

**INVENTORY OF SEABIRDS, PLANTS, AND ARTHROPODS ON
TWENTY OFFSHORE ISLETS IN THE MAIN HAWAIIAN ISLANDS
July 2008**

COVER

Aerial view of Pu'u pehe Islet with the Lanā'i coastline in the background.
Photo by Jaap Eijzenga.

**INVENTORY OF SEABIRDS, PLANTS, AND ARTHROPODS ON
TWENTY OFFSHORE ISLETS IN THE MAIN HAWAIIAN ISLANDS**

Final Report Prepared for the National Fish and Wildlife Foundation

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Executive Summary

Biological inventories were conducted on 20 islets offshore 7 of the main Hawaiian Islands: Ni'ihau (Lehua), Kaua'i (Moku'ae'ae), O'ahu (Mokoli'i, Kapapa, Kāohikaipu, Mānana), Maui (Moke'ehia, Moku mana, Mokuhuki, Mokupipi, Pu'uku, 'Ālau) Lanā'i (Po'opo'o, Pu'u pehe, Ki'ei), Moloka'i (Moku manu, Mokuho'oniki, Kanahā), and Kaho'olawe (Pu'u koa'e, 'Āle'ale). Our primary focus was to complete baseline arthropod surveys, but due to the expense and difficulty of accessing many of the islets, we took the opportunity to conduct seabird and plant surveys as well. All arthropods were collected and taken to Bishop Museum for identification and curation while plant and seabird identifications were made in the field.

The offshore islets surveyed are important sanctuaries for at least three species of seabird and provide critical habitat for many native plant species. Of the 129 total plant species found during our survey, 32 were endemic to Hawai'i and 25 were indigenous including nine species listed as endangered or species of concern. In general, Kāohikaipu, Moku mana, Mokuho'oniki, Kanahā, Pu'u koa'e, and 'Āle'ale represent the islets with the most intact, diverse, or unique native flora. The arthropod community, however, appears to have been decimated on all of the islets. Of the 155 total arthropod species collected, only 15 were native. Kāohikaipu, with four endemic and two indigenous arthropod species, had the highest native diversity, but no natives were found on the majority of islets surveyed.

The islets varied dramatically in size, topography, height, rainfall, isolation, and accessibility, but all were threatened by invasive species. Introduced weeds were ubiquitous and ten of these are of particular concern because they are known to be invasive. Some islets are already dominated by these noxious species. For example, on three islets (Mānana, Po'opo'o and Pu'u pehe) the invasive grass *Cenchrus ciliaris* forms an almost complete monoculture at the exclusion of native taxa. Other islets have incipient weed populations that will follow a similar path if left untreated. Introduced ants are also a widespread problem. Some of the particularly aggressive species have undoubtedly played a role in the demise of native arthropod populations. They may also affect the plant community and disrupt entire colonies of nesting seabirds. Humans can also be seen as a major threat as visitors trample weeds, crush burrows, and introduce new pest species.

Fortunately, the small size and discrete boundaries of the offshore islets makes eradication and restoration feasible management options and their relative isolation helps prevent re-invasion. A restoration program coupled with education and community involvement will help safeguard remaining native populations and restore those that have been degraded.

Table of Contents

| | |
|--|-----|
| Executive Summary | i |
| List of Tables | iv |
| List of Figures | v |
| 1. Introduction..... | 1 |
| 2. Methods..... | 1 |
| 2.1 Plants..... | 2 |
| 2.2 Seabirds..... | 2 |
| 2.3 Arthropods | 2 |
| 3. Results and Discussion | 5 |
| 3.1 Plants..... | 5 |
| 3.2 Seabirds..... | 7 |
| 3.3 Arthropods | 7 |
| 4. Threats and Remediation Strategies..... | 8 |
| 4.1 Plants..... | 8 |
| 4.2 Invertebrates..... | 9 |
| 4.3 Mammals..... | 11 |
| 4.4 Owls | 11 |
| 4.5 Anthropogenic disturbance | 11 |
| 5. Acknowledgements..... | 12 |
| 6. KAUA'I : Moku'ae'ae Islet..... | 13 |
| 7. O'AHU: Mokoli'i Islet (Chinaman's Hat) | 24 |
| 8. O'AHU : Kapapa Islet (Moku Kapapa)..... | 37 |
| 9. O'AHU : Kāohikaipu Islet (Black Rock)..... | 50 |
| 10. O'AHU : Mānana (Rabbit) Islet | 64 |
| 11. MAUI : Moke'ehia Islet | 77 |
| 12. MAUI : Mokupipi Islet..... | 85 |
| 13. MAUI : Pu'uku (Pu'uki'i) Islet | 92 |
| 14. MAUI : Moku mana Islet..... | 101 |
| 15. MAUI: 'Ālau Islet..... | 109 |
| 16. MAUI: Mokuhuki Islet | 119 |
| 17. LANAI : Po'opo'o Islet | 129 |
| 18. LANĀ'I : Pu'u pehe Islet (Sweetheart Rock) | 137 |
| 19. LANĀ'I : Ki'ei Islet..... | 144 |
| 20. MOLOKA'I : Mokuho'oniki Islet..... | 150 |
| 21. MOLOKA'I : Kanahā Islet | 163 |
| 22. MOLOKA'I : Moku manu Islet..... | 171 |
| 23. KAHO'OLAWA : 'Āle'ale Islet..... | 178 |
| 24. KAHO'OLAWA : Pu'u koa'e | 188 |
| 25. References..... | 197 |

Appendix: Arthropods of Lehua Islet, Ni'ihau 200

List of Tables

| | |
|--|-----|
| Table 1. Islets surveyed for this project. | 4 |
| Table 2. Total number of plant species and occurrence on the offshore islets. | 5 |
| Table 3. Plant diversity on 19 offshore islets with adjustment for islet size. Plant index = plant diversity / island size. | 6 |
| Table 4. Key threats to Moku'ae'ae ecosystem and recommendations. | 20 |
| Table 5. Key threats to Mokoli'i ecosystem and recommendations. | 34 |
| Table 6. Key threats to Kapapa ecosystem and recommendations. | 46 |
| Table 7. Key threats to Kāohikaipu ecosystem and recommendations. | 59 |
| Table 8. Key threats to Mānana ecosystem and recommendations. | 73 |
| Table 9. Key threats to Moke'ehia ecosystem and recommendations. | 82 |
| Table 10. Key threats to Mokupipi ecosystem and recommendations. | 89 |
| Table 11. Key threats to Pu'uku ecosystem and recommendations. | 98 |
| Table 12. Key threats to Moku mana ecosystem and recommendations. | 106 |
| Table 13. Key threats to 'Ālau ecosystem and recommendations. | 115 |
| Table 14. Key threats to Mokuhuki ecosystem and recommendations. | 125 |
| Table 15. Key threats to Po'opo'o ecosystem and recommendations. | 135 |
| Table 16. Key threats to Pu'u pehe ecosystem and recommendations. | 141 |
| Table 17. Key threats to Ki'ei ecosystem and recommendations. | 148 |
| Table 18. Key threats to Mokuho'oniki ecosystem and recommendations. | 159 |
| Table 19. Key threats to Kanahā ecosystem and recommendations. | 168 |
| Table 20. Key threats to 'Āle'ale ecosystem and recommendations. | 184 |
| Table 21. Key threats to Pu'u koa'e ecosystem and recommendations. | 193 |

List of Figures

| | |
|---|----|
| Figure 1. The bare summit of Moku'ae'ae (looking towards Kilauea Point) with guano piles from roosting frigatebirds. | 21 |
| Figure 2. More erosion along the southwest slope exposing artificial burrows. | 21 |
| Figure 3. The southeast slope has a mixture of <i>Sesuvium portulacastrum</i> and <i>Portulaca</i> spp. with <i>Chenopodium oahuense</i> and <i>Boerhavia coccinea</i> interspersed. | 22 |
| Figure 4. <i>Sesuvium portulacastrum</i> and <i>Portulaca lutea</i> dominate the eastern slope. | 22 |
| Figure 5. The western cliff is riddled with holes creating excellent nesting habitat for seabirds. <i>Sesuvium portulacastrum</i> dominates with occasional grasses. | 23 |
| Figure 6. Extensive intertidal pools surround the base of the island. | 23 |
| Figure 7. Long-legged ants line along a fracture in a Wedge-tailed shearwater egg to suck moisture. | 35 |
| Figure 8. A shearwater hatchling with eyes swollen shut due to swarming ants which spray formic acid into their eyes. | 35 |
| Figure 9. Pitfall traps were the same throughout the island: densely packed with long-legged ants. | 36 |
| Figure 10. Pan trap contents were the same throughout the island: packed with long-legged ants, roaches, and isopods. | 36 |
| Figure 11. Bermuda grass, <i>Cynodon dactylon</i> , and other non-native grasses dominate the landing area. A fire pit sits in the foreground. All burrows in this area were crushed. | 47 |
| Figure 12. Intertidal areas along the north and east sides of the island support a diversity of marine life. | 47 |
| Figure 13. <i>Scaevola sericea</i> and <i>Tornefortia argentea</i> encircle the north and east ends of the islet. | 48 |
| Figure 14. View from the eastern intertidal zone where <i>Sesuvium portulacastrum</i> dominates. | 48 |
| Figure 15. Wind and salt spray create harsh conditions on the southeast quadrant allowing natives (<i>Ipomoea carica</i> , <i>Jaquemontia ovalifolia</i> , <i>Sida fallax</i> , <i>Sporobolus virginicus</i> , and <i>Lycium sandwicense</i>) to dominate. | 49 |
| Figure 16. <i>Casaurina</i> spp. dominate the southwest quadrant of the islet. | 49 |
| Figure 17. A large contiguous patch of <i>Ipomoea carica</i> dominates the west section of the islet. Bulwer's petrels nest in the boulder piles in the background. | 60 |
| Figure 18. A Sooty tern killed by an owl. | 60 |
| Figure 19. <i>Verbesina encelioides</i> seedlings and a few flowering plants flourish after a month of rain, <i>Portulaca oleracea</i> and <i>Cenchrus echinatus</i> are interspersed. | 61 |
| Figure 20. <i>Cenchrus echinatus</i> forms large patches after a month of rain. | 61 |
| Figure 21. Abundant <i>Argemone glauca</i> seedlings on the rocky northern shore. | 62 |
| Figure 22. View towards Mānana I. from the summit. | 62 |
| Figure 23. Caterpillar of the passion vine butterfly, <i>Agraulis vanilla</i> , eating <i>Passiflora suberosa</i> | 63 |
| Figure 24. <i>Rhyncogonus</i> beetle on <i>Sida fallax</i> | 63 |

| | |
|--|-----|
| Figure 25. Native plants and dunes persist along the west coast. | 74 |
| Figure 26. Monk seals regularly haul-out and pup on the island. | 74 |
| Figure 27. The crater bottom in January 2008, it is dominated by <i>Amaranthus spinosa</i> in the foreground followed by <i>Verbesina encelioides</i> and <i>Cenchrus ciliaris</i> in the background. | 75 |
| Figure 28. The crater bottom in September 2007. Erosion is a concern when the plants senesce annually. | 75 |
| Figure 29. Walking along the rim towards the summit, <i>Cenchrus ciliaris</i> dominates the crater rim and slopes. | 76 |
| Figure 30. A late-nesting Brown noddy chick. | 76 |
| Figure 31. Some natives persist near the water. | 76 |
| Figure 32. The densely burrowed east slope. Very little vegetation is present. | 83 |
| Figure 33. A closer look at the dense burrows. | 83 |
| Figure 34. View towards the smaller, northern peak. | 84 |
| Figure 35. Collecting from available plants. | 84 |
| Figure 36. <i>Osteomeles anthyllidifolia</i> on the summit. | 84 |
| Figure 37. <i>Sesuvium portulacastrum</i> and <i>Scaevola sericea</i> dominate the islet. | 90 |
| Figure 38. Collecting from <i>Scaevola sericea</i> | 90 |
| Figure 39. <i>Fimbristylis cymosa</i> on the lower shelf. | 90 |
| Figure 40. Shearwater chicks nest in rocky crevices on the summit. | 91 |
| Figure 41. Tide pools on the western side of the island. | 91 |
| Figure 42. Aerial view of the islet. | 99 |
| Figure 43. Steep cindery slopes. | 99 |
| Figure 44. Gap separating the islet | 99 |
| Figure 45. The island and adjacent coast supports a healthy population of <i>Lepidum bidentatum</i> . Photo | 100 |
| Figure 46. A weedy mix on the summit. | 100 |
| Figure 47. <i>Casaurina</i> stand. | 100 |
| Figure 48. A ravine divides the island, view of south stack. | 107 |
| Figure 49. <i>Bidens mauiensis</i> | 107 |
| Figure 50. Weedy mix, south stack. | 107 |
| Figure 51. View from north tip, snails abundant in <i>Sesuvium portulacastrum</i> (foreground). | 108 |
| Figure 52. View of north stack. | 108 |
| Figure 53. <i>Schinus</i> and <i>Scaevola</i> on the north stack. | 108 |
| Figure 54. <i>Schideia globosa</i> and <i>Capparis sandwichiana</i> on the western cliffs. | 116 |
| Figure 55. <i>Sesuvium</i> on the north shore. | 116 |
| Figure 56. View towards the summit. | 116 |
| Figure 57. Outplanting <i>Scaevola coriacea</i> among the carpet of <i>Sesuvium</i> on the northwest coast. | 117 |
| Figure 58. <i>Vigna marina</i> atop western cliffs. | 117 |
| Figure 59. Weedy mix on north slope of summit. | 117 |

| | |
|--|-----|
| Figure 60. Small cove on the east side of the island. | 118 |
| Figure 61. <i>Sesuvium</i> around the cove. | 118 |
| Figure 62. Roosting frigatebirds. | 118 |
| Figure 63. Aerial view of <i>Pandanus tectorius</i> and ferns along the summit ridge. | 126 |
| Figure 64. Climbing to the summit. | 126 |
| Figure 65. Summit ridge. | 126 |
| Figure 66. A dense mix of ferns dominates the summit understory. | 127 |
| Figure 67. A single <i>Wikstroemia oahuense</i> on the eastern cliff. | 127 |
| Figure 68. <i>Pandanus tectorius</i> infested with <i>hala</i> scale. | 128 |
| Figure 69. Vegetaion on the north outcropping. | 128 |
| Figure 70. <i>Sadleria pallida</i> along northern outcropping. | 128 |
| Figure 71. The narrow northern point. | 136 |
| Figure 72. Tide pools on the southern bench. | 136 |
| Figure 73. <i>Cenchrus ciliaris</i> forms a monoculture over the entire islet. | 136 |
| Figure 74. <i>Cenchrus ciliaris</i> dominates the entire islet. | 142 |
| Figure 75. <i>Cenchrus ciliaris</i> and shrub skeletons (primarily <i>S. fallax</i>) along the steep east side of the islet. | 142 |
| Figure 76. Heiau at the summit. | 143 |
| Figure 77. Heavy guano load SE of the summit. | 143 |
| Figure 78. Bulwer's nests found in this rock pile. | 143 |
| Figure 79. <i>Waltheria indica</i> and <i>Sida fallax</i> dominate the summit of the islet. | 149 |
| Figure 80. Abundant tide pools surround the base of the islet. | 149 |
| Figure 81. The upper slopes of the islet's north section is dominated by <i>Jaquemontia ovalifolia</i> and <i>Sida fallax</i> | 160 |
| Figure 82. Large patches of <i>Panicum fauriei</i> exist on the rocky north tip of the islet. | 160 |
| Figure 83. <i>Panicum torridum</i> forms large, contiguous patches along the southwest quarter of the island. | 161 |
| Figure 84. Ordnance litters the island. | 161 |
| Figure 85. A large patch of <i>Scaevola coriacea</i> | 161 |
| Figure 86. A large patch of <i>Setaria verticillata</i> invading areas of <i>Panicum torridum</i> | 162 |
| Figure 87. Cliffs on the east side of the islet. | 162 |
| Figure 88. A red-tailed tropicbird on an egg. | 162 |
| Figure 89. View from the south end with the landing zone just west of the gear. | 169 |
| Figure 90. <i>Panicum fauriei</i> dominates. | 169 |
| Figure 91. Patches of <i>Tribulus cistoides</i> | 169 |
| Figure 92. View north from the summit, with ordnance in the foreground. | 170 |
| Figure 93. <i>Sida fallax</i> , <i>Portulaca oleracea</i> , and <i>Panicum fauriei</i> dominate the north end. | 170 |
| Figure 94. A closeup of the densest vegetation on the upper east side of the islet. | 175 |
| Figure 95. Twisted shape of the islet. | 175 |
| Figure 96. Fractures and vegetation on the east side. | 175 |

| | |
|---|-----|
| Figure 97. Most of the weeds exist on the upper east side. <i>Kalanchoe pinnata</i> and <i>Digitaria ciliaris</i> are the most common along with some native species (<i>Chamaesyce celastroides</i> and <i>Eragrostis variabilis</i>). | 176 |
| Figure 98. Red-tailed tropicbirds nest on the islet's ledges. | 176 |
| Figure 99. <i>Eragrostis variabilis</i> , <i>Chamaesyce celastroides</i> and <i>Schidea globosa</i> are common on the northeast section of the islet. | 177 |
| Figure 100. <i>Artemesia australis</i> , northeast tip. | 177 |
| Figure 101. Ferns growing in the islet's cracks. | 177 |
| Figure 102. The <i>Kanaloa</i> was in excellent health and had several seed pods. | 185 |
| Figure 103. <i>Eragrostis leptophylla</i> is the dominant grass. | 185 |
| Figure 104. The eastern slope is dominated by grasses with <i>Ipomoea tuboides</i> , <i>Senna gaudichaudii</i> and <i>Portulaca molokiniensis</i> interspersed. | 186 |
| Figure 105. 'Āle'ale hosts one of the most significant populations of <i>Portulaca molokiniensis</i> . | 186 |
| Figure 106. An owl roost with seabird remains. | 187 |
| Figure 107. Caterpillar feeding on <i>N. glauca</i> . | 187 |
| Figure 108. The steep western slopes. | 194 |
| Figure 109. Sheer cliffs make up the east side. | 194 |
| Figure 110. <i>Argemone glauca</i> along the upper slopes. | 194 |
| Figure 111. Non-native grasses, <i>Nicotiana glauca</i> and <i>Chenopodium murale</i> dominating the flatter areas. | 195 |
| Figure 112. Large patch of <i>Nicotiana glauca</i> . | 195 |
| Figure 113. A healthy population of <i>Sesbania</i> . | 195 |
| Figure 114. A large population of <i>Sesbania tomentosa</i> and <i>Chamaesyce celastroides</i> dominates the lower northwest slope. | 196 |
| Figure 115. A young Red-tailed tropicbird chick. | 196 |

1. Introduction

The Hawaiian Archipelago comprises seven main islands, at least 44 offshore islets and a chain of islands to the northwest. The offshore islets, which are uninhabited and mostly located within 10 km of the coast of the main Hawaiian Islands, act as preserves for species and ecosystems that have been lost or are disappearing from the main islands.

Hawaii's biota of ca. 25,000 species evolved in isolation from many of the predators, herbivores, diseases, and other biological factors prevalent on continents. The introduction during historical times of goats, pigs, rabbits, and rats, as well as insect pests and weeds have led to dramatic losses of Hawai'i's native biota. Although Hawai'i has only 0.2% of the land area of the U.S., approximately 75% of the species historically documented to have gone extinct in the U.S., and ca. 33% of the nation's endangered species are endemic to Hawai'i. This same extinction process is underway on the offshore islets, which harbor a wealth of native species highly susceptible to extinction because of small population size. Although this makes the conservation needs of the offshore islets particularly acute, the small sizes of these islets and their geographic isolation makes it feasible to eliminate destructive alien species and to restore and maintain native ecosystems. Restoration of the offshore islets is among the highest and most readily achievable conservation priorities in Hawai'i.

The Offshore Islet Restoration Committee (OIRC) is a multiagency group dedicated to conducting biological surveys and restoration on Hawai'i's offshore islets. The OIRC has completed a preliminary assessment of the biological value, threats and restoration needs of offshore islets based on limited data. Our goal was to aid the efforts of the OIRC by developing a comprehensive information system and conducting field surveys to document the biota of offshore Hawaiian islets. This information will prioritize, guide and inform restoration efforts. We compiled a comprehensive literature database and checklist of the biota found on each islet, which can be accessed via the Offshore Islet Project website at: <http://hbs.bishopmuseum.org/offshoreislets/>. The following report documents the results of our biological surveys along with restoration recommendations.

2. Methods

Each of Hawai'i's offshore islets was evaluated and ranked by the following properties: gaps in baseline data, islet size, plant diversity and ease of access. Members of the OIRC were then consulted and 20 islets were prioritized for biological surveys (Table 1).

The largest information gap existed for arthropods, so arthropod surveys were our primary focus. However, visits to the offshore islets are infrequent because access is typically difficult and costly, so every effort was made to completely document the flora and fauna on each visit. The basic methods are described below, but adaptations for each islet were necessary due to a variety of logistical constraints including permit restrictions (time on islet, number of assistants), topography, size, weather and time of year. Adjusted methods are detailed in each islet account.

Status codes for organisms are as follows: nat = naturalized, ind = indigenous, end = endemic, E = endangered, and SOC = species of concern.

2.1 Plants

Botanical surveys were completed as time allowed. For complete surveys we ran rough transects throughout the islet to document all plant species and note their abundance. For partial surveys, the majority of the islet was searched, but some sections were omitted, such as vegetation on steep cliffs. When time was extremely limited, plants were surveyed opportunistically during the arthropod survey. In these cases, notes on the vegetation only reflect the areas covered during the arthropod survey. Plant abundance is reported as either rare (typically less than 5-6 plants), occasional (scattered individuals or patches, nowhere really abundant) or common (widespread throughout the islet, dominant in part of the islet).

2.2 Seabirds

The extent of the seabird surveys was dependant on species, breeding season, time on the islet and accessibility of nest sites. For wedge-tailed shearwaters, a full census was conducted on small islets during the breeding season (mid March-mid November). On large islets, a subsample of burrows was counted and the number was extrapolated to nesting habitat on the island. Other seabird species were surveyed opportunistically during our visits.

2.3 Arthropods

To document arthropod diversity on the islet, we used a variety of collecting methods. We established one or more transects oriented to cover the highest habitat diversity on the islet. We established sampling points every 10 meters along the length of the transect and at each point used the following techniques:

1. Pitfall trap – to collect organisms walking along the ground we dug small Solo® brand cups into the soil so they were flush with the ground, or when this was not possible, buried the cups under rocks. Cups were filled water and a surfactant, baited with blue cheese, and left out for 24-48 hours. Arthropods attracted to the traps drowned and were collected.
2. Pan trap – to collect flying organisms we secured yellow Solo® brand bowls to the ground in open areas, filled them with water and surfactant and left them out for 24-48 hours. Arthropods attracted to the traps drowned and were collected.
3. Ant cards – Because ants are considered problematic as invaders, we specifically searched for them. We applied 3 baits (peanut butter, honey, and spam) to a 3"x 5" index card and placed the majority of the card inside a Ziploc ® brand sandwich bag. Cards were placed in a shaded area closest to each sampling point and collected after 1 hour. Ant cards are fairly time consuming, so we only able to use this technique on a few islets. However, we did not find any species on the ant cards that were not collected using our standard techniques (traps, ground search, litter sifting, sweep net)
4. Sweep net – we walked the length of the transect swinging a net to collect organisms.

5. Ground search – we walked the length of the transect and searched under rocks and along the ground for organisms.

We supplemented the transect collections with general collecting and host searching to document any host-specific organisms. For each plant species, we selected 3-5 individual plants to sweep. We then visually inspected the plants for insects and related arthropods, searching the leaves and stems down to the base of the plant, and then sifted the leaf litter around each plant. Because many insects are nocturnal and remain hidden during the day, we collected at night when possible. We used headlamps for light and employed the same techniques at night as during the day.

In the lab, the collected specimens were sorted to separate each morphologically similar form (usually species), and representative specimens of each “morpho-species” were appropriately mounted, labeled, and curated for identification. Larger insects were mounted on pins and stored dry. Soft-bodied groups were collected and remain in 95% ethanol, while the smaller species were mounted on slides to be identified and preserved. Each morpho-species was identified as far as practical and sent to experts if possible. Some species could not be named either because they were new to science or because there was no qualified taxonomic authority to identify them. Names and status follow (Nishida 2002).

Table 1. Islets surveyed for this project.

| Islet | Trip date(s) | Surveys conducted | Time on islet (including trap time) |
|---------------------|-----------------------------------|---------------------------|--|
| Ni'ihau | | | |
| Lehua | 3-4 May 2007 | Arthropod | 27 hours |
| Kaua'i | | | |
| Moku'ae'ae | 10-11 September 2007 | Plant, seabird, arthropod | 27 hours |
| O'ahu | | | |
| Kapapa | 29 April 2007, 20-21 October 2007 | Plant, seabird, arthropod | 31 hours |
| Kāohikaipu | 28 March 2007, 1-2 December 2007 | Plant, seabird, arthropod | 32 hours |
| Mānana | 9-11 February 2008 | Plant, seabird, arthropod | 52 hours |
| Mokoli'i | 12 May 2007, 14-16 October 2007 | Plant, seabird, arthropod | 53 hours |
| Maui | | | |
| 'Ālau | 19 February 2008 | Plant, seabird, arthropod | 8 hours |
| Moke'ehia | 25-26 October 2007 | Plant, seabird, arthropod | 24 hours |
| Mokuhuki | 20 February 2008 | Plant, seabird, arthropod | 4 hours |
| Moku mana | 1 November 2007 | Plant, seabird, arthropod | 5 hours |
| Mokupipi | 26 October 2007 | Plant, seabird, arthropod | 4 hours |
| Pu'uku | 27 October 2007 | Plant, seabird, arthropod | 3 hours |
| Lana'i | | | |
| Ki'ei | 3 November 2007 | Plant, seabird, arthropod | 4 hours |
| Po'opo'o | 1-2 November 2007 | Plant, seabird, arthropod | 24 hours |
| Pu'u pehe | 2 November 2007 | Plant, seabird, arthropod | 4 hours |
| Moloka'i | | | |
| Kanahā | 16 February 2008 | Plant, seabird, arthropod | 4 hours |
| Mokuho'oniki | 15-16 February 2008 | Plant, seabird, arthropod | 25 hours |
| Moku manu | 16 February 2008 | Plant, seabird | 0.25 hours |
| Kaho'olawe | | | |
| 'Āle'ale | 26 March 2008 | Plant, seabird, arthropod | 4 hours |
| Pu'u koa'e | 26 March 2008 | Plant, seabird, arthropod | 6 hours |

3. Results and Discussion

Biological surveys were conducted on 20 offshore islets around 7 major islands (Table 1). More effort was focused on O’ahu islets, which are easily accessible and larger islets where we were permitted to overnight. Our trip to Lehua, Ni’ihau was cut short due to inclement weather. This left us with an insufficient amount of time to survey the plant and seabird populations on the island. Because several reports documenting the plant and bird life of Lehua already exist (see (Wood et al. 2004; VanderWerf et al. 2007), we omitted a full trip account and appended the arthropod list to this document. For Moku manu, Moloka’i, our helicopter pilot was unable to find a safe landing area, so we were only able to conduct an aerial survey.

3.1 Plants

Plant surveys were conducted on 19 islets (all but Lehua). We were unable to perform full surveys on all islets and, as a result, likely overlooked several rare or patchy species. The following summary is based solely on our findings. Across all islets we detected a total of 72 non-native species and 57 native species, of which 32 were endemic to Hawai’i and 25 were indigenous (Table 2). Twenty-four of these were new islet records. Looking at abundance patterns of native compared to non-native species yields a slightly different pattern. Of the 47 species we listed as occurring commonly on an islet, 22 were non-native, 12 were endemic and 13 were indigenous. Of the 78 rare species, 44 were non-native, 18 were endemic and 16 were indigenous. Mokoli’i is a unique island in that it has high plant diversity with the majority of plants not occurring on other islets. Of all 129 species found on the islets, 14% were found only on Mokoli’i. Omitting the data from Mokoli’i shows that both the number and abundance of native and non-native plant species are fairly balanced on the offshore islets (Table 2).

Table 2. Total number of plant species and occurrence on the offshore islets.

| All 19 islets | Native species | | Non-native species | Total species |
|----------------------------|----------------|------------|--------------------|---------------|
| | Endemic | Indigenous | | |
| Total across islets | 32 | 25 | 72 | 129 |
| Common occurrence | 12 | 13 | 22 | 47 |
| Rare occurrence | 18 | 16 | 44 | 78 |
| Mokoli'i omitted | | | | |
| Total across islets | 31 | 24 | 56 | 111 |
| Common occurrence | 11 | 12 | 15 | 38 |
| Rare occurrence | 17 | 15 | 33 | 65 |

The islets surveyed differ dramatically in terms of topography, rainfall, exposure to salt spray, and adjacent shore conditions, but in general, smaller islets had lower plant diversity than larger islets (Table 3). Mānana and Mokuhuki are two notable exceptions. Mokuhuki, measuring a mere 0.1 hectares, had 25 plant species, resulting in a plant species index of 83.3 species per acre. This is by far the highest number of species per acre of all the islets surveyed. At 27.1 hectares Mānana was the largest islet in our survey, yet only 26 plant species were found compared to 27 and 28 species on nearby Kapapa and Kāohikaipu respectively, islets less than a

sixth the size of Mānana. Low plant diversity may be attributed to harsh growing conditions, as is the case on Ki’ei and Mokupipi, or invasion by aggressive non-native species. For example, the invasive grass *Cenchrus ciliaris* dominates the vegetation on Pu’u pehe, Po’opo’o, and Mānana. Other species have been extirpated or are only able to persist in small numbers along exposed areas of these islets.

The islets support populations of several notable natives including five federally endangered species: *Ischaemum byrone*, *Kanaloa kahoolawensis*, *Scaevola coriacea*, *Sesbania tomentosa*, *Panicum fauriei* var. *carteri* and four species listed by the State as Species of Concern: *Bidens hillebrandiana* subsp. *polycephala*, *Bidens mauiensis*, *Capparis sandwichiana*, *Lepidium bidentatum* var. *o-waihiense* and *Portulaca molokiniensis*. However, the islets also host several invasive plants species which are currently threatening or have already decimated native plant populations. The most insidious species include *Cenchrus ciliaris*, *Cenchrus echinatus*, *Setaria verticillata*, *Pluchea* spp., *Casuarina equisetifolia*, *Schinus terebinthifolius*, *Lantana camara*, *Portulaca oleracea* and *Verbesina encelioides*. Recommendations for management of non-native plant species are included in section 4.1 below.

Table 3. Plant diversity on 19 offshore islets with adjustment for islet size. Plant index = plant diversity / island size.

| Island | Islet | Island size (ha) | Plant diversity | Plant index |
|------------|--------------|------------------|-----------------|-------------|
| Maui | Mokuhuki | 0.1 | 25 | 83.3 |
| Maui | Mokupipi | 0.4 | 9 | 10.0 |
| Lana’i | Ki’ei | 0.4 | 9 | 9.0 |
| Maui | Moku mana | 0.6 | 18 | 12.9 |
| Maui | Pu’uku | 0.6 | 16 | 10.7 |
| Lana’i | Pu’upehe | 0.6 | 6 | 3.8 |
| Moloka’i | Kanahā | 0.8 | 13 | 6.5 |
| Lana’i | Po’opo’o | 0.8 | 8 | 3.8 |
| Moloka’i | Moku manu | 0.9 | 17 | 7.4 |
| Kaua’i | Moku’ae’ae | 1.2 | 6 | 2.0 |
| Kaho’olawe | ‘Āle’ale | 1.2 | 21 | 7.0 |
| Maui | ‘Ālau | 2.0 | 19 | 3.8 |
| Maui | Moke’ehia | 3.4 | 13 | 1.5 |
| O’ahu | Kapapa | 3.8 | 27 | 2.8 |
| O’ahu | Kāohikaipu | 4.5 | 28 | 2.5 |
| O’ahu | Mokoli’i | 5.1 | 51 | 4.1 |
| Moloka’i | Mokuho’oniki | 5.7 | 23 | 1.6 |
| Kaho’olawe | Pu’u koa’e | 6.9 | 18 | 1.1 |
| O’ahu | Mānana | 27.1 | 26 | 0.4 |

3.2 Seabirds

We found evidence of three species of nesting seabird across the 19 islets surveyed (all but Lehua). More species likely nest on these islets but were missed because of small populations and cryptic nesting habits or because we visited outside the breeding season. For example, sooty terns and brown noddies nest in large numbers on Mānana, but our survey fell outside of their summer nesting season to avoid disturbance. Wedge-tailed shearwaters were the most common nesting species and were found on all but three islets: Mokuhuki, Pu'uku (where there were recently abandoned burrows), and Moku manu where we could not confirm nesting during our aerial survey. The largest colonies were found on Mānana and Moke'ehia. Nesting by Bulwer's petrels was detected on five islets: Mokupipi, Pu'u pehe, Moku'ae'ae, 'Āle'ale, and Pu'u koa'e. Bulwer's petrels typically nest in small, inaccessible crevices and are difficult to document. The easiest way to detect them is by imitating their call early in the breeding season (ca. mid May to mid July). We were unable to conduct surveys during this time of year and our accounts are based on observations of depredated fledglings and abandoned eggs. Moku'ae'ae, Kāohikaipu, and Pu'u pehe appear to have the largest colonies, but there has been no attempt to document population size. Red-tailed tropicbirds were nesting in small numbers on Mānana, Mokuho'oniki, Moku manu, Moku'ae'ae and Pu'u koa'e. Their nesting season is protracted and varies among islands, so it is likely they nest on additional islets as well.

Offshore islets represent the bulk of seabird nesting habitat in the main Hawaiian Islands and it should therefore be a priority to assess baseline status on all islets (where possible) using species specific surveys. Once this is accomplished, a long-term monitoring program should be established to enable detection of population fluctuations. Monitoring is an especially useful tool for detecting new threats at specific sites or at-sea factors affecting seabird nesting success. On Moku'auia and Mokoli'i islets on O'ahu, crashes in the shearwater populations led to the detection of destructive rats and ants. Methods should be standardized across all islands by conducting surveys at the same time of year and using the same plot size and type. Census efforts on small islets may be feasible, but on large islands, monitoring plots are less destructive and more time efficient. Distribution of some species such as Bulwer's petrels has been poorly documented due to the inaccessibility of their nest sites. Confirmation of nesting and estimates of breeding population can be assessed using call-back surveys early in the breeding season (May-July). Monitoring of this species is valuable because they are highly sensitive to threats such as rodents, ants and human disturbance and can therefore be used as an indicator species.

3.3 Arthropods

We conducted arthropod surveys on 19 offshore islets (all but Moku manu) and found a total of 155 species constituting 284 new islet records. A very small fraction of these species was native: 4 were indigenous and 11 were endemic. However, we were unable to identify all the material collected during our surveys and some of the indeterminate species may be native.

Some of the natives collected represent important finds. For example *Odynerus* spp. were discovered on Kanahā, Mokuho'oniki and 'Ālau. *Odynerus* spp. are typically hunting wasps that catch native caterpillars and place them in a hollow twig or mud "pot" inside a twig, branch, or under a leaf. The wasp then lays an egg onto the caterpillar and their larvae then parasitizes the caterpillar. Competition from non-native wasps as well as parasites that attack the *Odynerus*

larvae and pupae have cause them to crash and many species have gone extinct or have become very rare.

It is impossible to know how many native arthropods were originally present or how many have become extinct, but it appears that native arthropod populations have been decimated on all the offshore islets we surveyed. Although low population levels or seasonal absence may be partial explanations, these trends are likely due to competitive displacement or predation by alien arthropods, incursion of weeds and other perturbations including climatic change. Of the introduced arthropods, ants represent the greatest threat to offshore islet ecosystems. Ant species were detected on all of the offshore islets (except 'Āle'āle) for a total of 16 different species. Three of these are of particular concern (fire ant, big-headed ant, and long-legged ant) and are discussed in section 4.2 below.

The relatively short time spent surveying the offshore islets limited our ability to conduct a comprehensive inventory of all the invertebrates that may occur there. If future collecting opportunities exist, it would be ideal to make several trips to each islet at different times of the year to take into account changes in rainfall, shifts in vegetation composition and other discrete seasonal changes over time. Many of these changes are not readily apparent and how they affect the invertebrate species composition is poorly understood. Additional focus should be placed on offshore islets that have permanent or semi-permanent wet spots (i.e., Lehua) as they are known to attract a diversity of species.

4. Threats and Remediation Strategies

Following is a general overview of the threats and recommended solutions common across multiple islets. Recommendations specific to each islet are included after each islet account.

4.1 Plants

Most introduced plant species have not significantly affected the ecological equilibrium of the offshore islets. However, some species have invaded large areas and/or appear to be adversely affecting the long-term survival of native species, the integrity or sustainability of natural communities, or genetic variation within indigenous species on one or more islets. The most damaging weeds are ones causing drastic habitat changes on the island by forming monospecific stands, shading out or otherwise replacing native vegetation communities, or preventing seedling regeneration by forming impenetrable carpets. Many of these plants die off in the dry season, leaving barren, exposed soil, which may lead to erosion, and collapse of seabird burrows.

Invasive plants may further affect seabird productivity by reducing habitat for ground- and burrow-nesting seabird species. Many problem weeds are annuals and as a result, birds nesting late in the year may dig burrows under a dense canopy of non-native vegetation only to have it die-off months later leaving chicks exposed. The opposite is true of birds nesting early in the year. Species that nest in short, sparse weed fields are disrupted as the vegetation grows tall and dense around them.

In addition, invasive plants may affect terrestrial arthropods by displacing native vegetation that provides critical habitat. However, a lack of baseline data on invertebrate populations makes it impossible to fully understand the effects. Some non-native plants host introduced ants and scale and appear to be sustaining unnaturally large populations of these noxious species, which in turn negatively impacts native plant, bird, and arthropod communities.

The best strategy for dealing with invasive species is to prevent their introduction altogether. Quarantine protocols should be established for the all islets closed to public access, especially those with intact vegetation communities such as Mokuho'oniki and Kanahā. Basic measures such as cleaning all gear and clothing can go a long way in preventing the dispersal of weedy species. Other precautions such as avoiding use of vegetated landing zones for helicopter operations and limiting transfer between islets should also be considered.

Quarantine efforts can slow, but not stop introductions. Therefore, a monitoring program must be incorporated to detect new invasions before they have a chance to become widely established. Early detection and rapid actions are the keys to successful, cost-effective eradication of new invasives that evade these controls. Searching for incipient invasives is of paramount importance on islets visited infrequently as an overlooked patch of weeds may have years to spread before a repeat visit.

Eradication is the most appropriate management tool for dealing with noxious weeds on the offshore islets. Eradication is typically more environmentally sound than long-term control, which may involve the perpetual use of toxins and can entail more environmental risks than a brief eradication campaign. Furthermore, control efforts may be negated by a lapse in funding and will be more costly in the long run. Eradication is a cost-effective, long-term solution.

Priority should be given to islets with incipient weed populations that are known to be invasive (i.e., Mokuho'oniki and Moku mana) followed by islets with rare species or fairly intact native plant communities (i.e., Mokuho'oniki, Kanahā, Kāohikaipu, Kapapa, Moku mana, 'Āle'ale and Pu'u koa'e). If left untreated, invasive weeds will undoubtedly spread at the expense of native taxa. Other islets that have been highly degraded, such as Po'opo'o, Pu'u pehe, Mokoli'i and Mānana, will require a more intense restoration campaign that will necessitate good planning, adequate techniques and sustained effort.

4.2 Invertebrates

Despite the islets' relative isolation, many of the organisms that threaten native communities on the main Hawaiian Islands are also threats on the offshore islets. In addition to invasive weeds, countless arthropod species have been inadvertently or intentionally introduced, or found their way to the islets over the years. Arthropods have received relatively little attention in the past and there have been few surveys and no studies on the ecological effects of these introductions. However, introduced arthropods have been observed biting nesting seabirds, damaging native plant species, and have likely played a major role in decimating native arthropod populations

Of the introduced arthropod species, ants have the ability to cause the most damage to entire islet ecosystems. Ants are voracious predators and are thought to be the most prevalent threat to

native invertebrates anywhere in Hawai'i. A total of 16 species were found during our surveys, including the highly invasive big-headed ant (*Pheidole megacephala*), fire ant (*Solenopsis geminata*), and long-legged ant (*Anoplolepis gracilipes*). These and other ant species are known to exclude or prey upon native arthropods, damage plant communities by forming symbiotic relationships with scale insects and aphids (order Homoptera), and some hamper seabird reproduction or even kill chicks and adult birds. Fire ants are known to negatively affect nesting wedge-tailed shearwaters on O'ahu's offshore islands (Plentovich et al. 2008) and big-headed ants have been seen harassing red-tailed tropicbirds, sooty and grey-backed terns, bonin petrels, and wedge-tailed shearwaters (H.Eijzenga, pers. obsv.).

However, the largest and most destructive species is the long-legged ant, a relatively new problem to the offshore islands. Long-legged ants are known to alter entire ecosystems, disrupt bird nesting, displace entire seabird colonies, and directly and indirectly kill hatching or newly hatched bird chicks (O'Dowd et al. 2003; H. Eijzenga, pers. obsv.). The species was introduced to Hawai'i in 1952 (Reimer et al. 1990) and is currently found on four offshore islets: Mokoli'i, Moku'auia, Mānana, and Pu'uku. On Mokoli'i the ants have reduced Wedge-tailed shearwater nesting success to zero, have recently invaded Moku'auia causing a precipitous decline in shearwater nesting success and are increasing their range on Mānana, one of the most important seabird sanctuaries in the state. Their effects on Pu'uku are harder to document because no seabird surveys were conducted before their introduction. However, recently abandoned burrows indicate that seabirds are attempting to nest, but being driven away. Long-legged ants form polygynous (multi-queened) super-colonies, in which workers occur at extremely high densities (O'Dowd et al. 2003; Abbott 2005). The impact of these ants stretches beyond their threat to seabirds. Restoration efforts in other areas in Hawai'i have been hampered by long-legged ants (N. Hoffman, pers. comm.), which have a mutually beneficial relationship with certain insects (*Homoptera*). These insects are tended and defended by these ants in exchange for their sugary excretions (honey dew), and as a result plants are weakened by these insects and often are further weakened by growth of sooty molds, which cover leaves and inhibit photosynthesis. Long-legged ants are also aggressive foragers in the inter-tidal area. On Christmas Island, entire ecosystems were disrupted when long-legged ants decimated endemic land crab populations (O'Dowd et al. 2003).

Although both fire ants and big-headed ants can be easily eradicated with commercial baits, there is currently no bait effective for the eradication of long-legged ants. As part of this project we have been working with the Department of Land and Natural Resources, Division of Forestry and Wildlife to study the ecology of this species and to test the effectiveness of trial baits. Although progress has been made, eradication attempts have not yet been successful. As a result we highly recommend postponing any eradication plans for the less destructive big-headed or fire ants. Once established, these aggressive ants will greatly reduce the chances of colonization by long-legged ants. We also recommend thoroughly searching gear and clothing for ants before visiting any offshore islets (the most common method of dispersal) and a regular ant monitoring program to detect and eradicate noxious species before they become problematic.

4.3 Mammals

No mammals were found on any of the islets surveyed. However, mice (*Mus musculus*) have been recorded on Mānana, and some islets' proximity to shore (especially Pu'uku and 'Āle'ale) make them vulnerable to invasion by mammalian predators. Monitoring of seabird nesting success and periodic rodent trapping will help detect problems at an early stage and allow for rapid response.

4.4 Owls

Seabirds, especially small species like Bulwer's petrels, have been routinely killed by owls on several of the offshore islets. Many questions need to be addressed to fully understand the extent of the problem and to consider possible solutions. Moku'ae'ae's proximity to Kilauea Point National Wildlife Refuge (KPNWR) makes it an ideal site for researching owl predation. Not only can the islet be monitored from the point, but KPNWR has access to monitoring equipment such as night vision binoculars and a large volunteer base to assist with the project. Two main questions need to be addressed: which species of owl is the problem and what effect is predation having on seabird populations. There are only two owls in Hawai'i, the native Short-eared owl (*Asio flammeus sandwichensis*) and the introduced Barn owl (*Tyto alba*). The larger Barn owl is the most likely culprit and if this can be confirmed, owl control is an option. Before embarking on an owl control program, it is important to fully understand the effects of predation on seabird populations. For example, 20-30 owl-killed Bulwer's have been found on Moku'ae'ae during multiple visits, but there has been no attempt to confirm that they are nesting on the islet let alone document the number of nesting petrels. The age of depredated birds can also be an important factor to consider. During our surveys for this project, the majority of dead Bulwer's petrels were identified as fledglings; indicating that owls may be targeting the islets during fledging season when young birds are easy to catch.

4.5 Anthropogenic disturbance

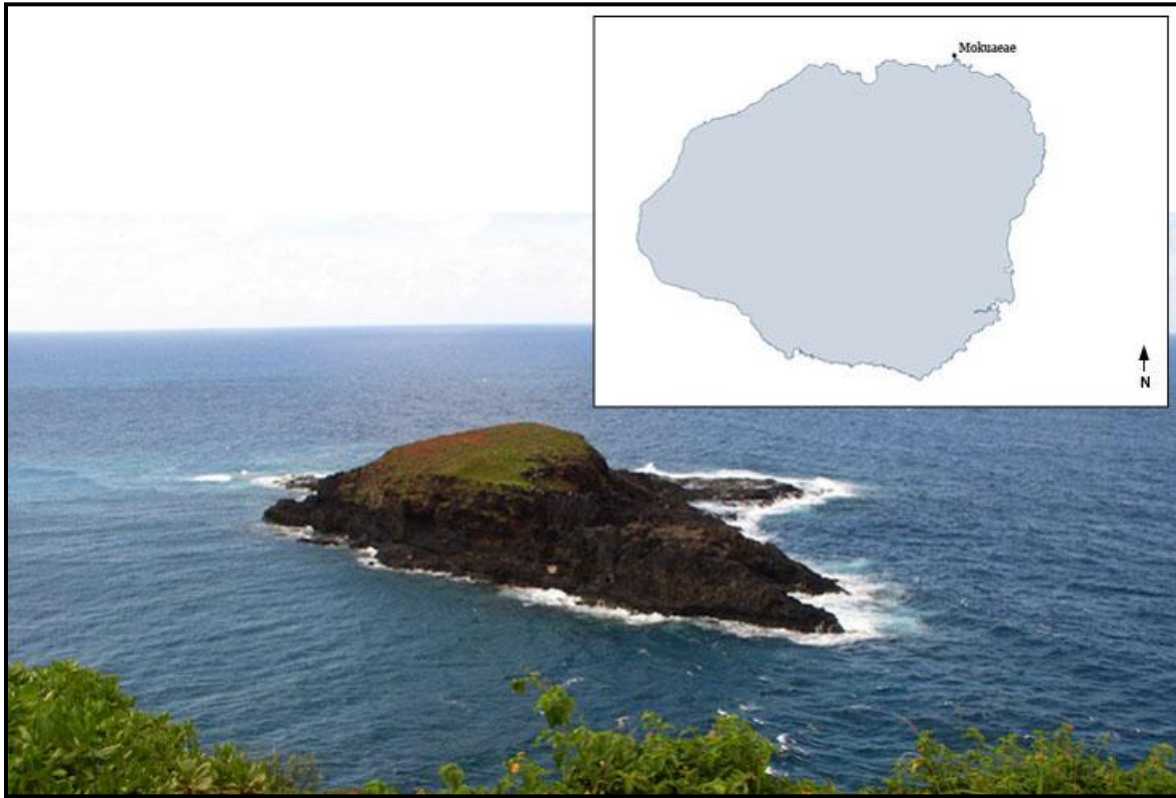
Anthropogenic disturbance is a major problem on O'ahu islets, which have easy access and receive high visitation rates. Visitors threaten the islets directly by crushing seabird burrows and trampling vegetation and indirectly by introducing non-native species and leaving trash, which can create entanglement hazards. Additionally, many seabird species are sensitive to human activities and will not nest where humans are present. Education and community support are the key tools to remedy these problems, but should also be supplemented with increased monitoring and enforcement.

5. Acknowledgements

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6. KAUA'I : Moku'ae'ae Islet



LOCATION

Moku'ae'ae is Kaua'i's only offshore islet. It is located on the northeastern part of Kaua'i just north of Kilauea Point at 22°14'5" N latitude, 159°24' 11" W longitude.

STATUS

Moku'ae'ae is part of the Hawai'i State Seabird Sanctuary, protected by the Hawai'i Department of Land and Natural Resources (DLNR). Permission to land must be obtained in writing from DLNR.

PHYSICAL DESCRIPTION

Moku'ae'ae is only 1.3 hectares in size including the surrounding basalt bench and reaches 31.7 meters at its highest point. The top of Moku'ae'ae gently slopes to the southeast with steep cliffs on the north and west sides. Flat, rocky shelves surround the base of the islet and include abundant tide pools.

ACCESS

Heather Eijzenga (Bishop Museum), Heather Laederich (Bishop Museum), Brenda Zaun (USFWS), and Leah Webb (USFWS) visited the islet from 10 September 2007 at 0900 to 11 September 2007 at 1200. The islet was accessed by kayak from the southwestern corner of the

surrounding basalt bench. This was relatively easy with a northeastern swell of 0.6-1.2 meters. However, leaving was much more difficult with an increased swell of 1.5-2.1 meters. from both the northwest and northeast. Accessing the islet by kayak under these conditions or worse is tricky and potentially dangerous.

VEGETATION

Methods and general description

A botanical inventory was conducted by walking rough transects around the entire islet. Our visit coincided with a drought period and there was little vegetation. The summit area was predominantly bare with occasional patches of stunted *Chenopodium oahuense* and *Boerhavia coccinea*, while the slopes were dominated by *Sesuvium portulacastrum*. Small patches of *Portulaca lutea* were interspersed in the *Sesuvium*. Plant cover was approximately 35% with 6 plant species total: 3 non-native and 3 indigenous. Seven species found during the most recent botanical survey in June 2002 (Wood and Boynton 2002) were not detected during this trip: *Sonchus oleraceus*, *Chamaesyce celastroides* var. *stokesii*, *Sida fallax*, *Lycium sandwicense*, *Cynodon dactylon*, *Digitaria ciliaris*, and *Eleusine indica* (likely a result of drought conditions). We did, however, discover a new islet record, the non-native herb *Boerhavia coccinea*.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Aizoaceae

Sesuvium portulacastrum ('akulikuli), ind.

Common, abundant on the slopes and lower shelves of the islet; flowering.

Chenopodiaceae

Chenopodium oahuense (aweoweo), ind.

Common, plants mostly located on the summit and upper slopes, some were defoliated due to drought; fruiting.

Nyctaginaceae

Boerhavia coccinea, nat.

Occasional, patches primarily confined to the summit area and upper slopes; flowering. New islet record. *B. coccinea* has recently become widespread at Kilauea Point (Brenda Zaun pers. Comm.). Its sticky seeds are easily dispersed by birds.

Portulacaceae

Portulaca lutea ('ihi), ind.

Occasional, large patches mixed with *S. portulacastrum* on the lower shelves and a few plants found on upper slopes; flowering.

Portulaca oleracea (pigweed), nat.

Occasional, primarily found on the summit and upper slopes, but also found growing near *P. lutea* with which it could potentially hybridize.

Angiosperms-Monocots

Poaceae

Digitaria insularis (sourgrass), nat.

Rare, one cluster of six plants on the lower shelves of the northwest section of the islet.

SEABIRDS

Methods and general description

Brenda and Leah searched the entire islet for evidence of nesting seabirds and conducted a Wedge-tailed shearwater census on the summit area of the island. Additionally, they used night vision goggles to search for nocturnal species, such as Newell's shearwaters and Bulwer's petrels. Only two seabird species were found nesting on the islet, wedge-tailed shearwaters and red-tailed tropicbirds. Although big-headed ants were abundant on the islet, there was no evidence that they were negatively affecting nesting seabirds. No nocturnal species were seen or heard, however 20 fresh Bulwer's petrel carcasses were discovered. In the past, Moku'ae'ae supported a large colony of nesting red-footed boobies (Tomich 1986) and Laysan albatross (*Phoebastria immutabilis*) have unsuccessfully attempted to nest on the island (Byrd and Telfer 1977).

Checklist of Seabirds with notes

Fregatidae

Fregata minor (Great frigatebird), ind.

Great frigatebirds flew over the islet throughout the day and in the evening roosted on the summit as well as on rocks around the periphery of the island. Thirty-five individuals were counted at 0530 on 11 September 2007; however, some had likely departed earlier.

Phaethontidae

Phaethon rubricauda (Red-tailed tropicbird), ind.

Two Red-tailed tropicbird nests were found, one containing a 6-week-old chick and the other a 9 to 11-week old chick. Both were banded. Two to four adults were seen flying over the island, but none were found on the ground or with the chicks.

Procellariidae

Bulweria bulweri (Bulwer's petrel), ind.

No Bulwer's petrels were seen (using night vision goggles), but it was the end of the breeding season when adult visits are infrequent. We did, however, collect and remove 20 Bulwer's carcasses from the entire islet. Characteristic of owl kills, the head and breast of each individual

had been removed, leaving a pair of intact wings. Owl predation of Bulwer's petrels has been recorded on past visits to Moku'ae'ae. In August 2005, 24 Bulwer's petrel carcasses were found and removed (Zaun 2005). Similarly, 26 Bulwer's carcasses were found primarily on the eastern and southern slopes of the islet during a survey in September 1984 (Moriarty et al. 1986). Although nesting by Bulwer's has never been confirmed on Moku'ae'ae, the owl kills are strong evidence of breeding activity.

Puffinus auricularis newelli (Newell's shearwater), end. E.

From 1978-1980, 67 Newell's eggs were transported to Moku'ae'ae and nearby Kilauea Point as part of a cross-fostering experiment with wedge-tailed shearwaters (Byrd et al. 1984). Sixty-seven of the chicks fledged and in 1997 the first Newell's pair was found nesting at Kilauea Point. Since then a small number of birds have nested at Kilauea Point (B. Zaun pers. comm.). A special effort was made to search for Newell's shearwaters on or around Moku'ae'ae, but no birds were seen or heard.

Puffinus pacificus (Wedge-tailed shearwater), ind.

Brenda and Leah conducted a Wedge-tailed shearwater survey on the summit of the island only. They located 91 active nests with chicks and banded 42 of them. There were an estimated total of 300-400 shearwater adults on the islet during a morning survey. Many of the artificial burrows created for nesting seabirds (PVC and cinder blocks) were utilized. Several shearwater eggs had been depredated, presumably by avian nest predators, but the eggs may have been abandoned prior to predation.

Sulidae

Sula sula (Red-footed booby), ind.

Several adults and immature birds flew around the islet throughout the day. Although a large number of birds nest at nearby Kilauea Point, no birds were nesting or roosting on Moku'ae'ae.

Sula leucogaster (Brown booby), ind.

At least one Brown booby roosted on the island. Several adults were seen flying around the islet throughout the day including one bird fishing near the islet.

OTHER BIRDS

A family group of three *nene*, *Branta sandvicensis*, (B. Zaun identified by bands) visited the islet during the evening.

ARTHROPODS

Methods and general description

To document arthropod diversity on the islet, we used a variety of collecting methods. We established a transect that ran along an elevation gradient from the intertidal zone up to and

across the summit. It was oriented to cover the highest habitat diversity on the islet. We established sampling points every 10 meters along the length of the transect and at each point we used the following techniques: pitfall trap, pan trap, ant cards, sweep nets, host search and ground search. Traps were collected after 24 hours. Additionally, we employed the same methods on any plant species or habitat not included in our transect and performed two hours of night collection.

Arthropods were abundant despite the lack of vegetation. Big-headed ants were found throughout the islet in high numbers with several colonies found in the fleshy roots of *B. coccinea*. Cockroaches were also caught in high numbers and were especially abundant in the rocky southwest section of the islet. Several moths, crickets, earwigs, and spiders were collected around the summit at night.

Checklist of Arthropods

ARANEAE

Clubionidae

Cheiracanthium mordax (pale leaf spider), nat.

Salticidae

Hasarius adansoni (Adanson's house jumper), nat.

New islet record.

BLATTODEA

Blaberidae

Pycnoscelus indicus (burrowing cockroach), nat.

Blattidae

Periplaneta Americana (American cockroach), nat.

New islet record.

Blattidae

Periplaneta australasiae (Australian cockroach), nat.

New islet record.

COLEOPTERA

Coccinellidae

Diomus notescens (minute two-spotted ladybird), purposely introduced

New islet record.

Symunus ocellatus, nat.

New islet record.

Scarabaeidae

Adoretus sinicus (Chinese rose beetle), nat.

New islet record.

Tenebrionidae

Gonocephalum adpressiforme (gonocephalum darkling beetle), nat.

New islet record.

DIPTERA

Sarcophagidae

Sarcophaga peregrina (flesh fly), nat.

New islet record.

Sarcophaga sp. (flesh fly), nat.

New islet record.

Sciaridae

Sciara sp. (dark-winged fungus gnat), unknown status

New islet record.

HETEROPTERA

Cydnidae

Geotomus pygmaeus (burrowing bug), nat.

New islet record.

Lygaeidae

Nysius kinbergi (seed bug), end.

New islet record.

HOMOPTERA

Cicadellidae

Agallia lingual, nat.

New islet record.

Coccidae

Parasiassetia nigra (nigra scale), nat.

New islet record.

Pseudococcidae

Planococcus sp. (mealybug), nat.

New islet record.

HYMENOPTERA

Formicidae

Pheidole megacephala (big-headed ant), nat.

ISOPODA

Ligiidae

Ligia hawaiiensis (mangrove slater), end.

New islet record.

Scyphacidae

Alloniscus oahuensis (terrestrial isopod), nat.

New islet record.

LEPIDOPTERA

Pterophoridae

Lantanophaga pusillidactyla (lantana plume moth), purposely introduced

New islet record.

ORTHOPTERA

Gryllidae

Gryllodes sigillatus (tropical house cricket), nat.

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

There were no signs of rats or mice on the island. Skinks were abundant, especially in the rocks on the southeast section, but they all appeared to be of the same species. One was collected and identified as Snake-eyed skink (*Cryptoblepharus poecilopleurus*). We also found and collected one gecko identified as: Mourning gecko (*Lepidodactylus lugubris*).

THREATS AND RECOMMENDATIONS

Little vegetation was present during our visit. Therefore, a repeat survey during a wetter time of year is advisable for a more complete understanding of vegetation status. Overall, Moku'ae'ae has a relatively low number of threats, which are detailed below.

Table 4. Key threats to Moku'ae'ae ecosystem and recommendations

| Threat | Impacts | Recommendations |
|---------------------------|--|---|
| Owls | Predation of Bulwer's petrels and to a lesser extent, wedge-tailed shearwaters | Confirm nesting, monitor population, research needed (see section 4.4) |
| Weeds | | |
| Grasses | Displacement of natives | Repeat visit needed to assess status and consider eradication |
| <i>Boerhavia coccinea</i> | Displacement of natives; succulent roots support ants | Ongoing control, since it is bird dispersed and present on the adjacent coast |
| <i>Portulaca oleracea</i> | Potential hybridization with <i>P. lutea</i> | Research needed |
| Erosion | Collapsed burrows | Outplant hearty native groundcover and native shrubs |
| Big-headed ants | Disrupt nesting seabirds, alter arthropods populations | No action, research needed (see section 4.2) |
| N/A | Lack of nesting habitat for red-footed boobies | Outplanting shrubs, such as <i>Chamaesyce celastroides</i> and <i>Scaevola sericea</i> may encourage boobies to nest on the islet again |



Figure 1. The bare summit of Moku'ae'ae (looking towards Kilauea Point) with guano piles from roosting frigatebirds.



Figure 2. More erosion along the southwest slope exposing artificial burrows.



Figure 3. The southeast slope has a mixture of *Sesuvium portulacastrum* and *Portulaca* spp. with *Chenopodium oahuense* and *Boerhavia coccinea* interspersed.



Figure 4. *Sesuvium portulacastrum* and *Portulaca lutea* dominate the eastern slope.

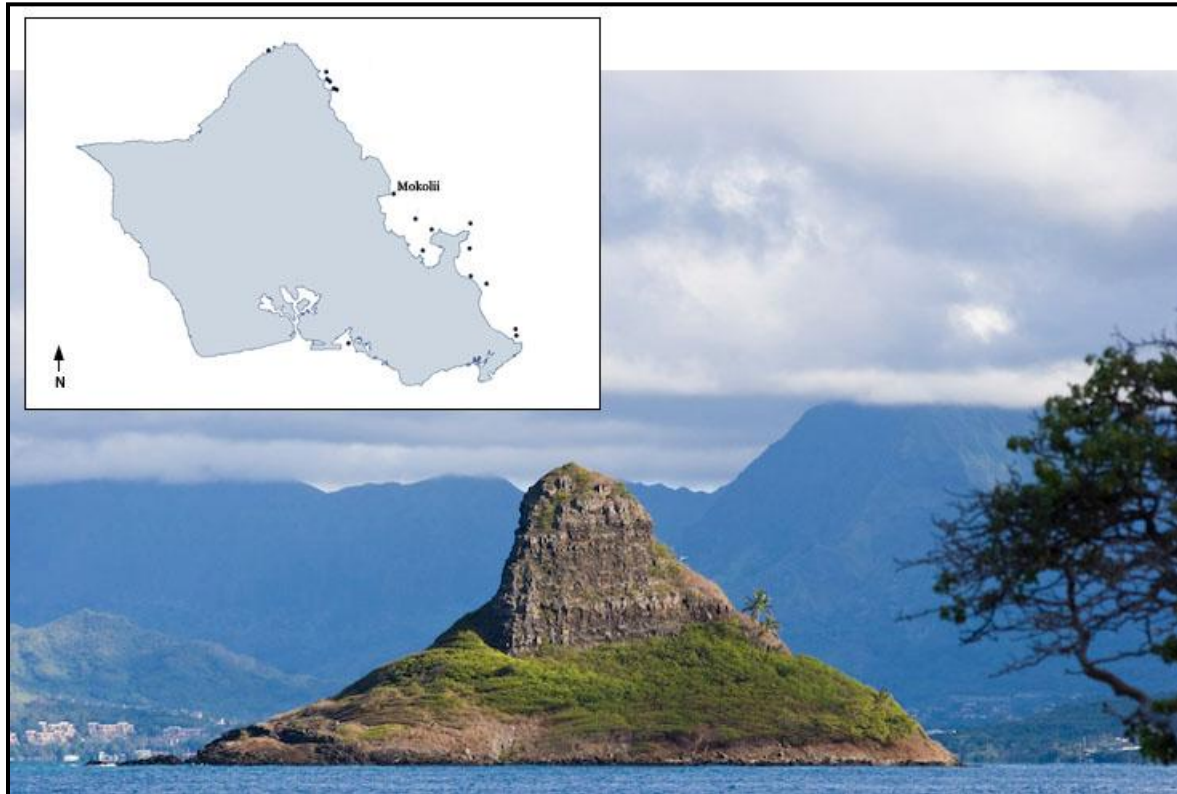


Figure 5. The western cliff is riddled with holes creating excellent nesting habitat for seabirds. *Sesuvium portulacastrum* dominates with occasional grasses.



Figure 6. Extensive intertidal pools surround the base of the island.

7. O'AHU: Mokoli'i Islet (Chinaman's Hat)



LOCATION

Mokoli'i is located about 460 meters offshore from Kualoa State Park on windward O'ahu at 21°30'34" N latitude, 157°49'460" W longitude.

STATUS

Mokoli'i is owned by the City and County of Honolulu and is part of Kualoa Regional Park. No camping is allowed on the islet and park regulations apply. State and/or federal laws protect all native wildlife and plants.

PHYSICAL DESCRIPTION

Mokoli'i, also called Chinaman's Hat because of its distinctive conical shape, is 5.1 hectares in size and 62.8 meters high. Mokoli'i is a small volcanic islet that was once a basalt pinnacle on a ridge connected to Kualoa Park. The ridge was subsequently worn away by marine erosion, creating the islet. Mokoli'i is surrounded by shallow reef flats which people can wade across during low tide on calm days.

ACCESS

We made four visits to the islet for surveys. The first was conducted by Heather Eijzenga (Bishop Museum), Jaap Eijzenga (DOFAW), Malia Paresa (project intern), Kim Morishige

(project intern), and Dennis Hollier (Hana Hou reporter) on 12 May 2007 from 0900 to 1400. Our main focus on this trip was ant assessment, but we also conducted a partial arthropod survey. On 17 August 2007 Heather and Jaap Eijzenga made a brief visit to check the status of hatching Wedge-tailed shearwater chicks. A complete arthropod survey was conducted on 14 October 2007 from 1000 to 1500 by Heather Eijzenga, Jaap Eijzenga, Clare Pidot (project intern), Hailey Kauhane (project intern), and Dana Crompton (volunteer). Heather Eijzenga conducted the final visit on 16 October 2007 to collect traps set during the previous visit. Access for these trips was made either by boat from He'eia Pier in Kaneohe or by kayak from Kualoa Beach Park.

VEGETATION

Methods and general description

A botanical inventory was conducted in May by walking loose transects throughout the islet. Several invasive plants dominate the island including *Schinus terebinthifolius*, *Pluchea indica*, *Lantana camara* and *Digitaria insularis*. Natives persist along the exposed north and east coasts and on the sheer cliffs. Mokoli'i hosts one of three known populations of *Panicum fauriei* var. *carteri*, but the population appears to be dwindling. Plant cover was approximately 95% with 51 plant species total: 36 non-native, 11 indigenous, 3 endemic and 1 unknown. Twenty-three species found during the most recent botanical survey in April 2005 (Starr and Starr 2006) were not detected during this trip, but the majority of these species were listed as rare and are either no longer present or were overlooked.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Aizoaceae

Sesuvium portulacastrum ('akulikuli), ind.

Occasional, a few near-shore patches along the north and east sides of the islet; Flowering.

Anacardiaceae

Schinus terebinthifolius (christmasberry), nat.

Dominant, patches on the summit, on sheer cliffs and forming large, dense stands on the north and south sides of the islet. The large stand on the east side was removed early in 2007; Fruiting.

Asteraceae

Ageratum conyzoides (maile honohono), nat.

Rare, only a few plants seen on vertical cliffs; Flowering.

Bidens alba (spanish needles), nat.

Very common throughout the island, except in *Schinus* patches; Flower, fruit.

Emilia fosbergii (flora's paintbrush), nat.

Occasional, plants are scattered in areas little affected by salt spray; Flowering.

Pluchea carolinensis (sourbush), nat.

About a dozen shrubs, scattered among *P. indica* on the south and east slopes; Flower, fruit.

Pluchea indica (Indian fleabane), nat.

Common throughout the island, forms dense patches below and between areas of *Schinus*; Flower, fruit.

Boraginaceae

Heliotropium curassavicum (*nena*), ind.

Rare, only a few plants near the east shore; Flowering.

Tournefortia argentea (tree heliotrope), nat.

Rare, one plant on the eastern spit; Flowering.

Cactaceae

Opuntia ficus-indica (*panini*), nat.

Rare, five or six individuals on the sheer, north wall.

Combretaceae

Terminalia catappa (false kamani), nat.

Occasional, a few large trees on the northwest side, near shore and one small tree halfway up the northeast slope.

Convolvulaceae

Ipomoea pes-caprae subsp. *brasiliensis* (*pohuehue*), ind.

Occasional, large patches near the west and south shores; Flower, fruit.

Ipomoea sp. (morning glory), unk.

Rare, one patch climbing on the outside of *Schinus* on the south side; Flowering.

Jacquemontia ovalifolia subsp. *sandwicensis* (*pau o Hi'iaka*), end.

Rare, some patches near the southeast shore; Flowering.

Euphorbiaceae

Phyllanthus debilis (*niruri*), nat.

Rare, a few plants seen on lower half of the west and south slopes; Flower, fruit.

Cucurbitaceae

Coccinia grandis (ivy gourd), nat.

Occasional, scattered patches throughout the island with the exception of the north side; Flowering.

Fabaceae

Alysicarpus vaginalis (alyce clover), nat.

Rare, a couple of patches on the south side of the island; Fruiting.

Chamaecrista nictitans (partridge pea), nat.

Common around the west and north sides; Flower, fruit.

Crotalaria incana (fuzzy rattlepod), nat.

Rare, three or four plants seen on the south side, near shore; Fruiting.

Desmodium triflorum (tick clover), nat.

Occasional, a few patches on the west side near the landing, and on the southwest side; Fruiting.

Pithecellobium dulce (Manilla tamarind), nat.

Rare, one tree halfway up the west slope.

Tephrosia pupurea (tephrosia), nat.

Rare, a couple of plants on the south slope; Fruiting.

Goodeniaceae

Scaevola sericea (beach *naupaka*), ind.

Common, a large patch on the east side along with scattered shrubs along the shore and near the cliff base on the east side; Flower, fruit.

Lamiaceae

Plectranthus parviflorus ('*ala'ala wai nui wahine*), ind.

Rare, one plant found on the north cliff and another on the west cliff.

Malvaceae

Malvastrum coromandelianum (malvastrum), nat.

Occasional, a few plants along the south side; Flowering.

Sida fallax ('*ilima*), ind.

Common near the coast and on the east side, some plants scattered along eastern cliff base; Flowering.

Myrtaceae

Psidium guajava (guava), nat.

A patch of 10-15 plants halfway up the west slope.

Nyctaginaceae

Boerhavia repens (*alena*), ind.

Occasional, individual plants to large patches in near-shore areas around the island; Flower, fruit.

Bougainvillea sp. (*bougainvillea*), nat.

One plant near the northeast cliff.

Oxalidaceae

Oxalis corniculata (yellow wood sorrel), nat.

Rare, a few plants just below the east cliffs.

Passifloraceae

Passiflora foetida (love-in-a-mist), nat.

Rare, five or six patches on the south and east slopes; Flower, fruit.

Passiflora suberosa (*huehue haole*), nat.

Rare, one plant halfway up the east slope.

Portulacaceae

Portulaca oleracea (pigweed), nat.

Occasional, a few plants near shore and halfway up the east slope.

Solanaceae

Lycium sandwicense (*'ohelo kai*), ind.

Rare, only a few plants near the exposed east shore; Flower, fruit.

Nicotiana tabacum (tree tobacco), nat.

About a dozen plants near the north shore; Flower, fruit. Hand pulled.

Sterculiaceae

Waltheria indica (*'uhaloa*), ind.

Occasional, plants are scattered throughout the island, primarily on the south slope; Flowers, fruit.

Verbenaceae

Lantana camara (lantana), nat.

Common to dominant throughout the island with the exception of the north side; Flowering.

Stachytarpheta jamaicensis (Jamaica vervain), nat.

Common, scattered plants throughout the island, except near shore; Flowering.

Angiosperms-Monocots

Areaceae

Cocos nucifera (coconut), nat.

Rare, a group of about six trees on the northwest side and one young tree on the northeast side.

Cyperaceae

Cyperus javanicus (*ahu 'awa*), end.

Patches are very common, especially along the east and northeast coast; Fruiting.

Fimbristylis cymosa (button sedge), ind.

Rare, isolated on the far east/northeast side of island near shore; Flower, fruit.

Poaceae

Cenchrus echinatus (sand bur), nat.

Rare, five plants on the northeast side; Fruiting. All individuals pulled.

Chloris barbata (swollen fingergrass), nat.

Common throughout the island; Flowering.

Digitaria ciliaris (Henry's crabgrass), nat.

Common, especially on the more barren east side; Fruiting.

Digitaria insularis (sourgrass), nat.

Dominant throughout the island, except under *Schinus*; Flower, fruit. This grass is the dominant colonizer where *Schinus* was removed.

Eleusine indica (wiregrass), nat.

Rare, only a few clumps at mid-elevation on the north side.

Heteropogon contortus (*pili* grass), ind.

Common, scattered from shore to summit except on the north side; Flower, fruit.

Melinis repens (natal red top), nat.

Common, especially around high rocky areas where it coexists with *pili* grass; Flowering.

Panicum fauriei var. *carteri* (Carter's panic grass), end. E

No plants were found in 2006 or 2007 despite multiple visits throughout the year. However in June 2008, four plants were found on the east side (historical location). Two plants were growing in mixed grass and *Cyperus javanicus*, while the other two were growing in bare, rocky areas closer to shore; Fruiting. Seed collected for propagation.

Sporobolus pyramidatus (dropseed), nat.

Locally abundant on the east coast, likely displacing *Panicum fauriei*; Fruiting.

Pteridophytes

Polypodiaceae

Phymatosorus grossus (*lau'ae*), nat.

Occasional in the *Schinus* understory and at the base of the east and north cliffs.

SEABIRDS

Methods and general description

We searched the entire island for evidence of nesting seabirds on 12 May, but only found nesting wedge-tailed shearwaters. We returned to the islet during the shearwater hatching period on 17 August to check the status of active burrows and again prior to shearwater fledging on 21 September, but no birds remained. In the past, the island supported a population of 200-300 nesting shearwater pairs (Fitch 1968), in addition to one White-tailed tropicbird nest in 1954 and 1955 (Norton 1955).

Checklist of Seabirds with notes

Procellariidae

Puffinus pacificus (Wedge-tailed shearwater), ind.

There were approximately 50 active burrows this year, but most nests were abandoned at some point prior to hatching. Only 15 eggs were attended until hatching as evidenced by dead pipping eggs or dead chicks. During our August visit, all eggs and chicks were dead except one. The newly hatched chick was attended by an adult, both of which were being swarmed by long-legged ants, *Anoplolepis gracilipes*. The chick's eyes were swollen and it continually twitched to rid itself of ants while the adult had cloudy eyes and did not respond to human interference. No live chicks or adults were found during our final visit in September. The same observations were made during the 2006 breeding season (pers. obsv.) after long-legged ants began to dominate the island.

OTHER BIRDS

One or two erckel's francolins, *Francolinus Erckelii*, were observed during most trips to the island.

ARTHROPODS

Methods and general description

During the May trip we focused on ant assessment using ant cards, but we were also able to conduct a partial arthropod survey by searching host plants, sweep-netting and litter sifting. We were able to conduct a full arthropod survey in October. Two transects were established (one on the north and the other on the south side of the islet) with 12 sampling points total spaced 10 meters apart. At each point we used the following techniques: pitfall trap, pan trap, sweep nets, host search and ground search. Traps were collected after 72 hours. Additionally, we employed the same methods on any plant species or habitat not included in our transects.

Mokoli'i's arthropod community is dominated by a supercolony of long-legged ants, *Anoplolepis gracilipes*. It is unclear when the ant species was introduced, but the population became superabundant in 2006. Since then long-legged ants have dominated the islet, covering every area from the intertidal zone to the summit. Although ant abundance fluctuates seasonally, it remains high. Also notable is a very high roach density on the islet. Our traps were packed with ants, roaches, and isopods while little else was found.

Checklist of Arthropods

BLATTODEA

Blattellidae

Symploce pallens (smooth cockroach), nat.

New islet record.

Blattidae

Periplaneta americana (American cockroach), nat.

New islet record.

Periplaneta australasiae (Australian cockroach), nat.

New islet record.

Platyzosteria soror, nat.

New islet record.

COLEOPTERA

Cerambycidae

Sybra alternans (long-horned beetle), nat.

New islet record.

Coccinellidae

Ceolophora inaequalis (common Australian lady beetle), purposely introduced

Curinus coeruleus (metallic blue ladybird beetle), purposely introduced
New islet record.

DIPTERA

Tephritidae

Acinia picturata (Tephritid fly), nat.
New islet record.

HETEROPTERA

Lygaeidae

Nysius sp. (seed bug), unknown status
New islet record.

Tingidae

Teleonemia scrupulosa (lantana lace bug), purposely introduced
New islet record.

HOMOPTERA

Cicadellidae

Carneocephala sagittifera (Bermuda grass leafhopper), nat.
New islet record.

Sophonia rufofascia (two-spotted leafhopper), nat.
New islet record.

Flatidae

Melormenis basalis (west Indian flatid), nat.
New islet record.

Margarodidae

Icerya purchasi (cottony cushion scale), nat.
New islet record.

Tropiduchidae

Ommatissus sp. (flatid planthopper), nat.
New islet record.

HYMENOPTERA

Formicidae

Anoplolepis gracilipes (long-legged ant), nat.

ISOPODA

Armadillidae

Cubaris murina (terrestrial isopod), nat.

New islet record.

Scyphacidae

Alloniscus oahuensis (terrestrial isopod), nat.

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

No skinks or geckos were observed and there was no evidence of rats or mice. Black rats, *Rattus rattus*, were present on the island from the 1950's until they were eradicated in 2002 (Smith 2006; Smith, Shiinoki et al. 2006).

THREATS AND RECOMMENDATIONS

Mokoli'i is easily accessible and receives a high number of visitors. Fishing from and around the island is common, but most visitors are kayakers or boaters on short day trips. Camping, although not permitted, is also common on the northern spit as evidenced by several fire rings and glass bottles. As a direct result, shearwater burrows are crushed, trash accumulates and native plants are trampled. Indirectly, the high number of visitors increases the opportunity for invasion by non-native species.

Since Mokoli'i is not part of the State Seabird Sanctuary, there are no regulations to impose. Therefore, it is extremely important to involve the local community in the protection and restoration of the island. Support already exists as it was the community that acted as the driving force behind the rat eradication in 2002. Working with the community to increase awareness about current threats in conjunction with signage to inform visitors of sensitive areas would greatly benefit the islet ecosystem.

Currently, however, the greatest threat is the pervasive supercolony of long-legged ants, which has decimated the seabird colony and has likely altered the arthropod community. Weeds, such as *Schinus terebinthifolius*, that host scale support these unusually dense populations of ants and need to be concurrently controlled (see section 4). Many additional invasive plant species exist on the island including *Pluchea indica* and *Lantana camara* along with several grasses and vines. Control should begin along the northeast coast where natives persist and continue upslope. Outplanting should immediately follow any clearing to reduce the amount of invasion by non-native species, which have been found to document the seedbank (Eijzena unpubl. data). See Starr and Starr (2006) for outplanting recommendations.

Of special concern is the dwindling population of the endangered, endemic grass *Panicum fauriei* var. *carteri*. This species occurs along the northern shore in a high traffic area. In 2002 the population was fairly large (ca. 25 flowering plants), but from 2002-2007 the non-native grass *Sporobolus pyramidatus* spread into that area and no *P. fauriei* was found. Fortunately, in June 2008 four plants were found, so a seedbank continues to persist.

Table 5. Key threats to Mokoli'i ecosystem and recommendations

| Threat | Impacts | Recommendations |
|---------------------------------|---|--|
| Human disturbance | Crushed burrows, trampled plants, potential to introduce non-native species | Community awareness program and signage |
| Weeds | | |
| <i>Schinus terebinthifolius</i> | Displacement of natives, poor nesting habitat, supports high ant density | Eradicate prior to ants |
| <i>Lantana camara</i> | Displacement of natives; poor nesting habitat | Widespread, attempt to control with eventual goal of eradication |
| <i>Pluchea indica</i> | Displacement of natives; poor nesting habitat | Widespread, attempt to control with eventual goal of eradication |
| Grasses | Displacement of natives, especially <i>Panicum fauriei</i> | Eradicate <i>Sporobolus pyramidatus</i> ; for the remainder attempt to control with eventual goal of eradication |
| Vines | Entanglement hazard for nesting seabirds | Attempt to control with eventual goal of eradication |
| Long-legged ants | Decimate seabird colony; alter arthropod community | Continue eradication research |



Figure 7. Long-legged ants line along a fracture in a wedge-tailed shearwater egg to suck moisture.



Figure 8. A shearwater hatchling with eyes swollen shut due to swarming ants which spray formic acid into their eyes.



Figure 9. Pitfall traps were the same throughout the island: densely packed with long-legged ants.



Figure 10. Pan trap contents were the same throughout the island: packed with long-legged ants, roaches, and isopods.

8. O'AHU : Kapapa Islet (Moku Kapapa)



LOCATION

Kapapa is located just inside the outer reef of Kaneohe Bay approximately 3.2 km offshore at 21°28'35" N latitude, 157°47' 54" W longitude.

STATUS

Kapapa is state property. State and/or federal laws protect all native wildlife and plants, as well as cultural sites.

PHYSICAL DESCRIPTION

Kapapa is a low islet, reaching a height of only 4.6 meters above sea level. The 3.8 hectare islet is formed from a lithified sand dune, limestone, sand, and sandy soil.

ACCESS

We made two trips to survey Kapapa. The first was on 29 April 2007 from 0900 to 1500 with Heather Eijzenga (Bishop), Jaap Eijzenga (DOFAW), Danielle Frohlich (volunteer) Paul McDonald (volunteer), and Princes Rosit (project intern). Our primary objective was to assess the ant population on the islet, but we also conducted a partial arthropod survey. Complete arthropod, plant, and seabird surveys were conducted from 20 October 2007 at 0900 to 21 October 2007 at 1000 with Heather Eijzenga, Jaap Eijzenga, Dana Crompton (volunteer),

Brittany Akina (volunteer), Sheldon Plentovich (volunteer), Naomi Hoffman (volunteer), Ron Fenstermacher (volunteer), and Randi Rhodes (volunteer). Access for both trips was by boat from He'eia pier.

VEGETATION

Methods and general description

A complete botanical inventory was conducted by walking loose transects throughout the islet. We visited the islet during a dry time of year and there was less vegetation cover and total species compared to previous visits. Although many non-native species occur on the islet including a large stand of ironwood trees, *Casuarina equisetifolia*, native plants dominate the ground cover. Most common are *Jacquemontia ovalifolia* and *Boerhavia repens*. Plant cover was approximately 70% with 27 plant species total: 15 non-native, 10 indigenous and 2 endemic. Several species found during the most recent botanical survey in April 2005 (Starr and Starr 2005) were not detected during this trip: *Cuscuta sandwichiana*, *Digitaria insularis*, *Eleusine indica*, *Emilia fosbergii*, *Stachytarpheta jamaicensis*, *Portulaca pilosa*, *Chenopodium oahuense*, *Bidens alba*, *Solanum americanum*, *Sonchus oleraceus*, *Portulaca oleracea*, *Sidastrum micranthum*, *Paspalum vaginatum* and *Sporobolus pyramidatus*. However, conditions were dry during both visits and many of these plants are likely present in the seed bank. One new islet record, the non-native herb *Boerhavia coccinea*, was detected and removed from the islet.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Agavaceae

Aloe vera (aloe), nat.

Rare, a patch on the south side of the islet; flowering.

Aizoaceae

Sesuvium portulacastrum ('akulikuli), ind.

Dominant on northwest tip and eastern spray zone.

Tetragonia tetragonioides (New Zealand spinach), nat.

Rare, patches found in the area above and to the right of the landing and another south of *C. equisetifolia* stand.

Amaranthaceae

Alternanthera pungens (khaki weed), nat.

Occasional, especially along the western edge of the islet, all plants were removed.

Asteraceae

Pluchea carolinensis (sourbush), nat.

Rare, a small patch in the middle of the *C. equisetifolia* stand.

Pluchea indica (Indian fleabane), nat.

Rare, a few plants scattered around the islet; flowering.

Bataceae

Batis maritima (pickleweed), nat.

Rare, one patch hanging from the islet on the western side, south of the landing area.

Boraginaceae

Heliotropium anomalum (*hinahina*), end.

Rare, a few patches on the south side.

Tournefortia argentea (tree heliotrope), nat.

Occasional, found along the northern margins of the islet and to a lesser extent, along the east and south margins; flowering.

Casuarinaceae

Casuarina equisetifolia (ironwood), nat.

Common; covers the southwest section of the islet with little able to grow beneath; fruiting.

Casuarina glauca (longleaf ironwood), nat.

Occasional, mixed with *C. equisetifolia*.

Convolvulaceae

Ipomoea indica (*koali 'awa*), ind.

Occasional; large patches on the southwest side; flowering.

Goodinaceae

Scaevola sericea (beach *naupaka*), ind.

Occasional, several patches on the northeast and south parts of the islet; fruit, flower.

Jacquemontia ovalifolia (*pa'u o Hi'iaka*), end.

Common throughout islet, dieback due to dry weather, very little observed during October trip; flowering.

Malvaceae

Sida fallax (*'ilima*), ind.

Occasional, patches found primarily on the south side of the islet and around landing area; flowering.

Thespesia populnea (*milo*), ind.

Rare, a few trees near the landing on the northwest part of islet.

Nyctaginaceae

Boerhavia coccinea, nat.

Rare, a few plants on the western side of the islet, all plants were removed; flowering. New islet record.

Boerhavia repens (*alena*), ind.

Common, found in open areas throughout the islet; much dieback due to dry weather; fruiting.

Polygonaceae

Coccoloba uvifera (seagrape), nat.

Rare, a few large trees near the landing area.

Portulacaceae

Portulaca lutea (*'ihi*), ind.

Rare, a small cluster of plants near the landing area on a rock under *T. argentea*.

Solanaceae

Lycium sandwicense (*'ohelo kai*), ind.

Occasional, especially along the southern margins of the islet.

Angiosperms-Monocots

Arecaceae

Cocos nucifera (coconut), nat.

Rare, one young tree on the northwest side.

Cyperaceae

Fimbristylis cymosa (button sedge), ind.

Rare, a few plants on the northwest tip.

Poaceae

Chloris barbata (swollen fingergrass), nat.

Occasional, primarily near the landing area; fruit, flower.

Cynodon dactylon (Bermuda grass), nat.

Occasional, patches near the landing area, much dieback due to dry weather.

Eragrostis amabilis (lovegrass), nat.

Rare, a few plants near the landing and along the west side of the islet; flowering.

Sporobolus virginicus (*'aki'aki*), ind.

Common along margins of islet especially the south and east side.

SEABIRDS

Methods and general description

In October, seven people conducted a Wedge-tailed shearwater census on the island, which lasted three hours. We did not detect other nesting seabirds. In the past, Bulwer's petrels (*Bulweria bulweri*) have been reported nesting on the island (Munro 1947). Although we did not

find any, it was late in their breeding season. Potential nesting habitat for them exists along the northwest section of the islet.

Checklist of Seabirds with notes

Laridae

Anous minutus (Black noddy), ind.

One bird was hunting for fish in the surrounding waters from perches on the islet.

Procellariidae

Puffinus pacificus (Wedge-tailed shearwater), ind.

We counted 191 chicks during our survey (a decline from 328 chicks counted during October 2004). Most burrows on the islet were crushed and empty (some with abandoned eggs) as a result of human traffic. Only burrows that were protected by dense vegetation (primarily *Casaurina equisetifolia*, but also *Tornefortia argentea* and *Scaevola sericea*) or rocks were intact and housed chicks.

OTHER BIRDS

None.

ARTHROPODS

Methods and general description

During the April trip we focused on ant assessment using ant cards, but we were also able to conduct a partial arthropod survey by searching host plants, sweep-netting, and litter sifting. We were able to conduct a full arthropod survey in October. One transect was established that ran east-west through the middle of the islet with eight sampling points total spaced 10 meters apart. At each point we used the following techniques: pitfall trap, pan trap, sweep nets, host search and ground search. Traps were collected after 24 hours. Additionally, we employed the same methods on any plant species or habitat not included in our transect. We conducted one hour of night collection. During both trips we also focused on finding *Rhyncogonus kapapa* by searching on and around its host plant, *Sida fallax*.

Although *Rhyncogonus kapapa* was not found on either collecting trip, endemic *Hylaeus* bees were common. Several plants were in flower and were attracting large numbers of Coccinellid beetles, bees, and wasps. Spiders and grasshoppers were abundant in the Ironwood grove along with ants and roaches. Although big-headed ants were present, they did not occur in the dense populations seen on other islets. We were unable to collect more than a few moths during night collecting.

Checklist of Arthropods

ARANAEA

Dysderidae

Dysdera crocota (woodlouse spider), nat.

New islet record.

Araneidae

Argiope appensa (garden spider), nat.

Araneidae

Neoscona oaxacensis (western spotted orbweaver), nat.

New islet record.

Salticidae

Hasarius adansoni (Adanson's house jumper), nat.

New islet record.

BLATTODEA

Blaberidae

Pycnoscelus indicus (burrowing cockroach), nat.

New islet record.

Blattidae

Periplaneta americana (American cockroach), nat.

New islet record.

COLEOPTERA

Coccinellidae

Coccinella septempunctata (seven-spotted ladybird beetle), purposely introduced

New islet record.

Cryptolaemus montrouzieri (mealybug destroyer), purposely introduced

New islet record.

Micraspis lineola (coccinellid beetle), purposely introduced

New islet record.

Tenebrionidae

Ammophorus insularis, nat.

New islet record.

Gonocephalum adpressiforme (gonocephalum darkling beetle), nat.

New islet record.

DIPTERA

Chloropidae

Siphunculina striolata (chloropid fly), nat.

New islet record.

Tachinidae

Gonia longipulvilli (tachinid fly), nat.

New islet record.

HETEROPTERA

Lygaeidae

Nysius coenosulus (seed bug), end.

New islet record.

Nysius kinbergi (seed bug), end.

New islet record.

HOMOPTERA

Cicadellidae

Agallia lingual, nat.

New islet record.

Pseudococcidae

Pseudococcus sp. (mealybug), unknown status

New islet record.

HYMENOPTERA

Anthophoridae

Ceratina arizonensis (small carpenter bee), nat.

New islet record.

Chrysididae

Chrysis angolensis (cuckoo wasp), nat.

New islet record.

Colletidae

Hylaeus sp. (yellow-faced bee), end.

New islet record.

Dryinidae

Gonatopus dichromus (flightless Dryinid wasp), nat.
New islet record.

Formicidae

Tetramorium bicarinatum (Guinea ant), nat.
New islet record.

Leptogenys falcigera (long-legged ponerine ant), nat.
New islet record.

Pheidole megacephala (big-headed ant), nat.
New islet record.

Plagiolepis alluaudi (little yellow ant), nat.
New islet record.

Ochetellus glaber (glaber ant), nat.
New islet record.

HYMENOPTERA

Anthophoridae

Ceratina arizonensis (small carpenter bee), nat.
New islet record.

Apidae

Apis mellifera (honey bee), nat.
New islet record.

Sphicidae

Dolichurus stantoni (black cockroach wasp), purposely introduced
New islet record.

Vespidae

Pachodynerus nasidens (keyhole wasp), nat.
New islet record.

ISOPODA

Indeterminate family

New islet record.

Scyphacidae

Alloniscus oahuensis (terrestrial isopod), nat.

New islet record.

ORTHOPTERA

Acrididae

Oxya japonica (rice grasshopper), nat.

New islet record.

Schistocerca nitens (vagrant grasshopper), nat.

New islet record.

THYSANOPTERA

Phlaeothripidae

Haplothrips sp. (thrip), unknown

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

There is a small ephemeral anchialine pond approximately 1 m² in size lasting for four hours daily with many *Halocaridina rubra* (*opae'ula*) north of landing area at start of islet extension. UTM (NAD83 Z4: 0624415/2375398). No skinks or geckos were observed.

THREATS AND RECOMMENDATIONS

Kapapa receives a high number of visitors and human disturbance remains the single greatest threat to the island ecosystem. Like Mokoli'i, Kapapa is not part of the State Seabird Sanctuary. Efforts to include the islet as part of the sanctuary in the past have been met with strong protest and have included killing hundreds of shearwaters and setting the island on fire. Camping is currently allowed and is common on weekends. Visitors typically access the island by boat, but occasionally by kayak. Fishing is the most common activity, but seems to have the lowest impact as fishermen tend to stay around the perimeter of the island. The most damage is caused by campers and day visitors that wander throughout the island crushing burrows and leaving large amounts of trash. They also have the potential to introduce non-native species.

Once again, the State is attempting to include Kapapa in the State Seabird Sanctuary. In order for this attempt to be successful it is imperative to work with the community on the proposed regulations and garner their support. Small measures such as limiting camping, closing nesting areas, and installing informational signs could be extremely effective in protecting nesting seabirds.

Although many non-native species are present on Kapapa, native species dominate the landscape. Natives are able to persist on many of the low-lying islets because few non-natives are able to tolerate the harsh salt spray that washes over much of the islet. Currently the large stand of *Casaurina* is blocking the wind and sea spray, and if removed, the natives will be able to expand into this area. However, any removal project should be postponed until there is community support and protection for nesting seabirds, as the *Casaurina* currently provides a safe nesting site.

Several incipient populations of non-native species should be eradicated; especially those that are known to be invasive (see Starr and Starr 2006 for control and outplanting suggestions). Because of Kapapa’s high visitation rate, regular plant monitoring should be conducted to detect and remove new, non-native species.

During future visits, an effort should be made to confirm nesting of Bulwer’s petrels, which have historically nested on the island and the presense of the native weevil, *Rhyncogonus kapapa*. *Rhyncogonus kapapa* was discovered on Kapapa in 1968 and is only known from this location. It is unknown if this rare endemic species is still present.

Table 6. Key threats to Kapapa ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|--------------------------------|--|--|
| Human disturbance | Crushed burrows, trampled plants, potential to introduce non-native species | Community awareness program and signage |
| Weeds | | |
| <i>Casaurina equisetifolia</i> | Displacement of natives, blocks salt spray, little able to grow beneath canopy | Eradicate with community support and protection for nesting seabirds |
| Incipient spp. | Displacement of natives; potential to alter habitat | Eradicate and monitor regularly for new problem species |
| Big-headed ants | Affect nesting seabirds; alter arthropod community | No action, research needed (see section 4.2) |



Figure 11. Bermuda grass, *Cynodon dactylon*, and other non-native grasses dominate the landing area. A fire pit sits in the foreground. All burrows in this area were crushed.

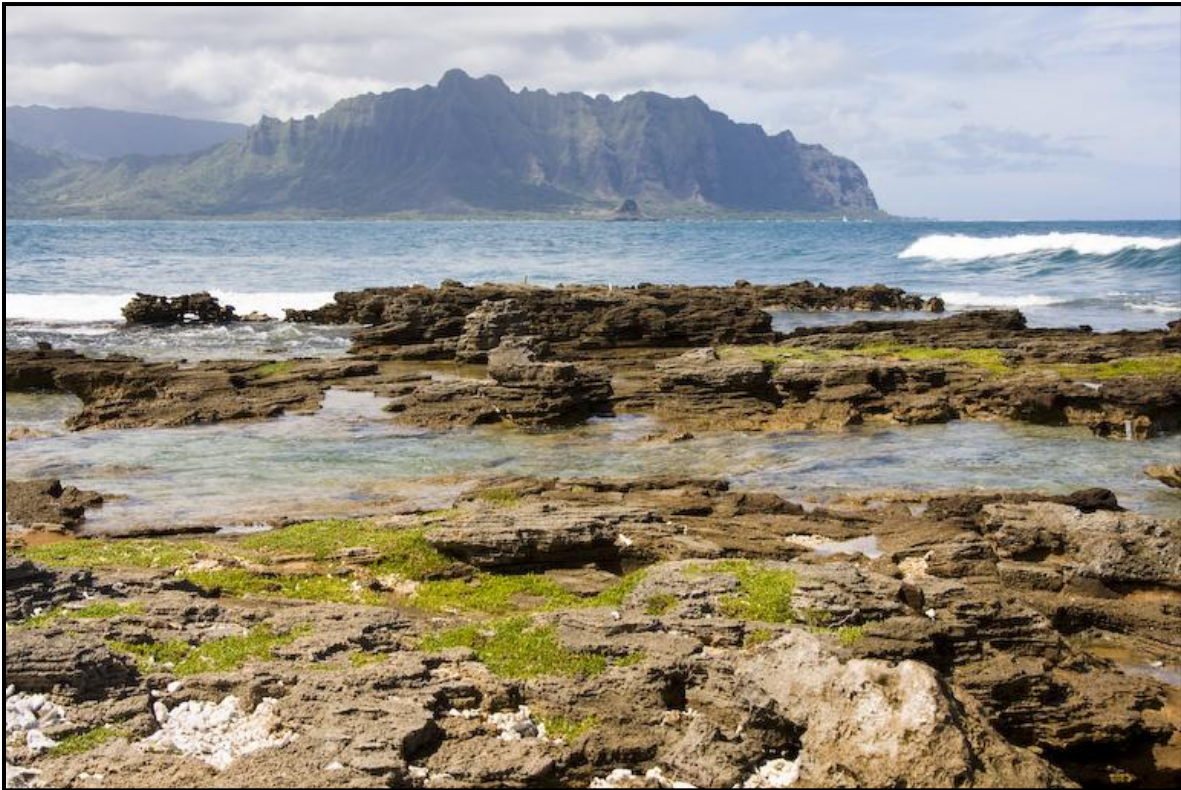


Figure 12. Intertidal areas along the north and east sides of the island support a diversity of marine life.



Figure 13. *Scaevola sericea* and *Tornafortia argentea* encircle the north and east ends of the islet.



Figure 14. View from the eastern intertidal zone where *Sesuvium portulacastrum* dominates.

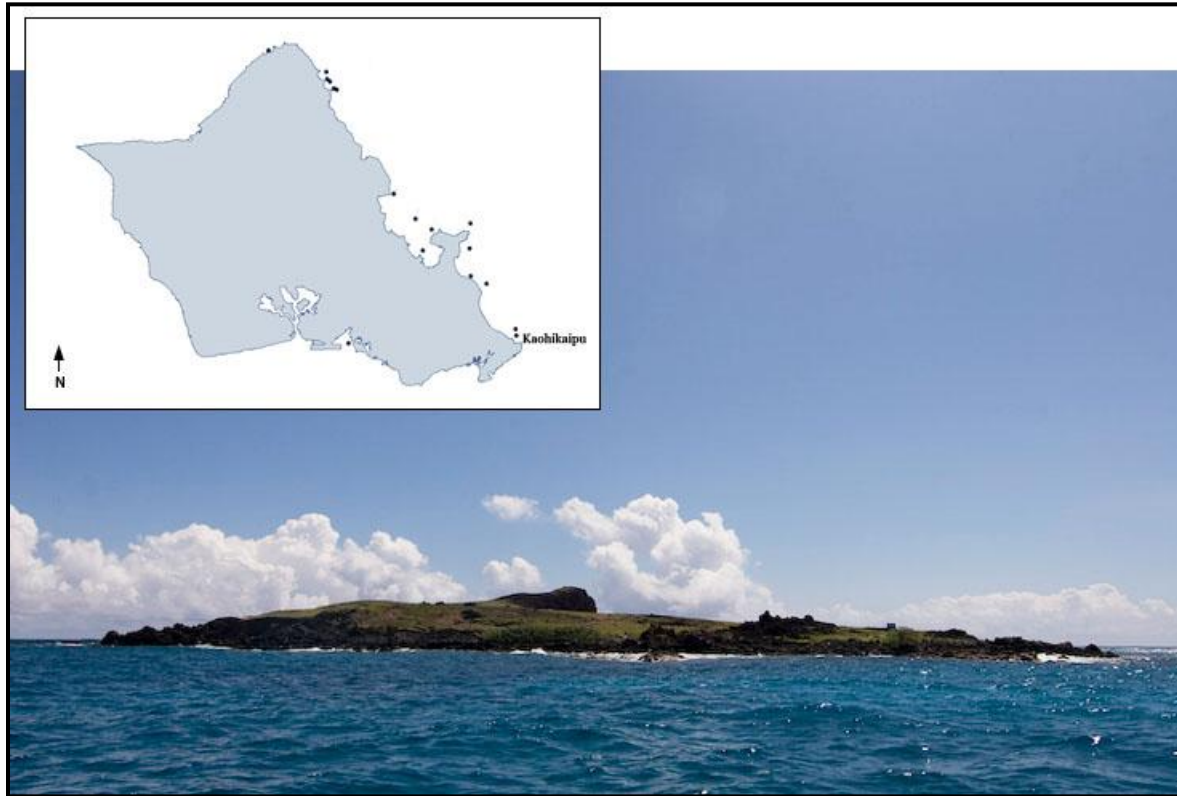


Figure 15. Wind and salt spray create harsh conditions on the southeast quadrant allowing natives (*Ipomoea carica*, *Jaquemontia ovalifolia*, *Sida fallax*, *Sporobolus virginicus*, and *Lycium sandwicense*) to dominate.



Figure 16. *Casuarina* spp. dominate the southwest quadrant of the islet.

9. O'AHU : Kāohikaipu Islet (Black Rock)



LOCATION

Kāohikaipu is located near Mānana Islet and is 800 meters north of Makapu'u Beach on the southeast coast of O'ahu at 21°28'35" N latitude, 157°39' 20" W longitude.

STATUS

Kāohikaipu is part of the Hawai'i State Seabird Sanctuary, protected by the Hawai'i Department of Land and Natural Resources (DLNR). Permission to land must be obtained in writing from DLNR.

PHYSICAL DESCRIPTION

Kāohikaipu is 4.5 hectares in size with a maximum elevation of 12.2 meters. The islet is O'ahu's southernmost and geologically youngest offshore islet. It is primarily composed of a volcanic cinder cone that was formed only a few thousand years ago by cinder, spatter, and lava from the Koko fissure. An old vent forms a tiny bay on the northeastern side. The islet must have formed when sea levels were lower because if it had erupted underwater, it would have formed tuff cone like Mānana.

ACCESS

We made three trips to survey the islet. The first trip was made by Heather Eijzenga (Bishop),

Jaap Eijzenga (DOFAW), Malia Paresa (project intern), Kim Morishige (project intern), Jason Misaki (DOFAW) and Pat Porter (DOFAW) on 28 March 2007 from 0900 to 1200. For this trip we practiced arthropod collecting techniques and made some opportunistic collections. Heather Eijzenga, Jaap Eijzenga, and Jiny Kim (project intern) visited the islet again on 1 December 2007 from 1300 to 2000 and on 2 December 2007 from 0900 to 1700. During the second two trips we conducted a complete arthropod and botanical survey. We accessed the islet by kayak from the Makai Research Pier and by boat from Kailua boat ramp.

VEGETATION

Methods and general description

During the December trip, a complete botanical inventory was conducted by walking loose transects throughout the islet. There was lush growth following several weeks of heavy rain and native plants dominated the majority of the islet. Despite control efforts, two invasive species (*Cenchrus echinatus* and *Verbesina encelioides*) continue to spread. Plant cover was approximately 90% with 27 plant species total: 13 non-native, 11 indigenous and 4 endemic. Seven species found during the most recent botanical survey in February 2005 (Star and Star 2006) were not detected during this trip: *Cenchrus ciliaris*, *Dactyloctenium aegyptium*, *Sporobolus pyramidatus*, *Eleusine indica*, *Leucaena leucocephala*, *Emilia fosbergii* and *Ipomoea indica*. We detected a new islet record, the non-native herb *Coronopus didymus*.

Checklist of Vascular plants with notes

Aizoaceae

Sesuvium portulacastrum ('akulikuli), ind.

Occasional, found primarily in the spray zones on the northeast side of the islet up to the summit and around the cove on the south side; flowering.

Amaranthaceae

Achyranthes aspera, nat.

Rare, a few plants found around boulders on the northwest side of the islet; flowering.

Asteraceae

Melanthera integrifolia (nehe), end.

Large patches occasional throughout the islet, primarily limited to rocky areas; flowering.

Sonchus oleraceus (sow thistle), nat.

Individuals occasional throughout most of the islet.

Verbesina encelioides (golden crown-beard), nat.

Locally common in the northwest section with *Cenchrus echinatus*, mostly new seedlings, but also a few mature plants; flowering.

Boraginaceae

Heliotropium curassavicum (nena), ind.

Rare, a few plants scattered around the perimeter of the islet; flowering.

Tournefortia argentea (tree heliotrope), nat.

Rare, one tree on the northwest point; flowering.

Brassicaceae

Coronopus didymus (swinecress), nat.

Rare, four small plants at the summit of the islet. New islet record.

Chenopodiaceae

Atriplex semibaccata (Australian saltbush), nat.

Occasional, restricted to the northeast tip where it forms a large mat.

Convolvulaceae

Ipomoea carica (*koali ai*), ind.

Locally common in the northwest section of the islet where it forms large patches; flowering.

Jacquemontia ovalifolia subsp. *sandwicensis* (*pau o Hi'iaka*), end.

Common throughout the islet with high seedling recruitment; flowering.

Fabaceae

Sesbania tomentosa (*'ohai*), end., E.

Two individuals found, a mature plant in the center of the islet and a young plant outplanted in 2006. Outplanting from 2007 was not successful due to a lack of rain. During our March visit, both plants were completely defoliated, but after a few weeks of rain in November, they were full of new growth.

Goodinaceae

Scaevola sericea (beach *naupaka*), ind.

Three patches found around the perimeter of the islet; flowering.

Malvaceae

Hibiscus tiliaceus (*hau*), ind.

One grove of trees on northeast section; flowering.

Sida fallax (*'ilima*), ind.

Common throughout the islet; many seedlings; flowering

Nyctaginaceae

Boerhavia repens (*alena*), ind.

Occasional, patches found throughout the islet; flower, fruit.

Papavaraceae

Argemone glauca (*pua kala*), end.

Occasional throughout rocky areas along the north section of the islet, many seedlings; flowering, fruiting.

Passifloraceae

Passiflora suberosa (*huehue haole*), nat.

A few patches along the western section of the islet; being eaten by *Hyles lineata* caterpillars; not in fruit, flower.

Portulacaceae

Portulaca oleracea (pigweed), nat.

Common throughout the islet; forming monotypic patches in the northeast section of the islet; flowering, fruiting. This species has been increasing in range and abundance over the past few years.

Portulaca pilosa (kiss me quick), nat.

Occasional, scattered throughout the western side of the islet, mostly seedlings.

Solanaceae

Lycium sandwicense ('ohelo kai), ind.

One patch found in the center of the islet; flowering.

Solanum americanum (popolo), ind.

Rare. A few plants found along the northern section of the islet; flowering.

Cyperaceae

Fimbristylis cymosa (button sedge), ind.

Found primarily around the perimeter of the islet in occasional patches; fruiting.

Poaceae

Cenchrus echinatus (sandbur), nat.

Forming large mats on the northwest section of the islet; some in fruit and flower.

Chloris barbata (swollen fingergrass), nat.

Occasional, plants interspersed with other vegetation; flowering

Digitaria ciliaris (Henry's crabgrass), nat.

Rare. A few plants scattered around the center of the islet.

Setaria verticillata (bristly foxtail), nat.

Rare. A few plants mixed in with the *Cenchrus echinatus* on the northwest side.

Sporobolus virginicus ('aki'aki), ind.

Common on the northeast side of the islet where it forms large patches.

SEABIRDS

Methods and general description

Our visits did not overlap with the breeding season of the two species known to currently nest on Kāohikaipu, Bulwer's petrel and Wedge-tailed shearwater. Shearwaters were beginning to nest during our March visit and by December, only one chick remained on the islet. Historically, black noddies, *Anous minutus*, nested in small numbers on the southern cliffs (Munro 1941; Richardson and Fisher 1950; Munro 1956) and from 1993-1996, a Laysan albatross (*Phoebastria*

immutabilis) attraction project was conducted on the island (Podolsky and Kress 1996). Neither species was observed during our visits.

Checklist of Seabirds with notes

Procellariidae

Puffinus pacificus (Wedge-tailed shearwater), ind.

In November, DOFAW staff conducted a shearwater census on the island and counted 445 chicks (DOFAW unpubl. data).

Bulweria bulweri (Bulwer's petrel), ind.

Although our visit did not coincide with nesting season, we found and removed 16 owl-killed Bulwer's petrel fledglings from the islet. The carcasses were all found around the large boulder pile on the northwest corner of the islet where they are known to nest.

OTHER BIRDS

Black-crowned night herons, *Nycticorax nycticorax*, were observed on each visit flying over Kāohikaipu from Mānana Island to the adjacent coast. They occasionally nest in the *milo* along the north end of the islet (J. Eijzenga pers. comm.).

ARTHROPODS

Methods and general description

During our first trip, the project interns practiced arthropod collecting techniques and only opportunistic collections were made. A full arthropod and botanical survey was conducted in December. Two loose transects were set up, the first running from the middle of the west side of the islet towards the center and the second ran north south along the east side of the islet. There were 10 sampling points total spaced 10 meters apart. At each point we used the following techniques: pitfall trap, pan trap, sweep nets, host search and ground search. Traps were collected after 24 hours. Additionally, we employed the same methods on any plant species or habitat not included in our transects. We conducted two hours of night collection, but did not use light trapping to limit our visibility from shore.

On our first trip, grasshoppers and beetles were abundant throughout the islet and we were able to locate a single individual of the endemic weevil *Rhyncogonus vestitus*. Ants were abundant, but no single species seemed to dominate. Fire ants were especially abundant in the northwest section of the islet with *Verbesina*. Most plants were in flower during our second trip and attracting large numbers of butterflies, Coccinellid beetles and flies. Several endemic crickets and a single mangrove slater were found along the east coast of the island.

Checklist of Arthropods

ARANEAE

Oxypodidae

Oxyopes sp. [of Kumashiro, 1990] (lynx spider), nat.
New islet record.

Theridiidae

Steatoda crocota, nat.
New islet record.

BLATTODEA

Blaberidae

Pycnoscelus indicus (burrowing cockroach), nat.
New islet record.

COLEOPTERA

Bostrichidae

Sinoxylon conigerum (auger beetle), nat.
New islet record.

Cerambycidae

Sybra alternans (long-horned beetle), nat.
New islet record.

Coccinellidae

Coelophora inaequalis (common Australian lady beetle), purposely introduced
New islet record.

Micraspis lineola (coccinellid beetle), purposely introduced
New islet record.

Curculionidae

Rhynchogonus vestitus (weevil), end.
New islet record.

Elateridae

Cardiophorus stolatus (click beetle), nat.
New islet record.

Tenebrionidae

Ammophorus insularis, nat.
New islet record.

Gonocephalum adpressiforme (gonocephalum darkling beetle), nat.
New islet record.

Lobometopon diremptus, nat.
New islet record.

DIPTERA

Canicidae

Canaceoides angulatus (beach fly), nat.
New islet record.

Ephydriidae

Scatella sexnotata, ind.
New islet record.

Hippoboscidae

Olfersia aenescens, ind.
New islet record.

Sarcophagidae

Sarcophaga peregrina (flesh fly), nat.
New islet record.

Sarcophaga sp. (flesh fly), nat.
New islet record.

HOMOPTERA

Aphididae

Aphis craccivora (cowpea aphid), nat.
New islet record.

Psyllidae

Heteropsylla cubana (leucaena psyllid), nat.
New islet record.

HYMENOPTERA

Anthophoridae

Ceratina arizonensis (small carpenter bee), nat.
New islet record.

Apidae

Apis mellifera (honey bee), nat.

New islet record.

Bethylidae

Epyris extraneus, nat.

New islet record.

Formicidae

Camponotus variegatus (carpenter ant), nat.

New islet record.

Cardiocondyla sp. (cardiocondyla ant), nat.

New islet record.

Ochetellus glaber (glaber ant), nat.

New islet record.

Solenopsis geminata (fire ant), nat.

New islet record.

ISOPODA

Ligiidae

Ligia hawaiiensis (mangrove slater), end.

New islet record.

LITHOBIOMORPHA

Lithobiidae

Lithobius moananus (centipede), end.

New islet record.

LEPIDOPTERA

Nymphalidae

Agraulis vanillae (passion vine butterfly), nat.

New islet record.

ORTHOPTERA

Acrididae

Schistocerca nitens (vagrant grasshopper), nat.

New islet record.

Gryllidae

Caconemobius sandwichensis (beach rock cricket), end.

New islet record.

Gryllodes sigillatus (tropical house cricket), nat.

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

Skinks were abundant, but they all appeared to be of the same species. One was collected and identified as Snake-eyed skink (*Cryptoblepharus poecilopleurus*). We also found and collected one gecko identified as: Mourning gecko (*Lepidodactylus lugubris*).

THREATS AND RECOMMENDATIONS

Kāohikaipu has a fairly diverse assemblage of native coastal plants. However, several small populations of invasive plant species (listed below) have been found on the island in recent years. Despite control measures, the number and range of these species is slowly spreading and they have the potential to dominate the islet. Eradication of these species should be the highest priority. Of secondary concern are weeds such as *Atriplex semibaccata* and *Portulaca oleracea*, but these have already become widespread across the island. See Starr and Starr (2006) for outplanting suggestions.

Kāohikaipu receives few visitors and the majority remains (legally) in the intertidal zone. Although camping on the island has been a problem in the past, there have been no recent violations.

Table 7. Key threats to Kāohikaipu ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|------------------------------|--|--|
| Owls | Predation of Bulwer’s petrels and to a lesser extent, wedge-tailed shearwaters | Monitor population, research needed (see section 4.4) |
| Weeds | | |
| <i>Verbesina encelioides</i> | Displacement of natives, poor nesting habitat | Eradicate |
| <i>Cenchrus echinatus</i> | Displacement of natives; poor nesting habitat | Eradicate |
| <i>Achyranthes aspera</i> | Displacement of natives; poor nesting habitat | Eradicate |
| <i>Setaria verticillata</i> | Displacement of natives; poor nesting habitat | Eradicate |
| Other non-natives | Displacement of natives | Widespread, attempt to control with eventual goal of eradication |
| Fire ants | Disrupt nesting seabirds, alter arthropods populations | No action, research needed (see section 4.2) |



Figure 17. A large contiguous patch of *Ipomoea carica* dominates the west section of the islet. Bulwer's petrels nest in the boulder piles in the background.



Figure 18. A Sooty tern killed by an owl.



Figure 19. *Verbesina encelioides* seedlings and a few flowering plants flourish after a month of rain, *Portulaca oleracea* and *Cenchrus echinatus* are interspersed.



Figure 20. *Cenchrus echinatus* forms large patches after a month of rain.



Figure 21. Abundant *Argemone glauca* seedlings on the rocky northern shore.



Figure 22. View towards Mānana I. from the summit.

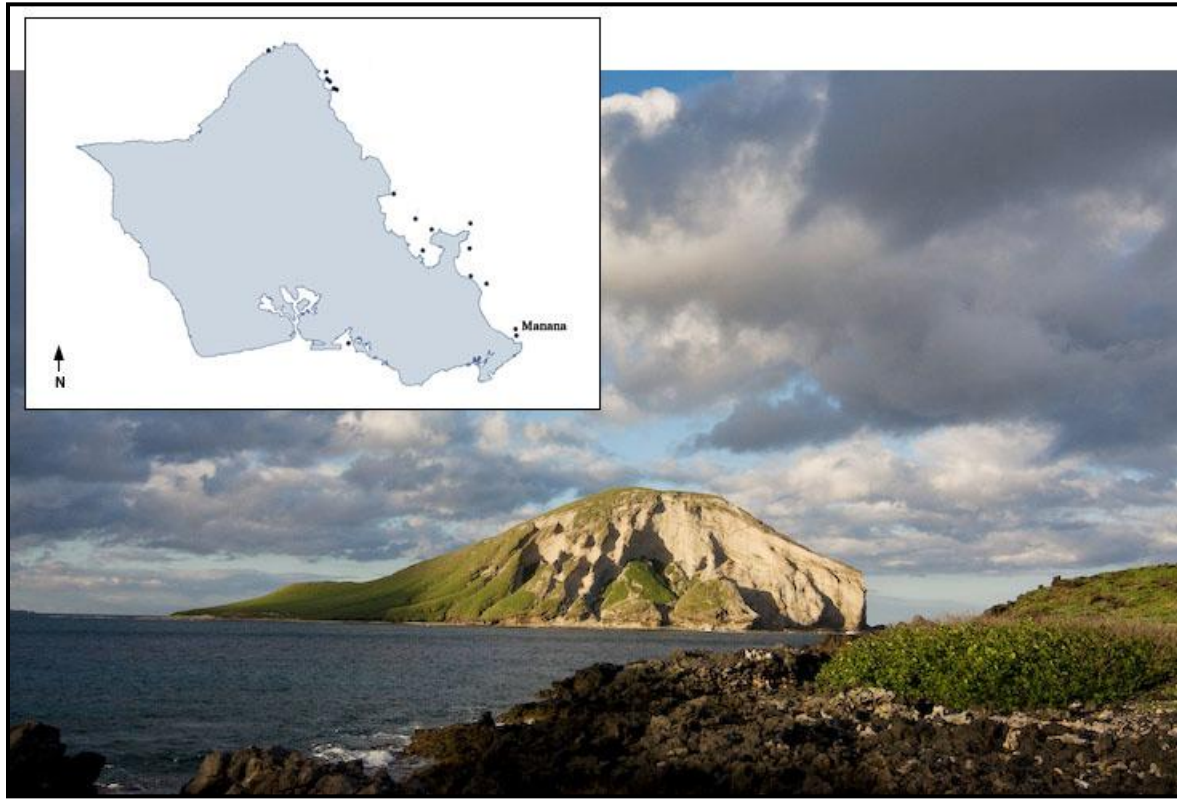


Figure 23. Caterpillar of the passion vine butterfly, *Agraulis vanilla*, eating *Passiflora suberosa*.



Figure 24. *Rhyncogonus* beetle on *Sida fallax*. Photo: J. Eijzenga

10. O'AHU : Mānana (Rabbit) Islet



LOCATION

Mānana is located 1.6 km north of Makapu'u Beach on the southeast coast of O'ahu at 21°19'43" N latitude, 157°39' 25" W longitude.

STATUS

Mānana is part of the Hawai'i State Seabird Sanctuary, protected by the Hawai'i Department of Land and Natural Resources (DLNR). Permission to land must be obtained in writing from DLNR.

PHYSICAL DESCRIPTION

At 27.1 hectares and 109.7 meters in height, Mānana is O'ahu's largest islet. Mānana is made up of the remnants of two adjoining tuff cones. The vents are each marked by a crater, the main crater remains intact but the seaward crater has been reduced to half by surf washing over its old floor. The main cone has a complete rim with deep erosion gullies along the outer and inner slopes and it makes up the majority of the island.

ACCESS

We made two survey trips to the islet. The first was on 9 February 2008 from 1300 to 1800 with Heather Eijzenga (Bishop Museum), Danielle Frohlich (Bishop Museum), Jaap Eijzenga

(DOFAW), Ryan Hoan (project intern), and Robyn Takamine (volunteer) to set traps and begin the survey. The second trip was made on 11 February 2008 from 0900 to 1700 with Heather Eijzenga, Jaap Eijzenga, Jiny Kim (project intern), and David Duffy (University of Hawai'i). For both trips we accessed the island by kayak from the Makai Research Pier.

VEGETATION

Methods and general description

Due to time constraints and the size of the islet, we were unable to perform a full botanical survey. Instead, we recorded all plants and their abundance in the areas of the islet we targeted for arthropod collection, which consisted of the landing area, the crater bottom, the crater rim around to the backside of the islet where we dropped down to the intertidal zone. This left out the summit area, steep cliffs around the islet, steep gullies in the crater, and the area south of the beach. Non-native species dominate the islet. Of the 25 total species recorded during our visit, only three species constitute the majority of plant biomass: *Cenchrus ciliaris*, *Verbesina encelioides* and, to a lesser extent, *Amaranthus spinosa*. After several months of heavy rainfall, plant cover was approximately 75% with 27 plant species total: 17 non-native, 9 indigenous and 1 endemic. Fifteen species found during the most recent botanical survey in February 2005 (Starr and Starr 2006) were not detected during this trip: *Amaranthus viridis*, *Boerhavia*, *Chamaesyce hirta*, *grandis*, *Cocos nucifera*, *Leucaena leucocephala*, *Pluchea carolinensis*, *Prosopis pallida*, *Reichardia picroides*, *Stapelia gigantea*, *Tetragonia tetragonioides*, *Tridax procumbens*, *Eragrostis variabilis*, *Eleusine indica*, and *Cenchrus echinatus*.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Aizoaceae

Sesuvium portulacastrum ('akulikuli), ind.

Occasional, found along the lower slopes at the back (east) side of the islet; flowering.

Amaranthaceae

Achyranthes aspera, nat.

Occasional, along the crater rim; fruiting.

Amaranthus spinosa (spiny amaranth), nat.

Common in the crater where it is mixed with *Verbesina encelioides*; senescing.

Asteraceae

Ageratum conyzoides (*maile honohono*), nat.

Rare, one plant found along the crater bottom.

Emilia fosbergii (flora's paintbrush), nat.

Rare, a couple plants found on the lower slopes of the back (east) side of the islet; towards intertidal zone; flowering.

Pluchea indica (Indian fleabane), nat.

Rare, one plant found on makai side of the north slope; flowering.

Sonchus oleraceus (sow thistle), nat.

Individuals occasional throughout most of the islet; fruit, flower.

Verbesina encelioides (golden crown-beard), nat.

Dominant, found throughout the islet, but this species forms large, monotypic stands in the crater bottom; fruit, flower.

Boraginaceae

Heliotropium curassavicum (*nena*), ind.

Rare, a few plants on the lower slopes of islet's back (east) side; flowering.

Chenopodiaceae

Atriplex semibaccata (Australian saltbush), nat.

Rare, a small patch found along the north section of the crater rim. Not found during 2005 survey.

Chenopodium oahuense (*aweoweo*), ind.

Rare, a few individuals along the eastern crater rim and along the back (east) side near the intertidal zone; fruiting.

Convolvulaceae

Ipomoea pes-caprae (*pohuehue*), ind.

Occasional, large patches around the landing area; fruit, flower.

Merremia aegyptia (hairy morning glory), nat.

Locally common along the edge (above beach) of the northwest section of the islet; interspersed with *Cenchrus ciliaris*; fruit, flower.

Goodeniaceae

Scaevola sericea (beach *naupaka*), ind.

Occasional, a cluster at the landing beach and a larger one on the back (east) side of the islet; flower, fruit.

Malvaceae

Sida fallax (*'ilima*), ind.

Rare, a few plants found along the lower slopes of the back (east) side of the islet; flowering. Not observed during the 2005 survey.

Nyctaginaceae

Boerhavia repens (*alena*), ind.

Occasional patches found primarily on the back (east) side of the islet; flower, fruit.

Passifloraceae

Passiflora suberosa (*huehue haole*), nat.

Rare, a few patches along the back (east) side of the islet from the crater rim down towards the intertidal zone.

Papaveraceae

Argemone glauca (*pua kala*), end.

Rare, a few plants found on the makai slopes of the crater rim; flower, fruit.

Portulacaceae

Portulaca oleracea (pigweed), nat.

Occasional throughout islet; fruiting.

Solanaceae

Nicotiana tabacum (tree tobacco), nat.

Occasional along the lower slopes of the back (east) side, only seedlings found.

Solanum americanum (*popolo*), ind.

Rare, a few stunted individuals found along back (east) side of the islet; flower, fruit.

Zygophyllaceae

Tribulus cistoides (*nohu*), ind.

Occasional, several large patches around the landing area; fruit, flower. Plants were healthy, no evidence of biocontrol beetle (*Microlarinus* sp.) damage.

Angiosperms-Monocots

Poaceae

Cenchrus ciliaris (buffel grass), nat.

Dominant, forms monotypic stands in many areas, co-dominant with *Verbesina encelioides* on the crater bottom. The majority of plants had finished flowering and fruiting and were in a state of senescence.

Chloris barbata (swollen fingergrass), nat.

Occasional plants interspersed with other vegetation around crater rim, landing, and back (east) side; flowering.

Cynodon dactylon (Bermuda grass), nat.

Occasional, large patch found above the landing area, interspersed with *Cenchrus ciliaris*.

Dactyloctenium aegyptium (Beach wiregrass), nat.

Occasional, especially near the coast on the east side of the island; fruiting.

Setaria verticillata (bristly foxtail), nat.

Rare, a few plants mixed in with *Cenchrus ciliaris* around the landing area and along the northwest tip of the islet; fruiting.

SEABIRDS

Methods and general description

Mānana is an important nesting area for several species of seabird including sooty terns (*Sterna fuscata*), brown noddies (*Anous stolidus*), wedge-tailed shearwaters (*Puffinus pacificus*), red-tailed tropicbirds (*Phaethon rubricauda*), and Bulwer's petrels (*Bulweria bulweri*). However, we scheduled our visit outside the breeding season to avoid disturbance. The only birds observed on the island during our visit were prospecting red-tailed tropicbirds.

Checklist of Seabirds with notes

Fregatidae

Fregata minor (Great frigatebird), ind.

Several birds were observed flying over the island.

Phaethontidae

Phaethon rubricauda (Red-tailed tropicbird), ind.

Twenty-five adults were observed courting and prospecting.

OTHER BIRDS

None.

ARTHROPODS

Methods and general description

To document arthropod diversity on the islet, we used a variety of collecting methods. We established three transects that covered three vegetation zones: one that ran parallel to the western landing beach, another that ran from the rim to the bottom of the crater, and the last that ran along the eastern side of the island down to the coast. We established sampling points every 10 meters along the length of the transects and at each point we used the following techniques: pitfall trap, pan trap, sweep nets, host search and ground search. Traps were collected after 48 hours. We employed the same methods on any plant species or habitat not included in our transects. Additionally, we ran ant cards on a separate transect to evaluate the range of long-legged ants (*Anoplolepis gracilipes*). It ran from the eastern coast up to the rim and dropped down towards the crater bottom. We could not obtain a permit for night collecting.

Spiders and moths were extremely abundant throughout the islet. It seemed as if every step sent up a cloud of moths and became tangled in a web. Beetles were common along the crater floor cockroaches were common along the coast. Long-legged ants were present from the west coast near the intertidal zone up to the crater rim.

Checklist of Arthropods

ARANEAE

Araneidae

Neoscona oaxacensis (western spotted orbweaver), nat.
New islet record.

Clubionidae

Cheiracanthium mordax (pale leaf spider), nat.
New islet record.

Dysderidae

Dysdera crocota (woodlouse spider), nat.
New islet record.

Oxypodidae

Oxyopes sp. [of Kumashiro, 1990] (lynx spider), nat.
New islet record.

Salticidae

Hasarius adansoni (Adanson's house jumper), nat.
New islet record.

Theridiidae

Steatoda crocota, nat.
New islet record.

Latrodectus geometricus (brown widow), nat.
New islet record.

Uloboridae

Zosis geniculatus (humped spider), nat.
New islet record.

BLATTODEA

Blaberidae

Diploptera punctata (Pacific beetle cockroach), nat.
New islet record.

Blattellidae

Symploce pallens (smooth cockroach), nat.

New islet record.

Blattidae

Periplaneta americana (American cockroach), nat.

New islet record.

COLEOPTERA

Cerambycidae

Sybra alternans (long-horned beetle), nat.

New islet record.

Coccinellidae

Coccinella septempunctata (seven-spotted ladybird beetle), purposely introduced

New islet record.

Dermestidae

Dermestes frischii (dermestid beetle), nat.

New islet record.

Histeridae

indet (hister beetle), unknown

New islet record.

Tenebrionidae

Ammophorus insularis, nat.

New islet record.

Gonocephalum adpressiforme (gonocephalum darkling beetle), nat.

Lobometopon diremptus, nat.

Trogidae

Trox suberosus, nat.

New islet record.

DERMAPTERA

Labiduridae

Labidura riparia (sand earwig), nat.

New islet record.

DIPTERA

Tachinidae

Lespesia archippivora (tachinid fly), nat.
New islet record.

HETEROPTERA

Anthocoridae

Orius persequens, nat.
New islet record.

HOMOPTERA

Membracidae

Vanduzee segmentata (vanduzee treehopper), nat.
New islet record.

HYMENOPTERA

Braconidae

Apanteles opacus, nat.
New islet record.

Evaniidae

Evania appendigaster (ensign wasp), nat.
New islet record.

Formicidae

Anoplolepis gracilipes (long-legged ant), nat.
New islet record.

Ochetellus glaber (glaber ant), nat.
New islet record.

Pheidole megacephala (big-headed ant), nat.
New islet record.

Solenopsis geminata (fire ant), nat.

Ichneumonidae

Pimpla punicipes, nat.
New islet record.

ISOPODA

Ligiidae

Ligia hawaiiensis (mangrove slater), end.

New islet record.

Porcellionidae

Porcellio laevis (pill bug), nat.

New islet record.

LEPIDOPTERA

Crambidae

Spoladea recurvalis (Hawaiian beet webworm), nat.

ORTHOPTERA

Gryllidae

Gryllodes sigillatus (tropical house cricket), nat.

OTHER OPPORTUNISTIC OBSERVATIONS

Five adult monk seals (*Monachus schauinslandi*) were observed hauled out on the western landing beach. Photos and tag numbers were given to NOAA. One Mourning gecko (*Lepidodactylus lugubris*) was observed but could not be collected. No skinks were seen.

THREATS AND RECOMMENDATIONS

The vegetation on Mānana has been extremely altered over the years and now a few invasive species dominate the island with small pockets of natives. Since seabirds occupy the island during much of the year, there is a small window for restoration activities. Even with the birds absent, outplanting and weed control activities would destroy existing burrows. The benefits of restoring the vegetation should outweigh the disturbance. The biggest cause for concern is erosion caused when the dominant grass senesces annually. It is important to understand how much erosion is happening and what areas are affected the most before restoration decisions can be made.

A more pressing concern is the presence of long-legged ants. They were first detected on the eastern slope of the island from the crater bottom to the rim in 2005 (S. Plentovich pers. comm.). In 2006, a Wedge-tailed shearwater chick was discovered in that area with swollen eyes along with dozens of abandoned Sooty tern eggs. Our survey in 2008 indicated that the ants are spreading west along the crater rim. The ant population should be monitored and if possible, their effect on nesting seabirds should be evaluated. Eradication should be attempted once successful measures have been found.

A standard seabird monitoring protocol should be created for species that nest on the island. This will take some ingenuity to minimize disturbance, but will be extremely beneficial in terms of management. Monitoring population trends is a clear way to detect problems in the colony. For example, changes in shearwater counts on other O’ahu islets have led to the detection of recent invasions by rats and ants.

Human visitation is minimal, but there are a few incidents annually involving a group of visitors hiking to the summit of Mānana. One person walking to the summit during breeding season has the potential to kill thousands of birds and is, therefore, of great concern. The island is regularly monitored by a monk seal volunteer, but attempts at enforcement have met with limited success. A DOCARE official dedicated to offshore islet surveillance and boat access at the Makai Pier would be ideal.

Table 8. Key threats to Mānana ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|------------------------------|---|--|
| Mice | Mice can eat native seeds and insects and may impact small seabirds | Determine if present, if so eradicate |
| Weeds | | |
| <i>Verbesina encelioides</i> | Displacement of natives, poor nesting habitat, causes erosion | Research erosion threat to decide if control/eradication should be attempted |
| <i>Cenchrus ciliaris</i> | Displacement of natives, poor nesting habitat, causes erosion | Research erosion threat to decide if control/eradication should be attempted |
| <i>Amaranthus spinosa</i> | Displacement of natives; poor nesting habitat | Control in conjunction with <i>V. encelioides</i> |
| Long-legged ants | Decimate seabird colony; alter arthropod community | Monitor and attempt eradication |



Figure 25. Native plants and dunes persist along the west coast.



Figure 26. Monk seals regularly haul-out and pup on the island.



Figure 27. The crater bottom in January 2008, it is dominated by *Amaranthus spinosa* in the foreground followed by *Verbesina encelioides* and *Cenchrus ciliaris* in the background.



Figure 28. The crater bottom in September 2007. Erosion is a concern when the plants senesce annually.



Figure 29. Walking along the rim towards the summit, *Cenchrus ciliaris* dominates the crater rim and slopes.



Figure 30. A late-nesting Brown noddy chick.

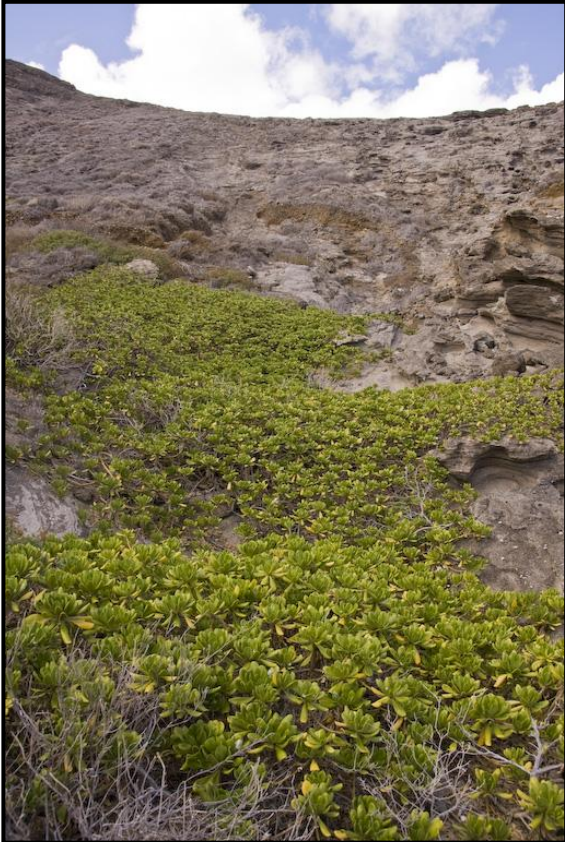
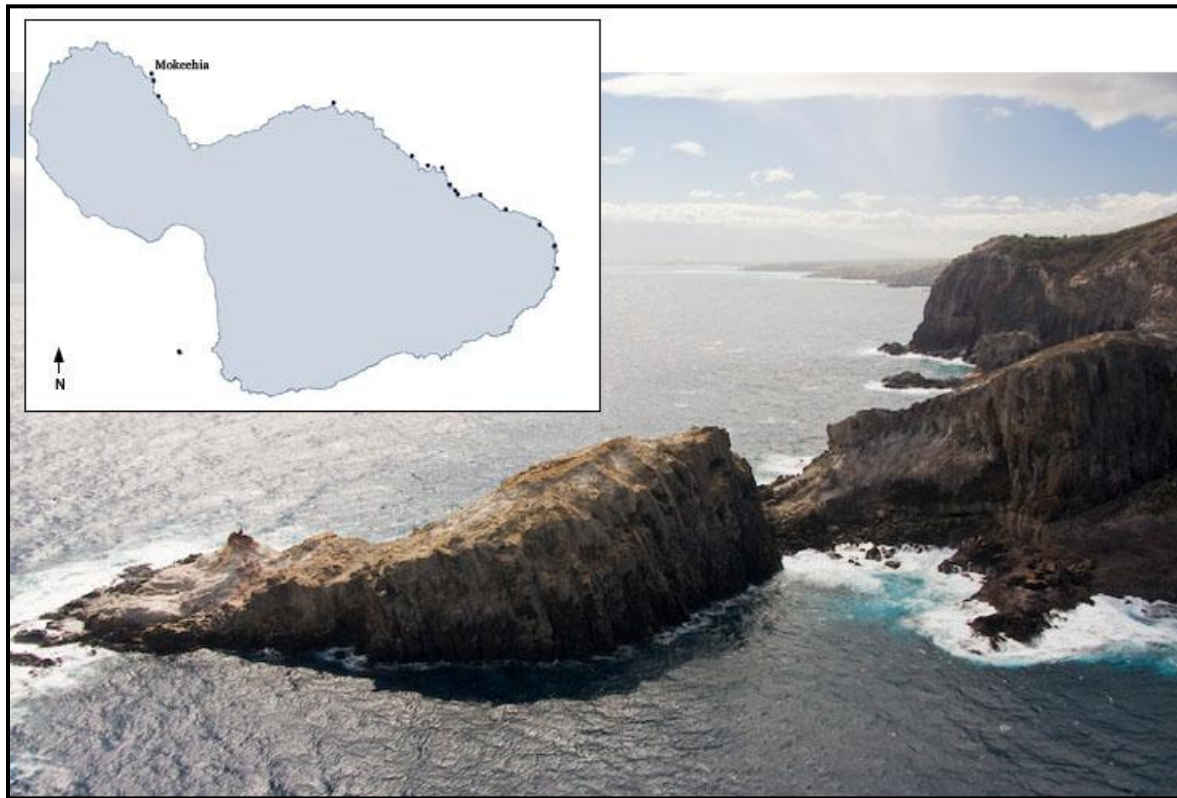


Figure 31. Some natives persist near the water.

11. MAUI : Moke'ehia Islet



LOCATION

Moke'ehia is located on the windward coast of west Maui off Hakuhe'e Point at 20°59'239" N latitude, 156°31'430" W longitude.

STATUS

Moke'ehia is part of the Hawai'i State Seabird Sanctuary, protected by the Hawai'i Department of Land and Natural Resources (DLNR). Permission to land must be obtained in writing from DLNR.

PHYSICAL DESCRIPTION

At 3.4 hectares and 48.8 meters in height, Moke'ehia is Maui's second largest islet after Molokini. Steep cliffs make up the east and south shores, the latter separating the islet from Maui by a narrow, treacherous channel. From the summit the islet slopes steeply in a northeasterly direction.

Moke'ehia is rocky throughout with pockets of powdery, crumbly soils formed from weathered lava.

ACCESS

Heather Eijzenga (Bishop Museum), David Preston (Bishop Museum), and Jiny Kim (project

intern) accessed the islet from 0900 on 25 October 2007 to 0900 on 26 October 2007. We charted a helicopter and landed on the lower shelf at the northeast end of the islet.

VEGETATION

Methods and general description

A botanical inventory was conducted by walking loose transects throughout the islet. Overall, the vegetation was very dry and live plants were primarily defoliated. Non-native plants dominate the islet. Plant cover was approximately 5% with 13 plant species total: 8 non-native and 5 indigenous. Four species found during the most recent botanical survey in April 2005 (Starr et al. 2006) were not detected during this trip: *Panicum fauriei*, *Sida fallax*, *Lantana camara*, *Chamaesyce celastroides* var. *amplectens*, but a few unidentifiable shrub skeletons remained. We were also not able to find *Scaevola coriacea*, which was formerly on the islet (Kepler et al. 1984) and had been recently out-planted by the Maui Nui Botanical Garden.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Aizoaceae

Sesuvium portulacastrum ('akulikuli), ind.

Occasional, scattered along the lower parts of the island in the spray zone; flower, fruit.

Anacardiaceae

Schinus terebinthifolius (Christmasberry), nat.

Rare, one mostly dead tree on the eastern slope; fruiting.

Asteraceae

Sonchus oleraceus (sow thistle), nat.

Rare, one individual on the west side of the small peak; not flowering or fruiting.

Boraginaceae

Heliotropium curassavicum (nena), ind.

Rare, a couple of small patches on the west side of the small peak; flowering.

Chenopodiaceae

Atriplex semibaccata (Australian saltbush), nat.

Occasional, primarily dead patches, scattered throughout islet.

Chenopodium oahuense (aweoweo), ind.

Occasional, individuals scattered along the summit and eastern slope, most very dry, defoliated or dead; flower, fruit.

Rosaceae

Osteomeles anthyllidifolia ('ulei), ind.

Rare, only one plant at the southwest tip of the summit; fruit, flower.

Solanaceae

Lycium sandwicense ('ohelo kai), ind.

Occasional, several plants clustered along the east side of the small peak, most defoliated but some in fruit and flower.

Portulacaceae

Portulaca oleracea (pigweed), nat.

Occasional, individuals clustered on the west side of the small peak.

Angiosperms-Monocots

Poaceae

Cenchrus echinatus (sandbur), nat.

Occasional, largest patch found at the southwest tip of the summit (tried to pull, but unable to extract roots from cracks) and scattered along the lower eastern slope, many seeds collected on the ground and in cracks; fruit, flower.

Digitaria ciliaris (Henry's crabgrass), nat.

Rare, one small patch on the west side of the small peak (pulled); flowering.

Digitaria insularis (sourgrass), nat.

Occasional, individuals scattered along the lower section of the eastern slope; flowering.

Eleusine indica (beach wiregrass), nat.

Occasional, scattered along the summit and along the eastern slope, loaded with scale and ants; flowering.

SEABIRDS

Methods and general description

We opportunistically searched for seabirds during our botanical and seabird survey and roughly estimated the number of nesting wedge-tailed shearwaters by using aerial photos to approximate the number of total burrows and checking the occupancy of 50 randomly selected burrows. In the past, Bulwer's petrels (*Bulweria bulweri*) were found nesting on the island and both black noddies (*Anous minutus*) and white-tailed tropicbirds (*Phaethon lepturus*) were thought to be nesting (Kepler et al. 1984). Wedge-tailed shearwaters were the only birds we observed, but Bulwer's petrels had completed their breeding season by the time of our visit.

Checklist of Seabirds with notes

Procellariidae

Puffinus pacificus (Wedge-tailed shearwater), ind.

Using aerial photos we estimated a total of 1,200-1,500 burrows throughout the island. Based on evaluation of 50 burrows, occupancy was 56% for an overall estimate of 672-840 chicks. This is lower than a previous estimate of 1,060 chicks in 1981 (Kepler et al. 1984), but is primarily a result of low burrow occupancy. We found many burrows with dead chicks and abandoned or depredated eggs (appeared to be from an avian predator such as Ruddy turnstone, *Arenaria interpres*). High winds combined with very little vegetation cover appeared to result in many collapsed burrows as well. Chicks on Moke'ehia were approximately two weeks later in development than chicks on O'ahu islets.

OTHER BIRDS

None.

ARTHROPODS

Methods and general description

We established a loose transect that ran from the saddle north along the ridge with sampling points every 10 meters. At each point we used the following techniques: pitfall trap, pan trap, sweep nets, host search and ground search. We employed the same methods on any plant species or habitat not included in our transect. Traps were collected after 24 hours.

High winds throughout our visit and little vegetation made it difficult to locate arthropods and heavy rainfall in the evening prevented us from night collecting. Most abundant were several species of ants that were tending Homopterans on introduced grasses. Interestingly, opportunistic surveys by Starr et al. (2006) after a period of rain turned up a completely different set of arthropods.

Checklist of Arthropods

BLATTODEA

Blattidae

Periplaneta americana (American cockroach), nat.

New islet record.

COLEOPTERA

Elateridae

Cardiophorus stolatus (click beetle), nat.

New islet record.

Tenebrionidae

Ammophorus insularis, nat.

New islet record.

Gonocephalum adpressiforme (gonocephalum darkling beetle), nat.

New islet record.

Lobometopon diremptus, nat.

New islet record.

Trogidae

Trox suberosus, nat.

New islet record.

DERMAPTERA

Labiduridae

Labidura riparia (sand earwig), nat.

New islet record.

EMBIIDINA

Oligotomidae

Oligotoma saundersii (Saunders's webspinner), nat.

New islet record.

HYMENOPTERA

Formicidae

Camponotus variegatus (carpenter ant), nat.

New islet record.

Pheidole megacephala (big-headed ant), nat.

Vespidae

Paravespula pensylvanica (western yellowjacket)

New islet record.

ORTHOPTERA

Gryllidae

Gryllodes sigillatus (tropical house cricket), nat.

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

Many skinks were observed throughout the island, but we were unable to capture any. They appeared to be the Snake-eyed skink (*Cryptoblepharus poeciloplurus*).

THREATS AND RECOMMENDATIONS

Little vegetation was present during our visit. Therefore, a repeat survey during a wetter time of year is advisable for a more complete understanding of vegetation status. Currently, the greatest vegetation threat is an incipient population of *Cenchrus echinatus* discovered in 2006 (Starr et al. 2006), which appears to be spreading. Other non-native grasses should also be controlled as they support high scale, and therefore ant, densities. Many other potentially invasive plant species were present such as *Sonchus oleraceus*, *Atriplex semibaccata* and *Portulaca oleracea*, but it is difficult to make recommendations based on the few plants observed during our visit. See (Starr et al. 2006) for outplanting recommendations.

There is some degree of human visitation to the island. Several fishing pole holders had been cemented into the intertidal area on the west side of the islet and fishing supplies (grill, tarps, buckets, hooks, weights) had been stashed under a ledge. Although enforcement may not be possible, informational signs may help to keep visitors in the intertidal area.

Table 9. Key threats to Moke'ehia ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|---------------------------------|---|---|
| Human disturbance | Trample burrows, vegetation; introduce non-native species | Consider signage to keep people in the intertidal area |
| Weeds | | |
| <i>Cenchrus echinatus</i> | Displacement of natives, poor nesting habitat | Eradicate before it becomes widespread |
| <i>Schinus terebinthifolius</i> | Displacement of natives | Girdle single tree |
| Other non-natives | Displacement of natives | Evaluate status on subsequent visit, consider control or eradication measures |
| Erosion | Collapsed burrows | Outplant hearty natives, especially those historically found on the island |
| Big-headed ants | Disturb seabird colony; alter arthropod community | No action, research needed (see section 4.2) |



Figure 32. The densely burrowed east slope. Very little vegetation is present.



Figure 33. A closer look at the dense burrows.



Figure 34. View towards the smaller, northern peak.



Figure 35. Collecting from available plants.

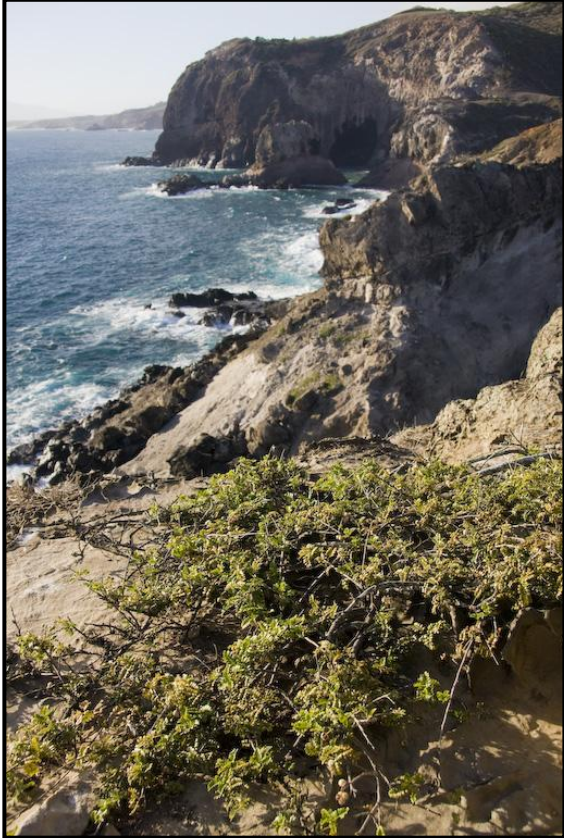
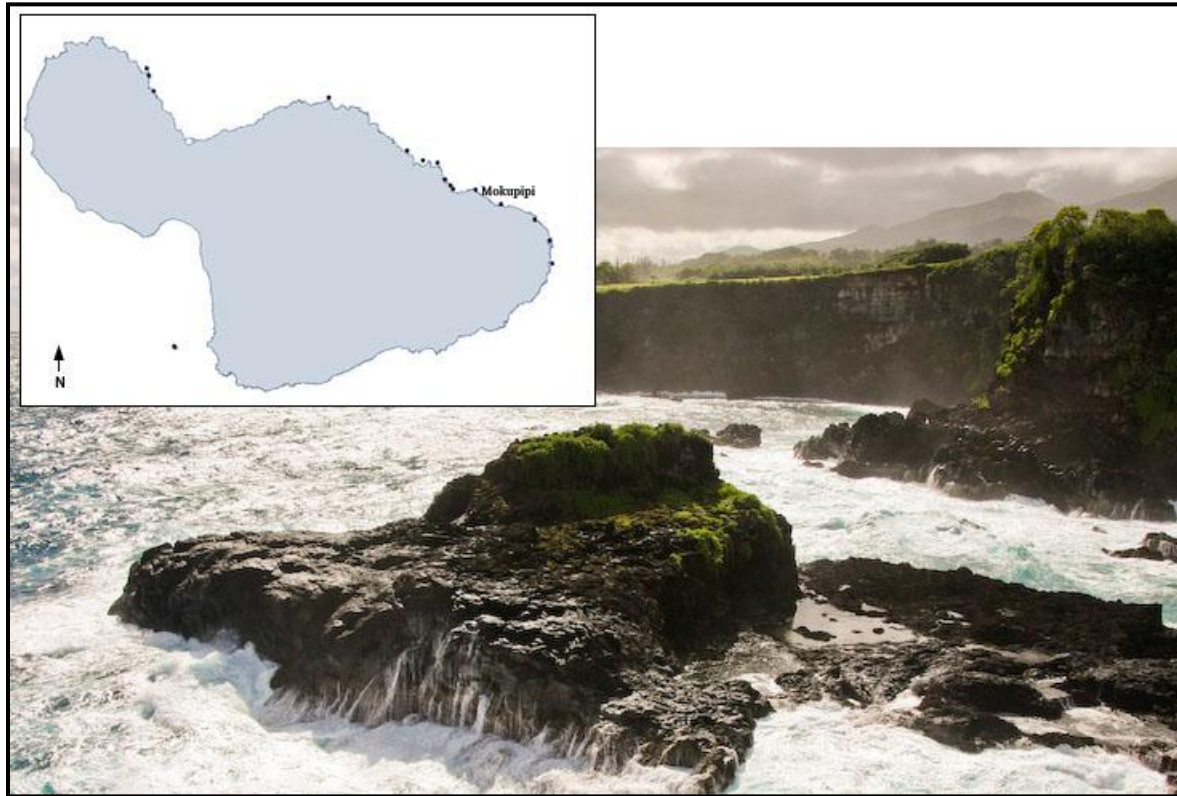


Figure 36. *Osteomeles anthyllidifolia* on the summit.

12. MAUI : Mokupipi Islet



LOCATION

Mokupipi lies off of Nahiku on the north shore of east Maui at 20°49'40" N latitude, 156°4' 57" W longitude.

STATUS

Mokupipi is state property. All native plants and wildlife are protected by state and/or federal law.

PHYSICAL DESCRIPTION

Mokupipi is a small (0.4 hectares), low islet with a large central outcrop reaching 12 meters in height. Tide pools surround the islet and in large surf, the spray washes over the summit.

ACCESS

Heather Eijzenga (Bishop Museum), David Preston (Bishop Museum) and Jiny Kim (project intern) accessed the islet on 26 October 2007 from 0900 to 1300. We chartered a helicopter and were dropped off on the lower northwest shelf.

VEGETATION

Methods and general description

A botanical inventory was conducted by walking the entire area of the small islet. The islet and adjacent coast was very green with evidence of recent rains. Native plants dominated the islet with *Scaevola sericea* covering the tallest outcropping and a *Sesuvium portulacastrum*-*Fimbristylis cymosa* mix dominating the lower portion. Plant cover was approximately 40% with 9 plant species total: 3 non-native, 6 indigenous. Two species found during the most recent botanical survey in April 2005 (Starr et al. 2006) were not detected during this trip: the endangered grass *Ischaemum byrone* and the non-native grass *Eleusine indica*.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Aizoaceae

Sesuvium portulacastrum ('akulikuli), ind.

Common, widespread along the lower shelf and hanging from the summit; flowering.

Goodeniaceae

Scaevola sericea (beach *naupaka*), ind.

Dominant, occupies the summit and half of the lower shelf; fruit, flower.

Moraceae

Ficus microcarpa, (Chinese banyan), nat.

Rare, one large tree on the summit.

Portulacaceae

Portulaca oleracea (pigweed), nat.

Occasional, several individuals scattered on the lower shelf and summit; fruiting.

Scrophulariaceae

Bacopa monnieri ('ae'ae), ind.

Rare, one patch submersed in and surrounding a pool of rain water; flowering.

Solanaceae

Lycium sandwicense ('ohelo kai), ind.

Rare, a few individuals hanging from the summit.

Angiosperms-Monocots

Poaceae

Digitaria ciliaris (Henry's crabgrass), nat.

Rare, a few individuals scattered on the lower section of the islet.

Cyperaceae

Cyperus polystachyos, ind.

Rare, a few individuals clustered around a pool of rain water; fruiting.

Fimbristylis cymosa (button sedge), ind.

Common, widespread on the lower shelf; fruiting.

SEABIRDS

Methods and general description

The entire islet was searched for evidence of nesting seabirds. A small number of wedge-tailed shearwaters were nesting and there was recent evidence of nesting Bulwer's petrels.

Checklist of Seabirds with notes

Procellariidae

Puffinus pacificus (Wedge-tailed shearwater), ind.

Ten partially downy shearwater chicks were counted; one on the lower shelf and the remainder on the top shelf under ledges and *naupaka*.

Bulweria bulweri (Bulwer's petrel), ind.

We found the owl-killed remains of 2 Bulwer's petrels. Based on their plumage, they appeared to be fledglings indicating that birds were nesting on the island or adjacent coast. No nests were found on Mokupipi, but boulders at the summit provide potential nesting habitat. This is the first time Bulwer's petrels have been reported on the island.

OTHER BIRDS

None.

ARTHROPODS

Methods and general description

Because of the short time we had on the island, we did not set out any traps. Instead, we focused on collecting from different host plants using a sweep net, litter sifter, and physical search of each plant species on the island. This was supplemented with a ground search around rocky and intertidal areas.

Arthropod diversity and abundance was low. Ants were present throughout the islet, but in low numbers. Grasshoppers were abundant in the *naupaka* on the lower shelf and spiders (especially Asian spiny-backed spider) were abundant on the summit.

Checklist of Arthropods

ARANEAE

Araneidae

Gasteracantha mammosa (Asian spiny-backed spider), nat.
New islet record.

Oxyopidae

Oxyopes sp. [of Kumashiro, 1990] (lynx spider), nat.
New islet record.

COLEOPTERA

Cerambycidae

Sybra alternans (long-horned beetle), nat.
New islet record.

DIPTERA

Ceratopogonidae

Dasyhelea sp., end.
New islet record.

Dolichopodidae

Chrysosoma globiferum (long-legged fly), nat.
New islet record.

HETEROPTERA

Lygidae

Nysius coenosulus (seed bug), end.

HOMOPTERA

Tropiduchidae

Kallitaxila granulata (grainy planthopper), nat.
New islet record.

HYMENOPTERA

Formicidae

Paratrechina longicornis (crazy ant), nat.

ORTHOPTERA

Tettigoniidae

Conocephalus saltator (longhorned grasshopper), nat.

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

Skinks were abundant throughout the islet. One species was collected and identified as a Snake-eyed skink (*Cryptoblepharus poecilopleurus*), but there appeared to be another species that we could not capture.

THREATS AND RECOMMENDATIONS

Few threats exist on this small island. The most pressing concern is the *Ficus microcarpa*, which has the potential to take over the summit.

Table 10. Key threats to Mokupipi ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|--------------------------|-------------------------------|---|
| Owls | Predation of Bulwer's petrels | Confirm petrel nesting, monitor population, research needed (see section 4.4) |
| Weeds | | |
| <i>Ficus microcarpa</i> | Displacement of natives | Girdle single tree |
| Grasses | Displacement of natives | Monitor and consider eradication if they spread |
| Other non-natives | Displacement of natives | Monitor and consider eradication if they spread |



Figure 37. *Sesuvium portulacastrum* and *Scaevola sericea* dominate the islet.

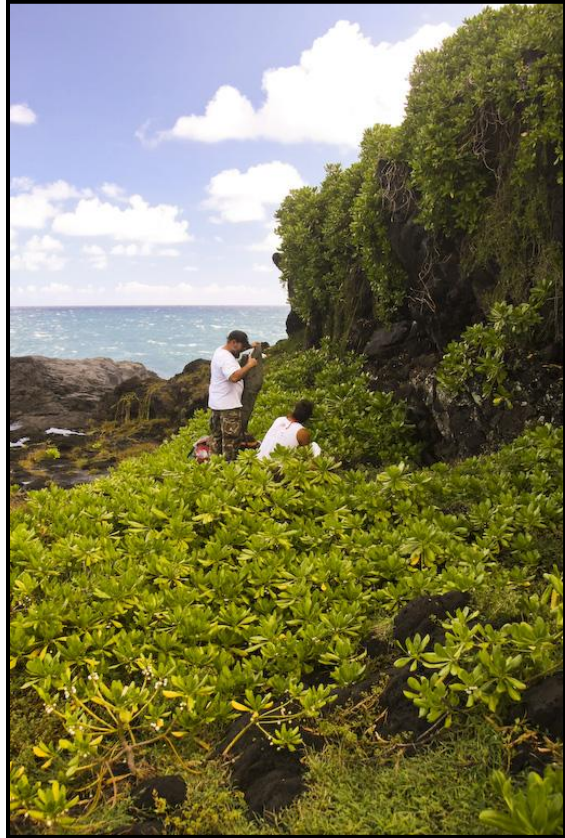


Figure 38. Collecting from *Scaevola sericea*.

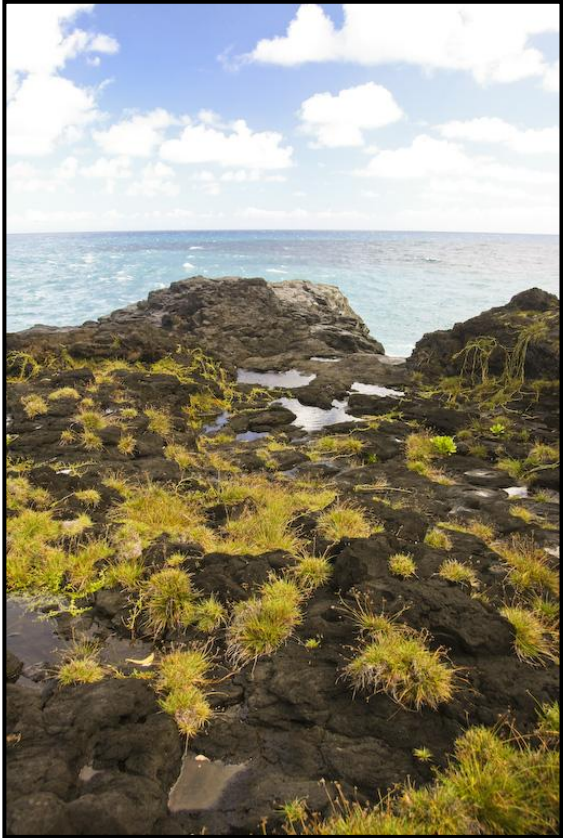


Figure 39. *Fimbristylis cymosa* on the lower shelf.



Figure 40. Shearwater chicks nest in rocky crevices on the summit.

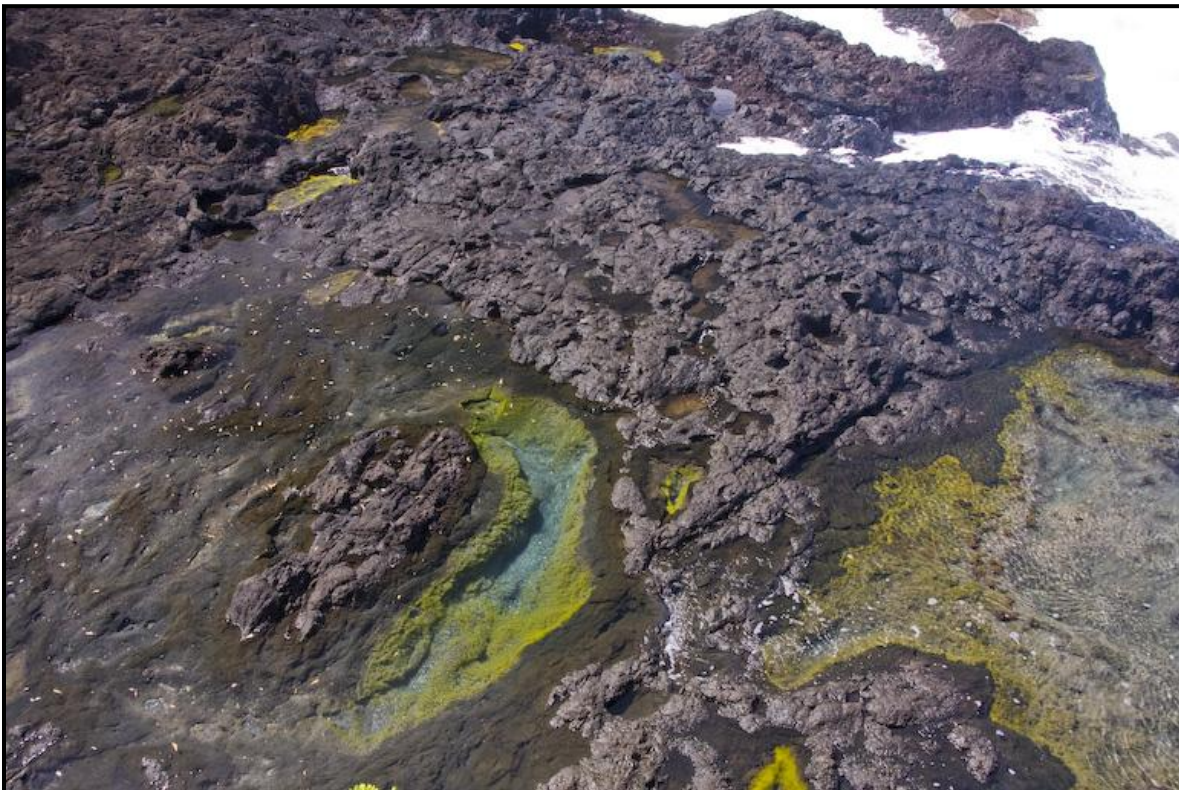


Figure 41. Tide pools on the western side of the island.

13. MAUI : Pu'uku (Pu'uki'i) Islet



LOCATION

Pu'uku is located off of the north end of Kauiki in Hana Bay at 20°45'379" N latitude, 155°58'570" W longitude.

STATUS

Permission to land on federally owned Pu'uku is required from the U.S. Coast Guard (USCG), which maintains a small lighthouse at the summit. Pu'uku is also part of the Hawai'i State Seabird Sanctuary, protected by the Hawai'i Department of Land and Natural Resources (DLNR). Permission to land must be obtained in writing from both DLNR and USCG.

PHYSICAL DESCRIPTION

The 0.6 hectare, 18.3 meter tall islet is separated from the shoreline by a narrow channel. Pu'uku is part of the east rift of Haleakala and is composed of solid lava and loose cinder, making it difficult to navigate around the island. A small lighthouse sits at the summit and a bridge once connected the island to the nearby shore to allow for servicing.

ACCESS

Heather Eijzenga (Bishop Museum) and Jiny Kim (project intern) accessed the islet on 27 October 2007 from 1100 to 1400. We walked around Hana Bay to the closest access point, swam

across the narrow channel and climbed onto the island at the northwest corner. A bridge formerly connected the island to shore, but it no longer exists.

VEGETATION

Methods and general description

A botanical inventory was conducted by walking loose transects throughout all accessible parts of the islet. We may have overlooked some species along the steep cliffs of the east and south sides of the islet. The islet was fairly wet and green, with salt spray reaching all the way to the summit. Overall, the vegetation on Pu'uku is a fairly even mix of native and non-native plant species, but the presence of 2 species of concern make it unique. Plant cover was approximately 65% with 14 plant species total: 6 non-native, 6 indigenous and 2 endemic. Five species found during the most recent botanical survey in April 2005 (Starr et al. 2006) were not detected during this trip: *Sonchus oleraceus*; *Digitaria ciliaris*, *Andropogon virginicus*, and *Oxalis corniculata*. We were also not able to find the endangered *Scaevola coriacea*, dwarf *naupaka*, that was reported by Hobdy (1982) and outplanted on the islet a few years ago by Maui Nui Botanical Garden.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Casuarinaceae

Casuarina equisetifolia (ironwood), nat.

Occasional, several large trees along the north and east sides of the islet, very little growing under the carpet of needles beneath the trees.

Capparaceae

Capparis sandwichiana (*maiapilo*), end., SOC

Occasional, several large shrubs found along the steep north and east slopes; fruit, flower.

Goodinaceae

Scaevola sericea (beach *naupaka*), ind.

Common, shrubs throughout the islet, especially along the lower west side; fruit, flower.

Brassicaceae

Lepidium bidentatum var. *o-waihiense* (*anaunau*), end., SOC

Occasional, several plants along the east side of the summit and down the steep eastern slope; fruit, flower.

Asteraceae

Pluchea carolinensis (sourbush), nat.

Occasional, a dense cluster of shrubs occupies the summit and a few exist on the lower west shelf; fruit, flower.

Rosaceae

Osteomeles anthyllidifolia, ('ulei), ind.

Occasional, several sprawling shrubs found on the summit; fruit, flower.

Verbenaceae

Lantana camara, (lantana), nat.

Occasional, a few dense patches exist on the summit; flowering.

Portulacaceae

Portulaca oleracea (pigweed), nat.

Occasional, several individuals scattered on the lower slopes and on the the summit; fruiting.

Angiosperms-Monocots

Pandanaceae

Pandanus tectorius (*hala*), ind.

Rare, a few trees around the perimeter of the islet.

Poaceae

Heteropogon contortus (*pili* grass), ind.

Rare, two individuals on the north side of the summit; flowering. New islet record

Digitaria ciliaris (Henry's crabgrass), nat.

Rare, a few individuals scattered on the lower section of the islet.

Cyperaceae

Fimbristylis cymosa (button sedge), ind.

Locally common on the lower shelf in the spray zone; fruiting.

Cyperus polystachyos, ind.

Rare, a few individuals found on the summit.

Pteridophytes

Polypodiaceae

Phymatosorus grossus, (*lau'ae*), nat.

Rare, a few clumps adjacent to the lighthouse on the summit.

SEABIRDS

Methods and general description

The entire island was searched for evidence of nesting seabirds. Although no birds were seen, there was recent activity by wedge-tailed shearwaters (feathers, guano, smell). Starr et al. (2006)

also observed shearwater sign and one adult sitting in a burrow during their visit in April 2005. No other seabird species have been recorded on the island.

Checklist of Seabirds with notes

Procellariidae

Puffinus pacificus (Wedge-tailed shearwater), ind.

Approximately 20 shearwater burrows were found; the majority was located under the Ironwood on the lower, northwest side of the islet. Only two of the burrows showed recent occupation with feathers, guano and typical procellarid smell. Most likely long-legged ants (*Anoplolepis longipes*) are deterring seabirds from nesting as is the case on several O'ahu islets.

OTHER BIRDS

None.

ARTHROPODS

Methods and general description

Because of the short time we had on the island, we did not set out any traps. Instead, we focused on collecting from different host plants using a sweep net, litter sifter, and physical search of each plant species on the island. This was supplemented with a ground search around rocky areas.

A dense population of long-legged ants was found throughout the island. High winds made it difficult to collect flying insects, but we were able to capture Coccinellid beetles and flies, which were abundant in the weedy mix at the summit. The few *Pandanus* trees on the islet were heavily infested with *hala* scale.

Checklist of Arthropods

ARANEAE

Araneidae

Argiope appensa (garden spider), nat.

New islet record.

BLATTODEA

Blaberidae

Pycnoscelus indicus (burrowing cockroach), nat.

New islet record.

Blattidae

Periplaneta americana (american cockroach), nat.

New islet record.

COLEOPTERA

Coccinellidae

Nephus roepkei (coccinellid beetle), purposely introduced
New islet record.

DIPTERA

Dolichopodidae

Asyndetus carcinophilus (long-legged fly), end.
New islet record.

Chrysosoma globiferum (long-legged fly), nat.
New islet record.

Tephritidae

Dioxyna sororcula, nat.
New islet record.

HETEROPTERA

Tingidae

Teleonemia scrupulosa (lantana lace bug), purposely introduced
New islet record.

HOMOPTERA

Halimococcidae

Thysanococcus pandani (*hala* scale), nat.

Membracidae

Vanduzee segmentata (vanduzee treehopper), nat.
New islet record.

Pseudococcidae

Indeterminate (mealybug), unknown status
New islet record.

HYMENOPTERA

Formicidae

Anoplolepis gracilipes (long-legged ant), nat.
New islet record.

ISOPODA

Armadillidae

Cubaris murina (terrestrial isopod), nat.

Indeterminate

Indeterminate (terrestrial isopod), unknown

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

We observed several skinks, but were unable to catch any. They appeared to be the Snake-eyed skink (*Cryptoblepharus poeciloplurus*).

THREATS AND RECOMMENDATIONS

Long-legged ants currently pose the greatest threat to nesting seabirds on Pu'uku. As on O'ahu islets, this species has formed a supercolony that dominates every part of the island and it is unlikely that any seabirds will successfully nest in these conditions. Further complicating the matter is the proximity of the island to the coastline, which is also infested with long-legged ants. Any successful eradication attempts will have to be regularly monitored due to the high chance of reinvasion. An additional threat to nesting seabirds is the ability of mammalian predators to access the island from the nearby shore.

Several non-native plant species also threaten the island including *Casaurina equisetifolia*, *Lantana camara* and *Pluchea carolinensis* and to a lesser extent, *Digitaria ciliaris*, *Portulaca oleracea* and *Phymatosorus grossus*. The islet supports some rare native plant species and restoration should be a high priority to protect these populations. See Starr et al. (2006) for outplanting recommendations.

Table 11. Key threats to Pu'uku ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|--------------------------------|--|---|
| Mammalian predators | Predation of seabirds | Regular monitoring of seabird populations to enable early detection |
| Weeds | | |
| <i>Casaurina equisetifolia</i> | Displacement of natives; increases erosion risk | Eradicate, leave stumps to reduce additional erosion |
| <i>Lantana camara</i> | Displacement of natives; poor nesting habitat | Eradicate |
| <i>Pluchea carolinensis</i> | Displacement of natives; poor nesting habitat | Eradicate |
| Erosion | Collapsed burrows | Outplant hearty native groundcover and native shrubs |
| Long-legged ants | Decimates seabird colonies; alters arthropod populations | No action, research needed (see section 4.2) |
| Hala scale | Decreased vigor and death of <i>Pandanus tectorius</i> | Unknown, problem along west Maui coastline |



Figure 42. Aerial view of the islet.



Figure 43. Steep cindery slopes. Photo: J. Kim

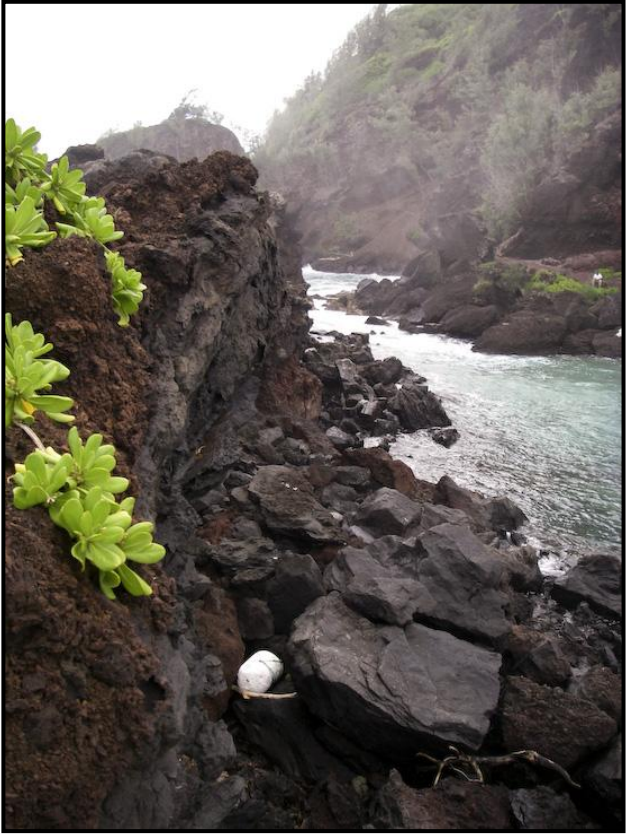


Figure 44. Gap separating the islet. Photo: J. Kim



Figure 45. The island and adjacent coast supports a healthy population of *Lepidum bidentatum*. Photo: J. Kim

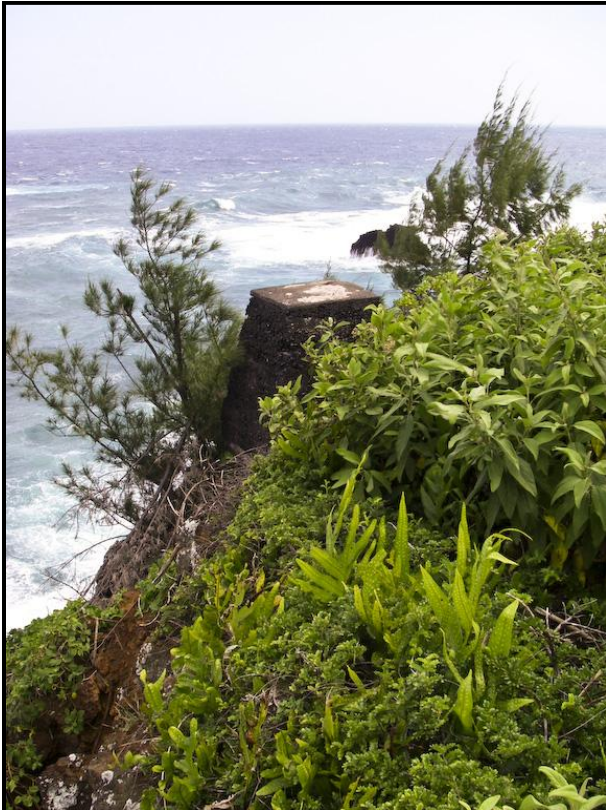


Figure 46. A weedy mix on the summit. Photo: J.Kim



Figure 47. *Casaurina* stand. Photo: J. Kim

14. MAUI : Moku mana Islet



LOCATION

Moku mana is located off the tip of Pauwahu Point Wildlife Sanctuary, 0.4 km east of Mokuhala at 20°51'46" N latitude, 156°8'1" W longitude.

STATUS

Moku mana is part of the Hawai'i State Seabird Sanctuary, protected by the Hawai'i Department of Land and Natural Resources (DLNR). Permission to land must be obtained in writing from DLNR.

PHYSICAL DESCRIPTION

Moku mana is 0.6 hectares in size and 19.8 meters tall. The narrow island has a flat top and is surrounded by steep cliffs. It is divided by a steep ravine, creating southern and northern stacks that are virtually separate islets.

ACCESS

Heather Eijzenga (Bishop Museum), Jiny Kim (project intern) and Jaap Eijzenga (DOFAW), accessed the islet on 1 November 2007 from 0700 to 1200. We chartered a helicopter and had one person dropped off on the small, south section and two on the larger north section.

VEGETATION

Methods and general description

A botanical inventory was conducted by walking all accessible areas of the islet. We were also able to examine aerial photos taken from the helicopter to examine inaccessible parts of the islet, but no additional species were detected. The islet was lush with vegetation cascading down sheer cliff faces and dominated by native plants. The north stack was dominated by *Sesuvium portulacastrum* and at higher elevations to the south, by *Scaevola sericea*. The south stack was a mix of species. Non-native species (notably an incipient population of *Cenchrus echinatus*) were present and pose a significant threat. Plant cover was approximately 100% with 18 plant species total: 8 non-native, 7 indigenous and 3 endemic. Two species found during the most recent botanical survey in April 2005 (Starr et al. 2006) were not detected during this trip: *Desmodium incanum* and *Phyllanthus* sp.. Additionally, we discovered two new records for the island: the non-native fern *Phymatosorus grossus* and the indigenous sedge *Cyperus polystachyos*.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Aizoaceae

Sesuvium portulacastrum ('akulikuli), ind.

Dominant, forming dense carpets along the northern half of the north stack, draped down sheer sides and along the lower ledges. Also common on the south stack, especially along the north side; fruit, flower.

Anacardiaceae

Schinus terebinthifolius (christmasberry), nat.

Occasional, several trees on the eastern cliffs and summit of the north stack; Several trees on the south end of the south stack; fruiting.

Asteraceae

Bidens hillebrandiana subsp. *polycephala* (ko'oko'olau), end., SOC

Rare, a large patch (1 m²) on the south stack; flowering.

Emilia fosbergii (flora's paintbrush), nat.

Common, interspersed with *Sesuvium portulacastrum* throughout both stacks; flower, fruit.

Goodinaceae

Scaevola sericea (beach *naupaka*), ind.

Dominant on a large section of the north stack (provides only space for nesting wedge-tailed shearwaters); three patches on the south stack; fruit, flower.

Portulacaceae

Portulaca lutea ('ihi), ind.

Occasional, individuals clustered along the south section of the north stack; fruit, flower.

Portulaca oleracea (pigweed), nat.

Occasional, individuals interspersed among *Sesuvium portulacastrum* on both stacks; fruiting.

Rosaceae

Osteomeles anthyllidifolia ('ulei), ind.

Rare, a few plants along the eastern cliffs of the north stack; not in flower or fruit.

Solanaceae

Solanum americanum (popolo), ind.

Rare, a few plants on the north end of the north stack mixed with *Sesuvium portulacastrum*; several individuals occur in a shrub mix on the south stack; fruit, flower.

Verbenaceae

Lantana camara (lantana), nat.

Several stunted individuals clustered along the eastern margin of the north stack; on the south stack individuals encircle a patch of *Schinus terebinthifolius*; flowering.

Angiosperms-Monocots

Cyperaceae

Carex wahuensis, end.

Rare, two individuals on the summit of the north stack mixed with *Sesuvium portulacastrum*.

Cyperus polystachyos, ind.

Rare, one clump on the eastern portion of the south stack; fruiting. New islet record.

Cyperus phleoides, end.

Rare, four patches on the south stack; fruiting.

Fimbristylis cymosa subsp. *spathacea*, (button sedge), ind.

Rare, a few plants located along the steep, northern walls of the south stack; fruiting.

Poaceae

Cenchrus echinatus (sandbur), nat.

Occasional, Starr et al. (2006) reported one plant in their 2005 survey. We found two large clumps on the north stack and about 25 individuals dispersed throughout the south stack. Individual plants were removed, but they had already set a considerable amount of seed.

Digitaria ciliaris (Henry's crabgrass), nat.

Rare, a few individuals on the north ledge of the south stack; fruit, flower.

Eleusine indica (beach wiregrass), nat.

Occasional, clumps scattered throughout both stacks, including ledges, most common grass; fruiting.

Pteridophytes

Phymatosorus grossus (*laua'e*), nat.

Rare, a few individuals scattered along sheer cliffs of the south stack. New islet record.

SEABIRDS

Methods and general description

We searched all accessible parts of the island for nesting seabirds. Wedge-tailed shearwaters were the only birds nesting, but great frigatebirds also roost on the island. Historically, black noddies, (*Anous minutus*) and brown boobies (*Sula leucogaster*) also roosted on the island (Ueoka 1982, 1984, 1989).

Checklist of Seabirds with notes

Fregatidae

Fregata minor (Great frigatebird), ind.

One adult flew over the island during our visit and we found feathers and guano piles on the northern tip, which indicates roosting.

Procellariidae

Puffinus pacificus (Wedge-tailed shearwater), ind.

A thorough search revealed two dead and nine live shearwater chicks on the north stack and one dead and three live shearwater chicks on the south stack. None of the birds were in burrows, but nesting underneath *Scaevola sericea* and *Schinus terebinthifolius* shrubs.

OTHER BIRDS

None.

ARTHROPODS

Methods and general description

Because of the short time we had on the island, we did not set out any traps. Instead, we focused on collecting from different host plants using a sweep net, litter sifter, and physical search of each plant species on the island. This was supplemented with a ground search around rocky areas. High winds made it difficult to collect flying insects.

Checklist of Arthropods

ARANEAE

Araneidae

Gasteracantha mammosa (Asian spiny-backed spider), nat.
New islet record.

Oxyopidae

Oxyopes sp. [of Kumashiro, 1990] (lynx spider), nat.
New islet record.

BLATTODEA

Blaberidae

Pycnoscelus indicus (burrowing cockroach), nat.
New islet record.

COLEOPTERA

Dermestidae

Dermestes frischii (dermestid beetle), nat.
New islet record.

DIPTERA

Muscidae

Stomoxys calcitrans (stable fly), nat.
New islet record.

HOMOPTERA

Delphacidae

Indeterminate (planthopper), unknown status
New islet record.

Ortheziidae

Orthezia insignis (enzign coccid), nat.
New islet record.

Pseudococcidae

Pseudococcus sp. (mealybug), unknown status
New islet record.

HYMENOPTERA

Apidae

Apis mellifera (honey bee), nat.

OTHER OPPORTUNISTIC OBSERVATIONS

Snails were abundant on the north tip of the islet under mats of *Sesuvium portulacastrum*. These tiny snails (2-3 mm in size) were sent to Rob Cowie's lab at the University of Hawai'i at Manoa for identification. Little is known about these snails in Hawai'i. They could only be identified to family, Achatinellidae, and are most likely native. No skinks or other reptiles were observed.

THREATS AND RECOMMENDATIONS

The greatest threat to Moku mana is from invasive plant species. Two individuals of *Cenchrus echinatus* were discovered on the north stack in 2005 (Starr et al. 2006), but the population has increased to two large patches on the north stack and has spread to the south stack where individuals are interspersed with natives. We pulled all plants, but many seeds were present in the soil. The non-native tree, *Schinus terebinthifolius*, and shrub, *Lantana camara*, are a secondary threat as they appear to be slowly spreading. Other non-native species exist and should be controlled as resources allow.

Table 12. Key threats to Moku mana ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|---------------------------------|--|--|
| Weeds | | |
| <i>Cenchrus echinatus</i> | Displacement of natives | Eradicate before it becomes widespread |
| <i>Lantana camara</i> | Displacement of natives; poor nesting habitat | Eradicate |
| <i>Schinus terebinthifolius</i> | Displacement of natives; poor nesting habitat | Eradicate |



Figure 48. A ravine divides the island, view of south stack.

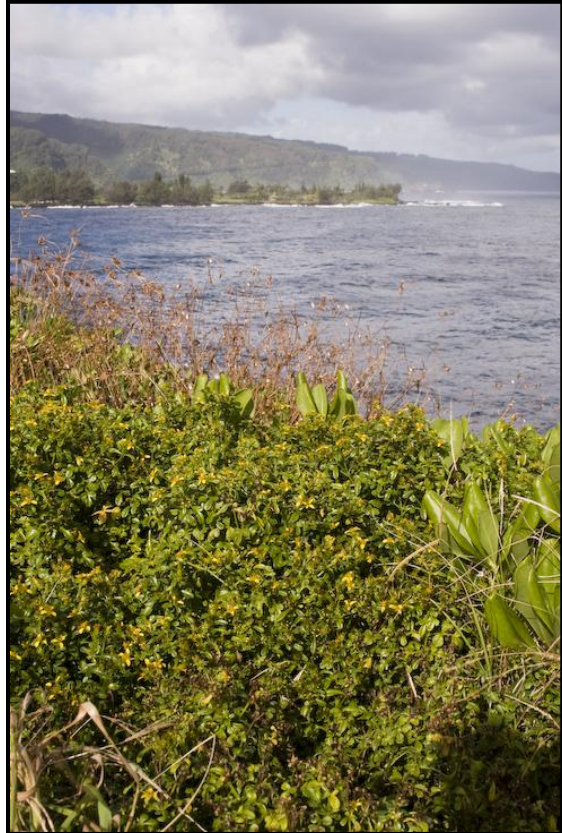


Figure 49. *Bidens mauiensis*. Photo: J.Eijzenga

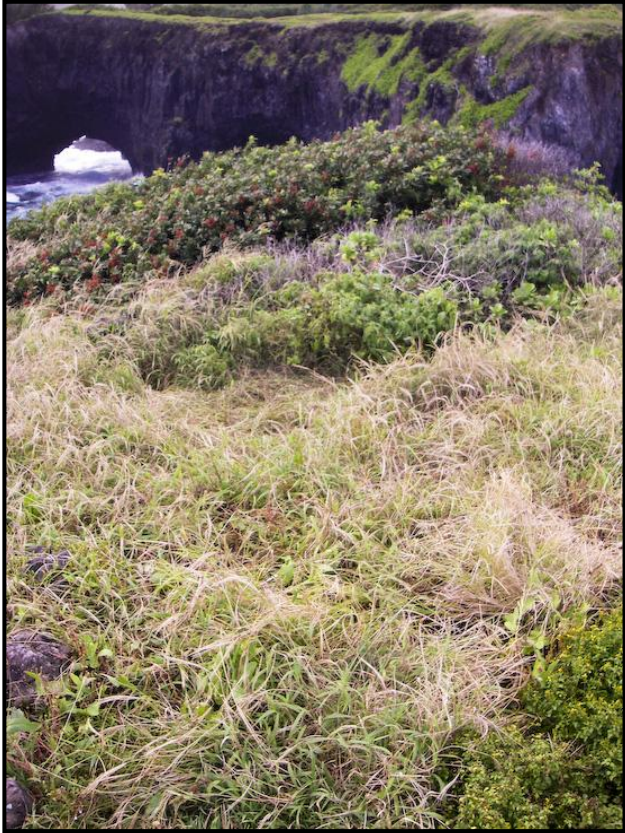


Figure 50. Weedy mix, south stack. Photo: J.Eijzenga



Figure 51. View from north tip, snails abundant in *Sesuvium portulacastrum* (foreground).

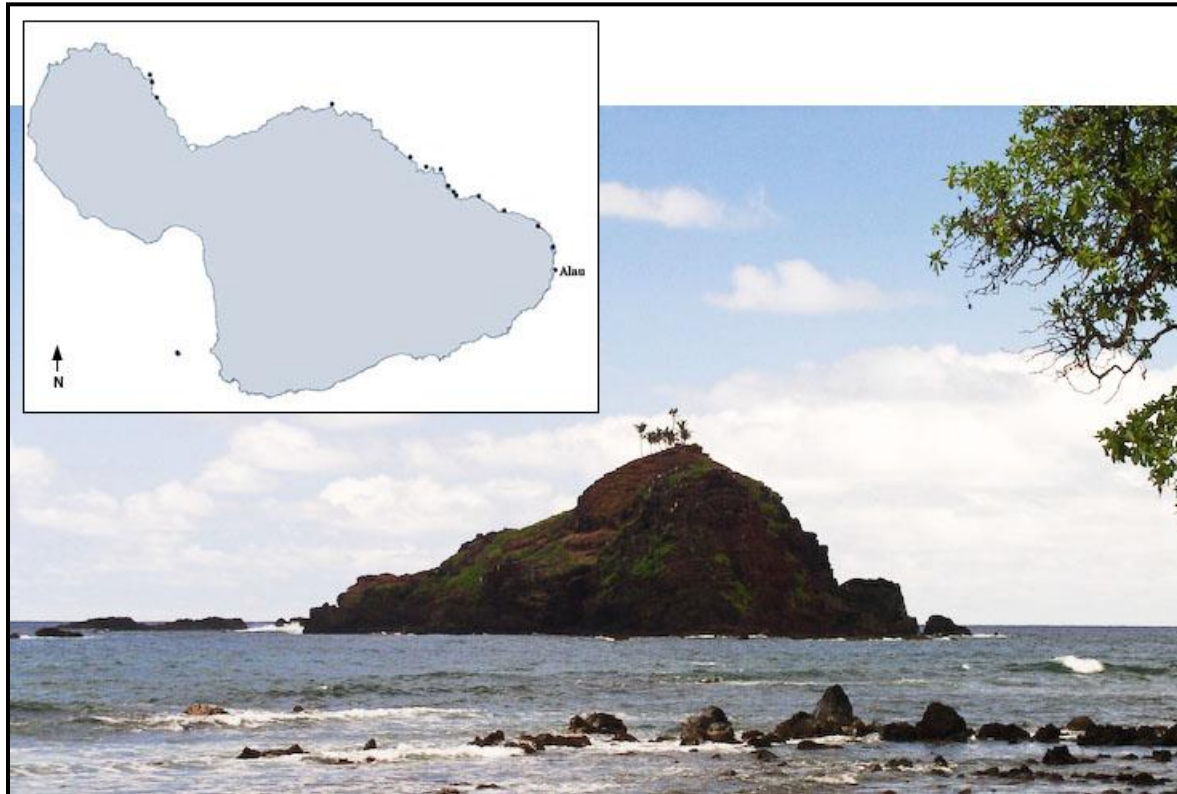


Figure 52. View of north stack. Photo: J.Eijzenga



Figure 53. *Schinus* and *Scaevola* on the north stack

15. MAUI: ‘Ālau Islet



LOCATION

‘Ālau is located south of Hana off the eastern coast of Maui at 20°43'53" N latitude, 155°58'490" W longitude.

STATUS

‘Ālau is part of the Hawai‘i State Seabird Sanctuary, protected by the Hawai‘i Department of Land and Natural Resources (DLNR). Permission to land must be obtained in writing from DLNR.

PHYSICAL DESCRIPTION

‘Ālau is a 2.0 hectare cinder cone rising to a height of 45 meters with steep cliffs on the south and west sides. Two ridges slope seaward and enclose a small, unprotected cove.

ACCESS

Heather Eijzenga (Bishop Museum), Ken Wood (National Tropical Botanical Garden) and Hank Oppenheimer (Plant Extinction Prevention Program) accessed the islet on 19 February 2008 from 0900 to 1700. We chartered a helicopter, which dropped us off on the northern ridge.

VEGETATION

Methods and general description

A partial botanical inventory was conducted by walking throughout the islet. Ken was able to rappel down the southern cliffs to assess plant life and collect seed from the large population of *Schiedea globosa*. Hank outplanted six individuals of the endangered dwarf *naupaka*, *Scaevola coriacea*, along the lower northeast arm. This species was outplanted in 2002, but never became established. Native plants, especially *Scaevola sericea* and *Sesuvium portulacastrum*, dominated the lower section of the islet while many weedy species were found along the upper ridges. Plant cover was approximately 65% with 19 plant species total: 10 non-native, 5 indigenous and 4 endemic. Three species found during the most recent botanical survey in April 2005 (Starr 2006) were not detected during this trip: *Sporobolus indicus*, *Conyza bonariensis* and *Cyperus phleoides*. However, in 2005 these species were reported as rare and were likely overlooked during our partial survey.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Aizoaceae

Sesuvium portulacastrum ('akulikuli), ind.

Common along the lower sections of the islet where it forms dense mats; fruit, flower.

Areaceae

Cocos nucifera (coconut), nat.

Occasional, primarily restricted to the summit area.

Asteraceae

Emilia fosbergii (flora's paintbrush), nat.

Rare, a few plants scattered throughout the islet; flowering.

Sonchus oleraceus (sow thistle), nat.

Occasional, individuals scattered throughout islet; fruiting.

Capparaceae

Capparis sandwichiana (maiapilo), end.

Rare, a few plants on the sheer, southwest wall

Caryophyllaceae

Schiedea globosa (maolioli), end.

Locally common on the sheer, southwest wall; fruit, flower.

Fabaceae

Vigna marina (*nanea*), ind.

Occasional, primarily along the western ridge; fruit, flower.

Goodinaceae

Scaevola sericea (beach *naupaka*), ind.

Common throughout the islet; fruiting.

Nyctaginaceae

Boerhavia repens (*alena*), ind

Occasional in open areas; fruit, flower

Passifloraceae

Passiflora foetida (love-in-a-mist), nat.

Occasional, several plants growing along the western ridge; fruiting.

Portulacaceae

Portulaca lutea (*'ihi*), end.

Rare, a few plants along the low areas of the islet.

Portulaca oleracea (pigweed), nat.

Common throughout the islet; fruit, flower.

Portulaca villosa (*'ihi*), end.

Rare, three plants on the eastern part of the islet.

Solanaceae

Solanum americanum (*popolo*), ind.

Occasional, several plants along the summit ridge; fruit, flower.

Verbenaceae

Lantana camara (lantana), nat.

Occasional, along the western ridge; flowering.

Angiosperms-Monocots

Poaceae

Digitaria ciliaris (Henry's crab grass), nat.

Common throughout the islet.

Digitaria insularis (sourgrass), nat.

Occasional, especially on the west side of the islet.

Eleusine indica (wiregrass), nat.

Common, especially along the summit ridge where it forms dense carpets.

Pteridophytes

Nephrolepidaceae

Nephrolepis multiflora (sword fern), nat.

Rare, a few individuals on the eastern cliffs.

SEABIRDS

Methods and general description

Seabirds were observed opportunistically during the botanical and arthropod surveys. Wedge-tailed shearwaters were pairing up in burrows at the start of their breeding season. Black noddies were courting and a flock of 50 great frigatebirds roosted on the island. White-tailed tropicbirds have been reported to nest on the island in the past (Hobdy 1982), but none were observed on the island.

Checklist of Seabirds with notes

Fregatidae

Fregata minor (Great frigatebird), ind.

Upon our arrival by helicopter, 50 roosting frigatebirds were stirred from their roosts. Most were juveniles, but some male and female adults were also mixed with the group.

Laridae

Anous minutus (Black noddy), ind.

Eight adults were seen courting and flying around the north end of the island. They were roosting on guano-stained rock ledges, but no nests were found.

Phaethontidae

Phaethon lepturus (White-tailed tropicbird), ind

One bird was observed flying over the island.

Procellariidae

Puffinus pacificus (Wedge-tailed shearwater), ind.

Birds were pairing up in burrows at the start of the breeding season. We saw approximately 150 birds, but many more were returning to the island in the evening when we departed.

Sulidae

Sula leucogaster (Brown booby), ind.

Three adults were observed offshore.

OTHER BIRDS

Six ruddy turnstones, *Arenaria interpres*, and one wandering tattler, *Tringa incana*, were seen foraging around the island along with a flock of eight nutmeg mannikins, *Lonchura punctulata*.

ARTHROPODS

Methods and general description

Because we only had one day on the island, we did not set out any traps. Instead, we focused on collecting from different host plants using a sweep net, litter sifter, and physical search of each plant species on the island. This was supplemented with a ground search around rocky areas and along the cove.

Nysius bugs were extremely abundant, primarily under the *Portulaca oleracea*. *Odynerus* were common around the small cove and several butterflies were observed visiting *Vigna marina*.

Checklist of Arthropods

ARANEAE

Araneidae

Argiope appensa (garden spider), nat.

New islet record.

Oxyopidae

Oxyopes sp. [of Kumashiro, 1990] (lynx spider), nat.

New islet record.

BLATTODEA

Blaberidae

Pycnoscelus indicus (burrowing cockroach), nat.

New islet record.

COLEOPTERA

Coccinellidae

Coelophora inaequalis (common Australian lady beetle), purposely introduced

New islet record.

Tenebrionidae

Gonocephalum adpressiforme (gonocephalum darkling beetle), nat.

New islet record.

DIPTERA

Syrphidae

Allograpta sp. (hover fly), nat.

New islet record.

HETEROPTERA

Lygaeidae

Nysius coenosulus (seed bug), end.

Nabidae

Nabis capisiformis (damselfly bug), nat.

New islet record.

HOMOPTERA

Cicadellidae

Empoasca solana (bean leafhopper), nat.

Psyllidae

Diaphorina citri (Asian citrus psyllid), nat.

New islet record.

HYMENOPTERA

Braconidae

Apanteles trifasciatus, nat.

New islet record.

Formicidae

Pheidole megacephala (big-headed ant), nat.

Vespidae

Odynerus sp. (mason wasp), end.

New islet record.

ISOPODA

Scyphacidae

Alloniscus oahuensis (terrestrial isopod), nat.

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

One adult monk seal, *Monachus schauinslandi*, was hauled out in the small cove at the backside

of the island. In 2007, traps were set to determine if any rodents were present on the island and none were found.

THREATS AND RECOMMENDATIONS

Non-native plants are the primary threat to the island. Both *Lantana camara* and *Passiflora foetida* are localized on the western ridge and can easily be eradicated. Several non-native grasses and *Portulca oleracea* are widespread along the ridges and upper slopes of the island. Control of these species is therefore more difficult and should be considered as resources allow. See Starr et al. (2006) for outplanting suggestions.

‘Ālau is a fairly large island with potential nesting habitat for several seabird species. It would be beneficial to conduct a thorough seabird survey to document the number and abundance of nesting species.

Table 13. Key threats to ‘Ālau ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|---------------------------|---|--|
| Human disturbance | Trample burrows, weeds, introduce non-native species | Consider informational signs |
| Weeds | | |
| <i>Lantana camara</i> | Displacement of natives; poor nesting habitat | Eradicate |
| <i>Passiflora foetida</i> | Displacement of natives; entanglement hazard | Eradicate |
| Other non-natives | Displacement of natives | Control/eradicate as resources allow |
| Big-headed ants | Disturb seabird colonies; alter arthropod populations | No action, research needed (see section 4.2) |



Figure 54. *Schidea globosa* and *Capparis sandwichiana* on the western cliffs.

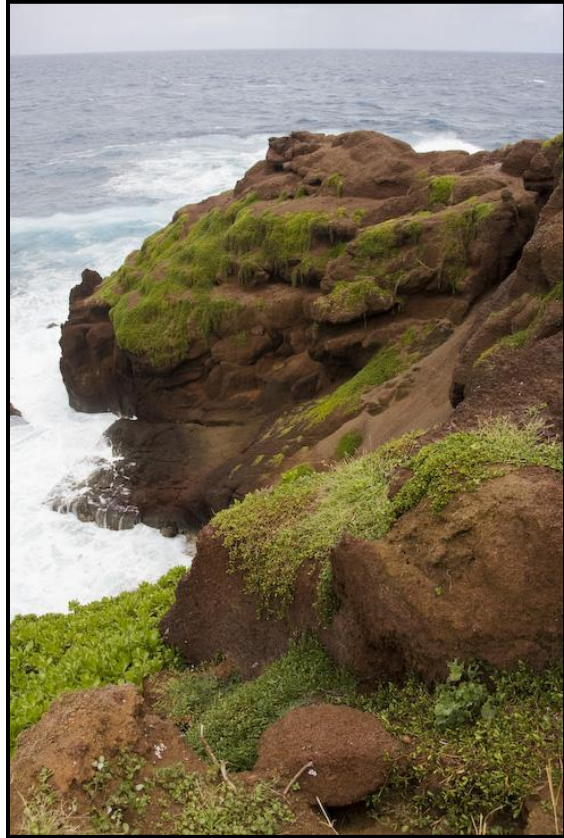


Figure 55. *Sesuvium* on the north shore.

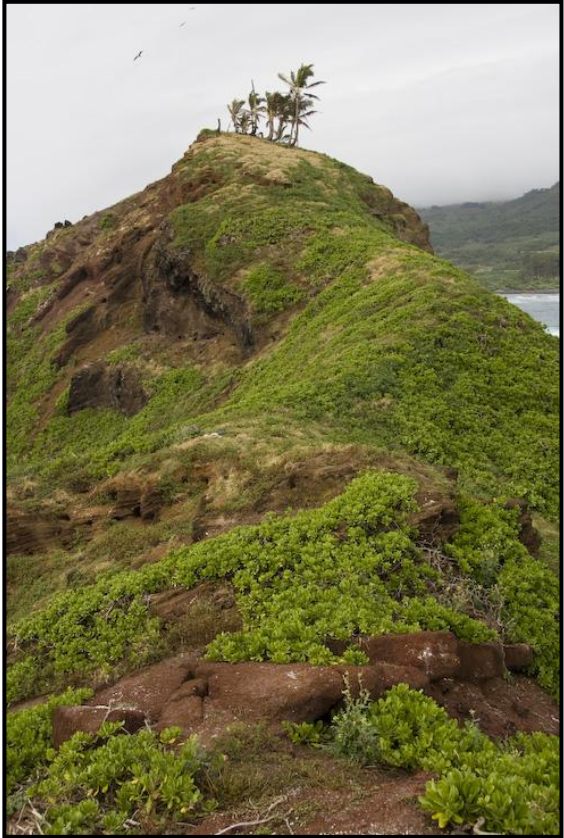


Figure 56. View towards the summit.



Figure 57. Outplanting *Scaevola coriacea* among the carpet of *Sesuvium* on the northwest coast.



Figure 58. *Vigna marina* atop western cliffs.

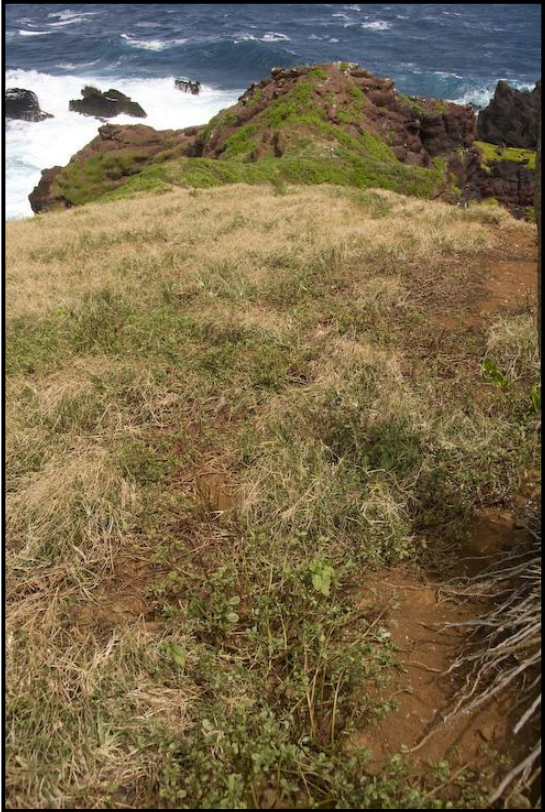


Figure 59. Weedy mix on north slope of summit.



Figure 60. Small cove on the east side of the island.

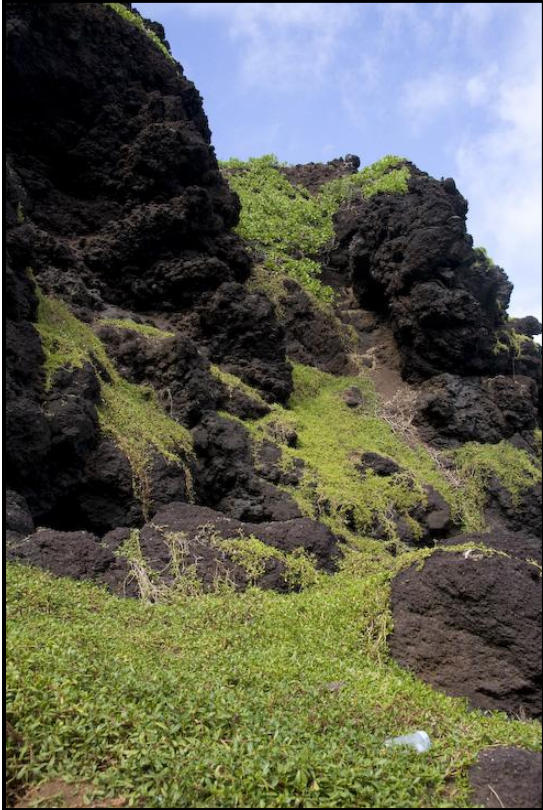


Figure 61. *Sesuvium* around the cove.

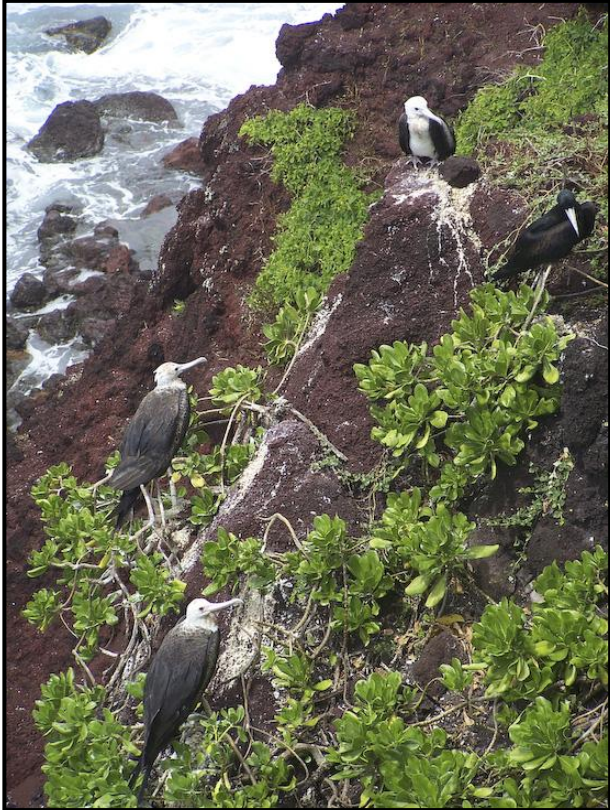
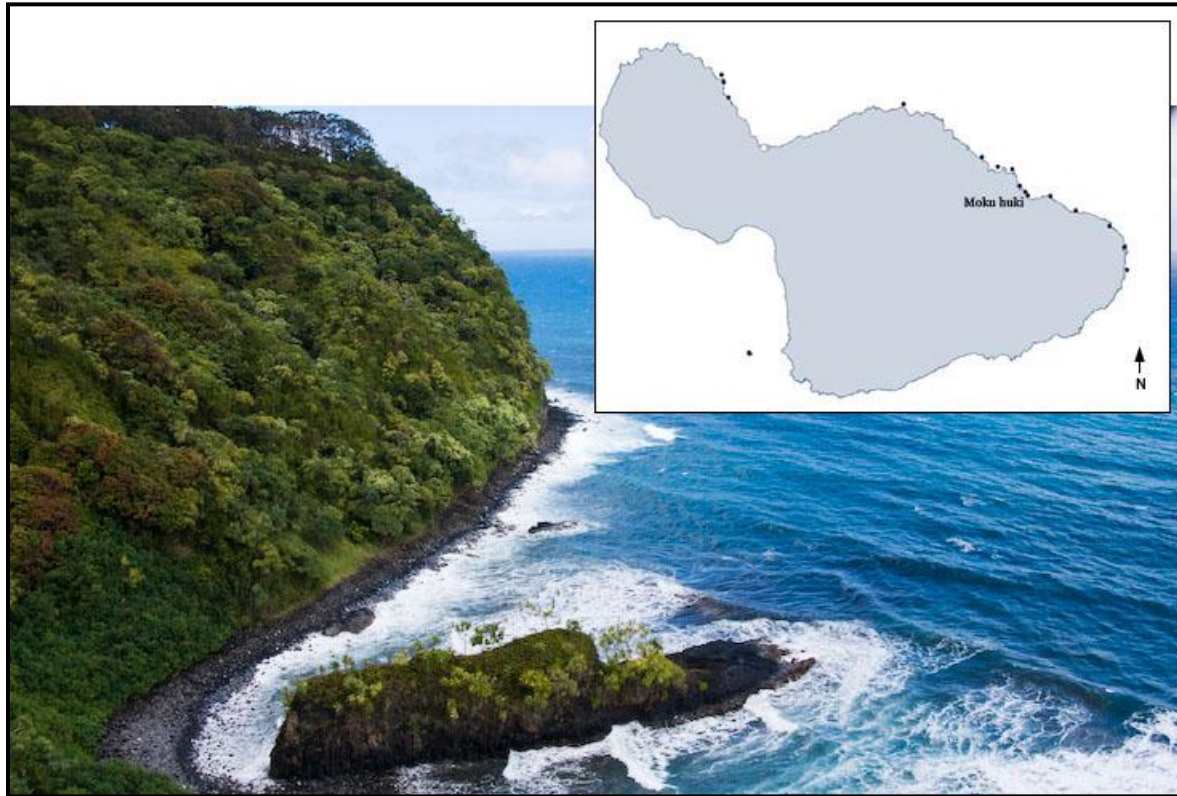


Figure 62. Roosting frigatebirds. Photo: H.Oppenheimer

16. MAUI: Mokuhuki Islet



LOCATION

Mokuhuki lies in the middle of Waiohue Bay along the north coast of east Maui at 20°49'51" N latitude, 156°7'60" W longitude.

STATUS

Mokuhuki is state property. State and/or federal law protects all native wildlife and plants.

PHYSICAL DESCRIPTION

Mokuhuki is a small, 0.1 hectare islet that rises abruptly to a height of about 16.7 meters. The islet is barely separated from the adjacent shoreline by a rough, narrow channel.

ACCESS

Heather Eijzenga (Bishop Museum), Ken Wood (National Tropical Botanical Garden) and Hank Oppenheimer (Plant Extinction Prevention Program) accessed the islet on 20 February 2008 from 1000 to 1400. We chartered a helicopter and were dropped off on the northern basalt shelf.

VEGETATION

Methods and general description

A partial botanical survey was conducted by walking the length of the narrow islet, although no

effort was made to survey the steep cliffs. Two species of invasive plants were killed, *Ficus microcarpa* and *Ardisia elliptica*. Additionally, Hank outplanted four individuals of dwarf *naupaka*, *Scaevola coriacea*, along the summit ridge. This section of the Maui coast averages 380 cm per year making Mokuhuki one of the wettest of Maui's islets. The vegetation was lush and exceptionally dense along the summit ridge, which is dominated by *Pandanus tectorius* and a variety of ferns. Plant cover was approximately 90% with 27 plant species total: 12 non-native, 11 indigenous and 4 endemic. Six species found during the most recent botanical survey in April 2005 (Star et al. 2006) were not detected during this trip: *Cyperus halpan*, *Hibiscus tiliaceus*, *Spathoglottis plicata*, *Emilia fosbergii*, *Conyza bonariensis* and *Morinda citrifolia*.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Agavaceae

Cordyline fruticosa (*ti*), nat.

Occasional, several plants on the summit ridge.

Aizoaceae

Sesuvium portulacastrum (*'akulikuli*), ind.

Common in the lower areas of the islet exposed to salt spray.

Apiaceae

Centella asiatica (*pohe kula*), nat.

Occasional, individuals scattered throughout the islet.

Asteraceae

Pluchea carolinensis (sourbush), nat.

Occasional, individuals scattered throughout islet; flowering.

Goodeniaceae

Scaevola sericea (beach *naupaka*), ind.

Common, individuals found throughout the islet.

Moraceae

Ficus microcarpa (Chinese banyan), nat.

Rare, two trees (girdled during this trip).

Myrsinaceae

Ardisia elliptica (shoebuttton ardisia), nat.

Occasional, several trees over 2.5 meters tall and many seedlings; fruiting.

Myrtaceae

Psidium guajava (common guava), nat.
Rare, a few trees along the summit ridge.

Pandanaceae

Pandanus tectorius (*hala*), ind.
Common, trees scattered throughout the islet.

Rosaceae

Osteomeles anthyllidifolia (*'ulei*), ind.
Occasional, individuals found primarily on the low, northern section of the islet and along the southern section of the upper ridge; flowering.

Rubiaceae

Morinda citrifolia (*noni*), nat.
Rare, a few plants along the summit ridge.

Scrophulariaceae

Bacopa monnieri (*'ae'ae*), ind.
Several plants restricted to the northern basalt shelf; flowering.

Solanaceae

Lycium sandwicense (*'ohelo kai*), ind.
Rare, a few plants on the northern basalt bench; flowering.

Thymelaeaceae

Wikstroemia oahuensis (*'akia*), end.
Rare, one tree on the southeastern cliff.

Verbenaceae

Lantana camara (lantana), nat.
Occasional, especially along the southern end of the summit ridge.

Angiosperms-Monocots

Cyperaceae

Carex wahuensis, end.
Occasional, individuals scattered along the low, northern section of the islet and along the steep eastern and western slopes.

Fimbristylis cymosa (button sedge), ind.

Occasional on the northern basalt shelf.

Poaceae

Digitaria ciliaris (Henry's crab grass), nat.
Occasional, individuals throughout the islet.

Ischaemum byrone (ischaemum), end. (E)
Occasional, especially along the low, northern section of the islet.

Paspalum scrobiculatum (*mauu laiki*), ind.
Occasional, individuals throughout the islet.

Pteridophytes

Blechnaceae

Sadleria pallida (*amau*), end.
Occasional, plants scattered throughout the islet.

Dryopteridaceae

Cyrtomium falcatum (holly fern), nat.
Rare, a few plants on the northwestern cliff.

Lindsaeaceae

Sphenomeris chinensis (*palaa*), ind.
Common, dominates the understory of the summit ridge.

Nephrolepidaceae

Nephrolepis multiflora (sword fern), nat.
Occasional, plants scattered throughout the islet, but especially along the summit ridge.

Polypodiaceae

Phymatosorus grossus (*laua'e*), nat.
Common, plants scattered throughout the islet.

Psilotaceae

Psilotum nudum (*moa*), ind.
Rare, one individual on the southeast slopes.

SEABIRDS

Methods and general description

We searched for evidence of nesting seabirds as we walked around the small island, but none

was found. There does not appear to be suitable habitat for most seabird species and none have been recorded historically.

Checklist of Seabirds with notes

None.

OTHER BIRDS

None.

ARTHROPODS

Methods and general description

Because of our short time on the island, we did not set out any traps. Instead, we focused on collecting from different host plants using a sweep net, litter sifter, and physical search of each plant species on the island. This was supplemented with a ground search around rocky areas.

With occasional rain squalls during our short visit and few plants flowering, very few flying insects were detected. Spiders were abundant throughout the island from underneath dense fern cover to the canopy. Isopods were abundant in the soil and leaf litter and few ants were detected.

Checklist of Arthropods

AMPHIPODA

Talitridae

Indeterminate (terrestrial scud), unknown status

New islet record.

ARANEAE

Araneidae

Argiope appensa (garden spider), nat.

New islet record.

Gasteracantha mammosa (Asian spiny-backed spider), nat.

New islet record.

Salticidae

Hasarius adansoni (Adanson's house jumper), nat.

New islet record.

HOMOPTERA

Flatidae

Melormenis basalis (West Indian flatid), nat.

New islet record.

Halimococcidae

Thysanococcus pandani (hala scale), nat.

New islet record.

Margarodidae

Icerya purchasi (cottony cushion scale), nat.

New islet record.

HYMENOPTERA

Formicidae

Ochetellus glaber (glaber ant), nat.

New islet record.

ISOPODA

Armadillidae

Cubaris murina (terrestrial isopod), nat.

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

None. No skinks or geckoes observed.

THREATS AND RECOMMENDATIONS

Invasive species pose a significant threat to Mokuhuki. *Ardisia elliptica* and *Ficus microcarpa* are known to be invasive and have the potential to cover large areas of the island. Since 2005, the population of *A. elliptica* has spread from one tree (Starr et al. 2006) to several fruiting trees and numerous seedlings. Unfortunately, the surrounding coastline is dominated by *A. elliptica* and *F. microcarpa* and the bird-dispersed fruits can easily be transferred to the island. An ongoing control program is necessary to keep these trees from dominating the island. Other problem species include *Lantana camara*, *Pluchea carolinensis*, *Nephrolepis multiflora* and other introduced grasses and herbs.

Any control or eradication attempts will be destructive to Mokuhuki's unique fern understory. There is no way to avoid trampling the ferns in order to walk along the upper ridge. The effects of the trampling should be monitored to determine how long it takes the ferns to recover and if disturbance increases the chance of invasion by non-native species. This information will be essential in guiding a restoration program.

Human disturbance appears to be a minor threat as camping gear was stored on the islet. Access to the summit is difficult and visitors most likely remain on the lower shelf to fish.

Table 14. Key threats to Mokuhuki ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|-----------------------------|---|--|
| Human disturbance | Trampled vegetation; introduction of non-native species | Enforcement difficult; remove stored gear and consider signage |
| Weeds | | |
| <i>Ardisia elliptica</i> | Displacement of natives | Consider ongoing control efforts |
| <i>Ficus microcarpa</i> | Displacement of natives | Consider ongoing control efforts |
| <i>Lantana camara</i> | Displacement of natives | Eradicate |
| <i>Pluchea carolinensis</i> | Displacement of natives | Eradicate |
| Other non-natives | Displacement of natives | Consider eradication as resources allow |
| <i>Hala scale</i> | Decreased vigor and death of <i>Pandanus tectorius</i> | Unknown, problem along west Maui coastline |



Figure 63. Aerial view of *Pandanus tectorius* and ferns along the summit ridge.



Figure 64. Climbing to the summit.



Figure 65. Summit ridge. Photo: H. Oppenheimer



Figure 66. A dense mix of ferns dominates the summit understory.



Figure 67. A single *Wikstroemia oahuense* on the eastern cliff. Photo: H. Oppenheimer



Figure 68. *Pandanus tectorius* infested with *hala* scale. Photo: H. Oppenheimer



Figure 69. Vegetation on the north outcropping.



Figure 70. *Sadleria pallida* along northern outcropping.

17. LANA'I : Po'opo'o Islet



LOCATION

Po'opo'o is located on the south-central coast of Lana'i near Huawai Bay at 20°44'19" N latitude, 156°55' 25" W longitude.

STATUS

Po'opo'o is part of the Hawai'i State Seabird Sanctuary, protected by the Hawai'i Department of Land and Natural Resources (DLNR). Permission to land must be obtained in writing from DLNR.

PHYSICAL DESCRIPTION

Po'opo'o is a 0.9 hectare sea stack, approximately 18.3 meters high. Steep cliffs make up the sides of the island while the top is fairly flat and slopes to the west. At the northern end, the island narrows to a steep ridge while at the southern end there is a low lava bench with abundant tide pools.

ACCESS

Heather Eijzenga (Bishop Museum), Jiny Kim (project intern) and Jaap Eijzenga (DOFAW) accessed the islet from 1200 on 1 November 2007 to 1200 on 2 November 2007. We chartered a

helicopter and were dropped off near the summit. Boat access is also an option during calm seas by swimming to the southern bench and making an easy climb to the summit.

VEGETATION

Methods and general description

A botanical inventory was conducted by walking loose transects throughout the islet. Vegetation on the islet was scorched and primarily dead. The dominant plant species on the islet as well as along adjacent coastal sites was *Cenchrus ciliaris*, which formed a monoculture over much of the islet. Native plants, notably *Waltheria indica* and *Sida fallax* persisted in low numbers along the rocky margins of the islet along with some unidentifiable shrub skeletons. Plant cover was approximately 85% with 8 plant species total: 3 non-native and 5 indigenous. Six species found during the most recent botanical survey in April 2006 (Starr et al. 2006) were not detected during this trip: *Chloris virgata*, *Digitaria insularis*, *Lantana camara*, *Merremia aegyptia*, *Portulaca oleracea* and *Tribulus cistoides*.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Cucurbitaceae

Momordica charantia (bitter melon), nat.

Rare, one plant growing at the top of the south tip; no fruit or flower.

Malvaceae

Abutilon incanum (hoary abutilon), ind.

Rare, one shrub near the summit, dead, but with seed

Sida fallax ('ilima), ind.

Occasional, several plants found throughout the islet, most were only skeletons, but some were alive and flowering.

Nyctaginaceae

Boerhavia acutifolia (alena), ind.

Rare, one partially dead plant tentatively identified as *B. acutifolia* based on lanceolate leaves.

Boerhavia repens (alena), ind.

Rare, three individuals interspersed with *C. ciliaris*; flowering.

Sterculiaceae

Waltheria indica ('uhaloa), ind.

Occasional, several plants scattered along the rocky margins of the islet; flowering.

Angiosperms-Monocots

Poaceae

Cenchrus ciliaris (buffelgrass), nat.

Dominant, covering 90% of the islet, most plants had set seed and were senescing; fruiting.

Cenchrus echinatus (guinea grass), nat.

Rare, a few plants interspersed in *C. ciliaris* along the western margins, all dead; fruiting.

SEABIRDS

Methods and general description

We performed a short survey for wedge-tailed shearwaters by counting the number of chicks along two transects (22 chicks in 228 m²) and extrapolating to the area of potential nesting habitat (1,147 m²). No other birds were observed nesting on the island but, Bulwer's petrels as well as white-tailed tropicbirds may nest in the cliffs along the south side of the islet.

Checklist of Seabirds with notes

Laridae

Anous stolidus (Black noddy), ind.

One Black noddy observed foraging around the islet

Phaethontidae

Phaethon lepturus (White-tailed tropicbird), ind.

Several birds were observed flying over and around islet; one flew into a crevice along the adjacent Lanā'i pali coast. Birds may nest in the cliffs on the south side of the islet, but this could not be confirmed.

Procellariidae

Puffinus pacificus (Wedge-tailed shearwater), ind.

An estimated 110 chicks were recorded. Burrows were scattered throughout the island, but predominantly clustered along the southwest slopes where soil is deeper.

Bulweria bulweri (Bulwer's petrel), ind.

No birds were found, but the breeding season had just finished. In the cliffs on the south side of the island there were ca. 20 natural crevices that were filled with guano and smelled strongly of musky Procellariidae. Bulwer's petrels likely nested there.

OTHER BIRDS

None.

ARTHROPODS

Methods and general description

To document arthropod diversity on the islet, we used a variety of collecting methods. We established a transect that ran along the length of the island from the narrow northern ridge to the southern cliffs. It was oriented to cover the highest habitat diversity on the islet. We established sampling points every 10 meters along the length of the transect and at each point we used the following techniques: pitfall trap, pan trap, sweep nets, host search and ground search. Traps were collected after 24 hours. Additionally, we employed the same methods on any plant species or habitat not included in our transect and performed two hours of night collection.

Despite intense efforts, we found very few arthropods other than ants, moths and the occasional Coccinellid beetle. At night crickets and beetles were abundant along with a few cockroaches and more moths. We saw a spider in the crevices on the south side of the islet that appeared to be a *Lycosid*, but it was too fast to catch.

Checklist of Arthropods

ARANEAE

Dysderidae

Dysdera crocota (woodlouse spider), nat.

New islet record.

BLATTODEA

Blaberidae

Diploptera punctata (Pacific beetle cockroach), nat.

New islet record.

Blattellidae

Symploce pallens (smooth cockroach), nat.

New islet record.

COLEOPTERA

Anthribidae

Araecerus levipennis (*koa haole* seed weevil), nat.

New islet record.

Carabidae

Aephnidius opaculus, nat.

New islet record.

Chrysomelidae

Epitrix hirtipennis (tobacco flea-beetle), nat.

New islet record.

Coccinellidae

Coelophora inaequalis (common Australian lady beetle), purposely introduced

New islet record.

Scolytidae

Xylosandrus sp., unknown

New islet record.

DIPTERA

Canicidae

Canaceoides angulatus (beach fly), nat.

New islet record.

Tachinidae

Ormia ochracea (cricket tachinid), nat.

New islet record.

HYMENOPTERA

Evaniidae

Evania appendigaster (ensign wasp), nat.

New islet record.

Formicidae

Camponotus variegatus (carpenter ant), nat.

New islet record.

Vespidae

Polistes olivaceus (redbrown paper wasp), nat.

New islet record.

ISOPODA

Indeterminate

Indeterminate sp. (terrestrial isopod), unknown status

New islet record.

LEPIDOPTERA

Noctuidae

Melipotis indomita (kiawe moth), nat.

New islet record.

NEUROPTERA

Chrysopidae

Chrysoperla comanche (green lacewing), nat.

New islet record.

ORTHOPTERA

Gryllidae

Caconemobius sandwichensis (beach rock cricket), end.

New islet record.

THYSANURA

Lepismatidae

Ctenolepisma sp. (bristletail), nat.

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

No skinks observed. Extensive tide pools with a diversity of algae, fish and invertebrates.

THREATS AND RECOMMENDATIONS

In 1982, 12 native plant species occurred on Po'opo'o (Hobdy 1982). Since then, the number of native species has dwindled to five and the islet is now dominated by the introduced grass *Cenchrus ciliaris*. It is likely that a native seedbank still persists and upon removal of *C. ciliaris*, natives may become re-established. However, *C. ciliaris* dominates the adjacent Lanā'i coast and the wind-dispersed seeds are easily transferred to the island. Any successful restoration program would involve long-term monitoring and on-going control. There is high boat activity in the area and one of the tour companies may be willing to assist with restoration logistics. See (Starr et al. 2006) for outplanting recommendations.

Bulwer's petrel nesting grounds are poorly documented because nests are typically inaccessible and cryptic. It would also be beneficial to document if Bulwer's petrels are still nesting on the island and estimate the population using call-back surveys early in the breeding season. Surveys could also be conducted for white-tailed tropicbirds.

Table 15. Key threats to Po'opo'o ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|---------------------------|-------------------------|---|
| Weeds | | |
| <i>Cenchrus ciliaris</i> | Displacement of natives | Consider ongoing control program |
| <i>Cenchrus echinatus</i> | Displacement of natives | Eradicate |
| Other non-natives | Displacement of natives | Control or eradicate as resources allow |



Figure 73. *Cenchrus ciliaris* forms a monoculture over the entire islet.



Figure 71. The narrow northern point

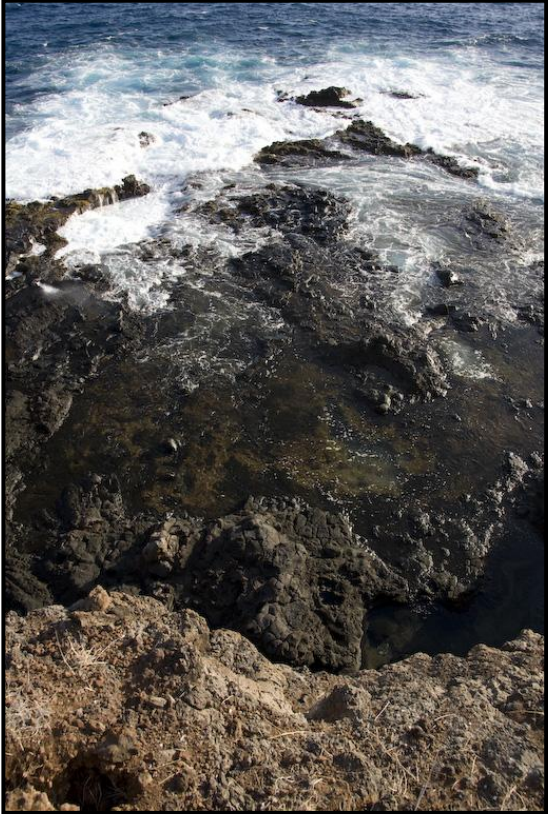


Figure 72. Tide pools on the southern bench.

18. LANĀ'I : Pu'u pehe Islet (Sweetheart Rock)



LOCATION

Pu'u pehe is located near Manele Bay on the south-central coast of Lana'i at 20°44'15" N latitude, 156°53' 35" W longitude.

STATUS

Pu'u pehe is part of the Hawai'i State Seabird Sanctuary, protected by the Hawai'i Department of Land and Natural Resources (DLNR). Permission to land must be obtained in writing from DLNR.

PHYSICAL DESCRIPTION

Pu'u pehe is a 0.7 hectare basalt sea stack, reaching approximately 30.5 meters in height. Steep cliffs make up the sides of the islet and the flat summit area slopes steeply to the east. Rock ledges and tide pools surround the base of the islet.

ACCESS

Heather Eijzenga (Bishop Museum) and Jiny Kim (project intern) accessed the islet on 2 November 2007 from 1200 to 1600. We chartered a helicopter and were dropped off on the summit near the heiau.

VEGETATION

Methods and general description

A botanical inventory was conducted by walking the entire area of the small islet. Vegetation on the islet was scorched and primarily dead. The dominant plant species on the islet as well as along adjacent coastal sites was *Cenchrus ciliaris*. Native plants, notably *Waltheria indica* and *Sida fallax* were interspersed with the non-native grass. Plant cover was approximately 30% with 7 plant species total: 3 non-native and 4 indigenous. Three species found during the most recent botanical survey in April 2006 (Starr et al. 2006) were not detected during this trip: *Chloris virgata*, *Merremia aegyptia* and *Portulaca oleracea* (likely because of drought conditions during our visit). We did, however, discover a new islet record, the indigenous shrub *Chenopodium oahuense*.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Chenopodiaceae

Chenopodium murale (lamb's quarters), nat.

Occasional, several plants scattered throughout the islet in loose patches, all dead; fruiting.

Chenopodium oahuense (*aweoweo*), ind.

Rare, two plants observed on the rocky west slope, both dead; fruiting. New islet record.

Malvaceae

Abutilon incanum (hoary abutilon), ind.

Rare, one shrub on the summit near the heiau, dead, but with seed

Sida fallax (*'ilima*), ind.

Occasional, several plants throughout islet, most were only skeletons, but some were alive and flowering.

Sterculiaceae

Waltheria indica (*'uhaloa*), ind.

Occasional, several plants scattered throughout the islet; flowering.

Angiosperms-Monocots

Poaceae

Cenchrus ciliaris (buffelgrass), nat.

Dominant, throughout the islet all brown; fruiting.

Cenchrus echinatus (guinea grass), nat.

Common, interspersed with *C. ciliaris*, all brown; fruiting.

SEABIRDS

Methods and general description

Due to time constraints, we were unable to perform a thorough seabird survey, and instead, opportunistically searched for evidence of nesting seabirds. Wedge-tailed shearwaters were nesting and what appeared to be a large colony of Bulwer's petrels had recently finished their breeding season.

Checklist of Seabirds with notes

Laridae

Anous stolidus (Black noddy), ind.

Four black noddies were observed foraging offshore.

Procellariidae

Bulweria bulweri (Bulwer's petrel), ind.

Bulwer's petrels had recently finished their breeding season (chicks fledge by the end of September), but there was evidence of nesting. Several abandoned eggs and 1 dead chick were found around the heiau at the summit and among a rock pile west of the summit. There appears to be excellent nesting habitat along the east slope of the island. We inspected the boulders and crevices in this area and found many burrows that appeared to be recently used (feathers, guano, odor), but unoccupied. Bulwer's may have been nesting here indicating a fairly large (ca. 100) colony. This is the first time Bulwer's petrels have been reported on this island.

Puffinus pacificus (Wedge-tailed shearwater), ind.

wedge-tailed shearwaters were nesting in high numbers on the small island. A few burrows existed around the summit area, but the majority were scattered along the eastern slope of the island. Burrow occupancy was approximately 50% with an estimated 150-200 chicks.

OTHER BIRDS

A wandering tattler (*Tringa incana*) foraged in the intertidal area and a House finch (*Carpodacus mexicanus*) visited the island briefly.

ARTHROPODS

Methods and general description

Because of the short time we had on the island, we did not set out any traps. Instead, we focused on collecting from different host plants using a sweep net, litter sifter, and physical search of each plant species on the island. This was supplemented with a ground search around rocky areas.

High winds and heat made it very difficult to find many arthropods. Homopterans were especially abundant on *Waltheria indica* and they were being tended by ants. Very little else was seen.

Checklist of Arthropods

ARANEAE

Araneidae

Argiope appensa (garden spider), nat.

New islet record.

HOMOPTERA

Margarodidae

Icerya purchasi (cottony cushion scale), nat.

New islet record.

Pseudococcidae

Antonina graminis (grass-root mealybug), nat.

New islet record.

Ferrisia virgata (striped mealybug), nat.

New islet record.

HYMENOPTERA

Apidae

Apis mellifera (honey bee), nat.

New islet record.

Formicidae

Solenopsis geminata (fire ant), nat.

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

Extensive tide pools and coral cover in surrounding waters, but could not access from summit.

No skinks observed.

THREATS AND RECOMMENDATIONS

No complete botanical survey was conducted on the island until 2006 when the invasive grass *Cenchrus ciliaris* had already become widespread on the island. However, in 1982 (Hobdy 1982) recorded two endemic species which no longer exist, *Panicum xerophilum* and *Ipomoea tuboides*. These species along with other natives may persist in the seedbank and become re-

established upon removal of invasive grasses. However, *C. ciliaris* dominates the adjacent Lanā'i coast and the wind-dispersed seeds are easily transferred to the island. Any successful restoration program would involve long-term monitoring and on-going control. See (Starr et al. 2006) for outplanting recommendations.

Bulwer's petrel nesting grounds are poorly documented because nests are typically inaccessible and cryptic. It would also be beneficial to estimate the population using call-back surveys early in the breeding season. Activity can also be monitored with night vision goggles from the adjacent coast. Surveys could also be conducted for white-tailed tropicbirds.

Table 16. Key threats to Pu'u pehe ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|---------------------------|-------------------------------|---|
| Owls | Predation of Bulwer's petrels | Monitor population, research needed (see section 4.4) |
| Weeds | | |
| <i>Cenchrus ciliaris</i> | Displacement of natives | Consider ongoing control program |
| <i>Cenchrus echinatus</i> | Displacement of natives | Eradicate |
| Other non-natives | Displacement of natives | Control or eradicate as resources allow |



Figure 74. *Cenchrus ciliaris* dominates the entire islet.



Figure 75. *Cenchrus ciliaris* and shrub skeletons (primarily *S. fallax*) along the steep east side of the islet.



Figure 76. Heiau at the summit.



Figure 77. Heavy guano load SE of the summit.

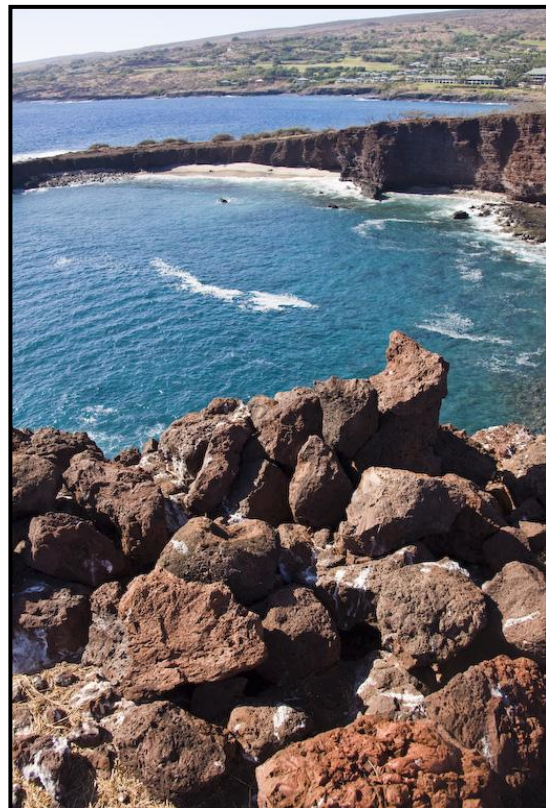


Figure 78. Bulwer's nests found in this rock pile.

19. LANĀ'I : Ki'ei Islet



LOCATION

Ki'ei is located just offshore the west coast of Lana'i near Ki'ei Bay at 20°49'17" N latitude, 156°59' 23" W longitude.

STATUS

Ki'ei is state property. All native plants and wildlife are protected by state and/or federal law.

PHYSICAL DESCRIPTION

Ki'ei is a 0.4 hectare basalt sea stack, reaching 12.2 meters in height and located near Ki'ei Bay. Rock ledges and tide pools surround the islet.

ACCESS

Heather Eijzenga (Bishop Museum) and Jaap Eijzenga (DOFAW) accessed the islet on 3 November 2007 from 1200 to 1600. We chartered a helicopter and were dropped off on the middle shelf.

VEGETATION

Methods and general description

A botanical inventory was conducted by walking the entire area of the small islet. There was little vegetation on the islet and the majority of plants were found along the summit. Native species including *Sida fallax*, *Waltheria indica*, and *Abutilon incanum* were dominant, but the islet is threatened by invasion of *Cenchrus ciliaris* from the adjacent Lana'i coast.

Plant cover was approximately 10% with 9 plant species total: 3 non-native, 5 indigenous and 1 unknown. Sixteen species found during the most recent botanical survey in April 2006 (Starr et al. 2006) were not detected during this trip: *Bidens pilosa*, *Bothriochloa pertusa*, *Cenchrus echinatus*, *Conyza bonariensis*, *Digitaria insularis*, *Emilia fosbergii*, *Gamochaeta purpureum*, *Gnaphalium sp.* *Heteropogon contortus*, *Ipomoea tuboides*, *Lycopersicon piminellifolium*, *Momordica charantia*, *Oxalis corniculata*, *Portulaca oleracea*, *Sonchus oleraceus*, *Veronia cinerea*. However, their visit followed a period of rain and most of these species were present as seedlings. Many were removed or may not have become established.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Aizoaceae

Sesuvium portulacastrum ('akulikuli), ind.

Rare, two small patches on middle shelf; not flowering or fruiting.

Fabaceae

Leucaena leucocephala:

Occasional, approximately ten plants under 0.5 meters in height found; fruit, flower.

Malvaceae

Abutilon incanum (hoary abutilon), ind.

Common, patches at summit and between level two and three; fruiting.

Sida fallax ('ilima), ind.

Dominant species, located on the summit and terrace slopes.

Nyctaginaceae

Boerhavia sp.

Rare, one plant under water, not collected.

Solanaceae

Lycium sandwicense ('ohelo kai), ind.

Rare, one patch on west side of islet at mid-terrace; not flowering or fruiting

Sterculiaceae

Waltheria indica ('*uhaloa*), ind.

Dominant, several plants scattered throughout summit and terrace slopes.

Angiosperms-Monocots

Poaceae

Cenchrus ciliaris (buffelgrass), nat.

Rare, three individuals, dead; seed on ground.

Panicum maximum (guinea grass), nat.

Rare, three small patches on summit, all pulled.

SEABIRDS

Methods and general description

The entire islet was thoroughly searched for evidence of nesting seabirds. A small number of nesting wedge-tailed shearwaters were the only birds observed. In the past, Bulwer's petrels, *Bulweria bulweri*, also nested on the island in small numbers (Walker et al. 1985) and brown boobies, *Sula leucogaster*, used the island for roosting (Walker et al. 1985).

Checklist of Seabirds with notes

Procellariidae

Puffinus pacificus (Wedge-tailed shearwater), ind.

Twenty Wedge-tailed shearwater chicks were found in rock crevices around the island, primarily on the northwest ledges. There were approximately 20 unoccupied nest sites that may support more birds.

OTHER BIRDS

Two erckel's francolins, *Francolinus Erckelii*, were found at the summit.

ARTHROPODS

Methods and general description

Because of the short time we had on the island, we did not set out any traps. Instead, we focused on collecting from different host plants using a sweep net, litter sifter, and physical search of each plant species on the island. This was supplemented with a ground search around rocky areas.

High winds, heat and little vegetation made it very difficult to find many arthropods. Fire ants were present, but only locally abundant. A dragonfly was observed flying over the summit, but could not be identified.

Checklist of Arthropods

ARANEAE

Dysderidae

Dysdera crocota (woodlouse spider), nat.

New islet record.

Oxypodidae

Oxyopes sp. [of Kumashiro, 1990] (lynx spider), nat.

New islet record.

Salticidae

Hasarius adansoni (Adanson's house jumper), nat.

New islet record.

COLEOPTERA

Anthribidae

Araecerus levipennis (*koa haole* seed weevil), nat.

New islet record.

Coccinellidae

Nephus roepkei (coccinellid beetle), purposely introduced

New islet record.

EMBIIDINA

Oligotomidae

Oligotoma saundersii (Saunders's webspinner), nat.

New islet record.

HYMENOPTERA

Apidae

Apis mellifera (honey bee), nat.

New islet record.

Formicidae

Solenopsis geminata (fire ant), nat.

New islet record.

LEPIDOPTERA

Pterophoridae

Lantanaophaga pusillidactyla (lantana plume moth), purposely introduced

New islet record.

NEUROPTERA

Hemerobiidae

Micromus timidus (brown lacewing), purposely introduced

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

No skinks or geckoes were observed. The surrounding tidepools have an abundance of algae, fish, and invertebrates.

THREATS AND RECOMMENDATIONS

Conditions on the islet were very dry during our visit making it difficult to fully assess the vegetation. Several incipient weed species reported and removed by Starr et al. (2006) were not found. They may have been effectively eradicated or may persist in the seedbank. It would be beneficial to survey the islet again after several months of rain.

Table 17. Key threats to Ki'ei ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|------------------------------|---|--|
| Fire ant | Disturb nesting seabirds; alter arthropod community | No action, research needed (see section 4.2) |
| Weeds | | |
| <i>Leucaena leucocephala</i> | Displacement of natives | Eradicate |
| <i>Cenchrus ciliaris</i> | Displacement of natives | Ongoing control |
| <i>Panicum maximum</i> | Displacement of natives | Eradicate |

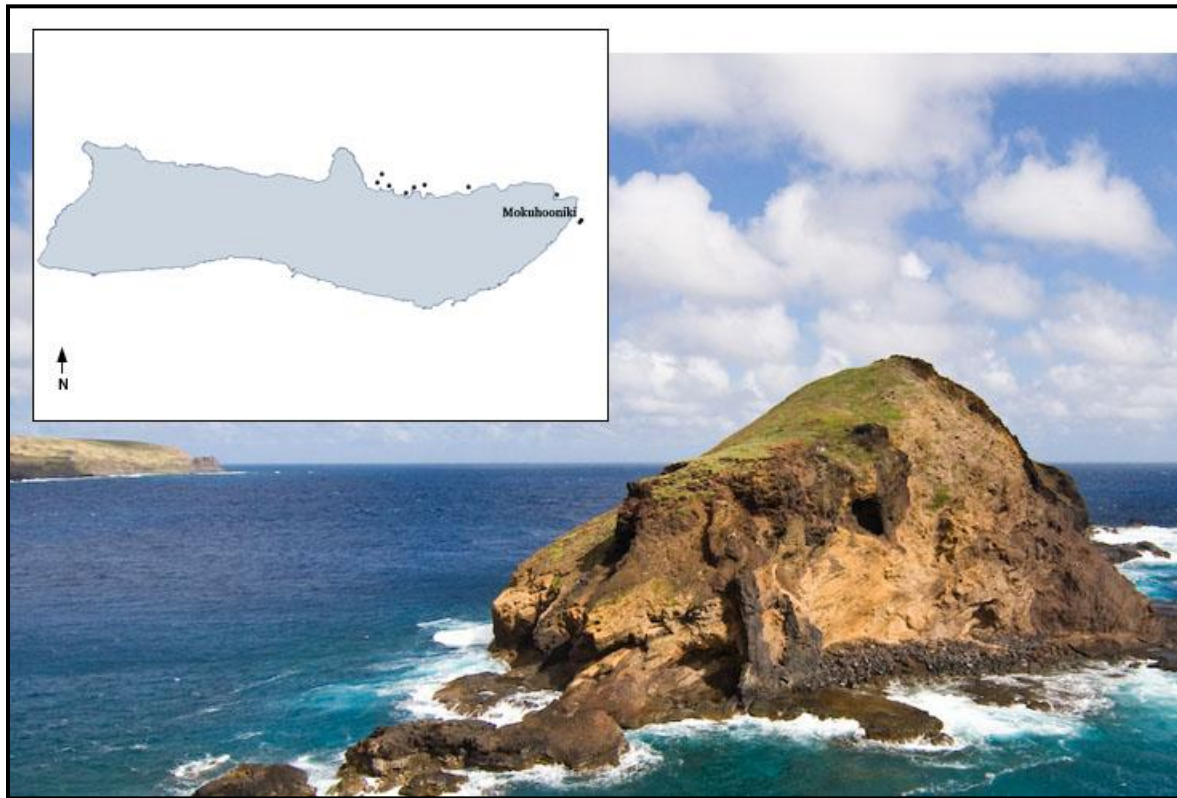


Figure 79. *Waltheria indica* and *Sida fallax* dominate the summit of the islet.



Figure 80. Abundant tide pools surround the base of the islet.

20. MOLOKA'I : Mokuho'oniki Islet



LOCATION

Mokuho'oniki is located in the Pailolo Channel east of Moloka'i and 50 meters northeast of Kanahā at 21°8'9" N latitude, 156°42' 20" W longitude.

STATUS

Mokuho'oniki is part of the Hawai'i State Seabird Sanctuary, protected by the Hawai'i Department of Land and Natural Resources (DLNR). Permission to land must be obtained in writing from DLNR.

PHYSICAL DESCRIPTION

Mokuho'oniki, formerly connected to Kanahā, is a remnant tuff cone. Wave erosion split the islet in two, but they are connected by an underwater shoal. Mokuho'oniki has an area of 5.7 hectares and a maximum height of almost 62 meters (Macdonald et al. 1983). Overall the islet is very crumbly. Shells and shrapnel are abundant from military bombing. Crater marks are also evident in many places along with fractures.

ACCESS

Heather Eijzenga (Bishop Museum), David Preston (Bishop Museum), Jaap Eijzenga (DOFAW), and Sheldon Plentovich (University of Hawai'i) accessed the islet from 15 February 2008 at

0900 to 16 February at 1000. We chartered a helicopter which dropped us off in the middle of the summit ridge where an impact crater provided a flat landing zone. It is also possible to access the islet by boat in calm seas and swim ashore.

VEGETATION

Methods and general description

A botanical inventory was conducted by walking loose transects throughout the islet. We were also able to examine aerial photos taken from the helicopter to examine inaccessible parts of the islet, but no additional species were detected. There was lush growth following several months of rain, especially in the southwest section of the islet where soil is deeper. Native plants dominated the islet although many non-native species (some known to be invasive) were present and pose a significant threat. Plant cover was approximately 40% with 23 plant species total: 10 non-native, 6 indigenous and 6 endemic. Four species found during the most recent botanical survey in 2002 (Wood and LeGrande 2002) were not detected during this trip: *Scaevola sericea*, *Eleusine indica*, *Boerhavia repens* and *Cenchrus ciliaris*. Additionally, we discovered the invasive grass, *Setaria verticillata*, has become established.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Aizoaceae

Sesuvium portulacastrum ('akulikuli), ind.

Occasional, especially on the lower slopes with high salt spray; flower, fruit.

Asteraceae

Melanthera integrifolia (nehe), end.

Only three large patches along the summit towards the north end; flowering.

Sonchus oleraceus, nat.

Individuals occasional throughout the island; fruit, flower.

Boraginaceae

Heliotropium curassavicum (nena), ind.

Rare, a few plants on the southeast slopes near the spray zone; flowering.

Chenopodiaceae

Atriplex semibaccata (Australian saltbush), nat.

Occasional, scattered throughout the islet; fruiting.

Chenopodium murale (lamb's quarters), nat.

Occasional throughout islet; fruit, flower.

Convolvulaceae

Jacquemontia ovalifolia subsp. *sandwicensis* (*pa'u-o-Hi'iaka*), end.

Common throughout the island, especially in the southwest section; flower, fruit.

Euphorbiaceae

Chamaesyce celastroides (*'akoko*), end.

Common throughout islet; fruit, flower.

Goodeniaceae

Scaevola coriacea (dwarf *naupaka*), end., E.

Only one live plant persisted along the north end of the summit (measuring ca. 1 m²) along with two dead stumps. The patch was previously described as occupying a 1.5 x 2.5 m² area, but there was no mention of number of individuals (Kepler et al. 1990); flowering, not fruiting.

Malvaceae

Sida fallax (*'ilima*), ind.

Occasional throughout the islet, especially in the south end; flower, fruit.

Portulacaceae

Portulaca oleracea (pigweed), nat.

Occasional throughout the islet, predominantly in the northeast section; fruit, flower.

Portulaca lutea (*'ihi*), ind.

Occasional on the north and northeast slopes; rare elsewhere; fruit, flower.

Portulaca pilosa (kiss me quick), nat.

Individuals occasional throughout the islet, especially in the northeast section; fruit, flower.

Solanaceae

Lycium sandwicense (*'ohelo kai*), ind.

Occasional patches along ledges of the north and northeast section; fruit, flower.

Verbenaceae

Lantana camara (lantana), nat.

Approximately six stunted individuals, too deeply rooted to pull out, along the summit towards the north end; flowering.

Angiosperms-Monocots

Cyperaceae

Fimbristylis cymosa subsp. *umbellato-capitata* (button sedge), ind.
Individuals occasional along the summit and north end.

Poaceae

Cenchrus echinatus (common sandbur), nat.

Occasional, locally common on the northeast slope where it forms large patches with *Setaria verticillata*, but a few individuals were found scattered along the southwest slope as well; fruiting. In 1981 Kepler et al. (1990) documented this species occurring in two patches near the summit. Although their survey was conducted in September (end of dry season) and ours in the middle of the wet season, this species appears to be spreading.

Cynodon dactylon (bermuda grass), nat.

Occasional, several patches east and west of the middle of the summit ridge.

Dactyloctenium aegyptium (beach wire grass), nat.

Occasional, primarily restricted to the south end where it forms large patches, few plants scattered along the summit ridge; fruit, flower.

Digitaria ciliaris (Henry's crabgrass), nat.

Occasional along the summit ridge; flowering.

Panicum fauriei var. *fauriei* (Faurie's panicgrass), end.

Healthy population, individuals are common throughout the islet, large patches are found at the north tip; flowering.

Panicum torridum (*kakonakona*), end.

Common, mostly restricted to the southern half of islet where the soil is deeper and it forms large monotypic stands, but individuals are also occasional throughout the islet; fruit, flower.

Setaria verticillata (Bristly foxtail), nat.

Several patches ranging from 1-5 m² poses a major threat. Individuals are primarily found at the north and south end of the islet. The largest patches are found at the north end where it mixes with *C. echinatus*. There are fewer, smaller patches at the south end, but it appears to be displacing *P. torridum* in this area. Pulled scattered individuals, but not the large patches on the southwest slope; flower, fruit. New islet record.

SEABIRDS

Methods and general description

Our visit occurred outside the breeding season for most seabird species. However, we searched for birds or evidence of nesting during our botanical and arthropod survey. Red-tailed tropicbirds

were nesting and we found evidence of nesting wedge-tailed shearwaters and Bulwer's petrels from the previous breeding season. Great frigatebirds and brown boobies were also roosting on the island. Interestingly, there is a record of a Dark-rumped petrel (*Pterodroma phaeopygia sandwichensis*) on the island in "the early days" (Banko 1980).

Checklist of Seabirds with notes

Fregatidae

Fregata minor (Great frigatebird), ind.

Juveniles were roosting in low numbers.

Phaethontidae

Phaethon rubricauda (Red-tailed tropicbird), ind.

Red-tailed Tropicbirds, *Phaethon rubricauda*, began nesting on O'ahu islets during the previous weeks. On Mokuho'oniki, several individuals were prospecting around the islet and one was on an egg already. This is the first record of red-tailed tropicbirds nesting on the island.

Phaethon lepturus (White-tailed tropicbird), ind.

One individual flew around the islet.

Procellariidae

Puffinus pacificus (Wedge-tailed shearwater), ind.

Although it was too early for wedge-tailed shearwaters to return, we found evidence of ca. 100 burrows and several abandoned eggs from the previous season, most were on the southwest slope of island in *Panicum torridum*, where the soil is deepest.

Bulweria bulweri (Bulwer's petrel), ind.

We found ca. 12 dead Bulwer's petrels on the south slopes of the islet. The heads were missing and breasts were removed indicating that these were owl kills. Judging from the fresh plumage, these birds were most likely fledglings from the past season.

Sulidae

Sula sula (Red-footed booby), ind.

Several adults flew past the islet.

Sula leucogaster (Brown booby), ind.

Adults were roosting in low numbers along the lower ledges of the island.

OTHER BIRDS

None.

ARTHROPODS

Methods and general description

To document arthropod diversity on the islet, we used a variety of collecting methods. We established two transects: one that ran along the summit ridge to the rocky, northern end, and the other that ran down the southwest slope. They were oriented to cover the highest habitat diversity on the islet. We established sampling points every 10 meters along the length of the transects and at each point we used the following techniques: pitfall trap, pan trap, sweep nets, host search and ground search. Traps were collected after 24 hours. Additionally, we employed the same methods on any plant species or habitat not included in our transects and performed 1 hour of night collection.

Despite the predominate native plant community, there was a lack of native arthropods. This is most likely a result of big-headed ants, voracious predators, which are abundant throughout the islet. There were a few exceptions including the discovery of *Odynerus* wasps which were observed near *Chamaesyce celastroides* and a dragonfly that flew over the summit.

Checklist of Arthropods

BLATTODEA

Blattidae

Platyzosteria soror, nat.

New islet record.

COLEOPTERA

Carabidae

Aephnidius opaculus, nat.

New islet record.

Coccinellidae

Coccinella septempunctata (seven-spotted ladybird beetle), purposely introduced

New islet record.

Cryptolaemus montrouzieri (mealybug destroyer), purposely introduced

New islet record.

Curculionidae

Asynonychus godmanni (Fuller's rose weevil), nat.

New islet record.

Dermestidae

Dermestes frischii (dermestid beetle), nat.

New islet record.

Tenebrionidae

Lobometopon diremptus, nat.

New islet record.

DIPTERA

Ceratopogonidae

Forcipomyia hardyi (Hardy's non-biting biting midge), end.

New islet record.

Syrphidae

Allograpta exotica (hover fly), nat.

New islet record.

Tachinidae

Archytas cirphis, purposely introduced

New islet record.

Tephritidae

Bactrocera dorsalis (oriental fruit fly), nat.

New islet record.

Tipulidae

Dicranomyia hawaiiensis (crane fly), end.

New islet record.

HETEROPTERA

Cydnidae

Geotomus pygmaeus (burrowing bug), nat.

New islet record.

Lygaeidae

Lygaeus sp. (milkweed bug), nat.

New islet record.

Neacoryphus bicrucis (whitecrossed seed bug), nat.

New islet record.

Nysius sp. (seed bug), unknown

New islet record.

Tenebrionidae

Gonocephalum adpressiforme (gonocephalum darkling beetle), nat.

New islet record.

Ammophorus insularis, nat.

New islet record.

HOMOPTERA

Aphididae

Aphis craccivora (cowpea aphid), nat.

New islet record.

Aphis gossypii (melon aphid), nat.

New islet record.

Cicadellidae

Planiocephalus flavicosta (cicadellid leafhopper), nat.

New islet record.

Psyllidae

Heteropsylla cubana (leucaena psyllid), nat.

New islet record.

HYMENOPTERA

Apidae

Apis mellifera (honey bee), nat.

New islet record.

Formicidae

Pheidole megacephala (big-headed ant), nat.

New islet record.

Solenopsis geminata (fire ant), nat.

New islet record.

Vespidae

Odynerus sp. (mason wasp), end.

New islet record.

ODONATA

Libellulidae

Pantala flavescens (globe skimmer), ind.

New islet record.

ORTHOPTERA

Gryllidae

Gryllodes sigillatus (tropical house cricket), nat.

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

Skinks and geckoes were abundant throughout the island. They were collected and identified as the Snake-eyed skink (*Cryptoblepharus poecilopleurus*) and Mourning gecko (*Lepidodactylus lugubris*). Humpback whales, *Megaptera novaeangliae*, were active around the islet, some had young calves. One green turtle, *Chelonia mydas*, was observed offshore and monk seals, *Monachus schauinslandi*, were hauled out on the ledge at the southeast side of the island. One adult was present on 15 February and three were present on 16 February. We were unable to determine sex, see if they were tagged, or take photos.

THREATS AND RECOMMENDATIONS

This islet is unique in that the plant community is native dominated. However, several non-native species pose a serious threat and weed control should become the highest priority to protect this system. *Cenchrus echinatus* and *Setaria verticillata* are both considered invasive species. When introduced to other islets and coastal sites, they rapidly spread leading to the local extinction of native flora. *Cenchrus echinatus* has been spreading since it was first reported in 1990 and *S. verticillata* has become quickly established since the 2003 survey. Other non-native species should be removed as resources allow.

The patch of *Scaevola coriacea* is smaller than previously reported in 1990 and currently consists of a single individual. It was flowering during our trip (visited by honeybees, *Apis mellifera*), but since there has been no recruitment it is unclear if it can produce viable fruit. It would be beneficial to outplant others near this plant and to collect cuttings to be used for restoration of other islets.

Bulwer's petrel nesting grounds are poorly documented because nests are typically inaccessible and cryptic. It would also be beneficial to estimate the population using call-back surveys early in the breeding season.

Table 18. Key threats to Mokuho'oniki ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|---------------------------------|---|--|
| Owls | Predation of Bulwer's petrels | Confirm nesting, monitor population, research needed (see section 4.4) |
| Weeds | | |
| <i>Setaria verticillata</i> | Displacement of natives | Eradicate before becoming widespread |
| <i>Cenchrus echinatus</i> | Displacement of natives | Eradicate before becoming widespread |
| <i>Lantana camara</i> | Displacement of natives; poor nesting habitat | Eradicate before becoming widespread |
| <i>Portulaca oleracea</i> | Potential hybridization with <i>P. lutea</i> | Research needed |
| <i>Dactyloctenium aegyptium</i> | Displacement of natives | Eradicate before becoming widespread |
| Other non-natives | Displacement of natives | Control/eradicate as resources allow |
| Big-headed and fire ants | Disrupt nesting seabirds, alter arthropods populations | No action, research needed (see section 4.2) |



Figure 81. The upper slopes of the islet's north section is dominated by *Jaquemontia ovalifolia* and *Sida fallax*.



Figure 82. Large patches of *Panicum fauriei* exist on the rocky north tip of the islet.



Figure 83. *Panicum torridum* forms large, contiguous patches along the southwest quarter of the island.



Figure 84. Ordnance litters the island.

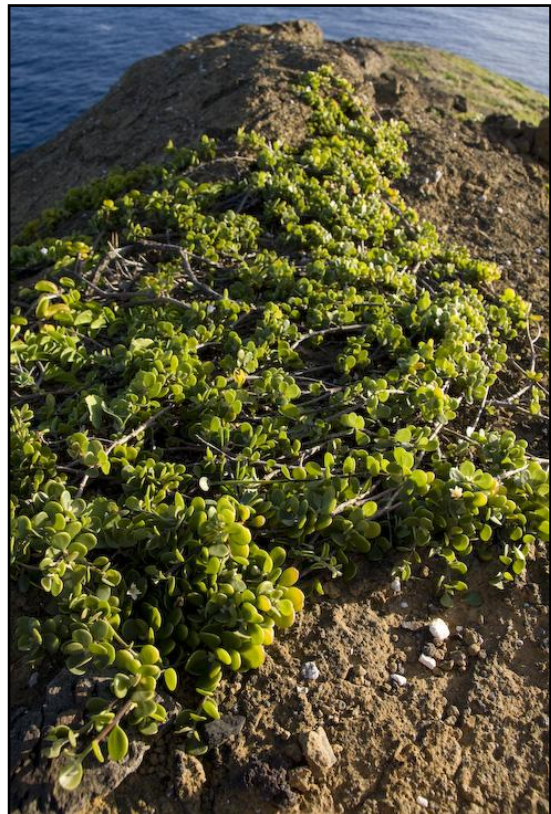


Figure 85. A large patch of *Scaevola coriacea*.



Figure 86. A large patch of *Setaria verticillata* invading areas of *Panicum torridum*.

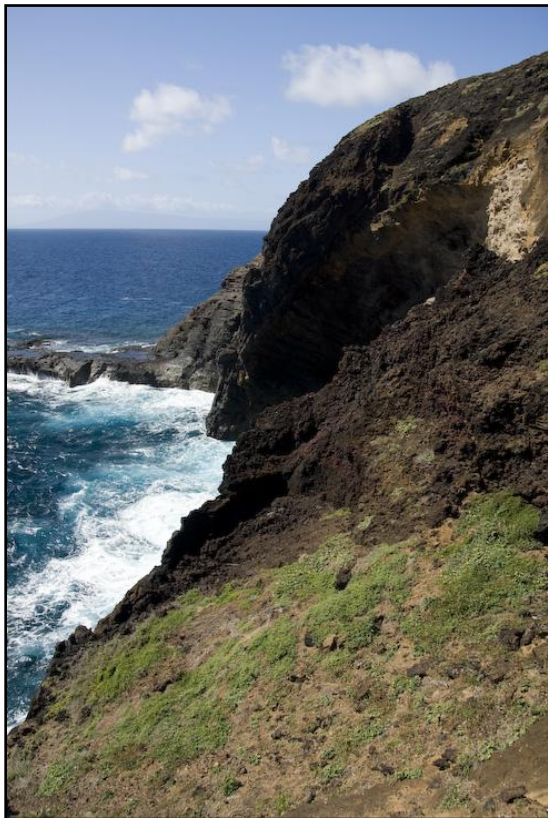


Figure 87. Cliffs on the east side of the islet.



Figure 88. A red-tailed tropicbird on an egg.

21. MOLOKA'I : Kanahā Islet



LOCATION

Kanahā is located in the Pailolo Channel east of Moloka'i and 50 meters southwest of Mokuho'oniki at 21°8'2" N latitude, 156°42' 28" W longitude.

STATUS

Kanahā is part of the Hawai'i State Seabird Sanctuary, protected by the Hawai'i Department of Land and Natural Resources (DLNR). Permission to land must be obtained in writing from DLNR.

PHYSICAL DESCRIPTION

Kanahā, formerly connected to Mokuho'oniki, is a remnant of a vitric tuff cone built from hydromagmatic explosions containing pieces of submerged basalt and coral reef, followed by spatter and lava flows once the cone had emerged from the Pailolo Channel (Macdonald et al. 1983). Wave erosion split the islet in two, but they are connected by an underwater shoal. Kanahā has an area of 0.8 hectares and a maximum height of 35 meters. Shells and shrapnel are abundant throughout the islet. Crater marks are evident in many places along with fractures. Overall the islet is very steep and crumbly.

ACCESS

Heather Eijzenga (Bishop Museum), Jaap Eijzenga (DOFAW), and Sheldon Plentovich (University of Hawai'i) accessed the islet on 16 February 2008 from 0900 to 1300. We chartered a helicopter which dropped us off on the north side of the islet where an impact crater provided a flat landing zone.

VEGETATION

Methods and general description

A botanical inventory was conducted by walking all accessible areas of the islet. We were also able to examine aerial photos taken from the helicopter to evaluate inaccessible parts of the islet, but no additional species were detected. The islet was uniquely native dominated (*S. portulacastrum*, *H. curassavicum*, *L. sandwicense*, *P. torridum* and *P. fauriei*) with one exception, *P. oleracea*. There was lush growth following several months of rain and plant cover was approximately 60% with 13 plant species total: 3 non-native, 7 indigenous and 3 endemic. Four species found during the most recent botanical survey in September 1981 (Kepler et al. 1990) were not detected during this trip: *Digitaria ciliaris*, *Chamaesyce celastroides*, *Boerhavia repens* and *Melanthera integrifolia*. Additionally, we discovered three new islet records: *Panicum torridum*, *Tribulus cistoides* and *Scaevola sericea*.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Aizoaceae

Sesuvium portulacastrum ('akulikuli), ind.

Common, dominant along the sheer cliffs and lower sections of the islet; flowering.

Asteraceae

Sonchus oleraceus, nat.

Individuals occasional throughout the island.

Boraginaceae

Heliotropium curassavicum (nena), ind.

Common, plants scattered throughout the islet; flowering.

Chenopodiaceae

Atriplex semibaccata (Australian saltbush), nat.

Occasional, about six plants scattered throughout the islet.

Convolvulaceae

Jacquemontia ovalifolia subsp. *sandwicensis* (pa'u-o-Hi'iaka), end.

Occasional, two large patches on the summit; flowering.

Goodeniaceae

Scaevola sericea (beach *naupaka*), ind.

Rare, one small shrub at the bottom of the plateau. New islet record.

Malvaceae

Sida fallax ('*ilima*), ind.

Occasional, individuals scattered throughout the islet; flowering.

Portulacaceae

Portulaca lutea ('*ihi*), ind.

Occasional, mixed in with *P. oleracea*; fruit, flower.

Portulaca oleracea (pigweed), nat.

Common, patches scattered along the top of the islet; fruit, flower.

Solanaceae

Lycium sandwicense ('*ohelo kai*), ind.

Common throughout the islet; flowering.

Zygophyllaceae

Tribulus cistoides (*nohu*), ind.

Occasional, one individual on the north section of the ridge, two large patches on the southern end of the summit ridge; fruit, flower. New islet record.

Angiosperms-Monocots

Poaceae

Panicum fauriei var. *fauriei* (Faurie's panicgrass), end.

Common throughout the islet, most abundant plant species on top of the islet; fruit, flower.

Panicum torridum (*kakonakona*), end.

Common at the summit, elsewhere individuals are occasionally scattered; flowering. New islet record.

SEABIRDS

Methods and general description

February is outside the breeding season for most seabird species. However, we searched for birds or evidence of nesting during our botanical survey. Wedge-tailed shearwaters nested on the island during the previous season. No additional species have been reported to nest on the island.

Checklist of Seabirds with notes

Phaethontidae

Phaethon rubricauda (Red-tailed tropicbird), ind.

Three adults flew by the islet. None were observed nesting, but they were just beginning to nest on nearby Mokuho'oniki.

Procellaridae

Puffinus pacificus (Wedge-tailed shearwater), ind.

Although it was too early for wedge-tailed shearwaters to return, we found 50-100 old burrows along with one dead adult and one abandoned egg.

Sulidae

Sula leucogaster (Brown booby), ind.

Three adults flew by the islet.

OTHER BIRDS

None.

ARTHROPODS

Methods and general description

Because of our short time on the island, we did not set out any traps. Instead, we focused on collecting from different host plants using a sweep net, litter sifter, and physical search of each plant species on the island. This was supplemented with a ground search around rocky areas.

Despite its proximity to Mokuho'oniki, no big-headed ants were found on Kanahā. The only ant species detected was fairly benign. Possibly as a result, *Nysius* bugs were very abundant whereas on Mokuho'oniki, very few were found.

Checklist of Arthropods

COLEOPTERA

Coccinellidae

Cryptolaemus montrouzieri (mealybug destroyer), purposely introduced
New islet record.

Diomus notescens (minute two-spotted ladybird), purposely introduced
New islet record.

Dermestidae

Dermestes frischii (dermestid beetle), nat.
New islet record.

Tenebrionidae

Alphitobius diaperinus, nat.

New islet record.

Lobometopon diremptus, nat.

New islet record.

DIPTERA

Syrphidae

Allograpta exotica (hover fly), nat.

New islet record.

Allograpta obliqua (hover fly), nat.

New islet record.

Tachinidae

Archytas cirphis, purposely introduced

New islet record.

HETEROPTERA

Lygaeidae

Neacoryphus bicrucis (whitecrossed seed bug), nat.

New islet record.

Nysius sp., unknown

New islet record.

Tenebrionidae

Gonocephalum adpressiforme (Gonocephalum darkling beetle), nat.

New islet record.

HOMOPTERA

Aphididae

Aphis gossypii (melon aphid), nat.

New islet record.

HYMENOPTERA

Apidae

Apis mellifera (honey bee), nat.

New islet record.

Formicidae

Ochetellus glaber (glaber ant), nat.

New islet record.

Paratrechina longicornis (crazy ant), nat.

New islet record.

Vespidae

Odynerus sp. (mason wasp), end.

New islet record.

ODONATA

Libellulidae

Pantala flavescens (globe skimmer), ind.

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

None.

THREATS AND RECOMMENDATIONS

Like Mokuho'oniki, the vegetation on Kanahā is dominated by native plants. In fact only a few exist and the islet and should be relatively easy to remove. Eradication of invasive grasses from nearby Mokuho'oniki will decrease the chance of invasion on Kanahā.

Table 19. Key threats to Kanahā ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|-----------------------------|--|--------------------------------------|
| Weeds | | |
| <i>Atriplex semibaccata</i> | Displacement of natives | Eradicate before becoming widespread |
| <i>Portulaca oleracea</i> | Potential hybridization with <i>P. lutea</i> | Eradicate |
| <i>Sonchus oleraceus</i> | Displacement of natives | Eradicate |



Figure 89. View from the south end with the landing zone just west of the gear. Photo: J.Eijzenga



Figure 90. *Panicum fauriei* dominates.



Figure 91. Patches of *Tribulus cistoides*.

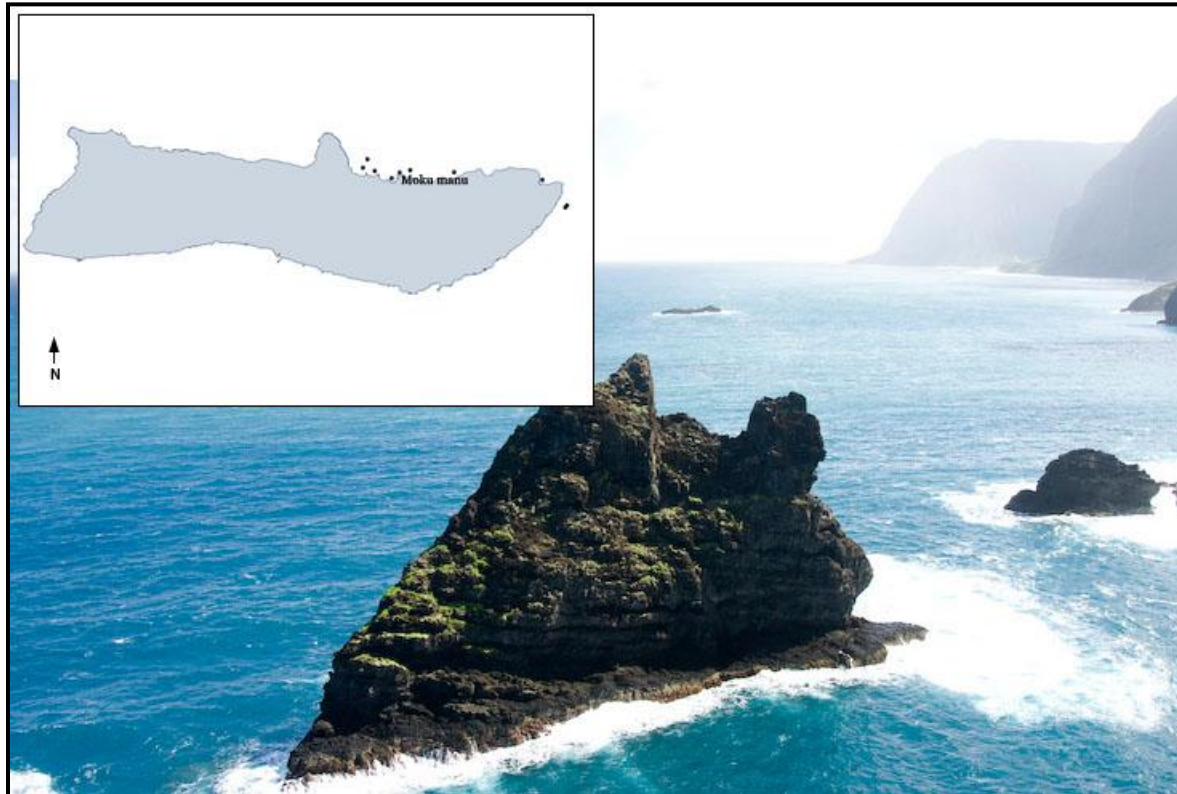


Figure 92. View north from the summit, with ordnance in the foreground. Photo: J.Eijzenga



Figure 93. *Sida fallax*, *Portulaca oleracea*, and *Panicum fauriei* dominate the north end. Photo: J.Eijzenga

22. MOLOKA'I : Moku manu Islet



LOCATION

Moku manu is located about 6.4 km east of Kalaupapa Peninsula between Haupu and Pelekunu Bays at 21°10'21" N latitude, 156°53' 28" W longitude.

STATUS

Moku manu is part of the Hawai'i State Seabird Sanctuary, protected by the Hawai'i Department of Land and Natural Resources (DLNR). Permission to land must be obtained in writing from DLNR.

PHYSICAL DESCRIPTION

Moku manu is a twisted, basalt sea stack that is 0.9 hectares in size and approximately 45.7 meters high.

ACCESS

Heather Eijzenga (Bishop Museum) and David Preston (Bishop Museum) attempted to access the islet on 16 February 2008. Our pilot was unable to land on the steep, heavily fractured seastack, so we circled the islet and took photographs to act as a partial survey.

VEGETATION

Methods and general description

A partial botanical inventory was conducted by flying around the islet and taking photos of all the vegetation. Photos were later used to aid identification, but without vouchers none are entirely accurate. Furthermore, some rare, small statured species are likely to have been overlooked. Overall the islet was a fairly even mix of native and non-native species with *Scaevola sericea*, *Chamasyce celastroides*, *Schidea globosa*, and *Kalanchoe pinnata* dominating. Plant cover was approximately 15% with 16 plant species total: 9 non-native, 3 indigenous and 4 endemic. No full botanical survey has ever been conducted, but three species (*Scaevola sericea*, *Artemesia australis* and *Eragrostis variabilis*) were observed from a kayak in August 1984 (Hobdy 1984).

Checklist of Vascular plants with notes

Angiosperms-Dicots

Aizoaceae

Sesuvium portulacastrum ('akulikuli), ind.

Occasional along the lower slopes of the islet. New islet record.

Asteraceae

Artemesia australis (*hinahina*), end.

Rare, three individuals clustered on the northeast tip.

Emilia fosbergii (flora's paintbrush), nat.

Individuals occasional throughout the island; flowering. New islet record.

Sonchus oleraceus, nat.

Individuals occasional throughout the island; flowering. New islet record.

Pluchea carolinensis (sourbush), nat.

Rare, a few shrubs on the east side; flowering. New islet record.

Caryophyllaceae

Schiedea globosa (*maolioli*), end

Common throughout the islet; flowering. New islet record.

Crassulaceae

Kalanchoe pinnata (cathedral bells), nat.

Common throughout the islet; flowering. New islet record.

Euphorbiaceae

Chamaesyce celastroides ('akoko), end.

Common throughout the islet. New islet record.

Goodeniaceae

Scaevola sericea (naupaka), ind.

Common, especially on the north side of the islet.

Portulacaceae

Portulaca lutea ('ihi), ind.

Portulaca sp. are occasional throughout the islet. One flowering cluster identified this species as *P. lutea*. Most patches were not flowering, however, and some more closely resembled *P. oleracea*. Both species may co-occur on the islet. New islet record.

Verbenaceae

Lantana camara (lantana), nat.

Rare, one plant observed on the east side. New islet record.

Angiosperms-Monocots

Poaceae

Digitaria ciliaris (Henry's crabgrass), nat.

Occasional, individuals scattered throughout the islet; flowering. New islet record.

Eragrostis variabilis (kawelu), end.

Occasional throughout the islet with large patches on the east side.

Pteridophytes

Dryopteridaceae

Cyrtomium falcatum (Holly fern), nat.

Rare, six individuals observed on the eastern side of the islet.

Nephrolepidaceae

Nephrolepis exaltata (sword fern), nat.

Rare, three individuals observed on the eastern side of the islet.

Polypodiaceae

Phymatosorus grossus (lau'ae), nat.

Rare, three individuals observed on the eastern side of the islet.

SEABIRDS

Methods and general description

Despite not being able to land on the islet, we were able to obtain some information on nesting seabirds. The islet's exposed, rocky terrain made it possible to identify potential nest sites and we were clearly able to see nesting red-tailed tropicbirds. Although it was too early in the year to find wedge-tailed shearwaters, the lack of substantial soil and exposure makes it an unlikely choice for burrowing birds.

Checklist of Seabirds with notes

Phaethontidae

Phaethon rubricauda (Red-tailed tropicbird), ind.

Twelve birds were sitting on nests. Based on observations from other islets, their nesting season recently started and more birds may nest on the islet.

OTHER BIRDS

None.

ARTHROPODS

No collections made.

OTHER OPPORTUNISTIC OBSERVATIONS

Humpback whales, *Megaptera novaeangliae*, were abundant around the islet, some with young calves.

THREATS AND RECOMMENDATIONS

Although non-native plants exist on the islet (*Pluchea carolinensis* and *Lantana camara* being the primary threats), its inaccessibility makes any management impractical.



Figure 94. A closeup of the densest vegetation on the upper east side of the islet.

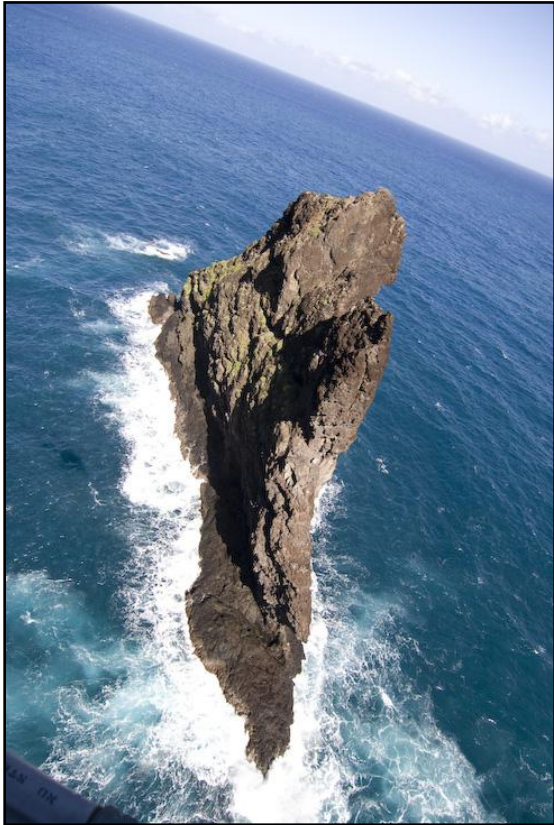


Figure 95. Twisted shape of the islet.

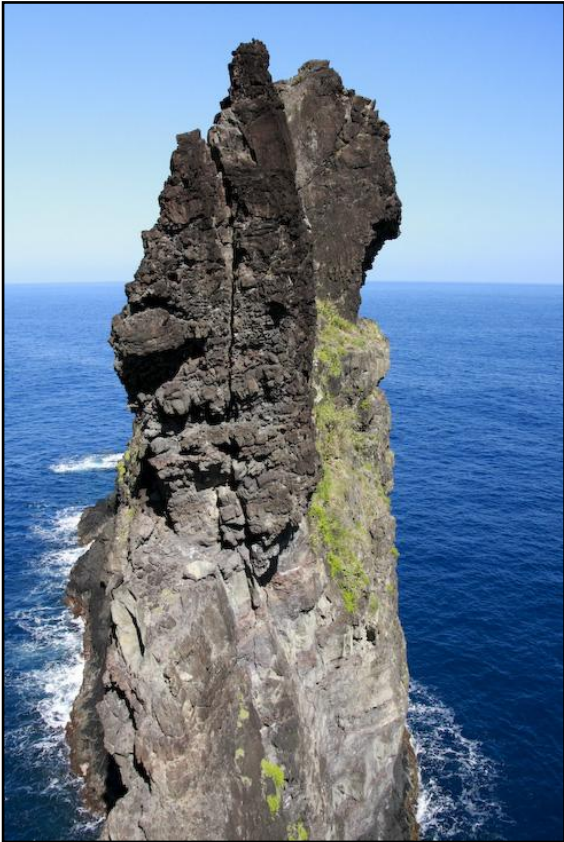


Figure 96. Fractures and vegetation on the east side.



Figure 97. Most of the weeds exist on the upper east side. *Kalanchoe pinnata* and *Digitaria ciliaris* are the most common along with some native species (*Chamaesyce celastroides* and *Eragrostis variabilis*).



Figure 98. Red-tailed tropicbirds nest on the islet's ledges.



Figure 99. *Eragrostis variabilis*, *Chamaesyce celastroides* and *Schideea globosa* are common on the northeast section of the islet.



Figure 100. *Artemesia australis*, northeast tip.



Figure 101. Ferns growing in the islet's cracks.

23. KAHO'OLAWE : 'Āle'ale Islet



LOCATION

'Āle'ale is located along the south central coast of Kaho'olawe at 20°30'50" N latitude, 156°36'168" W longitude.

STATUS

Public access to 'Āle'ale is restricted and a permit from the Kaho'olawe Island Restoration Commission is required in order to land. Additionally, all native plants and wildlife are protected by state and/or federal law.

PHYSICAL DESCRIPTION

'Āle'ale is a steep, 1.2 hectare sea stack that is connected to Kaho'olawe by a thin land bridge. Like the rest of Kaho'olawe, it was previously subject to military target practice.

ACCESS

Heather Eijzenga (Bishop Museum) and Ken Wood (National Tropical Botanical Garden) accessed the islet on 26 March 2008 from 0630 to 1030. The Kaho'olawe Island Restoration Commission chartered a helicopter for us and the pilot was able to make a single skid landing on a boulder located on the lower section of the island's east side.

VEGETATION

Methods and general description

Due to time constraints and difficulty moving around the island, we were unable to perform a full botanical survey. Instead, we recorded all plants and their abundance in the areas targeted for arthropod collection, which focused on the eastern side of the island. A full survey was conducted in November of 2003 (Wood and LeGrande 2003). In addition, Ken assessed the health and reproductive status of the last wild *Kanaloa kahoolawensis*. Native species dominate the islet. The most common plants include the indigenous bunchgrass, *Eragrostis leptophylla*, indigenous shrub, *Senna gaudichaudii*, and the endemic vine, *Ipomoea tuboides*. Plant cover was approximately 40% with 21 plant species total recorded during our trip: 8 non-native, 8 indigenous and 5 endemic. Six species found during the 2003 botanical survey were not detected during this trip: *Bidens mauiensis*, *Conyza bonariensis*, *Boerhavia repens*, *Portulaca villosa*, *Cyperus phleoides*, *Panicum torridum*, and *Doryopteris decipiens*, but they are likely present in low numbers or in areas we were unable to survey. We discovered a new island record, the non-native grass *Melinis repens*.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Asteraceae

Emilia fosbergii (flora's paintbrush), nat.

Rare, a few individuals scattered throughout the islet; flowering.

Melanthera lavarum (*nehe*), end.

Occasional, individuals scattered throughout the islet; flowering.

Capparaceae

Capparis sandwichiana (*maiapilo*), end. (State SOC)

Rare, one plant near the landing zone.

Chenopodiaceae

Atriplex semibaccata (Australian saltbush), nat.

Rare, one large patch upslope of the *Kanaloa*; fruit, flower.

Convolvulaceae

Ipomoea tuboides (*hunakai*), end.

Common throughout the islet; fruit, flower.

Cuscutaceae

Cuscuta sandwichiana (*kauna'oa*), end.

Rare, one plant in the middle section of the eastern part of the islet.

Euphorbiaceae

Chamaesyce celastroides var. *amplectens* ('akoko), end.
Occasional, plants scattered throughout the islet; flowering.

Fabaceae

Kanaloa kahoolawensis (*kanaloa*), end. (E)
Rare, one plant; fruiting.

Senna gaudichaudii (*kolomona*), ind.
Common, plants scattered throughout the islet; fruit, flower.

Malvaceae

Sida fallax ('ilima), ind.
Occasional, plants scattered throughout the islet; fruit, flower.

Portulacaceae

Portulaca molokiniensis ('ihi), end, (State SOC)
Common, individuals scattered throughout the islet; flowering.

Portulaca oleracea (pigweed), nat.
Rare, one plant found along the middle of the east side of the islet.

Solanaceae

Nicotiana glauca (tree tobacco), nat.
Occasional, trees scattered throughout the islet, primarily on the upper slopes; fruit, flower.

Sterculiaceae

Waltheria indica ('uhaloa), ind.
Occasional, individuals scattered throughout the islet; flowering.

Angiosperms-Monocots

Poaceae

Cenchrus echinatus (sand bur), nat.
Occasional, a few large patches scattered around the islet; fruiting.

Chloris barbata (swollen fingergrass), nat.
Occasional, individuals scattered throughout the islet; fruit, flower.

Eragrostis leptophylla (lovegrass), ind.

Common, widespread throughout the islet; fruiting.

Heteropogon contortus (pili grass), ind.

Rare, a few plants mixed in with *E. leptophylla*; flowering.

Melinis repens (natal red top), nat.

Rare, one plant south of the *Kanaloa*; flowering. New islet record

Panicum fauriei var. *latius* (Faurie's panicgrass), end.

Rare, a couple of individuals scattered throughout the islet; flowering.

Tragus berteronianus (bur grass), nat.

Occasional, large patches along the lower slopes of the islet; fruiting.

SEABIRDS

Methods and general description

During the arthropod survey we opportunistically searched for evidence of nesting seabirds. In the past a single, dead Band-rumped storm-petrel (*Oceanodroma castro*) was discovered on 'Āle'ale along with the remains of wedge-tailed shearwaters and red-tailed tropicbirds (LeGrande and Wood 2001). During our visit the only seabird sign was in an apparent owl roost, which was littered with skulls, bones, and feathers of both wedge-tailed shearwaters and Bulwer's petrels.

Checklist of Seabirds with notes

Phaethontidae

Phaethon rubricauda (Red-tailed tropicbird), ind.

Several birds were observed courting over the island, no nests found.

Procellariidae

Puffinus pacificus (Wedge-tailed shearwater), ind.

Remains were found in an old owl roost, but no active burrows were detected. However, it was the beginning of the breeding season and we did not search the entire island.

Bulweria bulweri (Bulwer's petrel), ind.

Remains were found in an old owl roost, no active burrows were detected, but we did not have time to search specifically for them.

OTHER BIRDS

None.

ARTHROPODS

Methods and general description

Because of the short time we had on the island, we did not set out any traps. Instead, we focused on collecting from different host plants using a sweep net, litter sifter, and physical search of each plant species on the island. This was supplemented with a ground search around rocky areas.

Windy conditions and time of day made it very difficult to locate and collect arthropods. Several *Hylaeus* were seen visiting *Portulaca molokiniensis* and *Chamaesyce celastroides*, but we were unable to collect them.

Checklist of Arthropods

ARANEAE

Araneidae

Argiope appensa (garden spider), nat.

New islet record.

COLEOPTERA

Chrysomelidae

Epitrix hirtipennis (tobacco flea-beetle), nat.

New islet record.

Coccinellidae

Diomus notescens (minute two-spotted ladybird), purposely introduced.

New islet record.

Micraspis lineola (coccinellid beetle), purposely introduced

New islet record.

HETEROPTERA

Lygaeidae

Neacoryphus bicrucis (whitecrossed seed bug), nat.

New islet record.

Pentatomidae

Nezara viridula (southern green stink bug), nat.

New islet record.

Tingidae

Corythucha morrilli (morrill lace bug), nat.

New islet record.

HOMOPTERA

Membracidae

Vanduzea segmentata (vanduzee treehopper), nat.

New islet record.

HYMENOPTERA

Anthophoridae

Ceratina arizonensis (small carpenter bee), nat.

New islet record.

Colletidae

Hylaeus sp. (yellow-faced bee), end.

New islet record.

LEPIDOPTERA

Sphingidae

Hyles lineata (white lined sphinx), nat.

New islet record.

MANTODEA

Mantidae

Indeterminate sp. (praying mantis), nat.

New islet record.

THYSANURA

Lepismatidae

Ctenolepisma sp. (bristletail), nat.

New islet record.

OTHER OPPORTUNISTIC OBSERVATIONS

None.

THREATS AND RECOMMENDATIONS

Isolation of the Kaho'olawe islets has allowed for the preservation of several rare and endangered native plant species. Unfortunately, non-native plants are threatening the vegetation community. Non-native grasses are the primary concern as they have become widespread on

several islets and along coastal zones at the expense of native species. Since these species are wind dispersed and present on the adjacent coastline, an ongoing control program would be necessary to prevent their spread. However, great care must be taken to avoid killing the native grasses on the island. Two other species are known to be invasive, but were found in low numbers, *Atriplex semibaccata* and *Portulaca oleracea*. It should be fairly easy to eradicate these incipient populations. Other non-native species should be monitored and removed as resources allow.

Seabird observations on ‘Āle’ale have been made opportunistically. It would be extremely beneficial to document which species are nesting on the island and to estimate their abundance. Information on band-rumped storm petrels is of particular interest because the nesting habits and population status of these storm petrels are poorly understood in Hawai’i. Furthermore, anecdotal information indicates that mammalian predators may occasionally cross the narrow strip of land that connects ‘Āle’ale to the coast. If this can be confirmed, a predator-proof fence may prevent this from occurring.

Table 20. Key threats to ‘Āle’ale ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|-----------------------------|-------------------------------|---|
| Owls | Predation of nesting seabirds | Control likely unpractical, research needed (see section 4.4) |
| Weeds | | |
| Grasses | Displacement of natives | Ongoing control program |
| <i>Atriplex semibaccata</i> | Displacement of natives | Eradicate |
| <i>Portulaca oleracea</i> | Displacement of natives | Eradicate |
| Other non-natives | Displacement of natives | Control or eradicate as resources allow |
| Mammalian predators | Predation of nesting seabirds | Confirm, consider predator-proof fence |



Figure 102. The *Kanaloa* was in excellent health and had several seed pods.



Figure 103. *Eragrostis leptophylla* is the dominant grass.



Figure 104. The eastern slope is dominated by grasses with *Ipomoea tuboides*, *Senna gaudichaudii* and *Portulaca molokiniensis* interspersed.



Figure 105. ‘Āle’ale hosts one of the most significant populations of *Portulaca molokiniensis*.



Figure 106. An owl roost with seabird remains.



Figure 107. Caterpillar feeding on *N. glauca*.

24. KAHO'OLAWE : Pu'u koa'e



LOCATION

Pu'u koa'e is located off the south central coast of Kaho'olawe at 20°30'50" N latitude, 156°36'480" W longitude.

STATUS

Public access to Pu'u koa'e is restricted and a permit from the Kaho'olawe Island Restoration Commission is required in order to land. Additionally, all native plants and wildlife are protected by state and/or federal law.

PHYSICAL DESCRIPTION

Pu'u koa'e is a steep, rocky 6.9 hectare sea stack that is 115.8 meters at its highest point. The islet is oddly shaped with east facing vertical cliffs, steep western slopes and is constricted in the middle to approximately 50 meters. Like the rest of Kaho'olawe, the island was previously subject to military target practice.

ACCESS

Heather Eijzenga (Bishop Museum) and Ken Wood (National Tropical Botanical Garden) accessed the islet on 26 March 2008 from 1030 to 1630. The Kaho'olawe Island Restoration Commission chartered a helicopter which dropped us off on the ridgeline saddle.

VEGETATION

Methods and general description

Due to time constraints and difficulty moving around the island, we were unable to perform a full botanical survey. Instead, we recorded all plants and their abundance in the areas targeted for arthropod collection, which focused on the western slopes of the island. The last complete survey was conducted in November of 2003 (Wood and LeGrande 2003). In addition, Ken assessed the health and reproductive status of the endangered shrub, *Sesbania tomentosa*.

The island supports populations of several rare coastal plant species, but several invasive plant species pose a threat to their continued existence. The most common plants on the island include the introduced tree, *Nicotiana glauca*, endemic shrub, *Sesbania tomentosa*, and the endemic vine, *Ipomoea tuboides*. Plant cover was approximately 40% with 19 plant species total recorded during our trip: 8 non-native, 2 indigenous and 9 endemic. Twelve species found during the 2003 botanical survey were not detected during this trip: *Sesuvium portulacastrum*, *Merremia aegyptia*, *Cuscuta sandwichiana*, *Boerhavia repens*, *Portulaca villosa*, *Lycium sandwicense*, *Cenchrus ciliaris*, *Eragrostis leptophylla*, *Heteropogon contortus*, *Panicum torridum*, *Tragus berteronianus* and *Setaria parviflora*, but they are likely present in low numbers or in areas we were unable to survey. We discovered a new island record, the non-native herb *Chenopodium murale*.

Checklist of Vascular plants with notes

Angiosperms-Dicots

Asteraceae

Bidens mauiensis (ko'oko'olau), end. (State SOC)

Occasional, individuals scattered throughout the islet; flowering.

Emilia fosbergii (flora's paintbrush), nat.

Occasional, individuals scattered throughout the islet; flowering.

Melanthera lavarum (nehe), end.

Rare, two individuals; flowering.

Chenopodiaceae

Atriplex semibaccata (Australian saltbush), nat.

Occasional, plants scattered throughout the islet; fruit, flower.

Chenopodium murale (lamb's quarters), nat.

Locally common, especially around mid-elevation along the western side of the islet where the slope is less severe and more soil has accumulated; fruiting. New islet record.

Convolvulaceae

Ipomoea tuboides (*hunakai*), end.

Common throughout the islet; fruiting.

Jacquemontia ovalifolia subsp. *sandwicensis* (*pau o Hi'iaka*), end.

Rare, a few plants around the middle of the west side of the islet; flowering.

Euphorbiaceae

Chamaesyce celastroides var. *amplectens* (*'akoko*), end.

Occasional, plants primarily found along the lower, northwest section of the islet; flowering.

Fabaceae

Sesbania tomentosa (*'ohai*), end. (E)

Common, individuals primarily found along the lower, northwest section of the islet; fruit, flower.

Malvaceae

Sida fallax (*'ilima*), ind.

Occasional, plants scattered throughout the islet; fruit, flower.

Papavaraceae

Argemone glauca var. *glauca* (*pua kala*), end.

Occasional, individuals scattered along the upper slopes of the islet; fruit, flower.

Portulacaceae

Portulaca molokiniensis (*'ihi*), end, (State SOC)

Occasional, individuals scattered throughout the islet.

Portulaca oleracea (pigweed), nat.

Rare, two small plants found along the middle of the west side of the islet; fruit, flower.

Solanaceae

Nicotiana glauca (tree tobacco), nat.

Common, trees scattered throughout the islet, especially along the upper slopes; fruit, flower.

Sterculiaceae

Waltheria indica (*'uhaloa*), ind.

Occasional, individuals scattered throughout the islet; flowering.

Angiosperms-Monocots

Poaceae

Cenchrus echinatus (sand bur), nat.

Common, especially in mid to upper elevations of the west side of the islet where it forms contiguous patches with *Chloris barbata*; fruit, flower.

Chloris barbata (swollen fingergrass), nat.

Common, especially in mid to upper elevations of the west side of the islet where it forms contiguous patches with *Cenchrus echinatus*; flowering.

Melinis repens (natal red top), nat.

Rare, a few plants scattered on the upper slopes of the western side; flowering.

Panicum fauriei var. *latius* (Faurie's panicgrass), end.

Common, individuals scattered throughout the islet; fruit, flower.

SEABIRDS

Methods and general description

We opportunistically searched for evidence of nesting seabirds during the arthropod survey. Both wedge-tailed shearwaters and Red-tailed tropicbird nests were discovered along with the owl-killed remains of Bulwer's petrels. No other species have been reported on Pu'u koa'e.

Checklist of Seabirds with notes

Phaethontidae

Phaethon rubricauda (Red-tailed tropicbird), ind.

Three nests were found (two on eggs, one with a newly hatched chick) in the rocky crevices along the upper slopes of the western side. Adults were actively courting and nest searching throughout the visit with a maximum of 12 birds seen at once.

Procellariidae

Puffinus pacificus (Wedge-tailed shearwater), ind.

Still early in the breeding season, only five pairs of adults were observed in burrows. An additional estimate of 100 active burrows were scattered around the upper western slopes.

Bulweria bulweri (Bulwer's petrel), ind.

Two owl-killed birds (likely fledglings by examining plumage) were found under the highest point on the island.

OTHER BIRDS

None.

ARTHROPODS

Methods and general description

Because of our short time on the island, we did not set out any traps. Instead, we focused on collecting from different host plants using a sweep net, litter sifter, and physical search of each plant species on the island. This was supplemented with a ground search around rocky areas.

Windy conditions made it difficult to collect flying insects and it was so hot that it was hard to find any arthropods for collection. Endemic yellow-faced bees were seen visiting *C. celastroides*, but could not be collected. We also searched for the endemic *Rhyncogonus* beetle that was associated with *Ipomoea tuboides* during a previous survey, but no individuals were found.

Checklist of Arthropods

ARANEAE

Araneidae

Neoscona oaxacensis (western spotted orbweaver), nat.

New islet record.

HETEROPTERA

Pentatomidae

Nezara viridula (southern green stink bug), nat.

New islet record.

HYMENOPTERA

Colletidae

Hylaeus sp. (yellow-faced bee), end.

New islet record.

Formicidae

Cardiocondyla sp. (cardiocondyla ant), nat.

New islet record.

Ochetellus glaber (glaber ant), nat.

New islet record.

Solenopsis geminata (fire ant), nat.

OTHER OPPORTUNISTIC OBSERVATIONS

None.

THREATS AND RECOMMENDATIONS

Isolation of the Kaho’olawe islets has allowed for the preservation of several rare and endangered native plant species. Unfortunately, non-native plants are currently threatening the vegetation community. Non-native grasses are the primary concern as they have become widespread on several islets and along coastal zones at the expense of native species. Since these species are wind dispersed and present on the adjacent coastline, an ongoing control program may be necessary to prevent their spread. However, great care must be taken to avoid killing the native grasses on the island. *Chenopodium murale* was newly recorded on this trip and is already locally common. This species along with several non-native grasses and *Atriplex semibaccata* are currently dominating the flatter areas of the island where more soil has been allowed to accumulate. Other non-native species should be monitored and removed as resources allow.

Table 21. Key threats to Pu’u koa’e ecosystem and recommendations.

| Threat | Impacts | Recommendations |
|-----------------------------|--|---|
| Owls | Predation of nesting seabirds | Control likely unpractical, research needed (see section 4.4) |
| Weeds | | |
| Grasses | Displacement of natives | Eradicate, potentially need an ongoing control program |
| <i>Chenopodium murale</i> | Displacement of natives | Eradicate before it becomes widespread |
| <i>Atriplex semibaccata</i> | Displacement of natives | Eradicate |
| <i>Portulaca oleracea</i> | Displacement of natives | Incipient, eradicate before it becomes widespread |
| Other non-natives | Displacement of natives | Control or eradicate as resources allow |
| Fire ants | Disrupt nesting seabirds, alter arthropods populations | No action, research needed (see section 4.2) |



Figure 108. The steep western slopes.

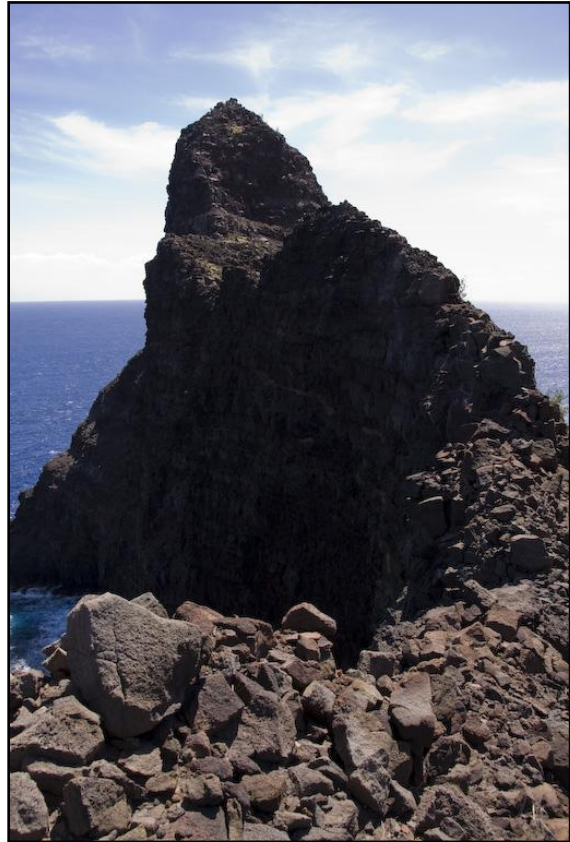


Figure 109. Sheer cliffs make up the east side.



Figure 110. *Argemone glauca* along the upper slopes.



Figure 111. Non-native grasses, *Nicotiana glauca* and *Chenopodium murale* dominating the flatter areas.



Figure 112. Large patch of *Nicotiana glauca*.



Figure 113. A healthy population of *Sesbania*.



Figure 114. A large population of *Sesbania tomentosa* and *Chamacyse celastroides* dominates the lower northwest slope.



Figure 115. A young Red-tailed tropicbird chick.

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Appendix: Arthropods of Lehua Islet, Ni'ihau¹

| Order | Family | Scientific name | Common name | Status ² |
|-------------|-----------------|-----------------------------------|------------------------------|---------------------|
| ARANEAE | Araneidae | <i>Argiope appensa</i> | garden spider | Nat |
| ARANEAE | Araneidae | <i>Neoscona oaxacensis</i> | western spotted orbweaver | Nat |
| ARANEAE | Clubionidae | <i>Cheiracanthium mordax</i> | pale leaf spider | Nat |
| ARANEAE | Salticidae | <i>Hasarius adansoni</i> | Adanson's house jumper | Nat |
| ARANEAE | Theridiidae | <i>Latrodectus geometricus</i> | brown widow | Nat |
| BLATTODEA | Blattellidae | <i>Symptloce pallens</i> | smooth cockroach | Nat |
| COLEOPTERA | Carabidae | <i>Aephnidius opaculus</i> | -- | Nat |
| COLEOPTERA | Carabidae | <i>Gnathaphanus picipes</i> | -- | Nat |
| COLEOPTERA | Chrysomelidae | <i>Systema blanda</i> | palestriped flea beetle | Nat |
| COLEOPTERA | Curculionidae | <i>Asynonychus godmanni</i> | Fuller's rose weevil | Nat |
| COLEOPTERA | Curculionidae | <i>Hypurus bertrandi</i> | -- | Nat |
| COLEOPTERA | Dermestidae | <i>Dermestes frischii</i> | dermestid beetle | Nat |
| COLEOPTERA | Phalacridae | <i>Phalacrus sp.</i> | -- | Nat |
| COLEOPTERA | Scarabaeidae | <i>Aphodius lividus</i> | -- | Nat |
| COLEOPTERA | Scarabaeidae | <i>Protaetia fusca</i> | mango flower beetle | Nat |
| COLEOPTERA | Tenebrionidae | <i>Gonocephalum adpressiforme</i> | gonocephalum darkling beetle | Nat |
| COLLEMBOLA | Entomobryidae | <i>Entomobrya marginata</i> | -- | Nat |
| DERMAPTERA | Carcinophoridae | <i>Euborellia eteronoma</i> | Hawaiian earwig | Nat |
| DIPTERA | Canicidae | <i>Canaceoides angulatus</i> | beach fly | Nat |
| DIPTERA | Chloropidae | <i>Siphunculina striolata</i> | chloropid fly | Nat |
| DIPTERA | Ephydriidae | <i>Discomyza maculipennis</i> | -- | Nat |
| DIPTERA | Ephydriidae | <i>Ephydra gracilis</i> | brinefly | Nat |
| DIPTERA | Ephydriidae | <i>Hecamede granifera</i> | -- | Nat |
| HETEROPTERA | Anthoridae | <i>Orius sp.</i> | -- | Nat |
| HETEROPTERA | Lygaeidae | <i>Graptostethus manillensis</i> | woodrose bug | Nat |
| HETEROPTERA | Nabidae | <i>Nabis capisiformis</i> | damsel bug | Nat |
| HETEROPTERA | Saldidae | <i>Micracanthia humilis</i> | shore bug | Nat |
| HOMOPTERA | Cicadellidae | <i>Acinopterus angulatus</i> | -- | Nat |
| HOMOPTERA | Delphacidae | <i>Perkinsiella saccharicida</i> | sugarcane delphacid | Nat |
| HOMOPTERA | Membracidae | <i>Vanduzee segmentata</i> | Vanduzee treehopper | Nat |
| HYMENOPTERA | Braconidae | <i>Chelonus blackburni</i> | -- | Nat |
| HYMENOPTERA | Formicidae | <i>Camponotus variegatus</i> | carpenter ant | Nat |
| HYMENOPTERA | Formicidae | <i>Pheidole megacephala</i> | big-headed ant | Nat |
| LEPIDOPTERA | Crambidae | <i>Euchromius ocellus</i> | -- | Nat |
| LEPIDOPTERA | Crambidae | <i>Spoladea recurvalis</i> | Hawaiian Beet Webworm | Nat |
| LEPIDOPTERA | Gelechiidae | <i>Dichomeris acuminata</i> | -- | Nat |
| LEPIDOPTERA | Lycaenidae | <i>Lampides boeticus</i> | bean butterfly | Nat |
| LEPIDOPTERA | Noctuidae | <i>Amyna natalis</i> | -- | Nat |
| LEPIDOPTERA | Noctuidae | <i>Eublemma accedens</i> | waltheria moth | Nat |
| LEPIDOPTERA | Noctuidae | <i>Heliothis virescens</i> | tobacco budworm | Nat |
| LEPIDOPTERA | Sphingidae | <i>Hippotion rosetta</i> | -- | Nat |
| MANTODEA | Mantidae | <i>Hierodula patellifera</i> | praying mantis | Nat |
| ORTHOPTERA | Acrididae | <i>Schistocerca nitens</i> | vagrant grasshopper | Nat |
| ORTHOPTERA | Gryllidae | <i>Gryllodes sigillatus</i> | tropical house cricket | Nat |
| Order | Family | Scientific name | Common name | Status |

| | | | | |
|-------------|-----------------|--------------------------------------|-------------------------------|-----|
| ORTHOPTERA | Gryllidae | <i>Trigonidomorpha sjostedti</i> | -- | Nat |
| ORTHOPTERA | Tettigoniidae | <i>Conocephalus saltator</i> | longhorned grasshopper | Nat |
| ORTHOPTERA | Tettigoniidae | <i>Euconocephalus nasutus</i> | agravating grasshopper | Nat |
| HYMENOPTERA | Anthophoridae | <i>Xylocopa sonorina</i> | Sonoran carpenter bee | Nat |
| LEPIDOPTERA | Geometridae | <i>Anacamptodes fragilaria</i> | kiawe moth | Nat |
| ARANEAE | Lycosidae | <i>Lycosa sp.</i> | wolf spider | End |
| COLEOPTERA | Dytiscidae | <i>Rhantus pseudopacificus</i> | -- | End |
| DIPTERA | Canicidae | <i>Canaceoides hawaiiensis</i> | -- | End |
| DIPTERA | Dolichopodidae | <i>Hydrophorus pacificus</i> | long-legged fly | End |
| DIPTERA | Dolichopodidae | <i>Thambemyia acrostacalis</i> | long-legged fly | End |
| HETEROPTERA | Lygaeidae | <i>Nysius kinbergi</i> | seed bug | End |
| HYMENOPTERA | Colletidae | <i>Hylaeus sp.</i> | yellow-faced Bee | End |
| ISOPODA | Ligiidae | <i>Ligia hawaiiensis</i> | mangrove slater | End |
| LEPIDOPTERA | Cosmopterigidae | <i>Hyposmocoma sp.</i> | -- | End |
| LEPIDOPTERA | Crambidae | <i>Omiodes localis</i> | Hawaiian grass leafroller | End |
| LEPIDOPTERA | Crambidae | <i>Tamsica floricolens</i> | Hawaiian tamsica crambid moth | End |
| LEPIDOPTERA | Oecophoridae | <i>Thyrocopa sp.</i> | -- | End |
| LEPIDOPTERA | Olethreutidae | <i>Crociosema sp. (near leprara)</i> | -- | End |
| ORTHOPTERA | Gryllidae | <i>Caconemobius sp.</i> | -- | End |
| DIPTERA | Ephydriidae | <i>Scatella sexnotata</i> | -- | Ind |
| COLEOPTERA | Coccinellidae | <i>Cryptolaemus montrouzier</i> | mealybug destoryer | PI |
| LEPIDOPTERA | Crambidae | <i>Salbia haemorrhoidalis</i> | -- | PI |
| DIPTERA | Canicidae | <i>Canaceoides sp.</i> | -- | Unk |
| HOMOPTERA | Cicadellidae | <i>Balclutha sp.</i> | -- | Unk |

¹ This list has been compiled from several collecting trips between 2003-2007.

More information on specific trips is available on our project website at:

<http://www2.bishopmuseum.org/HBS/islets/?isl=Kaua'i%20and%20Ni'ihau&id=-578660136>

² Status codes: Nat = naturalized, End = endemic, Ind = indigenous, PI = purposely introduced, Unk = unknown.