stands, where most of the harvesting activity would occur, has no running streams except during periods of heavy rainfall, and normal patterns in the area consist mainly of ground infiltration.

As noted previously, all forest management activities would be required to comply with the measures listed in the State's BMPs and the Hawaiʻi Watershed Guidance. Specific best management practices to be incorporated to minimize water quality impacts include avoiding any disruption of natural drainages, preventing excessive soil displacement, providing culverts, water bars, and similar structures on roads and skid trails to minimize erosion, avoiding earthwork in inclement weather or periods of excessively wet soil conditions, using vegetative buffers for erosion control and soil stabilization, revegetating bare areas with vegetative cover as an interim measure between harvest and replanting, directing disposal of slash and debris away from valleys and stream channels, and maintaining a 50-ft buffer adjacent to all stream and wetlands prior to timber management activities. To minimize water quality degradation from nutrients and pesticides, best management practices would include choosing pesticides or herbicides suitable for use on the target species, using all chemicals in strict adherence with all label requirements, incorporating protocols for transportation, storage, use, and disposal of chemicals to minimize opportunities for spills or contamination, and where necessary, establishing use limitations or buffer zones where chemicals may not be used.

5.4 AIR QUALITY

There is no data on ambient air quality specific to the KTMA. However, due to tradewinds experienced year-round as well as the low population and limited development on the island, air quality on Kauaʻi is generally considered good.

Potential impacts and mitigation measures
Some air pollution from use of heavy machinery and small power tools will be unavoidable; however, emissions from these forest management activities are not expected to exceed the state and national standards. Discharge of visible fugitive dust, if any, is not anticipated to travel outside the KTMA. Any debris hauled out from the project areas would be covered when necessary.

5.5 THREATENED AND ENDANGERED SPECIES

ʻŌpeʻapeʻa

The Hawaiian hoary bat, or ʻōpeʻapeʻa, appears to be fairly common in the KTMA. Individuals are regularly seen in the evenings and are often seen feeding near stands of mature eucalyptus. However, the extent of their distribution and density is unknown, and there are no documented observations of roosting within the KTMA.

The ʻōpeʻapeʻa is a medium-sized member of the vesper bat family (Vespertillionidae) and is an endemic and endangered subspecies of the North American hoary bat, a solitary tree-rooster. The ʻōpeʻapeʻa is Hawaii's only native terrestrial mammal and can be found from sea level to 14,000 feet in elevation. Males and females have a wingspan of about 1 foot, and females are typically larger than males. Both sexes have brown and gray fur. Individual hairs are tipped or frosted with white; "hoary" means frosted. The Hawaiian name refers to a half taro leaf or canoe sail shape; these being similar to the shape of the bat. Fur color, frosted or reddish, may be related to location or age.

The ʻōpeʻapeʻa is primarily solitary, nocturnal and insectivorous. It is a major predator of night-flying insects such as moths, beetles, and termites. Bats forage in open and wooded landscapes and linear habitats such windbreaks and riparian zones, and roost in both native and non-native trees with dense foliage and with open access for launching into flight. ʻŌpeʻapeʻa have been found roosting in ʻōhiʻa, eucalyptus, and sugi pine, among other species. Females are believed to give birth to twins May - August and rear pups May - September. Pups fledge from about July - September, which is a critical time in the reproductive cycle (Menard 2001, Bonaccorso et al. 2008). Because warm temperatures are strongly associated with reproductive success in this and other bat species, it has been suggested that key breeding habitat is likely to occur at sites where the average July minimum temperature is above 52ºF, which would occur throughout the island of Kauaʻi.

The population size is unknown. Resident populations occur on Kauaʻi, Maui, and Hawaiʻi and possibly other main islands, with the highest abundance on Kauaʻi and Hawaiʻi. Threats are largely unknown but may include roost disturbance, introduced predators, obstacles to flight (e.g., barbed wire fences, vehicles), and pesticides (USFWS 1998).

Potential impacts and mitigation measures

Noise and activities associated with timber management may temporarily disrupt the activities of the ʻōpeʻapeʻa. The following measures will be taken to avoid any impacts to the ʻōpeʻapeʻa from harvesting or other silviculture activities within the KTMA:

- timber felling will not be allowed between June 1 and September 15, the bat birthing and pup rearing season to prevent harm to undetected juveniles; and
- If any ʻōpeʻapeʻa fall to the ground during operations, the operator must immediately cease all activity and contact DOFAW.

The restriction on timber felling between June 1 and September 15 may be modified or lifted upon additional surveys and the development and implementation of additional mitigation actions, if

DOFAW Wildlife staff and USFWS concur that the proposed mitigation actions will adequately reduce the possibility of take during ongoing harvesting activities.

Impact, if any, from the loss of roosting habitat due to harvesting would be temporary in nature as reforestation efforts and natural regeneration will replace the vegetation in the harvested area, and would be minimized by the availability of substitute roosting opportunities in the surrounding KTMA forest.

Impacts on foraging are anticipated to be minimal because ʻōpeʻapeʻa are crepuscular, while harvesting activities would occur during the day. Tree removals might temporarily benefit the ʻōpeʻapeʻa by increasing forage opportunities by creating open areas adjacent to forest stands.

Nēnē

The nēnē, or endangered Hawaiian goose (*Branta sanwicensis*), or is observed within the KTMA with regularity. There is a resident nēnē population living within the Kōkeʻe area, and nēnē are commonly seen at State Park lookouts where they have learned to beg for handouts from visitors. Nēnē are not regularly observed within the forested areas of the KTMA; due to tree cover, these areas are not typically good habitat for nēnē grazing.

The endangered nēnē is a member of the waterfowl family (Anatidae) and closely related to the Canada goose *(Branta canadensis*). It is light gray-brown with a mostly black head, cream-colored neck with distinctive dark furrows, and black tail and feet. In the 1950s, the nēnē population declined to about 30 birds on Hawaiʻi because of introduced predators, historic over-hunting, and habitat loss. In 2011, there were an estimated 2,457 - 2,547 nēnē on four islands; Kauaʻi supports 1,421- 1,511 birds or 59% of the State population (USFWS unpublished data). Nearly all birds are the result of an aggressive captive propagation and release program which was initiated by the territorial government in 1949. Despite a comeback, nēnē still face obstacles on the road to recovery. Current threats include depredation by predators, inadequate nutrition, lack of suitable lowland habitat, human-related disturbance and mortality, behavioral problems, lack of genetic diversity, and disease (USFWS 2004).

Nēnē are browsing grazers eating the leaves, seeds, fruits, and flowers of grasses, sedges, forbs, and shrubs (Banko et al. 1999), and occasionally climb into or perch in bushes to reach berries (e.g., naupaka (*Scaevola* spp.), māmaki (*Pipturus albidus*)). In many areas nēnē feed on cultivated grasses. In mid-elevation Hawaiʻi, birds select forage with high water and protein content such as the young shoots of a Kikuyu grass–Spanish clover grassland. They prefer sward-forming (turf-like growth) over bunch grasses and short (2-4 inches) over tall grasses and use grasslands less during drought (Woog and Black 2001).

Habitat types frequently used by nēnē include grasslands dominated by introduced species (e.g., saltgrass (*Distichlis spicata*), Kikuyu grass (*Pennisetum clandestinus*)) and open-understory shrublands (e.g., naupaka, koa haole (*Leucaena leucocephala*)), and sea cliffs. Nēnē build nests on the ground usually under woody and herbaceous plants with an open canopy. Nesting habitats range widely but generally is associated with woody vegetation. Nēnē mate for life. The average clutch size is 3 eggs (range 1-6), incubation is usually 30 days (range 29-32), and goslings fledge at 10-14 weeks (Banko et

al. 1999). Breeding occurs mainly October to March and molting March to June, which is when adults become flightless for 4 to 6 weeks while they grow new flight feathers. During this period, they become secretive, and are extremely vulnerable to attacks by introduced predators. During the rest of the year, from June to September, nēnē disperse or flock with other family groups in non-breeding areas where young nēnē have opportunities to find mates. Historically, nēnē are believed to have bred and molted in the lowlands during the winter and to have moved to higher elevations in the summer. Today, birds move daily between feeding and roosting areas and seasonally between breeding and non-breeding areas, but altitudinal patterns are less apparent (USFWS 2004).

Potential impacts and mitigation measures
Noise and activities associated with commercial harvest operations, road maintenance, and replanting are not anticipated to impact the activities of nēnē, as forested areas are not preferred habitat for foraging or nesting. Individual tree removals associated with selective harvest, hazard reduction, road, trail and fence maintenance, and salvage of dead or dying trees would not be anticipated to impact these birds due to the limited scope of the removal.

<u>*Drosophila* species</u>
Drosophila (pomace flies) are true flies (Order: Diptera). Numerous adaptive shifts and unusual evolutionary developments characterize the species found in Hawaiʻi, which are often called "picture-wing flies." *Drosophila* are specialized microbivores that rely on over 40 families of native plants, and recent declines in the genus are associated with the loss of these host plants. Since 2006, thirteen species of *Drosophila* have been listed as endangered and one as threatened.

The KTMA is historically known to contain 2 listed species of *Drosophila*: *D. musaphilia* and *D. sharpi*. The general life cycle of Hawaiian *Drosophila* is typical of most flies: after mating, females lay eggs from which larvae hatch; as larvae grow, they molt through three successive stages; when fully grown, the larvae change into pupae in which they metamorphose and emerge as adults. (USFWS 2012a). Bait can be used to survey for Hawaiian *Drosophila* but only to indicate the presence or absence of taxa. There is no technique currently available to uniquely mark individual flies, and thereby quantify numbers. In addition, Hawaiian *Drosophila* life cycles are influenced by rainfall patterns and other environmental factors, making survey results difficult to compare over time and across sites. (USFWS 2012a).

D. musaphilia is found only on the island of Kauaʻi. The host plant for *D. musaphilia* is koa. The females lay their eggs upon, and the larvae develop in, the moldy slime flux (seep) that occasionally appears on certain trees with injured plant tissue and seeping sap (USFWS 2012a). In the absence of slime flux, the fly is not likely to be found. *D. musaphilia* was last reported in 2010 in surveys off Nuʻalolo trail and Kōkeʻe Road. A total of 794 acres was designated as critical habitat in the Kōkeʻe region of Kauaʻi. Much of this habitat overlaps with the KTMA; approximately 2.8 acres overlaps with the non-native timber plantation areas.

D. sharpi, a large species of Hawaiian picture-wing fly, occurs in wet forest in the montane mesic and montane wet ecosystems of Kauaʻi at elevations generally between 3,000 and 4,000. Like most picture wing flies, the adult flies are believed to be generalist microvores and feed upon a variety of

decomposing plant material. The larval host plants are unknown, but thought to be species of native *Cheirodendron* (ʻōlapa) and *Tetraplasandra* based on observations that its sibling species *D. primaeva*, lays its eggs within the decomposing bark of these species, where the hatching larvae complete development before dropping to the soil to pupate. *D. sharpi* has been observed within the KTMA; including at Mōhihi stream and at Kōkeʻe stream (USFWS 2010).

Potential impacts and mitigation measures
To avoid negative impacts to *D. musaphilia*, surveys for slime flux on dead or dying koa trees would be done and if found, surveys for *D. musaphilia* will be conducted before any salvage activities. If found, the tree will not be eligible for salvage and a buffer will be placed, as necessary. No impacts are anticipated to *D. musaphilia* related to commercial harvest activities within the non-native timber plantation areas.

No impacts are anticipated to *D. sharpi* related to commercial harvest activities within the non-native timber plantation areas due to the absence of native *Cheirondendron* and *Tetraplasandra* along these ridge-top locations. To avoid negative impacts to *D. sharpi* associated with selective harvest of identified trees, hazard reduction, road, trail and fence maintenance, and salvage of dead and dying trees, DOFAW will conduct vegetation surveys to determine the presence or absence of the larval host plants in proximity to the planned activity, and if *Cheirondendron* or *Tetraplasandra* are found, bait surveys will be conducted to determine the presence or absence of *D. sharpi*. If found, an appropriate buffer will be established to minimize harm to *D. sharpi*.

<u>Rare Plants</u>
Because of its age and relative isolation, levels of diversity and endemism are higher on Kauaʻi than on any other island in the Hawaiian archipelago (USFWS 2010). However, the vegetation of Kauaʻi has undergone extreme alterations because of past and present land use, including conversion to agricultural use, intentional and inadvertent introduction of alien plant and animal species, and development. 362 plant taxa have been listed as threatened or endangered in the State; many of these species are found on Kauaʻi.

The west-facing ridgetops of Waimea Canyon State Park and the forest reserves of the KTMA were historically altered by livestock grazing, reforestation with a variety of non-native timber species, and by wind damage from Hurricanes Iwa and Iniki that created openings in the forest canopy and dispersed invasive plants. Over 100 rare plant taxa may be found within the boundaries of KTMA, but are typically restricted to valley bottoms, to small pockets of native vegetation on the ridgetops, or cliff sides on the makai ends of ridges. These rare plant taxa remain threatened by habitat loss, predation, competition with non-native plants, loss of pollinators, catastrophic events, disease, skewed sex rations, and reduced reproductive vigor.

Rare plants found near or within the non-native timber plantation areas of the KTMA include *Lobelia niihauensis* and *Wilkesia hobdyi* at the end of Polihale Ridge; *Wilkesia hobdyi* at end of Kāʻaweiki and Hāʻeleʻele Ridges; *Alectryon macrococcus var. macrococcus*, *Isodendrion laurifolium*, *Pteralyxia kauaiensis*, *Nesoluma polynesicum*, *Euphorbia haeleeleana*, *Lipochaeta fauriei*, and *Lepidium serra* in Hāʻeleʻele Valley; *Remya kauaiensis* in Kaulaula Valley and Hāʻeleʻele Ridge (near Puʻu Lua

Reservoir); and *Chamaesyce halemanui* in Kauhao Valley. Several individuals of *Cyanea leptostegia* (listed as Species of Concern) are located along the Contour Road and the upper portions of the ridge top roads including and between Hāʻeleʻele and Kauhao ridges. The presence of other rare plants is possible, especially in areas dominated by native species, and may be found upon additional survey.

Potential impacts and mitigation measures
Felling and clearing activities associated with commercial harvest operations, selective harvest, hazard tree removal, road, fence and trail maintenance, and salvage of dead or dying trees could result in accidental disturbance or destruction of rare plant populations. No harvesting activities will occur within valley bottoms or cliff areas where most existing rare plant taxa occur. To further protect rare plant populations, botanical surveys will be conducted in any area to be impacted by timber management activities before any harvest occurs. Though not anticipated, if threatened or endangered plant species are found, rare species protocols (e.g., flagging plants, identifying buffer zones, etc.) would be implemented to minimize impacts to rare or listed species. Buffer zones would range in size to adequately protect the individual or population of interest, and no tree cutting or related major disturbance will be allowed within this buffer. Where necessary, known locations of threatened and endangered plant species will be visited to collect seed or cuttings for propagation efforts, which may lead to outplanting in areas actively managed for rare species protection within that species' historical range.

<u>Endangered seabirds and forest birds</u>
Endangered seabirds (Newell's shearwater (ʻaʻo, *Puffinus auricularis newelli*), Hawaiian petrel (ʻuaʻu, *Pterodroma sandwichensis*)) and the band-rumped storm petrel (ʻakēʻakē, *Oceanodroma castro*, candidate for listing) have been detected within the boundaries of the KTMA, and the KTMA overlaps with critical habitat for the endangered forest birds (ʻakikiki (*Oreomystis bairdi*) and ʻakekeʻe (*Loxops caeruleirostris*)).

The Kauaʻi Endangered Seabird Project recorded calls of ʻaʻo and ʻakēʻakē from the Pine Forest picnic area on Mākaha Ridge, suggesting that ʻaʻo may be transiting or breeding in small numbers on the sea cliffs at the valley mouth and indicating that ʻakēʻakē were breeding in the general area (DLNR 2009a). ʻUaʻu and ʻaʻo have been detected around the Kōkeʻe Air Force station near Kalalau Lookout during breeding season (RM Towill 2014). All three seabirds nest at high elevation, inland locations; ʻaʻo utilize both wet montane forest dominated by native vegetation (ōhiʻa (*Metrosideros polymorpha*) forest with an uluhe fern (*Dicranopteris linearis*) understory) and steep dry cliffs, ʻuaʻu utilize wet montane forest dominated by native vegetation (ōhiʻa forest with an uluhe fern understory), and ʻakēʻakē utilize burrows or natural cavities in steep valleys vegetated with shrubs and grasses (Mitchell et al. 2005). Primary threats to these seabirds include predation from introduced mammals (predation by cats, pigs, rats and barn owls have all been documented), and light attraction and collision with artificial structures (fallout).

Critical habitat for the ʻakikiki and ʻakekeʻe was designated in 2010, at the time of listing these species, and overlaps with montane mesic forest within Kōkeʻe State Park and Nā-Pali Kona Forest Reserve. The ʻakekeʻe or Kauaʻi ʻākepa is a small Hawaiian honeycreeper found only on the island of Kauaʻi, in montane mesic and wet ecosystems of the Alaka ʻi, upper Waimea, and Kōkeʻe region, generally above

3,200 ft, in forests dominated by ʻōhiʻa, koa, ʻōlapa (*Cheirodendron trigynum)*, and lapalapa (*C. platyphyllum)*. The ʻakekeʻe was considered common in higher elevation native forests, but population declines since 2000 led to its listing as an endangered species in 2010. (USFWS 2010). The ʻakikiki or Kauaʻi creeper is a small Hawaiian honeycreeper found only on the island of Kauaʻi in montane mesic and montane wet ecosystems, most commonly in forests dominated by ʻōhiʻa with a diverse subcanopy, from elevations between 1,968 and 5,248 ft. (USFWS 2010). The ʻakikiki was considered common in the late 1800s, but surveys indicating a decline in the population by approximately 80 percent in the last 40 years led to its listing as an endangered species in 2010 (USFWS 2010). Both species rely heavily on ʻōhiʻa for foraging; ʻakekeʻe pry open ʻōhiʻa leaves and flower buds in search of arthropods, psyllids, and caterpillars and ʻakikiki glean and probe the bark and lichens and moss on ʻōhiʻa and koa for insects and spiders.

Potential impacts and mitigation measures
Noise and activities associated with commercial harvest operations, road maintenance, and replanting are not anticipated to impact the activities of endangered seabirds or forest birds as these birds are not typically observed in the non-native timber plantation areas where the majority of timber management activity would take place. The non-native timber plantation areas contain none of the characteristics of the seabird breeding habitat, and breeding is equally unlikely in areas of public use where hazard tree reduction might occur, or along roads, trails, or fencelines where maintenance might occur. Similarly, the non-native timber plantation stands do not contain habitat suitable for breeding or foraging by the endangered forest birds, and tree removal associated with selective harvest will only affect non-native species unused by these birds. The endangered forest birds may be impacted by the extremely limited tree removal associated with trail or fence maintenance, but in these cases, removal of entire native trees, particular ʻōhiʻa, is unlikely and would occur only where trimming is not sufficient to remove the safety hazard.

5.6 BOTANICAL RESOURCES

The vegetation communities found within KTMA generally belong in the Lowland Mesic and Wet Shrublands, and Lowland Mesic and Wet Forests described by Wagner et al. (1999). The structure of these communities varies considerably due to the wide range in elevation and rainfall found within the area. As a general matter, the vegetation of KTMA can be characterized as a combination of existing stands of non-native timber plantations, native dominated forest and shrubland, and degraded native forest and shrubland. Invasive plant species are found throughout the KTMA, in varying distribution and abundance.

Lower-elevation ridges and pali areas are considered severely degraded or highly altered from their natural state, due to erosion caused by historic grazing, the presence of feral ungulates, hurricane damage and natural erosion processes, and the intentional planting of introduced species in an effort to halt erosion. Upper-elevation areas within the KTMA reflect a considerable amount of disturbance from their natural state, due to hurricane damage, the presence of feral ungulates, and the introduction and spread of invasive plants. In general, the vegetation does not reflect a naturally evolved species composition, but rather a mixture of small remnant patches dominated by native plants, patches of largely invasive weedy alien plants, and areas of mixed native and non-native plants.

Understory vegetation consists of common native species such as pūkiawe (*Styphelia tameiameiae*), ʻaʻaliʻi (*Dodonaea viscosa*), and ʻuki ʻuki (*Dianella sandwicensis*) and non-native species such as beard grass (*Schizachryium condensatum*), lantana (*Lantana camara*), blackberry (*Rubus argutus*), molasses grass (*Melinus minutiflora*), and kikuyu grass. There are also pockets of native overstory species on ridgetops and in adjacent valley bottoms consisting primarily of koa (*Acacia koa*), ʻōhiʻa, kauila (*Alphitonia ponderosa*), ʻiliahi (*Santalum* spp.), as well as stands of naio (*Myoporum sandwicense*) coastal dry shrubland, ʻaʻaliʻi lowland dry shrubland, and lonomea (*Sapindus oahuensis*) lowland dry forest (DLNR 2009a). A representative species list is included as Appendix B.

Timber plantations

Various timber species have been planted in the Forest Reserves over the years, to reduce erosion, improve the watershed, and provide forest products such as fuel wood, fence posts, and building material. The majority of the planted non-native timber stands are located on the west-facing ridge tops of Puʻu ka Pele Forest Reserve in the 1,000-3,200 foot elevation range. Timber groves consist primarily of eucalyptus and pine and smaller acreage of various species of conifers, silk oak, blackwood acacia, sugi pine, and brushbox. Understory vegetation within the eucalyptus timber stands typically consists of invasive plants such as lantana, blackberry, molasses grass, and kikuyu grass with scattered native species. Understory vegetation within the pine timber stands is less diverse and consists primarily of non-native grasses and shrubs. Some intentionally planted non-native timber species, such as silk oak and Formosan koa, have spread into native forest areas adjacent to the KTMA. This encroachment has been exacerbated in some areas by major disturbances such as fires or hurricanes, which open the native forest canopy, providing opportunities for exotic and pest species to become established.

Invasive plant species

Invasive plant species threaten the native ecosystems and their constituents directly through physical disturbance of the habitat and resident species and indirectly through competition with native plants. Established species have become naturalized in the environment, and in many cases, no reasonable potential for eradication exists, despite the risk the species may pose to areas of native habitat. Control efforts are focused on containment and removal from sensitive areas. Incipient species are non-native species that have not yet become established but that pose a significant threat due to their aggressiveness, rapid rate of dispersal, and potential for displacing native species, and control efforts focus on monitoring and removal to prevent establishment of these species, or for more widespread species, to prevent establishment in new areas.

Invasive weed species that occur in thick and fast-growing patches throughout the KTMA include strawberry guava (*Psidium cattleianum*), lantana, blackberry, molasses grass, banana poka (*Passiflora mollissima*), guinea grass (*Panicum maximum*), and black wattle (*Acacia mearnsii*). Additional fast-growing species currently scattered throughout the KTMA that could become bigger weed problems include palm grass (*Setaria palmifolia*), karaka nut (*Corynocarpus laevigatus*), fire bush or faya tree (*Myrica faya*), kahili ginger (*Hedychium gardnerianum*), yellow ginger (*Hedychium flavescens*), white ginger (*Hedychium coronarium*), bushy beardgrass, Vasey grass (*Paspalum urvillei*), wild olive (*Olea europaea* ssp. *cuspidata*), Formosan koa, Australian tree fern (*Cyathea cooperi*), honeysuckle (*Lonicera japonica*), and koa haole. Species not yet established but of concern include thatching grass

(*Hyparrhenia rufa*), aramina (*Urena lobata*), chinese privet (*Ligustrum sinense*), firethorn (*Pyracantha angustifolia*), glorybush (*Tibouchina urvilleana*), and tree privet (*Ligustrum lucidum*) (DLNR 2009a, RM Towill 2014).

Potential impacts and mitigation measures
Both native and non-native vegetation could be impacted by commercial timber management, selective harvest of identified non-native trees, hazard tree reduction, road, trail, and fence maintenance, and salvage of dead and dying trees, as these activities necessarily involve the clearing or removal of vegetation in varying degrees.

All operations associated with commercial timber management would be conducted on areas that were degraded and intentionally reforested with non-native timber species. Non-native trees and shrubs dominate the non-native timber plantation areas, and replanting would occur within six months, to re-establish forested watershed. Species proposed for replanting would be evaluated under the Hawaiʻi Pacific Weed Risk Assessment and other appropriate methods to assess invasiveness before use.

Selective harvest of identified non-native trees, hazard tree removal, road, trail and fence maintenance, and the salvage of dead or dying trees also involves clearing or removing vegetation, but to a reduced degree. Trees would be removed only on an individual basis, and best management practices would be implemented to minimize damage to vegetation surrounding the specified tree. Stands of native forest will not be harvested, and best management practices to minimize impacts to remaining native plant populations would be implemented. Removal of entire native trees for hazard reduction or road, trail and fence maintenance would occur rarely, and only where trimming is not sufficient to remove the hazard.

Mitigation measures are not proposed to protect invasive plants because these plants are introduced species that largely exist in sizable populations outside the KTMA. The transport of equipment, gear, and machinery could potentially introduce new invasive plants and spread existing invasive plants into new areas within the KTMA, and the disturbance to the ground surface and vegetation associated with timber management create conditions suitable for the establishment of invasive plants. In addition, the transport of equipment, gear, and machinery and introduction of seeds and seedlings during reforestation leads to the possibility of spreading fungal plant diseases, including ʻōhiʻa rust (*Puccinia psidii*) and koa wilt (putative *Fusarium oxysporum*). Mitigation measures to be implemented include a sanitation and inspection protocol for machinery, gear, equipment, and materials to minimize the movement of existing invasive plant species and to prevent the introduction of new invasive plant species into the area and education of workers on specific procedures to follow to minimize the potential for the introduction and spread of invasive species.

5.7 WILDLIFE RESOURCES

The KTMA contains a variety of wildlife resources. Some provide for consumptive and non-consumptive use such as public hunting and wildlife viewing, and some are considered invasive pests.

<u>Mammals</u>

The only native mammal found within the KTMA is the ʻōpeʻapeʻa, discussed above. Non-native mammals found within the KTMA include both game and non-game species. Game animals found within the KTMA consist of feral pigs (*Sus scrofa*), feral goats (*Capra hircus*), and black-tailed deer (*Odocoileus hemionus columbianus*). No game population studies have been conducted in the area, but the overall number of game mammals likely fluctuates depending on food and water availability, hunting pressure, and fencing of nearby conservation areas.

Other non-native mammals found within the KTMA include feral dogs (*Canis familiaris*), cats (*Felis catus*), rats (*Rattus* spp.), and house mice (*Mus musculus*). Small Indian mongoose (*Herpestes auropunctatus*) are not established within the KTMA; however, credible mongoose sightings occurred in 2012-2013 all over Kauaʻi, from Polihale to Līhuʻe to Kīlauea, indicating that mongoose could eventually become established or could be unintentionally introduced. A remnant feral cow population (*Bos taurus*) is thought to remain within the western ridge section of the Puʻu ka Pele forest reserve section of the KTMA.

Potential impacts and mitigation measures
Non-native mammals may be disturbed by noise and activity associated with commercial harvest, selective harvest, hazard tree reduction, road, trail, and fence maintenance, and the salvage of dead and dying trees. Mitigation measures to protect these species are not proposed because these introduced species exist in sizable populations outside the KTMA and can move easily away from human activity to another portion of the KTMA.

The transport of equipment, gear, and machinery from another island could unintentionally introduce the mongoose. Mitigation measures to be implemented include a sanitation and inspection protocol for machinery, gear, equipment, and materials to minimize the possibility of introducing the mongoose into the KTMA and education of workers on specific procedures to follow to minimize the potential for the introduction and spread of invasive species.

<u>Native birds</u>
In addition to the endangered forest birds discussed earlier, the KTMA also contains relatively more common native forest birds. Remnant populations of the ʻelepaio (*Chasiempis sandwichensis sclateri*), ʻapapane (*Himatione sanguinea*), and ʻamakihi (*Hemignathus kauaiensis*) are still found in the higher elevation valley bottoms that contain remnant native forest. An occasional ʻanianiau (*Hemignathus parvus*) or ʻiʻiwi (*Vestiaria coccinea*) may be seen in the upper-elevation native forested areas but are very uncommon. Avian malaria and avian pox, diseases which are transmitted primarily by mosquitos which range up to 3,500 ft elevation, are suspected as the primary reasons for the decline in native bird populations in the KTMA (DLNR 2009a). There are no documented observations of native forest birds from the non-native timber plantation areas.

Other native birds found within the KTMA include pueo (*Asio flammeus sandwichensis*) and various seabirds that transmit and may nest within the KTMA, including the brown noddy (noio-kōhā, *Anous stolidus*), koaʻe kea (white-tailed tropic-bird, *Phaethon lepturus*), koaʻe ʻula (red-tailed tropicbird, *Phaethon rubricauda),* and ʻiwa (great frigatebird, *Fregata minor*) (DLNR 2009a).

Potential impacts and mitigation measures
Noise and activities associated with commercial harvest operations, selective harvest, hazard tree reduction, road, trail, and fence maintenance, and salvage of dead or dying trees may temporarily disrupt the activities of the few native forest birds foraging or transiting the KTMA. Any impact is anticipated to be minor, because native forest birds do not utilize and native seabirds do not breed within the non-native timber plantation areas where the majority of disruptive activity is anticipated to occur, because tree removal in native forest used by native forest birds will be primarily associated with hazard reduction, and thus extremely limited, and because overflying birds can easily avoid areas of disruptive activity.

Non-native birds
A large variety of introduced song birds inhabit the western Kauaʻi forests, including the melodious laughing thrush (*Garrulax canorus*), the shama (*Copsychus malabaricus*), Japanese bush warbler (*Cettia diphone*), Japanese white-eye (*Zosterops japonicus*), greater necklaced laughing thrush (*Garrulax pectoralis*), pigeon (*Columbia livia domestica*), common mynah (*Acridotheres tristis*), northern mockingbird (*Mimus polyglottus*), northern cardinal (*Cardinalis cardinalis*), red-crested cardinal (*Paroaria coronata*), house sparrow (*Passer domesticus*), house finch (*Carpodacus mexicanus*), chestnut mannikin (*Lonchura malacca*), and nutmeg mannikin (*Lonchura punctulata*). Problem species include the barn owl (*Tyto alba*), which prey on native species, and the junglefowl (*Gallus gallus*), which carry avian malaria and small pox. These birds utilize the area for feeding, roosting and nesting, and make up the typical fauna enjoyed by those using the KTMA for hiking, hunting, and camping (DLNR 2009a).

In addition, a variety of game birds are found within the KTMA, including ring-necked pheasant (*Phasianus colchicus*), Erckel's francolin (*Francolinus erckelii*), black francolin (*Francolinus francolinus*), chukar partridge (*Alectoris graeca*), lace-necked doves (*Streptopelia chinensis*), barred doves (*Geopelia striata*), and Japanese quail (*Coturnix japonica*) (DLNR 2005).

Potential impacts and mitigation measures
Non-native bird populations may also be impacted by noise and activities associated with commercial harvest, selective harvest, hazard tree reduction, road, trail, and fence maintenance, and the salvage of dead and dying trees. Mitigation measures are not proposed because these birds are introduced species that largely exist in sizable populations outside the KTMA and because these birds can easily fly to other locations.

Native invertebrates
Endemic Hawaiian invertebrates are sensitive to environmental changes such as forest clearing and invasion of alien plant and animal species, although research on direct impacts of timber harvesting and other forest management activities in Hawaiʻi still needs to be conducted. Many native arthropods have evolved to specific habitats and often require one or more native plants to complete their life cycle.

Thousands of species of native invertebrates, insects, spiders, and snails are found in the KTMA among native vegetation, litter and other habitats. Most of the native habitats, including those found underground, support numerous species of endemic invertebrates. Many of these organisms have yet to

be discovered and scientifically described (RM Towill 2014). Within the Kōkeʻe region, there are approximately 1,000 species of insects, making it one of the richest insect habitats in the State (DLNR 2009a). In addition to the *Drosophila* discussed earlier, some of the endemic insects known from the Kōkeʻe forests are the rare Fabulous Green Sphinx of Kauaʻi (*Tinostoma smaragditis*), that lives in the tops of ʻōhiʻa trees, the Kauaʻi antlion (*Eidoleon* sp.), the flightless cranefly (Diptera: Limoniidae), and the Pacific megalagrion damselfly (*Megalagrion pacificum*) (now believed extirpated on Kauaʻi) (DLNR 2009a). The large Kauaʻi land snail, *Carelia evelynae*, may have also have once existed within the KTMA (DLNR 2009a).

Due to the lack of studies on most of the native Hawaiian invertebrates, there is little biological knowledge of these species. Moreover, survey techniques are limited and often can only determine presence or absence of a species, rather than species' abundance. As such, detailed invertebrate survey information regarding overall invertebrate diversity or density within the KTMA is not currently available.

Potential impacts and mitigation measures
Given the lack of data on invertebrate abundance and diversity in the KTMA and their habitat needs, it is difficult to fully assess the impact the proposed action would have on invertebrate populations. Any impact is anticipated to be minor, because native invertebrates are generally host-specific to native plants and are not believed to be found in large numbers in the non-native timber plantation stands where the majority of disruptive activity is anticipated to occur. Because tree removal in native forest used by native invertebrates will be primarily associated with hazard reduction, and thus extremely limited, and because cut timber will be left on-site and thus still available for some use by native invertebrates, significant impacts to native invertebrates are not anticipated.

<u>Non-native invertebrates</u>
The following non-native invertebrate pests are known or suspected to occur in the KTMA: the two-spotted leafhopper (*Sophonia* sp.), Formosan subterranean termite (*Coptotermes formosanus*), Argentine ant (*Linepithema humile*), and various species of mosquito. The two-spotted leafhopper affects many native plants in the region, including uluhe fern, ʻōhiʻa, naupaka, hame (*Antidesma platyphyllum*), and others. Formosan subterranean termite is known to infect native koa and other trees. Argentine ants are observed in built areas and along trails, and could become a potential danger to bird populations through competition for available insect prey and to native arthropods. Mosquitoes carry avian diseases impacting native birds (RM Towill 2014). Other invasive insect pests that may threaten the KTMA generally include *Myoporum* thrips, which are a pest on species similar to naio, *Erythrina* gall wasp (*Quadrastichus erythrinae*), a serious pest of wiliwili (*Erythrina sandwicensis*), koa seed predators (*Araecerus levipennis* and *stator* spp. and *Cryptophlebia illepida*), and *Vespula* spp. wasps, which are voracious predators of native insects (DLNR 2009b). Potential pests to the non-native timber plantation stands within the KTMA include the Black twig borer (*Xylosandrus compactus*) and the eucalyptus longhorned beetle (*Phoracantha semipunctata*) (DLNR 2005). The black twig borer is known to attack the smaller branches and stems (seedlings) of many woody species, particularly those stressed by drought or disease. Eucalypts, particularly *E. robusta*, are susceptible to invasion by the eucalyptus longhorned beetle, the grubs of which tunnel around the bole of trees in the cambial area, to effectively girdle the branch or stem.

Potential impacts and mitigation measures
Non-native invertebrate populations may be impacted by the clearing and vegetation removal associated with commercial harvest, selective harvest, hazard tree reduction, road, trail, and fence maintenance, and the salvage of dead and dying trees. Mitigation measures to protect these species are not proposed because these are introduced species that largely exist in sizable populations outside the KTMA. The transport of equipment, gear, and machinery could potentially introduce new invasive invertebrates and soil-borne organisms and spread existing invasive organisms into new areas within the KTMA. Mitigation measures to be implemented include a sanitation and inspection protocol for machinery, gear, equipment, and materials to minimize the movement of non-native organisms into and within the KTMA and education of workers on specific procedures to follow to minimize the potential for the introduction and spread of invasive species.

6. SUMMARY DESCRIPTION OF THE HUMAN ENVIRONMENT, POTENTIAL IMPACTS, AND MITIGATION MEASURES

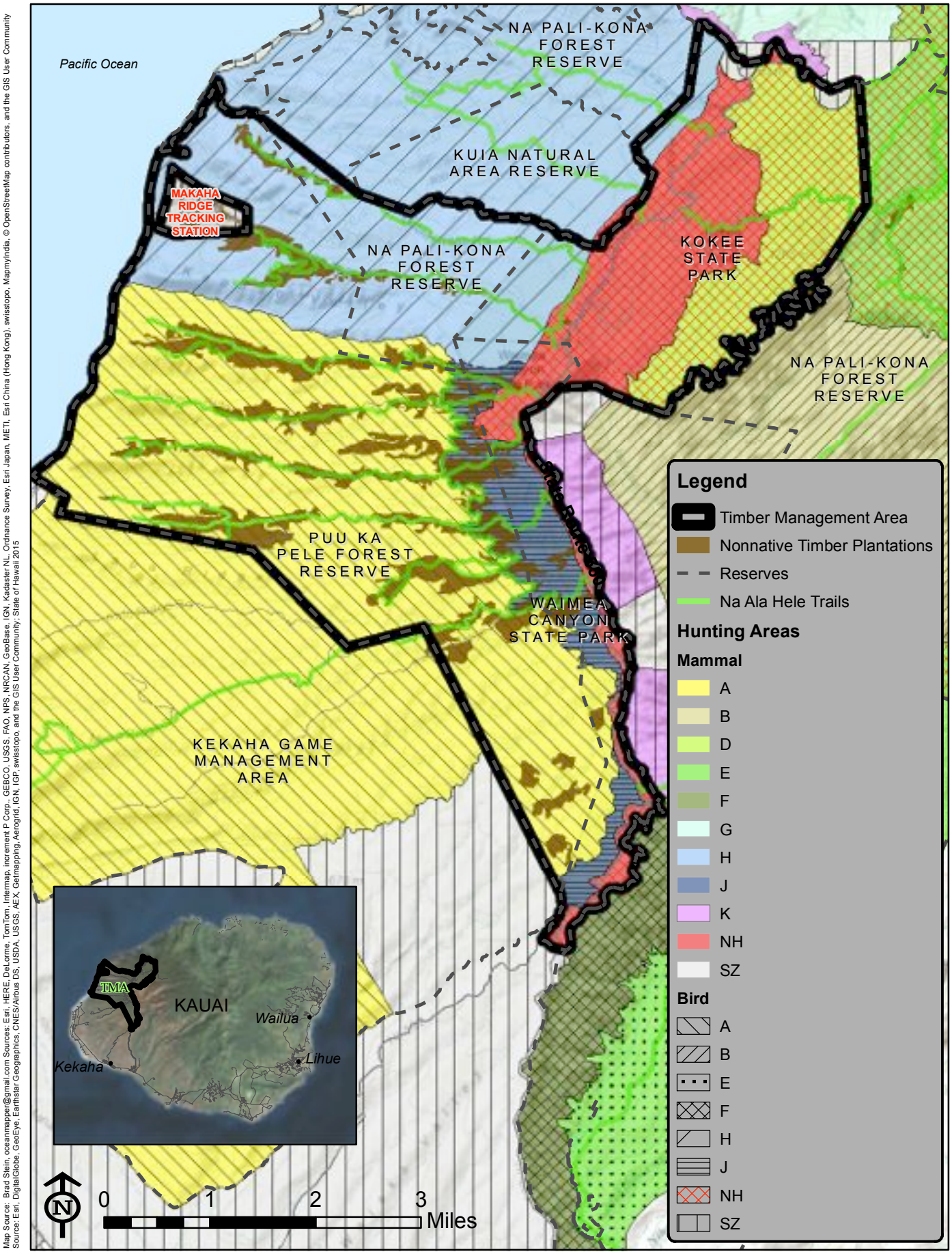
This section describes existing conditions of the human environment, potential impacts of the project, and mitigation measures to minimize impacts.

6.1 PUBLIC USE

The KTMA supports a range of public uses, including hunting, recreational use, and gathering.

Hunting
The KTMA is used extensively for black-tailed deer, goat, feral pig, and game bird hunting, overlapping with State hunting units A, D, H and J (Figure 7). Public hunting is managed by DOFAW by hunting unit through seasons, bag limits and hunting methods.

Within the KTMA, black-tailed deer may be hunted by permit only, in Units A and H, on seven consecutive weekends ending the last full weekend in October, and in Unit J weekends and holidays mid-September through November, by archery only. Goats may be hunted by permit only in Units A and H, for 8 consecutive weekends from mid-July to mid-September. Feral pigs may be hunted in Unit A by permit only on weekends and holidays from February to October and on the fifteen weekends of goat and deer season for hunters with a valid goat or deer tag, in Unit D on weekends and holidays in September through November and February through April with bow and arrow or dog and knife only, in Unit H on weekends and holidays from November to June and on the fifteen weekends of goat and deer season for hunters with a valid goat or deer tag, and in Unit J by archery only on weekends and holidays from February to June and on weekends and holidays mid-September to November for hunters with a valid deer archery permit. Methods allowed depend upon the season and the hunting unit, but range from archery only (Unit J) to rifle, muzzleloader, handguns, bow and arrow, and dogs and knives (Unit H, November to June). Hunting is not allowed on weekdays (with the exception of State holidays). Game bird hunting is allowed weekends and state holidays only, from the first Saturday in November through Martin Luther King Day or the third Sunday in January, whichever is later.



Map Source: Brad Stein, oceanmapper@gmail.com Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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Figure 7. KTMA: Hunting Units.

Hunters are required to check in and out at established checking stations and to report game harvests on official field forms. Some illegal hunting activity occurs, but it has been limited to some degree by a system of locked gates during weekdays. Reported hunter success gives an indication of the relative usage of the different Units.

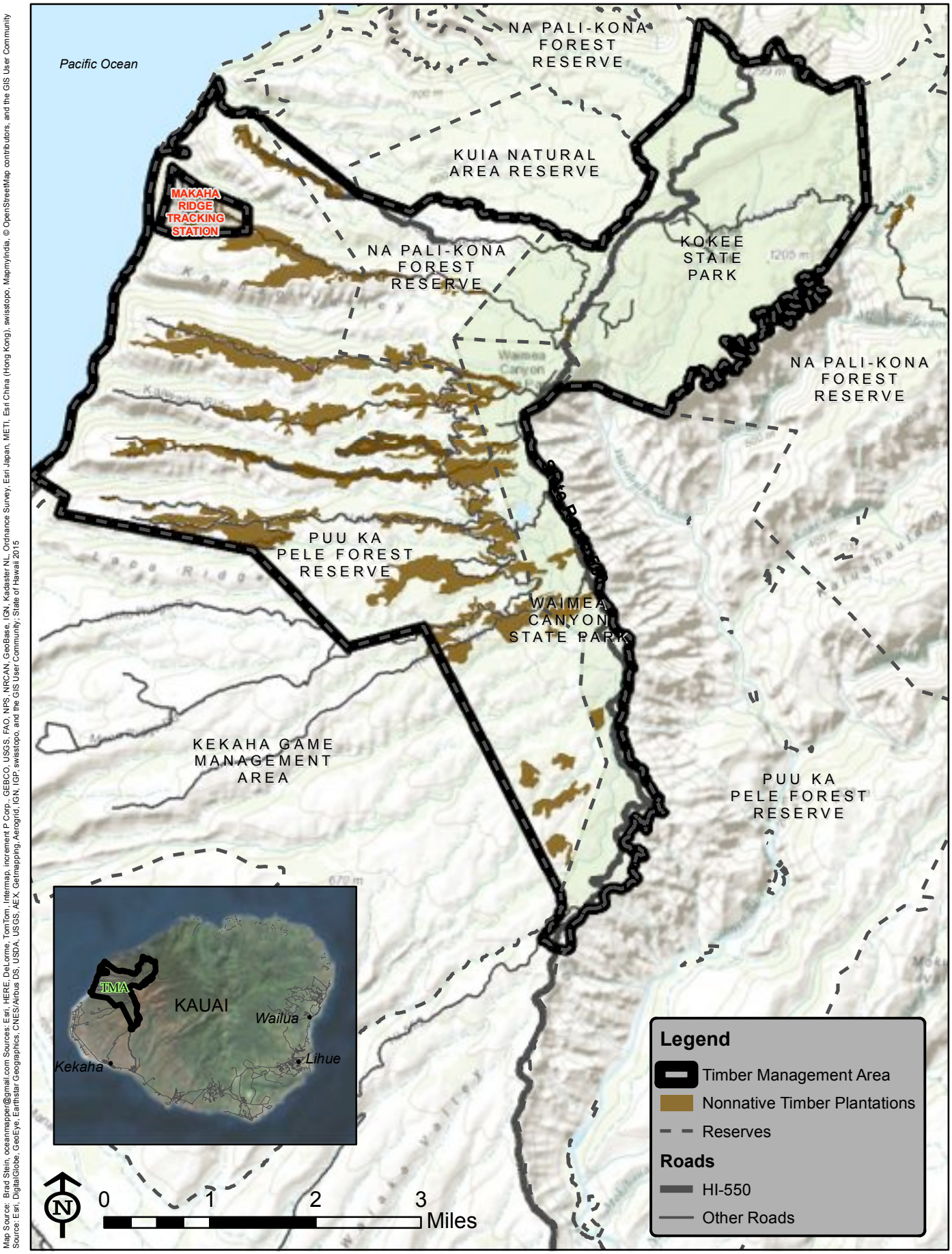
Table 6-1. Reported hunter activity for Units A, D, H and J (entire Units, not limited to portion within KTMA).

	Fiscal Year	**Unit A**	**Unit D**	**Unit H**	**Unit J**
Pigs	13-14	167	32	82	27
	14-15	127	38	82	8
Goats	13-14	319		58	
	14-15	974		48	
Deer	13-14	0		5	0
	14-15	31		3	2

Potential impacts and mitigation measures
Public access for hunting may be restricted in portions of the KTMA during active harvesting and transporting operations for safety, but because commercial timber management activities will not be allowed on weekends, access restrictions would be anticipated to be minimal and the majority of KTMA would be anticipated to remain open to hunting, consistent with existing seasons, at any given time. Habitat changes may occur in the non-native timber plantations along the ridges, as timber harvest and replanting occurs. No habitat changes would be anticipated outside of the non-native timber plantation areas that support the majority of the hunting activity. Access within the KTMA could improve over time as unpaved forest roads are maintained to support harvesting operations. Mitigation measures to be implemented would include regular status updates to existing hunting organizations.

Recreational use
The KTMA contains an extensive network of unpaved roads and trails, many of which start near Kōkeʻe Road and follow ridgelines west toward the coast (Figure 8). These unpaved secondary roads provide both management and recreational access within and throughout the KTMA, and many also function as firebreaks. These roads include: 3,000 ft Contour Road, Miloliʻi Ridge Trail, Mākaha Ridge Road and Pine Forest Drive, Kauhao Ridge Road, Kāʻaweiki Road, Polihale Ridge Road, Hāʻeleʻele Ridge Road, Lapa Ridge Road and Loop, Papaʻalai Ridge Road, Kolo Ridge Road, Mānā Ridge Road, and Kahelu Ridge Road. Many of these roads begin within the State Park and continue into the Forest Reserve. Unpaved roads and trails in the KTMA are maintained by the Division of State Parks or the DOFAW Na Ala Hele Program depending on their location, and public use is regulated by different rules depending on whether the road or trail is within State Park or Forest Reserve.

Hiking on the system of trails and secondary roads is open to the public year round. The variety of trails offer different recreational opportunities, with differing lengths, difficulty, views, and nature experiences.



Map Source: Brad Stein, oceanmapper@gmail.com Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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Figure 8. KTMA: Recreational Access.

All trails within Kōkeʻe and Waimea Canyon State Parks are closed to horseback riding; however, Kukui Trail in Waimea Canyon State Park provides equestrian access to the canyon floor and several hunting areas, and Nuʻalolo trail in Kōkeʻe State Park provides equestrian access to Kuʻia NAR and Hunting Unit H (RM Towill 2014). Horseback riding is allowed on designated roads within the Forest Reserve, including the ridge and contour roads within the Puʻu ka Pele Forest Reserve. Some riders voluntarily restrict their riding to weekdays, to avoid conflicts with hunting activity on weekends.

Off-road bicycling is currently prohibited within Kōkeʻe and Waimea Canyon State Parks due to conflicts with hikers and hunters, damage to trails and sensitive areas, erosion, weed dispersal, and noise. Mountain biking is allowed in designated areas within the Forest Reserves, including the ridge and contour roads within the Puʻu ka Pele Forest Reserve.

All-terrain vehicle use and commercial motorized recreational vehicle use is prohibited throughout the KTMA.

Nine group camping facilities, accommodating approximately 400 people exist within the boundaries of the State Parks; public tent camping is available in Kōkeʻe State Park (Kanaloahuluhulu Meadow), and back-country camping is available in Waimea Canyon State Park. Camping within the Forest Reserve portion of the KTMA is restricted due to fire hazards.

There are at least nine picnic facilities available within the KTMA: three in Kōkeʻe State Park (Kanaloahuluhulu meadow, Kalalau lookout, and Cliff Trail viewpoint); one in Waimea Canyon State Park (Puʻu ka Pele picnic area); and 5 in the forest reserve section of the KTMA (2 on Mākaha Ridge road, Hāʻeleʻele picnic area, Nuʻalolo, and Miloliʻi picnic sites). In addition, there are several shelters composed of a roof over one or two picnic tables for public day use found throughout the KTMA (including two along Lapa Ridge, one each at Mākaha Arboretum and Pine Forest Drive).

Rainbow trout fishing is permitted in the Kōkeʻe public fishing area during the fishing season (which runs from the first Saturday in August through September) with a valid freshwater game fishing license from the Division of Aquatic Resources, with the principal fishing area located west of Kōkeʻe Road centered around Puʻu Lua Reservoir. Fishing is prohibited in Kōkeʻe Stream and its tributaries above Camp Sloggett.

Potential impacts and mitigation measures
Recreational use is primarily composed of hiking, passive enjoyment, horseback riding, biking, and fishing. Public access for recreational use may be restricted in portions of the KTMA during active harvesting and transporting operations for safety, but these restrictions will be temporary and limited in duration. The majority of the KTMA would be anticipated to remain open for recreational use at any given time. Most of the non-native timber plantation areas are located outside of the State Parks and are not located adjacent to the most popular and heavily used trails and picnic areas, so restrictions associated with commercial timber management of these areas would affect at most a small number of recreational users. Most recreational use would not be affected. Mitigation measures to be implemented would include signage on the status of planned activities and use restrictions.

Gathering

The KTMA is accessible for gathering of forest resources. The most commonly collected forest resources include banana poka vines, eucalyptus firewood, fruits including Methely plums (*Prunus salicina*), ferns, flowers, maile (*Alexia oliviformis*), mokihana (*Melicope anisata*), pine cones and boughs, and guava poles (*Psidium* spp.). Most gathering activity occurs within the State Park or near existing access roads.

Gathering of material from plant species that are not on Federal or State threatened and endangered species lists is regulated by permit from the Division of State Parks for gathering in Kōkeʻe and Waimea Canyon State Parks and by permit from DOFAW for gathering in Puʻu ka Pele and Nā-Pali Kona Forest Reserves. Gathering for personal or traditional and cultural use is regulated through issuance of a free collection permit, the purpose of which is mainly to inform people where not to go and about resource conservation efforts. Gathering in quantities determined to represent commercial use is regulated through issuance of a commercial harvest permit for a fee. Gathering of threatened or endangered species requires a special collecting permit issued from the DOFAW Administrative office in Honolulu and a permit from USFWS.

Potential impacts and mitigation measures

Gathering of forest resources may be restricted in portions of the KTMA during active harvesting and transporting operations for safety, but these restrictions will be temporary and limited in duration. The majority of the KTMA would be anticipated to remain open for gathering at any given time.

Illegal use

Poaching and vandalism occurs within the KTMA. However, accurate measures on the impact of this activity on forest resources are not specifically recorded. Poaching has been generally focused on game mammals, koa and other high value native woods, and unpermitted gathering. Vandalism is generally focused on infrastructure such as shelters, locks, and signs. Off-road motorcycle riders regularly trespass into the park, primarily at lower elevations near the entrance to Waimea Canyon State Park (RM Towill 2014).

Potential impacts and mitigation measures

Expanding opportunities for legal harvest of forest resources, through selective harvest via permit and salvage harvest of valuable dead or dying trees and trees cut for hazard reduction and management requirements, may reduce illegal theft of timber resources but are unlikely to have any impact on other illegal use. No mitigation measures are planned.

6.2 TRANSPORTATION, ROADS, AND ACCESS

KTMA is accessed via paved highway from Waimea (Waimea Canyon Drive, State Road 550) or from Kekaha (Kōkeʻe Road, State Road 552). Kōkeʻe Road climbs at a less steep incline and is the favored route for tour buses and other heavy vehicles. Both roads are not lighted and do not have paved shoulders, except at occasional pullout areas. Approximately six miles from Waimea, these two roads intersect just above the KTMA boundary (park boundary - milepost 6.8), at the approximately 2,300 ft elevation. Kōkeʻe Road continues another 11 miles through Waimea Canyon and Kōkeʻe State Parks

and ends at Kalalau lookout.

The County of Kauaʻi is responsible for Kōkeʻe Road from Kekaha to Waimea Canyon Drive intersection. The State Department of Transportation is responsible for the entire length of Waimea Canyon Drive and for Kōkeʻe Road from the intersection with Waimea Canyon Drive to the southern boundary of Kōkeʻe State Park. DLNR is responsible for maintenance of Kōkeʻe Road within Kōkeʻe State Park.

In general, State Road 550 is a narrow, windy two-lane road with limited or no shoulder, and is primarily used by visitors to Waimea Canyon and Kōkeʻe State Parks, with secondary use by island residents who work or have cabins at Kōkeʻe. Visitor counts summarized in the Kōkeʻe Master Plan indicated that on average, 420 vehicles (and 1,447 people) a day visit the Waimea Canyon lookout, of which 93% were visitors and 7% residents. Peak visitation is thought to occur between 10 a.m. and 1 p.m., with a second peak from 3 p.m. to 4 p.m. Based on other Park surveys, approximately 75% of the visitors to Waimea Canyon State Park (430,700 visitors in 2004) continue to Kōkeʻe State Park (303,900 visitors in 2004) (RM Towill 2014).

At least one commercial tour operator offers downhill biking on Kōkeʻe Road, including both a "sunrise" and a "sunset" bike tour (Outfitters Kauaʻi 2015). All downhill bicycling operations are staged within the State right-of-way, outside of the jurisdiction of the Division of State Parks. Riders go from Waimea Canyon to the coast (RM Towill 2014).

Several agencies operate facilities within the boundaries of the KTMA. NASA operates a tracking station on Kaunuohua Ridge within Kōkeʻe State Park. The U.S. Navy operates two radar stations, one on Kaunuohua Ridge, and one at the end of Mākaha Ridge Road. The Hawaiʻi Air National Guard operates a radar tracking station within Kōkeʻe and a microwave antennae site within Waimea Canyon State Park. Verizon Hawaiʻi operates a communications tower at Puʻu ka Pele. Ceatech HHGI Breeding Corp operates the Kōkeʻe Irrigation Ditch system under lease from the State to serve diversified agricultural users in the Kekaha Agricultural Park.

Potential impacts and mitigation measures
Large trucks, carrying 20' or 40' containers, welled on bunks, or flat-bed trailers, will be used to haul timber and equipment to and from the KTMA. Transportation on public roadways is expected to occur during the week, between 5 a.m to 7 p.m., with up to 10 regularly spaced hauling trips occurring throughout the day, during periods of active harvest. There is limited space for passing for the entire length of Kōkeʻe Road and Waimea Canyon Road. As a result, timber hauling could impact park visitor traffic on Kōkeʻe Road. Mitigation measures to reduce impact on visitor traffic to the Kōkeʻe area include monitoring the traffic situation and modifying the timing of timber transport to reduce impacts on traffic during peak visitor hours.

Use of large, heavily loaded trucks could increase wear and tear on Kōkeʻe Road. DOFAW will require that all transportation of timber comply with applicable state and county requirements regarding oversize and overweight vehicles and the transport of heavy materials. During timber transportation, operators will be required to utilize appropriate road and traffic warning signs and use signal cars, if

necessary. Mitigation measures to reduce wear and tear on Kōkeʻe Road include hiring an appropriately certified transporter and evaluating the feasibility of assessing a road maintenance fee from commercial timber operations.

6.3 VISUAL RESOURCES

There are four primary public lookouts and one designated viewpoint within the KTMA: Waimea Canyon Lookout, Puʻu Hinahina Lookout, Kalalau Lookout, Puʻu o Kila Lookout, and Waipoʻo Falls Viewpoint. These lookouts offer views of Waimea Canyon, Kalalau Valley and the ocean, and Mt. Waiʻaleʻale.

The non-native timber plantation stands within KTMA are generally not visible from any public viewing area or public highway, due to the location of these stands and the topography of the island. However, the KTMA is visible from the air by helicopter tours of the island that regularly overfly this part of the island as part of advertised tours of Waimea Canyon and the Nā-Pali coast.

Potential impacts and mitigation measures
Generally speaking, the remote, undeveloped nature of KTMA and the surrounding topography means the area is not visible from any traditional scenic viewpoint, such as public highways or from homes or vantage points on Kauaʻi. There may be an aerial visual impact, as part of a larger forested greenscape viewed by tour helicopters overflying Waimea Canyon and the Nā-Pali coast, due to a reduction in vegetative cover associated with harvesting activities. This visual impact would be localized and temporary, and would be mitigated by the planned reforestation and the limited total acreage available for commercial timber management. There is no anticipated visual impact from activities related to selective harvest, hazard tree reduction, road, trail and fence maintenance, and the salvage of dead or dying trees.

6.4 ECONOMIC USE

The 2004 survey "Economic Value of Hawaii's Forest Industry in 2001" revealed that over 900 workers were employed in the Hawaiʻi forest industry, with a corresponding payroll of $30.7 million (Yanagida et al. 2004). The retail value of Hawaiʻi-grown forest products was estimated at $23.9 million, among all the main islands; however, the majority of this value (75%) was associated with sales of koa (Friday et al. 2006).

The estimated stumpage value (the price paid for the right to harvest trees) of the KTMA is unknown and depends largely on the market and planned use for the timber (e.g., biofuel, minimally processed products, value-added products like furniture, etc.). Current market interest in the KTMA as a timber resource is unknown, but may be limited due to the dispersed nature of the non-native timber plantation areas, the limited total acreage available for commercial harvest opportunities, and the anticipated cost of transporting timber. All revenues received would be deposited into the Forest Stewardship special fund and be spent on future forest reserve management.

Some local purchases associated with harvesting activities may include rental of heavy equipment,

lodging for harvesting crews, purchase of seedlings, herbicide, and other supplies, and transportation costs associated with moving the timber from the site for processing. Salary spending associated with harvesting, site restoration, and timber license monitoring could generate secondary benefits by providing jobs in other industries where monies are spent. Personal spending could include rent, utilities, food, entertainment, gas, etc.

Potential impacts and mitigation measures
Given the size of the project relative to the overall DOFAW budget or to other economic inputs into the local economy, the project is not anticipated to have any negative economic impact and the potential for a minor positive economic impact. No mitigation measures are proposed.

6.5 CULTURAL, HISTORIC, AND ARCHAEOLOGICAL RESOURCES

There is evidence of extensive pre-contact population and agriculture outside the KTMA, along the Nā-Pali coast and up into the valleys located there. Archaeological findings in the coastal area included house sites, taro terraces, irrigation ditch lines, heiau, burial caves, and trails. Archival research indicates that the uplands were not populated, but used as forest exploitation areas (for feathers, canoe logs, etc.) (DLNR 2005). Many legends substantiate the use of the Puʻu ka Pele area as a resource-gathering site, especially for canoe logs as well as hardwoods, bird feathers, and medicinal plants (DLNR 2009a). A well-established trail system connected the west side of the island to the north shore, including trails passing to the uplands from the Nā-Pali coast and trails through the Alakaʻi Swamp (DLNR 2009b).

Puʻu ka Pele is the name of a prominent hill located on the rim of Waimea Canyon just past mile marker 11. The area is a legendary site of an ancient Hawaiian village founded by Ola, the ruling chief of Waimea in 600 A.D. and was used for harvesting forest resources, notably koa trees for use in making canoes, paddles, and other implements (DLNR 2005). Halemanu, or Bird House, is the name given to the valley area at the entrance to Kōkeʻe State Park, and is thought to refer to an ancient house site used by the Kia Manu (bird catchers) who trapped forest birds to harvest feathers (DLNR 2005).

The archaeological evidence recorded to date tends to support the idea that the upland area contained within the Kōkeʻe and Waimea Canyon State Parks and surrounding forest reserve was used largely as a resource gathering zone with limited habitation (RM Towill 2014). Previous archaeological surveys conducted in the region include a 1906 island-wide survey of heiau sites (two sites recorded in Kōkeʻe – Ahuloulu Heiau and Kaunuʻaiea Shrine); a recording of two house site complexes on or near Puʻu ka Pele crater in 1928-29 by Wendell Bennett; a 1993 reconnaissance survey by state archaeologist Nancy McMahon along the ridge roads in the Kōkeʻe uplands, recording one site interpreted to be a sweet potato planting area, at the end of Polihale Ridge Road; a 1993 recording of a site near Waimea Canyon lookout by Alan Carpenter interpreted to be a temporary habitation likely associated with canoe-making; a 1993 survey of Kahuamaʻa Flat in Kōkeʻe State Park by Martha Yent and Alan Carpenter, which noted few archaeological sites, and cited legends suggesting the area was a resource gathering zone rather than an area of permanent habitation; a 1994 archaeological reconnaissance survey by Martha Yent of the former Army camp site near the Awaʻawapuhi trailhead identifying one abandoned standing concrete building and two concrete foundation slabs associated with the Army Camp circa

1940-1950s. Other archaeological surveys conducted in the area include a 1978 reconnaissance of Kukui Trail by Francis Ching, a 1982 reconnaissance of the Kōkeʻe hydropower project by Martha Yent, and a 1990 survey of USN Radio Telescope Project Area in Waimea by Paul Rosendahl; these later surveys did not result in the discovery of previously unidentified archaeological sites (RM Towill 2014). In 2004, in conjunction with master planning for Kōkeʻe and Waimea Canyon State Parks, an archaeological fieldcheck was conducted at 10 sites identified future park development and did not locate any significant sites at any of these locations.

The 1993 survey by Nancy McMahon along the ridge roads was conducted for the 'Roadside Fuel Hazard Reduction' project (which involved fuel load reduction and widening of the ridge roads as firebreaks after Hurricane Iniki) and included most of the ridge tops of Puʻu ka Pele Forest Reserve (containing some of the non-native timber plantation areas). This survey concluded that extensive alteration of the ridge lines had occurred in this century due to grazing, forest planting and other activities, making it highly unlikely that significant historic sites remain on these ridges. The survey further identified four specific locations of interest within or adjacent to the non-native timber plantation stands:
1. Hāʻeleʻele Ridge Road – located at the top of Kepapa Ridge. Possible historic sites may occur at the bottom of the valley, in the vicinity of Kepapa Springs.
2. Kauhao Ridge Road – An area covered with ti plants, which could be a possible site near a fork in the ridge road, approximately 2.5 miles from the Contour Road.
3. Papaʻalai Road – An area at the road beginning, near the highway, may contain a site.
4. Polihale Ridge – an archaeological site consisting of a 5-meter long stone alignment that may have served as a sweet potato planting area (DLNR 2005).

Anecdotal information indicates that the very end of Polihale Ridge Road, near a known location of the endangered plant *Wilkesia hobdyi,* may contain cultural sites or be of cultural importance as one of the soul's leap spots for Kauaʻi, where spirits of the newly dead assemble to begin their journey onwards. Another legend locates a soul's leap on Kāʻana ridge, on the lookout across the road from the Puʻu ka Pele picnic area (DLNR 2005).

The sandalwood trade dominated the early 1800s, which on Kauaʻi came almost exclusively from the upland gulches of Waimea Canyon and Kōkeʻe and were largely depleted by the mid-1830s. In 1821, when Reverend Hiram Bingham traveled from Waimea to Hanalei along an old foot-path passing through Kōkeʻe, he described the uplands as uninhabited with the presence of temporary shelters that he attributed to sandalwood cutters. Valdemar Knudsen obtained a lease to much of the area in the mid-1800s to run cattle, which provided beef to provision the whaling vessels. Queen Emma made a trek in 1871 from Waimea to the Kilohana of Hanalei, at the edge of Wainiha Valley, going through the Alakaʻi Swamp on a “cordoroy road” built of tree-fern logs placed side-by-side (DLNR 2005).

The cattle industry declined as whaling declined, to be replaced with the sugar industry. Beginning in the late 1800s, the upland streams were tapped to irrigate the sugarcane fields on the west side; the Kōkeʻe Ditch was built in 1923 as part of the larger irrigation system.

Lands within the KTMA were set aside as Forest Reserves as early as 1907 in an attempt to curb

erosion and degradation by grazing cattle and feral goats. Land use in the 20th century consisted mainly of recreational and military activities. Depression-era efforts to alleviate unemployment led to U.S. government-sponsored activities in the KTMA area in the 1930s. In addition to reforestation efforts, the Civilian Conservation Corps constructed a camp at Kōkeʻe and the Federal Emergency Relief Agency (FERA) did roadwork in the Kōkeʻe region, including a project to build four concrete bridges across streams and the construction of lookouts. In 1941, approximately 15 acres surrounding the CCC's Kōkeʻe Camp were removed from the Forest Reserve and turned over for confidential military installations. This land was restored to the State and is now part of Kōkeʻe State Park (DLNR 2009b). Waimea Canyon and Kōkeʻe State Park were withdrawn from Forest Reserve in 1919 and 1922 for recreational use and officially were established as State Parks in 1952.

By the 1960s, helicopters were commonly transporting tourists into the Nā-Pali coast area; today, the Kōkeʻe area remains popular with both visitors and residents for sightseeing, recreation, and cultural and educational pursuits, and relaxation. In 2014, the Master Plan to guide the management, enhancement, and development of Kōkeʻe and Waimea Canyon State Parks for a twenty-year period was finalized.

Potential impacts and mitigation measures
Based on a review of the information available, pre-contact use of the forested areas of the KTMA was likely for the procuring of natural resources (e.g., canoe logs, medicinal plants, olona, feathers) and temporary habitation associated with this activity. As such, the physical evidence of these activities would have been ephemeral and left little if any surviving physical evidence. The potential soul's leap sites are outside the non-native timber plantations in areas that will not be harvested due to erosion. The non-native timber plantations stands are largely located along ridges that have been extensively altered, and previous surveys associated with road clearing on these ridges did not identify any specific sites that would be impacted by harvesting activities.

Should evidence of any undetected archaeological or cultural property (e.g., burial cave) be encountered during timber harvest, road maintenance, site preparation or replanting, all activities would immediately stop and the appropriate parties, including the State Division of Historic Preservation, would be consulted immediately. Where possible, cultural resources would be avoided through the use of buffer zones. Other options would include documentation and data recovery, using either collection techniques or in-site site stabilization protection.

Timber management activities proposed for the developed areas of the KTMA (e.g., near lookouts or recreational cabins) would be limited to hazard tree removal for safety purposes and maintenance of existing roads, trails, and fences and would not be anticipated to impact any historic, cultural or archaeological feature.

7. CUMULATIVE IMPACTS

HAR §11-200-2 defines cumulative impact as

> *"The impact on the environment which results from the incremental impact of the action when*

added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

Cumulative impacts are the overall, net effects on a resource that arise from multiple actions. Impacts can "accumulate" spatially, when different actions affect different areas of the same resources. They can also accumulate over the course of time, from actions in the past, the present, and the future. Occasionally, different actions counterbalance one another, partially canceling out each other's effect on a resource. But more typically, multiple effects add up, with each additional action contributing an incremental impact on the resource. In addition, sometimes the overall effect is greater than merely the sum of the individual effects, such as when one more reduction in a population crosses a threshold of reproductive sustainability, and threatens to extinguish the population.

A thorough analysis of impacts always considers their cumulative aspects, because actions do not take place in a vacuum; there are virtually always some other actions that have affected that resource in some way in the past, or are affecting it in the present, or will affect it in the reasonably foreseeable future. So any assessment of a specific action's effects must in fact be made with consideration of what else has happened to that resource, what else is happening, or what else will likely happen to it.

DOFAW is not aware of any past, present, or planned actions that would result in a significant cumulative impact when added to the proposed action.

8. ANTICIPATED DETERMINATION AND FINDINGS AND REASONS SUPPORTING THE ANTICIPATED DETERMINATION

The Division of Forestry and Wildlife anticipates a **Finding of No Significant Impact (FONSI)** declaration for this project. In determining whether the proposed action will have a significant impact on the environment, DOFAW considered the phases of the proposed action, the expected consequences, both primary and secondary, and the cumulative as well as short and long-term effects of the action. In addition, DOFAW specifically evaluated the project under the following 13 significance criteria, as provided in HAR §11-200-12:

1. Involves an irrevocable commitment to loss or destruction of any natural or cultural resource;

Activities associated with commercial harvest of non-native timber plantation areas, selective harvest of identified non-native species, and routine removal of trees for hazard reduction, road, trail and fence maintenance, and salvage of dead and dying trees would create a temporary disturbance to portions of the forest. Harvesting activities would be followed by reforestation, and the acreage affected at any given time is small in comparison to the total acreage of the KTMA. Existing native forest will not be harvested. As such, no irrevocable commitment to loss or destruction of natural or cultural resources is involved.

2. Curtails the range of beneficial uses of the environment;

The proposed project does not curtail the range of beneficial uses of the environment. The KTMA will continue to support existing recreational uses of the forest, including hunting, hiking, gathering, and general public enjoyment. The KTMA will continue to act as watershed and habitat for native species. Access to specific areas of KTMA may be temporarily limited during periods of active harvesting and loading operations, but these restrictions are anticipated to be limited in both scope and duration.

3. Conflicts with the state's long-term environmental policies or goals and guidelines as expressed in HRS Chapter 344;

HRS §344-3 provides in part:

> It shall be the policy of the State, through its programs, authorities, and resources to:
> (1) Conserve the natural resources, so that land, water, mineral, visual, air and other natural resources are protected by controlling pollution, by preserving or augmenting natural resources, and by safeguarding the State's unique natural environmental characteristics in a manner which will foster and promote the general welfare, create and maintain conditions under which humanity and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of the people of Hawaiʻi. …

HRS §344-4 provides in part:

> In pursuance of the state policy to conserve the natural resources and enhance the quality of life, all agencies, in the development of programs, shall, insofar as practicable, consider the following guidelines:
> …
> (2) Land, water, mineral, visual, air, and other natural resources
> (A) Encourage management practices which conserve and *fully utilize* all natural resources; …
> (D) Encourage management practices which conserve and protect watersheds and water sources, forest, and open space areas; …
> (5) Economic development.
> (A) Encourage industries in Hawaiʻi which would be *in harmony* with our environment; …
> (D) Encourage all industries including the fishing, aquaculture, oceanography, recreation, and forest products industries to protect the environment; … (emphasis added).

The proposed action is based on sound forest stewardship and sustainable, long-term productivity. Permitting the harvest of timber from the non-native timber plantation areas or from identified non-native species as proposed in this document would improve forest health by reducing fuel loads while providing support for an emerging forest products industry in a manner harmonious with the environment. The proposed action focuses on utilizing the resources of an existing non-native timber forest and supports development of a forest products industry that does not rely upon exploitation of native forest. As such, the proposed action does not conflict with the State's long-term environmental policies or goals and guidelines as expressed in HRS Chapter 344.

4. Substantially affects the economic welfare, social welfare, and cultural practices of the community

or State;

The proposed action does not substantially affect the economic welfare, social welfare or cultural practices of the community or State. It is consistent with DLNR-DOFAW's existing initiatives regarding forest management. Implementation of the KTMA Plan could provide employment opportunities and could positively impact the economic welfare of the community by creating a sustainable forestry sector on Kauaʻi. No specific cultural practice has been identified that would be affected by the proposed action.

5. Substantially affects public health;

The proposed action does not substantially affect public health.

6. Involves substantial secondary impacts, such as population changes or effects on public facilities;

The proposed action is not anticipated to result in any substantial secondary impacts, such as population changes or effects on public facilities. Minor impacts on traffic are anticipated.

7. Involves a substantial degradation of environmental quality;

The proposed action does not involve a substantial degradation of environmental quality. The KTMA will remain forested watershed; harvesting and tree removal activities will be spread over time and followed by reforestation. Best management practices will be incorporated to minimize the impact on water quality, the potential for soil erosion, and the introduction or spread of invasive species into and within the KTMA. Reducing the overall fuel load contained within with the non-native timber plantations may enhance environmental quality by reducing fire risk and improving habitat.

8. Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions;

The proposed action does not have a cumulative considerable effect on the environment nor does it involve a commitment for larger actions.

9. Substantially affects a rare, threatened or endangered species or its habitat;

The proposed project does not substantially affect a rare, threatened, or endangered species, or its habitat. As noted earlier, the native Hawaiian Hoary Bat, or ʻōpeʻapeʻa, has been detected in the KTMA, but the extent of their distribution and density is unknown. Because no ʻōpeʻapeʻa have been observed roosting in the project area, because harvesting activities will be restricted from June 1 to September 15 to prevent harm to undetected juveniles, because ʻōpeʻapeʻa are crepuscular and harvesting activities would occur during the day, and because harvesting activities could provide short-term benefits by increasing foraging opportunities, the anticipated negative impact on the ʻōpeʻapeʻa is minor.

The endangered Hawaiian goose, or nēnē, has been observed within the KTMA with regularity, but nēnē are not regularly observed within the forested areas of the KTMA because the tree cover does not provide good habitat for nēnē grazing. Because the majority of noise and activity associated with the proposed action will take place in forested areas, nēnē are not anticipated to be substantially affected by the proposed action.

Two species of threatened picture-wing fly, *Drosophila sharpi* and *D. musaphilia*, are historically known from the KTMA. To avoid negative impacts to *D. musaphilia*, surveys for slime flux on dead or dying koa trees and if found, surveys for *D. musaphilia* will be conducted before any salvage activities. If found, the tree will not be eligible for salvage and a buffer will be placed, as necessary. No impacts are anticipated to *D. musaphilia* related to commercial harvest activities within the non-native timber plantation areas. No impacts are anticipated to *D. sharpi* related to commercial harvest activities within the non-native timber plantation areas due to the absence of habitat elements, native *Cheirondendron* and *Tetraplasandra*, along these ridge-top locations. To avoid negative impacts to *D. sharpi* associated with selective harvest of identified trees, hazard reduction, road, trail and fence maintenance, and salvage of dead and dying trees, DOFAW will conduct vegetation surveys to determine the presence or absence of the larval host plants in proximity to the planned activity, and if *Cheirondendron* or *Tetraplasandra* are found, bait surveys will be conducted to determine the presence or absence of *D. sharpi*. If found, an appropriate buffer will be established to minimize harm to *D. sharpi*.

Felling and clearing activities associated with commercial harvest operations, selective harvest, hazard tree removal, road, fence and trail maintenance, and salvage of dead or dying trees could result in accidental disturbance or destruction of rare plant populations. No harvesting activities will occur within valley bottoms or cliff areas where most existing rare plant taxa occur. To further protect rare plant populations, botanical surveys will be conducted in any area to be impacted by timber management activities before any harvest occurs. Though not anticipated, if threatened or endangered plant species are found, rare species protocols (e.g., flagging plants, identifying buffer zones, etc.) would be implemented to minimize impacts to rare or listed species. Buffer zones would range in size to adequately protect the individual or population of interest, and no tree cutting or related major disturbance will be allowed within this buffer. Where necessary, known locations of threatened and endangered plant species will be visited to collect seed or cuttings for propagation efforts, which may lead to outplanting in areas actively managed for rare species protection within that species' historical range.

10. Detrimentally affects air or water quality or ambient noise levels;

The proposed action does not detrimentally affect air or water quality or ambient noise levels.

Based on the characteristics of the planned action, the planned best management practices to be incorporated, the location of the project within a forest reserve and away from development, and the surrounding environment, effects to air quality from the proposed action is anticipated to be negligible.

Due to distance from the ocean and the incorporation of best management practices, no impacts to marine water quality are anticipated. Further, due to the incorporation of best management practices,

the underlying soil characteristics, the lack of streams near the non-native timber plantations where the majority of harvesting activity would take place, and existing patterns of runoff, no significant changes to the quality or quantity of existing discharges is anticipated. Overall, it is expected that the proposed action will have minor negative impacts on water quality.

Periodic noise from heavy equipment, power tools and other activities associated with this project will be unavoidable. The KTMA is generally remote, and construction noise would be localized and temporary.

11. Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters;

The proposed action does not affect nor is likely to suffer damage by being located in an environmentally sensitive area such as a floodplain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters. Activities associated with the proposed action would not be located in or near any of the above-mentioned environmentally sensitive areas.

12. Substantially affects scenic vistas and view planes identified in county or state plans or studies; or

The proposed action does not affect scenic vistas and view planes identified in county or state plans or studies. Generally speaking, the remote, undeveloped nature of KTMA and the surrounding topography means the area is not visible from any traditional scenic viewpoint, such as public highways or from homes or vantage points on Kauaʻi. There may be an aerial visual impact, as part of a larger forested greenscape viewed by tour helicopters overflying Waimea Canyon and the Nā-Pali coast, due to a reduction in vegetative cover associated with harvesting activities. This visual impact would be localized and temporary, and would be mitigated by the limited acreage associated with commercial timber harvest (approx. 2,370 acres) and the required reforestation. There is no anticipated visual impact from activities related to selective harvest, hazard tree reduction, road, trail and fence maintenance, and the salvage of dead or dying trees.

13. Requires substantial energy consumption.

The proposed action does not require substantial energy consumption. Petroleum fuels would be used by the heavy equipment utilized for timber harvesting, road maintenance, timber transportation, and site replanting, but this energy consumption is not anticipated to be substantial, especially in comparison to island-wide energy consumption.

9. LIST OF PERMITS REQUIRED

Implementation of the proposed action may require the following permits and permissions:

Permit	Issuing Agency	Comment
Board approval	Board of Land and Natural Resources	HRS §183-16.5 requires BLNR approval of a management plan before the harvest of trees on public lands. Approval of the initial KTMA Plan was granted in 2005.
National Pollution Discharge Elimination System (NPDES) General Permit	State Department of Health Clean Water Branch	NPDES general permit coverage required if construction activities involve clearing, grading and excavation that result in the disturbance of one or more acres.

10. ENVIRONMENTAL ASSESSMENT PREPARATION INFORMATION

This environmental assessment was prepared by Anden Consulting for the Department of Land and Natural Resources, Division of Forestry and Wildlife.

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Appendix A: List of Tax Map Key Parcels within the KTMA

4-1-2-001-001	4-1-4-002-022	4-1-4-002-071	4-1-4-004-014	4-1-4-004-059
4-1-2-001-003	4-1-4-002-023	4-1-4-002-073	4-1-4-004-016	4-1-4-004-060
4-1-2-001-004	4-1-4-002-024	4-1-4-002-075	4-1-4-004-017	4-1-4-004-061
4-1-2-001-006	4-1-4-002-025	4-1-4-002-076	4-1-4-004-018	4-1-4-004-062
4-1-2-001-007	4-1-4-002-026	4-1-4-002-078	4-1-4-004-019	4-1-4-004-063
4-1-2-001-008	4-1-4-002-027	4-1-4-002-079	4-1-4-004-020	4-1-4-004-064
4-1-2-001-009	4-1-4-002-028	4-1-4-002-081	4-1-4-004-021	4-1-4-004-065
4-1-2-001-010	4-1-4-002-029	4-1-4-002-085	4-1-4-004-024	4-1-4-004-066
4-1-2-001-011	4-1-4-002-030	4-1-4-002-086	4-1-4-004-027	4-1-4-004-067
4-1-2-001-999	4-1-4-002-031	4-1-4-002-093	4-1-4-004-028	4-1-4-004-068
4-1-2-002-001	4-1-4-002-032	4-1-4-003-001	4-1-4-004-029	4-1-4-004-069
4-1-2-002-020	4-1-4-002-034	4-1-4-003-002	4-1-4-004-030	4-1-4-004-070
4-1-2-002-023	4-1-4-002-035	4-1-4-003-003	4-1-4-004-031	4-1-4-004-072
4-1-2-002-024	4-1-4-002-036	4-1-4-003-004	4-1-4-004-032	4-1-4-004-073
4-1-2-002-033	4-1-4-002-037	4-1-4-003-005	4-1-4-004-033	4-1-4-004-074
4-1-2-002-999	4-1-4-002-039	4-1-4-003-006	4-1-4-004-035	4-1-4-004-075
4-1-4-001-002	4-1-4-002-040	4-1-4-003-007	4-1-4-004-036	4-1-4-004-076
4-1-4-001-003	4-1-4-002-041	4-1-4-003-008	4-1-4-004-037	4-1-5-001-002
4-1-4-001-007	4-1-4-002-042	4-1-4-003-009	4-1-4-004-038	4-1-5-001-017
4-1-4-001-013	4-1-4-002-043	4-1-4-003-010	4-1-4-004-039	4-5-9-001-001
4-1-4-001-014	4-1-4-002-044	4-1-4-003-011	4-1-4-004-040	4-5-9-001-016
4-1-4-001-015	4-1-4-002-045	4-1-4-003-012	4-1-4-004-041	4-5-9-001-017
4-1-4-001-018	4-1-4-002-046	4-1-4-003-013	4-1-4-004-042	4-5-9-001-023
4-1-4-001-019	4-1-4-002-047	4-1-4-003-014	4-1-4-004-043	
4-1-4-001-020	4-1-4-002-048	4-1-4-003-016	4-1-4-004-044	
4-1-4-001-999	4-1-4-002-051	4-1-4-003-017	4-1-4-004-045	
4-1-4-002-004	4-1-4-002-052	4-1-4-004-001	4-1-4-004-046	
4-1-4-002-005	4-1-4-002-053	4-1-4-004-002	4-1-4-004-047	
4-1-4-002-007	4-1-4-002-054	4-1-4-004-003	4-1-4-004-048	
4-1-4-002-008	4-1-4-002-055	4-1-4-004-004	4-1-4-004-049	
4-1-4-002-010	4-1-4-002-059	4-1-4-004-005	4-1-4-004-050	
4-1-4-002-012	4-1-4-002-060	4-1-4-004-006	4-1-4-004-051	
4-1-4-002-013	4-1-4-002-061	4-1-4-004-007	4-1-4-004-052	
4-1-4-002-014	4-1-4-002-062	4-1-4-004-008	4-1-4-004-053	
4-1-4-002-015	4-1-4-002-063	4-1-4-004-009	4-1-4-004-054	
4-1-4-002-016	4-1-4-002-066	4-1-4-004-010	4-1-4-004-055	
4-1-4-002-018	4-1-4-002-067	4-1-4-004-011	4-1-4-004-056	
4-1-4-002-020	4-1-4-002-068	4-1-4-004-012	4-1-4-004-057	
4-1-4-002-021	4-1-4-002-069	4-1-4-004-013	4-1-4-004-058	

Appendix B: KTMA Representative Species List

Scientific name	Common name	Hawaiian name (E) = endangered (T) = threatened (SOC) = species of concern
Native Plant Species		
Acacia koa		Koa
Alectryon macrococcus var. macrococcus		(E)
Alyxia oliviformis		Maile
Alphitonia ponderosa		Kauila
Aleurites moluccana		Kukui
Antidesma platyphyllum var. hillebrandii		Hame
Bobea brevipes		Ahakea lau li‘i
Broussaisia arguta		Kanawao
Canthium odoratum		alahe‘e
Chamaesyce atrococca		‘akoko
Chamaesyce halemanui		(E)
Cheirodendron trigynum		‘Ōlapa
Coprosma sp.		Pilo
Cibotium spp.		Hāpu‘u
Cyanea leptostegia		Hala lua (SOC)
Dianella sandwicensis		‘uki ‘uki
Dicranopteris linearis		Uluhe
Diospyros hillebrandii		Lama
Dodonea viscosa		‘a‘ali'i
Eragrostis variabilis		kawelu
Euphorbia haeleeleana		(E)
Freycinetia arborea		‘Ie‘ie
Hedyotis terminalis		Manono

Isodendrion laurifolium		(E)
Lepidium serra		(E)
Lipochaeta fauriei		(E)
Lobelia niihauensis		(E)
Marattia douglasii		Mule's foot fern
Melicope spp.		Alani
Melicope anisata		Mokihana
Metrosideros polymorpha		ʻŌhiʻa lehua
Microlepia strigosa		palapalai
Myoporum sandwicensis		naio
Myrsine lanaiensis		Kōlea
Nesoluma polynesicum		(E)
Nestegis sandwicensis		Olopua
Perrottetia sandwicensis		Olomea
Pipturus albidus		Māmaki
Pisonia sandwicensis		Papala kepau
Pleomele aurea		halapepe
Psilotum nudum		Moa
Psychotria spp.		Kōpiko
Pteralyxia kauaiensis		(E)
Remya kauaiensis		(E)
Sadleria spp.		ʻAmaʻu
Santalum spp.		ʻiliahi
Sapindus oahuensis		Lonomea
Scaevola gaudichaudii		Naupaka kuahiwi
Sida fallax		ʻilima
Smilax melastomifolia		Hoi kuahiwi
Styphelia tameiameiae		pūkiawe
Syzigium sandwicensis		ʻŌhiʻa ha
Vaccinium calycinum		ʻŌhelo
Tetraplasandra spp.		

Wikstoemia oahuensis		‘akia
Wilkesia gymnoxiphium		iliau
Wilkesia hobdyi		Dwarf iliau (E)
Xylosma hawaiiense		maua
Zanthoxylum dipetalum		kawa'u
Intentionally Planted Timber Species		
Acacia melanoxylon	Blackwood acacia	
Cryptomeria japonica	Sugi pine	
Eucalyptus deglupta	Indonesian gum	
Eucalyptus microcorys	Australian tallowwood	
Eucalyptus paniculata	Gray ironbark	
Eucalyptus robusta	Swamp mahogany	
Eucalyptus saligna	Sydney bluegum	
Eucalyptus sideroxylon	Red ironbark	
Grevillea robusta	Silk oak	
Lophostemon confertus	Brushbox	
Pinus elliotti	Slash pine	
Pinus radiata	Monterey pine	
Pinus taeda	Loblolly pine	
Sequoia sempervirens	Redwood	
Non-Native Plant Species		
Acacia mearnsii	Black wattle	
Acacia confusa	Formosan koa	
Acanthospermum australe	Spiny-bur	
Adiantum hispidulum	Maidenhair fern	
Casuarina equisetifolia	Ironwood	
Cirsium vulgare	Thistle	
Clidemia hirta	Koster's curse	
Corynocarpus laevigatus	Karaka nut	
Cyathea cooperi	Australian tree fern	
Erigeron karvinskianus	Daisy fleabane	

Eriobotrya japonica	Loquat	
Hedychium coronarium	White ginger	
Hedychium flavescens	Yellow ginger	
Hedychium gardnerianum	Kahili ginger	
Hyparrhenia rufa	Thatching grass	
Lantana camara	Lantana	
Leucaena leucocephala	Koa haole	
Ligustrum lucidum	Tree privet	
Ligustrum sinense	Chinese privet	
Lonicera japonica	Honeysuckle	
Melaleuca quinquenervia	Paper bark	
Melastoma spp.	Melastoma family	
Melinus minutiflora	Molasses grass	
Melia azedarach	Chinaberry	
Myrica faya	Firebush or faya tree	
Nephrolepis multiflora	Sword fern	
Olea europaea ssp. cuspidata	Wild olive	
Opuntia ficus-indica	Panini	
Panicum maximum	Guinea grass	
Paraserianthes falcateria	Molucca albizia	
Paspalum urvillei	Vasey grass	
Paspalum dilatatum	Dallis grass	
Passiflora edulis	Passionfruit	
Passiflora mollissima	Banana poka	
Pennisetum clandestinum	Kikuyu grass	
Pluchea symphytifolia	Sourbush	
Psidium cattleianum	Strawberry guava	
Psidium guajava	Common guava	
Pyracantha angustifolia	Firethorn	
Ricinus communis	Castor bean	
Rubus argutus	Blackberry	

Rubus rosifolius	Thimbleberry	
Schinus terebinthifolius	Christmas berry	
Schizachyrium condensatum	Beardgrass	
Setaria palmifolia	Palm grass	
Stachytarpheta urticifolia	Canyon vervain	
Solanum americanum	Popolo	
Thelypteris parasitica	Downy woodfern	
Tibouchina spp.		
Urena lobata	Aramina	
Wedelia trilobata	Wedelia	
Native Wildlife		
Lasiurus cinereus semotus	Hawaiian hoary bat	‘ōpe‘ape‘a (E)
Hemignathus kauaiensis		‘Amakihi
Hemignathus parvus		‘Anianiau
Himatione sanguinea		‘Apapane
Chasiempis sandwichensis sclateri		‘Elepaio
Vestiaria coccinea		‘I‘iwi
Oreomystis bairdi	Honey creeper	‘Akikiki (E)
Loxops caeruleirostris	Kaua‘i ‘ākepa	‘Akeke‘e (E)
Asio flammeus sandwichensis		Pueo
Pterodroma sandwichensis	Hawaiian petrel	‘Ua‘u (E)
Puffinus auricularis newelli	Newell's shearwater	‘A‘o (E)
Oceanodroma castro	Band-rumped storm petrel	‘Akē‘akē (C)
Puffinus pacificus chlororhynchus	Wedge-tailed shearwater	‘Ua‘u kani
Phaethon lepturus	White-tailed tropicbird	Koa‘e kea
Phaethon rubricauda	Red-tailed tropicbird	Koa‘e ‘ula
Fregata minor palmerstoni	Great frigatebird	‘Iwa
Anous stolidus	Brown noddy	Noio-kōhā
Sterna fuscata oahuensis	Sooty tern	
Branta sandvicensis	Hawaiian goose	Nēnē (E)

Pluvialis fulva, dominica	Pacific golden plover	Kōlea
Drosophila musaphilia	Hawaiian picture wing fly	(E)
Drosophila sharpi	Hawaiian picture wing fly	(E)
Non-Native Game Wildlife		
Sus scrofa	Feral pig	
Capra hircus	Feral goat	
Odocoileus hemionus columbianus	Black-tailed deer	
Francolinus erckelii	Erckel's francolin	
Francolinus francolinus	Black francolin	
Alectoris graeca	Chuckar partridge	
Phasianus colchicus	Ring-necked pheasant	
Streptopelia chinensis	Lace-necked dove/spotted dove	
Geopelia striata	Barred dove	
Coturnix japonica	Japanese quail	
Non-Native Non-Game Wildlife		
Bos taurus	Feral cow	
Canis lupus familiaris	Feral dog	
Felis catus	Feral cat	
Rattus spp.	Rat	
Mus musculus	House mouse	
Acridotheres tristis	Common mynah	
Alauda arvensis	Skylark	
Amandava amandava	Red avadavat (red munia)	
Bubulcus ibis	Cattle egret	
Callipepla californica	California quail	
Cardinalis cardinalis	Northern cardinal	
Carpodacus mexicanus	House finch	
Cettia diphone	Japanese bush warbler	
Columbia livia domestica	Pigeon	
Columbia livia	Rock dove	

Copsychus malabaricus	Shama thrush	
Estrilda a. astrild	Common waxbill	
Gallus gallus	Red junglefowl	
Garrulax canorus	Melodius laughing thrush	
Garrulax pectoralis	Greater necklaced laughing thrush	
Leiothrix lutea	Red-billed leiothrix	
Lonchura malacca	Chestnut mannikin	
Lonchura punctulata	Nutmeg mannikin	
Mimus polygottus	Northern mockingbird	
Paroaria coronata	Red-crested cardinal	
Passer domesticus	House sparrow	
Padda oryzivora	Java sparrow	
Psittacula krameri	Rose-ringed parakeet	
Sturnella neglecta	Western meadowlark	
Tyto alba	Barn owl	
Zosterops japonicus	Japanese white-eye	

Appendix C: Forest Management Plan for the Kokee Timber Management Area, Island of Kauai

Forest Management Plan for the Kokee Timber Management Area, Island of Kauai

January 2005

Prepared by:

State of Hawaii
Department of Land and Natural Resources
Division of Forestry and Wildlife
Division of State Parks

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FOREST MANAGEMENT PLAN SIGNATURE PAGE

Kauai District certification: This plan was prepared by a team of Division of Forestry and Wildlife (DOFAW) and State Parks (SP) staff to provide a management framework for the listed Forest Reserves and State Parks.

Alvin M. Kyono – DOFAW Kauai Branch Manager — Date 6/25/07

Wayne H Souza – Kauai District Parks Superintendent — Date 06/25/07

DOFAW and SP Administrator's approval: We have reviewed the enclosed Forest Management Plan and concur with the recommendations herein. We agree that resource management implementation will follow those specified in the Management Plan for the Kokee Timber Management Area.

Paul J. Conry – DOFAW Administrator — Date 6/27/07

Daniel S. Quinn – SP Administrator — Date 6/27/07

Department of Land and Natural Resources Board approval: This plan meets the criteria established for State Forest Reserve Management Plans as mandated by Chapter 183, Section 16.5, Hawaii Revised Statutes.

Peter T. Young - Board Chairperson — Date 6/27/07

I. INTRODUCTION

The Department of Land and Natural Resources (DLNR) is responsible for a wide range of resource management objectives including but not limited to watershed and endangered species protection, forest product development, nursery seedling production, Natural Area Reserve protection and management, wildland fire suppression, camping, public trails and access, and wildlife and game management programs. Cooperative natural resource programs are also planned and implemented on privately owned forestlands through natural area partnerships, forest stewardship programs, urban forestry projects, service forestry, and other agreements.

In 2001, the forest industry in Hawaii contributed 30.7 million dollars and 926 jobs to Hawaii's economy (Yanagida et al., in press). Sustainable commercial forest management is a viable contributor to economic stability and can enhance the environment while retaining the rural character of the islands. This concept gained credibility when Kamehameha Schools purchased thousands of acres on the island of Hawaii that were subsequently leased to Prudential Timber for the establishment of a multi-million dollar *Eucalyptus* plantation project. The State also played a strategic role in the development of Hawaii's forest product industry when the Board of Land and Natural Resources approved the Waiakea Timber Management Area plan on September 11, 1998 – a process that ultimately lead to the issuance of a large-scale timber land license.

Although the primary focus for industrial forestry has been on the island of Hawaii, similar opportunities exist on a smaller scale for the island of Kauai. Lihue Plantation was growing cane on what is considered prime timber production areas, but recently ceased operations. Gay and Robinson is the sole remaining active sugar plantation on Kauai. The latter operates on the drier side of the island, occupying sites of lesser yet valid forest growth potential. In this climate of changing land use the private company Hawaiian Mahogany has begun planting hundreds of acres of new forest plantations. While these and future plantations are established and grow on Kauai, presently mature State timber resources have the potential to influence how Kauai's forest industry develops and help define the role of public assets in overall commercial forestry development throughout the State.

Considerable land area in the western uplands of Kauai were originally placed into Forest Reserves and State Parks in an attempt to curb erosion and degradation by grazing cattle and goats. Components of Puu Ka Pele Forest Reserve were established by Governors proclamation in 1918 and 1938. The Na Pali Kona Forest Reserve portions were proclaimed in 1907. In 1919, the Governor signed a proclamation withdrawing approximately 415 acres along the edge of Waimea Canyon from the Puu ka Pele Forest Reserve and subsequently issued an executive order turning over the land to the County of Kauai for public recreational use. In 1922, 485 acres from the Puu ka Pele Forest Reserve and 230 acres from the Na Pali-Kona Forest Reserve added a total of 715 acres to what would later become Kokee State Park. Act 185, Session Laws of 1949 created a Division of Territorial Parks and by Executive Order Nos. 1509, 1510, 2197 and 2209, which set aside the lands. Kokee and Waimea Canyon State Parks were officially established in 1952.

Even before all of the lands were removed from grazing, tree planting was started in an attempt to slow down soil erosion. Trees of many species - both exotic and native - were planted during the 1930's and early 1940's until World War II stopped operations by sugar plantation and

government personnel. During the late 1950's and 1960's tree planting was started again on the lower eroded slopes of the area, primarily with *Eucalyptus saligna*, *Pinus taeda* and *P. elliottii*.

As a result, lands managed by DOFAW and SP in western Kauai presently contain considerable mature timber resources that represent a potential wood supply for Kauai's forest products industry. Both the approximately 10 small sawmills on Kauai, as well as numerous craftsmen who make wood items ranging from writing pens, bowls, to custom furniture could benefit from gaining access to timber resources. Since Kauai imports most of its lumber, there is good potential for marketing locally grown and manufactured timber products.

Through this management plan, these Divisions propose the establishment of the Kokee Timber Management Area (KTMA) to add active timber management to present management goals for the subject areas, and to promote Kauai's forest industry development through sustainable management of public lands. This plan proposes three principal methods of forest management for the KTMA:

1. Sustainable commercial management of non-native timber plantation areas, where harvesting would be followed by replanting of either native or non-native species.
2. Selective harvest of non-native or invasive species in native forest areas, where harvesting would be followed by replanting of native species.
3. Harvest of native trees for the purposes of fence and roadway maintenance, hazard reduction or the salvage of dead or dying trees.

Board of Land and Natural Resources approval of the KTMA Plan would trigger the following actions:

1. Preparation of an environmental assessment and pursuit of its approval.
2. Periodic solicitation of requests for proposals for harvest of KTMA timber resources.
3. Development and issuance of permits (Hawaii Administrative Rules §13-104-22) or timber land licenses for approved proposals based on the proposed scope of work.

II. THE KOKEE TIMBER MANAGEMENT AREA

A. Location: On Kauai DOFAW has direct management responsibility for over 100,000 acres (including over 88,000 acres of Forest Reserve), and SP has direct management responsibility of over 13,674 acres. The KTMA is comprised of Puu Ka Pele Forest Reserve, Na Pali Kona Forest Reserve South of and including Milolii ridge, Waimea Canyon State Park, and Kokee State Park – an area totaling approximately 17,092 acres (Table 1). Situated on the western part of the island, the KTMA is located along and adjacent to State Route 550 (Kokee Road), starting approximately 5 miles north of Waimea town (Figure 1).

B. Geographic Site Data: Kauai is one of the oldest Hawaiian Islands, and is a remnant of a huge shield volcano that began its volcanic activity in the early or middle Pliocene epoch of the Tertiary period. The island grew rapidly and volcanic activity ceased around the end of the Pliocene period. Through time and the effects of erosion, faulting, collapse, and weathering, the island's original shape has been greatly altered. Despite the natural weathering process, the

shape of a shield volcano is still the island's dominant feature with Mt. Waialeale and its highest peaks of Kawaikini (5,243 feet) and Waialeale (5,148 feet).

Table 1. Acreage summary for the KTMA.

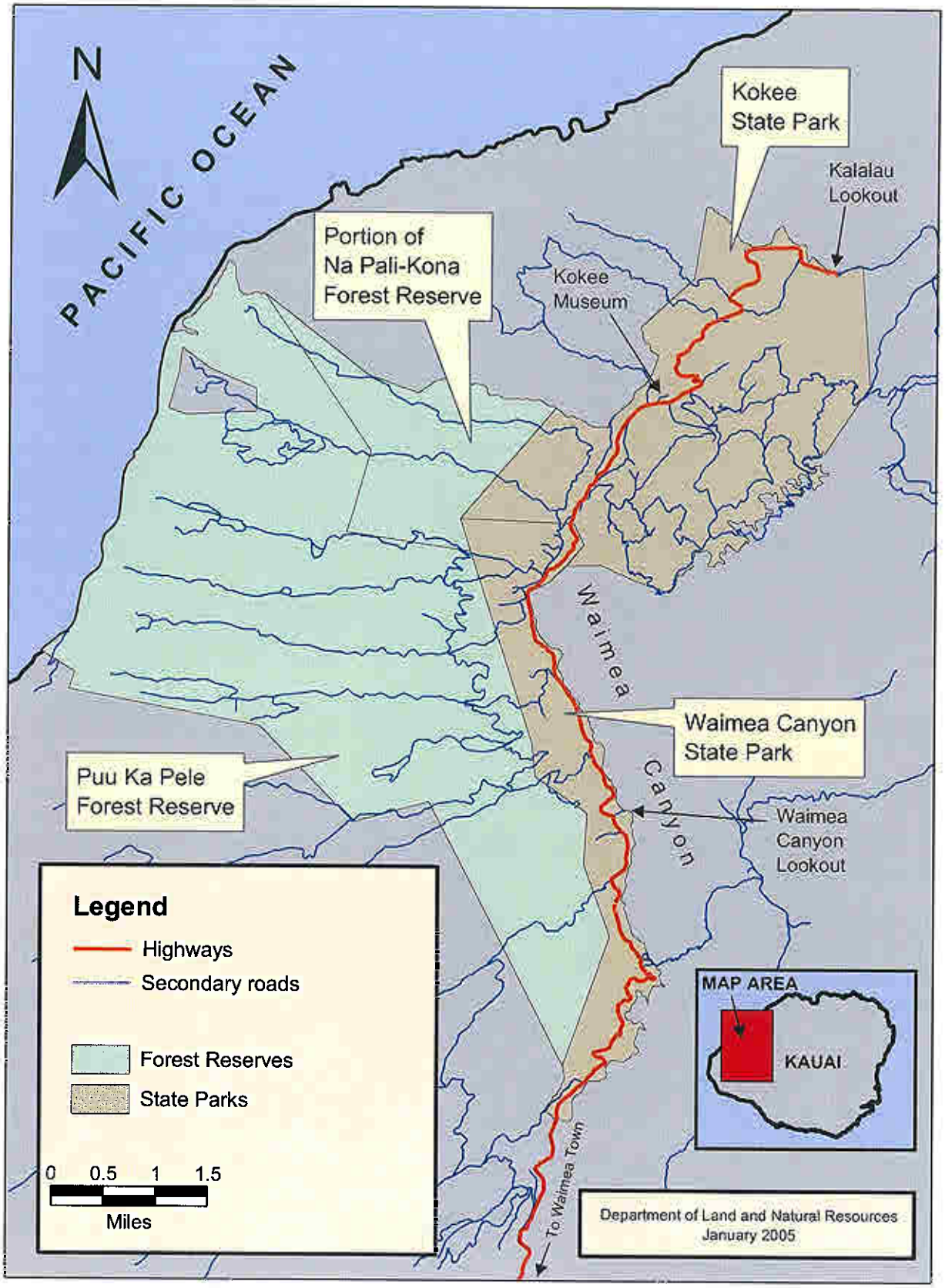
Area	Non-native timber plantation acres	Total acres
Puu Ka Pele Forest Reserve	2,110	9,405
Portion of Na Pali Kona Forest Reserve	95	1,505
Waimea Canyon State Park	160	1,837
Kokee State Park	5	4,345
KTMA totals	2,370	17,092

C. <u>Physical Site Data</u>: The steep windward slopes of Mt. Waialeale and Wainiha Ridge force the moisture-laden winds upward, where changes in temperature and pressure cause rapid condensation, cloud formation and heavy rain. This effect produces an average annual rainfall of 433 inches on Mt. Waialeale (elevation 5,148 feet) and generated a record high of 666 inches in 1982. Median annual rainfall in the KTMA varies with elevation, averaging 30 inches annually at 1,000 feet elevation, and gradually increasing to 120 inches at 4,000 feet elevation. In the approximately 8 miles between Mt. Waialeale and Kanaloahuluhulu Meadow in Kokee State Park, the rainfall contour drops from 433 inches to 60 inches. Within the park boundaries, average rainfall varies from 118 inches at the Puu o Kila lookout (elevation 4,160 feet) to 59 inches at the entrance to Kokee State Park (elevation 3,600 feet) to 39 inches at the entrance to Waimea Canyon State Park (elevation 2,100 feet). Moisture gradients within the two areas are some of the most extreme in the world. Within a single scenic vista can be seen montane and wet forest covered ridges as well as dry, desert-like canyons and cliffs. Mean annual temperature at 1,800 foot elevation is approximately 77°.

The soils in the KTMA are mostly ash-derived silty loams from the Mahana and Oli Series, or basalt derived clay loams from the Niu, Kokee, Kunuweia and Puu Opae Series (Appendix A; Foote et al., 1972). This complex landscape of soil types provides evidence of the island's volcanic origin and the natural forces that shaped the unique terrain. These soils are classified as well drained. Slopes exceeding 25% are common within the KTMA.

D. <u>Existing Vegetation</u>: A majority of the vegetation communities in the KTMA represent native or disturbed native ecosystems. The structure of these communities varies considerably due to the wide range in elevation and rainfall found within the area. The vegetation communities generally belong in the Lowland Mesic and Wet Shrublands, and Lowland Mesic and Wet Forests described by Wagner et al. (1990). A majority of planted non-native timber stands are located on the west-facing ridge tops of Puu Ka Pele Forest Reserve in the 1,000-3,200 foot elevation range. Understory vegetation within these timber stands typically consists of lantana (*Lantana camara*), blackberry (*Rubus argutus*), molasses (*Melinus minutiflora*) and kikuyu grass (*Pennisetum clandestinum*) and native species such as uki, pukiawe (*Styphelia tameiameiae*), aalii (*Dodonaea viscosa*), and uki uki (*Dianella sandwicensis*). There are also pockets of native species on these ridge tops and in adjacent valley bottoms consisting primarily

Figure 1. The Kokee Timber Management Area



of koa (*Acacia koa*), ohia (*Metrosideros polymorpha*), kauila (*Alphitonia ponderosa*), iliahi (*Santalum* spp.), etc., with an understory of native and non-native species. Within some of the planted stands and along their fringes are several listed or proposed Threatened and Endangered plant species. Threatened and Endangered species are located on some of the cliff sides and valley bottoms, as well as in the pockets of native vegetation on the ridge tops. Some common plants as well as the eleven (11) threatened and endangered species known to exist in the KTMA are listed in Appendix B.

E. <u>Existing Wildlife</u>: The KTMA has a variety of wildlife resources that provide for both consumptive use such as public hunting, and non-consumptive uses such as wildlife viewing and native species preservation and restoration (Appendix C).

1. **Public hunting:** DOFAW manages public hunting on all forest reserve lands on Kauai by the regulation of hunting seasons, bag limits and varied hunting methods. Enforcement of hunting regulations (Chapter 122 Rules Regulating Game Bird Hunting, and Chapter 123 Rules Regulating Game Mammal Hunting) is accomplished by the Division of Conservation and Resources Enforcement (DOCARE), of DLNR.

   Hunting within the KTMA is divided among designated Hunting Units "A", "H" and "J". Each of these units is managed for specific purposes and goals. Game found within these hunting units consists of feral pigs (*Sus scrofa*), feral goats (*Capra hirca*), and black-tailed deer (*Odocoileus hemionus columbianus*). Game birds are: Ring-necked pheasant (*Phasianus colchicus*), Erckel's francolin (*Francolinus erckelii*), black francolin (*Francolinus francolinus*), chukar partridge (*Alectoris graeca*), lace-necked doves (*Streptopelia chinensis*), and barred doves (*Geopelia striata*).

   Hunting in all of these forest areas is restricted to weekends and State holidays only. There is some illegal hunting activity that occurs, but it has been controlled to some degree by a system of locked gates during weekdays.

2. **Native species:** Only the most common native forest birds remain in those forested areas west of Waimea Canyon rim and Kokee State Park. Remnant populations of the Elepaio (*Chasiempis sandwichensis*), the Apapane (*Himatione sanguinea*), and Amakihi, (*Hemignathus virens, stejnegeri*), are still found in the higher elevation valley bottoms that contain remnant native forest. An occasional Anianiau (*Hemignathus parvus*), or I'iwi (*Vestiaria coccinea*) may be seen in the upper forested areas, but they are very uncommon. The main reason for the paucity of native birds in this forest is believed to be avian malaria, transmitted by mosquitos which generally range up to 3,500 feet elevation. Some of the more common native forest birds have evidently developed some resistance to the disease, while the uncommon birds have not.

   The Hawaiian Bat (ope'ape'a) is Kauai's only endemic land mammal and exists island wide. The ope'ape'a is a subspecies of the mainland hoary bat and is officially listed as endangered. Hawaiian hoary bats roost solitarily in the foliage of trees. They are most active at dusk when they forage on flying insects. Bats appear to be fairly common in the Puu ka Pele Forest area. Individuals are regularly seen in the evenings, and are often seen feeding near stands of mature eucalypts, but no information on the density and distribution of these animals is available. They are apparently quite versatile and exist

from sea level to over 4,000 feet elevation, and feed heavily on both native and introduced insects.

Native birds and bats are protected under Hawaii's Administrative Rules, and Title 13, Chapter 124 Indigenous Wildlife, Endangered and Threatened Wildlife and Introduced Birds, as well as the Federal Endangered Species Act of 1973.

3. Non-native species: A large variety of introduced song birds inhabit the western Kauai forests, some of which include: The Melodious Laughing Thrush (*Garrulax canorus*), the Shama (*Copsychus malabaricus*), Japanese Bush Warbler (*Cettia diphone*), Japanese White-eye (*Zosterops japonicus*), Common Mynah (*Acridotheres tristis*), Northern Mockingbird (*Mimus polyglottus*), Northern Cardinal (*Cardnalis cardinalis*), Red-crested Cardinal (*Paroaria coronata*), House Sparrow (*Passer domesticus*), House Finch (*Carpodacus mexicanus*), Chestnut Mannikin (*Lonchura malacca*), and Nutmeg Mannikin (*Lonchura punctulata*). Although not of great economic impact, these birds make up of the typical fauna enjoyed by recreationists while using the forest areas for hiking, hunting, camping and fishing.

F. Access: Vehicular access to the subject area is available via paved highways and a series of connected secondary roads. Kokee Road (State Route 550) provides the primary access and is maintained by the State Department of Transportation. There are approximately 75 miles of secondary roads, most having unimproved surfaces within the KTMA. These roads are found on the main ridge tops and include a road that connects the ridges from Papaalai to Kauhao along the 3,000 foot contour. The roads provide public access for hunting, recreation, and non-timber forest product gathering. Secondary roads also provide DLNR and other governmental agencies access for forest protection, timber and resource management, facility maintenance and other management and public service activities.

G. Timber Harvesting: There has been no large-scale commercial timber harvesting sale from within the KTMA. Some salvaging of logs along roadsides was conducted after Hurricanes Iwa and Iniki.

H. Other Public Uses within the KTMA: Although the non-native timber plantations were established primarily for watershed management and commercial timber, the KTMA provides several other important public uses and functions such as watershed protection and important habitat for native resources: the area is also used extensively for wild pig, black-tailed deer, goat, and bird hunting; rainbow trout fishing is permitted in the Puu Lua Reservoir and feeder ditch system; motorcycle riders and 4-wheel drive enthusiasts use the well developed road network within the area for outings; other recreational activities include mountain biking, horseback riding, bird watching, botanical exploration, picnicking, camping and hiking.

I. Archaeological and Historical Sites: Historical sites are categorized based on the period of their construction. The first type – archaeological – belongs to the pre-western contact period. Structures include heiaus, burials, and house sites. The second type – historic – are associated with the period following the arrival of westerners. Structures are usually of a commercial, religious, or residential nature. Archival research indicates that these ridges were once forest exploitation areas (for feathers, canoe logs, etc.), thus temporary campsites and access trails are

expected to be the primary sites found. A survey by Historic Preservation staff in 1993 for the "Roadside Fuel Hazard Reduction" project which included most of the ridge tops of Puu Ka Pele Forest Reserve, found that extensive alteration of the ridge lines had occurred in this century due to grazing, forest planting and other activities, making it highly unlikely that significant historic sites remain within the non-native timber plantation areas. Three locations within the non-native timber plantations that may be possible exceptions include:

1. Haeleele Ridge Road – located at the top of Kepapa Ridge. Possible historic sites may occur at the bottom of the valley, in the vicinity of Kepapa Springs.
2. Kauhao Ridge Road – An area covered with ti plants, which could be a possible site near a fork in the ridge road, approximately 2.5 miles from the Contour Road.
3. Papaalai Road – An area at the road beginning, near the highway, may contain a site.

Kokee and Waimea Canyon State Parks contain a diversity of historical, archaeological and cultural resources from the pre-contact (1778) to the post-contact (1778 to present) periods (Appendix D).

III. MANAGEMENT PLAN PURPOSE AND GOALS

Hawaii Revised Statutes (HRS) Chapter 183 "Forest Reserves, Water Development, Zoning" provides the legal framework for management activities proposed in this plan. HRS Chapter 183 Section 183-1.5 subsection (5) states that the Department shall: "Devise and carry into operation, ways and means by which forests and forest reserves can, with due regard to the main objectives of title 12, be made self-supporting in whole or in part" (Appendix E). Section 183-16.5 requires that all harvesting of trees on public lands be done in accordance with a Board approved management plan (Appendix E). Furthermore, Senate Resolution No. 42 was adopted by the Senate of the 22nd Legislature of the State of Hawaii in 2004, stating in part that "...DLNR and Department of Agriculture are urged to consider and incorporate the importance of economic factors and impacts in the application of laws and adoption of rules and policies concerning the conservation of forestry and agricultural resources..." Enhancing revenue generation through timber harvesting and timber management can support these legislatively mandated goals.

This timber management plan for the KTMA will provide the framework for sustainable, responsible and proactive management of forest resources in support of the following goals:

- Initiate active long-term commercial forestry operations on Kauai.
- Restore native plant communities where partial/remnant native plants exist within areas degraded or dominated by non-native species.
- Promote tree removal or harvest methods in support of hazard reduction.
- Increase existing limits on salvage operations for dead or dying trees.
- Promote use of forests or forest products for cultural or educational purposes.
- Stimulate economic activity and growth in the timber processing sectors of both Kauai and the State.
- Provide DLNR with an opportunity to supplement annual budgets through timber sales revenues, effectively increasing funding available for resource management activities.

As previously noted the KTMA provides a wide variety of important functions and uses from natural resource and public use perspectives. While this plan applies specifically to timber resource management in the KTMA, all objectives and prescriptions were developed with the intention of balancing all resource management goals for the area. Plan revisions will be conducted as necessary to reflect environmental changes, technical advancements and cultural changes.

IV. FOREST MANAGEMENT PRESCRIPTIONS

All field management prescriptions related to commercial timber management will be guided by Best Management Practices (BMP) policies (Appendix F). Timber inventory data from a 1998 survey indicates that non-native timber plantations in the KTMA contains over 3,250,000 net cubic feet of timber (Table 2). Species specific forest management prescriptions and detailed volume analyses by species and diameter class are presented in Appendix G. This represents enough wood to build and panel approximately 1,200 houses. Based on more than 50 years of management experience in the KTMA, DOFAW and SP propose five principal timber resource management methods for the KTMA:

Table 2. 1998 Forest inventory data summary for the KTMA expressed as net wood volume (Net volume is equal to gross volume with the following deductions: volume below a 1' stump; volume above a 4" top; volume losses due to defect or poor form; and gross volume of all trees with DBH < 8").

			Net volume (ft^3) by log minimum diameter class		
Tree Species	**Acreage**	**Net Cubic Feet**	**4-8"**	**8-12"**	**>12"**
Eucalyptus robusta	408	715,285	256,278	229,383	229,624
Eucalyptus saligna	431	722,397	263,457	219,732	239,208
Other/Mixed eucalypts	246	449,919	147,389	117,797	184,733
Total eucalyptus (Percent of eucalyptus)	**1,085**	**1,887,601**	**667,124 (35%)**	**566,912 (30%)**	**653,565 (35%)**
Slash Pine (*Pinus elliottii*)	345	731,175	413,944	262,304	54,927
Loblolly Pine (*Pinus taeda*)	128	417,723	152,174	179,660	85,889
Mixed pines	195	208,650	163,509	45,141	0
Total pines (percent of pine)	**668**	**1,357,548**	**729,627 (54%)**	**487,105 (36%)**	**140,816 (10%)**
Brushbox (*Lophostemon confertus*) (Percent of brushbox)	7	8,827	1,001 (11%)	3,117 (35%)	4,709 (54%)
TOTALS	**1,760**	**3,253,976**	**1,396,758 (43%)**	**1,054,025 (32%)**	**794,381 (25%)**

A. <u>Sustainable commercial management of non-native timber plantations</u>: Because existing plantations have already been subject to extensive disturbance and conversion to non-native vegetation, such acreage is viewed as best suited for long-term commercial timber management.

1. **Harvesting practices:** Harvesting can either be selective, in that all trees to be taken will be individually chosen and marked, or, if large-scale species changes are desired, clear cut. Extraction methods will conform to the BMP.

2. **Regeneration:** Timber harvesting in non-native plantation areas will be immediately followed by tree planting of either native or non-native species.

3. **Species selection:** Selecting the appropriate species to plant in a given area is largely dependent on growth potential for a given site. Site productivity for tree growth in the KTMA can be broadly linked to rainfall and elevation. Rainfall averages correlate positively with the rise in elevation. Data collected from the 1998 inventory shows the mean annual increment (MAI) at elevations above 2400 feet were considerably higher than the lower elevations for all of the species. Upon harvest, these areas will likely be converted to higher value native hardwoods such as koa. Below that 2400 foot elevation, species selection will be based on species best suited to the given rainfall and elevation of the respective area.

4. **Site preparation:** Site preparation is achieved by the removal of competing vegetation and exposure of surface soils to aid planting operations. Site preparation is often the most costly silvicultural operation. Site preparation activities will occur only in stands that are harvested. If species changes are desired, the residual stumps will be killed with herbicides. No new plantation areas will be cleared within the KTMA. Desirable stems of both native and non-native tree species not harvested can be left standing, contributing to future stand diversity and value.

5. **Timber stand improvement:** Fertilizer applications are essential for satisfactory seedling survival and growth. During and after planting, commercial fertilizer applications will be manually applied as needed. Weed control may be required in newly planted stands to reduce seedling mortality and competition. Herbicide use should be limited to manual applications in an area about two to three feet in radius around seedlings. Chemical quantities will be carefully prescribed at levels to control the specified target population, and will not be applied in buffer zones for surface waters. Only approved chemicals will be used in the KTMA in strict accordance with the manufacturer's label.

   Young tree stands may require side branch pruning to maximize potential value of crop trees. Pruning will be conducted manually, on species that can produce high-value solid wood end products.

B. <u>Selective harvest of non-native or invasive species in areas outside of plantations</u>: Most areas outside of existing non-native timber plantations represent native ecosystems of widely ranging quality - from nearly undisturbed to almost completely dominated by non-native or invasive species. Non-native trees species that have commercial value in such areas will be made available for harvest, followed by replanting of native species. Within the KTMA, native

forest inclusions will be accessible for traditional gathering of forest resources, research, hunting and recreation. In those areas containing 60 percent or more native forest cover, this selective harvest approach will be implemented only through small-scale commercial harvest or special use permits – not large-scale licenses. Management of threatened and endangered plants and forest protection measures in native forest areas will follow the guidelines below.

C. Harvest of non-native and native trees for maintenance or hazard reduction: Individual trees or small pockets of trees may be cut during maintenance operations or to mitigate potential hazards to public safety along trails or roads, to protect buildings, fence lines or other infrastructure and to support fire prevention measures.

D. Salvage harvest of dead or dying native trees : Readily accessible koa and other native trees of significant value that are dead or dying may be harvested for salvage purposes. DOFAW issues commercial harvest permits for such purposes only on an occasional basis because present Administrative Rules for forest reserves strongly limit permit values. As a result, koa sold under this mechanism is typically undervalued, causing the state to lose potential revenue. More frequently such trees are simply left to rot, and all potential commercial value is lost. SP also issues special use permits for the purpose of koa salvage.

E. Special harvesting permits for non-native or native trees: Such permits may be issued on a case-by case basis for cultural or educational non-commercial gathering purposes.

V. GENERAL GUIDELINES

A. Threatened and Endangered Plant Species: The west-facing ridge tops of Waimea Canyon State Park and the Forest Reserves of the KTMA were historically altered by livestock grazing and reforestation with a variety of non-native timber species. These activities have heavily impacted the native plants that once were found on these ridge tops. Endangered plant species known to exist in the valleys and the makai end of some of these ridges include *Lobelia niihauensis* and *Wilkesia hobdyi* at the end of Polihale Ridge; *Wilkesia hobdyi* at end of Kaaweiki and Haeleele Ridges; *Alectryon macrococcus* var. *macrococcus*, *Isodendrion laurifolium*, *Pteralyxia kauaiensis*, *Nesoluma polynesicum*, *Euphorbia haeleeleana*, *Lipochaeta fauriei*, and *Lepidium serra* in Haeleele Valley; *Remya kauaiensis* in Kaulaula Valley and Haeleele Ridge (near Puu Lua Reservoir); and *Chamaesyce halemanui* in Kauhao Valley. None of these species are known to occur within any of the planted stands. Several individuals of *Cyanea leptostegia* (listed as Species of Concern) are located along the Contour Road and the upper portions of the ridge top roads including and between Haeleele and Kauhao ridges.

Endangered plant information in this plan is derived from The Nature Conservancy of Hawaii's Rare Plant Database and the National Tropical Botanical Garden and should not be considered comprehensive. In order to insure that no rare plant species are accidentally destroyed, botanical and wildlife surveys will be conducted in areas that will be impacted by commercial timber management activities. If threatened or endangered species are found in those areas, a buffer of 50 feet will be established around the individual or population of interest, and no tree cutting, logging activity or related major disturbances will be allowed in this buffer. Known locations of threatened and endangered plant species will be visited to collect seed or cuttings for propagation

efforts as needed. Such activity will lead to out planting in areas actively managed for rare plant species that are within that species' historical range. Potential out planting sites include the blocks of native forest scattered throughout the KTMA.

B. Wildlife Management: Within Unit A, some harvest of the formerly planted timber species would be beneficial to game resources, because it would release some of the under story plants that provide beneficial forage for game, and create additional "edge" that is favorable for game.

The impact of timber planting and harvesting on native bird and bat populations in this area is likely to be minimal. Timber plantations are well dispersed throughout the forested landscape. There are no large expanses of mono-typical forest to harvest. The resulting mixture of both mature forested areas with more recently harvested or re-planted forest areas would actually provide a more diverse habitat that favors nearly all bird and mammal species found in the area.

C. Watershed Management: The KTMA has extensive tree and ground cover making the area a valuable watershed. The area contains no permanent streams, and the few intermittent streams present eventually lead to ground infiltration. There are no known surface water sources used for domestic or agricultural purposes. Maintaining tree and ground cover will ensure steady infiltration of surface water into ground water systems. All water courses will be protected in order to retard rapid runoff of storm flows, prevent soil erosion, improve water quality, prolong periods of stream flow and aid in recharging underground aquifers. A 50-foot buffer adjacent to all streams and wetlands will be established within the KTMA prior to timber management activities to ensure maintenance of water quality.

D. Weed management: Noxious or invasive weeds are a serious threat within KTMA and can be spread rapidly by birds, wind and mammals, including humans. Invasive weed species that occur in thick and fast-growing patches throughout the KTMA include strawberry guava (*Psidium cattelianum*), lantana, blackberry, molasses grass, banana poka (*Passiflora* spp.) guinea grass (*Panicum maximum*) and black wattle (*Acacia mearnsii*). Additional fast-growing species that could become weed problems in this area include palm grass (*Setaria palmifolia*), karaka nut (*Corynocarpus laevigatus*), fire bush (*Myrica faya*), kahili ginger (*Hedychium gardnerianum*), bushy beardgrass (*Schizachyrium condensatum*), and Vasey grass (*Paspalum urvillei*). These latter species are scattered throughout the KTMA, but have the potential to become dominant species under the right circumstances.

Although it has not been a major problem to date, non-native timber species have shown a capability to spread into native forest areas adjacent to the KTMA. This encroachment has been exacerbated in some areas by major disturbances such as fires or hurricanes, which open the native forest canopy, providing opportunities for exotic and pest species to become established. DOFAW has an ongoing program to monitor changes and threats that occur, and initiate control actions where necessary. Prior to entering and leaving the project area all equipment will be power washed with water to help control transmitting seeds of exotic plants.

E. Insects and Disease Monitoring: Within the Kokee region, there are approximately 1,000 species of insects, making it one of the richest insect habitats in the State. Due to the lack of studies on most of the native Hawaiian insects, there is little biological knowledge of these species. Furthermore, there is strong evidence that there are many more endemic insects, which are restricted to pockets of native forest, yet to be discovered. Some of the endemic insects

known to exist in the Kokee forests are the Green Sphinx of Kauai (*Tinostoma smaragditis*), the only known green species of Hawk or Sphinx moths in the world that lives in the tops of ohia trees, the Kauai Antlion, the Flightless Cranefly, and various species of the most ancient Hawaiian fruitfly (*Drosophila* spp.).

The insect species that is likely to represent the greatest threat to flora in the KTMA is the Black Twig Borer (*Xylosandrus compactus*). This species is known to attack the smaller branches and stems (seedlings) of many woody species, particularly those that have been stressed by drought or disease. Eucalypts, particularly *E. robusta*, would also be susceptible, under similar drought conditions, to invasion by the Eucalyptus Longhorned Beetle (*Phoracantha semipunctata*). Grubs of this species tunnel around the bole of trees in the cambial area that effectively girdles the branch or stem.

Due to the dry weather that normally prevails in the KTMA, the incidence of plant disease is expected to be low. However, during drought conditions the death of trees attributed to the lack of water is often erroneously diagnosed as caused by plant pathogens.

Trees within the KTMA will be monitored by DOFAW employees for evidence of pest problems. If problems arise, qualified entomologists or plant pathologists will be consulted to identify the problem and develop a solution to control or minimize the damage.

F. <u>Fire Prevention and Control</u>: The KTMA is located in a low rainfall zone where wild fire is a constant threat that requires active fire control planning and prevention efforts. Following Hurricane Iniki, a Fuel Hazard Reduction project was accomplished along approximately 21 miles of roads utilizing a USDA grant. A total of 228 acres was cleared of all standing and fallen debris along the roadsides to create firebreaks and to reduce the hazard of falling trees and branches blocking access into the area during emergencies.

Typically, fire risk increases in forested areas with increased human activity. Intensification of timber management activities within the KTMA is expected to increase fire risk. Offsetting that, maintenance of the road network within the KTMA for timber management activities will improve access and monitoring and facilitate rapid containment of fires. All harvesting permits or licenses will include a fire prevention and response plan approved by DOFAW. This plan will detail prevention and suppression responsibilities for fire control in the project area. All roads and trails, designated by DOFAW and needed for fire protection or other purposes, will be kept free of logs or logging debris resulting from operations as much as practical during maintenance operations. DOFAW will post fire prevention signs, distribute brochures, and employ Public Service Announcements to increase public awareness of fire risk. In extreme conditions, public access will be restricted and timber management activities will be minimized or suspended.

G. <u>Timber Harvesting</u>: DOFAW and SP periodically receive inquiries from the private sector for access to timber resources within the KTMA. DOFAW can presently issue commercial harvest permits for koa salvage and other small-scale timber operations. Many inquiries have been for koa salvage opportunities located within Waimea Canyon and Kokee State Parks. SP issues special use permits for timber salvage, primarily for koa, of individual dead or hazardous trees along roadways. Continued implementation of the issuance of permits for small-scale timber harvest or salvage will occur under the premise that no new roads will be created and that

any disturbance of ground area will not exceed 2,000 square feet for a given location. Trees with less than 15% remaining live crown area comprised of healthy leaves will be defined as dying. All proposed salvage harvest trees will be evaluated and marked by a DOFAW forester or staff from SP prior to active salvage operations.

Large-scale and high value timber sales within the KTMA will be administered through a public bidding process, resulting in issuance of timber licenses that require Board of Land and Natural Resources approval. All large-scale timber harvesting activities will be conducted according to a timber harvesting plan approved by DOFAW. The timber harvesting plan shall include all of the forest management practices that are specified as BMP (Appendix F) for timber harvesting.

There are about 40 miles of unimproved roads in the KTMA that can be utilized for hauling the timber products out of the forest. All roads that will be utilized for such purposes as well as the number and location for all main skid trails and landing sites will be approved by DOFAW. The harvester will need to plan and secure access routes that will minimize impact on the Kokee Road for transporting the timber products to the manufacturing sites. All timber licenses will detail general conditions that at a minimum include:

1. **Treatment of logging debris:** Logging debris will be treated by one of the following methods in decreasing order of preference:
    a. Lop all logging debris such that it lies within 36 inches of the ground surface and away from stumps.
    b. Scatter logging debris with a bulldozer.
    c. Pile all logging debris in designated windrows or piles.

2. **Public convenience and safety:** All operators or contractors will required to conduct timber management operations with due regard to the convenience and safety of the public at all times. No materials or equipment shall be stored where it would interfere with the safe passage of public traffic. Operators or contractors will provide, install, and maintain in satisfactory condition, all necessary safety signs and equipment to protect the safety of the public.

H. <u>Road Construction</u>: A need for new road construction is not expected in relation to the objectives of this management plan. Any proposed road construction within the KTMA would be pursued through a separate plan and review process.

I. <u>Non-Timber Forest Products</u>: Non-timber forest products are commonly collected within the KTMA and include:

- pine cones
- fruits
- flowers
- tree seedlings
- ferns
- maile
- guava poles
- banana poka vines
- firewood

Gathering of material from plant species that are not on Federal or State threatened and endangered species lists will be permitted and regulated by DOFAW and SP through standard forest permit procedures. Gathering of plant materials from threatened or endangered species may be allowed if individuals have obtained a special collecting permit from DLNR. Harvesting permits are required for gathering firewood, maile, and greenery for floral arrangements.

Permits for gathering plant material can be obtained from the DLNR Lihue office at 3060 Eiwa Street, Room 306. Hours are Monday through Friday except State holidays from 8:00 AM to 4:00 PM for DOFAW and 8:00 AM to 3: 30 PM for SP. These permits are free and are available for non-commercial, home use only. Approximately 300 permits are issued for the Kokee area annually.

J. Education and Research: There is great potential for field studies within the KTMA, especially in regard to native and introduced timber species in Hawaii. Should the Kauai Community College develop a forestry curriculum, the KTMA could be used as an outdoor classroom as well as silvicultural research site.

Permanent growth plots could be established by DOFAW in all principal timber types that will be thinned or harvested. Tree growth data will be obtained and reviewed annually to guide future timber management decisions and practices for the management of commercial species in this forest.

There are opportunities for applied research in tree improvement, silviculture, and studies of wood properties. Tree improvement can enhance forest productivity by increasing both the quality and quantity of wood. Silviculture research will aid in developing sustainable timber management practices. Wood properties studies will help to optimize the value of timber grown for commercial use by targeting the highest end value for each timber species. Public-private partnerships are a cost effective method of enhancing forest research activities. Research organizations such as the Hawaii Agriculture Research Center (HARC) and the U.S. Forest Service's Institute of Pacific Islands Forestry (Honolulu) and the Forest Product Laboratory (FPL) in Madison, Wisconsin, have expressed interest and support for DOFAW research efforts and needs.

Research is needed in the following areas: (1) the effects of nutrient depletion caused by sustained eucalyptus plantation over several rotations; (2) koa silviculture in a mixed species plantation setting; (3) whether a symbiotic relationship exists between koa and eucalypts, and (4) agroforestry opportunities in plantation stands.

K. Management of Historical and Archaeological Sites: The KTMA contains a wealth of historic resources. The five known archaeological sites within the parks do not represent a comprehensive inventory of such historic properties extant in the KTMA. However, minimally, the sites indicate that the area was used by Hawaiians for ceremonial, habitation (whether temporary or permanent), and work activities. Areas within and immediately surrounding known sites will be avoided.

Specific plans for the harvest of KTMA timber resources should be reviewed by SP Archaeologists prior to commencement of active field operations. In the event unanticipated heiau and habitation sites or remains such as shells, bones, rock or wall alignments are encountered during forest management operations, work will stop immediately and the State Historic Preservation Division will be notified.

VIII. OPTIONS FOR DISPOSITION OF FOREST PRODUCTS

The following mechanisms will be employed for maintenance, salvage or commercial disposition of forest products from the KTMA:

A. **Division operations:** Maintenance operations conducted directly by DOFAW or SP may not involve the commercial disposition of salvaged or felled timber resources. All debris and slash from salvaged felled trees will be treated in the manner described above. Wood resources resulting from such work have in the past been donated to public schools for craftwork curriculums. This practice will continue. Any remaining debris and slash will be left to decompose on-site or salvaged as firewood.

B. **Small-scale sales or timber salvage operations:** The DOFAW-Kauai Branch office currently issues commercial harvest permits for small-scale sales or timber salvage operations that are valued within the limits defined in Chapter 13-104, Hawaii Administrative Rules, Section 13-104-22 (Appendix H). In the context of the guidelines outlined in this plan, this practice will continue for forest products harvested from forest reserves as needed. Similarly, the SP-Kauai Branch office issues special use permits for timber salvage and hazard tree reduction within the parks lands of the KTMA, and will also continue to issue such permits.

C. **Commercial timber management contracts:** For commercial-scale operations within the KTMA, timber licenses will be employed to administer the sale of timber resources valued greater than the limit defined for the commercial harvest permits for forest reserves. Such licenses will be offered through a public bidding process with final timber licenses approved by the Board of Land and Natural Resources. For any major commercial harvesting activities to occur within the KTMA, reforestation and other essential forest management activities must be supported to assure the sustainable management of the KTMA. Including clauses in timber harvest licenses that require reforestation, "stewardship contracting," or reinvesting a portion of the value derived from the license in managing the KTMA would all serve to provide such support.

   If employed, stewardship contracting terms would stipulate that a portion of the value owed to the State from the purchase of timber within the KTMA would be used to offset cost of specific stewardship services performed. These could include site preparation, replanting, wildlife habitat enhancement, silviculture programs, and watershed improvements. Reinvested revenues can improve forest health as well as stimulate job creation and value-added processing, without impacting existing general funds. The public is likely to respond more favorably to the use of its forest resources if proceeds derived from harvesting can be reinvested into our forests. At a minimum, the following contract terms and oversight shall be applied for timber licenses:

   1. Unique sources of potential forest products that contain economic value, are of interest to forest product processors and whose availability is consistent with overall KTMA management objectives will be identified by the Divisions. Prospective bidders will be shown such sources. The Divisions will conduct value assessments of these segments while affording prospective bidders and opportunity to do so as well.

2. The Divisions will solicit requests for proposals. The Chairperson may stipulate criteria or conditions that all proposals must comply with or incorporate, for example specifications listed above or the responsibility of respective parties during field operations. The Divisions will then conduct a proposal review and selection process, or dismiss the proposals if none are deemed adequate.
3. Licenses will be developed that include or specify: an expiration date; Best Management Practices to be followed; language that gives the Divisions the power to suspend operations or revoke the license for non-compliance; language requiring final site conditions; applicable access issues and permissions; language prohibiting damage to or harvest of any native trees not marked for harvest; treatment of logging debris; treatment of stumps; treatment of slash, erosion control measures; fire prevention and control plan; guidelines for applying or handling chemicals and hazardous waste; a weed control plan.
4. Licenses will be approved only after the successful bidder has deposited a bond equal to double the value of their bid for a given license.
5. When the contractor informs the Divisions that the project is complete, the site will be inspected for contract compliance. The Divisions will release the remaining half or appropriate proportion of the bond if the project was completed satisfactorily.
6. Under conditions of non-compliance, the Divisions will retain the remaining portion of the bond. Administrative proceedings will be pursued to quantify perceived damages and determine the fate of the retained funds.

IX. REVENUE

Revenue obtained from sales of forest products in forest reserves in the KTMA will be deposited in the forest stewardship fund. For commercial harvest permits or timber licenses involving native timber resources, DOFAW can only make deposits into the stewardship fund if the timber originates from degraded forests (HRS 183-16). Degraded forests are defined "areas which have had considerable disturbance, are altered from their natural state, and contain less than twenty percent crown canopy of native tree species" (HRS 186-5.5). Revenue from sales or contracts involving native timber resources not originating from "degraded forests" as provided above shall be deposited in the State General Fund.

Revenue obtained from sales of forest products in State Parks in the KTMA will be deposited in the State Parks Special Fund, pursuant to section 184-3.4, HRS.

XI. TIME LINE AND PROCESSES TO BE FOLLOWED

Through open dialogue and input, a widely accepted plan for the management of the KTMA can support Hawaii's growing forest industry while fitting within the broader context of resource management and protection. Input and assistance from special interest groups and community groups will be solicited to address issues and concerns relating to KTMA resources and public use. Community field trips will be held so interested parties can see the KTMA first hand. Integration of timber management with hunting, recreational and gathering activities will aid in developing community support for growing and processing timber resources. This management plan will be the basis for an Environmental Assessment developed under HRS Chapter 343. Both documents will be used as the basis for forest management activities within the KTMA.

APPENDIX A. DOMINANT SOILS OF THE KTMA

The following information summarizes soil data compiled by Foote et al. (1972) of the Soil Conservation Service.

Kokee silty clay loams are composed of material weathered from igneous rock mixed with volcanic ash. They are characterized by well-drained, strongly acidic clay loam and silty loam soils on gently rising (0 to 35 percent) to very steep (35 to 70 percent) slopes. Permeability of these soils is moderately rapid, runoff is medium to rapid, and the erosion hazard is slight to severe, depending on slope. These soils support water supply, woodland growth, and wildlife habitat, with natural vegetation typical of montane wet forest types (ohia, koa, pukiawe).

Kunuweia Very Gravelly Clay Loams are geographically associated with Kokee soils and are also formed of materials weathered from basic igneous rock. Where Kokee soils typically represent valley in-fill material, Kunuweia soil types are identified on ridge tops in nearly level to strongly-sloping conditions. This soil type is found in elevations ranging from 3,500 feet to 4,000 feet in areas with annual rainfall of 70 to 150 inches. Kunuweia soils are characterized as well-drained, strongly acidic soils that consist of very gravelly clay loam that contain fragments of ironstone underlain by soft, weathered rock. Permeability is moderately rapid, runoff is slow, and the erosion hazard is slight. Like Kokee soils, Kunuweia soils are identified with water bearing properties and woodland growth.

Oli silt loams typically occur on the side of gulches and may be found along the upper rim of Waimea Canyon from the area of Möhihi and Kumuwela Ridge down approximately to mile marker 10. Oli soils are also present along the edges of the ridges that slope westward from the Waimea scarp, and include all of the area around Puu Lua reservoir. Formed from volcanic ash, this soil is typically found at elevations from 1,000 feet to 2,250 feet in areas with annual rainfall of 30 to 40 inches. Oli soils are characterized by well-drained, strongly acidic deep silt loam and loam underlain by slightly weathered hard rock. In the KTMA, Oli soils occur on slopes of 30 to 70 percent punctuated by rock outcrops. Permeability is moderately rapid runoff is very rapid, and the erosion hazard is very severe.

Paaiki soils are primarily found in Waimea Canyon and alternate with Oli soils along the westward sloping crest of the Waimea scarp. Paaiki soils underlie major portions of the mesic forests that skirt the canyon rim down to the Waimea Canyon lookout. Formed from material weathered from igneous rock, volcanic ash, and ejected magma, Paaiki soils are characterized as well-drained loam and silty clay loam over clay subsoil, underlain by hard saprolite (weathered remains of intrusive igneous rock). Permeability is moderately rapid, runoff is slow to rapid and the erosion hazard is slight to severe, depending on the slope that can be as steep as 70 percent.

Areas of predominantly exposed bedrock formed of basalt and andesite are called rock outcrops and can be found in conditions of gently sloping to precipitous and is the predominant soil type in Waimea Canyon. Rough broken land is characterized by very steep land broken by numerous, intermittent gullies located on steeply sloping (40 to 70 percent) mountainsides and gulches. A variable soil type, it is generally not stony although small areas of rock outcrop are common. Runoff is rapid and geologic erosion is active with associated colluvium and alluvium along gulch bottoms.

APPENDIX B. COMMON COMPONENTS OF FORESTS IN THE KTMA

A. T&E species

- *Alectryon macrococcus var. macrococcus*
- *Euphorbia haeleeleana*
- *Lepidium serra*
- *Lobelia niihauensis*
- *Nesoluma polynesicum*
- *Remya kauaiensis*
- *Chamaesyce halemanui*
- *Isodendrion laurifolium*
- *Lipochaeta fauriei*
- *Lysimachia kalalauensis*
- *Pteralyxia kauaiensis*
- *Wilkesia hobdyi*

B. Native species

- koa (*Acacia koa*)
- maile (*Alyxia oliviformis*)
- ahakea lau li'i (*Bobea brevipes*)
- 'akoko (*Chamaesyce atrococca*)*
- pilo (Coprosma sp.)
- 'uki 'uki (*Dianella sandwicensis*)
- lama (*Diospyros hillebrandii*)
- kawelu (*Eragrostis variabilis*)
- manono (*Hedyotis terminalis*)
- 'ohi'a (*Metrosideros polymorpha*)
- naio (*Myoporum sandwicense*)
- olopua (*Nestegis sandwicensis*)
- papala kepau (*Pisonia sandwicensis*)
- moa (*Psilotum nudum*)
- ama`u (*Sadleria spp.*)
- naupaka kuahiwi (*Scaevola gaudichaudii*)
- pukiawe (*Styphelia tameiameiae*)
- 'akia (*Wikstoemia oahuensis*)
- dwarf iliau (*Wilkesia hobdyi*)
- kawa`u (*Zanthoxylum dipetalum*)
- kauila (*Alphitonia ponderosa*)
- mule's foot fern (*Marattia douglasii*)
- alahe'e (*Canthium odoratum*)
- hapu'u (Cibotium sp.)
- hala lua (*Cyanea leptostegia*) *
- uluhe (*Dicranopteris linearis*)
- 'a 'ali 'i (*Dodonea viscosa*)
- 'i'e'i'e (Freycinetia arbore
- alani (*Melicope spp.*)
- palapalai (*Microlepia strigosa)*
- kolea (*Myrsine lanaiensis*)
- mamaki (*Pipturus albidus*)
- halapepe (*Pleomele aurea*)
- kopiko (*Psychotria* sp.)
- iliahi (*Santalum* spp.)
- 'ilima (*Sida fallax*)
- ohia ha (*Syzigium sandwicensis*)
- iliau (*Wilkesia gymnoxiphium*)
- maua (Xylosma hawaiiense)
- hame (*Antidesma platyphyllum var. hillebrandii*)

* Federally proposed or Candidate species.

Appendix B. continued

C. Invasive non-native species

- black wattle (*Acacia mearnsii*)
- maidenhair fern (*Adiantum hispidulum*)
- daisy fleabane (*Erigeron karvinskianus*)
- loquat (*Eriobotrya japonica*)
- lantana (*Lantana camara*)
- canyon vervain (*Stachytarpheta urticifolia*)
- molasses grass (*Melinus minutiflora*)
- wild olive (*Olea europaea*)
- Guinea grass (*Panicum maximum*)
- Vasey grass (*Paspalum urvillei)*
- banana poka (*Passiflora mollissima*)
- sourbush (*Pluchea symphitifolia*)
- strawberry guava (*Psidium cattleianum*)
- blackberry (*Rubus argutus*)
- Christmas berry (*Schinus terebinthifolius*)
- palm grass (*Setaria palmifolia*)
- wedelia (*Wedelia trilobata*)
- spiny-bur (*Acanthospermum australe*)
- thistle (*Cirsium vulgare*)
- karakanut (*Corynocarpus laevigatus*)
- kahili ginger (*Hedychium garderianum*)
- haole koa (*Leucaena leucocephala*)
- Chinaberry (*Melia azedarach*)
- firetree (*Myrica faya*)
- panini (*Opuntia ficus-indica*)
- dallis grass (*Paspalum dilatatum*)
- passion fruit (*Passiflora edulis*)
- kikuyu grass (*Pennisetum clandesinum*)
- common guava (*Psidium guajava*)
- castor bean (*Ricinus communis*)
- thimbleberry (*Rubus rosifolius*)
- beardgrass (*Schizachyrium condensatum*)
- popolo (*Solanum americanum*)
- downy woodfern (*Thelypteris parasitica*)

APPENDIX C. SUMMARY OF GAME AND NON-GAME WILDLIFE SPECIES PRESENT IN THE KTMA

Game Species	**Mammal**	Feral Pig (*Sus scrofa*)
		Feral Goat (*Capra hirca*)
		Black-tailed Deer (*Odocoileus hemionus columbianus*)
	Birds	Ring-necked pheasant (*Phasianus colchicus*)
		Erckel's francolin (*Francolinus erckelii*)
		Black francolin (*Francolinus francolinus*)
		Chuckar partridge (*Alectoris graeca*)
		Lace-necked Dove (*Streptopelia chinensis*)
		Barred Dove (*Geopelia striata*)
Non-Game Species	**Introduced Mammals**	Feral Dog (*Canis familiaris*)
		Feral Cat (*Felis catus*)
		Rat (*Rattus spp.*)
	Native Mammal	Bat (*Lasiurus cinereus semotus*)
	Native Birds	Amakihi (*Hemignathus virens*)
		Anianiau (*Hemignathus parvus*)
		Apapane (*Himatione sanguinea*)
		Elepaio (*Chasiempis sandwichensis*)
		Iiwi (*Vestiaria coccinea*)
		Pueo (*Asio flammeus*)
	Introduced Birds	Barn Owl (*Tyto alba*)
		Chestnut Mannikin (*Lonchura malacca*)
		Common Mynah (*Acridotheres tristis*)
		House Finch (*Carpodacus mexicanus*)
		House Sparrow (*Passer domesticus*)
		Japanese Bush Warbler (*Cettia diphone*)
		Japanese White Eye (*Zosterops japonicus*)
		Melodious Laughing Thrush (*Garrulax canorus*)
		Northern Cardinal (*Cardinalis cardinalis*)
		Northern Mockingbird (*Mimus polygottus*)
		Nutmeg Mannikin (*Lonchura punctulata*)
		Rd-Billed Leiothrix (*Leiothrix lutea*)
		Red-crested cardinal (*Paroaria coronata*)
		Shama thrush (*Copsychus malabaricus*)

APPENDIX D. HISTORICAL AND ARCHAEOLOGICAL SITES ON PARKS LANDS IN THE KTMA

A. <u>Background</u>: Traditional, legendary sites within the KTMA are "Boiling Pots", Papu, Puu ka Pele, Kaana, Halemanu, and Pohakuwaawaa.

"Boiling Pots" are holes in the rocks at the top of Waipoo Falls. Legend says that they were used to put babies in while mothers dyed kapa or did other chores at the stream.

Papu is the name given to the pin-hole lookout just upslope from Waimea Canyon lookout near the 10.75 mile marker. The site is associated with the legend of the Menehune Papu, the King's messenger, who was waylaid by robbers at this spot and thrown to his death with a bundle of fish he was carrying for the King. Legend has it that during certain times of a full moon, the scent of rotting fish fills the area and the site is believed to be visited by Papu who tries to lure visitors over the cliff edge.

Puu ka Pele is the name of a prominent hill located on the rim of Waimea Canyon just past mile marker 11. The area is a legendary site of an ancient Hawaiian village found by Ola, the ruling chief of Waimea in 600 A.D and was used for harvesting forest resources, notably koa tress for use in making canoes, paddles and other implements. A trail is believed to have existed between Puu ka Pele and Waimea village to facilitate the transport of canoe logs to the workshops on the coast (ibid.) Table 4-9 illustrates the location of archaeological sites within the Puu ka Pele area.

The lookout across the road from the Puu ka Pele picnic area sits atop the ridge called Kaana (sadness). According to legend, the spirits of the newly dead would assemble here before beginning their journey down the ridge to the sea (ibid.). Halemanu, or Bird House, is the name given to the valley area at the entrance to Kokee State Park. It refers to an ancient house site used by the Kia Manu, or bird catchers, who trapped forest birds to harvest feathers to be made into cloaks for the heifs. Halemanu is also the site of the first mountain cabin built in the region by the Knudsen family in the late 1800's. Purportedly built on the site of the old bird catcher's house, the Knudsen cabin incorporated beams from the original thatched structure in its construction.

Pohakuwaawaa is a large, furrowed stone located on the east side of Kaunuohua Ridge overlooking Kapukaohelo between Nualolo and Awaawapuhi valleys. On the USGS map, the stone is misplaced; it is further down the ridge's flank towards Kanaloahuluhulu, not on the ridge's peak. This rock marks the boundary of the ahupuaa.

It appears likely that the upland area of Kokee and the Alakai Swamp were utilized in the pre-contact period as resource gathering zones, rather than areas of permanent habitation or agriculture. Several legends suggest this use. One attributes the road of sticks through the Alakai Swamp to the *menehune* (Rice, 1923). Another refers to Lahi (or Lauhaka), a young man who would eat only birds, and traveled to the top of Kilohana (a lookout at the edge of the Alakai Swamp) where the *Uwau* bird nested to satisfy his hunger (ibid). Puu Ka Pele is referred to as an area for gathering *koa* canoe logs and other building materials:

At one time the Menehune built two canoes of koa in the mountains near Puu ka Pele. As they were dragging them down to the lowlands, they were caught by a heavy rain storm, and were forced to leave the canoes across the little valley. The storm covered the canoes with debris, and later, a road was built across them, over which all the materials to build the village of Waimea were hauled (ibid).

Further evidence for the gathering of canoe logs from the uplands comes from the narrative of the Dutch merchant Captain Jacobus Boelen, who visited Waimea in 1828. While his ship was being loaded with sandalwood, he spent some time exploring the region and included the following observation:

On that day we visited Quequaheva's [Kaikioewa's] shipyard, which consisted of large sheds where the largest and most beautiful canoes that can be found in the islands were made. We were assured that the island of Atooi [Kauai] had always been the principal workshop of the islands in these matters. Under one very neatly made roof I saw two of the largest double canoes I have ever seen . . . Long, narrow, and lightly built, although of a strong and heavy type of wood [*koa*], they have only a shallow draught. . . some of these vessels - especially those double canoes of the largest sort, which the highest chiefs use - are up to seventy or eighty feet long . . . (Broeze 1988).

It is apparent from this description that *koa* trees of exceptional size were being harvested in the uplands, where they were partially worked to lessen their weight prior to transport to the coast.

Handy does not specifically mention Kokee with respect to Hawaiian agriculture, although he does state that "the upper gulches and forests in and above Waimea Canyon should be favorable localities for yams" (Handy 1940: 171). He also mentions that boggy areas in the uplands were utilized for the cultivation of *olona.*

There are trails recorded which ran from the valleys of Na Pali to Kokee and Waimea Canyon. Bennett (1931) recorded several trails connecting different areas of Na Pali coast with the uplands. A network of upland and coastal trails is recorded in the following:

More anciently the old Hawaiians used a number of overland trails. The Kamaile trail descended into Nuulolo [Nualolo] Valley inland. There was a trail connecting Nualolo with Honopu. A good trail overland connects Kalalau with Haena. There is a trail from Kokee in the mountains above Kekaha down into Kalalau. From Polihale travelers could go on foot, with a little swimming, to Milolii, and a trail connected Milolii with Nualolo flats. Another trail connects Milolii with Kokee. And there was the path (*ala*), said to have been built by King Ola, that led from Waimea Delta up the canyon to Kokee, over the Alakai Swamp, where it was said to have been paved with sticks (*kipapa*), and thence down Maunahina ridge into Wainiha by way of Kokee. (Handy and Handy, 1972)

This trail system suggests a connection between the north and south sides of the island, although whether the trails facilitated trade or simply travel between the two areas is not known. It can be assumed that the upland forests were utilized as resource gathering zones for such items as hardwoods, bird feathers, and medicinal plants. Undoubtedly a substantial trail existed between the upper Waimea Canyon and Waimea Village to facilitate the transport of large canoe logs.

The Reverend Hiram Bingham traveled from Waimea to Hanalei in 1821 along the old established route passing through Kokee. The trail consisted of a "narrow, winding, slippery foot-path, sometimes on sharp ridges, here ascending and there descending rugged steps" (Bingham, 1981). He described the uplands as being uninhabited but mentioned several temporary shelters along the way which he attributed to sandalwood cutters and reported abundant sandalwood forests still in existence at that time.

Queen Emma, in 1871, made a trek from Waimea to the "Kilohana of Hanalei", at the edge of Wainiha Valley. A party of about 100 people accompanied the queen, along a route which again likely followed the old trail. At that time the trail was very overgrown but still recognizable. Among the more interesting anecdotes of the trip was a stop the party made on the edge of Kauaikinana Valley where Queen Emma, overcome by the beauty of the spot, insisted upon a *hula* performance. The trip then continued through the Alakai Swamp where the party spent the night. The trail through the swamp was described as a "corduroy road", built of tree-fern logs placed side by side. They reached the Kilohana the next morning and then retraced their steps to Waimea (Knudsen, 1940).

The sandalwood trade dominated the Kauai economy in the early nineteenth century. Beginning in 1810 and reaching a peak in 1821-22, commoners were forced to leave their taro fields and head into the mountains to cut the precious wood. The resource was controlled by King Kaumualii, who exchanged the commodity for ships and other western luxuries. Unfortunately, this took a great toll upon the people as well as the sandalwood forests, which were all but depleted by the mid-1830's. Waimea was the sole port of export on Kauai for the wood, which came almost exclusively from the upland gulches of Waimea Canyon and Kokee (Joesting 1984).

Valdemar Knudsen obtained a lease to much of the present day Kokee State Park in the mid-1800's. He used the land to run cattle, which provided beef to provision the whaling vessels. The cattle industry on Kauai diminished greatly by 1900 due to the decline of the whaling business (Joesting, 1984). Also in the early 1850s, Mr. Archer built the first house in Kokee at Halemanu. Mr. Archer traveled through Kokee in transit between his tobacco farms in Hanalei and Mana (Damon 1931).

The decline of cattle overlapped with the onset of the sugar industry. Beginning in the late 1800's and continuing into early this century, an irrigation system known as the Waimea Canyon-Kekaha ditch tapped the upland streams to irrigate the cane lands on the west side of the island. In 1923, the Kokee Ditch was built by Kekaha Sugar as part of this larger system. The Kokee Ditch captures water from streams in the Kokee area (Wilcox, 1984). In conjunction with this development, plantation camps were constructed in the uplands to house the Chinese and Japanese workers who built and maintained the ditch system.

Land use in Kokee during the 20th Century consists mainly of recreational and military activities (Heathcote 1993). Wealthy sugar plantation owners built vacation cabins in Kokee to escape the summer heat of the lowland plains. Hunters traveled on horseback to the uplands in search of pigs and goats. In 1929, there was an effort to establish forest reserves to encourage the recovery of the native forests after the range fire of 1890 (Wenkam, 1967). This met with objections from the ranchers of Kokee, but was supported by the public seeking recreational opportunities in the

mountains. In 1930, 755 acres were designated the Waimea Canyon Territorial Park, but it was not until 1952 that Kokee Territorial Park was designated when 4,451 acres were removed from the Na Pali-Kona Forest Reserve for park purposes. At this time, these parks were under the jurisdiction of the Board of Agriculture and Forestry.

The Civilian Conservation Corps (CCC) facility at Kokee was constructed in 1935 and a large network of trails was built and existing trails were refurbished by the CCC following the Great Depression. During World War II, the CCC Camp was used by the Army's Signal Corps while laying a telephone line through the Alakai Swamp and down to Hanalei. In 1940, the Army also constructed a support camp for a radar station at Kokee in the vicinity of the Kalalau Lookout. This camp consisted of one concrete administrative building, several wooden buildings, numerous tents, a motor pool, and an extensive garden (Plews, 1995). The radar station was returned to the Territory of Hawaii in 1949.

In the 1940's, the road to Kokee was improved, and the lookouts at Waimea Canyon and Kalalau were constructed. The Army camp was dismantled in the early 1950s and the wooden buildings were relocated or dismantled to create many of the buildings for Kokee State Park. One building is now the Kokee Museum while wood from other buildings was used to construct the Kokee Lodge and four park cabins. Between 1947 and 1953, much of Kokee State Park was built, including the Kalalau Lookout and the Waimea Canyon Lookout (DLNR, 1962).

The last major developments in Kokee were in the 1960's with the establishment of a Hawaii Air National Guard installation and a NASA tracking station was constructed as part of the National Space Program. The Air National Guard (Air Force) has operated its radar tracking facility on the former site of the Army radar station since 1961 (Dept. of the Air Force, 1995). This use of recreational areas for military purposes was controversial when these activities were first proposed at Kokee (Wenkam, 1967).

B. <u>Previous archaeological surveys</u>: Archaeological surveys in the Kokee and Waimea Canyon State Parks have been limited in number and scope. As a result, few archaeological sites are recorded in the Kokee area. Kokee is generally regarded as a resource gathering zone rather than an area of permanent habitation which implies that few archaeological sites will be found.

A 1906 survey of *heiau* sites by Thomas Thrum (1906) identified 2 sites in Kokee:

> Ahuloulu *Heiau*: Located at the base of Puukapele, this site consists of 3 platforms. The central platform is described as an enclosure measuring 12 by 30 feet with walls about 3 feet high but badly dilapidated. Thrum states that "no special significance seems to be attached to this so called heiau".
>
> Ka-unu-aiea Shrine: Small shrine in the dense *koa* forest of Milolii but there is no platform left to indicate its existence. Thrum states that this shrine is located on Kaunuohua Ridge and it may have been located in the area of the NASA tracking station. Thrum classifies the shrine as an *unu* for the shifting population of the forest belt. When Bennett (1931) recorded this site in 1928-29, he called it a *heiau* and described it as a small clearing containing a line of stones forming no outline or platform. He further added that the location is "in the forest above Halemanu".

Bennett recorded 2 additional sites at Puu ka Pele, both being house site complexes. Three site numbers were given to the sites at Puu ka Pele:

> 50-30-01-19: Ahuloulu Heiau. This *heiau* consists of a walled enclosure, the outside dimensions of which are 37 by 41 feet. The walls are four feet wide and badly broken. In front of this structure is a flat area about 50 by 50 feet without paving or boundaries. Back of the enclosure there is a paved platform 8 by 12 feet. This platform is backed by a large rock, the plugged-up holes in which indicate that it might have been used as a depository for umbilical cords.
>
> 50-30-01-20: House sites around the crater of Puu ka Pele. The remains of seven house sites are indicated by stones in line forming a terrace with a flat space behind. Some of these house sites measure 30 by 20 feet.
>
> 50-30-01-21: House sites toward the sea from Puu ka Pele on the north side of the road. A series of house sites are located on top of a flat ridge, the edge of which is lined with stones for 50 feet or more.
>
> 50-30-01-22: Kaumauaiea Heiau.

Francis Ching (1974) field checked the sites in 1974 in conjunction with the Statewide Inventory of Historic Places. He relocated sites 19 and 20 and although he suggested that site 21 was probably still present, he could not confirm this because of the dense vegetation. Subsequently, sites 19, 20, and 21 were consolidated under site #19, the Puu ka Pele Complex. The condition of the *heiau* site (#19) was evaluated during a field check in April, 1995 by State Parks Archaeologist Martha Yent. The site is covered by a dense growth of lantana and *koa haole* with a dense mat of silk oak leaves on the surface.

Brief reconnaissance surveys in the Kokee area have been conducted by Ching (1978a, 1978b), Kikuchi (1982), Yent (1982), and Walker and Rosendahl (1990). However, these surveys did not locate any archaeological sites.

In 1993, an archaeological reconnaissance survey was conducted along the ridge roads of Kokee prior to widening of these roads as firebreaks after Hurricane Iniki (McMahon 1993). A single archaeological site was recorded at the end of Polihale Ridge (State site #50-30-05-499). This site consists of a 5-meter long stone alignment that may have served as a sweet potato planting area. The general lack of sites recorded during this survey is believed to be the result of the extensive disturbance in the 20th Century from the sugarcane plantations, military activities, and reforestation.

Another 1993 survey involved 3 facilities in the Kokee and Waimea uplands (Dowden and Rosendahl 1994). No sites were located at the Pacific Missile Range - Makaha Ridge Facility, the Halemanu section of the Pacific Missile Range - Kokee Facility, or at the Kokee Air Force Station and Former NASA site.

Two independent archaeological surveys were conducted in conjunction with the proposed concession facility at the Waimea Canyon Lookout. State Parks archaeologists recorded site

#50-30-06-707 during a 1993 survey (Carpenter 1993). This site consists of a single row of stones on 3 sides on a level area about 80 meters southwest of the men's restroom at the lookout. The site is may be a temporary habitation site related to the logging of wood for canoes. The other survey conducted at the lookout involved archaeological testing (Chaffee and Spear 1993). No sites or subsurface cultural deposits were located during this survey.

In December 1993, an archaeological survey was conducted on the *makai* portion of Kahuamaa Flat for a plant sanctuary proposed by DOFAW (Carpenter and Yent 1994). This survey area is on the *makai* side of the Kokee Park Road and approximately 1.25 miles northeast of the Army Camp project area. Much of the Kahuamaa survey area consists of extremely steep cliffs at the back of Kalalau Valley. The dense vegetation hampered a thorough survey of the flat portion on the rim of the valley. No archaeological sites were located during this survey.

A survey of the old Army Camp site at Kokee was conducted in October 1994 (Yent 1995a). This camp was built in the early 1940s on Kaunuohua Ridge and was dismantled in the 1950s. This camp site is approximately 1.5 miles northeast of the CCC camp site. The Army Camp consisted of 5 major buildings along a dirt roadway off the paved Kokee Road with an additional 4 outlying structures. One concrete building remains along with the concrete slabs from 2 other buildings. No subsurface archaeological deposits or features other than those associated with the camp were located during the survey. A similar survey of the CCC Camp was conducted in 1995 (Yent 1995b). This facility consists of 7 wooden buildings around a grassed quadrangle. No subsurface testing has been conducted to determine the presence or absence of cultural deposits at the CCC Camp. The CCC Camp was listed on the Hawaii and National Registers of Historic Places in 1996.

In 2004, in conjunction with the master planning for Kokee and Waimea Canyon State Parks, an archaeological fieldcheck was conducted at 10 sites identified for future park development (Chiogioji et al. 2004). Several of these sites are existing park facilities, such as the lookouts. No significant sites were located at any of the 10 locations.

The archaeological surveys conducted to-date in Kokee tend to support the idea that this upland area was used largely as a resource gathering zone with limited habitation. The stone-lined platforms recorded at Puu ka Pele and near the Waimea Canyon Lookout appear to be temporary habitation sites.

APPENDIX E. SELECTED SECTIONS OF HAWAII REVISED STATUTES, CHAPTER 183

Section 183-1.5 Duties in general. The department shall:

(1) Gather and compile information and statistics concerning the area, location, character, and increase and decrease of forests in the State;

(2) Gather and compile information as necessary concerning trees, plants, and shrubs recommended for planting in different localities, including the care and propagation of trees and shrubs for protective, productive, and aesthetic purposes and other useful information, which the department deems proper;

(3) Have the power to manage and regulate all lands which may be set apart as forest reserves;

(4) Devise ways and means of protecting, extending, increasing, and utilizing the forests and forest reserves, more particularly for protecting and developing the springs, streams, and sources of water supply to increase and make that water supply available for use;

(5) Devise and carry into operation, ways and means by which forests and forest reserves can, with due regard to the main objectives of title 12, be made self-supporting in whole or in part;

(6) Devise and carry into operation, ways and means of reforesting suitable state lands;

(7) Formulate and from time to time recommend to the governor and legislature such additional legislation as it deems necessary or desirable for better implementing the objectives of title 12;

(8) Publish, at the end of each year, a report of the expenditures and proceedings of the department and of the results achieved by the department, together with such other matters as are germane to the subject matter under title 12 and which the department deems proper. [L 1903, c 44, pt of §5; am L 1919, c 65, §1; RL 1925, §586; RL 1935, pt of §176; am L 1941, c 228, §1; RL 1945, pt of §1006; RL 1955, pt of §18-7; am L Sp 1959 2d, c 1, §22; am L 1961, c 132, §1; HRS §183-1; am L 1981, c 85, §3; am L 1985, c 174, §2; am L 1988, c 337, §6; am L 1990, c 315, §3]

Section 183-16.5 Harvesting from state-owned lands. All harvesting of trees on public lands shall be done in accordance with a management plan approved by the board, and in accordance with the provisions regarding conservation of aquatic life, wildlife, and land plants, and the provisions regarding environmental impact statements. For any harvesting of native trees from public lands, the department shall use existing fire prevention and management programs and ensure that appropriate silvicultural practices are used to encourage native biodiversity and ecosystem processes. No native forests on public lands shall be converted to introduced forest plantations. [L 1997, c 256, §1]

APPENDIX F. BEST MANAGEMENT PRACTICES

Available upon request from DOFAW offices in Lihue and Honolulu:

Division of Forestry and Wildlife
3060 Eiwa Street #306
Lihue, HI 96766
808-274-3433

Division of Forestry and Wildlife
1151 Punchbowl Street #325
Honolulu, HI 96813
808-587-4186

Or on the web at:

http://www.state.hi.us/dlnr/dofaw/pubs/BMPs_bestmanagement.pdf

APPENDIX G. SPECIES SPECIFIC CONSIDERATIONS

Each of the commercial introduced timber species or species groups grown and managed within the KTMA have unique management requirements. These are due to differences in physiology and growth potential and utilization considerations such as value and products.

A. <u>Eucalyptus species</u>: Eucalyptus stands, which comprise 1,085 acres or 60 percent of the non-native plantations in the KTMA, contain a total net wood volume of 1,887,601 ft^3. *E. robusta* and *E. saligna* constitute 76 percent of the total eucalypt volume in the KTMA, with other mixed species making up the remaining volume. *Eucalyptus saligna* and *E. microcorys* appear to be well suited to the growing conditions found in the KTMA. Rapid growth rates, high yields, and the straight form of these trees make them desirable for a wide variety of processing opportunities including dimensional lumber, veneer, plywood, poles, and chips. *E. robusta* has not grown as well, because of the relatively dry climate conditions. *Eucalyptus* stands in the KTMA were heavily damaged by hurricane Iniki, with most species sustaining volume losses of 20% or more and approximately 25% of the trees having broken tops.

Current eucalypt stands within the KTMA range from young seedlings, to stands that contain medium or "pole" sized (4-12" diameter) trees, and mature or "saw timber" sized (> 12" diameter) trees. About one-third of the *Eucalyptus* stands are in the latter two categories, indicating a potential to begin harvesting mature "saw timber" sized stands and stagnant "pole" sized stands immediately while allowing younger seedling and pole stands to continue growing. The following harvesting guidelines are recommended for the Eucalypts:

1. Clear-cutting is the preferred harvesting method for Eucalypts because these species require open, well prepared sites to regenerate and grow vigorously.

2. In order to minimize ecosystem and aesthetic impacts of eucalypt clear cutting, each harvest unit will not exceed 25 acres, and no adjacent timber plantation unit will be harvested for a minimum of five (5) years.

3. All harvested areas will be replanted either with Eucalypts, other high value hardwood timber species, or native tree species, based on the potential of the site.

To manage the 1,085 acres of Eucalypts on a sustained yield bases, up to 50 acres of Eucalypts could to be harvested and replanted annually based on a 20-year rotation cycle. The 20-year cycle is desirable for maximizing wood production over time and maintaining harvest log size near a 12 inch DBH, since larger logs are prone to splitting and checking. This prescription may be changed based on shorter rotations or different end product mixes. Annual wood production from the harvest of Eucalypts in the KTMA may contribute to supporting a local wood manufacturing company that obtains its wood requirements from a variety of sources. Data collected from the 1998 inventory shows the mean annual increment (MAI) at elevations above 2,400 feet were considerably higher than the lower elevations for all of the species. These areas will likely be converted to higher value native hardwoods such as koa.

B. <u>Pine Species</u>: Slash (*Pinus elliottii*), Loblolly (*Pinus taeda*), and mixed pine plantings are found on 668 acres or 37 percent of the KTMA. While initially planted on a smaller scale than the Eucalypts and primarily for erosion control on the lower ridges, Southern pines have not

grown as well as the Eucalypts in their current locations with typically lower mean annual increments. The southern pines proved to be the most resistant to wind damage, suffering minor defects ranging from 2% to 5%. There presently appears to be little demand for pine wood products on Kauai. As such pines in the KTMA will be harvested selectively or in small patches that do not exceed 5 acres. No adjacent timber plantation unit will be harvested for a minimum of five (5) years. Income generation from the sale of branches and pine cones is a more likely scenario for the future than timber related products. Harvested pine units will either be converted to native species or planted with non-native species that are more desirable than pine for commercial forestry purposes.

C. <u>Other non-native species</u>: Other non-native tree species found in minor quantities in the KTMA include brushbox (*Lophostemon confertus*) on seven acres, Monterey pine (*Pinus radiata*) on two acres, paperbark (*Melaleuca quinquenervia*) on less than one acre, Formosan koa (*Acacia confusa*) on eight acres, ironwood (*Casuarina equisetifolia*) on eight acres, and silk oak (*Grevillia robusta*) on 16 acres. With the exception of brushbox, no detailed volume or distribution data are available for these species due to their scattered occurrences. Some refer to brushbox as "chocolate heart," and it is used primarily for flooring in Australia. DOFAW has received inquiries regarding the availability and volume of this desirable wood. Silk oak is a finely figured wood and used in the wood craft industry mainly on the island of Hawaii. Demand for this wood is periodic but could be constant should a sustained volume be made available. In addition to the 16 acres of silk oak plantations, this species has spread into non-plantation zones of the KTMA. Where feasible, such silk oak will be selectively harvested in an effort to convert such sites back to native species while recovering value from the harvested silk oak trees.

These "other species" presently exist in only very small stands or are considered invasive, and will be harvested selectively or in small patches. Any harvesting of species that are considered invasive would be done with a primary interest in control, removal and conversion to native species. Because of these factors, no harvest unit size limit or time frame limit will be employed for these species. Harvested "other species" units will either be converted to native species (for invasive species) or planted with non-native species that are more desirable for commercial forestry purposes (e.g. brushbox and Monterey pine).

D. <u>Native species</u>: Koa and other native species will be harvested within the KTMA only for the purposes of salvaging dead and dying trees, removing hazardous trees, or during road and fence maintenance operations.

APPENDIX G (continued). E. PRINCIPAL TIMBER TYPE CLASSES IN THE KTMA

Descriptive statistics for timber types in the West Kauai study area. Age data represent original planting date, while stocking and DBH data represent all tree species with a minimum DBH of 2 inches. Maximum DBH data represent planted, non-native trees only.
*****NOTE: DOFAW MANAGED STANDS ONLY*****

Species & Type Description		Net Acres	Age in Years	Stocking Trees ac^{-1}	DBH Range	Mean DBH	--Mean ft3 ac^{-1}-- Gross	Net	Total net volume (ft^3) by log minimum diameter class 4-8"	8-12"	> 12"	Row Sub-Totals
Eucalyptus robusta												
ER00	Recent plantings / sapling stands	47	NA	1,248	2-22	5	1,750	884	31,306	9,538	703	**41,548**
ER11	Low volume pole and saw timber	169	37-62	504	2-40	8	2,353	1,281	93,854	69,193	53,442	**216,489**
ER44	Moderate volume pole and saw timber	116	59-65	545	2-22	9	2,860	1,726	93,738	90,590	15,889	**200,216**
ER55	Moderate volume saw timber	76	59	270	2-38	14	4,734	3,382	37,380	60,062	159,590	**257,032**
Sub-Total ER:		**408**							**256,278**	**229,383**	**229,624**	**715,285**
Eucalyptus saligna												
ES11	Low volume pole and saw timber	338	13-33	420	2-39	8	2,433	1,191	187,839	153,488	61,231	**402,558**
ES22	Low to moderate volume pole timber	36	18	619	2-18	6	2,956	1,970	37,464	27,076	6,380	**70,920**
ES55	Moderate volume saw timber	57	18	376	2-32	9	5,547	4,367	38,154	39,168	171,597	**248,919**
Sub-Total ES:		**431**							**263,457**	**219,732**	**239,208**	**722,397**
Eucalyptus sideroxylon												
EE00	Recent plantings / sapling stands	11	NA	587	2-20	6	1,304	579	5,344	288	737	**6,369**
Sub-Total EE:		**11**							**5,344**	**288**	**737**	**6,369**
Eucalyptus microcorys												
EM22	Low to moderate volume pole timber	55	18	903	2-20	7	2,993	1,362	64,470	10,440	0	**74,910**
Sub-Total EM:		**55**							**64,470**	**10,440**	**0**	**74,910**
Mixed eucalyptus												
EX44	Moderate volume pole and saw timber	180	51-55	207	2-34	11	2,739	2,048	77,575	107,069	183,996	**368,640**
Sub-Total EX:		**180**							**77,575**	**107,069**	**183,996**	**368,640**
Lophostemon confertus												
LC11	Low volume pole and saw timber	7	27-59	350	2-23	11	3,289	1,261	1,001	3,117	4,709	**8,827**
Sub-Total LC:		**7**							**1,001**	**3,117**	**4,709**	**8,827**

Species & Type Description		Net Acres	Age in Years	Stocking Trees ac^{-1}	DBH Range	Mean DBH	--Mean ft3 ac^{-1}-- Gross	Net	Total net volume (ft^3) by log minimum diameter class 4-8"	8-12"	> 12"	Row Sub-Totals
Pinus elliottii												
PE22	Low to moderate volume pole timber	271	34-37	240	2-23	8	1,876	1,463	256,525	128,090	11,858	**396,473**
PE33	Moderate to high volume pole and saw timber	74	37-39	404	2-25	10	5,264	4,523	157,420	134,214	43,069	**334,702**
Sub-Total PE:		**345**							**413,944**	**262,304**	**54,927**	**731,175**
Pinus taeda												
PT22	Low to moderate volume pole timber	41	34-38	233	2-15	8	1,634	1,221	25,353	24,708	0	**50,061**
PT33	Moderate to high volume pole and saw timber	87	37-39	277	2-28	11	4,784	4,226	126,821	154,952	85,889	**367,662**
Sub-Total PT:		**128**							**152,174**	**179,660**	**85,889**	**417,723**
Mixed pines												
PX22	Low to moderate volume pole timber	195	34-38	212	2-15	8	1,396	1,070	163,509	45,141	0	**208,650**
Sub-Total PX:		**195**							**163,509**	**45,141**	**0**	**208,650**
Other non-surveyed types												
AC11	Acacia confusa	8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CE22	Casuarina equisetifolia	8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EZ11	Unknown Eucalyptus	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GR11	Grevillia robusta	16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GR33	Grevillia robusta	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PR22	Pinus radiata	2	39	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sub-Total:		**34**										

Total forested acreage: **1,794**

Net volume summary:
Cubic foot totals by log diameter and timber type class.

Type Class	Acres	----Log minimum diameter---- 4-8"	8-12"	> 12"	Total
00	58	36,650	9,826	1,441	47,917
11	538	282,693	225,798	119,383	627,874
22	608	547,320	235,455	18,238	801,014
33	161	284,240	289,166	128,958	702,364
44	296	171,313	197,659	199,884	568,856
55	133	75,534	99,230	331,187	505,951
Total	1,794	1,397,751	1,057,135	799,090	3,253,976

HOW TO INTERPRET TYPE AND VOLUME DATA

Sapling, pole and saw timber sized trees are defined as 0-6", 6-12", and > 12" in diameter, respectively (DBH is tree diameter measured 4.5 feet above the ground). Each type class has a typical gross volume range within which most stands of that type are included. Gross volume is defined as total cubic volume from tree base to tip. Occasionally a stand within a type class may have more or less gross volume than the specified range, but its structure and composition are similar to the assigned type class.

Because field survey and sampling intensity was not high, the timber type descriptions and associated summary statistics are general. Consider Eucalyptus saligna type class ES55: Moderate volume saw timber. In the KTMA there are several ES55 stands, summing 57 acres. The volume figures in this appendix represent combined analyses of plot data measured in all ES55 stands. Volumes reported within this table follow the theoretical assumption that all trees have been felled and cut into marketable lengths. Within the 57 acres of this type class, logs with minimum small-end diameters ranging from 4-8", 8-12", and > 12" have a total net volume of 37,380 ft^3, 60,062 ft^3, and 159,590 ft^3 respectively. Net volume is equal to gross volume with the following deductions: volume below a 1' stump; volume above a 4" top; volume losses due to defect or poor form; and gross volume of all trees with DBH < 8".

NOTE: These volume and acreage data represent estimates for use in forest management planning only. The data should not be relied upon as a basis for conducting timber sales. Each timber sale will require intensive survey work within harvest units.

APPENDIX H. CHAPTER 104, RULES REGULATING ACTIVITIES WITHIN FOREST RESERVES (as of January, 2005)

Section 13-104-22 Commercial harvest permits.

(a) The board or its authorized representative may issue permits for the purpose of purchasing, harvesting, and removing forest products (e.g. timber, seedlings, greenery, tree fern, cinder, and lava rock).

(b) Permits shall be obtained from the district offices of the division during regular working hours of the department..

(c) Each application for a harvest permit shall be considered on its own merits including its effect on the premises and the public's use and enjoyment of the forest reserve.

(d) Permits will not be issued for harvesting material for direct resale.

(e) The value of the raw material to be harvested shall not exceed $1,000. The quantity to be harvested shall be decided by the board or its authorized representative.

(f) The time of entry for harvesting shall not exceed 14 days, except that the board or its authorized representative may extend this time for good cause.

(g) No more than one permit within a thirty day period or three permits within a calendar year may be issued to the same person, group, organization, or association for harvesting the same product.

(h) Each permit shall specify:

(1) The products to harvested;
(2) The amount to be harvested;
(3) The dollar value of the products;
(4) The designated area to be harvested;
(5) The date or dates the harvesting may take place; and
(6) Any other terms or conditions deemed necessary by the board or its authorized representative.

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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
Division of Forestry and Wildlife
Honolulu, Hawaii 96813

January 14, 2005

Chairperson and Members
Board of Land and Natural Resources
State of Hawaii
Honolulu, Hawaii

Land Board Members:

SUBJECT: Establishment of the Kokee Timber Management Area and Approval of the Kokee Timber Management Area Plan

Background: The Divisions of Forestry and Wildlife (DOFAW) and State Parks (SP) have jointly developed a management plan for timber resources in the Kokee area of Kauai (Exhibit A). Through this management plan, these Divisions propose the establishment of the Kokee Timber Management Area (KTMA) to add active timber management to present management goals for the subject areas, and to promote Kauai's forest industry development through sustainable management of public lands. This plan proposes three principal methods of forest management for the KTMA:

1. Sustainable commercial management of non-native timber plantation areas, where harvesting would be followed by replanting of either native or non-native species.

2. Selective harvest of non-native or invasive species in native forest areas, where harvesting would be followed by replanting of native species.

3. Harvest of native trees for the purposes of fence and roadway maintenance, hazard reduction or the salvage of dead or dying trees.

HRS Chapter 183 "Forest Reserves, Water Development, Zoning" provides the legal framework for management activities proposed in this plan. HRS Chapter 183 Section 183-1.5 subsection (5) states that the Department shall: "Devise and carry into operation, ways and means by which forests and forest reserves can, with due regard to the main objectives of title 12, be made self-supporting in whole or in part". Section 183-16.5 requires that all harvesting of trees on public lands be done in accordance with a Board approved management plan. Furthermore, Senate Resolution No. 42 was adopted by the Senate of the 22nd Legislature of the State of Hawaii in

2004, stating in part that "...Department of Land and Natural Resources and Department of Agriculture are urged to consider and incorporate the importance of economic factors and impacts in the application of laws and adoption of rules and policies concerning the conservation of forestry and agricultural resources..." Enhancing revenue generation through timber harvesting and timber management can support these legislatively mandated goals.

KTMA Description and Location: The KTMA is comprised of Puu Ka Pele Forest Reserve, Na Pali Kona Forest Reserve south of and including Milolii ridge, Waimea Canyon State Park, and Kokee State Park – an area totaling approximately 17,092 acres (Exhibit A - Table 1). Situated on the western part of the island, the KTMA is located along and adjacent to State Route 550 (Kokee Road), starting approximately 5 miles north of Waimea town (Exhibit A - Figure 1).

Next Steps: Board of Land and Natural Resources approval of the KTMA Plan would trigger the following actions:

1. Preparation of an environmental assessment and pursuit of its approval in compliance with Chapter 343, Hawaii Revised Statues (HRS).
2. Periodic solicitation of requests for proposals for harvest of KTMA timber resources.
3. Development and issuance of permits (Hawaii Administrative Rules §13-104-22 and §13-146-54) or timber land licenses for approved proposals based on the proposed scope of work.

RECOMMENDATIONS

That the Board:

1. Approve the establishment of the Kokee Timber Management Area, comprised of approximately 17,092 acres as detailed in the KTMA Plan.
2. Approve the Kokee Timber Management Area Plan and its corresponding objectives.
3. Authorize the Divisions of Forestry and Wildlife and State Parks to:
    a. Prepare an Environmental Assessment for the activities proposed in the KTMA Plan in compliance with Chapter 343, Hawaii Revised Statutes.
    b. Periodically solicit proposals for commercial forestry operations.
    c. Issue commercial harvest or special use permits for approved small-scale forestry operations.
    d. Develop timber land licenses for Board approval for large-scale forestry operations.

Respectfully submitted,

PAUL J. CONRY, Administrator
Division of Forestry and Wildlife

DANIEL S. QUINN, Administrator
Division of State Parks

Attachment: Exhibit A

APPROVED FOR SUBMITTAL:

PETER T. YOUNG, Chairperson
Board of Land and Natural Resources

Appendix D: Best Management Practices for Maintaining Water Quality in Hawai‘i

BEST MANAGEMENT PRACTICES

FOR

MAINTAINING WATER QUALITY

IN HAWAII

State of Hawaii
Department of Land and Natural Resources
Division of Forestry and Wildlife
February 1996

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FOREWORD

Best Management Practices (BMPs) are effective, practical, structural or nonstructural methods which prevent or reduce the movement of sediment, nutrients, pesticides and other pollutants from the land to surface or ground water, or which otherwise protect water quality from potential adverse effects of silvicultural activities. These practices are developed to achieve a balance between water quality protection and the production of wood crops within natural and economic limitations.

A thorough understanding of BMPs and the flexibility in their application are of vital importance in selecting BMPS which offer site specific control of potential nonpoint source pollution. With each situation encountered at various sites, there may be more than one correct BMP for reducing or controlling potential nonpoint source pollution. Care must also be taken to select BMPs that are practical and economical while maintaining both water quality and the productivity of forest land.

The Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500 (and as amended by Sec. 319, 1986), require the management of nonpoint sources of water pollution from sources including forest-related activities. BMPs have been developed to guide forest landowners, other land managers and timber harvesters toward voluntary compliance with this act. Maintenance of water quality to provide "fishable" and "swimmable" waters is central to this law's objectives. The Environmental Protection Agency (EPA) recognizes the use of BMPs as an acceptable method of reducing nonpoint source pollution.

Nonpoint source is diffuse pollution that comes from almost everywhere; it even occurs naturally to a certain extent. The amount of pollutants from any particular spot is small and insignificant, but when combined from over the landscape, can create water quality problems. **Although it is unrealistic to expect that all nonpoint source pollution can be eliminated, BMPs can be used to minimize the impact of forestry practices on water quality. These practices must be reasonable, achievable and cost effective.** The adoption and use of BMPs will provide the mechanism for attaining the following water quality goals:

* to maintain the integrity of stream courses;
* to reduce the volume of surface runoff originating from an area of forest management disturbance and running directly into surface water;
* to minimize the movement of pollutants i.e. pesticides, nutrients, petroleum products, etc. and sediment to surface and ground water;
* to stabilize exposed mineral soil areas through natural or artificial revegetation means.

The intent of this guide is to promote better stewardship of the forest resources. This guide delineates environmentally responsible land management methods which, when applied properly, minimizes adverse impacts on the forest ecosystem and maximizes landowner objectives. Unusual situations may arise or pollution control measures other than those recommended here may be found. In these cases, common sense is most often the best guide.

Information presented in this guide is not to be used as the basis for setting water quality standards or as the basis of required use of watershed protection practices. Compliance with any watershed protection practices would be on a voluntary basis backed up with a public water quality education and awareness program. Changing of water quality standards or the required use of protection practices should not be attempted without careful study of the beneficial effects gained from modifying existing silvicultural practices now in use.

INTRODUCTION

The Division of Forestry and Wildlife (DOFAW) is mandated by HRS, Chapter 183 to "...devise ways and means of protecting, extending, increasing, and utilizing the forests and forest reserves, more particularly for protecting and developing the springs, streams, and sources of water supply to increase and make that water supply available for use..."

The number one resource that is generated by the forest is water. Since the establishment of the Department of Agriculture and Forestry in 1900, the concern for the protection of forest lands for the purpose of water has been a high priority. Fencing to keep out wild cattle and other feral animals and reforestation efforts to re-establish watersheds have been the key to the continuance of the production of high quality water.

In 1961, Hawaii created, by law, the nation's first statewide zoning districts, and today approximately 95% of the Hawaii's four million acres are zoned for agricultural or conservation uses. The Conservation district, which is under the jurisdiction of the Department of Land and Natural Resources (DLNR), encompasses almost one-half of the State, of which one million acres is state-owned. The majority of Conservation lands are covered by forests, but also contain grasslands, coastlines, cliffs, offshore islets, and wetlands. Vegetative communities include lowland and montane rainforests and unique examples of tropical biodiversity, much of it endangered.

The Division of Forestry and Wildlife recognizes the need for responsible stewardship of the natural resources, which include soil and water. **The success of BMPs to protect water quality within Hawaii depends on mutual cooperation and trust among landowners, industry, environmentalists, wood producers, regulatory agencies, governmental officials, and the general public.** All have an interest in good land management as it relates to water quality.

THE FOREST/WATER RELATIONSHIP

The forest and water resources are mutually dependent upon one another. Forests depend on water, namely rain, surface water, and groundwater for their growth and reproduction. Major long-term changes in the water supply can cause permanent changes in the content, quality and vitality of forest lands.

On the other hand, surface and groundwater quantity and quality are largely influenced by the surface on which rain falls and through which it percolates. The tremendous filtering capacity of forest lands provide effective and high quality groundwater recharge.

Hawaii's streams and aquifers all benefit from the presence of forests. In addition to these water quality benefits, forests provide needed wood and fiber products, wildlife habitat, aquatic resources and habitat, recreation values and aesthetic benefits. It is in managing forests for these benefits that damage to the water resource can result. Following is a brief discussion of the most commonly used forest management practices and the impacts they can have on the quality of the water resource.

Timber Harvesting

The removal of trees from a site has little impact on water quality, as long as the trees do not provide vital shade to streams and as long as the slope of the land is not excessive. The natural warmth of many streams can be exaggerated by removing shading vegetation from their banks. Increased water temperature promotes lower dissolved oxygen levels, placing stress on fish and other aquatic organisms.

Removing timber per se does not directly cause significant water quality changes, since ground cover is not excessively disturbed during proper logging operations. On steep slopes, however, careless timber removal can increase the likelihood of runoff and soil loss. This may lead to water quality degradation as well as a loss of site productivity. Steep areas should therefore be logged carefully using proper harvesting techniques for the sake of both water quality protection and site protection.

Road Construction and Drainage Techniques

All facets and phases of a sound forest management program rely heavily on accessibility to the forest. Consequently, temporary and permanent access roads are necessary components of all management programs. They are also one of the most costly investments made in a forests.

Temporary access roads are constructed to facilitate harvesting operations, site preparation and planting and often abandoned after the new stand is established. When abandoned, these temporary roads are normally allowed to revegetate naturally or are planted with trees.

Pollutants from Silvicultural Activities

The major types of water pollutants that can be generated from forest management disturbances to the forest ecosystem include sediment, nutrients, pesticides, and debris.

1) Sediment

Sediment is the most common pollutant resulting from silvicultural activities. Sediment principally results from erosion of soil, but may also include organic matter. Excessive sediment upsets balanced ecology within streams by smothering bottom dwelling organisms in the water, interfering with photosynthesis by reducing light penetration, serving as carriers of nutrients and pesticides, inhibiting fish reproduction and altering stream flow.

2) Nutrients

Nutrients, primarily phosphorous and nitrogen fertilizers, are sometimes applied to the forest to stimulate tree growth. Soluble nutrients may reach surface or ground water through runoff, seepage, and percolation. Insoluble forms may be absorbed on soil particles and reach water by direct wash-off of debris and recently applied fertilizer. Excessive nutrients lead to an imbalance in natural life cycles of water bodies.

3) Pesticides

Pesticides, if applied during silvicultural activities, may be soluble or insoluble. Pesticides in surface or ground water may result in toxicity problems, affecting water quality and food sources for aquatic life.

4) Debris

Tree limbs, tree tops, and other waste materials are the principal organic pollutants from silviculture. They reach streams through direct pushing or felling into water drainages, and washout during storms. Organic materials may place an oxygen demand on the receiving water body during the decomposition process. In addition, associated problems may include odor, color, taste and nutrients. Inorganic material such as oil cans and pop bottles are also considered nonpoint source debris.

BEST MANAGEMENT PRACTICES

1.0 Forest Roads

Standards and Use

Forest roads are managed to provide adequate access to lands for timber management, fire suppression, wildlife habitat improvement and a variety of dispersed and developed recreational activities. Generally, these are low volume roads that must carry heavy loads for short periods of time. The potential for adverse impacts from forest roads exists in areas where steep slopes, erodible soils, or where forest roads are located near water. **Forest roads cause more erosion than any other forestry activity.** Most of this erosion can be prevented by locating, constructing, and maintaining roads to minimize soil movement and pollution of streams. The need for higher standard roads can be alleviated through better road-use management. Design roads to the minimum standard necessary to accommodate anticipated use and equipment.

Planning, Design, and Location

A well planned access system is a sound method of reducing erosion and sedimentation in areas requiring frequent or temporary access. Proper location and construction of roads will provide for safety, longer operating periods, lower maintenance and operating costs, and minimal impacts to water quality. The value of the resource served and site characteristics will influence the choice of road construction standards and maintenance activities. The following practices are recommended:

(1) Use a design to minimize damage to soil and water quality.

(2) Roads should be designed no wider than necessary to accommodate the immediate anticipated use.

(3) Design cut and fill slopes to minimize mass soil movement.

(4) Provide culverts, dips, water bars, and cross drainages to minimize road bed erosion.

(5) Design bridge and culvert installations using stream flow data, with a margin of safety proportional to the importance of the road and the protected resources.

(6) Provide drainage where surface and groundwater cause slope instability.

(7) Avoid diverting water from natural drainage ways. Dips, water bars, and cross drainage culverts should be placed above stream crossings so that water can be filtered through vegetative buffers before entering streams.

(8) Locate roads to fit the topography and minimize alterations to the natural features.

(9) Avoid marshes and wetlands.

(10) Minimize the number of stream crossings.

(11) Cross streams at right angles to the stream channel.

(12) A road may not be located in a Streamside Management Zone (SMZ) except where access is needed to a water crossing, or where there is no feasible alternative. A road in any SMZ must be designed and located to minimize adverse effects on fish habitat and water quality.

Construction

Once the road's location and design is staked out, road construction begins. Timber is out, logs and vegetation are removed and piled along the lower side of the right-of-way.

Most forest roads are built by excavating a road surface. Road design and layout on-the-ground show machine operators the proper cut slopes and indicate cut slope steepness. The bulldozer starts at the top of the cut slope, excavating and sidecasting material until the desired road grade and width is obtained. Material from cuts is often pushed in front of the blade to areas where fill is needed. Road fill is used to cover culverts and build up flat areas. Since fill must support traffic, it needs to be spread and compacted in layers to develop strength. The following practices are recommended:

(1) Construct roads when moisture and soil conditions are not likely to result in excessive erosion or soil movement.

(2) The boundaries of all SMZs shall be defined on the ground prior to the beginning of any earth-moving activity.

(3) Construct a road sufficient to carry the anticipated traffic load with reasonable safety and with minimum environmental impact.

(4) When using existing roads, reconstruct only to the extent necessary to provide adequate drainage and safety.

(5) Avoid construction during wet periods, when possible, to minimize unnecessary soil disturbance and compaction.

(6) Road grades should be kept at less than 10%, except where terrain requires short, steep grades.

(7) Minimize the number of stream crossings. Stream crossing construction should minimize disturbance of the area in which the crossing is being constructed.

(8) As slope increases, additional diversion ditches should be constructed to reduce the damages caused by soil erosion; ditches, adequate culverts, cross drains, etc., should be installed concurrent with construction.

(9) To control erosion, cut and fill slopes should conform to a design appropriate for the particular soil type and topography.

(10) Stumps, logs, and slash should be disposed of outside of the road prism; in no cases should they be covered with fill material and incorporated into road beds.

(11) Stabilize the side banks of a road during construction to aid in the control of erosion and road deterioration; this may require mesh or other stabilizing material in addition to planting and/or seeding and other structural measures.

(12) Water bars should be located to take advantage of existing wing ditches and cross drainage. Water bars should be constructed at an angle of 30 to 45 degrees to the road. Water bars should be periodically inspected and damage or breeches should be promptly corrected. Install water bars at recommended intervals to provide the drainage. Water bar spacing recommendations are as follows:

Grade of Road	Distance Between Water bars
2%	250 ft.
5%	135 ft.
10%	80 ft.
15%	60 ft.
20%	45 ft.
25%	40 ft.
30%	35 ft.
40%	30 ft.

Water bars may need to be spaced closer together depending on soil type and rainfall.

(13) Bridges and overflow culverts should be constructed to minimize changes in natural stream beds during high water.

(14) Culverts on perennial streams should be installed low enough to allow passage of aquatic life during low water.

Maintenance

Maintenance of active and inactive roads shall be sufficient to maintain a stable surface, keep the drainage system operating, and protect the quality of streams. The following are recommended:

(1) Maintenance should include cleaning dips and crossdrains, repairing ditches, marking culverts inlets to aid in location, and clearing debris from culverts.

(2) Keep culverts, flumes, and ditches functional before and during the rainy season to diminish danger of clogging and the possibility of washouts. This can be done by clearing away any sediment or vegetation that could cause a problem. Provide for practical and scheduled preventative maintenance programs for high risk sites that will address the problems associated with high intensity rainfall events.

(3) Conduct road surface maintenance as necessary to minimize erosion of the surface and subgrade.

(4) During operations, keep the road surface crowned or outsloped, and keep the downhill side of the road free from berms except those intentionally constructed for protection of fill.

(5) Avoid using roads during wet periods if such use would likely damage the road drainage features.

(6) Water bars should be inspected after major rain storms and damage or breeches should be promptly corrected.

Harvesting - Temporary Access Roads and Landings

(1) The location of temporary access roads (logging roads) should be planned before operations begin.

(2) Road construction should be kept to a minimum.

(3) Landings should be located to minimize the adverse impact of skidding on the natural drainage pattern.

(4) Logging roads and landings should be located on firm ground.

(5) Landings should be kept as small an area as possible.

(6) When operations are completed, provisions should be made to divert water run-off from the landings and roads.

2.0 Pre-Harvest Planning

Pre-harvest planning is the collection of information about the area to be harvested and the synthesis of that information into an effective environmental plan. This plan will consider the silvicultural prescription for the species and site, the best estimate of the time and method of harvest and any post-harvest site preparation and reforestation activities.

At this stage, it is assumed that all federal, state, and local government regulations regarding harvesting have been met.

An effective pre-harvest plan will take into consideration all aspects of the timber harvest which may lead to water quality degradation and plan for the implementation of BMPs which will minimize or avoid the adverse effects of the operation. The objective of pre-harvest planning from the perspective of non-point source pollution is to determine which BMPs are necessary to protect water quality and how those BMPs will be implemented. The following is recommended:

(1) A pre-harvest plan should include the following information:

A. Physical and administrative description

1. Property boundaries & administrative boundaries (zoning, etc.)
2. Topography
3. Location of streams and drainages
4. Location of SMZs and buffer strips
5. Forest types
6. Soil types
7. Areas of ecological and/or archaeological concerns

B. Management Activities

1. Design and construction techniques for all new roads, skid trails, and landings or modification of existing roads, skid trails and landings.
2. Felling and bucking techniques
3. Yarding systems and layout
4. Planned stream crossings
5. Disposal of waste materials (machine lubricants)
6. Post-harvest site preparation
7. Reforestation activities

(2) The use of topographic maps, road maps, aerial photos, forest type maps, and soil surveys in combination with field reconnaissance is essential to determine site conditions and plan operations.

(3) Field reconnaissance with a trained forester or one who is knowledgeable about the specific area is highly recommended.

(4) Preliminary planning should consider the maintenance of existing drainage patterns and the location of environmentally sensitive areas such as streams, wet areas, and high erosion hazard areas.

(5) The design of roads, skid trails, and landings shall be integrated to minimize their impact.

(6) The grade of logging roads and skid trails should be less than 10% when possible, with 3-5% being the norm. Long, straight, unbroken grades are to be avoided. Adequate surface drainage shall be provided.

(7) Time the harvesting activity for the season or moisture conditions when the least impact occurs.

(8) A final pre-harvest site review shall be conducted by management so that road alignments and other considerations can be visually checked prior to road construction. The reconnaissance plan shall be modified as necessary to make desirable adjustments based on the final site review.

2.1 Timber Harvesting

Standards and use

Timber harvesting is an integral part of most forest management programs. Harvesting operations cause a temporary disturbance in the forest as well as diminish water quality. However, it can be conducted in a manner where the impact to water quality is minimized and the re-establishment of vegetative cover is realized. Guidelines to help reduce the potential for nonpoint source pollution from harvesting trees are as follows:

Felling and Bucking

(1) Careful felling can minimize the impact of subsequent phases of the logging operation.

(2) Trees should not be felled into streams, except where no safe alternative exists. In the latter case, such trees should be removed promptly.

Skidding

(1) Skidding should be done so as to avoid disrupting natural drainage and to prevent excessive soil displacement.

(2) Stream channels or road ditches should not be used as skid trails.

(3) Skid trails on steep slopes should have occasional water bars.

(4) Servicing of equipment involving fuel, lubricants, or coolants should be performed in places where these materials cannot enter streams. Spent oil should be collected for proper disposal, never poured on the ground.

(5) Upon completion of logging, erosion-prone areas should be mulched or seeded.

Mechanical Site Preparation

(1) Avoid excessive soil compaction.

(2) Minimize erosion and the movement of sediment into waters.

(3) Prevent accumulation of debris in ponds, streams, or rivers.

(4) Windrows, disking, bedding, and planting with "furrow" type mechanical planters should follow contours.

(5) Avoid complete disking of steep slopes with extremely erodible soil.

(6) Plant trees on contour.

Disposal of Debris and Litter

(1) Logging debris in streams should be removed immediately.

(2) Debris from landings should not be pushed into drains, streams or Streamside Management Zones (SMZs)

(3) All trash associated with the logging operation should be promptly removed (not buried) and hauled to a legal disposal site.

3.0 Silvicultural Chemical Management

Description and Purpose

Pesticides are used on forest lands to facilitate meeting forest management objectives. The purpose of a pesticide application is to rid an area of undesirable vegetation or control insects or diseases to promote the establishment, survival, growth or maintenance of a desired species or condition.

Planning Considerations

Planning is an essential first step in reducing pest problems. A plan is needed by which the application of pesticides is utilized in an efficient manner that produces no adverse impacts on the environment. The maintenance of water quality is an important consideration in all aspects of pesticide operation planning.

Pesticide Selection

When the decision is made to use pesticides, choose products suitable for use on the target species and registered for the intended uses. Use only pesticides registered by the Environmental Protection Agency. Prior to using any pesticide, carefully read and follow all label directions.

When selecting pesticide options, more than effectiveness and cost should be evaluated. Consideration should be given to site factors, application conditions and techniques and products that can influence impacts to water quality.

Three main characteristics can greatly affect a pesticide potential to contaminate surface or ground water. They are solubility, absorption and breakdown rate.

1) Solubility

Solubility is the ability of a pesticide to dissolve in water. The greater the solubility, the greater the chance that the chemical will leach to ground water.

2) Absorption

Absorption is the inherent ability of a pesticide to bind with soil. Some pesticides stick very tightly to soil while others are easily dislodged. A greater absorption means a pesticide will remain longer in the soil and thus be less likely to leach down into the ground water before it has degraded. Absorption increases as soil organic matter increases.

3) Breakdown Rate

Breakdown rate or half-life is the time a pesticide takes to degrade or breakdown into other chemical forms. Pesticides that do not break down quickly can be hazardous if they move to ground water or surface water.

In a given situation, pesticides with the highest water solubilities, greatest persistence, lowest affinities for absorption to organic matter and other soil components, and highest application rates have the greatest potential for movement in surface water or to ground water. An alternative means of minimizing the potential movement of a pesticide is to select a non-broadcast application

technique for the same pesticide that reduces the amount of the chemical applied directly to the soil.

Procedures for Chemical Use

Proper pesticide management practices make efficient use of chemical while preventing contamination of surface water or ground water. Residues of pesticides used in forestry can affect water quality at several phases of the chemical use cycle. These phases are: 1) transportation, 2) storage, 3) mixing and loading, 4) application, and 5) cleanup and disposal. To minimize potential impacts on water quality, use of the following practices is encouraged.

A) Transportation

(1) Inspect all containers prior to loading and ensure all caps, plugs and bungs are tightened.

(2) Handle containers carefully when loading them onto vehicles.

(3) Secure containers properly to prevent shifting during transport.

(4) Check containers periodically enroute.

(5) Limit access to containers during transport to prevent tampering.

(6) Educate and inform the driver of the proper transportation precautions.

(7) Never transport pesticides unless arrangements have been made to receive and store them properly.

B) Storage

(1) Chemicals should be managed and stored in accordance with all applicable federal, state, or local regulations. These would include:

(a) The EPA container registration label, as printed on the label;

(b) Label instruction for use as provided by the manufacturer;

(c) Requirements or the use, application, and registration of pesticides;

(d) Requirements relating to the licensing of applicators.

(2) All containers should be labeled in accordance with applicable federal, state and local regulations.

(3) Apply pesticides under favorable weather conditions. Never apply a pesticide when there is a likelihood of significant drift.

(4) Always use pesticides in accordance with label instruction, and adhere to all Federal and State policies and regulations governing pesticide use.

E) Cleanup and Disposal

(1) Before disposal, containers should be rinsed as described in equipment cleanup.

(2) Cleanup should be in a location where chemicals will not enter any stream, pond, or where stream pollution might occur.

(3) Rinse empty pesticide containers and mixing apparatus as many times as needed. This flushing should be applied in spray form to the treated area, NOT into the ground near streams.

(4) Dispose of pesticide wastes and containers according to federal and state laws. Some pesticide wastes are specifically identified as hazardous wastes by law and must be handled and disposed of in accordance with hazardous waste regulations. For more information about proper management of waste pesticides, contact the Department of Health, Environmental Health Administration.

Other chemicals

Improper storage and handling of oil products and fuel can be a water quality hazard. Improper disposal of oil or fuel can contaminate ground water and seep into streams. The following are recommended:

(1) Locate facilities away from streams and be prepared to clean up spills.

(2) Know and comply with regulations governing the storage, handling, application (including licensing of applicators), and disposal of hazardous substances.

(3) Do not transport, handle, store, load, apply or dispose of any hazardous substance or fertilizer in such a manner as to pollute water supplies or cause damage or injury to land, including humans, desirable plants and animals.

(4) Do not store, mix, or rinse hazardous substances or fertilizers within the streamside management zone or where they might enter streams or waterways.

(5) Develop a contingency plan for hazardous substance spills, including cleanup procedures.

(6) Report all spills to the Department of Health, Environmental Health Administration.

4.0 Streamside Management Zone (SMZ)

The Special Management Zone (SMZ) is a specific area associated with a stream, lake, wetland or other waterbody that is designated and maintained during silviculture operations. The purpose of the SMZ is to protect water quality by reducing or eliminating forestry related ouputs, i.e. sediment, nutrients, logging debris, chemicals, and water temperature fluctuations that can adversely affect aquatic communities. SMZs provide shade, streambank stability and erosion control, as well as detritus and woody debris which benefit the aquatic ecosystem in general. In addition, the SMZ is designed to maintain certain forest attributes that will provide specific wildlife habitat values. Snags, den and cavity trees as well as mast producing trees, left in the SMZ, are necessary to meet habitat requirements for certain wildlife.

The SMZ has specific criteria, that defines operational restrictions and special management objectives. In addition, the SMZ has a specific width which is based on the size and type of waterbody involved.

A Streamside Management Zone (SMZ) is an area covered with vegetation or ground cover on both sides of perennial, intermittent streams and other bodies of open water, where extra precaution is used in carrying out forest management practices. The SMZ also provides shade and functions as a buffer when fertilizers, pesticides, etc. are applied to adjacent lands. For practical purposes, an SMZ must be wide enough to protect water quality and stream characteristics. Precaution is needed in carrying out forest management practices in order to protect bank edges and water quality. Determining the necessary width involves in part a judgement factor based on reliable local experience.

SMZs should be used where: 1) water quality is impaired and adjacent land use contributes to that degradation, 2) good water quality exists and protection against potential future impairment is desired, 3) streambank erosion is a concern, 4) wildlife habitat enhancement is desired, and/or 5) silviculture practices are to be implemented, and 6) the lower edge of cropland, grassland, or forest land is adjacent to permanent or intermittent streams, or border streams, rivers, ponds or intermittent or permanently flooded, open-water wetlands.

SMZ benefits include the following:

(1) Shade - Trees within the SMZs provide shade to maintain cool water temperatures which aid in the spawing of fish. Without trees and overhanging shrubs, stream temperatures would increase during the summer. Some fish species and aquatic organisms would then be unable to live in the streams. In the summer, water from shaded streams eventually flows into larger bodies of water and helps maintain its fish and aquatic life by keeping these waters cool all the way downstream.

(2) Food - Leaves and insects drop into streams from overhanging trees and shrubs. In fact, 90% of the food in the forested streams comes from bordering vegetation.

(3) Protection of Streambanks - Many streambanks are stabilized by streambank trees. They anchor banks and prevent erosion during periods of high water. Removing trees and shrubs and substituting shallow rooted grasses can lead to streambank collapse and stream sediment. Bank overhang is created by stream flows undercutting the stream bank and tree roots. Fish can rest, hide from predators, and feed in these protected areas.

(4) Flooding - Healthy SMZs stabilize floodplains. During times of high water, SMZs reduce the velocity of floodwaters. Their dense vegetation and deep humus slow down racing waters. Forest floodplains suffer less damage when SMZs are protected during harvesting activities.

(5) Recreation - The recreational activities that we enjoy in and around streams are many. This includes swimming, fishing, camping, hunting, and backpacking to name a few.

(6) Timber Production - For those who grow and harvest trees, the fact is that trees often grow best in SMZs. Trees respond to those deep, fertile, and moist soils. Logging activities should not be eliminated within SMZs but modified to insure that stream channels and banks are protected from disturbance. SMZs are not timber harvest "keep out" zones, but there are locations where timber harvesting activities must be modified to protect the many benefits mentioned above.

Recommendations

SMZs should be maintained along all perennial streams or where forest disturbances occur and surface runoff will carry sediment loads. SMZs should be maintained around streams, ponds, perennial flowing natural springs, and all springs and reservoirs serving as domestic water supplies. The following best management practices are recommended:

(1) The width of SMZs should be determined depending on the following conditions: slope of land adjacent to stream, soil erodibility, precipitation, knowledge of particular area, sensitivity of stream, etc. These factors can be obtained from soil maps, on-the-ground evaluation and measurements, weather data, etc.

(2) SMZs should be designed on a case-by-case basis. Most important is that SMZs be consistent with stream characteristics and wide enough to protect water quality.

Soil Type	Percent Slope	SMZ Width (each side)
Slightly erodible	0-5	35'
Slightly erodible	5-20	35-50'
Slightly erodible	20+	50-160'
Erodible	0-5	35-50'
Erodible	5-20	80' minimum
Erodible	20+	160' minimum

Table 1. Recommended Widths for Streamside Management Zone

[NOTE: Please contact your local Natural Resources Conservation Service office to determine the erodibility factor of the soil before determining the proper width of the SMZ.]

(3) On relatively flat terrain (0-5%) on slightly erodible soils, the width of an SMZ should be at least 35 feet wide on each side of a stream.

(4) On relative flat terrain (0-5%) on erodible soils, the SMZ width should range between 35 to 50 feet on each side of a stream.

(5) On slightly erodible soils with slopes ranging between 5 and 20 percent, the SMZ width should range between 35 to 50 feet wide on each side of a stream.

(6) On erodible soils with slopes ranging between 5 and 20 percent, the SMZ width should range between 50 to 160 feet on each side of a stream.

(7) On slightly erodible soils with slopes exceeding 20 percent, the SMZ width should be at least 80 feet on each side of a stream.

(8) On erodible soils with slopes exceeding 20 percent, the SMZ width should be a minimum of 160 feet on each side of a stream.

(9) Partial harvesting is acceptable. A minimum of 50% of the original crown cover or 50 square feet of basal area per acre, evenly distributed, should be retained in the SMZ. This may be adjusted to meet on-site conditions.

(10) Clearcutting is always prohibited within the SMZ.

(11) Designate SMZs to provide stream shading, soil stabilization, sediment and water filtering effects, and wildlife habitat.

(12) Strive to protect the forest floor and understory vegetation from unnecessary damage. Do not remove (harvest) trees from banks, beds or slopes if it will destablilize the soil. Trees on the south and west banks provide the most critical shading of water.

(13) Access roads should cross perennial or intermittent streams at or near a right angle.

(14) Drainage structures such as ditches, cross drain culverts, water bars, rolling dips, and broad-based dips should be used on all roads prior to their entrance into an SMZ to intercept and properly discharge runoff waters.

(15) SMZs may be desirable on intermittent streams for large drainage areas where wildlife is a major landowner concern or for other reasons.

5.0 Fencing

(1) Fencing out livestock, pigs, and other animals in certain areas will help to prevent water quality degradation of streams, protect threatened and endangered plants, reduce soil compaction and maintain soil productivity. Fencing is applicable where desired forest reproduction, soil hydrologic values, existing vegetation, aesthetic values, and recreation are prevented or damaged by these animals.

(2) Pastures should be fenced separately from woodlands. Consider maintenance as well as ease of construction when planning a fence location. By taking advantage of natural barriers such as cliffs, the cost of animal exclusion can be reduced. Also consider use of fences to protect vegetation that provides wildlife food and cover.

(3) Fences should be permanent stock fences built in accordance with good construction principles and workmanship.

6.0 Wildfire Damage Control and Reclamation/Prescribed Burn

The prevention, control, and extinguishment of all wildfires on grass, brush, and watershed lands and the implementation of a prescribed fire program is a desirable goal. Where wildfires do occur, the first and foremost concern is to control the fire and limit the damage. Fire suppression activities can add to the problem of water quality protection.

The loss of vegetative cover, destruction of soil-holding feature of root masses, the exposure of bare mineral soil, is a combination that makes the area burned a highly erodible one. The effects of suppression efforts and equipment operations necessary to control and stop the fire can magnify the erosion problem.

The following are best management practices for wildfire control and reclamation:

(1) The first and foremost concern in wildfire control is to prevent harm or damage to people and property. Fireline best management practices should incorporate minimum impact strategies, which meet land and resource management objectives;

(2) Areas with bare mineral soils should be revegetated and areas where vegetative cover has been killed or severely degraded should be regenerated with plant species appropriate for the soil conditions;

(3) First priority for revegetation/reforestation should be given to banks of surface water bodies so that the SMZ is reestablished;

(4) Firelines should be stabilized and, if necessary, revegetated. Erodible areas altered by suppression equipment activities should be repaired and revegetated as necessary;

(5) Access road surfaces should be repaired and stabilized as necessary.

(6) Whenever possible, avoid using fire suppression chemicals over watercourses and prevent their runoff into watercourses. Do not clean application equipment in watercourses or locations that drain into watercourses.

(7) Provide advance planning and training for firefighters that considers water quality impacts when fighting wildfires. This can include increasing awareness so direct application of fire suppression chemicals to waterbodies is avoided and firelines are appropriately placed.

(8) Include rehabilitative practices as part of suppression and post-suppression tactics and strategies to mitigate non-point source pollution.

6.1 Fireline Construction and Maintenance

Fireline construction and maintenance is an essential part of forest and other land management activities. It deals with site preparation burning, prescribed burning, and wildfire defense and control. A number of control practices can be implemented during fireline construction to prevent unnecessary erosion. Periodic inspection and proper maintenance can prevent potential erosion on established firelanes. The following are best management practices for fireline construction and maintenance:

(1) Firelines should be constructed on the perimeter of the burn area and along the boundary of the Streamside Management Zone. The purpose of protecting the Streamside Management Zone from fire is to safeguard the filtering effects of the litter and organic matter;

(2) Firelines should follow the guidelines established for logging trails and skid trails with respect to waterbars and wing ditches, and should be only as wide and as deep needed to permit safe prescribed burns or fire suppression needs;

(3) Firelines which would cross a drainage should be turned parallel to the stream or have a wing ditch or other structure allowing runoff in the line to be dispersed rather than channeled directly into the stream.

(4) All firelines should be assessed after the fire is controlled for appropriate stabilization, and if necessary, proper rehabilitation should be done while equipment and people are in place.

6.2 Prescribed Burn

(1) Intense prescribed fire for site preparation shall be conducted only if it achieves desired results with minimum impacts to water quality.

(2) Burning on steep slopes or highly erodible soils should be conducted when they are absolutely necessary and should follow carefully planned prescriptions.

(3) Carefully plan burning to adhere to time of year, weather, topography, and fuel conditions that will help achieve the desired results and minimize impacts on water quality. With proper planning, prescribed fires should not cause excessive sedimentation due to the combined effect of removal of canopy species and the loss of soil-binding ability of the subcanopy and herbaceous vegetation roots, in streamside vegetation, small ephemeral drainages, or on very steep slopes.

(4) Site preparation burning creates the potential for soil movement. Burning in the SMZ reduces the filtering capacity of the litter. All efforts should be made to plan burns to minimize impacts on the SMZ.

(5) All bladed firelines, for prescribed fire and wildfire activities, should be built so as to minimize erosion. If necessary, the firelines should be stabilized with water bars and/or other appropriate techniques to control excessive sedimentation or erosion of the fireline. Include any erosion control practices in the construction of firelines.

7.0 Reforestation

Reforestation refers to those operations undertaken to establish a new forest. Site preparation, for the purpose of forest regeneration, is a basic silvicultural tool where for competing vegetation and

reduction of logging debris are necessary. Common site preparation techniques include, manual, mechanical, fire, and herbicides.

Regeneration includes hand and machine planting and direct seeding. Since hand planting and direct seeding pose no water quality problems, BMPs are not necessary. Some mineral soil exposure does occur with machine planting and BMPs are offered.

1) Sites should receive the minimum preparation necessary to successfully control competing vegetation and establish a desirable timber stand. In general, the more intensive the treatment, the more concern for water quality.

2) When working on slopes, mechanical operations such as ripping, shearing, etc., should follow contours.

3) Hand planting, direct seeding or natural regeneration should be used on protected areas adjacent to streams or on slopes too steep to machine plant.

APPENDICES

1. Definition of Terms
2. Road Construction Applications
3. Streamside Management Zone
4. Available Assistance
5. Suggested Readings

definition of terms

DEFINITION of TERMS:

Best Management Practices -- effective, practical, structural or nonstructural methods which prevent or reduce the movement of sediment, nutrients, pesticides and other pollutants from the land to surface or ground water, or which otherwise protect water quality from potential adverse effects of silvicultural activities. These practices are developed to achieve a balance between water quality protection and the production of wood crops within natural and economic limitations.

Bucking -- to saw felled trees into predetermined lengths.

Clearcutting -- the removal of all standing trees within a designated area.

Cross drain -- a cross ditch used to move water from one side of the road to the other side to prevent accumulation of runoff without the need of a culvert or bridge.

Culvert -- a conduit through which surface water can flow under roads.

Diversion ditch - a ditch built across the top of a slope to divert surface water from that slope.

Felling -- the process of severing trees from stumps.

Firebreaks -- naturally occurring or man-made barriers preventing the spread of fire.

Fireline construction -- the construction of a barrier used to prevent the spread of fire.

Intermittent streams -- streams that provide water flow continuously during some seasons of the year but little or no flow during the remainder of the year.

Landing -- an area in the field where logs are collected.

Non-point source -- a source of water pollution which are induced by natural processes, including precipitation, seepage, percolation, and runoff; and not traceable to any discrete or identifiable source.

Perennial streams -- streams which provides water flow at all times except during extreme drought.

Pesticides -- any herbicide, insecticide, or rodenticide, but does not include non-toxic repellents or other chemicals.

Pre-commercial thinning - the removal of selected trees within an established forest destined for commercial use.

Prescribed burning -- the controlled application of fire as a management tool in forest management.

Reforestation -- the successful reestablishment of tree species following harvest.

Silvicultural practices -- all forest management practices, including the establishment, composition, constitution, and growth of forests.

Site preparation -- the removal of unwanted vegetation and other material prior to reforestation.

Skid trails -- routes over which logs are moved to a landing or road.

Streamside Management Zone -- an area on each side of the banks and above the head of intermittent streams, perennial streams, and other drains or bodies of water where extra precaution in carrying out best management practices is needed to protect bank edges and water quality.

Waterbar -- a cross drainage diversion ditch and/or hump in a trail or road for the purpose of diverting surface water runoff into roadside vegetation, duff, ditch, or dispersion area to minimize the volume and velocity which can cause soil movement and erosion.

Wetlands -- geographic areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support (and under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions.

Wing ditch -- a water turnout or diversion ditch constructed to move and disperse water away from the road and side ditches into adjacent undisturbed areas so that the volume and velocity of water is reduce on slopes.

Yarding -- the method of log transport from the harvest area to the storage area.

BROAD BASED DIPS

Definition:

A dip and reverse slope in a truck road surface with an outslope in the dip for natural cross drainage.

Purpose:

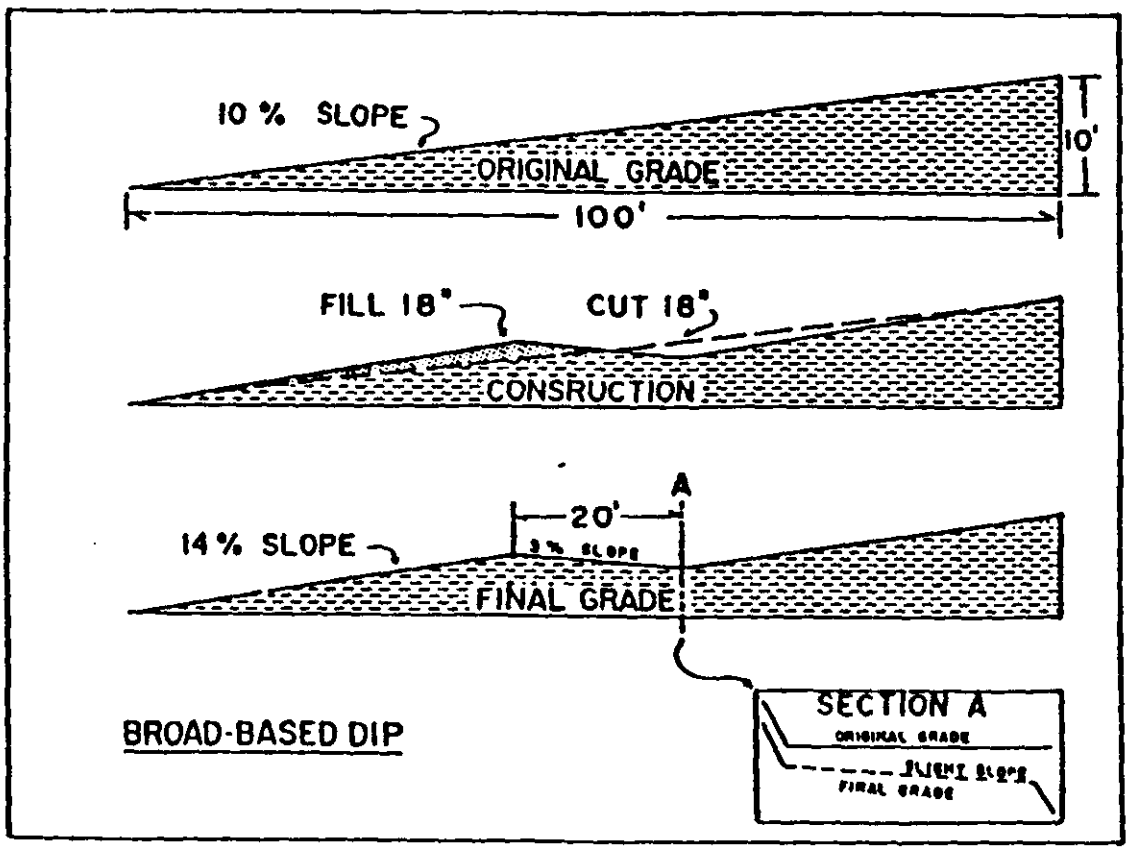
To provide cross drainage on insloped truck roads to prevent build-up of excessive surface runoff and subsequent erosion.

Conditions Where Practice Applies:

Use on truck roads and heavily used skid trails having a gradient of 10% or less. May be substituted for other cross drainage structures where no intermittent or permanent streams are present.

Guidelines:

* Proper construction requires an experienced bulldozer operator.
* Installed after the basic roadbed has been constructed and before major hauling use.



- On grades steeper than 8%, surface dips with stone (approx. 3" diameter) or gravel.
- Use dips on approaches to steep declines in heavily used skid trails.
- Discharge area should be protected with stone, grass sod, heavy litter cover or slash and logs to reduce the velocity and filter the water.

SPACING FOR BROAD BASED DIPS

Road Grade (percent)	Spacing Between Dips (feet)
2	300
4	200
6	165
8	150
10	140
12	130

WATER BARS

Definition:

An earthen or reinforced berm constructed across a truck road or skid trail.

Purpose:

To intercept and divert water from side ditches and truck road or skid trail surfaces, therefore minimizing erosion by decreasing the slope length of surface water flow.

Conditions Where Practice Applies:

Utilized on any sloping truck road or skid trail where surface water runoff may cause erosion.

Guidelines:

* Start placement of water bars at the farthest skid trail and work back to the log landing and then to the truck road.
* Install water bars with a skidder blade, dozer blade, or by hand.
* Install water bars at the top of any sloping road or trail and at proper spacing along steep sections.

* Water bars may be shallow or deep depending on the need.

* Soil should be left along the lower side of the water bar.

* Should be constructed at a 30° - 35° angle downslope from a line perpendicular to the direction of the truck road or skid trail.

* Should drain at a 3% outslope onto undisturbed litter or vegetation.

* The uphill end of the water bar should extend beyond the side ditch line of the road or trail to fully intercept any water flow.

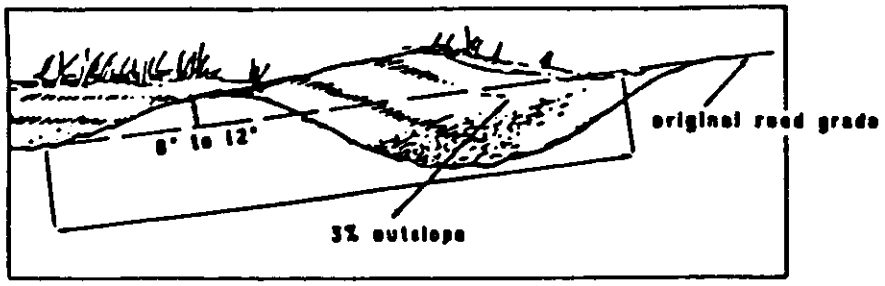
* The downhill end of the water bar should be fully open and extended far enough beyond the edge of the road or trail to disperse runoff water onto undisturbed forest floor.

* Place rocks, slash, or logs to disperse water coming from a water bar.

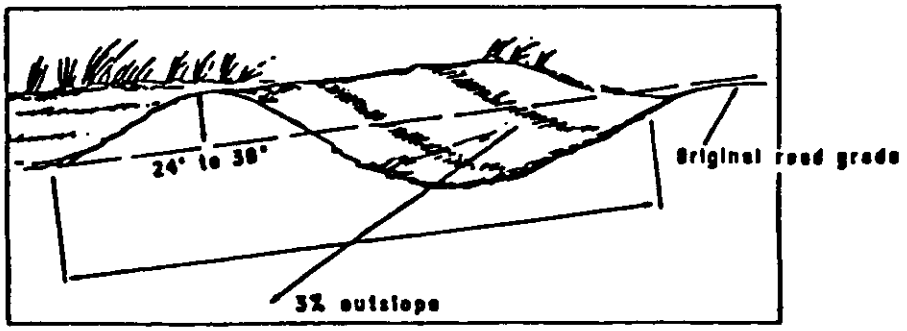
* If the road or trail is to be kept open after the harvesting operation, the following guidelines should be used in order to preserve effective water bars.

  - Reinforce the water bars
  - Keep travel to a minimum
  - Use only in dry weather
  - Make frequent inspections
  - Maintain as needed

SHALLOW WATER BAR



DEEP WATER BAR



SPACING FOR WATER BARS

Road/Trail Grade (percent)	Spacing Between Water Bars (feet)
2	250
5	135
10	80
15	60
20	45
30	35

CROSS DRAINAGE CULVERTS

Definition:

Corrugated pipe, well casing, dredge pipe, or other suitable material placed under a truck haul road or major skid road to transmit ditch runoff and seeps from a drainage area of less than 10 acres.

Purpose:

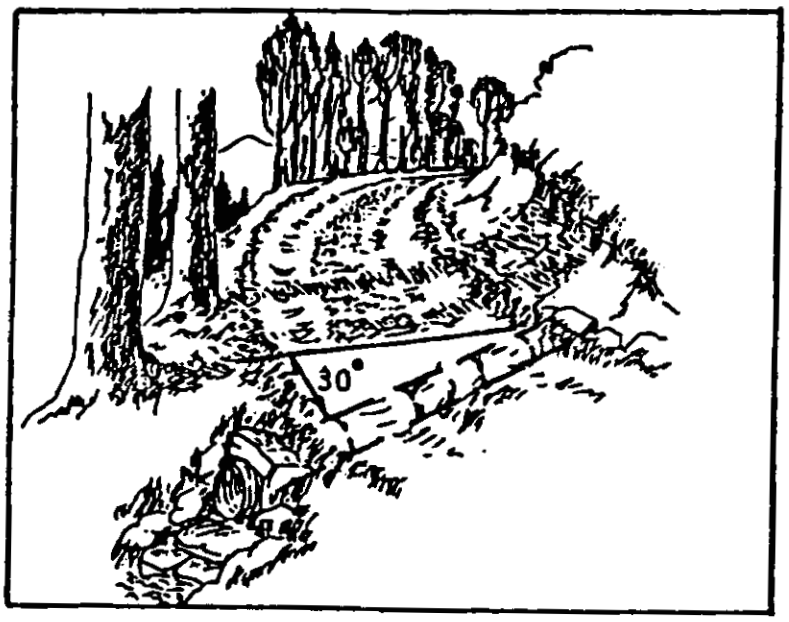
To collect and transmit water flows from side ditches and seeps, under truck haul roads and major skid trails safely without eroding a drainage system or road surface.

Conditions Where Practice Applies:

For any size operation where cross drainage of storm water is required temporarily or permanently.

Guidelines:

* This is the most expensive method of road cross drainage and should be used where heavy road use is anticipated during and after the harvesting operation.



* When sizing culverts for temporary roads, allow for periods of high flow, such as spring runoff or cloudbursts.

* The minimum size culvert to be installed is 12 inch diameter and 20 feet in length.

* When constructing roads on sidehill locations, ditch uphill side of the roadway to intercept surface runoff.

* Allow inlet end of culvert to extend into side ditch so that it intercepts water flowing in the ditch. Construct a berm across the side ditch to assist in diverting water into the culvert.

* Allow outlet end of culvert to extend beyond any fill and empty onto an apron of rock, gravel or logs.

* Space culverts according to road grade:

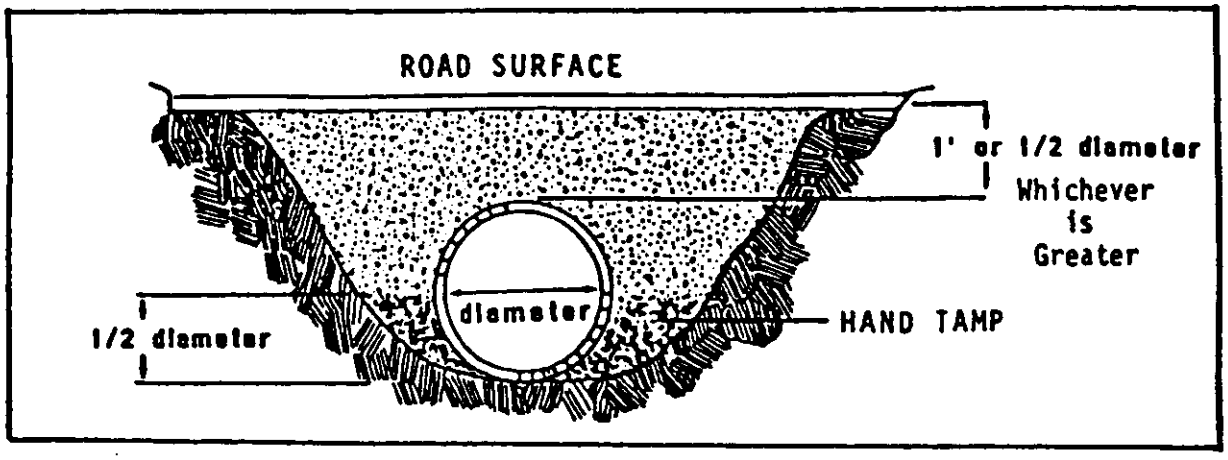
On gentle slopes (1-2%)	300 feet
On moderate slopes (3-10%)	150 feet
On steep slopes (10%+)	100 feet or less

* Culverts should be installed at a 30-35 degree angle downgrade.

* Culverts should be sloped at least 5 inches for every 10 feet of length to permit self-cleaning.

* When harvesting operation has been completed, the road should be stabilized by installing water bars and removing all pipe culverts from truck roads which will not be maintained.

* Culverts, when not maintained, are very likely to become blocked with rocks, ice or other debris. Runoff water can become rerouted over and around the culvert and may wash out sections of road into brooks, streams, ponds or wetlands. It is important to clean culverts regularly. Check after every storm.



* Culvert size selection should be based on the size of the drainage area of a forested watershed and should be able to handle the largest flows.

* Estimating drainage area by taking measurements on a USGS topographic map, using contour lines to define the drainage limits. The Soil Conservation Service can assist you with determination of drainage area.

OPEN TOP CULVERTS

Definition:

A wooden culvert placed across truck haul roads to convey surface runoff and side ditch flows across to downslope side.

Purpose:

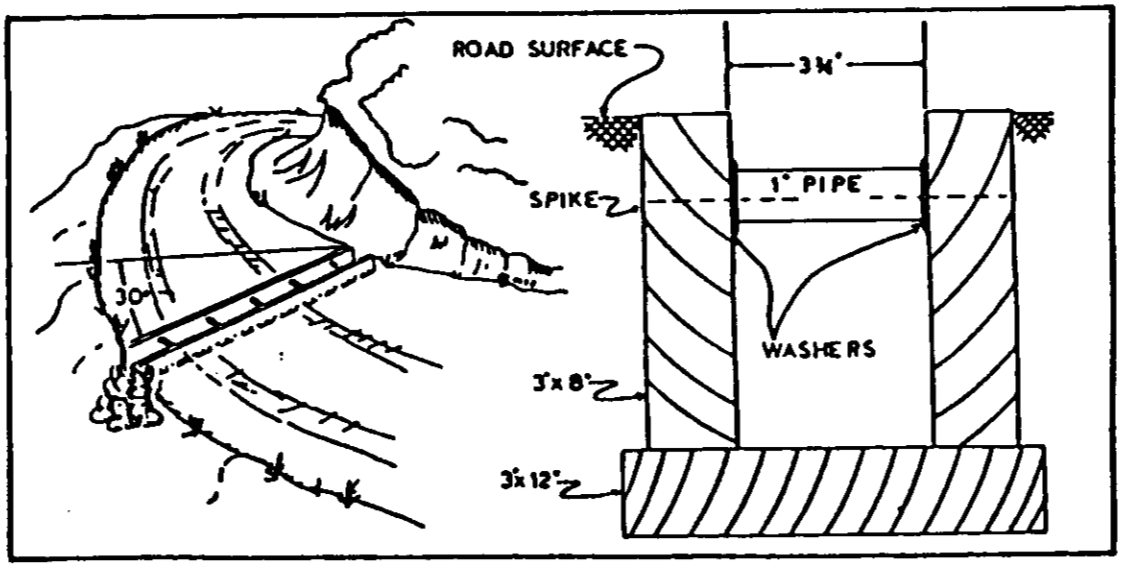
To collect and direct road surface storm runoff and upslope side ditch flows across road without eroding drainage system or road surfaces.

Conditions Where Practice Applies:

This is a temporary drainage structure for on-going harvesting operations. Property built and maintained, it can be used for cross drainage on roads of smaller operations as a substitute for a pipe culvert. This practice should not be used for handling intermittent or live streams or skid trail cross drainage.

Guidelines:

* Can be constructed of cull logs or from sawn lumber. If made of durable wood or treated material, these culverts will give many years of service.



* To be installed flush with the road surface and skewed at an angle not less than 30 degrees downgrade.

* Allow the inlet end to extend into the cut slope or side ditch so that it intercepts water.

* Allow outlet end to extend beyond any fill and empty onto an apron of rock, gravel or logs.

* Open top culverts must be cleaned regularly to remove sediments, gravel, and logging debris to allow normal function of structure at all times.

SPACING FOR OPEN TOP CULVERTS

Road Grade (percent)	Spacing Between Culverts (feet)
2	300
4	200
6	165
8	150
10	140
12	130

road construction applications

OUTSLOPING

Definition:

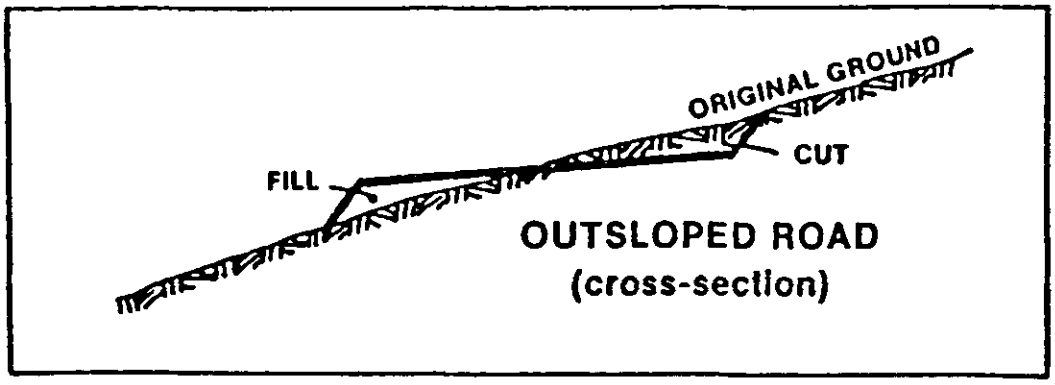
A section of road is sloped slightly (1-3%) from the cut bank to the outside edge of the road bed.

Purpose:

Effective way of limiting erosion because water is removed from the road surface quickly and diverted on to the forest floor.

Condition Where Practice Applies:

Used when the area is entirely rock, or when water can be diverted on to undisturbed forest floor.



INSLOPING

Definition:

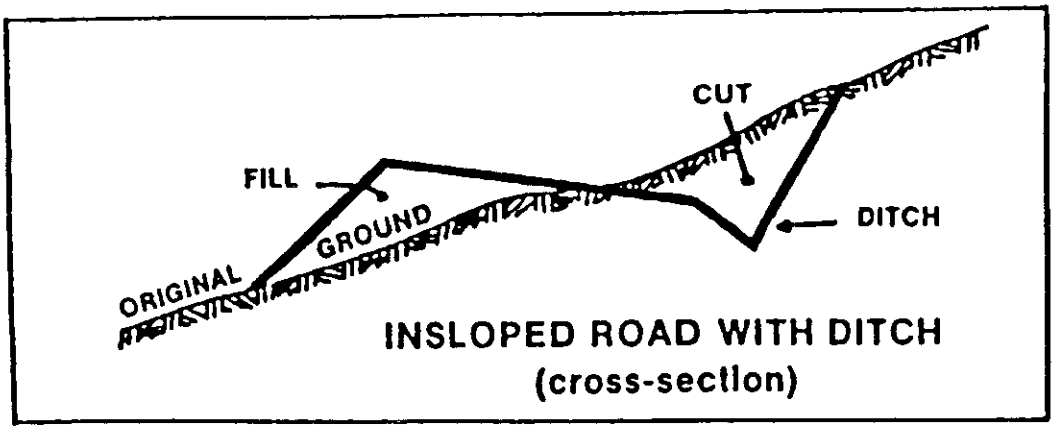
A section of road is sloped slightly (1-3%) toward the cut bank.

Purpose:

Effective way of limiting erosion because water is removed from the road surface quickly and diverted directly to the inside ditch which will carry the water into a culvert.

Condition Where Practice Applies:

Used when the soils are easily saturated or highly erodible. This will limit the amount of ditch water which will flow on to unstable fills.



INSLOPED ROAD WITH DITCH
(cross-section)

CROWNING

Definition:

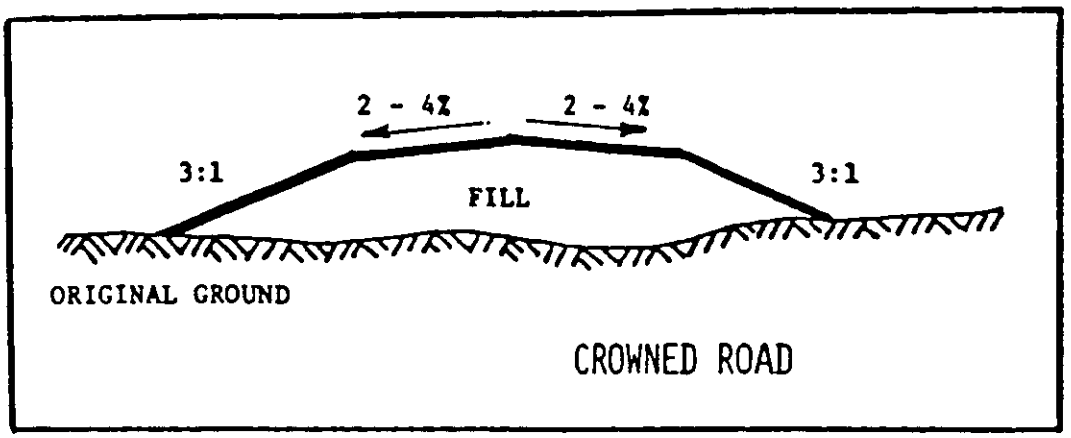
A section of road is sloped slightly (2-4%) from the center line of the road to the outside edges of the roadbed.

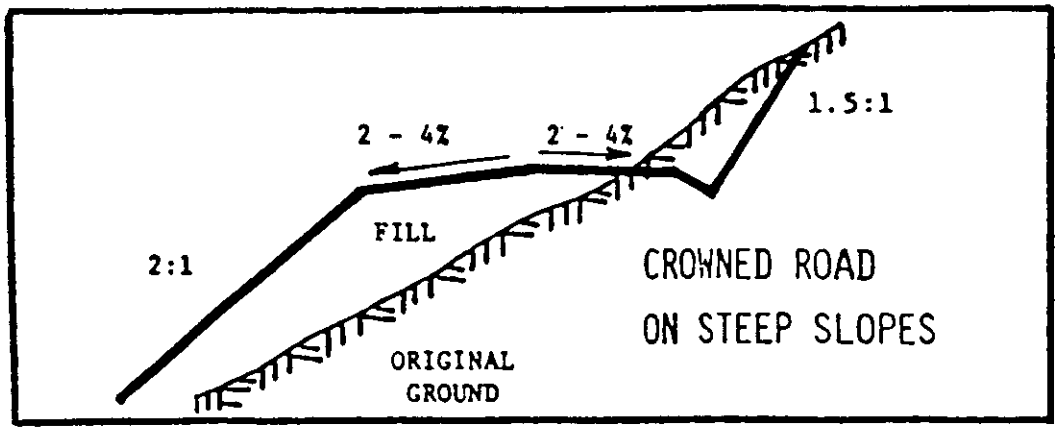
Purpose:

Effective way of limiting erosion because water is removed from the road surface quickly and diverted directly onto the forest floor or into a ditch which will carry the water into a culvert.

Conditions Where Practice Applies:

Used when soils are easily saturated or highly erodible when adjacent areas are relatively level with roadbed or on steep side hills.





streamside management zone

STREAMSIDE MANAGEMENT ZONE

Streamside Management Zones (SMZs) should be maintained along all perennial streams or where forest disturbances occur and surface runoff will carry sediment loads. SMZs should be maintained around streams, ponds, perennial flowing natural springs, and all springs and reservoirs serving as domestic water supplies.

The width of SMZs should be varied, depending on the following conditions: slope of land adjacent to stream, soil erodibility, precipitation, knowledge of particular area, sensitivity of stream, etc. These factors can be obtained from soil maps, on-the-ground evaluation and measurements, weather data, etc.

SMZs should be designed on a case-by-case basis. Most important is that SMZs be consistent with stream characteristics and wide enough to protect water quality.

The following is offered as a guideline:

Soil Type	Percent Slope	SMZ Width (each side)
Slightly erodible	0-5	35'
Slightly erodible	5-20	35-50'
Slightly erodible	20+	50-160'
Erodible	0-5	35-50'
Erodible	5-20	80' minimum
Erodible	20+	160' minimum

[NOTE: Please contact your local Natural Resources Conservation Service office to determine the erodibility factor of the soil before determining the proper width of the SMZ.]

available assistance

Available Assistance

Department of Land & Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl Street, Room 325
Honolulu, HI 96813
Telephone: (808) 587-0166 Facsimile: (808) 587-0160

Hawaii Branch

P.O. Box 4849
Hilo, HI 96720-0849
Telephone: (808) 974-4221
Facsimile: (808) 974-4226

Maui Branch

54 High Street
Wailuku, Hi 96793
Telephone: (808) 984-8100
Facsimile: (808) 984-8111

Oahu Branch

2135 Makiki Heights Drive
Honolulu, HI 96822
Telephone: (808) 973-9778
Facsimile: (808) 973-9781

Kauai Branch

3060 Eiwa Street, Rm. 306
Lihue, HI 96766-1875
Telephone: (808) 274-3433
Facsimile: (808) 274-3438

Natural Resources Conservation Service
Prince Kuhio Federal Bldg., Rm 4-118
Honolulu, HI 96850
Telephone: (808) 541-2600

Hawaii District Offices

Hilo Office
154 Waianuenue Avenue
Hilo, HI 96720
Telephone: (808) 961-5502

Kealakekua Office
P.O. Box 636
Kealakekua, HI 96750
Telephone: (808) 322-2484

Kamuela Office
P.O. Box 1089
Kamuela, HI 96743
Telephone: (808) 885-6602

Pahala Office
P.O. Box 807
Pahala, HI 96777
Telephone: (808) 928-6185

Natural Resources Conservation Service, cont'd.

Maui District Offices

Wailuku Office
70 S. High Street
Wailuku, HI 96793
Telephone: (808) 2444-3729

Molokai Office
P.O. Box 376
Kaunakakai, HI 96748
Telephone: (808) 567-6530

Kauai District Office

Lihue Office
4334 Rice Street, Rm. 104
Lihue, HI 96766
Telephone: (808) 245-6513

Consulting Foresters

Contact the Division of Forestry and Wildlife at (808) 587-0166 for the latest list.

NOTES

Suggested Readings

1. "Logging Roads and Skid Trails, A Guide for Soil Protection and Timber Access," Indiana Department of Natural Resources - Division of Forestry, 21 pp.

2. Dellberg, Robert A., "Road Building for Small Private Roads," Mendocino County Resource Conservation District, Ukiah, CA., July 1992, 73 pp.

3. Walbridge, T.A. Jr., "The Direct Location of Forest Roads," Virginia Polytechnic and State University, Blacksburg, VA., 1990, 70 pp.

4. Walbridge, T.A. Jr., "The Paper Location of Forest Roads," Virginia Polytechnic and State University, Blacksburg, VA., 1990, 75 pp.

5. Walbridge, T.A. Jr., "Field Tables for the Direct Location of Forest Roads," Virginia Polytechnic and State University, Blacksburg, VA., 1991, 15 pp.

6. Wenger, Karl F., "Forestry Handbook, Second Edition," Society of American Foresters, 1984, 1,335 pp.

7. "Erosion and Sediment Control Guide for Hawaii," Soil Conservation Service, 1981, 178 pp.