

TITLE: An Assessment of Insects and Pathogens Associated with Declining Dry Forest Ecosystems in Hawaii

LOCATION: Pu'uwa`awa'a and Ka`upalehu, island of Hawaii

DURATION: Year 2 of 2 year project

FUNDING SOURCE: Base Plan

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PROJECT OBJECTIVES: 1) To determine the role, if any, of forest insects and pathogens in the decline of native dry forests; 2) to develop appropriate management strategies to address the issues within the context of the overall Dry Forest Ecosystem Restoration Plan, and 3) to address needs associated with maintaining suitable levels of rare forest dependent insects, and insects associated with specific endangered plant taxa.

JUSTIFICATION:

- a. **Linkage:** Decline of native trees and shrubs in Hawaii dry forest ecosystems has been noted and recorded over a period of years during vegetation surveys and monitoring of research plots; mortality continues in enclosure plots.
- b. **Significance:** Dry forests are among the most endangered ecosystems in the world; over 90% of the original dry forests in Hawaii have been destroyed. Over 25% of the listed endangered plant taxa in the Hawaiian flora are from dry forest ecosystems.
- c. **Biological impact/political importance:** Dry forest ecosystems are of considerable political and biological importance. DOFAW and a 10 member citizens advisory council are finalizing a long-term management plan (<http://www.state.hi.us/dlnr/dofaw/puuwaawaa/draftplanv2.pdf>) for dry forests in the Pu'uwa`awa'a area. The resource agency and environmental organizations have recognized the need to investigate the possible role of insects and pathogens in the decline, and the need to consider insects and pathogens in the plan.

DESCRIPTION:

a. Background:

The maintenance of Hawaii's biological diversity has become an increasing concern as habitat alteration and land use practices increase the fragmentation of native habitats. The two remnant dry forest areas (Pu'uwa`awa'a, 37,000 acres; and Ka`upulehu, 80 acres) on the island of Hawaii lie within a previously forested region. Wildfires and more than 100 years of livestock grazing have removed much of the native vegetation, opening the region for invasive weeds like fountain grass. The remnant dry forest areas are currently at extreme risk from wildfire and have suffered decades-long decline that has been attributed to a variety of causal agents, including grazing-induced damage, pathogens, insects, and competition from introduced grasses and shrubs. Although several agencies and organizations have investigated various aspects of the decline, a comprehensive assessment of forest pathogens and insects has never been compiled for the area. DOFAW and Kamehameha Schools, land assets division (Bishop Estates) are currently developing strategies to preserve and restore these dry forest sites, and

to mitigate risks of fire, development, grazing and other uses. The groups recognize that the occurrence and significance of insects and pathogens that may be affecting natural and artificial regeneration of native tree and understory species needs to be a part of the overall restoration strategy. They have requested assistance from Forest Health Protection to accomplish this.

b. Methods: The comprehensive insect and pathogen assessment of the two areas will involve six phases:

- 1) Development, in cooperation with Hawaii partners, of a written plan of work with specific objectives, including appropriate sampling and long-term monitoring protocols.
- 2) Assessment of the overall pattern, extent and distribution of decline symptoms, using an initial aerial reconnaissance, and follow-up ground survey, using appropriate plot system.
- 3) Utilizing information from (2) above, conduct field sampling to determine insects, pathogens and site and stand factors associated with the decline.
- 4) Implement at least one additional follow-up, field survey to determine any progression of decline and to conduct additional insect and pathogen sampling.
- 5) Consider ways to implement long-term monitoring using forest health monitoring footprint procedures.
- 6) Identification of insects and pathogens associated with native vegetation involving taxonomic specialists from the University of Hawaii, Bishop Museum and other agencies.

Forest Health Protection will coordinate the plan of work and overall implementation. The appropriate plot systems (determined from initial aerial photography) to measure extent and severity of decline will be established. With Hawaii partners having expertise in host taxonomy and insect and pathogen identification, an initial field survey will be conducted. A subsequent survey, utilizing the plot system established in year one, will be conducted in year two of the project, to measure any progression of decline and to further identify associated insects and pathogens. At a minimum, expertise at the University of Hawaii (pathology) and the Bishop Museum (entomology) would be utilized for insect and pathogen identification. **Details of the Methods have changed. See list of seven task items below, from Challenge Cost-Share agreement established in Year 1.**

c. Products: The final product will be a written report (biological evaluation) that will include 1) a listing of identified insects and pathogens and site and stand factors associated with the decline; 2) a discussion of their probable roles in the decline and their potential threat to rare host species; and 3) management alternatives to reduce impacts, and long-term monitoring considerations. The evaluation would become part of the existing Management Plan.

d. Schedule of Activities:

Year one:

- 1) Late winter/spring, 2003: meet with cooperators and contractor on-site; complete study plan; aerial reconnaissance, plot installation and initial field survey
- 2) Summer/fall, 2003: identification of insects and pathogens associated with declining vegetation

Year two:

- 3) Winter/spring, 2004: subsequent field survey of original plots to determine progression, if any, of decline, and further collection of associated insects and pathogens
- 4) Summer/fall 2004: identification of insects and pathogens
- 5) December, 2004: completion of final evaluation

e. Progress/Accomplishments: Funding for the project was issued in April 2003 with the final Program and Budget Advice and received in May. As the original project coordinator (Jon Giffin of DOFAW) retired in May, we worked with Dr. Susan Cordell (PSW research ecologist investigating the ecological aspects of the dry forest decline with the IPIF Restoration of Ecosystem Processes project in Hilo), and Lisa Hadway (DOFAW scientist), to initiate the project. Kliejunas and Wenz conducted an on-site visit to dry forest areas in June with Susan, Lisa and Dr. Travis Idol (Department of Natural Resources and Environmental Management, University of Hawaii). The objectives were to determine potential cooperators, and to gather information on the extent of the current decline, on existing plot systems, and determine what information the project should provide to the existing overall research effort (IPIF, DOFAW) on the decline. Results of the site visit included:

1. New cooperators (Susan Cordell and Lisa Hadway; both involved in current dry forest research) to replace the retired District Manager (Jon Giffen) agreed to participate in the project.
2. Obtained existing maps/photography of the decline area —
 - 1) Hawaii Heritage Program historic and current State of Hawaii vegetation maps, showing dry forest areas pre and post human contact.
 - 2) DLNR-DOFAW aerial photos (used in the Blackmore and Vitousek paper).
 - 3) USDAFS-Riverside (Phil Riggins) False color IR imagery of the dry forests.
 - 4) Current imagery of the entire Pu'uwa'awa'a ranch (from Andrew Elmore, post doc with the Carnegie Institute).
3. A Challenge Cost-Share agreement with the University of Hawaii was completed August 25 to accomplish agreed upon aspects of the project. The Cooperator (Dr. Travis Idol) has hired a graduate student to perform the work summarized below, including:
 - 1) In a report to the Forest Service, summarize existing information and literature (published reports, unpublished data, maps, aerial photos, current research) on Hawaii's dry forest ecosystems.
 - 2) Utilizing resources of the State Division of Forestry and Wildlife, the USDA Forest Service, and other agencies, create a digital/GIS database of Hawaii's dry forest ecosystem. The professional expertise of a GIS/spatial data analysis University of Hawaii faculty member will be utilized. The digital/GIS database will include data layers that compare and contrast:
 - i. The historical and current extent of Hawaii's dry forest ecosystems;
 - ii. Grazed vs. ungrazed areas within the overall matrix;
 - iii. Areas where the invasive plant *Pennisetum setaceum* (fountain grass) is present or absent;
 - iv. Other data layers as appropriate or as needs arise.
 - 3) Establish permanent sampling and monitoring plots based on the report compiled in Item 1 above and the digital/GIS database created in Item 2 above. Plots will be established during the first year within the Kaupulehu restoration area in conjunction with research currently being conducted by the USDA Forest Service and university personnel. Permanent sampling locations will be established within the existing experimental plots at both sites, and overstory trees and shrubs will be marked and identified for long-term sampling and monitoring of health and decline status. A geo-references database of these permanent locations will be created.
 - 4) Monitor on a bi-monthly basis plant growth, mycorrhizal symbiosis, insect and pathogen indicators, and rare insect presence or associations with native species. This will include specifically:
 - i. Assessment of leaf area and crown condition for overstory trees and shrubs;
 - ii. Monitoring changes in size or biomass of understory plants;
 - iii. Collecting soil cores for assessment of root biomass and depth distribution;

- iv. Measurement of mycorrhizal colonization and status of plant roots;
 - v. Assessment of degree of insect and pathogen damage or incidence on selected plants;
 - vi. Collection and identification of insects present on selected plants.
- 5) Conduct on a bi-annual basis an intensive assessment of plant community composition, structure, and cover, inventory of plant insect community, and assessment of pest/pathogen incidence or damage. This will include:
- i. Inventory of plant cover and species composition;
 - ii. Excavation of selected plants for assessment of total root biomass, horizontal and depth distribution, and overall architecture;
 - iii. Examine and sample leaves, stems, and roots for insects and fungi associated with decline symptoms, depending upon the strata sampled. Outside professional assistance from the Forest Service, the University of Hawaii, or other qualified personnel will be utilized to train the project personnel and to support the sampling and analysis during the first sample period.
 - iv. Comprehensive assessment of insect/pathogen incidence and damage.
- 6) Expand the initial study into other sites within Hawaii's dry forest ecosystem. After the first year, report to the Forest Service on the results of the initial research. We will then review the digital GIS database and make recommendations for expansion of monitoring and study sites in other areas within the dry forest ecosystem, e.g., within the larger Pu'uwa'awa'a watershed. Research and monitoring within the larger recommended area will begin sometime in the second year, depending upon the time required for plot establishment and treatment installation.
- 7) Define the desired conditions of Hawaii's dry forest ecosystems with respect to forest health, decline, regeneration and restoration, and management objective. Through the research outlined in this proposal, we will be able to provide a comprehensive assessment of the effects of historical management and current restoration efforts on the health, decline, and regeneration or restoration potential of Hawaii's dry forest ecosystems. A synthesis of this information would include not only an assessment, but also a recommendation system for achieving desired levels of forest restoration, regeneration, and overall health.

SUMMARY: Although project initiation was delayed until June because of the lateness of the funding received and the retirement of the original principal investigator, the project is now on track. On-site cooperators (Susan Cordell, Lisa Hadway, Travis Idol) are contributing to the project and integrating it with existing studies. A Challenge Cost-Share Agreement is in place, and a graduate student has begun work on the agreed upon tasks. We request \$22,000 second year funding to complete the project.

COSTS:

	Item	Requested FHM EM Funding	Other- Source Funding	Source
YEAR 1 (2003)				
Administration	Salary	0	\$18,000	R5
	Overhead	0	0	0
	Travel	\$2,500	\$2,000	R5, cooperators
Procurements	In-Source Contracting	\$42,000 (\$37,500 for plot establishment & measurement, 3 individuals @ \$2,500/week for 5 weeks ¹ ; and \$4,500 for pathogen & insect identification)		
	Equipment	\$1,500		
	Supplies	\$0		
YEAR TOTALS		\$46,000	\$20,000²	See footnote
YEAR 2 (2004)				
Administration	Salary	0	\$18,000	R5 ¹
	Overhead	0		
	Travel	\$2,500	\$2,000	R5, cooperators
Procurements	Contracting	\$19,500 (\$15,000 for plot re- measurement, 2 individuals @\$2,500/week for 3 weeks; \$4,500 for pathogen & insect identification)		
	Equipment	\$0		
	Supplies	\$0		
YEAR TOTALS		\$22,000	\$20,000²	See footnote
PROJECT TOTALS		\$68,000	\$40,000²	See footnote

¹The plot system used or the number of plots needed to adequately cover the area is not completely known at this time. Estimated costs are \$40-\$160/plot, depending on information recorded at each plot.

² Cooperators will provide some additional in-kind services, including salary for site selection and field coordination, equipment, and local travel, but matching funds are not required.