S. S. MIDWAY EXPEDITION

MAY 21, 1999 - JUNE 16, 1999

TRIP REPORT

Prepared for:

United States Fish and Wildlife Service

Prepared by:

Forest Starr and Kim Martz

July 1999

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INTRODUCTION

On May 21, 1999 we departed from Sand Island, Midway Atoll aboard the S. S. Midway heading on an expedition to other Northwestern Hawaiian Islands. During our trip, we visited Gardner Pinnacles, French Frigate Shoals, Laysan Island, Lisianski Island and Pearl and Hermes Atoll. The S. S. Midway was chartered by a Japanese film crew working for Tokyo Broadcast Systems (TBS), filming an "Amazing Animals" show. Our primary duties on board were as deck hands, but we were able to spend some time on several islands to observe and document the existing flora and fauna.

The main focus of the following trip report is to provide botanical information for each island surveyed. Islands discussed in this report include Gardner Pinnacles, Tern Island of French Frigate Shoals, Laysan Island, Lisianski Island, and Seal / Kittery, North, and Southeast Island of Pearl and Hermes Atoll. Our surveys were brief and we did not search each island extensively. As a result, the following plant lists are not complete inventories. With the exception of Gardner Pinnacles which we did not land on, we spent about one day at each island noting plant species encountered and relative abundance of each species in terms of rare, occasional, common, or dominant. This report includes information about each plant observed, listed by island in alphabetical order by genus, a summary plant list for all the islands and photographs documenting our trip.

We found the quarantine regulations for the islands to be adequate. United States Fish and Wildlife Service (USFWS) crew, Dave Johnson, Dominique Aycock and Ron Walker were on board and orchestrated and oversaw the following activities. For all islands visited, with the exception of Tern Island, French Frigate Shoals, we wore newly purchased clothing which had been put in zip lock bags and frozen for 48 hours. All soft equipment, such as camera bags, backpacks and sunglass croakies were either new or were not brought to the island. The film crew had certain items, such as microphone booms, which could not be newly manufactured. These items were thoroughly washed and frozen for 48 hours (whenever possible) then searched for insects or seeds. Items were moved from the boat to the islands in 5 and 10 gallon plastic buckets. These were pressure washed and scrubbed with Clorox bleach prior to the first transport.

Though the measures were time consuming and laborious, we found them to be adequate and successful in decreasing the spread of alien plants and animals, particularly insects and spiders, to other islands. One area where the system could be improved is when equipment moves from the island to the boat. Insects, mostly ants and some spiders were found in buckets when returning from some islands, particularly Laysan, to the boat. This break in the system allows for a higher chance for moving things between islands.

Quarantine measures seem to be keeping things at bay, at least in the plant category, as we found nothing we did not expect. However, there is little to no control being done on most of the existing alien pest plants, except for Cenchrus echinatus on Laysan Island. There, control efforts have proven successful as we found very few C. echinatus plants. This same approach should be taken for other weeds at other islands and atolls. This would greatly reduce the weed problems while they are still relatively manageable.

Routine botanical surveys would help to find harmful alien species early in the invasion process which would reduce amount of effort and cost for control. It seems appropriate that each island should have its own restoration plan, similar to the Laysan model, outlining threats and opportunities unique to each island and the steps that it would take to bring that island to a more pristine state.

It became apparent that there is much to learn from these Northwestern Hawaiian Islands. Being so remote, it is not often that research is done in a routine matter on things such as plants, insects or other things such as seaweeds or coral. These remote islands are havens for life and have much to offer for any biologist. Certainly, there are many things waiting to be discovered.

The following report reviews our trip and provides botanical information about each island we visited. Included is the itinerary, list of passengers, plant descriptions by island, summary plant list for all islands and photographs taken during the trip.

Itinerary

1999	May 21-1300	Depart Midway.
	24-0900	Circle Gardner Pinnacles.
	25-0400	Arrive French Frigate Shoals. Enter at 0730
	31-1600	Leave French Frigate Shoals.
1999	June 02-0830	Arrive Laysan.
	09-1600	Leave Laysan.
	10-0730	Arrive Lisianski.
	12-1500	Leave Lisianski.
	13-0900	Arrive Pearl and Hermes.
	16-1800	Leave Pearl and Hermes.
	16-0500	Arrive Midway. End voyage.

Motor Vessel S. S. Midway WCX 4557 -- Passengers

Captain:	Bill Austin
First mate:	Jeff Vermillion
Second mate:	Pete Terrcott
Chief engineer:	Manny
Second engineer:	Bruce Jones
Cook:	Katie Stadler
Mess mate:	Patti Jones
Deck hands:	Forest Starr
	Kim Martz
USFWS:	Dave Johnson
	Ron Walker
	Dominique Aycock
USGS/BRD:	Michelle Reynolds
TBS:	Masaru Uchida
	Mitsuaki Iwago
	Hideko Iwago
	Manami Yamaguchi
	Jiro Sato
	Katsu
	Nabe

GARDNER PINNACLES

On May 24, 1999 our vessel reached Gardner Pinnacles, the oldest exposed piece of rock in the Hawaiian chain. We pulled up close and circled around the basaltic outcrop a few times (Fig. 1 & 2). There was one large outcrop with a smaller one next to it. Dikes were seen running up the sides of the rocks. The outcrop was a haven for wildlife in a vast ocean. There were about 4 Hawaiian monk seals (Monachus shaundslandi) basking on the smaller outcrop and a few swimming in the water. Several large ulua circled below the boat. The pinnacle is covered in guano like a snow capped peak. Seabirds occupied most areas of the rock and flew about inspecting our vessel. Masked, brown and red footed boobies were on top of outcrop and circling above. Brown and black noddies poured out of crevices in rock.

A single indigenous plant species is known from the island, Portulaca lutea (Herbst and Wagner 1992). From the boat we observed a small patch of plants growing in the cracks that we assumed was Portulaca lutea. We also observed some limu near the splash zone.

Plant List - Gardner Pinnacles

Portulaca lutea - 'ihi
Indigenous. We observed what appeared to be one clump of this plant between two large cracks on the northwest wall of the larger rock.

Limu - seaweed
Green, growing on the rock near the splash zone, would be good to Identify.

FRENCH FRIGATE SHOALS - TERN ISLAND

Our vessel arrived at French Frigate Shoals on May 25, 1999. We anchored about 1.2 miles off of Tern Island and about 3 miles from La Perouse Pinnacle. Our survey was done on May 30, 1999 (Fig. 3).

Tern island is man-made. Amerson (1971) reports that from July to November 1942, Navy personnel and civilian workers dredged coral from the lagoon, covered the original Tern Island, and constructed a new island in its place. This new Tern Island was devoid of vegetation; furthermore, several of the first Commanding Officers would not allow even a blade of grass to grow. The first recorded vegetation, Tribulus cistoides, reappeared in late December 1943 or early January 1944. Dabagh, the new C.O., carefully watered it and shortly the plant produced a small, yellow blossom. He carefully picked the blossom and enclosed it in his next letter home; his wife Jean still has the pressed Tribulus in her possession.

Today, the vegetation on Tern Island is limited to both sides of the airstrip (Fig. 4). Tern Island currently has many common native coastal plants, but also contains a few rather weedy plants. Because of its small size and existing native plants, it would be difficult, but not impossible to return the vegetation to a somewhat pristine state. Of the 24 plants observed during our survey, 14 are alien, 7 are indigenous, 1 is endemic, and 2 are questionable. Most of the island is compacted sand. The runway has a few ephemeral plants, mostly Spergularia marina. The edge of the runway is dominated by Sporobolus pyramidatus with a mix of the common species. Inland, Chenopodium murale and C. oahuense mix with Malva parviflora, Sporobolus pyramidatus, Eleusine indica and Tribulus cistoides. We did not see any Cenchrus echinatus, attesting to a successful control program. Further toward the coast are Tournefortia argentea, Ipomoea pes-caprae and Lepturus repens. We did not inventory the coast.

As noted earlier, our inventory is incomplete, as our search was limited to areas immediately near the runway and buildings. In addition, no other islets in the shoal were surveyed. A complete botanical inventory still needs to be done. Perhaps the best time to survey would be during times of the year when there are less birds nesting and less seals pupping.

Plant List - Tern Island

Boerhavia repens - alena
Indigenous. This low growing plant with purple flowers and often fuzzy leaves is a common component in the mix of plants seen throughout the Northwestern Hawaiian Islands. It is common in coastal areas and is also seen occasionally inland. On Tern Island, seen near the main building and elsewhere.

Casuarina equisetifolia - ironwood

Alien. The scourge of Midway Atoll, ironwood is represented by a few trees, dead and alive, around the camp at Tern Island. Trees that looked healthy in 1965 (Amerson 1971) are currently in a state of senescence, and have been slowly dying since at least 1991 (K. Neithammer pers. comm.).

Chenopodium murale - 'aheahea
Alien. This species is common everywhere on Tern Island. It is a small shrub that could be displacing native Chenopodium oahuense, an endemic species. Removal of C. murale in conjunction with throwing seeds of C. oahuense in its place would improve the situation.

Chenopodium oahuense - 'aweoweo
Endemic. Common to dominant in places throughout the island. A great restoration species.

Cocos nucifera - Coconut
Alien. A few trees are located near camp.

Conyza bonariensis - hairy horseweed
Alien. This weed is found scattered everywhere.

Cyperus rotundus - purple nut sedge
Alien. A common pest in gardens, this plant can be observed near the main building.

Digitaria ciliaris - Henry's crabgrass
Alien. Possibly seen near boat dock house. Could have been Sporobolus pyramidatus. If present, very rare.

Eleusine indica - goosegrass
Alien. This grass is common throughout the island.

Heliotropium currasavicum - nena, seaside heliotrope
Indigenous. This plant is common.

Heliotropium procumbens -
Alien. Scattered on both sides of runway.

Ipomoea pes-caprae - pohuehue, beach morning glory
Indigenous. Occasional in coastal sites.

Lepturus repens
Indigenous. Occasional to common just off the runway and into the vegetation.

Malva parviflora - cheese weed
Alien. Common everywhere. Though not completely habitat altering, this is one of the worst weeds at Tern Island.

Portulaca spp. - common purslane
What appears to be Portulaca lutea was observed near the end of runway. What was believed to be Portulaca oleracea and potentially a hybrid between the two (P. lutea x P. oleracea) was common most everywhere else. For plants that did not have flowers, we were unable to determine the species, but we lumped them all anyway.

Scaevola sericea - naupaka
Indigenous. A few bushes were observed near the dock and around the buildings, some of which appeared planted.

Sonchus oleraceus - sow thistle
Alien. Occasional everywhere.

Spergularia marina - saltmarsh sand spurry
Alien. Common everywhere, including the runway, where it must be occasionally scraped off to maintain the safety of the runway.

Sporobolus pyramidatus -
Alien. Dense near the edge of the runway and common further in vegetation.

Tournefortia argentea - tree heliotrope
Alien. Common on both sides of runway.

Tribulus cistoides - nohu
Indigenous. Common everywhere. Used as nesting material in red footed booby nests.

LAYSAN ISLAND

We arrived at Laysan Island around 1430 hr. on June 2, 1999 (Fig. 5). We surveyed the island on June 4, 1999 with Alex Wegmann and Dave Johnson. On June 8, 1999 we returned to assist Michelle Reynolds with vegetation transects and surveyed briefly. Our survey was not extensive. We saw many areas of the island but there may be plants that were missed, especially in the guano hard pan area and the northwest corner of the island.

The island is fairly pristine with very few alien species. We observed 30 different species of plants during our survey. Out of these, 10 were alien, 11 were indigenous, 6 were endemic, and 3 were questionable. There has been an enormous effort to control Cenchrus echinatus on the island. These efforts are proving successful as we saw very few C. echinatus plants. Similar efforts against Cynodon dactylon, Pluchea indica, and Sporobolus pyramidatus as suggested by Conant and Morin (1998) would probably prove as successful and should be undertaken as soon as possible while the distribution of these species is still limited.

Most of the island is covered with Eragrostis variabilis. In with the E. variabilis is occasionally Boerhavia repens, Tribulus cistoides, Conyza bonariensis, Sicyos spp. (Fig. 7), and Portulaca spp. The coastal areas are predominantly Nama sandwicensis, Ipomoea pes-caprae (Fig. 6) and Fimbristylis cymosa. Scaevola sericea is also found along the coast, especially the northeast coast. Near the pond (lagoon) margin is Sesuvium portulacastrum, Cyperus laevigatus, and Heliotropium currasavicum. A curious foam formed on the leeward side of the pond. Beach flotsum that we came across included >40 kukui nuts, 2 Terminalia cattappa (false kamani) fruits, 2 walnuts, 1 large triangular seed, and 1 Mucuna like seed with speckles.

Endemic Chenopodium oahuense and the federally listed Mariscus pennatiformis subsp. bryanii (Fig. 8) appeared healthy but limited in distribution. Efforts to expand their range should begin before the genetics are lost. Throwing seeds directly to other areas near the lagoon margin may help begin this process.

During our survey, we showed C. echinatus technician, Alex Wegmann, many invasive weeds and how to control them. In the future, along with C. echinatus control, Nicotiana tabacum, Conyza bonariensis, and Pluchea indica should also be controlled. Technicians should have some overlap during turnover to allow for training of identifying and controlling these species. These plants can all be hand pulled as they are come across in Cenchrus work. Other alien plants that will require herbicide includes Cynodon dactylon, Tournefortia argentea, and Casuarina equisetifolia. Perhaps also Sporobolus pyramidatus. Control work should be followed by outplanting of native species.

All alien species should have their distributions mapped. A single field technician should be able to map and knock back most of the alien species to very low numbers. As mentioned earlier, Cynodon dactylon will require herbicide. Portulaca needs taxonomic work before management action is taken.

All in all, Laysan is very well off. Morin and Conant (1998) do an admirable job of quantifying the steps to restoration of the vegetation of Laysan. Laysan is one of the most pristine examples of coastal vegetation in the Hawaiian Islands. Removing the few alien plants here and continued quarantine will go a long way to keeping Laysan that way.

Plant List - Laysan Island

Boerhavia repens - alena
Indigenous. Scattered over entire island. Nowhere did we observe alena as dominant.

Casuarina equisetifolia - ironwood
Alien. We observed 1 or 2 plants (unknown if rootsprout or seedling) at camp, both with female flowers and cones. Seedlings should be monitored for and seeds possibly collected for viability tests. Frigate birds roost in the trees but do not nest in them. Red footed boobies do nest in the trees, as do black noddies and white terns (Fig. 5).

Cenchrus echinatus - sand bur
Alien. Two plants were observed One at camp (replanted in pot for search image) and one on west coast near beginning at rock ledges.

Chenopodium oahuense - 'aweoweo
Endemic. Two individuals were seen on the west side of the ironwood trees near camp. Other plants were seen on the south side of the lagoon near the guano hard pan. This plant should be encouraged.

Cocos nucifera - coconut, niu
Alien. About 25 trees seen in clump at north end of lagoon. Frigates nest in them. All the trees observed were rather large, with no regeneration noted (Fig. 6).

Conyza bonariensis - hairy horseweed
Alien. Hairy horseweed can be found scattered over most of the island, especially the west side. This weedy plant should be pulled whenever stumbled upon.

Cynodon dactylon - Bermuda grass
Alien. Locally restricted to an area near camp, an area at the south end of the lagoon, an area near the coconut palms, and an area on the north end of the island. This grass has the potential to spread further and should be contained while it is still fairly restricted in distribution. A. Wegmann was planning to map this grass. This map should be updated to help prepare for control of this grass.

Cyperus laevigatus - makaloa
Indigenous. Large mats found all around margin of lagoon (Fig. 9&10). In places, the tussocks were over a meter tall. Finches eat seeds and ducks nest under it. Albatross nests were occasionally observed on top of these large tussocks.

Eragrostis variabilis - 'emoloa

Endemic. 'Emoloa can be found over almost all of the island. By far, the most dominant plant species on the island. Many bird species nest at the base of the plant and finches eat seeds and apparently nest in it also (Fig. 7). Not found in extreme coastal areas and areas directly around lagoon margin.

Fimbristylis cymosa - mau'u 'aki'aki, button sedge
Indigenous. Scattered in coastal areas and along the lagoon margin. Both subspecies, spathacea and umbellato-capitata, were seen. As on Midway, the two subspecies seem to intergrade.

Heliotropium curassavicum - seaside heliotrope, nena
Indigenous. Scattered in all areas of the island, especially near the lagoon (Fig. 10).

Ipomoea pes-caprae - beach morning glory, pohuehue
Indigenous. Pohuehue is common along coastal areas where it forms dense mats with long tendrils. It is also found inland near the lagoon, again forming large mats (Fig. 6).

Lepturus repens -
Indigenous. Scattered along coastal areas, especially western coast.

Mariscus pennatiformis subsp. bryanii -
Endemic. One clump with > 50 individuals of this extremely rare plant was seen restricted to the south end of the lagoon (Fig. 8). Seed should be collected and propagated. It was almost ripe at the time of our survey in June.

Nama sandwicensis - hinahina kahakai
Indigenous. Scattered all over the island and especially abundant near the coast where it is often the closest plant to the high tide line forming large patchy stands. Wagner et al. (1990) discuss an albino form with white flowers from plants found on Northwestern Hawaiian Islands. We did not look for this characteristic while on Laysan, but did notice white flowers on plants at Lisianski.

Nicotiana tabacum - tobacco, paka
Alien. Adults and seedlings of tobacco are scattered over the island, especially the west side. There is a large patch near the coconut grove at the north end of the lagoon, which apparently when dried and smoked is smokeable, but bitter (R. Walker pers. comm.). This large patch was pulled on June 4, 1999. Alex Wegmann helped and will follow up on this patch and pull others when he comes across them on the island. This should be continued by future technicians.

Pluchea indica - Indian fleabane, Indian pluchea
Alien. Occasional on the far margins of the lagoon. Red footed boobies occasionally nest in it. A fairly weedy species that has the potential to spread and should be controlled. Plants can be pulled up as they are come across, as long as there is not a nest in it.

Portulaca spp. - purslane

Purslane was found scattered throughout the island in Eragrostis and near the coast. The alien P. oleracea was seen, but flowers of most plants were not visible and are listed as Portulaca sp. As with other places where both P. oleracea and native P. lutea occur together, there is undoubtedly hybridization (P. lutea x oleracea) occurring. Management of Portulaca is clouded by this taxonomic quandary. Finches were seen eating seeds.

Scaevola sericea - naupaka kahakai
Indigenous. Naupaka was found along the coast, especially the northeast side of the island where it collects drifting sand in clumps 2m x 2m that are surrounded by Ipomoea pes-caprae. Seedlings were observed. Frigate birds, red footed boobies and black noddies nest in it. In many cases, birds were nesting in plants <1m tall (Fig. 6).

Sesuvium portulacastrum - 'akulikuli, sea purslane.
Indigenous. Solid mats occur around the margins of the lagoon (Fig. 10).

Sicyos spp. - 'anunu
All spp. are endemic. Scattered over entire island. Crawling over vegetation. Two species, S. maximowiczii and S. pachycarpus were found. The third, S. semitonsus, perhaps a hybrid, was possibly found, but positive identification is not certain. (Fig. 7).

Sporobolus pyramidatus -
Alien. Patches of this grass were seen on the south side of the lake on and near the guano hard pan. Seems to like compacted ground like on Tern Island.

Solanum americanum - glossy nightshade, popolo
Questionably Indigenous. Scattered along trail from lagoon to camp.

Tournefortia argentea - tree heliotrope
Alien. Tree heliotrope was first found on Laysan in 1961 (Ely and Clapp 1973). Currently restricted to area right around beach camp. Wait for habitat restoration before killing large plants, because of the nesting opportunities for some bird species. In the mean time, seedlings can be pulled as they are found.

Tribulus cistoides - nohu
Indigenous. Scattered over entire island. Nowhere did we observe nohu as dominant.

LISIANSKI ISLAND

The S. S. Midway arrived and anchored at Lisianski Island on June 10, 1999. We anchored about .8 miles off the western shore. The Neva Shoal is large, about 3 mi. at the northwest entrance and about 4-5 fathoms deep. Large grass tussocks of 'emoloa (Eragrostis variabilis) and Tournefortia argentea were apparent from the ship. On the morning of June 11, 1999, we arrived on the shore near the camp. One of the first things we noticed upon landing ashore was that the sand was much finer than the sand at Laysan Island. Lisianski also seemed to be drier than Laysan.

In the morning, we assisted Michelle Reynolds with Laysan duck research looking at vegetation types (Ipomoea indica / Sicyos spp. and Eragrostis variabilis) (Fig. 11) to compare the similarities and differences with the vegetation of Laysan Island and Pearl and Hermes Atoll. This information will help in making decisions in Laysan duck restoration. We hiked into the vegetation directly east of camp. We observed a single Pisonia grandis tree with about a 6 m by 6 m canopy and about 4 m tall (Fig. 13 & 14). After this we returned to camp and after lunch walked along the west beach from camp to south point of island and on to the "cove" on the east side of the island. We were unable to get to the northeast, north, and northwest part of the island and most of the interior.

In general, the vegetation of Lisianski is extremely intact and pristine. Only 3 (possibly 4 if Solanum americanum is treated as alien) alien species occur on Lisianski, sand bur (Cenchrus echinatus), a few dead ironwood trees (Casuarina equisetifolia) and tree heliotrope (Tournefortia argentea). Otherwise, the vegetation is completely native, 10 species are indigenous and 3 species are endemic. We were unable to locate Boerhavia herbstii, or we were unable to differentiate it from Boerhavia repens. Also known from literature are coconuts and tobacco. We found many coconut fruits on the beach, but did not find any live trees. 'Akulikuli (Sesuvium portulacastrum) was also not found. Beach flotsum that we came across included Terminalia cattappa (false kamani) fruit, coconuts, and kukui nuts. No tobacco was found.

The common plants repeat themselves and there are a few major vegetation types that exist in a concentric zonal pattern (Mueller-Dombois and Fosberg 1998). There is the coastal strand which consists of Nama sandwicensis and Lepturus repens closest to the ocean, with naupaka (Scaevola sericea) or tree heliotrope (Tournefortia argentea) behind them on the foredune (Fig. 12). The next vegetation type is the 'emoloa (Eragrostis variabilis) type which dominates most of the island. Scattered within the 'emoloa is nohu (Tribulus cistoides), alena (Boerhavia repens), koali 'awa (Ipomoea indica), sand bur (Cenchrus echinatus) and 'anunu (Sicyos spp.). In areas where Eragrostis does not dominate, there are Tribulus and Ipomoea types. The Tribulus type includes Cenchrus. The Ipomoea type includes Sicyos. Boerhavia can be found within all of these types. There may be a Chenopodium type, but it was not observed by us. The sprawling Pisonia grandis is conspicuous and is the only tree in the interior of the island.

All in all, Lisianski Island is in very good shape, and with some control work on Cenchrus echinatus and Tournefortia argentea, this island could return to a basically pristine state.

Plant List - Lisianski Island

Boerhavia repens - alena
Indigenous. Found in most parts of the island in association with all vegetation types. Boerhavia herbstii was not found.

Casuarina equisetifolia - ironwood
Alien. At least 4 dead trees believed to be Casuarina were found. Occurred on coast and in interior.

Cenchrus echinatus - sand bur
Alien. Common near camp, in interior of the island, and along west coast. This is the most widespread alien plant on Lisianski. The successful control on Laysan could potentially be repeated on Lisianski.

Chenopodium oahuense - 'aweoweo
Endemic. Rare along the coast. Some large patches in interior found by David Johnson, but not seen by us. These plants along with the naupaka could provide nest sites for those birds currently nesting on Tournefortia argentea, once T. argentea is removed.

Eragrostis variabilis - 'emoloa
Endemic. As on Laysan, this is by far the most prevalent plant species on the island. It appears less robust on Lisianski than it did on Laysan. It can be found in all parts of the island from the beach to the interior (Fig. 11-13).

Ipomoea indica - koali 'awa
Indigenous. Common in most parts of the island and in places forming distinct vegetation type along with Sicyos spp., Tribulus cistoides, Boerhavia repens and Cenchrus echinatus. Two forms of this species were found, form indica with purple flowers and form albiflora with white flowers.

Ipomoea pes-caprae - pohuehue
Indigenous. One seedling was found at the "cove" on the east side of the island.

Lepturus repens -
Indigenous. In Hawai'i, present only in the Northwestern Hawaiian Islands. Common along the coast. Forms mats between coast and Eragrostis variabilis vegetation.

Nama sandwicensis - hinahina kahakai
Indigenous. Common along the south and east coast. Appears more robust at Lisianski than at Laysan. Also has white flowers on Lisianski. Wagner et al. (1990) cite that all N. sandwicensis in the northwestern islands is of albino form.

Pisonia grandis -
Indigenous. In Hawai'i, presently known from this single tree only recently discovered by Herbst and Takeuchi in 1980 (Wagner et al. 1990). One tree located in the center of the island. The canopy is about 6 m in diameter and dome shaped. Branches sprawling. About 4 m tall. Sex unknown. Spreading vegetatively. No seedlings were seen. Many red footed booby chicks were nesting in the tree (Fig. 13 & 14).

Portulaca lutea - 'ihi
Indigenous. Locally common in southeast coastal corner of island. The flowers had closed when we arrived, but dissecting them, they appeared large enough to fit in lutea rather than oleracea. No plants were found that appeared to be oleracea.

Scaevola sericea - naupaka
Indigenous. Occasional to common along the coast, especially the southeast side of the island. Scattered individuals can be found in the interior of the island. Frigate birds and boobies were seen nesting in plants <1 m tall.

Sicyos maximowiczii - puaokama
Endemic. Common in interior of island. Found as associate with Ipomoea indica and Eragrostis variabilis (Fig. 11).

Solanum americanum - popolo, glossy nightshade
Questionably indigenous. Not common. Found scattered in Ipomoea indica and by Pisonia grandis. It is difficult to know whether to control or not as the native distribution is clouded. Nowhere is it dominant.

Tournefortia argentea - tree heliotrope
Alien. Common along western and eastern shores (Fig. 11 &12). This is the second most widespread alien plant on Lisianski. There are many large trees and hundreds of seedlings popping up along the coast. If left unchecked, the entire coastline could become covered with this plant. As at Laysan, it may be best to wait for habitat restoration to remove large trees, but in the mean time, seedlings could be pulled when doing routine monk seal monitoring.

Tribulus cistoides - nohu
This indigenous plant is not as abundant as Eragrostis variabilis. It was found in all of the areas of the island we surveyed. There appeared to be areas where the Eragrostis was less prevalent, and this is where the Tribulus seemed to be more common. Cenchrus echinatus seemed to also be found in these areas.

PEARL AND HERMES ATOLL -
NORTH, SEAL/KITTERY, & SOUTHEAST ISLAND

We arrived at Pearl and Hermes Atoll on the morning of June 13, 1999. The atoll is large, about 17 mi. across, and surrounds about 7 islands. We anchored just outside the atoll near the channel off of Southeast Island. Several islands have changed shape over time including Seal and Kittery Islands which are now joined. David Johnson collected plant specimens on Seal/Kittery Island for us to identify on June 13, 1999. We surveyed North and Southeast Island on June 14, 1999 and were on Southeast Island for a few more hours on June 15, 1999. These islands are small and were surveyed fairly extensively. In addition to the survey and film work, Ron Walker restored the refuge sign during our stay at Pearl and Hermes Atoll (Fig. 15 & 16).

The islands within the atoll still retain rare plants. Lepidium bidentatum o-waihiense is still found on several islands within the atoll (Fig. 17 & 18). We found this rare species nowhere else in the chain at islands we were able to visit. Also finding refuge on several islands within the atoll is Solanum nelsonii, which was present on all three islands we surveyed (Fig. 19). On Southeast Island, it was represented by a single old unhealthy looking plant. These islands may still retain rare species because of less human disturbance than other islands both historically and currently. Today, field camps inhabit Southeast Island for only a few months out of the year. As compared to other islands that are occupied year around.

While home to rare species, the islands within Pearl and Hermes Atoll are under siege by invasive weed species such as Verbesina encelioides, Setaria verticillata, and Cenchrus echinatus (Fig. 20 & 21). These weeds, which crowd out native plants and threaten to out-compete rare native species, are just beginning their invasion. On Southeast Island, the weeds mentioned above, are restricted to the eastern part of the island. They have not yet spread across the lagoon to the western part of the island. Measures to thwart the invasion should be taken immediately while the infestation is still relatively manageable and while the rarer plants still exist.

A control program modeled after the Laysan Island Cenchrus eradication effort would do a lot to help preserve the rarer native plants and prevent bird habitat degradation due to alien plant species. Plants that should be controlled include Verbesina encelioides, Setaria verticillata, Cenchrus echinatus, Cynodon dactylon, and Sonchus oleraceus. This could be followed by native plant restoration.

Also apparent is that while the quarantine for outsiders to enter the atoll is adequate, intra-atoll movement of weed species is currently not being addressed. Standard protocol for travel between islands within the atoll need to be established. These protocols could apply to all atolls in the chain with multiple islands. Perhaps Midway Atoll would be a good place to serve as a testing grounds.

NORTH ISLAND -- PEARL AND HERMES ATOLL

North Island was surveyed on June 14, 1999. All in all, North Island is in a relatively pristine state. The weeds that need control are Tournefortia argentea, which can be hand pulled while doing seal work, Cenchrus echinatus and Setaria verticillata. The latter two require more resources. Hand pulling and spraying with an herbicide as done on Laysan would help. Roundup or rodeo would work. Fusilade or some herbicide that selects against monocots may be a good option as there are few native grasses in the area where the alien grasses have a strong hold. Native plants should fill in areas denuded by herbicide. Follow up control and monitoring will be required.

There are a few distinct vegetation types. On the extreme south tip of the island is an Eragrostis paupera, Boerhavia repens association with a few Tournefortia argentea trees popping up (Fig. 17 & 18). On the southeast coast is a Lepidium bidentatum o-waihiense association with Tribulus cistoides and Boerhavia repens mixed in. Inland from the coast are two large Eragrostis variabilis patches. In areas where the E. variabilis is thin, Sicyos maximowiczii, Tribulus cistoides and Boerhavia repens are present. A few Solanum nelsonii patches are scattered about, especially on the north part of the island. Tribulus flats occur over most of the island. Cenchrus echinatus and Setaria verticillata are scattered about. There is one patch of Portulaca sp. on the northwest shoreline.

Lepidium bidentatum o-waihiense seeds were collected and taken back to Midway Atoll for propagation and out-planting there where the species no longer occurs.

During our survey 13 plant species were observed, 4 species were alien, 1 species was of questionable taxonomy, and 8 species are native, 5 indigenous and 3 endemic. The following plant list provides more detail about the plants found during our survey on June 14, 1999.

Plant List - North Island, Pearl and Hermes Atoll

Boerhavia repens - alena
Indigenous. Found over almost the entire island. A zig-zag form may be B. herbstii, but identification is uncertain. (Fig. 18).

Cenchrus echinatus - sand bur
Alien. Scattered over the north part of the island with a few large patches in the northwest part of the island.

Coronopus didymus - swine cress
Alien. Scattered in the interior of the island. Seems to grow where it is allowed to (it does not seem to push native plants out of the way).

Eragrostis paupera -

Indigenous. Found along the coast of the island, especially the south tip where it comes up in clumps scattered along the sand spit (Fig. 17).

Eragrostis variabilis - 'emoloa
Endemic. There are 2 main patches. One on the west coast and the other from the middle of the island to the east coast. Frigate birds were seen nesting in tussocks of it, about 2 feet off the ground. Red footed boobies are known to nest in it as well (Chad Yoshinaga pers. comm.) (Fig. 19).

Lepidium bidentatum o-waihiense - 'anaunau
Indigenous. Large patch in the southeast portion of the island near the coast. This is where seed for Midway was collected (Fig. 17 & 18).

Lepturus repens -
Indigenous. Found along the coast of most of the island.

Portulaca sp. - purslane
Unknown. One small patch found on the northwest coast of the island. No flowers were seen, species unknown.

Setaria verticillata - bristly fox tail
Alien. Scattered over the entire island with a few large patches on the north part of the island.

Sicyos maximowiczii - puaokama
Endemic. Crawling in the vegetation in the interior of the island.

Solanum nelsonii - popolo
Endemic. Small patches scattered over the north part of the island. Frigate birds were seen nesting in it < 1 foot off the ground (Fig. 19).

Tournefortia argentea - tree heliotrope
Alien. Scattered individuals on the south tip of the island on the west shore. All were pulled.

Tribulus cistoides - nohu
Indigenous. Perhaps the most common plant on the island. Forms mats in most vegetation types. Frigate birds were seen nesting in it, about 6 inches off the ground (Fig. 19).

SEAL/KITTERY ISLAND – PEARL AND HERMES ATOLL

On the afternoon of June 13, 1999, David Johnson visited Seal/Kittery Island and collected plant specimens for us to identify. He collected 10 plants, 2 were alien, 1 was of questionable taxonomy, and 7 were native, 4 indigenous and 3 endemic, 2 of which

(Solanum nelsonii and Lepidium bidentatum o-waihiense) are rare species. The rare plants were vouchered and will be sent to Bishop Museum to represent their presence on the island at this time and for archival. The following plant list describes the plants collected from Seal/Kittery Island by David Johnson on June 13, 1999.

Plant List - Seal/Kittery Island, Pearl and Hermes Atoll

Boerhavia repens - alena

Eragrostis variabilis - emoloa

Lepidium bidentatum o-waihiense - 'anaunau
Indigenous. A rare species which no longer known from Midway Atoll or Laysan Island. Historically known from Kure Atoll, not known if still present there. This rare species was vouchered and will be sent to Bishop Museum to archive. This collection represents the presence of 'anaunau at Seal/Kittery, Pearl and Hermes Atoll at this time. Collection *#Starr and Martz 990613-2*.

Lepturus repens

Portulaca sp. - purslane

Setaria verticillata - bristly fox tail

Sicyos maximowiczii - puaokama

Solanum nelsonii - popolo
Endemic. This rare species was vouchered and will be sent to Bishop Museum to archive. This collection represents the presence of popolo at Seal/Kittery, Pearl and Hermes Atoll at this time. Collection *#Starr and Martz 990613-1*.

Tournefortia argentea - tree heliotrope

Tribulus cistoides - nohu

SOUTHEAST ISLAND – PEARL AND HERMES ATOLL

On June 14, 1999 we surveyed Southeast Island accompanied by Andrew McClung. On June 15, 1999 we returned for a few hours and were accompanied by Chad Yoshinaga. The island is divided by a lagoon. During high tide the lagoon fills and the land bridge between the eastern and western sides of the islands is about 10 m wide. Though Setaria verticillata and a few other weeds such as Portulaca oleracea and Coronopus didymus exist on the west side, the east side is the side with the majority of the weeds. The east side is about 4 times as large as the west side. The camp is currently on the west side,

near the lagoon's edge, but was historically on the east side located just beyond the current sign (Amerson et al 1974; Ron Walker pers. comm.).

There is an anchialine pond (tidal fluctuations with no surface connection to the sea) in the center of the eastern side of the island. The pond is surrounded by Sesuvium portulacastrum. The water is warm and has a salinity of about 40%. We also noticed a layer of soil sand on the east end of the island which is being eroded. This may have been an older pond of some sort.

The island's vegetation mix is about split with both native species, some of which are rare, and alien species, some of which are highly invasive. Intervention to turn the tide in favor of the natives species needs happen if the rarer and even some of the more common native species are to be saved. During our survey 19 plant species were observed, 8 species were alien, 1 plant was of questionable taxonomy, and 9 species were native, 6 indigenous and 3 endemic. Beach flotsam that was observed here includes coconuts, kukui nuts and walnuts. The following plant list provides details for each species encountered on Southeast Island on June 14 and 15, 1999.

Plant List - Southeast Island, Pearl and Hermes Atoll

Boerhavia repens - alena
Indigenous. Mixed throughout the island. More dense on west side of island. We did not see Boerhavia herbstii. (Fig. 18).

Cenchrus echinatus - sand bur
Alien. There is a small patch (about 300 plants) located inland on the eastern side of the island marked off by floats. It is mixed in with Setaria verticillata and Tribulus cistoides. No plants were seen on the western side of the island. Very few plants were seeding at the time. A plant was vouchered and represents a new island record for C. echinatus on Southeast Island, Pearl and Hermes Atoll. Collection *#Starr and Martz 990614-2*. The patch was controlled on June 14, 1999 by Kim Martz and Dominique Aycock who hand pulled about 300 plants. Seeds were bagged and taken back to Midway Atoll and burned. Follow up control will be necessary.

Coronopus didymus - swine cress
Alien. Common throughout the island.

Cynodon dactylon - Bermuda grass
Alien. Only 2 small patches about 3 m by 3 m and 2 m by 2 m were found on the east side. Both patches were seeding. These could be easily controlled with herbicide.

Eragrostis paupera -
Indigenous. Occasional along coast and lagoon. There seems to be more this year (Andrew McClung pers. comm.). (Fig. 17).

Eragrostis variabilis - 'emoloa

Endemic. Rare. Few plants were seen along the coast on the western side of the island only. Finches were nesting in tussocks and were seen perched in plants. This plant is declining rapidly and seeds from these plants and other plants from other islands within the atoll should be collected and sown in areas of disturbance, such as in conjunction with weed removal. Seeds from North and at least one other island in the atoll were gathered and thrown by Andrew McClung (pers. comm.) on the east side of Southeast Island shortly after this survey was done in an attempt to re-establish E. variabilis on that side of the island where it no longer is found. (Fig. 19).

Lepidium bidentatum o-waihiense - 'anaunau
Indigenous. Occasional near coast and lagoon. Large robust green plants were found in flower and fruit. Many sooty and gray backed terns were nesting next to plants. Propagation of this rare native species should happen to ensure the survival of this species in the Northwestern Hawaiian Islands. (Fig. 17 &18).

Lepturus repens -
Indigenous. Occasionally along the coast at the high tide line. Finches were seen perched in it.

Portulaca oleracea - common purslane
Alien. All plants seen flowering were of this sp. Some plants were not flowering at all in which case, we could not tell the species, these are listed as Portulaca sp. Scattered occasionally around the island close to the beach.

Sesuvium portulacastrum - 'akulikuli
Indigenous. Large mats surrounded lagoon and anticline pond. A dominant in wet areas inland and adjacent to lagoon. Brown and masked boobies were observed nesting in this vegetation type.

Setaria verticillata - bristly fox tail
Alien. Large bands of it around the east side. Smaller patches on the west side. Seems to be taking Eragrostis variabilis habitat. Perhaps an herbicide, such as fusilade, which selects against monocots would be effective.

Sicyos maximowiczii - puaokama
Endemic. Patches here and there. A large patch located on the west side of the island. It seems to be more abundant this year and lasting longer (Andrew McClung pers. comm.). It is occasional to common throughout the island, especially dense on the western side of the island. There are remnants (debris) of old stands on the east side.

Solanum americanum - popolo, glossy nightshade
Questionably indigenous. Small patch of about 12-20 plants just inland of the lagoon and the inland Cynodon dactylon patch. Its questionable taxonomy makes it hard to make management recommendations.

Solanum nelsonii - popolo

Endemic. A single, unhealthy, old looking specimen located on the east side near the lagoon behind the fuel tank. It appears like Sicyos had been sprawling over it and in the area at one time, but had since died back.

Sonchus oleraceus - pualele
Alien. Occasional on east side only near Verbesina encelioides.

Tournefortia argentea - tree heliotrope
Alien. 1 dead tree was found on the coast of the eastern end.

Tribulus cistoides - nohu
Indigenous. Common throughout island. Large mats on west side of island.

Verbesina encelioides - golden crown-beard
Alien. A common to dominant species found on the eastern side of the lagoon. A few large patches and some smaller ones. The large patches were encroaching on sooty tern colonies. This weed also has possibly crowded out Solanum nelsonii, Eragrostis variabilis, and other native plants. Plants were flowering and seeding. Finches were seen perching and foraging in plants. Vouchers were taken and represent a new island record for Southeast Island, Pearl and Hermes Atoll. Collection #*Starr and Martz 990614-1*. The National Marine Fisheries Service camp pulled about 10 plants then floated them out to sea last year when they were first noticed. The field camp thought there would not be many plants this year. They were surprised at the large area now occupied by V. encelioides when they arrived just 2 weeks prior to the survey. The team felt they could not put a dent into the current infestation and accomplish their work at the same time (Chad Yoshinaga pers. comm.). In addition, most of the plants had already gone to seed. Indeed the scope of the infestation is large enough to warrant a technician that is focused on alien plant control. Plants should be hand pulled or sprayed with an herbicide in May or June when plants are in a growth stage but not yet seeding. Efforts should be made to prevent the spread of V. encelioides to the west side of Southeast Island and to other islands within the atoll and if found there should be controlled immediately.

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REFERENCES

Amerson, Binion A., Jr.. 1971. The natural history of French Frigate Shoals, Northwestern Hawaiian Islands No. 150. Smithsonian Institution. Washington, D.C..

Amerson, Binion A. Jr., Roger B. Clapp, and William O. Wirtz, II. 1974. The natural history of Pearl and Hermes Reef, Northwestern Hawaiian Islands. Atoll Research Bulletin No. 74. Smithsonian Institution. Washington, D.C..

Charles A. Ely and Roger B. Clapp. 1973. The natural history of Laysan Island, Northwestern Hawaiian Islands. Atoll Research Bulletin No. 171. Smithsonian Institution. Washington, D.C..

Herbst, D. R. and W. L. Wagner. 1992. Alien plants in the Northwestern Hawaiian Islands. In: Alien Plant Invasions in Native Ecosystems of Hawaii. C. P. Stone, C. W. Smith and J. T. Tunison. University of Hawaii Cooperative National Park Resources Studies Unit, Honolulu, Hawaii.

Morin, M. and S. Conant. 1998. Laysan Island Ecosystem Restoration Plan. University of Hawaii.

Mueller-Dombois, D. and F. R. Fosberg. 1998. Vegetation of the Tropical Pacific Islands. Springer-Verlag. New York, Inc. New York, New York.

Wagner, W. L., D. R. Herbst and S. H. Sohmer. 1990. Manual of the flowering plant of Hawai'i, 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, Hawai'i.

Fig. 1. Gardner Pinnacles, the oldest exposed piece of basalt in the Hawaiian Archipelago.

Fig. 2. Close up of Gardner Pinnacles with seals hauled out on ramp on right side of rock and dike running up left side of rock.

Fig. 3. Sooty terns --Tern Island, French Frigate Shoals.


Fig. 4. Barren runway (with scattered *Spergularia*) and vegetated non-runway area (*Sporobolus pyramidatus* just off runway and row of *Tournefortia* trees behind). Masked boobies look on – Tern Island.

Fig. 5. Refuge sign with lone ironwood tree in background – Laysan Island.


Fig. 6. *Ipomoea pes-caprae* and clumps of *Scaevola* less than a meter tall in foreground with *Cocos nucifera* and camp in background – Laysan Island.

Fig. 7. *Sicyos* in foreground and Christmas shearwater nesting under *Eragrostis variabilis* in background – Laysan Island.

Fig. 8. *Mariscus pennatiformis* subsp. *bryanii* with red footed boobies – South shore of lagoon, Laysan Island.

Fig. 9. Foam from the lagoon. *Cyperus laevigatus* on right with *Eragrostis variabilis* in the distance – West side of lagoon, Laysan Island.

Fig. 10. Laysan duck with common lagoon vegetation *Cyperus laevigatus*, *Heliotropium currasavicum*, and *Sesuvium portulacastrum* – East side of lagoon, Laysan Island.

Fig. 11. Concentric zonal pattern of *Ipomoea indica* / *Sicyos* vegetation type in foreground and *Eragrostis* type in background. Camp and a *Tournefortia* tree can be seen in distance – West coast of Lisianski Island.

Fig. 12. The cove with *Tournefortia* trees along coast and *Eragrostis* grassland inland – East coast of Lisianski Island.

Fig. 13. *Pisonia grandis* tree with red footed booby chicks. *Eragrostis* in foreground and background – Central portion of Lisianski Island.

Fig. 14. *Pisonia grandis* close up – Lisianski Island

Fig. 15. Refuge sign before restoration by Ron Walker– Southeast Island, Pearl and Hermes Atoll.

Fig. 16. Refuge sign after restoration by Ron Walker – Southeast Island, Pearl and Hermes Atoll.

Fig. 17. *Lepidium bidentatum* var. *o-waihiense* and *Eragrostis paupera* – Southeast Island, Pearl and Hermes Atoll.

Fig. 18. *Lepidium, Boerhavia repens*, and black footed albatross, Southeast Island – Pearl and Hermes Atoll.

Fig. 19. Frigate bird nesting in *Solanum nelsonii* and *Tribulus cistoides*. *Eragrostis* and a noddy in background. – North Island, Pearl and Hermes Atoll.

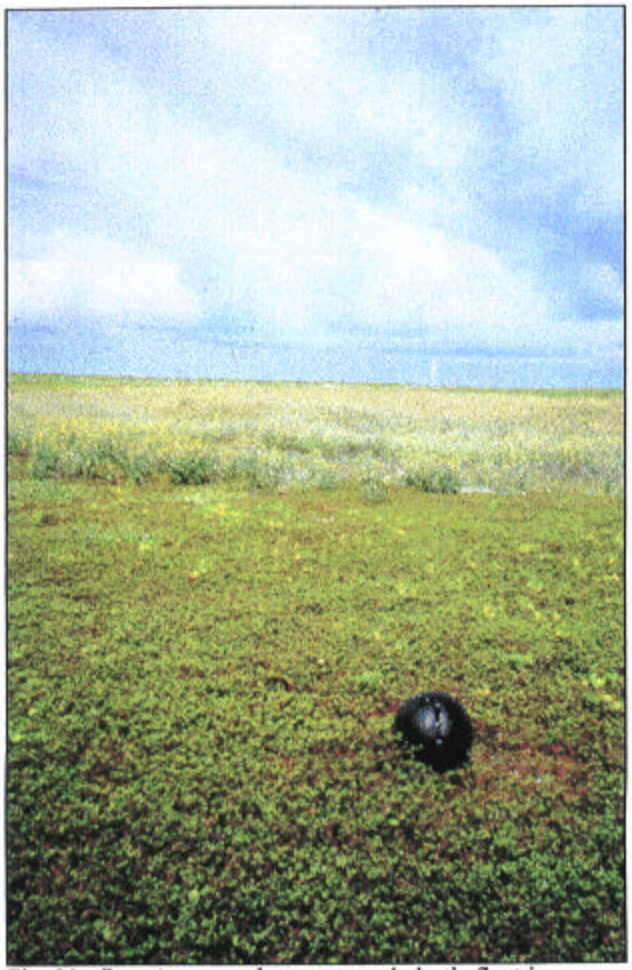

Fig. 20. *Sesuvium portulacastrum* and plastic float in foreground. *Verbesina encelioides* in background -- Southeast Island, Pearl and Hermes Atoll.

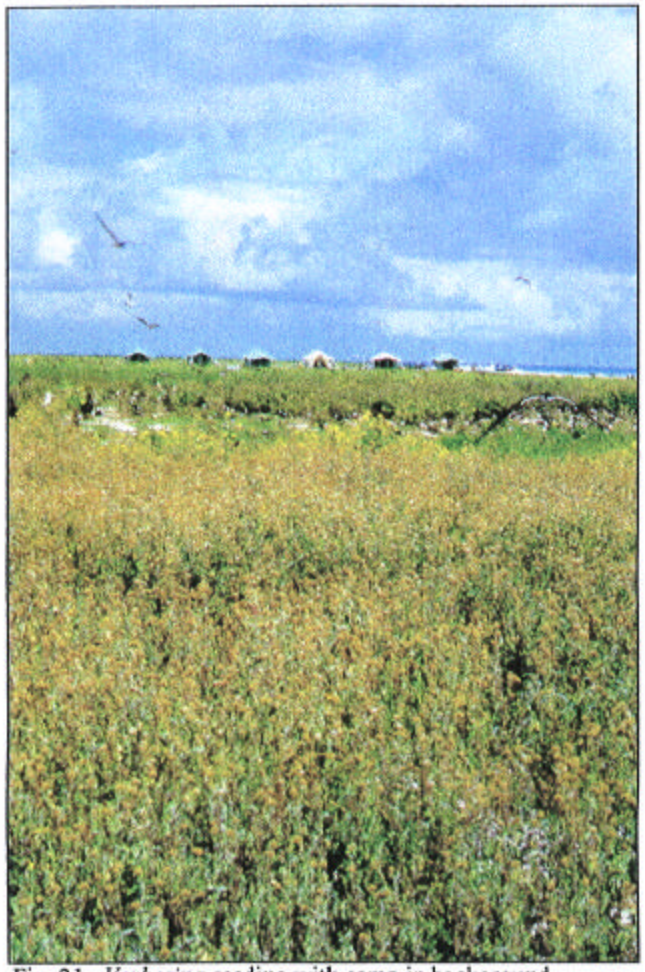

Fig. 21. *Verbesina* seeding with camp in background – Southeast Island, Pearl and Hermes Atoll.

Fig. 22. SS Midway expedition members Mitsuaki Iwago, Jeff Vermillion, Michelle Reynolds, Jiro Sato, Dave Johnson, Katie Stadler, Kim Martz, Patti Jones, Dominique Aycock, Nabe, Katsu, Manny, Manami Yamaguchi, Masaru Uchida, and Bruce Jones. Members not in photo: Bill Austin, Mitsuaki Iwago, Forest Starr, Pete Terrcott, and Ron Walker.