2003 Abstracts

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IDENTIFICATION OF FIRE-TOLERANT NATIVE PLANT SPECIES AT HAWAII VOLCANOES NATIONAL PARK. The spread of fire-adapted alien grasses has made native plant communities more susceptible to fire in dry and seasonally dry communities below 4,000-ft elevation. Because most native plant species are extremely fire-sensitive, wildfires result in the reduction of native tree and shrub species and an increase in alien grasses. Field and laboratory experiments to identify fire-tolerant native plant species were conducted between 1993-2001. Fire-tolerance, defined as the ability to survive or colonize after fire, was determined by evaluating plant survivorship, ability to recruit from seed following direct seeding in controlled burns, and germination response to laboratory oven-heating. Fourteen of nineteen native species tested show some capacity to survive or colonize after fire. Eleven of twelve species tested were able to establish seedlings from artificial seed banks placed prior to and immediately following controlled burning. Seedlings of seven species (*Argemone glauca, Bidens hawaiensis, Canavalia hawaiiensis, Dodonaea viscosa, Santalum paniculatum var. paniculatum, Sophora chrysophylla, Sida fallax*) survived beyond the first year in the post burn environment, including five that eventually reached reproductive maturity. Seeds of three additional species tested exclusively in oven heating experiments showed either a positive (*Myrsine lanaiensis*) or neutral (*Rhus sandwicensis, Senna gaudichaudii*) germination response to mild oven heating. Testing species ability to survive and colonize after fire is essential for immediate short-term rehabilitation of wildfires and long-term establishment of native plants that can survive and ideally spread in the inevitable alien grass/fire cycle.

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AVIAN MALARIA SURVEY IN KAAPAHU AND KIPAHULU VALLEY, HALEAKALA NATIONAL PARK, MAUI, HAWAII. Survey techniques and advanced diagnostic methods were used to evaluate the transmission of avian malaria in Kaapahu and Kipahulu Valley, Haleakala National Park, Maui, Hawaii. From August to December 2002, six sites at elevations ranging from 2200 to 4700 feet were sampled. At each site birds were captured and blood samples were collected. Mosquitoes were trapped using CO_2 and oviposition traps. Transects were surveyed for larvae and larval habitat as well as ungulate sign. When possible, streams were surveyed for mosquito larvae. Blood samples were analyzed for avian malaria using ELISA tests. Mosquitoes were dissected and infection status was noted. At low elevation sites Bravo (2200') and Fern (2500') mosquito larvae were collected in stream beds and infected adult

mosquitoes were captured in traps. Few birds were captured at Bravo and infection rates at Fern were higher than any other site. Infected birds were also captured at Lost Camp, Kaapahu (3200'), Ginger (3100') and Delta (3000') in Kipahulu, however prevalence of infection was low. We did not detect disease at the high elevation site (4700'). A similar study is ongoing on the Island of Molokai both at mid and low elevation sites managed by Hawaii State DOFAW, The National Park Service, and The Nature Conservancy of Hawaii. Evaluation of mosquito presence, larval habitat, and disease transmission allows land managers to effectively develop strategies to manage native forest bird habitat for recovery and possible reintroduction of extirpated species.

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STAND AND FOREST-SCALE SILVICULTURAL OPTIONS FOR THE RESTORATION OF NATIVE HAWAIIAN FORESTS. In this, "The Year of the Hawaiian Forest," considerable attention will focus on the dramatic changes that have occurred to Hawaii's native forest communities over the past century. One of the most substantial changes has been the widespread degradation and fragmentation of mid-elevation forests dominated by koa (*Acacia koa*) and ohia (*Metrosideros polymorpha*) due to logging and conversion to pasture. Reversing this process is an urgent priority, but is complicated by diverse ownership patterns across the landscape. A new collaborative effort between the USDA Forest Service and The Nature Conservancy of Hawaii (TNCH) seeks to address this challenge. A primary strategy of the project is to develop silvicultural practices for koa that improve the conservation value of the land, while providing economic incentives for private landowners to invest in forest management and restoration. Koa is highly valuable ecologically, economically, and culturally in Hawaii. Nonetheless, basic ecological and silvicultural knowledge for koa is lacking. Research at TNCH's Kona-Hema Preserve addresses the role of silviculture at the stand- and forest-scales. Research at the stand-scale has focused on thinning regimes and reforestation trials. Research at the forest-scale has focused on modeling the consequences of different silvicultural scenarios for a 500 ha block of Kona-Hema on stand structure diversity and koa wood volume production over the next 80 years. Preliminary results suggest a wide range of silvicultural strategies at both the stand- and forest-scale that will meet both conservation and economic management objectives.

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SUBALPINE FOREST STRUCTURE, DYNAMICS, AND CONSERVATION ON MAUNA KEA. Subalpine biological communities are generally regarded as ecologically simple and subject to relatively few threats; however, they are little studied on Mauna Kea or other high Hawaiian volcanoes. On Mauna Kea, we identify nine subalpine vegetation communities, four of which are dominated by only two native trees, mamane (*Sophora chrysophylla*) and naio (*Myoporum sandwicense*). Although these communities provide valuable habitat for Hawaiian plants and animals, a formidable array of alien threats impact native populations and impair ecosystem structure and function. Previous studies have demonstrated that feral ungulates negatively impact mamane health and regeneration; however, periodic removals of introduced sheep since 1980 have allowed mamane regeneration in some areas. Despite improving habitat conditions, our survey of 505 vegetation plots (40 m^2 each) reveals that 305 plots (60%) were recently disturbed or visited by feral ungulates, indicating that ungulate removal should be intensified. Patterns of m_mane distribution, phenology, seedling recruitment, and tree mortality indicate that forest restoration should be focused in sparsely wooded areas or where alien grasses dominate to augment seedling recruitment, reduce forest fragmentation, expand forest breadth across a larger range of elevation, decrease the likelihood of grass/fire cycles developing, and support native consumer populations. Studies of food web interactions between mamane, insects, and birds indicate that strategic control of alien species are needed to promote recovery of native populations and ecosystem function. However, complex interactions between native and alien species may hinder or obscure results of even simple management actions.

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FROM GUINEA GRASS TO NATIVE DRY SHRUBLAND: RESURRECTION OF MAO HAU HELE AND AKOKO HABITAT. In 2001, two endangered species, mao hau hele (*Hibiscus brackenridgii* ssp. *mokuleianus*), the state flower, and akoko *(Chamaesyce celastroides var. kaenana*), were discovered in low elevation dry scrub habitat in Makua valley. Directed by the Makua Implementation Plan, the Army Environmental began species management. All populations were dominated by haole koa (*Leucaena leucocephala*) and fire-prone guinea grass (*Panicum maximum*). Since the populations abut live-fire training facilities, management primarily consists of construction of 30 meter native shrub firebreaks around each population. This involves cutting and spraying guinea grass and removing haole koa. To date, staff have spent 1,170 hours clearing 7 acres; 804 hours in the first 5 months of management and 368 hours in the second 6 months. Photopoints document the changes in vegetation as a result of control. Once sparse native species, including *Abutilon incanum*, *Dodonea viscosa*, *Sida fallax*, *Heteropogon contortus*, *Erythrina sandwicensis*, and *Waltheria indica* now thrive in the managed areas. These species create less dead organic matter than guinea grass, thus reducing

fire-risk and improving habitat quality. Both the akoko and mao hau hele are responding positively to weed control; seedlings have been found in all populations. In particular, mao hau hele plants have shown remarkable growth, expanding greatly in diameter and leaf area. Low elevation dry shrublands tend to be the most degraded ecotypes in the state; they are also the least managed. As staff experience suggests, this ecotype is remarkably resilient.

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ALIEN PLANT SURVEYS IN HAWAII VOLCANOES NATIONAL PARK. Alien plant surveys conducted between 2000 and 2003 in Hawaii Volcanoes National Park quantify present range extents and abundances of 78 alien plant species, distributed over 60,000 hectares between sea level and 2070 meters. Surveys were conducted by foot, vehicle and helicopter, using a variety of sampling techniques, depending on the distribution of the target plant, the surrounding vegetation, and the terrain. Over 282 kilometers of trails and fence lines were surveyed, and more than forty kilometers of transects were established and read. A 50 x 50 meter GIS grid was created for sampling open grasslands throughout the park. GIS data layers documenting species abundance and distribution were generated from the data collected. Silk oak (*Grevillea robusta*), strawberry guava (*Psidium cattleianum*) and blackberry (*Rubus argutus*) were among 21 species distributed broadly across the park. Blackwattle (*Acacia mearnsii*), sisal (*Agave sisalana*), and Andean blackberry (*Rubus glaucus*) were among 48 locally distributed species, with few discrete populations. Nine species were incipient invaders not previously mapped, these included Australian tree fern (*Sphaeropteris cooperii*), fireweed (*Senecio madagascariensis*), and telegraph weed (*Heterotheca grandiflora*). Survey data will be compared to previous studies (Fosberg 1966; Tunison et. al.1992), and serve as baseline information for future studies. This will enable resource managers to track changes in alien plant distributions, monitor the success of the alien plant control program, and develop strategies for mitigating the impacts of invasive alien plants throughout the largest managed native reserve in the Hawaiian Islands.

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CONSERVATION PARTNERSHIPS PROGRAMS: HAWAIIAN FOREST PROJECTS
The Conservation Partnerships Program (CPP) is a collection of voluntary habitat restoration programs in the US Fish and Wildlife Service Pacific Islands Office. There are five program elements within the CPP that have different areas of emphasis, but share the overall goal of restoring native Pacific Island ecosystems through collaborative projects. These programs implement large-scale conservation efforts for the benefit of native ecosystems by working cooperatively with private landowners, conservation organizations, community groups, and other government agencies. During the Year of the Hawaiian Forest, it is important to recognize the tremendous efforts by private and public groups towards forest restoration and protection. The

forest restoration projects funded over the last decade through the CPP have collectively restored acres of dryland forest, mesic forest and rainforest in Hawaii. Projects range from directed research like "Oahu tree snail (*Achatinella* spp.) predation by rats in Waipio" to pilot projects like "Humu ula koa (*Acacia koa*) buffer demonstration." Partnership efforts include rare species management, native plant propagation and outplanting, feral ungulate control, native species reintroduction and fence construction. These voluntary conservation ventures can result in new management action, like reduction in designated critical habitat and better conservation techniques. Other highlighted forest projects are as follows: Olaa-Kilauea (Hawaii), Limahuli (Kauai), Lanaihale (Lanai), Auwahi (Maui), Kanaio (Maui), Puu Pahu (Maui), Humu ula (Hawaii), Kawaihae (Hawaii), Kamalo/Kapulei (Molokai) and Honouliuli Preserve (Oahu).

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MODELING THE CURRENT AND POTENTIAL DISTRIBUTION OF INVASIVE ALIEN PLANT SPECIES ON THE ISLAND OF HAWAII. Invasive alien species pose the greatest threat to the long-term conservation of native Hawaiian ecosystems and their unique species elements. Current efforts by federal, state, and private organizations are focused on preventing new species from becoming established in Hawaii, eliminating newly established invasive species before they can spread, and reducing or eliminating the impacts of established invasive species that pose a serious threat to the maintenance of native biodiversity. Information on current and potential distribution of invasive species is crucial for development and implementation of effective management programs to reduce or eliminate the effects of invasive species. This project focuses on the production of potential distribution maps for a set of approximately 200 particularly threatening invasive plant species that are either currently widespread or recently naturalized on the island of Hawaii. Location and habitat information was compiled from previous field surveys, augmented by new surveys of weeds found along selected major and secondary roads throughout the island. The maps are prepared by modeling potential distribution for each species based on habitat data using ArcView 3.2 GIS with Spatial Analyst. During 2001 and 2002, roadside weed surveys were conducted within Hawaii Volcanoes National Park and on approximately 25% of the other targeted roads on the island of Hawaii. These initial roadside surveys resulted in several new records of invasive species in Hawaii Volcanoes National Park and other new locations on the island of Hawaii.

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REVEGETATION STRATEGIES AFTER SEVERE OVERGRAZING ON THE FORMER U.S. NAVY BOMBING RANGE OF KAHOOLAWE ISLAND, MAUI. The Kahoolawe Island Reserve Commission (KIRC), implements a multi-tasked restoration plan to assist in the revegetation of Kahoolawe Island. Severe overgrazing by goats (*Capra hircus*) for 200 years has denuded the landscape and caused loss of topsoil with extensive erosion. Since 1992, KIRC has undertaken the task of prioritizing restoration and revegetation objectives, and identifying

Special Ecological Areas (SEA). With an arid desert-like environment and poor soil conditions, and without a permanent water source for the island, wide-scale revegetation presents a special challenge. In addition, the presence of subsurface Unexploded Ordnance (UXO) leaves traditional planting practices such as tilling hazardous. After the Navy cleanup project is completed this November, KIRC will gain more access to areas previously off-limits due to UXO. KIRC has adopted several strategies for revegetation. The newly completed 625,000-gallon water catchment system allows irrigation for out-plantings. A seed collection and germination program preserves the genetic integrity of remnant ecosystems and SEA. A combination of invasive species control and mulching increases potential for survivability of native species. Novel erosion control techniques with pili (*Heteropogon contortus*) grass bales achieve multiple restoration goals. Volunteers from local community groups help implement the restoration plan through service trips. Restoration trip objectives include out-plantings, invasive species control, erosion control mitigation, monitoring, and integration of Hawaiian cultural practices. In this poster presentation, we present an overview of the KIRC restoration plan emphasizing revegetation strategies.

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PREVENTING FURTHER EXTINCTIONS IN HAWAII'S FLORA. The informal coalition of the Hawaii Rare Plant Restoration Group (HRPRG) plays a critical role in preventing the extinction of native Hawaiian plants and providing for their recovery through integrated *in situ* (in the wild) and *ex situ* (out of the wild) efforts by its diverse and committed membership. Partners work collaboratively to sample, propagate, and reintroduce rare plants, and to advance the preservation of native plants and their habitats through effective communication and public education. In particular, HRPRG focuses on emergency actions needed to keep species from going extinct. This group has developed guidelines for monitoring, collection, and reintroduction. HRPRG has long been focused on the emergency actions needed for the rarest of the rare plants in Hawaii, such as monitoring, surveying, and collections, leading to reintroductions into protected areas. Currently, HRPRG, is developing strategies to help fund "genetic safety net" initiatives that will capture the remaining botanical diversity of Hawaii's most 150 endangered plant species, with fewer than 50 individuals remaining in the wild. The Group is approaching this plan by organizing into island committees and addressing island as well as state-wide rarities. HRPRG is composed of many public and private agencies. This group, which includes over 60 participants from 25 organizations, meets periodically to share information about monitoring, collection, *ex situ* propagation, reintroduction and restoration projects, and to plan new initiatives. The Hawaii Department of Forestry and Wildlife and the U.S. Fish and Wildlife Service facilitate this working group.

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RECENT ADVANCES IN PALILA (*Loxioides bailleui*) DEMOGRAPHY: THE SEX LIVES OF PALILA. Palila (*Loxioides bailleui*) are one of the best-studied endangered passerines in the world, with continuous annual monitoring since 1980. Long-term capture data allow us to reevaluate the results of previous demographic studies and to gain detailed insights on the social structure of palila. Periodic evaluation of these earlier studies is crucial to the development of effective restoration models. Recently, we identified substantial methodological biases in earlier studies. Different life history characteristics emerge when we account for these biases, suggesting that palila are much longer lived than formerly believed. Previously, annual survival was estimated to be 0.36 for HY (hatch year) and 0.63 for AHY (after hatch year) individuals. We now find palila to have higher survival rates (HY=0.58 and AHY=0.77). These survival estimates are consistent with the occurrence of extremely old individuals (14 years) in the population. Previous demographic studies that relied on plumage characteristics found that the population was significantly male-biased. New DNA evidence, however, shows an essentially even sex ratio. Data from over ten years of nest monitoring demonstrate that palila exhibit delayed reproductive maturity and that monogamy is the principal mating system. Taken together, these traits are consistent with those of long-lived animals with low reproductive capacity, and we therefore expect that palila recovery may lag far behind habitat recovery on Mauna Kea. Management strategies to restore palila must incorporate time frames that accommodate forest regeneration and the intrinsic slow growth potential of this population.

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IDENTIFYING NATURAL RESOURCE MONITORING TOPICS FOR THE BENEFIT OF MANAGERS IN THE NATIONAL PARKS OF THE PACIFIC. The Pacific Island Network of national parks consists of eight parks in Hawaii, one in American Samoa, one in Guam and one in Saipan. The managers of the natural resources of these eleven national parks must anticipate and respond to issues in both terrestrial and marine ecosystems. The Inventory and Monitoring Program is funded by the National Park Service to inventory the natural resources of our parks and to initiate long term ecological monitoring that will provide decision support for managers. The inventory portion of our program is well underway. Funding for the monitoring program is adequate for only a few critically significant environmental attributes, however. These significant attributes, “vital signs” of ecosystem health, are being identified via scoping sessions. Scoping sessions result in a lengthy list of concerns from a wide variety of constituents and stakeholders. Results of scoping sessions to date have shown that invasive species, development, aquatic resources, marine resources, threatened and endangered species, visitor impacts, and biotic communities top the list of concerns. Prioritization of these concerns is on-going and will result in a short list of environmental attributes for which monitoring protocols and data management plans will be developed. Upon completion and approval of a long term monitoring

plan (anticipated in 2005), funding will become available to implement monitoring projects in cooperation with stakeholders and scientists.

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ENEMY RELEASE AND HABITAT EXPANSION OF THE INVASIVE TROPICAL SHRUB (*Clidemia hirta)*. Exotic invasive plant species often increase in abundance or habitat distribution in introduced ranges. The enemy release hypothesis suggests that herbivores and pathogens limit population growth of plants in native areas and that release from control of natural enemies in areas of introduction accounts in part for observed changes in plant abundance. We tested this hypothesis experimentally with the invasive shrub *Clidemia hirta*, which does not occur in forest in its native range, but is a vigorous invader of tropical forest in its introduced range in Hawaii. We planted *Clidemia* into understory and open habitats where it is native (Costa Rica) and where it has been introduced (Hawaii) and applied pesticides to examine the effects of fungal pathogen and insect herbivore exclusion. *Clidemia hirta* survival was lower in Costa Rica than Hawaii in both habitats. Percent survival was much lower in the understory in Costa Rica (45%) than Hawaii (99%), but when insects and fungal pathogens were excluded 67% of *Clidemia hirta* grown in Costa Rica survived. Estimated herbivory rates were six times higher in the native sites than the introduced sites. No effects of natural enemy exclusion were found in open habitats of either area. Our study suggests that the absence of *Clidemia hirta* from forest understory in its native range likely results in part from the strong pressures of natural enemies. Development of effective biocontrol for *Clidemia* will necessitate searches for potential agents that are effective in a habitat where *Clidemia* is scarce in its native range.

Earthwatch Institute
Call for Proposals
Earthwatch Institute is an international non-profit organization that supports scholarly field research wordwide in the biological, physical, social, and cultural sciences. Field research grant awards are derived from funds contributed by Earthwatch members who serve as volunteer participants on research projects. Volunteers are educated and motivated individuals who are recruited and screened by Earthwatch to meet scientists' needs. To date, Earchwatch has supported over 2,800 research projects in 120 countries and 40 US states, with more than 65,000 volunteer field assistants contributing over $53 million in research grants. The Research Program at Earthwatch is interested in increasing its support of field-based conservation biology research in Hawaii and is currently seeking proposals for related research.

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RANGE, HABITAT, AND ECOLOGY OF THE WEKIU BUG (*Nysius wekiuicola*), A RARE INSECT SPECIES UNIQUE TO MAUNA KEA, HAWAII. Discovered in 1979, the wekiu bug is known only from the summit of Mauna Kea at elevations to above 4200 m. Wekiu bugs feed on aeolian drift and have blood with antifreeze properties allowing them to inhabit alpine areas. Little was known regarding their overall distribution throughout the Mauna Kea alpine ecosystem because previous studies were concentrated in areas near telescope construction. The primary objectives of this study were to survey for the presence or absence of wekiu bugs on various alpine zone cinder cone summits, and determine their elevational distribution. Wekiu bugs were infrequently collected except in certain localized areas centered on prominent cinder cones. On these cones they were restricted to the rims and inner craters of each alpine cone where they occur and with only one exception were found within 50 m of each cone summit. Except on the relatively undisturbed Puu Hau Kea, wekiu bugs were uncommon, attaining their highest densities along the crater rims and adjacent inner slopes. Evidence for wekiu bugs' rarity was demonstrated by the fact that despite 398 total trap days of effort during this study, only 47 individuals were captured. Substantial amounts of cone rim habitat have been lost to telescope development since the original 1982 Bishop Museum study which recorded robust populations, possibly accounting for population declines, although annual variations in weather may also play a role in determining abundance.

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FARM BILL PROGRAMS PROMOTE CONSERVATION PROJECT PARTNERSHIPS BETWEEN PRIVATE LANDOWNERS, MANAGERS, AND SCIENTISTS. The 2002 Farm Bill provides the most significant conservation funding for private lands in history. For Hawaii this is long overdue, with over 60% of its lands privately owned, the majority of listed endangered species in the nation, and agricultural lands in transition. The Farm Bill emphasizes protecting Hawaii's native forests, halting the decline of plant and animal habitats, restoring wetlands, and managing working agricultural lands to ensure they remain healthy and productive. Science and management partnerships have developed since the 1996 Farm Bill. One outstanding example is a ranch on Maui, who has used agency programs, NRCS field assistance, and cooperative agreements, including:

- *Wildlife Habitat Incentives Program(WHIP)* to control invasive species (e.g. *Casuarina*) around three anchialine ponds occupied by native opae (*Metabetaeus lohena*)
- Also through WHIP, botanists of the Hawaii Biological Survey, *Bishop Museum* surveyed 1325 acres and produced an inventory of vascular plants, assessment of resource concerns, and conservation practice recommendations. 195 species were documented, 89 native, including the first recorded *Hibiscus kokio* for East Maui.

- *Wetlands Reserve Program(WRP)*: With NRCS and *Ducks, Unlimited* help, the ranch will enhance ecological components for endangered waterbirds and other species, including habitat for nene, koloa, and potentially for moorhen reintroduction.
- *Environmental Qualities Incentives Program(EQIP)*: Water development and management practices were funded to restore pastureland.
- Partnerships with *U.S. Fish and Wildlife Service* funded miconia control on pasturelands and helped fund anchialine pond restoration.

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FERAL GOATS, PEOPLE AND LAND DEGRADATION: THE CASE OF-THE SOUTH SLOPE OF HALEAKALA, MAUI. Land managers have long recognized that feral goats adversely affect the native vegetation and soils of the south facing leeward slope of Mt. Haleakala, Maui, Hawaii, reducing biodiversity, watershed function and economic and cultural use of native hardwoods and other vegetation. The objective of this study was to discover the principle historic, political, social and economic factors that contribute to the persistence of feral goats at the study site. The focus was on the eight public and private landowners of the conservation zone lands above 1220 m elevation. Interviews were conducted with 14 land managers, as well as five individuals who have, or are currently conducting goat control elsewhere in Hawaii. This study finds that while nearly all managers are concerned about goat impacts, feral goats persist largely because of 1) divergent values and perceptions of south slope resources, 2) the politics of access and use of the area for hunting and conservation, and 3) the economic and logistic specifics of goat control. The situation is dynamic, however, and changes in land tenure, recently funded conservation initiatives, and a landowner partnership have increased the likelihood of future watershed protection. Interviews with managers involved in current goat control reveal that landowner partnerships and community involvement are key to successful. This study illustrates the importance of historical perspective, the social complexity of competing and overlapping access and resource claims, and the need for a social as well as physical responses to land degradation.

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SPATIAL HABITAT MODELING OF HAWAIIAN FOREST BIRD DENSITIES FOR ESTIMATION OF POPULATION SIZE AND DISTRIBUTION. The Pacific Island Ecosystems Research Center of the USGS Biological Resources Division has developed a GIS-intensive ecological study of the Hawaiian avifauna: the Hawaii Forest Bird Interagency Database Project. The project has produced a relational database of all forest bird survey data collected in the state since the mid-1970s. More than _ million records from over 400 surveys on all the major islands are included in the database. GIS has been used to integrate information on species densities at

surveyed locations with habitat data derived from remote sensing and field sampling, and to develop predictive models at the landscape level. We analyzed data from 65 variable circular plot surveys within a 64,843-hectare study area on the northeastern slopes of the Island of Hawaii that encompasses the Hakalau Forest National Wildlife Refuge. Results are presented for 8 native and 2 alien bird species. The models have used an autoregressive method that incorporates a spatially auto-correlated error structure, thereby accounting for fine-scale autocorrelation in density and habitat variables. Coarse-scale autocorrelation was controlled with trend surface terms. Estimates of densities were generated for all 1-hectare cells within the study area, and totaled to estimate population size. Density surface maps based on models that incorporate habitat characteristics more accurately depict the relationships of bird density and habitat than inter- and extrapolation of survey site data alone. Such modeling products will assist in guiding future census and management efforts.

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THE ARTHROPODS OF OHIA LEHUA: FOUNDATIONAL RESOURCES IN HAWAIIAN ECOSYSTEMS. **O**hia lehua (Myrtaceae: *Metrosideros polymorpha*) is the most common and widespread native tree in the Hawaiian Islands. It is dominant in a wide variety of ecosystems from sea level to treeline, in wet and dry forests, and from old growth to recent lava flows. I explored the nature and importance of arthropod interactions to ecosystem processes and to native birds, which are highly dependent on insects and spiders on ohia. I describe the most common and dynamically important arthropods from surveys on multiple islands and detailed research on Hawaii Island. Hundreds of endemic herbivorous and predatory species are found, many specialized on ohia, but biomass of the detritivorous guild is dominated by introduced species. A three-year study using fertilization and bird exclusion through caging revealed complex and interactive impacts of available resources and avian predation. Soil fertility and resource availability constrains the abundance and biomass of detritivores and herbivores, but birds limit arthropod predators, especially spiders. In rare evidence of biotic resistance, bird presence subdued the invasion of introduced species. Top predators are most vulnerable to extinction and many Hawaiian birds have already gone extinct, which may cause ripple effects through ecosystems. Forest birds, even the introduced Japanese white-eye (*Zosterops japonicus*), may be important food web stabilizing factors. As ohia lehua is the foundational resource in most Hawaiian natural areas, more attention to the integrity of the resident arthropod community is important to adequate management of *Metrosideros* forests.

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PRELIMINARY INVESTIGATIONS OF MAKAWAO FOREST RESERVE AND RECOMMENDATIONS FOR FUTURE INVENTORY AND MANAGEMENT. Makawao Forest Reserve (MFR), a small, accessible area at low- to middle-elevation (600-1500m), contains perhaps the most unique and diverse mesic forest remaining on East Maui. Although much of the reserve has been cleared and planted with non-native trees, many gulches and ridges remain essentially undisturbed. Prior to deforestation, the western slope of Haleakala was one of the most biologically diverse regions in the Hawaiian Islands. Recently, local botanists have casually explored MFR, documenting at least 167 native vascular plant species, including the federally endangered mahoe (*Alectryon macrococcus*) and haha (*Cyanea mceldowneyi*), as well as several candidate species and "species of concern". Mesic tree species including olopua (*Nestegis sandwicensis*), hala pepe (*Pleomele auwahiensis*), holei (*Ochrosia haleakalae*), koaia (*Acacia koaia*), and mokihana (*Melicope hawaiensis*) are naturally reproducing. Additionally, the reserve supports diverse populations of native insects and tree snails. However, the reserve has never been systematically surveyed and other rare or purportedly extinct species are likely to be present. Despite the persistence of native biota in MFR, aggressive weeds such as tropical ash (*Fraxinus uhdei*), strawberry guava (*Psidium cattleianum*), and quinine (*Cinchona pubescens*) have invaded the forest and will likely displace much of the remaining native forest within decades. Thorough surveys of plants and invertebrates are needed to designate valuable areas and prescribe appropriate management strategies. Potential options include cooperating with hunters to lower ungulate densities, controlling weeds, and building protective exclosures around rare plants and sensitive areas.

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THE IMPORTANCE OF SKIPJACK TUNA (*Katsuwonus pelamis*) IN THE FORAGING ECOLOGY OF HAWAIIAN SEABIRDS. Fishery managers are required by law to keep fish stocks at a sustainable level. Nevertheless, a large decrease in the standing stock or size distribution of a fish stock could affect ecologically-associated species in a dramatic way. Tropical seabirds in the "tuna-bird" guild rely heavily on commercially valuable fish, such as tunas and mahimahi, and other subsurface predators, such as dolphin, to drive prey to the surface waters within reach of the birds. In Hawaiian waters, which species of subsurface predators are particularly important in driving prey up for seabirds? Is there a strong enough dependence to make us worried about the ecological effects on seabirds of fishing? This ongoing study is collecting data, through at-sea surveys aboard fishing boats, on the relative proportion of different types of subsurface predator schools and the associated seabird assemblage. Preliminary data show that skipjack tuna (*Katsuwonus pelamis*) make up more than 80% of the surface schools around Oahu. In addition, at-least two seabird species, the Wedge-tailed Shearwater (*Puffinus pacificus*) and Brown Noddy (*Anous stolidus*), show a preference to forage in association with skipjack over other subsurface predators (shearwaters - $X^2_{(4)} = 390$; $P<0.0001$; noddies - $\chi^2_{(4)} = 73.4$; $P<0.0001$). This tight dependence suggests that overfishing of skipjack tuna could affect seabird populations, and that this secondary impact of fishing should be taken into account by fishery managers when setting fishing quotas.

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CONSERVATION STATUS OF HAWAIIAN LEPIDOPTERA: THE IMPORTANCE OF SYSTEMATICS FOR MANAGEMENT OF RARE SPECIES AND HABITATS. Lepidoptera are key components of Hawaii's terrestrial ecosystems yet very little is known about their distribution or ecology. Several surveys have been conducted historically, but without systematic revisions, identification tools have been either difficult to use or non-existent. In 1996 a survey was initiated for *Scotorythra* (Lepidoptera: Geometridae) which are one of the larger genera of large moths in the Hawaiian Islands. They are commonly encountered in forest habitats, and are thought to be very important in the diet of native birds. The results of the survey showed ten species to be either extremely rare or extinct. In addition to the survey, the genus was revised resulting in the production of an interactive, computer key that is accessible to non-experts and informative to all. With 870 endemic species of Lepidoptera in Hawaii the wealth of information we lack due to the absence of functional identification keys is staggering. Without tools for recognizing these species it is impossible to discover ecological or habitat associations, rendering conservation plans unmanageable for most insects in Hawaii. Many moths are likely to disappear from the Hawaiian landscape along with the plants and other animals with which they are associated unless further work is commenced on the systematics and biology of native Lepidoptera.

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OUT OF SIGHT, OUT OF MIND – CONSERVATION BIOLOGY OF HAWAIIAN CAVES. Caves are more than mere holes in the ground. Many are windows into a different world that supports marvelous, subterranean ecosystems inhabited by bizarre native organisms. Cave creatures are in double jeopardy since they live in island–like habitats on islands, and since subterranean resources are often "out of sight, out of mind" when management decisions are made on the surface. Forest degradation in turn begets the degradation of the unseen cave ecosystem and its specialized inhabitants. Often little is known of what is lost. In 2000, recognizing their vulnerability, the U.S. Fish and Wildlife Service formally listed as endangered two relict cave species on Kauai: the no-eyed, big-eyed wolf spider (*Adelocosa anops*) and the blind terrestrial amphipod (*Spelaeorchestia koloana*). These cave animals can only be observed in accessible caves, a circumstance that limits the understanding of their ecology and distribution and hampers efforts to protect them. To determine whether these animals live only in caves, or whether they also inhabit crevices and can disperse between caves, food and water were added to six isolated short, dry cave segments which were then sealed. The amphipod successfully colonized two of these modified caves supporting the conjecture that the animals live throughout the lava flow wherever their environment exists. These findings led to the on-going development of a management-by-research program to manage the surface vegetation within preserves in an effort to protect the endangered species living underground.

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EXPERT KNOWLEDGE OF DISTRIBUTION OF WEED SPECIES IN CONSERVATION AREAS ON THE ISLAND OF OAHU. The native ecosystems of islands are known to be vulnerable to invasions of non-native species. The USDA Forest Service Invasive Species Unit and the Geography Department of the University of Hawaii at Manoa have been conducting a survey of land managers to collect information on the distribution, abundance, impact, and management of common weeds. Although there are lists of problematic weed species in Hawaii, we lack information on their distribution and impacts in natural areas. A ground survey would provide the best data; however, such an approach is not currently feasible. Instead, estimates by experienced land managers are a largely untapped source of information. Such data would provide a basis for evaluating species impacts, distributions and habitat ranges and for setting priorities for control efforts. At this time, data have been collected for the island of Oahu; neighbor island surveys are underway. The Oahu survey encompasses an area roughly of 9500 hectares, ranging in elevation from sea level to 1250 meters. It covers habitat types ranging from coastal dry forests to montane wet forests. The species list now includes 265 exotic pest plants identified from the surveyed conservation areas on Oahu. We will present maps of the numbers of weed species per management area and the distribution of selected examples.

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USING DNA ANALYSIS TO IDENTIFY A CARNIVOROUS ALIEN FRESHWATER EEL IN HAWAII. In 2002, a previously unrecorded eel was captured in a freshwater stream on Maui. Using morphological characteristics it was tentatively identified as the Giant Mottled Eel, *Anguilla marmorata* (Quoy & Gaimard; Anguillidae). This is a widespread species native to the tropical and subtropical Indo-Pacific region. To confirm species identification and suggest its place of origin, the 12S and 16S rRNA regions were sequenced. With the assembled eel sequences in Genbank, analysis confirmed that the Maui eel is *A. marmorata*, and from the genetic diversity within this species its origin was determined to be from the north-west Pacific region. It is highly likely that Hawaiian stream organisms would have little defense against predation by an individual Giant Mottled Eel, or worse, a population of these Anguilla eels. Anguilla eels can cross dry land to travel from pond to pond, either in search of additional food or more favorable water conditions. Anguilla eels were introduced into Hawaii in the mid-1900s for consumption and aquaculture, but they were not believed to have been released into native freshwater streams. The discovery of this carnivorous eel on Maui raises serious concerns for native Hawaiian stream organisms and their protection from yet another alien predator.

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GENETIC AND MORPHOLOGICAL VARIATION OF *Metrosideros polymorpha* (MYRTACEAE) ON HAWAII. The highly polymorphic taxon *Metrosideros polymorpha* Gaud. (ohia) is the most abundant and widespread endemic tree in Hawaii, occupying a wide range of habitats across Federal, State and privately managed lands. Populations continue to be fragmented due to agricultural land use and pressure from invasive species. Five varieties (*glaberrima, incana*, *megaphylla*, *newellii*, and *polymorpha*) are currently recognized on the island of Hawaii. Overlaying taxonomic determinations on the morphological character states of 347 herbarium specimens separated the varieties in ordinal space, but intermediate phenotypes were prevalent. Morphological and RAPDs analyses were undertaken for ten individuals at three sites (5600m high-elevation dry, 1500m mid-elevation wet, and 500m low-elevation dry). Individuals from the high and low-elevation sites had smaller, pubescent leaves with a higher leaf mass per area and nitrogen content than the mid-elevation individuals. Analysis of 187 RAPDs bands indicated 63% to 88% similarity between individuals within populations and 73% between populations. RAPDs data separated the three populations in ordinal space, but genetic overlap was found between taxonomic varieties. Results suggested that while gene flow between geographically close populations is present, environmental and edaphic conditions influence selection pressure on the genotype and phenotype of *M. polymorpha*. Choosing appropriate genotypes and phenotypes of *M. polymorpha* for outplanting for habitat reconstruction, and maintaining sufficient connectedness of ohia stands for the movement of its pollinators is important for the continued vigor of this species and its associated forest.

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THREATENED HAWAIIAN GREEN SEA TURTLES (*Chelonia mydas*) AND ENDANGERED HAWKSBILL SEA TURTLES (*Eretmochelys imbricata*) IN THE KAHO`OLAWE ISLAND RESERVE; DEVELOPING MONITORING TECHNIQUES FOR MANAGEMENT PURPOSES. The Kahoolawe Island Reserve is the largest State-held, contiguous marine reserve in Hawaii. It encompasses a two-mile radius surrounding Kahoolawe's 26 miles of coastline, totaling 78 square miles of marine and terrestrial protected area. The Kahoolawe Island Reserve Commission (KIRC) oversees the environmental and cultural restoration of the island in order to return it to a recognized, sovereign Hawaiian entity. Commercial activities are prohibited, and access is limited to cultural, restoration and cleanup activities, potentially providing a variety of relatively undisturbed, natural habitats for sea turtles. In August 2002, KIRC's Ocean Resources Program began designing standardized monitoring

techniques for the Hawaiian green sea turtle, honu, and hawksbill sea turtle, ea, within the Reserve. Aerial, in-water, and shore-based surveys will be carried out to discern how sea turtles utilize Kahoolawe's coastal waters for foraging, and beaches for basking and nesting. Eighty incidental sightings (since 1997), 29 anecdotal/cultural references, and 60 documentations from five previous studies of Kahoolawe's resources (since 1978) have been collated with 44 sightings from this project's preliminary aerial and in-water surveys. These 213 observations, containing an assortment of information, initially suggest that this population is smaller compared to that of other main Hawaiian Islands, favors the northwestern shore, and is mostly comprised of small (<2' or cited as "small"= 50%, n=51) and "small-medium" (22.5%, n=23) turtles, with no documentation of fibropapillomatosis to date.

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RAPD ANALYSIS OF POPULATION DIVERSITY IN *Hibiscus arnottianus*. Certain *Hibiscus* species in Hawaii have been threatened over the past century due to invasive animals, plants, and the increasing human population. Due to these factors, *H. arnottianus* habitat has been reduced to small pockets along the Koolau and Waianae mountain ranges with a decreased number of individuals in each population. This genetic erosion through restricted mating leads to inbreeding depression. Genetic analysis using 6 randomly amplified polymorphic DNA (RAPD) markers indicated that the *H. arnottianus* subsp. *arnottianus* population on the Manoa cliffs Trail (Koolau range) has enough individuals (n=14) for the genetic variability (64.7% similarity) in that area to be maintained. Clones of *H. arnottianus* subsp. *punaluuensis* served as an "outgroup" and showed the RAPD analysis was valid for reproducibility. Preliminary data was also obtained for *H. waimeae* and *H. arnottianus* subsp. *punaluuensis* individuals, but the small number of (appx. 2-3 individuals) did not give an sufficient measure of similarity to compare with *H. arnottianus*. Conservation managers can use this baseline data in order to test different management strategies and how this could affect the genetic variability of *H. arnottianus* populations. Future studies will determine the genetic variability within other populations (Punaluu and Waianae), and the effects of different levels of habitat degradation on the populations of *Hibiscus arnottianus*.

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ADVENTITIOUS NODULATION OF THE ENDEMIC TREE LEGUME *Acacia koa* GRAY: A UNIQUE MECHANISM OF ADAPTATION ASSOCIATED WITH OPPORTUNITY. *Acacia koa* Gray (koa) is a dominant canopy species and as one of only 14 endemic legumes in Hawaii, is an essential contributor to the nitrogen cycle of Hawaii's forest ecosystems. Symbiotic relationships between koa and and the microsymbiont *Bradyrhizobium spp*. are consummated with the development of root nodules typically confined to the terrestrial system. However, within the natural habitat, koa has also demonstrated a unique capacity to develop adventitious nodulating root systems within the compartmentalized decay zones of the tree crown. The

compartmentalized zones within a koa crown have a well-developed organic layer derived mainly from the decomposed heartwood and can harbor complex epiphytic communities. In many cases where adventitious nodulation has been observed, few to no nodules were found within the terrestrial rhizosphere. Adventitious nodules are frequently observed to be well developed and effective. The initiation of host adventitious root systems within the compartmentalized decay zone may be an opportunistic adaptation to competitively resequester nutritional resources made available via natural necrotrophic processes of decomposition. Comparative analyses between neighboring adventitious and terrestrial rhizospheres have identified significant differences for several key nutrients. Simulation studies were performed to measure saprophytic competence and symbiotic potential of the divergent microsymbiont populations in response to these distinct environmental parameters. Results associated with this unique biological event verify the importance of incorporating appropriate nutritional management strategies in koa outplanting protocols which are designed to promote effective nitrogen cycling.

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JUSTIFICATION AND PROCEDURES FOR THE CAPTURE AND TRANSPORT OF THE THREE KNOWN POOULI (*Melamprosops phaeosoma*) INTO CAPTIVITY. Since 1997, the entire known population of Poouli (*Melamprosops phaeosoma*) has consisted of only three individuals. Residing in three non-overlapping home ranges within Hanawi Natural Area Reserve (Maui, Hawaii), the birds are unlikely to breed without direct intervention. In 2002, an interagency working group attempted, without success, to establish a wild breeding pair by translocating one individual into the home range of another. With the three birds advancing in age, a new strategy was needed to further recovery efforts. The working group used a structured decision-making process to evaluate and compare success probabilities for alternative recovery strategies. Consensus was reached within the USFWS and Hawaii DLNR to remove the birds from the wild for captive propagation. Rigorous capture, transport, and acclimation protocols were developed based on previous work and established methods to maximize safety of the birds and program success. These protocols will be presented here in an attempt to satisfy concerns about the welfare of the three birds during the proposed management activities. With these protocols in place, we attempted to capture one of the Poouli during 1389 mist net hours between February and April, 2003. This work represents the latest in a series of recovery actions for this species that have proceeded from habitat-based management approaches to more intensive species manipulation.

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ISLAND-BASED PARTNERSHIPS AND STATEWIDE COORDINATION TO ADDRESS INVASIVE PESTS. Addressing Hawaii's invasive species problems requires better prevention measures, rapid response to and monitoring of incipient pests, and continued control of established pests. The Coordinating Group on Alien Pest Species (CGAPS), a government/non-government partnership, has worked since 1994 to address policy and funding issues for these three areas of need. One area of success has been with the formation of the Invasive Species Committees of Hawaii (ISCs) to function as rapid response and monitoring crews on each island. The ISCs are island-based, grassroots, government/non-government/private-business partnerships working to protect each island from the most threatening invasive pests. The ISCs have been successful and innovative in securing a range of public and private funding for their operations. Each ISC has a list of priority target species, evaluated and ranked to determine the level of threat and potential for control. ISC field crews survey, map, control and monitor priority targets such as miconia (*Miconia calvescens*). Since July 2001, the ISCs have surveyed over 54,000 acres and eliminated more than 637,000 miconia plants statewide, including 334,000 seeding trees. Additional work includes rapid response to reports of coqui frogs (*Eleutherodactylus coqui*) in previously uninfested areas, and searches for veiled chameleons (*Chamaeleo calyptratus*) and snakes. ISCs also assist the under-staffed Hawaii Departments of Agriculture and Land and Natural Resources in search and control work. The amount of control work shows the success of the ISC partnerships as wells as the continuing need for dedicated rapid response crews.

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FOREST CERTIFICATION ON PUBLIC AND NATIVE FORESTLANDS ACROSS THE US: IN-FIELD COMPARATIVE ASSESSMENT RESULTS BETWEEN THE FOREST STEWARDSHIP COUNCIL (FSC) AND THE SUSTAINABLE FORESTRY INITIATIVE (SFI). Forest certification – a non-regulatory independent verification of forest management practices to meet "well-managed" designation - has quickly become a standard in the forest products industry. Non-certified wood product producers are now denied access to domestic and worldwide markets; many loosing current market share as a direct result of not offering certified product. The Pinchot Institute for Conservation in Washington DC has undertaken the nation's most ambitious comparison evaluation of forest certification on public and Indian Nation

forestlands, allowing for FSC and SFI assessments to be conducted on the same forestlands at the same time. Over 5 million acres of public forestlands and 4 million acres of forests on 30 Indian Nations across the US have been dual assessed. The project has resulted in millions of acres of public forestland being awarded certification under one or both certification systems, but with specific requirements for forest management improvements in native forests to maintain certification status. The certification status has increased market access for purchasers of the certified supply, and has even resulted in increased legislative funding for the certified management of public forestlands. The lessons learned from public and native forestland managers in these Pinchot projects may highlight how forest certification might prove an effective conservation management and product marketing tool for Hawaii's forest resources.

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CHALLENGES OF NATIVE PLANT PRODUCTION FOR EMERGENCY LARGE SCALE FIRE RESTORATION PROJECTS. Resource managers at Hawaii Volcanoes National Park are expanding restoration efforts from relatively small-scale plant recovery projects to large-scale restoration of whole communities. Increasing the scale of restoration presents unique challenges with regards to obtaining adequate seed supply, understanding propagation requirements for a large number of ecologically disparate species, timing plant production to meet tight outplanting schedules, and developing protocols to transport, nurture and monitor outplants in the field. The 1008 acre Broomsedge fire provided opportunities to develop seed collection, plant production, and outplant strategies to meet the goals of a large-scale emergency restoration project. Twenty thousand plants and 2.75 million seeds composed of 31 species were targeted for establishment over three years. An intensive burst of seed collecting, processing and storing (200 worker days) was required to meet plant production goals in the initial three months of the project. Routine use of volunteers was required to maintain seed collection, and plant production schedules. Seeds were collected from >100 individuals/species to ensure broad founder representation. Germination and growth rates of >25 species was qualitatively determined to estimate production rates and enable propagators to synchronize individual species production to outplant schedules. Eight hundred planting nodes were established on a grid to facilitate outplant distribution and relocation. Outplant survivorship has been extremely successful (80-95%) for most species. The plant production and outplant strategies developed during this project will be refined and applied to ongoing and future large-scale community restoration projects.

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MANUAL AND BIOLOGICAL CONTROL OF MICONIA IN FRENCH POLYNESIA.
The alien tree *Miconia calvescens* (Melastomataceae) is a dominant invasive plant in the islands of Tahiti and Moorea. It has recently become naturalized in Nuku Hiva and Fatu Iva after being

accidentally introduced in soil contaminated with seeds. An inter-agency government effort to control miconia was mobilized in 1992 on Raiatea. After ten years of manual control and public education campaigns using volunteers (including the French Army), over 1,200,000 miconia plants were destroyed, including about 1,200 reproductive trees, on a 350 ha treated area. Due to the longevity of the soil seed bank, eradication was not attained and follow-up campaigns are still necessary. Moreover, isolated populations and reproductive trees were recently detected in remote and steep areas. A biological control program was initiated in 1997 with collaboration from the Hawaii Department of Agriculture. The plant pathogen *Colletotricum gloeosporioides* f. sp. *miconiae* (Cgm) was released in a study-plot on the island of Tahiti at Taravao in 2000. Anthracnose leaf spots appeared three weeks after inoculation, and at two months, 100% of the inoculated plants became infected. Post-release monitoring showed that the mortality rate was 10%, with 50% of the remaining plants with severe leaf and stem damage, and that the Cgm had dispersed and infected nearly all the miconia seedlings in a 2 km radius from the inoculated site. Miconia containment will clearly require long-term manual and chemical control with collaborative efforts, appropriate fundings, and above all, strong dedication and perseverance.

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THE KAHANA VALLEY AHUPUAA, A PABITRA STUDY SITE ON OAHU, HAWAIIAN ISLANDS. The acronym PABITRA stands for **P**acific-**A**sia **Bi**odiversity **Tra**nsect, a network of island sites and conservation professionals collaborating throughout the Pacific-Asia region. An ideal PABITRA site is a broad landscape transect from sea-to-summit. Such a landscape is the Kahana Valley on Windward Oahu. Kahana Valley served during prior centuries as an ahupuaa, a Polynesian unit of land management that integrates the three biological resource zones, the upland forests, the agriculturally used land below, and the coastal zone, into a sophisticated human support system. Results of terrestrial biodiversity surveys, as begun with a vegetation/environment study and a paleoecological investigation, will be presented in relation to historical land use and sea level changes. In spite of the many former human-induced modifications of the Kahana Valley landscape, the natural structure and function of its ecosystems are well preserved. The distribution patterns of vegetation can be interpreted in terms of Hawaiian ecological zones in combination with the valley's precipitation, topography, stream system, and archeological features. Currently, efforts are underway to restore the Kahana State Park as a functional ahupuaa. Additionally focused collaborative research can yield helpful information for further restoration and integrated management of the Kahana ahupuaa as a historic Hawaiian Heritage Site.

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SENSITIVITY OF HAWAIIAN ECOSYSTEMS TO CLIMATE CHANGE: SEASONAL RESPONSES OF MEGALAGRION DAMSELFLIES TO TEMPERATURE GRADIENTS AND MOISTURE STRESS. In the last five years, Hawaii has experienced at least three droughts during peak rainfall months. All of the most severe winter droughts in Hawaii have been associated with the El Niño phase of the Southern Oscillation and climate change models have predicted increases both the frequency and intensity of El Niño events. Understanding the biological repercussions of such change is important for future management of Hawaii's ecosystems. *Megalagrion* damselflies are an ideal focal taxon with which to study the potential impacts of climate change in Hawaii. The taxon includes both rare (endangered) and common species associated with a broad range of aquatic habitat from sea level to high elevation bogs. In this study, *Megalagrion* damselflies and associated invertebrates were surveyed along a seasonally fluctuating temperature and moisture gradient in the ephemeral streambeds of the Pahala watershed (Kau, Hawaii) from the coast up to 3,500' elevation. An overall reduction in Odonates was noted during the cooler, drier months. Shifts in population abundance of *Megalagrion* damselfly species, however, suggest that montane and coastal communities respond differently to seasonal fluctuations in moisture/temperature regimes. The results of this survey will be integrated with mesocosm experiments and broader habitat surveys to better predict the consequences of drought on *Megalagrion* damselfly communities in Hawaii.

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THE ENDEMIC LOBELIOID (*Clermontia oblongifolia* subsp *oblongifolia)*, AN ENDANGERED SPECIES, A VARIATION OF *Clermontia arborescens*, OR HYBRID BETWEEN *C. arborescens* AND *C. kakeana*? Understanding inter and intra species relationships for a given set of taxa can provide valuable insights into determining strategies for properly managing a given set of resources. This is especially true when faced with important decisions concerning endangered species and critical habitat. A case study involving the endangered lobelioid *Clermontia oblongifolia* subsp. *mauiensis* illustrates this point. Otto Degener last collected this taxon on East Maui in 1927. In 1994, two collections that fit the description of *C. oblongifolia subsp. mauiensis* were made at 850-900m near the Waikamoi Stream, East Maui, and one collection along the Puu Kukui Trail, West Maui, at the same elevation. *Clermontia kakeana* and *C. arborescens* are sympatric at both sites. RAPD DNA analysis was performed with the three taxa, along with *C. oblongifolia subsp. oblongifolia* from Oahu and *C. faurei* from Kauai. A distance tree constructed from the RAPD data show that all of the purported *C. oblongifolia* subsp. *mauiensis* cluster with the *C. arborescens*. The *C. kakeana* are closely associated with the *C. arborescens/C. oblongifolia* subsp *mauiensis* group. *Clermontia faurei* and *C. oblongifolia* subsp. *oblongifolia* form a separate group. In light of critical habitat designation, further studies to better ascertain the relationship between these taxa are warranted.

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SAPSUCKING BEHAVIOR AND TREE SELECTION IN THE ENDANGERED AKIAPOLAAU (*Hemignathus munroi*). Akiapolaau (*Hemignathus munroi*) peck 5 mm holes in particular ohia lehua (*Metrosideros polymorpha*) and drink the sap that emerges; a remarkable example of convergent evolution with mainland sapsuckers. There has been no research on how this rare species chooses sap trees and what advantages they confer. I located, marked the coordinates, collected sap samples, and recorded microhabitat data for 100 sap trees and 75 random control trees at Hakalau Forest National Wildlife Refuge, Hawaii. I found that sap tree sap is approximately 16% sugar, which is six times the sugar content of commercial sugar maples. Sap trees gave more sap and gave sap faster than control trees. Sap trees also had a larger diameter and thinner bark than controls, and were located in more topographically concave areas where more moisture is available. Sap trees have a clumped spatial distribution and a low density of one per two hectares of forest. These results suggest that sap trees share unique environmental characteristics that distinguish them from other ohia lehua and are a rare and potent energy source for akiapolaau. Sap trees may be useful for management because their presence is a sure indication of current or past akiapolaau habitat, and because as a potentially important supplementary food source in times of low insect availability, or as a substitute for ohia nectar, they are another factor that must be considered when identifying or restoring quality habitat for this endangered species.

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UNMASKING THE VEILED CHAMELEON (*Chamaeleo calyptratus*): EFFORTS TO CONTROL AN INCIPIENT POPULATION. The veiled chameleon (*Chamaeleo calyptratus*), native to Yemen and Saudi Arabia, is considered an injurious alien species in Hawaii. A recently discovered veiled chameleon population in a residential area of Makawao (Maui) has been the target of a coordinated control effort by state, federal and invasive species committee personnel. Based on knowledge of the distribution of the species in its native range, its larger size, and omnivorous feeding habits, officials consider the veiled chameleon to pose a greater risk to native plants and animals than the well-established Jackson's chameleon (*Chamaeleo jacksonii*). Search efforts have concentrated on properties within a 150-meter diameter circle. Since December 2002, twelve searches have yielded a total of 52 individuals. Area residents independently captured and turned in an additional three individuals during that time. Of the total captured, 26 were identified as males and 31 as females. One gravid female contained 40 eggs. The chameleons were found in 11 different types of plants, with approximately 54% found in Christmas berry (*Schinus terebinthifolius*). The number of chameleons recovered per person-

hour during an intensive four-night sweep of the presumed population center suggests that control efforts to date have not caused a significant population decline. Additional research on unconfirmed sightings in peripheral areas is needed.

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MEASURING CONSERVATION SUCCESS ACROSS TERRESTRIAL LANDSCAPES. Measuring conservation success involves assessing threats and components of ecosystem integrity. TNCH has monitored ungulate and weed threats in its preserves for many years, and has conducted small-scale vegetation monitoring to assess the effects of specific management actions. With the advent of watershed partnerships, the need has arisen to devise simple, cost-effective methods that can be implemented over larger landscapes. Inherent in such a scheme is the identification and measurement of a small set of key factors or indicators in lieu of the more detailed, time-consuming, and costly monitoring attempted in the past. To that end, TNCH proposes several key factors to provide coarse-scale information about conservation progress in a landscape. Ground-based factors include the range and severity of habitat-modifying weeds and ungulates; the ratio of native to alien plant cover in the understory; and presence of selected native plant taxa. Ground-based measurements will be augmented by Hawaii GAP program analysis of remotely-sensed imagery, which is expected to yield information about two additional key factors: canopy condition and areal extent of native ecosystems. One more factor, landscape context, is based on the conservation and management mandates of surrounding lands. Products of this coarse scale monitoring are not designed to substitute for finer scale monitoring of specific management actions (adaptive management) but are designed to provide information about areas in which little management has heretofore taken place. This coarse-scale information is designed to assist land managers in prioritizing areas for more focussed conservation management action.

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EVALUATING THE POTENTIAL FOR MANAGEMENT OF AVIAN DISEASE (*Plasmodium relictum*) IN A MESIC-DRY FOREST OF HAWAII VOLCANOES NATIONAL PARK**.** Avian malaria has caused great losses and range reduction in Hawaii's endemic avifauna over the last century. Attempts to restore native forest bird communities will require management of this mosquito-borne disease. To assess the potential of mosquito (*Culex quinquefaciatus*) control for management of disease, we studied avian malaria transmission among Hawaii amakihi (*Hemignathus virens*) inhabiting an isolated mesic-dry forest within Hawaii Volcanoes National Park (Feb 2001 - August 2002). Surveys were conducted to identify and map all mosquito larval habitats, and adult mosquitoes were captured monthly and dissected to estimate densities and infection rates. Forest birds were mist-netted, bled, and specimens

analyzed utilizing serological techniques (ELISA) to determine prevalence and transmission rates. Ninety-five percent of producing larval mosquito habitats were anthropogenic (catchment systems, troughs). Only one of the potential natural larval habitats (tree hole in an exotic species) contained *Culex* at any time. Adult mosquito captures averaged .052 mosquitoes/trap night with a peak of .22 mosquitoes/trap night in June 2002. The mean infection rate in host-seeking mosquitoes was 7%. Despite apparently low mosquito densities, malaria was moderately prevalent (18%) in the amakihi population and there was active disease transmission. We conclude that elimination or treatment of anthropogenic larval habitat should result in a break of malaria transmission in this mesic-dry forest, thus creating a disease free area for the potential reintroduction of birds now extirpated from the park.

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HABITAT USE AND HOME RANGE OF THE LAYSAN TEAL (*Anas laysanensis*) ON LAYSAN ISLAND. The Laysan teal, *Anas laysanensis,* is a non-migratory duck previously widespread in the Hawaiian Islands, but currently restricted to the 415 ha of Laysan Island National Wildlife Refuge. The species is federally endangered, and occurs as a single, relict population. Refuge managers are interested in restoring ecosystems of the Northwestern Hawaiian Islands, however little is known about the Laysan teal's habitat use. Wild translocation, or the movement of wild birds to establish new populations, has been proposed to reduce the species' high extinction risks. Information on the species' range of resource use on Laysan will provide insights into its ecology, and may provide insights as to the suitability of translocation sites with respect to those resources. To provide details on the species' habitat use, Laysan teal were systematically radio tracked during 24 hr periods during 1998-2000. Glued radios were retained for a mean of 40 days (0-123 d; N=73 adult birds radio tagged). Daily habitat use comparisons showed strong evidence of selective habitat use by time of day (63-94%). Most adults preferred the terrestrial vegetation (88%), and avoided the lake and wetlands during the day. At night, 63% of the birds preferred the lake and wetlands. Most showed strong site fidelity during the tracking period, but habitat selection varied between individuals. Mean home range size was 9.78 ha (SE 2.6) using the fixed kernel estimator (95% kernel; 15 birds with >25 locations). Core areas of use (50% kernel) averaged 3.2 ha (SE 1.45).

Haldre Rogers

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NEW RAPID RESPONSE TEAM TRAINED ON GUAM TO RESPOND TO BROWN TREESNAKE SIGHTINGS ON US-ASSOCIATED PACIFIC ISLANDS. The Brown Treesnake (*Boiga irregularis*, BTS) is an invasive species that has been established on Guam since the 1940's and is a threat to other Pacific Island economies and ecological resources. The BTS is believed to spread from island to island primarily in cargo shipments. Despite extensive

outgoing cargo and aircraft inspection programs on Guam, snakes have been found in other locations, which are often ill equipped to respond adequately to the sightings. Therefore, the USGS-based Rapid Response Team (RRT) was developed to respond to BTS sightings on US-associated Pacific Islands. At the request of local officials, the RRT immediately deploys a team of 2-5 searchers to the location of a recent snake sighting. Since these nocturnal snakes are extremely cryptic, searchers are trained on Guam to capture a BTS in virtually any environment using nighttime visual searches. The team is also experienced in the use of snake traps, although some studies call into question the effectiveness of trapping in areas of high rodent density, as is often the case on Pacific Islands. A typical deployment may last for up to two weeks. In addition to searching for snakes, the RRT also raises awareness about the threat of BTS through media coverage and public presentations during deployments. These presentations encourage vigilance among islanders in locating and reporting BTS in order to prevent the spread of this invasive species.

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PROTECTING NATIVE HAWAIIAN FOREST THROUGH A UNIQUE PARTNERSHIP. The Olaa - Kilauea Partnership is a cooperative land management effort for 420,000 acres on the island of Hawaii. Recent additions to Partnership lands have lead to new challenges as well as opportunities for science and resource management on a landscape scale. The project area currently includes state lands (Kulani Correctional Facility and Puu Makaala Natural Area Reserve), federal lands (Hawaii Volcanoes National Park), and private lands owned by Kamehameha Schools (Keauhou Ranch, Kilauea Forest, Kau and Kona Uka). The Partnership also includes U.S. Fish and Wildlife Service, U.S. Geological Survey, and U.S. Forest Service. The Partnership area contains one of the best remaining native forest ecosystems in Hawaii with a high level of biodiversity. Overall goals include enhancing the long-term survival of native ecosystems and managing a large contiguous area across ownership boundaries. Active management is critical for the stabilization and recovery of rare species and will also keep more common native species from declining. Management guided by applied research is currently focused on removing or reducing impacts from feral ungulates, alien plants and non-native predators, documenting the response of native and alien species to management, restoring native habitat and rare species, and providing work training and education to Kulani inmates. Partnership members are also strategizing about how to effectively plan for and manage a large landscape which includes the additional Kamehameha Schools lands recently added to the partnership.

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AVIAN CAPTIVE MANAGEMENT TECHNIQUES FROM TWO ARCHIPELAGOS. By virtue of their geographic isolation, the New Zealand and Hawaiian archipelagos share many of the same ecological features that have resulted in a sharing of many of the same conservation issues. Of great conservation concern are the limiting factors that have severely impacted the endemic avifauna. One conservation strategy that has proven to be effective in restoring endangered avian species in New Zealand and Hawaii is captive management, which includes propagation and release, translocation and cross-fostering. The Hawaii Endangered Bird Conservation Program has hatched and reared over 300 chicks of 12 Hawaiian forest species with greater than 80% success in both hatching and rearing. This record is rarely met or exceeded. Since 1993, the techniques required to hatch and rear such small and difficult passerine species have been developed and refined using historical models from zoos and private aviculture. Providing nesting birds with artificial nests is one conservation strategy being tested with varying success in both New Zealand with the Kaka (*Nestor meridionalis)* and Hawaii with the Puaiohi (*Myadestes palmeri),* among other species. The opportunity to exchange knowledge about managing limiting factors and recovery techniques can be invaluable for the restoration of endangered birds as well as other species. The Hawaii Conservation Alliance and Landcare Research New Zealand, Ltd. provide such opportunities for the exchange of information between Hawaii and New Zealand.

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APPLICATION OF DERMAL TOXICANTS AS AN EFFECTIVE MANAGEMENT TOOL TO CONTROL AND ERADICATE THE COQUI FROG (*Eleutherodactylus coqui)* AND THE GREENHOUSE FROG *(E. planirostris)*. The Coqui frog (*Eleutherodactylus coqui*) and the greenhouse frog (*E. planirostris*) have recently become established in the state of Hawaiÿi and may affect the floriculture industry as plants maybe denied entry to other ports. These frogs may also affect Hawaiian forests through direct competition of food with native birds and direct consumption of endemic insects**.** Previous tests have shown that citric acid is an effective frog toxicant, and maybe used as a quarantine measure. Research has found that 16% citric acid is the lethal threshold for coqui and greenhouse frogs and has proven low phytotoxicity to common greenhouse plants. Citric acid may be an effective quarantine tool to remove frogs from plant

shipments and reduce populations in natural areas. Caffeine (2%) has also been found to be lethal to both species of frogs but is not currently registered for use by the Environmental Protection Agency (EPA). It is currently under review by the EPA for quarantine measures which include greenhouses and natural areas. USDA, APHIS, WS, NWRC also plans to research additional dermal toxicants for coqui and greenhouse frog control and eradication.

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WETLAND RESTORATION - A CASE STUDY: HAMAKUA MARSH ECOSYSTEM RESTORATION AND COMMUNITY DEVELOPMENT PROJECT. The Hawaii State Department of Land and Natural Resources along with numerous community partners are working to restore a 22-acre wetland ecosystem at Hamakua Marsh, Kailua, Oahu. The objective of the Hamakua Marsh Ecosystem and Community Development Project is to restore habitat for native Hawaiian water-birds and migratory shorebirds in Hamakua Marsh Wildlife Sanctuary, and to involve local organizations, businesses, schools and county, state and federal agencies in the process in order to integrate the wildlife sanctuary into the fabric of the community. By including a broad spectrum of community organizations, businesses, schools and government agencies, the project will instill a sense of ownership by local citizens, educate residents and visitors. Results from the first year of this multi-year project include significant on-the-ground wetland restoration accomplishments including the removal of invasive species and the development of an educational web site for the general public produced by local elementary school students. This project has generated positive environmental stewardship by involving community members in the restoration and management process. Through community involvement, conservation mangers can establish a working conduit that will generate funding and ensure the success of community-based habitat conservation projects.

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DIVERSITY, ABUNDANCE, SEASONALITY, AND INFECTION OF MOSQUITOES ON WINDWARD MAUNA LOA. As part of the Biocomplexity of Avian Disease project, we have spent the last year investigating mosquito populations and avian malaria, *Plasmodium relictum* in mosquitoes. Using CO_2 traps and Reiter Oviposition traps we trapped approximately 7000 trap nights over 12 months, on nine one-square-kilometer study grids at low- (<300m), mid- (1200m) and high- (1800m) elevations. We trapped three non-native species of mosquito, *Culex quinquefasciatus, Aedes albopictus*, and *Wyeomeia mitchelli*, in a variety of forest types between 0 and 1800m elevation on the southeast slopes of Mauna Loa. *Culex quinquefasciatus* mosquitoes (most competent *P. relictum* vector) were dissected and infection status determined by microscopy. All three species of mosquito were present at low-elevation, with highly variable

relative abundances among sites. Only *Culex* mosquitoes were found at mid and high elevation, with great variability between field sites, and virtually no mosquitoes found at high-elevation. *Wyeomyia* populations increased from May- June; *Aedes* and *Culex* populations at low elevation and *Culex* at mid elevation increased from June through November. At mid and low elevation sites, *Culex* populations experienced large spikes throughout the year. *Plasmodium relictum* was found at all sites below 1800m. Prevalence of *P. relictum* in *Culex* mosquitoes varied greatly among low elevation sites and among mid-elevation sites. Infection rates appear to rise in late summer and fall, decreasing gain in winter. These data aid in identifying key climatic, biological, and geological elements and land use practices that help predict disease risk and target management strategies.

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DISTRIBUTION AND ABUNDANCE OF NATIVE FOREST BIRDS IN LOW-ELEVATION HABITATS ON HAWAII. Recent studies have reported breeding populations of native bird species at low-elevation (<350m) sites on Hawaii. These findings contrast with previous studies that showed low-elevation areas were nearly devoid of native birds. Here we document the distribution and abundance of native forest birds over a wide area of low-elevation habitats on Hawaii. We conducted systematic Variable Circular Plot (VCP) counts along approximately 116 kilometers of primary and secondary roads on the east slope of Kilauea volcano (Lower Puna District) from February-June 2003. A total of 166 survey stations ranged in elevation from sea level to 320 meters covering much of the land between Hawaii Paradise Park subdivision and Kalapana town. Native Hawaii Amakihi (*Hemignathus virens*) were distributed widely throughout the study area and were common and patchily abundant at sea level, while native Apapane (*Himatione sanguinea*) were found less frequently, in smaller numbers, and locally below 30m. Relative abundance and frequency of Amakihi along a 35-km section of our lowest elevation route (0-55m) appear to have increased over the past decade: surveys in February 2003 documented Amakihi at 11/50 stations (19%, mean Amakihi per station =0.56, SE=0.17), compared with no Amakihi at 12 stations surveyed in December 1993 - February 1994. Our data expand the ranges of native bird species on Hawaii, and demonstrate need for greater conservation efforts to preserve remaining low-elevation Hawaiian forests as potential habitat for both existent and recolonizing populations of native bird species.

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INFORMATION GATHERING AND DEVELOPMENT OF METHODOLOGY TO ADDRESS NEWLY EMERGENT ALIEN PLANT SPECIES ON MAUI. The island of Maui was used to develop a prototype an test methodology over a 3-year period for detection of emerging invasions of alien plant species. Data were gathered for incipient plant invaders suspected of potentially posing threats to Haleakala National Park and other important reserves of biodiversity on Maui. Photos were used to develop search images of target plants

with which we were unfamiliar. Surveys involved driving all roads at 5-10 mph while recording locations of each target species with a GPS unit. Road surveys (1,246 miles) recorded 15,067 plant locations for 100+ pla species. Interviews with ten expert field botanists added 964 locations for 79 plant species. During surveys, a plants that were not known were collected and processed through Bishop Museum, resulting in 45 new state records and 65 new island records. Methodology used proved successful for locating new invaders and findir new locations for known incipient invaders. Island-wide distribution maps based on field surveys and reports based on field observations and literature searches were prepared (see www.hear.org/starr/hiplants). The wor demonstrates very clearly the relationship between plants in nurseries/gardens/yards and invasions of natural areas. Information gathered provides insights into potential, need, and priorities for proactive island-wide prevention, detection/eradication, and containment of invasive plants and is particularly useful to the NPS Exotic Plant Management Team and the Maui Invasive Species Committee.

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POPULATION TRENDS OF FERAL PIGS (*Sus scrofa*) IN MONTANE WET FORESTS IN AND AROUN HAWAII VOLCANOES NATIONAL PARK. Feral pigs (*Sus scrofa*) are well established in the Hawaiian Islands and have been shown to cause significant damage to native ecosystems and especially montane wet forests in Hawaii. Attempts to control pigs in conservation areas have included fencing, hunting, snaring and trapping. However, there has been relatively little effort devoted to monitoring population trends. Steve Anderson and Charles Stone showed that pig densities could be extrapolated from the frequency of observed activity along transects, including soil digging, plant feeding and other indirect sign. From 1993-2003, approximately biannual pig activity surveys have been conducted in both pig-control and non-pig-control are of Hawaii Volcanoes National Park (HAVO) and adjacent sections of the Kahaualea and Puu Makaala Natur Area Reserves. Estimates of pig densities in these areas were calculated using linear models developed by Anderson & Stone 1n 1994. Feral pig densities in montane wet forests surveyed ranged from 0 to approximately 16 pigs/sq.km. No significant seasonality was observed in pig populations during this time period. Similar population trends in closed and open units suggest that local population densities are not determined by migration. These results will be useful for developing future management strategies for feral pigs in rainforests of Hawaii.

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BIRD AND PLANT COMMUNITIES IN *Acacia koa* REFORESTATION AREAS. Forest communities in the Hawaiian Islands have been transformed by human occupation, with declines and extinctions of forest bird populations the result. *Acacia koa*, an endemic co-dominant tree in wet montane Hawaiian forests, is the current focus of reforestation projects with both ecological restoration and economic goals. We compared avian and vegetation communities in koa reforestation areas at Keauhou Ranch (Kamehameha Schools) and Hakalau Forest National

Wildlife Refuge to those in nearby native forests with two goals: 1) determine whether koa reforestation areas grow to resemble native Hawaiian forests in structure, composition and diversity, and 2) determine whether and how native forest bird species use the young koa. Over the study period we observed foraging activity in the koa reforestation areas by six native forest bird species, including one endangered species (akiapolaau, *Hemignathus munroi*). This compares with eight species that are common in nearby native forest. Iiwi (*Vestiaria coccinea*), apapane (*Himatione sanguinea*), common amakihi (*Hemignathus virens*), and elepaio (*Chasiempis sandwichensis*) were observed in the koa reforestation areas at Hakalau Forest NWR on at least 67% of visits. In addition to these species, omao (Myadestes obscurus) and akiapolaau were common (100% and 86% of visits respectively) in the koa stands at Keauhou Ranch.. These results suggest that establishment of *A. koa* plantations may facilitate native ecosystem regeneration on degraded lands though additional efforts may be necessary to ensure development of a diverse understory.

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EFFECTS OF PREDATOR CONTROL ON SEABIRD BREEDING AT KAENA POINT, OAHU, HAWAII. Kaena Point is one of the most remarkable new seabirds breeding sites in the main Hawaiian Islands. Only 10 years ago, there was virtually no seabird breeding activity at the Point. Now, two species of seabirds, Laysan albatross (*Diomedia immutabilis*) and wedge-tailed shearwater (*Puffinus pacificus*) currently breed at Kaena Point. However, introduced predators, such as cats, dogs, and mongooses, have historically prevented or restricted breeding success. The Hawaii state government started predator control at Kaena Point in 1992 after a pair of Laysan albatross successfully fledged the first chick recorded from that area. The predator control program became even more important when wedge-tailed shearwaters also started nesting there in 1994. Since then, both seabird species have continued to nest at Kaena Point. In 2000, the State government contracted the U.S Department of Agriculture (USDA) to work exclusively on predator control. USDA has used live traps, bait stations and night shooting to control predators. The resulting improvements in predator control, attributable to increased effort and an exclusive focus on predator control, caused a marked improvement in seabird breeding success. For example, the wedge-tailed shearwater fledging success rate has improved from nearly 0% in 1998 to 55% in 2002. Additional management actions to reduce the effects of predation and human disturbance, potentially including new baits, fencing and other methods, have the potential to further improve breeding success.

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MONITORING NATIVE FISH IN THE HANALEI RIVER, KAUAI. In response to the community's interest and concern for the status of native oopu in the Hanalei River, the Hanalei Heritage River Program has established a volunteer survey and monitoring program. Three sites in the lower reach of the river have been monitored monthly for nearly three years. Bottom substrate in the two lowest sites is sand-gravel-cobble, and oopu naniha (*Stenogobius hawaiiensis*) dominates. The upper site substrate changes to cobble-boulder and oopu nakea (*Awaous guamensis*) becomes more common. Oopu naniha does not occur above the upper site and oopu nopili (*Sicyopterus stimpsoni*) are not found below this site. The numbers of both species increase during the summer months. The increase appears to be juveniles recruiting upstream rather than adults drifting down to spawn. At some sites, even far upstream, alien green swordtails (*Xiphophorus helleri*) are the most abundant fish. Larvel output is monitored using a plankton net. Eighty percent of larvae captured drifting are oopu nakea. We found larvae drifting from November to February, corresponding to the rainy season. The most important pattern we observed is extremely low numbers of larvae. There appears to be less than 10% of oopu larvae coming out of Hanalei compared to Wainiha and Limahuli streams on Kauai. Chronic sedimentation affects the streambed spawning grounds of the Hawaiian oopu. Our program, with funding from EPA, is prepared to implement sediment control and wastewater contamination reduction during the next two years, to improve spawning grounds for the oopu.

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HAWAII OFFSHORE ISLET RESTORATION COMMITTEE (OIRC) SURVEYING AND RESTORING SELECTED SEABIRD ISLETS IN THE MAIN HAWAIIAN ISLANDS. Survey and restoration plans and initial survey results will be presented for Hawaii's newly formed Offshore Islet Restoration Committee (OIRC). The OIRC is a cooperative, multi-agency group that is prioritizing offshore islets in the main Hawaiian Islands for biological surveys and targeting selected islets for restoration, based on biological values, the nature of the threats and feasibility of restoration. The isolation of the islets has made them the last refuge for the majority of seabirds in the main islands as well as several rare and endangered coastal plants. Genetic material from rare plants will be collected and cultured. Restoration actions will include removal of rats, rabbits, invasive weeds and possibly alien ants. Re-introduction of appropriate coastal plants and erosion control will also be considered. One recent success story is the eradication of rats from Mokolii (Chinaman's Hat) in Kaneohe Bay. The Hawaii DLNR and a dedicated community group used diphacinone and snap traps to eradicate rats and the results were nearly immediate. After the rats were eradicated, 126 wedge-tailed shearwater chicks fledged in 2002, compared to 1 chick for the previous three years combined.

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SEROLOGICAL EVALUATION OF POXVIRUS AND MALARIA INFECTION OF NATIVE FOREST BIRDS ON THE BIG ISLAND OF HAWAII. Avian pox (*Poxvirus avium*) infections may severely impact native bird populations in Hawaii. The disease is characterized by proliferative lesions on the unfeathered skin of the toes, legs or head, and in severe cases on the mucous membranes of the mouth, eyelids and upper respiratory tract. We have developed an assay (ELISA) to measure avian IgG plasma antibodies directed against a poxvirus strain isolated from a cutaneous lesion removed from an Iiwi (*Vestiaria coccinea*) and propagated *in vitro* in Muscovy duck (*Cairina moschata*) embryonic fibroblast culture. Antibodies to poxvirus were detected in heparinized plasma from 11/110 Hawaii amakihi (*Hemignathus virens*), 25/103 apapane (*Himatione sanguinea*) and 4/48 Iiwi captured between April 2001 and March 2003 at 9 study locations from 200 m to 1800 m elevation on eastern Mauna Loa and Kilauea volcanoes. The same birds were tested for exposure to avian malaria (*Plasmodium relictum*) using another ELISA. The birds fell into 3 categories: (1) malaria-negative/pox-negative, (2) malaria-positive/pox-positive and (3) malaria-positive/pox-negative. We found no serological evidence of pox-positive/malaria-negative birds in the sample we evaluated. Strong association of pox antibody with mosquito-transmitted malarial infections (40 of 132 malaria-positive birds were also pox-positive) indicates poxvirus transmission in forest birds is predominantly mosquito-mediated, rather than between infected and susceptible birds or by contact with contaminated objects. Control of the vector mosquito *Culex quinquefasciatus* is critical to minimizing the spread of poxvirus and malaria in native forest birds.

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MODELS FOR INTERACTIONS BETWEEN RESEARCH AND RESOURCES MANAGEMENT AT HAWAII VOLCANOES NATIONAL PARK. The interaction of research and resource management in conservation areas in Hawaii can be described by two main models. The *classical model* is that researchers and resources managers collaborate to identify research priorities. Researchers then carry out the research and provide results to resource managers who apply them to conservation problems. The most straight- forward application is with tools to control alien species. This model is being followed in two current alien species suppression programs involving rats and yellowjacket wasps. Researchers are collecting efficacy data in support of registering pesticides for use in conservation areas. Managers will be provided with label instructions for control of these species. The more common science-management interaction is the *consultative-monitoring model* that is implemented in the context of adaptive management. Researchers are consulted by resource managers in developing management strategies, based on the best biological knowledge available. Managers then initiate action, monitor results, and revise strategies based on an evaluation of results. Often researchers are consulted in designing monitoring to evaluate results of management actions in more

sophisticated ways to evaluate the effects of management strategies such as removal of feral pigs. The dichotomy between research and resources management in Hawaii has become increasingly blurred in the past decade. This can be viewed as a paradigm shift where research and resources management have become in many ways indistinguishable. The process is best illustrated by the case history of the invasive faya tree.

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ENDANGERED SPECIES RESTORATION AT KANEPUU PRESERVE, LANAI Kanepuu Preserve, located on the western plateau of Lanai, contains the last remnant of olopua/lama (*Nestegis sandwicensis*/*Diospyros sandwicensis*) dryland forest in the world. This rare dryland forest community once covered large portions of the lowlands on the main Hawaiian Islands, but is now restricted to disjunct stands covering less than 1 square mile. Lands surrounding the preserve are utilized for sustained-yield sport hunting of axis deer and mouflon sheep, and for domestic cattle grazing. The preserve has been fenced to prevent these animals from further damaging native vegetation. The restoration goal at Kanepuu is to create conditions in which the olopua/lama dryland forest is regenerating with a sustainable level of human assistance in the form of fence maintenance and weed control. Restoration activities focus around the areas with the most intact native vegetation. Kanepuu Preserve is home to seven rare plant species including four federally listed as endangered: iliahi (*Santalum freycinetianum* var. *lanaiense*), nau (*Gardenia brighamii*), mao hau hele (*Hibiscus brackenridgei* ssp. *brackenridgei*) and the vine *Bonamia menziesii*. We have successfully propagated these rare species, and nearly 100 out-planted individuals are growing in the preserve. Kanepuu has self-regenerating populations of all four of these endangered plant species. As of 2003, naturally occurring and out-planted individuals bring the known population of these rare species in Kanepuu to: ~60 Gardenia; >100 Hibiscus; ~100 Bonamia; and >100 Santalum. A fifth endangered species, *Abutilon menziesii*, has also been propagated and seedlings are slated for out-planting into Kanepuu.

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PROTECTING STATE UNENCUMBERED LAND AND MARINE RESOURCES: A GRASSROOTS APPROACH AT KEONEOIO (LA PEROUSE BAY), MAUI. La Perouse Bay has some of the state's most pristine coral reef and is an important resting habitat for spinner dolphins (*Stenella longirostris*), which are protected under the Marine Mammal Protection Act. In the Keoneoio 65-acre Hawaiian Historic Register District there are over 80 archaeological sites, rare plant species, and anchialine ponds. Our human use data show that these natural and cultural resources are being impacted by hundreds of visitors each day. Between rapid growth of nearby Kihei and Wailea, and guidebook, TV, and other commercial advertisement, more people are using the site than ever before. Despite increased use, this unencumbered land lacks funding and personnel for effective management. Under the current circumstances, resource damage is inevitable: archeological sites have been raided, used as toilets and/or destroyed. Spinner dolphins, which hunt offshore at night and come into the bay in the daytime to rest, nurse their

young, and socialize, are subject to frequent intrusions by boats, swimmers, and kayakers. Parking is overcrowded and illegal commercial activities often block ocean access. The grassroots group known as Friends of Keoneoio has formed to help protect these resources. Working in partnership with Hawaii Wildlife Fund, we have received grants for the past two years to conduct baseline human use research, provide educational outreach, and participate in working groups with the State DLNR and others to implement emergency resource protection measures at Keoneoio and identify long-term management options.

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AERIAL INTERDICTION: MICONIA (*Miconia calvescens*) CONTROL ON MAUI ENTERS A NEW ERA. A rapidly expanding population of miconia (*Miconia calvescens*) was first discovered on East Maui during a helicopter reconnaissance flight in 1989. Since then, aerial reconnaissance and control have played an increasingly important role in the war on miconia. In the years between 2000-2003, the Maui Invasive Species Committee (MISC) has devoted over fifty percent of its resources to miconia operations in order to define and contain the population on East Maui. Significantly expanded support from the National Park Service is allowing MISC and coordinating agencies to escalate aerial control activities. Increased aerial operations have fostered improvements in herbicide mixtures, spray equipment and mapping methodology. Plant density models from previous ground operations are combined with data from recent aerial operations to help guide aerial control strategy and to achieve increased efficiency and effectiveness. As aerial operations continue to improve, containment of Maui's miconia population will become a reality.

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THE TALE OF TAAPE (*Lutjanus kasmira*) AND ROI (*Cephalopholis argus*). Introductions of non-native fish species, both accidental and deliberate, have occurred in Hawaii for over 100 years. Acknowledged declines in nearshore food and game fishes prompted a surge of such introductions in the late 1950's and early '60's. The introductions were viewed as a way to augment depleted nearshore fisheries. Two of the introduced species, taape (*Lutjanus kasmira*) and roi (*Cephalopholis argus*), have proven to be particularly controversial however. Both fishes adapted well to Hawaiian waters and are now well established. They are often blamed for depletion of desirable species due to competition or predation. Much misunderstanding exists as to the exact impact of these species on our reef communities. A PowerPoint presentation was designed to provide the public with the latest information on the introductions of taape and roi. Historical background, pertinent fisheries data, and scientific research information are graphically presented in an effort to educate the public and shed light on this longstanding controversy.

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MONITORING KOHOLA/HUMPBACK WHALE (*Megaptera novaengliae*) PRESENCE IN THE KAHOOLAWE ISLAND RESERVE FOR MANAGEMENT PURPOSES. The Kahoolawe Island Reserve faces unique management challenges due to its cultural importance as the sacred embodiment of the ocean god Kanaloa. Seized by the U.S. Navy in 1941 and used as a live-fire range for 50 years, the Kahoolawe Island Reserve's resources are now monitored by the Kahoolawe Island Reserve Commission (KIRC) and are held in trust for a future, sovereign Hawaiian entity. In partnership with the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS), KIRC's Ocean Resources Program conducts kohola (*Megaptera novaengliae*) land-based surveys from Lae O Na Kohola. Surveys are conducted during winter months in conjunction with HIHWNMS's official Annual Ocean Count, with Kahoolawe's count representing the four-island region – Maui, Kahoolawe, Lanai, and Molokai. In addition to incorporating Ocean Count methodologies, a theodolite is used to precisely record positions of pods around Kahoolawe. Connecting with the Auau channel and neighboring waters of the Sanctuary, Kahoolawe's shallower waters may serve as important habitat for the endangered kohola. KIRC has compiled and analyzed two years of theodolite survey data and cultural information to determine kohola habitat within the reserve. Initial results indicate that 23 percent of pods in waters shallower than 30 fathoms (Zone A, n=22 pods) include a calf, in comparison with 11 percent in waters deeper than 30 fathoms (Zone B, n=59 pods), suggesting that shallower waters in the reserve, frequented by kohola may benefit from some management protections similar to those of the Sanctuary.

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SEED SCIENCE IN THE SERVICE OF HAWAIIAN PLANT CONSERVATION. Recent years have witnessed a rapid increase in use of seeds in Hawaiian plant conservation. Parallel to this has been a rapid growth in application of seed science to Hawaiian plant conservation programs. Examples are seed storage and dormancy and germination studies. At Lyon Arboretum in Honolulu, the Center for Conservation Research and Training (CCRT) now operates a seed storage facility to support field conservation work. Earlier this year, Dr.s Carol and Jerry Baskin from the University of Kentucky held a seed dormancy master workshop at the University of Hawaii, using examples from their work on Hawaiian seeds. These activities advance both Hawaiian plant conservation and basic biology, as conservationists provide seeds

to researchers, whose results in turn provide valuable management information for conservationists. An information network has been established to maintain contact between seed users and researchers and coordinate research needs of seed users with research providers. This year, CCRT has started a program to provide on-site assistance to help seed users develop their own in-house seed storage facilities. Institutions interested in participating should contact the author at CCRT. Advice on seed storage is available on the Hawaiian Conservation Alliance web site at http://www.hawaii.edu/scb/seed/seedmanual.html.