Hawaiian Islands Subregion

Description of the Subregion

The Hawaiian Archipelago lies within the tropical and subtropical North Pacific, and consists of 132 islands, reefs, and shoals stretching 1,523 miles (2,452 km) from the Island of Hawai`i at Latitude 18° 54' N to Kure Atoll at 28° 15' N. There are eight, large volcanic islands, collectively called the Main Islands (Figure 3, Appendix 3) and numerous associated rocks and islets. The Leewards, or Northwestern Hawaiian Islands, comprise nine small islands/atolls extending from Nihoa to Kure.

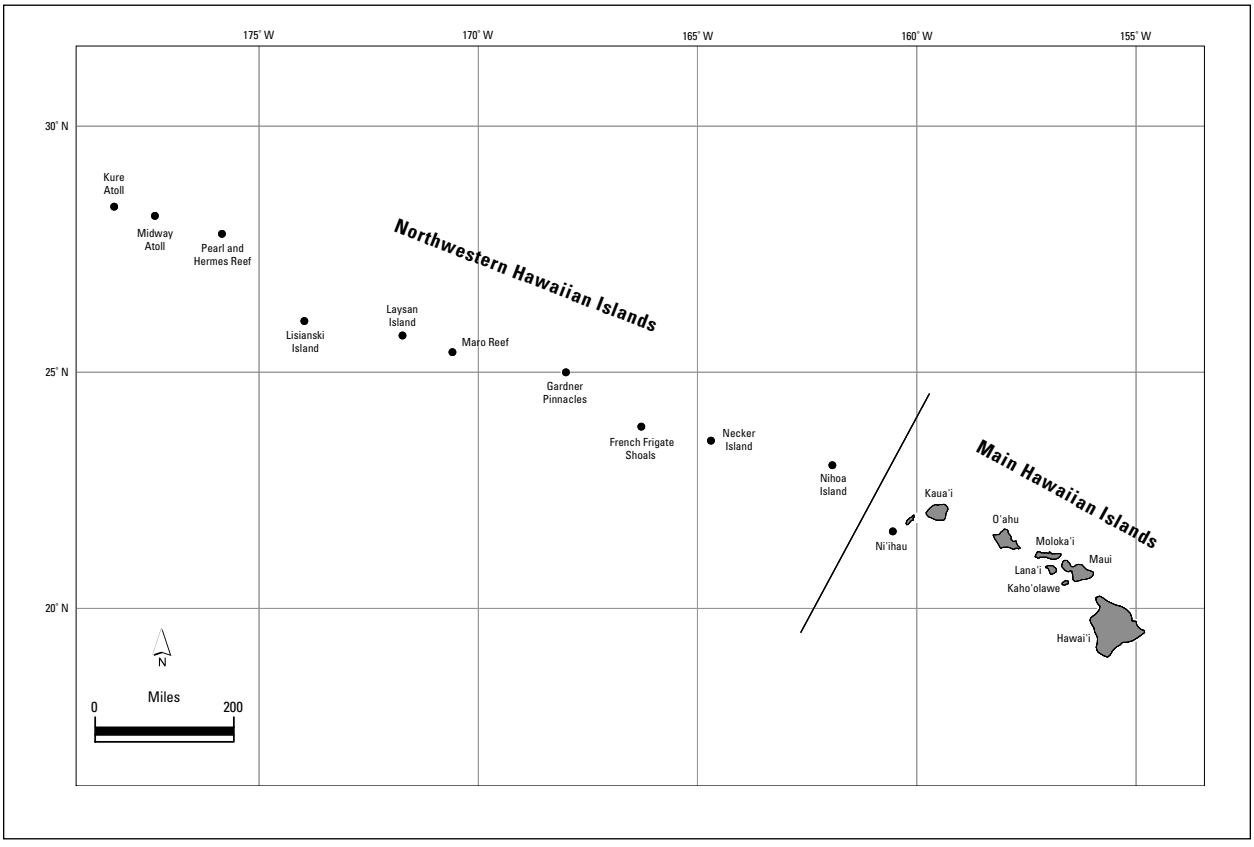
Main Hawaiian Islands

As one proceeds northwest along the chain from the island of Hawai`i (also known as Big Island), the largest and youngest island, the islands become progressively older. Ni`ihau, the oldest of the Main Islands, is privately owned. Until 1990, Kaho`olawe, the smallest of the Main Islands, was used as a Navy bombing range. Access is restricted on both islands.

The Main Islands lie completely within the tropics and comprise 99 percent of the landmass of the chain. Limited landmass, only 6,540 mi^2 (16,939 km^2), translates to limited land base for shorebirds. Add to this the mostly mountainous nature of the Main Islands, and it becomes clear that there is little space for lowland wetlands and coastal strands. Thus impacts on coastal habitats, used by shorebirds, are amplified. There is a distinct wet (windward) and dry (leeward) side to each island. Windward coasts and slopes have rainfall areas that can exceed 400 inches (1,016 cm) per year, whereas leeward habitats can be quite arid with less than 10 inches (250 cm) per year.

As a result of this inequity of precipitation, most of Hawai`i's wetlands are located in river valleys and estuaries on the windward coasts of the Main Islands. There are exceptions. For example, Pearl Harbor is located on O`ahu's south (dry) coast. In addition, basaltic islands possess perched freshwater lenses in the porous rock, resulting in coastal springs and groundwater wetlands, even on the leeward shores. The USFWS estimates the area of coastal plain wetlands decreased by 31 percent between 1780 and 1990, from 22,475 ac (9,095 ha) to 15,474 ac (6,262 ha) (Dahl 1990). Approximately 70 percent of the remaining wetlands are overgrown with invasive plants and have altered surface and ground hydrology (Shallenberger 1977). Many of

FIGURE 3. Hawaiian Islands Subregion



Hawai`i's largest wetlands have been protected by State and Federal agencies as sanctuaries and refuges. However, protection of the remaining areas, restoration, and active management are high priorities.

In contrast to the loss of wetlands, grassland habitats on the Main Islands have increased since human colonization. Much of this increase was at the expense of native forests, which were cleared and converted for agriculture, pastures, and human dwellings. Large ranches, especially on the islands of Hawai`i and Maui, provide extensive areas of non-grazed and grazed grasslands. Grassland acreage on these islands has declined over the past thirty years, due to shifts in land values and crop economics, and development for an expanding human population (Table 3). The Island of Hawai`i accounts for over 55 percent of the total farm acreage, mostly as pasture, and Maui accounts for an additional 20 percent, mostly as diversified agriculture (Morgan 1983, State of Hawai`i 1999).

Increasing human population has resulted in increased amounts of non-agricultural grasslands in the form of parks, golf courses, cemeteries, and lawns. The majority of this habitat type is privately owned or owned by city, county or State agencies and managed for uses other than wildlife. However, these parklands are widely used by golden-plovers, and to a lesser degree other shorebirds.

The Northwestern Hawaiian Islands

These small islands are in stark contrast to the Main Islands. In general, they are highly eroded, low sand islands and atolls that support extensive coastal strands and reefs relative to their landmass. Nihoa and Necker (the youngest) are small, steep rocky islands supporting only tiny sand beaches. Gardner and La Perouse pinnacles are also rocky outcroppings. Sandy beaches and bunchgrass dunes are the dominant habitat on the remaining Northwestern Islands. These islands support a low diversity of plants, mostly herbaceous species and small shrubs and trees. By definition, the atolls (Kure, Midway, Pearl and Hermes, French Frigate Shoals) have fringing coral reefs and interior lagoons that are open to the ocean. Laysan Island has a closed lagoon (technically a lake) that is hypersaline, and the only natural wetland in the leeward islands. Historically Midway, Kure, and French Frigate Shoals were operated as military installations and consequently have been highly altered. All have runways and permanent buildings. Midway, with the longest history of human occupation, has a well-developed, non-native ironwood forest (*Casuarina equisetifolia*). Midway Naval Air Station closed in 1996, and the Coast Guard Loran Stations on Kure and French Frigate Shoals were closed in 1991 and 1979, respectively. Today, all are protected as National Wildlife Refuges or State Wildlife Sanctuaries and public access is restricted and controlled by permit. USFWS maintains a small permanent staff at Midway and French Frigate Shoals and a private contractor maintains staff at Midway Atoll to support the airfield.

Shorebird Habitat Use

Wetlands, estuaries, tidal flats, grasslands, and uplands are the most important habitats for migrant and resident shorebirds. Wetlands and tidal flats support the highest diversity and density of shorebirds. Grasslands and beaches are important for two priority species, Pacific Golden-Plover and Bristle-thighed Curlew. Historical notes highlight the importance of tidal flats for migrant shorebirds (Perkins 1903, Munro 1945, Cogswell 1945). Tidal flats of Pearl Harbor were especially important through at least the late 1950s (R. L. Pyle pers. comm.). In 1945, surveys in Pearl Harbor yielded over 1,600 shorebirds (Cogswell 1945, Table 4). Most are now overgrown with introduced mangroves.

During high tide, golden-plovers that are utilizing tidal flats move inland, but readily return to tidal flats at low tide. Today, high numbers of golden-plovers can be found on O`ahu in Kewalo Basin, Pearl Harbor, the southeastern shore from Diamond Head to Koko Head, and on Moloka`i's south shore (SIGHTINGS Database, Audubon Society

TABLE 3. Farmland Acreage in the Hawaiian Islands (includes crops and pasture)

Year	Total State (Acres/Hectares x 1000)	Total Hawai`i Island (Acres/Hectares x 1000)	Total Maui (Acres/Hectares x 1000)
1970	2,300 (932)	1,340 (543)	526 (213)
1980	1,970 (798)	1,150 (466)	420 (170)
1988	1,720 (625)	1,010 (412)	290 (118)
1998	1,440 (588)	870 (355)	290 (118)
% decline	37%	35%	45%

Source: Morgan 1983, State of Hawai`i 1999

Christmas Counts, A. Engilis, Jr. unpub. data). Ephemeral playas and alkali wetlands also support large numbers of shorebirds, and are next in importance for diversity and abundance. Kealia Pond, during fall migration (August through October), supports over 1,000 golden-plovers and 14 species of shorebirds (USFWS unpubl. data). The small hypersaline lagoon on Laysan regularly supports over 4,000 shorebirds (Ely and Clapp 1973). Most other playas in the State have become overgrown with pickleweed and fleabane and are not used by shorebirds. Aerial surveys (DOFAW winter waterbird survey records) indicate Ni`ihau's playas are important for shorebirds. However, ground surveys are needed to more accurately assess shorebird abundance and diversity. The last reported ground survey, in 1939, provide only a glimpse of the potential of these ephemeral playas. Wetland complexes comprised of wildlife refuges and aquaculture facilities (involving playas, seasonal, semipermanent and permanent ponds, aquaculture, and cane waste ponds) historically supported numerous birds; particularly on O`ahu's North Shore from Kahuku to Wailua (Figure 4). Peak shorebird numbers, in diversity and population are in the middle of the fall migration (Oct. – Nov.).

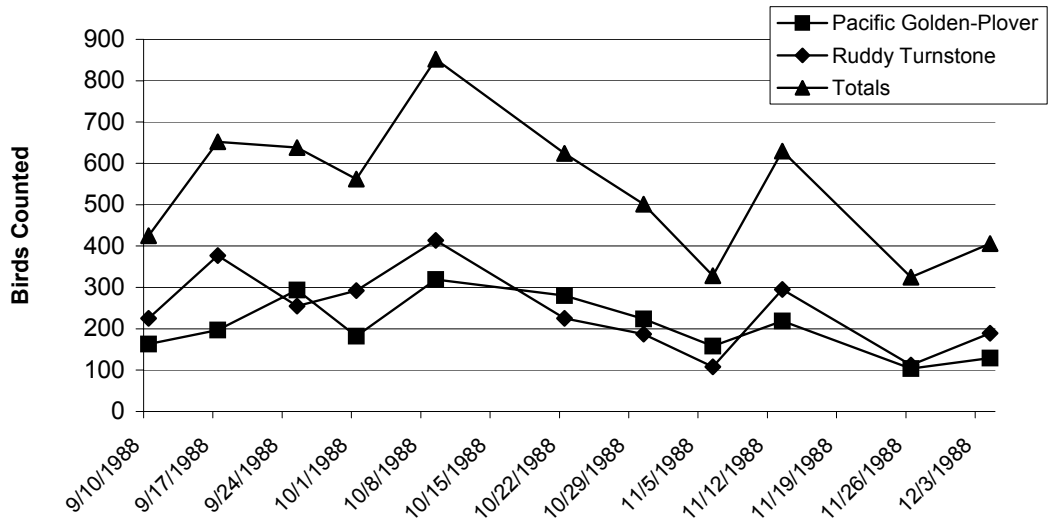
Many managed water projects in the Main Islands have become important habitat for shorebirds and the scant data available is summarized for the first time in this plan. Indeed some of the highest concentrations of shorebirds can be seen at the State's aquaculture farms. However, the endemic Hawaiian Stilt as well as migratory shorebirds, become dependent upon these managed sites and when economic pressures result in closure, the ponds are abandoned and allowed to dry.

TABLE 4. Summary of Birds Counted (mean) on Pearl Harbor Tidal Flats September - December 1945 (Cogswell 1945)

Species	Mean Count
Pacific Golden-Plover	583
Ruddy Turnstone	585
Wandering Tattler	35
Dowitcher sp.	1
Sanderling	251
Hawaiian Stilt	163
TOTAL	1,618

This pattern of dependence and loss of habitat has occurred numerous times in the past 15-20 years with the collapse of the sugar cane industry (resulting in the loss of reservoirs and wastewater ponds) and fluctuations of the heavily subsidized mariculture (shrimp) industry. Data from Hawai`i's Kona Coast verifies this over-dependence on waste ponds and aquaculture (Figure 5). Reservoirs are widely used by shorebirds, particularly when drawn down (Shallenberger 1977). Kaua`i and Maui support the largest concentration of reservoirs, all of which are now being lost due to the collapse of the cane industry. Waipi`o Peninsula in Pearl Harbor was used by the O`ahu Sugar Company as a site for disposal of cane water. Several ponds were created that were managed to catch water and sludge. These ponds were the most popular sites in the State for bird watchers because of the high numbers of shorebirds (both diversity and density). The ponds dwindled in numbers as production curtailed in the

FIGURE 4. Shorebird Counts on wetland complexes of O`ahu's Kahuku Plain (A. Engilis 1988, unpubl. data)



mid-1980s and then were lost entirely when the mill went under in the early 1990s. During that time shorebird numbers declined at Waipi`o (Figure 6).

As elsewhere in North America, wastewater treatment ponds attract large numbers of shorebirds. Normally these would not be mentioned in a plan of this nature, but with limited wetlands, their mere presence has altered patterns of bird use. In some cases they represent the only "wetlands" on an island or a particular region of an island. One need only look at the small facility on Lāna`i as an example. Lāna`i is a dry island and up until 1989 did not support native waterbirds. This changed with the opening of the Lāna`i City oxidation ponds. Pioneering Hawaiian Stilts quickly found this facility and are now nesting on Lāna`i. Surveys of the ponds in 1999 yielded seven species of shorebirds in small numbers (A. Engilis, Jr. pers. obs.). As long as these managed ponds exist, they will be an important resource for Hawaiian Stilt and migratory shorebirds.

FIGURE 5. Hawaiian Stilts in Aquaculture and Waste Ponds vs. Natural Wetlands, Kona Coast, Hawai`i (Ducks Unlimited 2002)

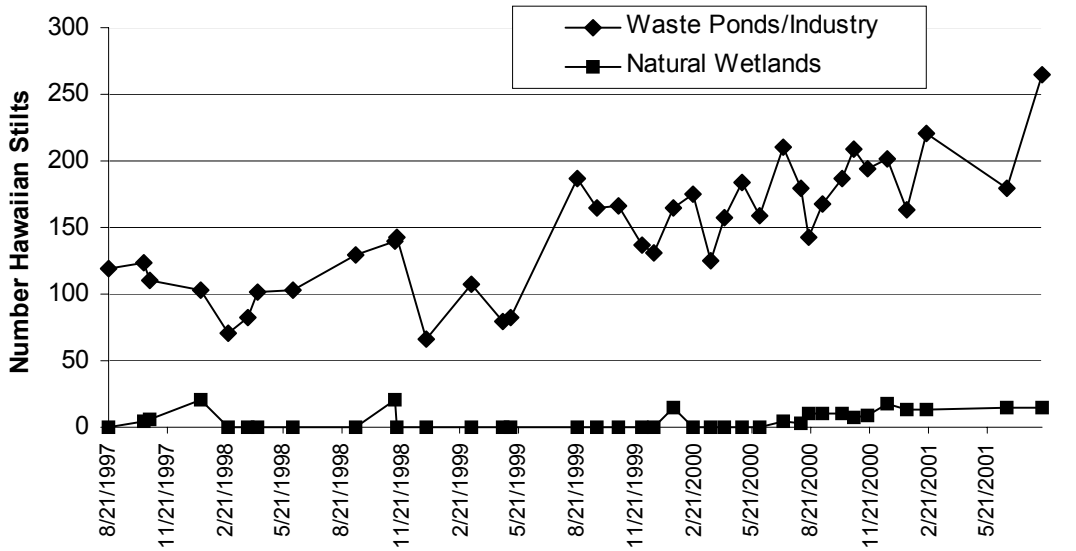
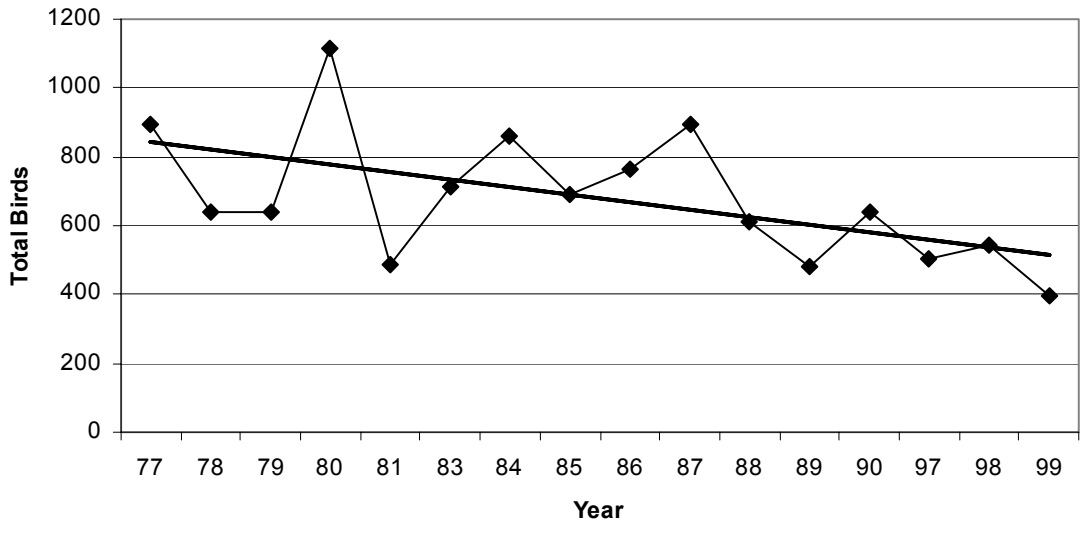


FIGURE 6. Shorebird Decline Since the Collapse of the O`ahu Sugar Mill in Early 1990s(Source: NAS 2000, 2001)



The beaches, bunch grasslands, and sparse shrublands of the Northwestern Hawaiian Islands support a surprising number of shorebirds (Amerson, Jr. 1971, Woodward 1972, Ely and Clapp 1973). Ample food, seclusion from human disturbance, and predator-free conditions are ideal for wintering species. Historically, beaches on the Main Islands no doubt provided important shorebird habitat, and still do, to a limited degree. Unfortunately most of the Main Island's beaches are key components to the tourist industry and human disturbance is high. A few secluded or protected beaches do provide limited habitat for shorebirds (*e.g.* on Lāna`i, Kaua`i's Na Pali Coast, and Kaena and Kahuku points, O`ahu).

The final habitat type used by shorebirds is grassland. These vary from urban parks and golf courses to large grazed pastures on the Island of Hawai`i. These habitats support a large number of golden-plovers, as well as a few turnstones, and Hawaiian Stilts (lowlands only). There are no data to quantify the importance of upland pastures, but field observations during the past decade indicate they are important for golden-plovers (A. Engilis, Jr. and K. Uyehara pers. obs.).

Northwestern Hawaiian Islands

Laysan Lagoon (735 ac [300-ha]) is a closed system that undergoes seasonal fluctuations in both depth and salinity. Brine flies and shrimp are abundant and provide an excellent food source for shorebirds. The lagoon along with adjacent sandy beaches provides important habitat for Pacific Golden-Plover, Bristle-thighed Curlew, and Ruddy Turnstone. Numbers exceeding 5,000 shorebirds are regularly counted during winter months (USFWS unpubl. records, NAS 2000, 2001, Ely and Clapp 1973). Another closed system is located on Spit Island, Midway Atoll. Smaller numbers of turnstone and tattlers winter there (A. Engilis pers. obs). An artificial water catchment on Midway Atoll also provides some wetland habitat for migrant shorebirds.

The most significant shorebird habitat in the Northwestern Hawaiian Islands is the secluded, uninhabited beaches and associated dry grasslands. The most extensive areas of this habitat type are on Kure, Midway, Pearl and Hermes, Lisianski, Laysan, and French Frigate Shoals. Fringing reefs also occur in association with the islands and support a few shorebirds, but are virtually unexplored and unsurveyed. The high counts of shorebirds on Christmas counts of Laysan and Midway show the importance of these islands (and habitats) for migratory shorebirds. These remote island habitats, particularly bunchgrass, are critical for Bristle-thighed Curlew (especially when they are flightless during molt) (Marks et al. 2002), but also support large numbers of Pacific Golden-Plover, Ruddy Turnstone, Wandering Tattler, and Sanderling.

Ni`ihau

As mentioned earlier, the ephemeral wetlands on Ni`ihau, are among the most important for migratory and endemic shorebirds in the Hawaiian Islands (Munro 1940, T. Telfer pers. comm.). State waterbird surveys have documented large numbers of Hawaiian Stilt (perhaps as many as 50 percent of the world population) nesting and foraging on Ni`ihau during wet years (Engilis and Pratt 1993). Three playas, when flooded, provide 1,900 ac (770 ha) of shallow basins. These are privately owned (as is the entire island). Little is known about importance of the upland habitats and beaches on Ni`ihau for shorebirds. Munro (1940) mentions Bristle-thighed Curlews present in November 1939 but did not directly associate them to habitat. Understanding the role of Ni`ihau's habitats for shorebirds remains a high priority in the Hawaiian Islands for recovery of endangered waterbirds (Ducks Unlimited 1998, USFWS 1999). Ni`ihau has not been surveyed by ground since 1939 so numbers and trends are poorly documented.

Kaua`i

Kaua`i is the wettest of the archipelago's Main Islands and supports the highest number of wetlands. Unfortunately many of the larger sites have been drained for agriculture. The 5,000-ac (2,024 ha) Mana Marsh was once the largest wetland in the islands but was drained in 1923 for sugar cane. Other coastal wetlands on Kaua`i were altered due to extensive hydrologic changes (*e.g.*, reservoirs for sugar cane and flood control). The remaining wetlands on Kaua`i are mostly overgrown with exotic vegetation and provide little habitat for shorebirds. Aquaculture is widespread and the extensive taro fields of the Hanalei River Valley and smaller fields in other valleys (Lumahai, Waimea, Hulei`a) support many shorebirds (Hawaiian Stilt, golden-plovers, turnstones, Calidris sandpipers). Kaua`i used to support several sugar cane effluent ponds, most of which have become recently inactive. These ponds, when active, supported numerous shorebirds; primarily turnstones, tattlers, golden-plovers, and Hawaiian Stilt (SIGHTINGS). The most common shorebird on Kaua`i is the Pacific Golden-Plover. It occurs in numerous habitats from coastal beaches up to the Alakai Swamp at 4,000 feet (1,219 m). There are no estuaries or playas of significance for shorebirds on Kaua`i. USFWS manages two refuges for waterbirds on Kaua`i (Hanalei and Hulei`a NWRs) and the State has two small reserves on the Mana Plain. A few Hawaiian Stilt breed at refuges and

State wildlife areas such as Hanalei and Hule`ia NWRs when conditions are suitable.

Most of Kaua`i's uplands are forested and steep, harboring only remnant patches of open grasslands and some bogs. Although golden-plovers can occur in these, they represent a small fraction of birds on the island. Lowland grasslands are associated with agricultural fields. The collapse of the sugar cane industry in Kaua`i jeopardizes much of the remaining agricultural lands, which has declined in acreage nearly 30 percent since 1970 (Morgan 1983, State of Hawai`i 1999). Much of this land is slated for urban development. In addition, pastures in some of the river valleys, *e.g.*, Hanalei and Wailua rivers, support migrant shorebirds, if they are grazed. Kaua`i has extensive golf courses and small parks that support numerous golden-plovers, but few other shorebirds.

The more extensive beaches have resorts and parks and thus, support few shorebirds.

O`ahu

O`ahu is perhaps the most diverse island in the chain in regards to shorebird habitat, with excellent tidal flats, estuaries, playas, ephemeral and permanent marshes, managed wetlands, and urban grasslands. However, many of the largest wetland and lowland sites have now been urbanized. Pearl Harbor, the largest estuary in the Pacific Islands, is heavily developed and industrialized. West Loch is the least developed portion of Pearl Harbor, but red mangroves *(Rhizophora mangle)*, an invasive species, have overgrown most of the mudflats historically used by shorebirds. Prior to mangroves, West Loch was heavily used by migratory shorebirds for foraging during low tide (Cogswell 1945, R. L. Pyle, pers. comm.). Other important tidal flats include Paiko Lagoon, Kaneohe Bay, Kewalo Basin, and the series of ponds at Nu`upia (Kaneohe Marine Corps Station Hawai`i). All are used by flocks of shorebirds for foraging at low tide, but mangroves have overgrown most flats and threaten others. Mangroves have been effectively removed from Nu`upia Ponds with positive benefits to shorebirds (Drigot 2001).

Most of the freshwater, ephemeral and managed wetlands on the windward and north shores of O`ahu are protected but exist in a degraded state (Kawainui Marsh, He`eia Marsh, Ka`ele`pulu Pond). Only the main complex of ponds at James Campbell NWR in Kahuku is widely used by shorebirds. Several playas exist on State land at Kahuku Point; most are overgrown by invasive plants. Historically, one of Hawai`i's largest wetland complexes was Waikiki. It was drained in the early 1920s paving the way for the development of Honolulu. Another critical wetland drained in the 1950s was Ka`ele`pulu Wetland in the town of Kailua. The USFWS manages two refuges for waterbirds on O`ahu, James Campbell and Pearl Harbor NWRs. The State of Hawai`i manages four refuges, Hamakua, Kawainui and He`eia marshes and Paiko Lagoon. The U.S. Marine Corps manages Nu`upia Pond, one of three critical sites for nesting Hawaiian Stilt (Drigot 2001). Other smaller outlets and estuaries, such as Kaiaka Bay, Opaeula, and Poamoho support small numbers of shorebirds.

O`ahu's historic shorebird habitats are mostly urbanized, but part of this development has been the creation of extensive mowed grass parks, golf courses, and lawns that support a surprising number of golden-plovers (Johnson and Johnson 1993). In addition, urban O`ahu rooftops provide important roosts for golden-plovers (Johnson and Nakamura 1981). Grasslands associated with dunes (Kahuku and Kaena points) provide habitat for golden-plovers and Bristle-thighed Curlews. At times curlews have been observed on North Shore Golf Courses

Waikiki circa 1920 and 1990. One of Hawai`i's largest wetland reclamation projects.

Photo by: Bishop Museum Photo Archives.

Photo by A.J. McCafferty.

(SIGHTINGS Database, A. Engilis, Jr. pers. obs.). Lowland grasslands are generally associated with agricultural fields, as fallow fields in crop rotation. The collapse of the sugar cane industry in Hawai`i jeopardizes many of the agricultural lands that are now slated for urban development. These cane lands provided open space buffers for wildlife areas, minimizing human disturbance to shorebirds and native waterbirds.

Some fringe coral reefs are exposed at low tides (Paiko Lagoon and North Shore of O`ahu) and frequented by golden-plovers, turnstones, tattlers, and Hawaiian Stilts. O`ahu's windward shore is dotted with several small islets and exposed rocks. These are important night roosts for migrant shorebirds that forage on the main island during the day (A. Engilis, Jr. pers. obs.). O`ahu's offshore islets (*e.g.* Moku Manu and Manana) are protected as seabird sanctuaries by the State of Hawai`i.

Maui Nui

Maui Nui comprises the four islands of Maui, Moloka`i, Lāna`i, and Kaho`olawe. Kaho`olawe is the driest and smallest island of Maui Nui. Lāna`i is also a dry island and contains no natural wetlands. Maui is a relatively young island and consequently does not possess the diversity of wetlands seen on O`ahu, despite its larger size. The windward slope of Haleakala creates high rainfall, but there are limited coastal flats to support wetlands. The main wetlands of Maui are located in the valley between Haleakala and West Maui. Kealia Pond, 740 ac (300 ha), is the largest wetland on Maui, and remains one of the most important sites in the Pacific for migratory shorebirds. It is part of Kealia Pond NWR and is a prime example of a coastal alkali marsh. Human modifications to the outlet have altered the hydrology and Refuge staff must now manage draining of the pond. These draw downs remain a critical management action needed to initiate nesting by Hawaiian Stilt and provide foraging habitat for stilts and migrant shorebirds. In early fall when small amounts of water sheet across this unvegetated pond, thousands of shorebirds can occur comprising as many as 14 species (plovers, turnstones, stilt, tattlers, Calidris sandpipers, dowitchers) (M. Nishimoto, USFWS pers. comm.). Nearly 50 percent of the world's population of Hawaiian Stilt use Kealia during this period (USFWS 1999). Numerous ephemeral basins occur in Kihei and along West Maui's southern shore, but most have been destroyed by development. Kanaha Pond, a deep-water habitat with some ephemeral habitat, is a State waterbird sanctuary surrounded by development on all sides. Despite this, the ephemeral basins are an important shorebird resource. Another small wetland, important for Hawaiian Stilt, is Nu`u Pond on Haleakala's southeast coast (USFWS 1999).

Most of Maui's beaches and dunes have been developed or degraded due to human alterations. Volcanic benches on Maui are exposed during low tides and are used by tattler, turnstone, golden-plover, and Hawaiian Stilt. Tattler, turnstone, and Sanderling sometimes use the beach fronting Kealia Pond. Maui's grasslands are diverse, ranging from golf courses to mid-altitude pasture, 3,000 to 6,000 feet (914 - 1,829 m) up Haleakala's slopes. Golden-plovers commonly use these grasslands throughout the winter.

Moloka`i's shorebird habitats are located principally in wetlands and playas along the southern coast. Most are degraded and have lost their wetland function, but the Pala`au Flats comprise a 6-mile (11 km) long stretch of coastal wetlands which, when flooded, are some of the most diverse in the islands (Table 5). Pala`au Flats was recently identified as an overwintering site for Bristle-thighed Curlew (A. J. McCafferty and A. Engilis, Jr. pers obs). Active restoration at several sites on the Pala`au Flats has provided excellent habitat for large numbers of shorebirds, including Hawaiian Stilt (Ducks Unlimited 1996). At the Ohiapilo Wetland restoration project Hawaiian Stilt production went from zero successful nesting prior to restoration, to 20 - 30 stilts fledged per year after restoration (K. Uyehara pers comm.).

Mo`omomi Dunes are remote and support a few curlews and golden-plovers. Moloka`i has large stretches of undeveloped dunes and coastal flats, but their importance remains unquantified. Mangrove invasion along the south shore has jeopardized most of these coastal flats. Grasslands are uncommon but some agricultural fields support golden-plovers. There are few parks or golf courses, and the latter are concentrated on Moloka`i's west shore. They provide for a minimal number of golden-plovers.

Lāna`i has no natural wetlands, but the wastewater treatment ponds now support a small number of shorebirds. Parks of Lāna`i City, golf courses, and fallow agricultural lands provide habitat for golden-plovers. Coastal beaches are frequented by only a few shorebirds.

Kaho`olawe is the driest of the Main Islands, however small ephemeral playas exist in the craters in normal and wet years. Lua Ke`ali`alalo is the largest one at 2 ha (4 acres) (P. Higashino, pers comm.). Both Pacific Golden-Plover and Black-bellied Plover have been recorded at this site in past years (R.E. David pers. comm.). Open space and the few beaches of the island support only a few shorebirds. There is a potential for habitat restoration on Kaho`olawe, and introduced mammals are currently being eradicated. The latter action could prove important for wintering curlews.

TABLE 5. Shorebird Surveys of Moloka`i's South Coast, 1995-1996 (Ducks Unlimited 1996)

Species	28-Sep-95	25-Oct-95	14-Nov-95	21-Dec-95	31-Jan-96	28-Feb-96	28-Mar-96
Pacific Golden-Plover	18	32	10	28	63	29	23
Ruddy Turnstone	23	22	16	9	35	14	16
Wandering Tattler	2	10	7	5	8	6	8
Sanderling	8	12	9	11	10	9	14
Bristle-thighed Curlew	7	14	9	5	3	4	5
Other Shorebirds	1	4	0	0	0	0	0
Species number	6	7	5	5	5	5	5
TOTALS	59	94	51	58	119	62	66

Hawai`i

Hawai`i is the youngest and largest of the Main Islands, and its wetlands are associated with the perched groundwater lenses along the Kona Coast and, to a lesser degree, several ponds along the windward coast. A few small lagoons occur as well. Two of the most important wetlands `Aimakapa and Opae`ula, are found on the Kona Coast. These two wetlands and several smaller ponds provide the only natural habitat for nesting Hawaiian Stilts on the island. Migratory shorebirds also use these wetlands. Windward coastal wetlands are deeper and heavily overgrown with emergent vegetation and provide limited habitat for shorebirds. The Kona Wastewater Treatment Plant and Cyanotech aquaculture facility are heavily used by stilts, golden-plovers, turnstones, tattlers, and *Calidris* sandpipers (Ducks Unlimited 2002)

Hawai`i has large tracts of short-grass pastures, the most extensive in the Pacific. These pastures are widely used by Pacific Golden-Plovers and Ruddy Turnstones. They range from sea level to 8,000 feet (0 – 2,440 m) elevation on Hawai`i's mountains: Kohala, Mauna Kea, Mauna Loa, and Hualalai. The most important are those of windward Kohala and Mauna Kea (K.Uyehara pers obs.). Typically the best pastures for shorebirds are those that receive greater than 60 inches (152 cm) of rainfall per year, are regularly grazed, and have fairly flat topography (A. Engilis, Jr. pers. obs). An example is the pastures of the Kehena region of windward Kohala. These become increasingly wet as you proceed towards the summit ridge. At the 60 inch isocline, pastures remain wet and sedges and other wetland indicators are common plants. In these zones flocks of up to 75 golden-plovers are recorded (K. Uyehara pers. obs). Lowland pastures also provide habitat for golden-plovers and turnstones, and are also used sparingly by Bristle-thighed Curlews (*e.g.*, pastures on Hawai`i's South Point).

Shorebird Species

Forty-seven species of shorebirds have been recorded in the Hawaiian Islands (Appendix 4). These can be grouped into three categories – resident, winter visitors, and migrants. The Hawaiian Islands are of primary importance, for four species: Hawaiian Stilt, Pacific Golden-Plover, Bristle-thighed Curlew, and Wandering Tattler. Only the Hawaiian Stilt is resident (and endemic). Other common winter visitors include Ruddy Turnstone and Sanderling. Winter visitors that occur annually in small numbers include Black-bellied Plover, Lesser Yellowlegs, Least Sandpiper, Pectoral Sandpiper, Sharp-tailed Sandpiper, Dunlin, and Long-billed Dowitcher. The remaining species are irregular or accidental. Pacific Golden-Plovers use the widest range of habitats and can be seen from sea level to 13,000 feet (3,960 m). They are most common in uplands, parks, pastures, and open wetlands. Ruddy Turnstones utilize high elevation

pastures, isolated beaches, flats and park lawns. Sanderlings are most faithful to mudflats, beaches, and open marshes. Bristle-thighed Curlews prefer undisturbed, predator-free habitats and most over-winter on secluded islands, beaches, and dunes. Small numbers winter on the Main Islands where dogs are controlled, or water is available for escape.

The Hawaiian Stilt is endangered, but at present the population is relatively stable, at low numbers. Limiting factors include habitat loss, predation by non-native vertebrates (*e.g.*, mongoose, cattle egrets, and bullfrogs) and habitat degradation. Stilt share habitat with three other endangered waterbirds, Hawaiian Coot (*Fulica alai*), Hawaiian Moorhen (*Gallinula chloropus sandvicensis)*, and Hawaiian Duck (*Anas wyvilliana*) and a draft recovery plan for these four Hawaiian waterbirds provides detailed information and recovery actions for this species (USFWS 1999, USFWS in prep.). The Hawaiian Stilt is coastal in its distribution and it is found on all the Main Islands except Kaho`olawe. Inter-island movements are common on a seasonal and perhaps even daily pattern (Reed et al. 1998). As with other recurvirostrids, the Hawaiian Stilt is a bird of open, early succession marshes and mudflats. Ephemeral wetlands, managed wetlands, and coastal playas are important habitats.

No comprehensive surveys of the entire archipelago are available to assess the status of migratory shorebirds in Hawai`i. Various surveys of specific habitats or individual islands are available but the trends indicated by these incomplete surveys are often contradictory. Engilis (1988) examined the Statewide waterbird surveys for trend data for a period of ten years and found the data set too limited to assess shorebird population trends (other than stilt). Other data sets include Audubon Christmas Bird Counts, field counts by agency biologists and birders, regular surveys of wildlife refuges (*e.g.*, Kealia Pond NWR, Hanalei NWR, Hamakua Marsh Wildlife Sanctuary), surveys for wetland restoration projects (*e.g.* Ducks Unlimited), and O`ahu golf course surveys for golden-plovers (Johnson and Johnson 1993). Audubon Christmas count data provided the most comprehensive coverage of shorebird habitats, but these were also limited by years of coverage. For Pacific Golden-Plover, these data suggest an increase in the islands since the 1940s. A significant action occurring at the beginning of the count (early 1940s) was the curtailment of golden-plover hunting in the islands in 1941 (Schwartz and Schwartz 1949).

The Statewide Waterbird Survey could provide a valuable data set once efforts to standardize protocol and enhance counts to cover shorebirds are implemented. Suggestions for strengthening the Statewide survey are listed in monitoring recommendations, below. In addition, the State of Hawai`i is working with the USFWS, the Hawai`i Natural Heritage Program, Tufts University, and the University of Hawai`i, Manoa to compile all data from State waterbird counts and analyze them using a GIS based framework. This data will provide a valuable means of assessing population status and trend for Hawaiian Stilt and other wetland associated shorebirds in the State.

Hawaiian Subregional Population Goals

- Support recovery actions in the Hawaiian Waterbird Recovery Plan (USFWS in prep.). Increase populations of Hawaiian Stilt to levels identified in the Recovery Plan for delisting and ensure multiple viable breeding populations on Kauai/Nihau, O`ahu, Maui/Molaka`i/Lāna`i and Hawai`i

- Protect and enhance populations of Bristle-thighed Curlews wintering in the Main Islands and maintain increasing or stable populations in the NWHI Islands

- Maintain or enhance populations of priority shorebirds species

- Accurately assess the population size and trends of over-wintering and migrating Pacific Golden-Plovers, Bristle-thighed Curlews, and Wandering Tattlers and coordinate with Alaska to develop quantitative population goals

Hawaiian Subregional Habitat Status, Threats and Management Goals

The following are specific recommendations for the Hawaiian Subregion.

Tidal Flats and Estuaries

The primary threats to this habitat are the spread of red mangrove and contaminants. Restoration through eradication of mangrove, followed by maintenance has met with success in the Nu`upia Pond complex, O`ahu (Drigot 2001), but if maintenance does not follow removal, the flats quickly become overgrown again as in the West Loch Project, Pearl Harbor (A. Engilis, Jr. pers. obs.). Pearl Harbor has experienced countless fuel and chemical spills over the past half century and more can be expected in the future. Four hazardous

waste sites at Pearl Harbor Naval Base have been identified by the U. S. Environmental Protection Agency (EPA) as superfund National Priorities. The Navy has identified 31 potential hazardous sources in Pearl Harbor alone. Hawai`i's estuaries are also impacted by non-point source pollution and sedimentation of flats has accelerated as a result of land use in the watershed (USFWS 1996). Thus as a wetland habitat type, tidal flats are among the most degraded in the Islands.

- Remove and control mangrove encroachment in tidal flats specifically in West Loch of Pearl Harbor, Kaneohe Bay, Kewalo Basin, Moloka`i's south shore, and in smaller impacted areas on all islands

- Continue mangrove control at Nu`upia Pond complex

- Protect remaining habitat from development and fill *e.g.*, Kewalo Basin, Pearl Harbor, Kaneohe Bay, and other estuarine systems

- Monitor habitats and shorebirds for contaminants and coordinate with response teams for clean-up of hazardous spills

Playas and Ephemeral Basins

The protection, restoration, and management of playa wetlands in the Hawaiian Islands is deemed crucial for the recovery of Hawaiian Stilt and maintenance of migratory shorebird populations (USFWS 1999). Major playas are still functional on Ni`ihau, O`ahu, Maui, and Moloka`i. On all islands, the main threat to playas has been the introduction of pickleweed and Indian fleabane. These aggressive plants have completely covered most coastal playas resulting in increased rates of siltation and accretion. In addition, accelerated sedimentation resulting from poor management of upland agricultural and ranch lands has heavily impacted playas (particularly on O`ahu and Moloka`i). The largest protected playa is Kealia Pond, but fleabane and pickleweed continue to encroach on the site. Annual drawdowns of Kealia Pond have created problems with the local community due to the stench of dead fish, midge (*Chironamidae*) blooms, and blowing dust (a natural deflation event characteristic of coastal playas), but this management action is critical for Hawaiian Stilt and migratory shorebirds. Wetland management should continue to investigate the manipulation of native and naturalized/exotic vegetation (moist-soil management) that provides important habitat for nesting, foraging, brooding, loafing, thermal/escape cover as well as minimizes impacts from human disturbance.

- Protect and restore degraded playa wetlands such as Mana Plains (Kaua`i), Pala`au Flats (Moloka`i), Kealia and Kihei wetlands (Maui) and Kahuku Point (O`ahu)

- Eradicate/control exotic plants (*e.g.*, pickleweed and fleabane) and restore the natural hydrology to playa wetlands

- Work with landowners and the local communities to survey and assess the Ni`ihau playas, and develop management strategies as needed

- Work with private landowners to restore and manage wetlands through cooperative and incentive programs (WRP, WHIP, PIF, NAWCA)

Permanent, Semi-permanent Wetlands

Coastal permanent and semi-permanent wetlands are used with less frequency by shorebirds than coastal strands, tidal flats, ephemeral wetlands, and playas. Most are also hydologically linked to montane watersheds. They suffer the same threats as ephemeral wetlands, overgrowth with invasive plants, and loss to urban encroachment. Most of the large, remaining wetlands in Hawai`i are protected by agencies but most have limited value to shorebirds due to poor habitat quality. Habitat restoration, vegetative clearing, and long-term management are required on these wetlands. The reader is referred to the Hawaiian Endangered Waterbirds Recovery Plan (USFWS 1999) for detailed needs and actions related to Hawai`i's wetlands.

Managed Water Projects (primary purpose is not wildlife related)

Managed water projects, whose primary purpose is not related to wildlife (*e.g.* taro, lotus, shrimp), include aquaculture, wastewater ponds, recreation areas, irrigation reservoirs, etc. These cultivated wetlands are most common on Kaua`i, O`ahu, Moloka`i, Maui, and Hawai`i. Cultivated wetlands are transient, in relation to long-term efforts to conserving habitats and maintaining populations of shorebirds. However, birds do become dependent upon them and local populations of Hawaiian Stilt and migratory shorebirds can be impacted if the practices are abandoned due to economic pressures, (*e.g.*, collapse of the sugar cane industry in Hawai`i). Minimizing dependence on cultivated wetlands must be made a priority by agencies as part of the recovery actions needed for endangered

Wastewater Pond, Hawai`i, Hawaiian Islands. Photo by A. Engilis, Jr.

Hawaiian waterbirds. These actions will also benefit migratory shorebirds. Balancing the restoration and management of wetlands dedicated for wildlife with reducing dependence on these habitats will remain a conservation challenge for some time to come.

- Identify standards for implementation of taro agricultural practices (drawdowns, weed control, fertilization) that avoid impacts to nesting, brooding and foraging shorebirds

- Minimize dependence on these habitats through improved shorebird habitat management on State and Federal refuges and reserves, particularly for Hawaiian Stilt

- Seek Safe Harbor Agreements or Habitat Conservation Plans for managed water projects to improve habitats for shorebirds

Sand Beach and Dunes

The most important beach and dune resources are located in the Northwestern Hawaiian Islands. These are critical habitat for wintering Bristle-thighed Curlew and important for turnstone and Pacific Golden-Plover. The main threats include human generated trash, contaminants, oil spills, and tarballs that wash up on the beaches. There are few beach sanctuaries in the Main Islands; exceptions include Ka`ena Point, O`ahu and Mo`omomi Dunes, Moloka`i protected under the Natural Area Reserve System, and National Park Service lands on Hawai`i and Maui. Beach access is not fully restricted by these agencies although in most cases vehicles and other destructive uses are prohibited. The main threat to shorebirds on Main Island beaches continues to be human related disturbance.

- Restore dunes on O`ahu, Moloka`i, and Maui and restrict ORV access to support native vegetation and habitat used by shorebirds, principally the Bristle-thighed Curlew

- Maintain secure beach and dune habitat in the Northwestern Hawaiian Islands

- Control introduced mammals in all Natural Area Reserves (State) and Federally protected beaches and maintain Northwestern Hawaiian Islands as mammal free

- Monitor the Northwestern Hawaiian Islands for trash accumulation, and clean periodically to maintain suitable beach and strand habitat

- Monitor beaches for oil and other contaminant issues and participate in response teams for emergency actions

Grasslands

Open and grazed grasslands are important habitats for wintering shorebirds, particularly those associated with small upland stock and wildlife ponds. The largest tracts are on private ranch lands located on Hawai`i and Maui where current management restricts public access and human disturbance is low. The primary issue with these grasslands is the best long-term use of the land, both from an economic and ecological perspective. Reforestation of native forests (for native forest birds) has been initiated, as have plantations for commercial production of Koa (native) and Eucalyptus (non-native). As the cattle industry becomes less lucrative, private landowners may explore other uses of pastoral lands. Management of pastoral lands has been proposed on Hawai`i and Kaua`i to support Hawaiian Goose (*Branta sandvicensis*) recovery and migratory shorebirds could also benefit.

- Develop Safe Harbor Agreements with landowners to protect grazed pasture for shorebirds and coordinate with ongoing efforts to provide habitat for Hawaiian Duck and Goose

Maui Golf Course. Photo by: Hawai`i Tourist Industry

- Develop Regional Habitat Conservation Plans for wetland and grassland management, incorporating shorebird needs, in coordination with landowners and agencies targeting key grassland regions (*e.g.*, upslope Maui, Kohala Mountains, and upslope Mauna Kea)

- Coordinate with reforestation efforts to incorporate grassland habitats to benefit a broad group of organisms

- Manage State and Federal protected, lowland grasslands in a state free from invasive plants such as Indian fleabane, fountain grass, and other invasive shrubs

- Seek to include grazing regimes in diversified farming operations by coordinating with landowners

- Promote integrated pest management practices of lawns and golf courses to minimize pesticide use

Rocky Shoreline/Offshore Islets

This habitat resource is relatively secure and is important for Wandering Tattlers, but provides limited habitat for other shorebirds. Uninhabited offshore rocks and islets are important as roost sites for shorebirds. Several offshore islets have been invaded by introduced mammals (rats, cats, and rabbits). There is an ongoing program by the Hawai`i Division of Forestry and Wildlife (DOFAW) to remove these predators. The re-colonization of islets by mammalian predators and human disturbance remain the principal threats to roost sites for shorebirds. Human access is currently restricted, but increased activity could pose a threat to shorebirds.

- Remove all introduced mammals from offshore islets and maintain predator free, relatively undisturbed roost habitats

- Restrict human access to minimize disturbance

Predator Control

Hawai`i has no living native, terrestrial mammals (except for a single species of bat). Introduced mammals, particularly Indian mongoose (*Herpestes javanicus*), rats (*Rattus rattus, R. norveigicus, R. exulans)*, feral cats (*Felis sylvestris*) and dogs (*Canis familiaris*) depredate native shorebirds reducing their populations and limiting suitable habitat. Rats were recently eradicated from Midway and Kure Atolls and the only remaining introduced mammal in the Northwestern Hawaiian Islands is the house mouse at Midway Atoll. Additional, predator specific actions are restated in habitat sections (above).

- Develop and maintain a predator control program particularly on O`ahu, Moloka`i, Maui, and Hawai`i, to protect Hawaiian Stilt and Bristle-thighed Curlews

- Monitor all islands and especially the Northwestern Hawaiian Islands to detect new predator introductions and initiate immediate eradication efforts

- Prevent introduction of brown tree snakes to the Hawaiian Islands

- Prevent spread of mongoose to mongoose free islands (Lāna`i, Ni`ihau, Kaho`olawe, and Kaua`i)

Monitoring Priorities

- Continue and fine-tune Statewide biannual monitoring of Hawaiian Stilt populations

- Monitor response of Hawaiian Stilt and migratory shorebirds to different management practices for managed wetlands

- Monitor shorebird response to habitat restoration to support an adaptive management approach to wetland and tidal flat conservation and management

- Develop a monitoring program for migratory shorebirds with initial emphasis on Pacific Golden-Plover, Bristle-thighed Curlew and Wandering Tattler. Assess and track changes in population size and habitat utilization

- Work with private landowners and local communities to monitor shorebird use of ephemeral playas, beaches, and dry grasslands on Ni`ihau

- Monitor trash accumulation (to target clean up efforts) on Northwest Hawaiian Islands to minimize impact on wintering shorebirds

Research Priorities

- Investigate population dynamics and inter-island movements of Hawaiian Stilt and determine the importance of playa wetlands (especially on Ni`ihau) to the maintenance of stilt populations

- Analyze and summarize Hawai`i Statewide waterbird survey data for past 25 years. Modify the survey as needed to improve the applicability to shorebirds

- Investigate the migration routes of curlew, golden-plover, and tattler and determine Hawai`i's role and linkages to Alaska and Asian populations. Identify important wintering sites, migratory stopover sites, and staging areas

- Analyze data from USFWS and DU restoration projects and initiate new studies to develop best management recommendations for shorebirds, especially Hawaiian Stilt, and distribute information to land managers

- Evaluate the effects of different management techniques on vegetation, water levels, and shorebirds. Continue research to identify management strategies for control of native and naturalized/exotic vegetation to produce habitat for nesting, brooding, foraging, and loafing habitat for shorebirds

- Evaluate the effects of contaminants, including pesticides on shorebirds (*e.g.*, golden-plovers utilizing managed grass lands: golf courses, lawns, pastures, etc.); shorebirds utilizing Pearl Harbor and other contaminated tidelands; shorebirds utilizing wastewater treatment ponds

- Identify important wintering sites, migratory stopover sites, and staging areas

- Study the ecology of Bristle-thighed Curlew on the wintering grounds including foraging habits, habitat requirements, population trends, and limiting factors

- Assess the incidence of disease in migratory birds, particularly the spread of West Nile Virus. Coordinate with animal disease specialists on the Mainland

- Assess Pacific Golden-Plover populations wintering and migrating through the region especially as it relates to habitat use and selection

- Research the removal and control of invasive plants including red mangrove, Indian fleabane, pickleweed, and California grass

- Investigate competition with Tilapia, design managed wetlands to control Tilapia invasions

- Quantify use of wastewater treatment ponds in relation to managed or natural wetlands

- Investigate the impacts of different grazing regimes on shorebird habitat use in pastures

- Investigate the implementation of a Statewide fall survey to capture the peak migration numbers, which will allow for comparison for over-wintering numbers as expressed by the mid-winter count

Education Priorities

- Educate the public about migratory and resident shorebirds and shorebird habitats (wetlands, tidal flats, grasslands, beaches)

- Expand education curricula looking at bird migration for grade school students

- Maintain and expand Kolea Watch that involves schools and the public in monitoring golden-plover

- Establish Kolea, Pacific Golden-Plover, as a centerpiece for a wildlife festival. Seek support from Hawai`i Tourism Office

- Maintain and enhance the Shorebird Sister Schools' Education Kit with region specific information, activities, games, books, etc.

Implementation and Coordination

The conservation of shorebirds (endemic and migratory) must be undertaken as part of a broad, landscape approach from wetlands and beach strand to grassland and upland conservation. Recently the Pacific Coast Joint Venture expanded its area of coverage to include Hawai`i. A technical subcommittee for shorebirds should be formed to provide input to the Joint Venture. Partners in this effort could include such agencies as USFWS, State Department of Land and Natural Resources, NRCS, USEPA, NPS, NOAA Fisheries, USDOD, Hawai`i Department of Education, Hawai`i Department of Agriculture. Private Sector would include groups such as DU; TNC; HAS; Hawai`i Nature Center, and research universities. Coordination with private landowners, aquaculture and agriculture interests will be instrumental in applying a landscape approach to shorebird conservation.

- Coordinate activities with Endangered Species Recovery efforts

- Encourage, on the ground, private and public partnerships to achieve habitat and population objectives

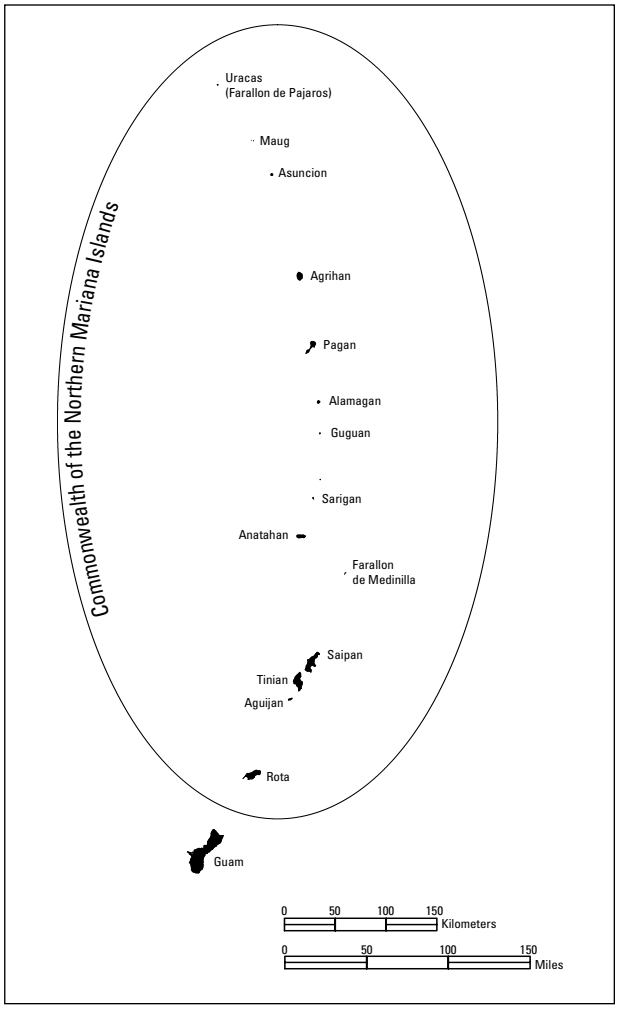
Mariana Islands Subregion

Description of the Subregion

The Mariana Islands include the island of Guam (U.S. Territory) and the Commonwealth of the Northern Mariana Islands (CNMI) (15 islands) (Figure 7). The chain extends from 13˚ to 21˚ North Latitude and 144˚to 146˚ East Longitude in the western Pacific Ocean. Guam, Rota, Tinian, and Saipan are inhabited by humans, small settlements also occur on a few of the other islands. The entire landmass of the chain is approximately 1,015 km^2, less than one tenth the size of the single island of Hawai`i. The largest island is Guam (554 km^2). The Mariana Islands are comprised of a combination of volcanic and uplifted limestone rock. The northern islands are mostly steep rock islets with rocky coastlines that receive little rainfall. The southern islands (including Guam, Rota, Aguijan, Tinian, Saipan, and Farallon de Medinilla) are generally larger, forested, and support coastal plain woodlands and grasslands. These islands are characteristically flat: the highest peak is 1,506 ft (459 m) on Rota, highest elevations on Guam reach only 1330 ft (406 m).

The Mariana Islands provide limited resources for migrant shorebirds due to their small size, narrow intertidal zone, and lack of extensive mudflats (Parish et al. 1987). The best habitat is on Guam and Saipan, the largest islands, with intertidal beaches, mudflats, freshwater wetlands, and grassy areas (Stinson et al. 1997a, 1997b). During the wet season, approximately June through November, ephemeral basins with short grass, exposed mud, and shallow pools provide habitat for migratory shorebirds wintering in the islands. These basins are dry by December or January and migrant birds concentrate on the few remaining wet areas or depart the islands (Stinson et al. 1997b). Many of the seasonal freshwater wetlands are choked with reed thickets and other weedy species and are not used by shorebirds. Farming activities help to reopen some choked sites and farm fields provide habitat, especially in the wet season. Larger expanses of short grass habitats associated with military bases, airports, golf courses, fields, and residential parks are utilized by golden-plovers and, to a lesser extent, turnstones. As in Hawai`i, acreage of these latter habitats has increased over the last century due to removal of native forests.

FIGURE 7.
Commonwealth of the Northern Mariana Islands



Shorebird Habitats

Wetlands of Importance to Shorebirds

Guam. Guam supports the most diverse setting of wetlands in the Marianas. Permanent wetlands are centered in four geographic regions (Talofofo River, Fena Valley, Atantano Marsh, and Agana Marsh). These wetlands are deep water habitats comprised of Pago tree swamps (*Hibiscus tiliaceus*) and are over grown by reeds (*Phragmites*) and California grass. Thus, they provide little available habitat for shorebirds. More important for shorebirds are the numerous depressions that fill as ephemeral ponds. Most are in agricultural settings and have degraded hydrology and support grasses and sedges. The importance of these wetlands is punctuated by the increase in acreage associated with seasonal rains. The base wetland

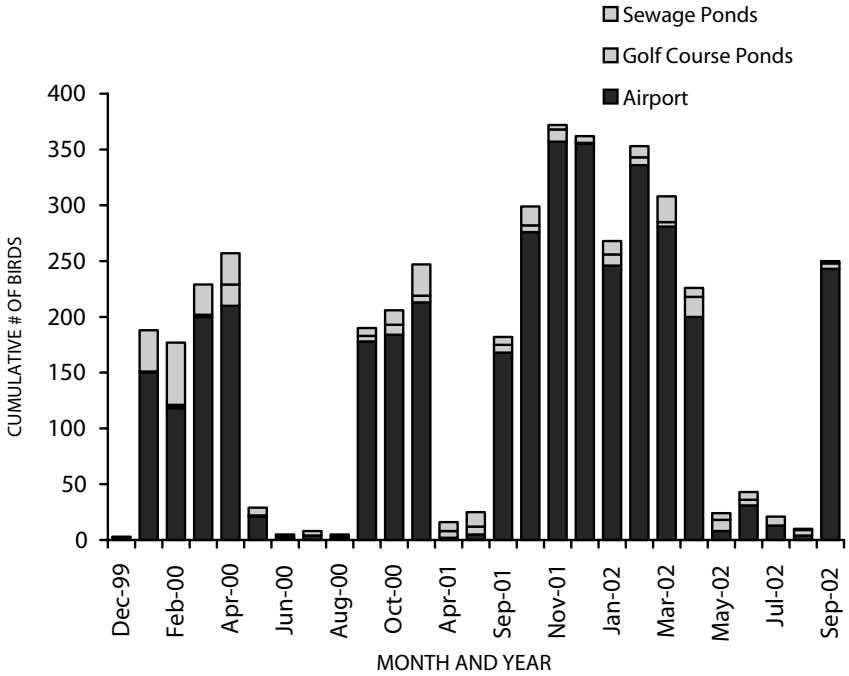
acreage on Guam averages 316 ac (128 ha) during the dry season (USFWS 1996). These are expanded to greater than 740 ac (300 ha) during the wet season. Man-made wetlands such as Fena Reservoir have further altered the wetlands landscape on Guam. Guam's western shore is lined with tidal flats and small estuaries that are used by wintering shorebirds. Over 170 ac (69 ha) of mangrove exist. Unlike Hawai`i, these mangrove forests are native and important for local fish and coastal species. They support some shorebirds, particularly tattlers.

Commonwealth of the Northern Mariana Islands. The islands of the CNMI have restricted wetlands used by shorebirds. Lake Susupe complex, located on Saipan, comprises over 60 percent of the wetland habitat. Lake Susupe, a brackish 42 ac (17 ha) pond, supports stands of *Phragmites, Scirpus*, sedges and water ferns along its shore and few shorebirds. Associated with Lake Susupe is a complex of semi-permanent ponds approximately 458 ac (185ha) in size. More important for shorebirds are the small ephemeral basins scattered along Saipan's western shore comprising approximately 90 ac (37 ha) of habitat. Many are overgrown with grasses, reeds, and sedges. The remaining wetlands of Saipan are seasonal in nature, filling during wet months and providing important foraging habitat for migrant shorebirds (turnstones, golden-plovers, tattlers, *Tringa* spp). Other significant habitats used by shorebirds are coastal flats, tidal estuaries and native mangrove swamps near Garapan. Limestone benches and exposed reefs dot Saipan's western shoreline. Emergent surfaces of these support migrant shorebirds. Tinian is the only other island with semi-permanent wetlands. The most important is Lake Hagoi, at 10 ac (4 ha). It is surrounded by 48 ac (20 ha) of ephemeral pools. Today, only about 2.4 ac (1 ha) of Lake Hagoi remain in open water, the remaining is overgrown with *Scirpus* and *Phragmites*. Tinian was heavily bombed during WWII creating depressions that fill in the wet season. A cluster of potholes are located near Tinian's northern, abandoned runway. Rota supports limited ephemeral wetlands but the runway seasonally accounts for most shorebirds observed (Figure 8). Wetlands that existed on Pagan were destroyed by a volcanic eruption in May 1981 (USFWS 1996).

Tidal Flats, Beaches, and Rocky Shoreline of Importance to Shorebirds

The remote islands of the northern Marianas are uninhabited and support rocky shoreline and limited strand beaches used by shorebirds such as golden-plovers, turnstones, and tattlers (Lusk et al. 2000). Beaches with intertidal zones, mud or sand flats are preferred. Key among beach sites are Tanapag and Puerto Rico mudflats and beaches (Saipan) and Dungcas flats and Beach (Guam) (Stinson et al. 1997b). On the larger islands, beaches provide little habitat for migrant shorebirds, in part due to human recreation and resorts. Rocky shorelines are extensive, especially on the northern islands. This habitat is utilized by tattlers, but is extremely remote and difficult to survey.

FIGURE 8. Seasonal Variation in Wetland Sites on Rota, 2000 - 2002. (Source: Dept. of Fish and Wildlife, Saipan)



Grasslands and Open Spaces of Importance to Shorebirds

Guam and Saipan support the only pastoral lands that are used by migrant shorebirds. Urban parks, golf courses, antenna fields, and grass edges of runways are frequented by golden-plovers and turnstones. On Tinian, the large concrete runways, abandoned after WWII, are used as loafing sites by golden-plovers and a few other species. During rainy periods, concrete runways can flood and shorebirds congregate to bathe and loaf, some ancillary foraging may occur in pools on the tarmac. Interior grassy patches on Farallon de Medinilla are frequented by Whimbrel, golden-plover, and turnstone (Lusk et al. 2000). The golf course on Rota supports a few shorebirds annually.

Shorebird Species

Forty species of shorebirds have been recorded in the Mariana Islands, most breed predominately in Asia, but the islands also support some North American populations (Reichel and Glass 1991, Wiles et al. 1993) (Appendix 4). Of these only the Pacific Golden-Plover is abundant (Jenkins 1981, Stinson et al. 1997b). Asiatic Whimbrel, Ruddy Turnstone, Wandering Tattler, and Grey-tailed Tattler are common to uncommon (Table 6). Another four species, all Palearctic breeders, are regular in very small numbers (10 – 50 birds per year): Mongolian Plover, Wood Sandpiper, Common Sandpiper, and Red-necked Stint (Stinson et al. 1997b). There are no resident shorebirds in the Mariana Islands. Few estimates of shorebird numbers are available for the Marianas. Baker (1951) and Owen (1977) summarized early 20th century accounts. The most recent estimates of relative abundance are provided by Jenkins (1981) and Stinson et al. (1997b). Reichel and Glass (1991) and Stinson (1994) provide a checklist of birds of the Mariana Islands with general categorization of abundance. Stinson et al. (1997b) estimates between 5,000 and 20,000 golden-plovers pass through the islands and a few thousand over winter, and Ruddy Turnstone wintering numbers fluctuate at several hundred birds. They give no estimates for tattlers in the Marianas probably due to identification problems associated with separating the two species. All other species occur in low numbers (< 200 birds). Radar studies indicate that only a small percentage of migrants stop at the Marianas. Most over-fly, probably on non-stop flights from Asia to the South Pacific, but exact patterns are poorly understood (Williams and Williams 1988). Recent studies suggest that shorebird populations in the islands naturally fluctuate, probably as a result of movements of birds through the islands en route to southern wintering quarters; October - December support the highest numbers of birds (Figures 9, 10). According to Stinson et al. (1997b), shorebird abundance and variety in the Marianas is greatest from September to April. Autumn migration, enhanced by first-year young, occurs longer than spring migration and involves larger numbers of birds.

TABLE 6. Shorebirds recorded on the 2000 Christmas Counts, Guam, Saipan, and Rota. (Source: NAS 2000, 2001)

	Pacific Golden-Plover	Ruddy Turnstone	East Asian Whimbrel	Tattlers (Gray-tailed and Wandering)	Other species (mostly Asian spp.)
South Guam	141	47	65	8	48
Dededo Guam	258	40	2	2	47
Rota	203	47	11	4	5
Saipan	284	53	0	3	10
TOTAL	886	187	78	17	110

FIGURE 9. Monthly Variation in Wetland/Wading Bird Counts on Siapan, 1999 -2002. (Source: CNMI Dept. of Fish and Wildlife, Saipan)

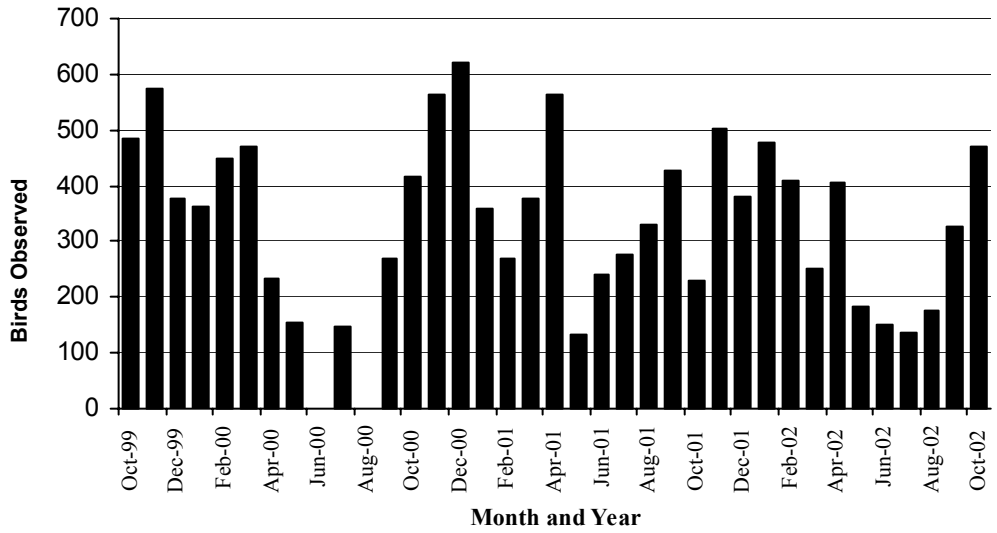
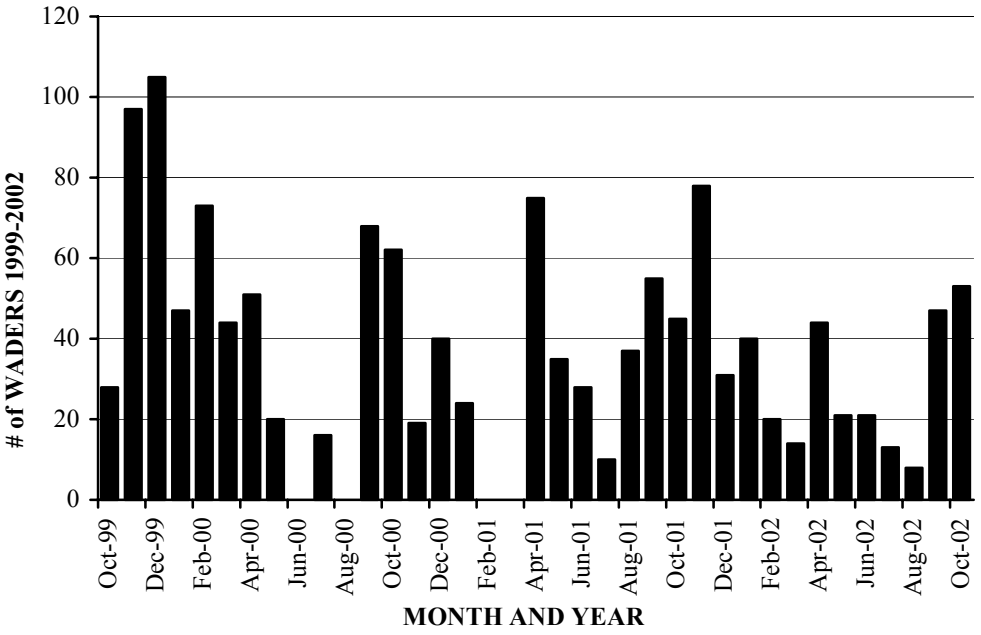


FIGURE 10. Seasonal Variation in Numbers of Shorebirds Along Saipan's Coasts. (Source: CNMI Dept. of Fish and Wildlife, Saipan)



Marianas Subregional Population and Habitat Goals

The population status of migrant shorebirds in the Marianas is unknown. Several species wintering in the Marianas exploit a variety of habitats. Pacific Golden-Plovers over-winter in close association with humans. They forage on lawns, fields and other short-grass habitats, and roost on tarmacs of military fields, and rooftops. Without a better understanding of existing populations and trends, it is impossible to set population goals. Key in the Marianas is the protection and management of tidal flats, beaches, ephemeral wetlands and grassy areas utilized broadly by many species of shorebirds.

- Conduct island-wide shorebird surveys to quantify population levels and habitat associations

- Manage existing wetlands, with emphasis on protection and restoration of wetlands and tidal flats

- Develop a GIS system that identifies and ranks key shorebird habitats in the Mariana Islands

Marianas Subregional Habitat Status, Threats, and Management Goals

Wetlands

Impacts to wetlands in the Mariana Islands are generally divided into two categories: agriculture prior to WWII and urbanization and military development after WWII. Agricultural development has resulted in the loss of numerous ephemeral basins through land leveling and plowing. Larger wetlands were drained and diked to cultivate rice and taro, and for public health reasons (USFWS 1992). During WWII, Japanese occupation expanded rice and taro production at the expense of wetlands on Guam, Saipan and Tinian. Forest clearing increased evapotranspiration drying ephemeral pools in forests (Nakajima 1944). Over the past two decades, the economies of the Mariana Islands have become more dependent on tourism and have moved away from subsistence-based lifestyle. The military continues to have a major presence in the Marianas. As the human population increases, so too will the need for more development. To support tourism, pressures have been placed on wetlands, estuaries, and beaches particularly on Guam and Saipan; the islands that support the highest numbers of shorebirds. No estimates as to the loss of wetlands on Guam are available, but nearly 65 percent of Saipan's wetlands have been lost due to human actions (Stinson et al. 1991). Coastal wetlands can also be affected by well development, impacting aquifers, which support perched wetlands along the coast of larger islands. Little emphasis has been placed on the protection of ephemeral basins and they continue to be farmed and hydrologically altered. Most major wetlands are protected, but without active management these systems will become choked with vegetation. Although this degrades shorebird habitat, *Phragmites* and *Scirpus* thickets do provide habitat to a varying degree for the endangered Mariana Moorhen *(Gallinula chloropus guami)* and Nightingale Reed-Warbler *(Acrocephalus luscinia)* and thus a balance of open wetlands vs. vegetated wetlands must be maintained (USWFS 1992, USFWS 1995). Recovery actions recommended for the Mariana Moorhen and Nightingale Reed-Warbler address the need to restore and manage habitat and reduce predation by introduced mammals and brown tree snake (*Boiga irregularis*). As in Hawai`i and continental populations, Mariana Moorhens use ephemeral wetlands as dispersal and nesting habitat and these needs should be coordinated with shorebird habitat needs (Nagata 1983, Stinson et al. 1991a, Takano 2003). The protection, restoration, and possibly even the creation of wetland complexes that support permanent wetlands associated with ephemeral basins should be developed on Guam, Tinian, and Saipan.

- Incorporate habitat considerations for shorebirds into wetland management on Guam (Agana Marsh, Atantano Marsh) and CNMI (Lake Susupe, Lake Hagoi). Restore ephemeral marshes at key wetland complexes through vegetation removal or control

- Develop management strategies to maintain ephemeral wetlands free of invasive vegetation

- Coordinate habitat management for shorebirds with recovery actions for endangered wetland species (reed warbler and moorhen)

- Coordinate mitigation wetlands to maximize complexes of ephemeral and permanent sites

Tidal Flats, Beaches, and Mangrove Estuaries

Historical loss of tidal habitats was accelerated by the USDOD between 1945-1950. During this period an estimated 1,200 ac (485 ha) that included mangroves and permanent wetlands were filled along the west-central coast of Guam (USFWS 1996). The majority of tidal flats, beaches and mangrove estuaries that remain on Guam are owned by territorial or Federal agencies. Threats to these systems include pollution, contaminants, and fuel spills associated with increasing human populations and military activities, particularly on Guam and Saipan. Numerous oil spills, offshore of Saipan,

Guam, and Tinian, have been documented by the USFWS (1996). Increasing tourism will undoubtedly put pressures on developing prime beach locations on Saipan, Guam, and Tinian. Specific recommended actions include:

- Coordinate with USDOD to support habitat protection of tidal and beach habitats as part of overall land management strategy

- Seek protection status for key beach and tidal flat habitats, *e.g.*, Tanapag and Puerto Rico (Saipan) and Dungcas (Guam)

- Address potential contamination of Puerto Rico Mudflat from the Saipan Dump and effect cleanup if needed

- Monitor habitats and shorebirds for contaminants

- Coordinate with response teams for damage assessments, contaminant clean-ups, or emergency response to spills

Agricultural Lands

Agricultural lands on Guam and Saipan and the seasonally flooded basins are threatened from expanded human development and conversion to other uses. Easement programs through NRCS might serve to help establish land easements.

Cultivated wetlands are not a significant resource in the Mariana Islands.

- Identify and map key agricultural areas that support ephemeral wetlands and target for restoration and protection

- Expand opportunities for agricultural land, easements, or cooperative agreements to protect open space from development pressures (NRCS, USFWS programs)

Predator Control

The extinction of most of Guam's avifauna has been directly attributed to the spread of the introduced brown tree snake (Savidge 1987). The impact of the brown tree snake on migrant shorebirds is unknown, but should be addressed in any conservation plan involving migrant shorebirds. It could become a serious problem throughout the Pacific if accidentally introduced to other islands. Currently it is restricted to Guam, but records from Saipan and Hawai`i continue to occur as snakes stow-away on airplanes and boats. Introduction to islands that support Bristle-thighed Curlews or resident endangered species such as Hawai`ian Stilt or Tuamotu Sandpiper could be catastrophic for these and other endemic species. An international effort has been developed to prevent the spread of the brown tree snake to other Pacific Islands (USFWS 1996). Introduced mammals, especially rats and feral dogs are a limiting factor in the survival of resident and migrant waterbirds. The impact on migrant shorebirds is undocumented.

- Control and ultimately eradicate brown tree snake

- Control introduced mammalian predators at key wetland complexes in the islands

- Eradicate introduced mammals and reptilian predators from islands where feasible

- Rigorously implement measures to ensure the brown tree snake does not spread to other Mariana Islands or other USPI

- Develop a response plan for quick detection and eradication in the event predators are introduced

Monitoring Priorities

- Implement regular surveys to assess species, abundance, population trends and habitat utilization of migratory shorebirds

- Develop and standardize Guam and CNMI biannual waterbird monitoring program inclusive of migrant shorebirds

- Monitor shorebird response to habitat restoration to support adaptive management strategies as a component of wetland and tidal flat conservation

- Establish a monitoring program for the early detection of brown tree snake and introduced mammals on predator free islands

- Monitor for contaminants and spills on beaches, wetlands, and tidal flats that are important for shorebirds

Research Priorities

- Identify where wetlands can be created in an effort to balance shorebird habitat needs with urban growth (GIS coordinated)

- Investigate habitat use and shorebird occurrence in the islands and quantify the importance of habitat type to maintenance of shorebird numbers

- Develop adaptive management strategies for ephemeral wetlands

- Continue research of life history and effectiveness of control/eradication efforts on brown tree snake

Education Priorities

- Educate the public about migratory shorebirds and the importance of shorebird habitats (wetlands, tidal flats, grasslands, beaches)

- Develop educational resources for USDOD personnel on shorebird ecology, threats (predators and disturbance) and important habitats: beaches, dunes, mudflats, wetlands, and grassy areas

- Develop education curricula on migration to promote an understanding of the connectivity of the Mariana Islands to other regions of the globe

- Involve schools and the public in the monitoring program for golden-plover, expand Kolea Watch efforts

Implementation and Coordination

CNMI Division of Wildlife and USFWS (Guam, Rota) have expanded efforts to develop an island-wide ecosystem planning effort through the development of Habitat Conservation Plans (HCP) for each island. These HCPs address habitat fragmentation, important wetlands resources, and attempt to address conservation with economic growth and development within watersheds. They also attempt to link the recovery actions for endangered species in the islands. Two endangered species use wetland habitats in the Marianas, the Mariana Moorhen and Nightingale Reed-Warbler. Recovery plans call for protection of wetlands for both species. Although the conservation of migratory shorebirds in the Mariana Islands will not be of primary focus in the development of HCPs and other planning efforts, resource managers should integrate the maintenance of shorebird populations in the Marianas. The USFWS has developed a multi-agency partnership with the USDOD for the protection, development, and management of fish and wildlife resources on Guam and Tinian. Natural areas on public and private lands are protected by local and Federal regulations but are not under cooperative management. Key areas need to be prioritized by local governmental agencies and the USFWS. Coordination with development and economic plans for expanding tourism needs to be a continuing focus by resource agencies.

Ephemeral freshwater wetlands on Guam. Farmed wetland with overgrown wetland in near foreground (left). Unfarmed wetland basin (right). Photos by Andrew Engilis, Jr.

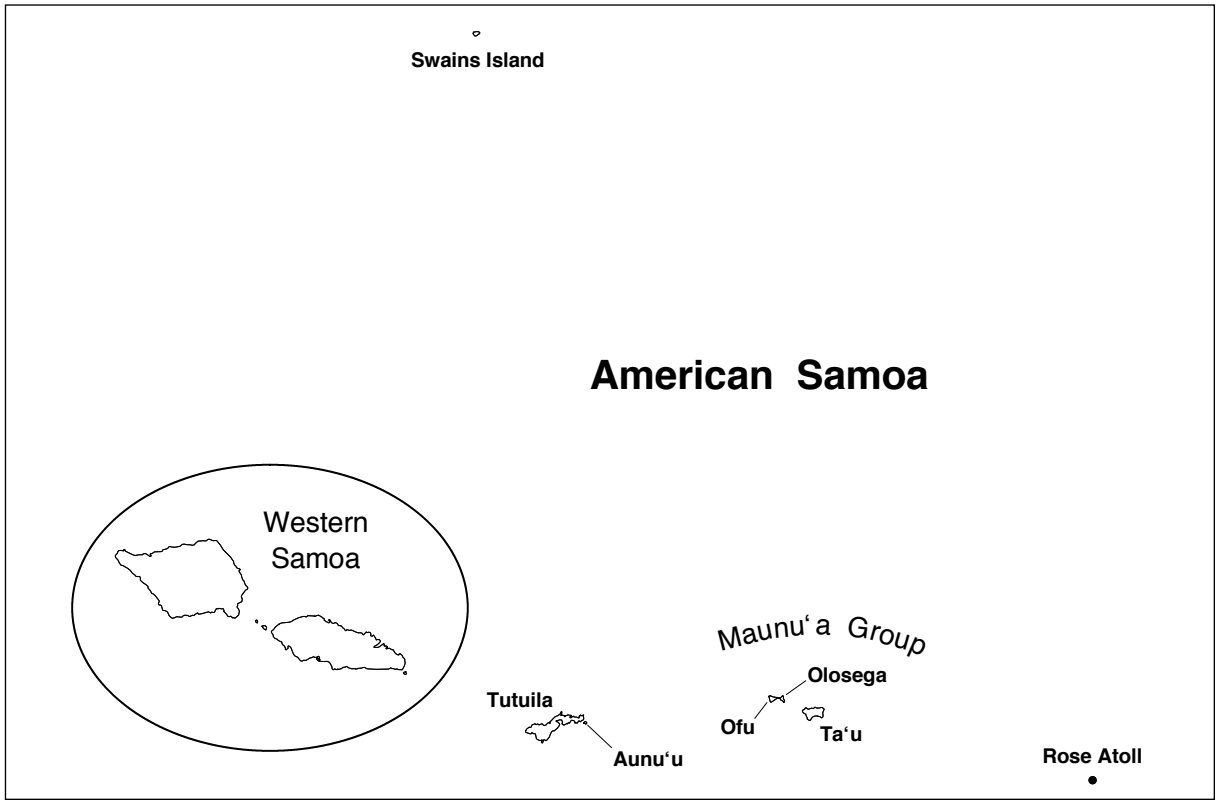
American Samoa Subregion

Description of the Subregion

American Samoa comprises five high volcanic islands (Tutuila, Aunu`u, Ta`u, Olosega, and Ofu) and two coral islands (Rose Atoll and Swains Island) (Figure 11). This plan does not cover the independent nation of Samoa (Savai`i and `Upolu). American Samoa is located at 14° south Latitude and from 168° - 171° west Longitude. All of the high islands rise steeply from the ocean, supporting rugged interior forests and narrow coastal plains. The islands receive from 125 – 300 inches (317 – 762 cm) of rainfall annually, most falling between October and March, with higher precipitation in the uplands. The islands range in size from 395 ac (1.6 km^2) (Aunu`u) to 54.8 $mi^2$ (142 $km^2$ ) (Tutuila) and the highest peak is 3,166 ft (965 m) (Ta`u). Wetland acreage is limited, occurring primarily along the coastal plains. Swains Island and Rose Atoll are low coralline islands less than 10 m high. Swains Island is a small raised atoll enclosing a 259-acre (105 ha) central, brackish lagoon bordered by 4 acres (1.61 ha) of coastal marsh. Similar to Laysan Island, Hawai`i, this water body functions more as a lake than a true lagoon. Rose Atoll is a USFWS National Wildlife Refuge (part of the Pacific Remote Islands National Wildlife Refuge Complex) and is the world's smallest atoll with two islets on a nearly circular reef. Rose Island is dominated by shrub vegetation and harbors a small Pu`avai (*Pisonia grandis*) forest. Sand Island is a sandy islet with no vegetation. The combined area of the two islets is approximately 24.7 ac (0.1 km^2).

Shorebird habitat in American Samoa is limited, and the migrant shorebird community is low in both species diversity and abundance. Habitats used by shorebirds include beaches and rocky shorelines, enclosed lagoons, mudflats, littoral and mangrove forests, and to a lesser degree, wetlands. The Pacific Golden-Plover is the most numerous species and uses a wide array of habitat including lawns, grasslands and other open spaces associated with human development in the Pacific. Wandering Tattlers are most common on rocky beaches but they also utilize a wide range of habitat from high mountains to grassy runways (Amerson, Jr. et al. 1982).

FIGURE 11. American Samoa



Shorebird Habitats

Wetlands and Enclosed Lagoons

American Samoa supports 495 wetland acres (200 ha): 350 ac (142 ha) on Tutuila, 112 ac (45 ha) on Aunu`u, 20 ac (8 ha) on Ta`u, and smaller sites are scattered on other islands. Only 100 acres (40 ha) are freshwater wetlands and most harbor emergent stands of ferns (*Cyclsorus interruptus* and *Acrostichum aureum*) and spike rush (*Eleocharis sp.*). The majority of these acres are at Nu`u`uli Pala lagoon and on the small offshore island of Aunu`u. Along river bottoms, swamps predominate with a dense understory of ferns. Some ephemeral wetlands exist but to a lesser degree than in the Marianas and Hawai`i, a result of Samoa's steep topography and narrow coastal plains. Except for Aunu`u, these wetlands are of limited importance for shorebirds, but habitat restoration and management could improve conditions for migrant birds.

Aquaculture is common in American Samoa; taro is the predominate crop. In 1989, taro covered 1,240 ac (495 ha) in American Samoa, mostly as small family farms and local commercial farms (Am. Samoa Comm. College web site 2002). Since then the taro blight affected numerous acres in production and hence has become a limited habitat for shorebirds. Dry land taro is now the predominate variety grown. Wetland taro is grown in limited acreage on Aunu`u and Ta`u. On these islands, taro fields are not flooded, as they are in Hawai`i. However, exposed mud and fallow ground during early growth stages of taro can support low numbers of shorebirds.

Beaches and Rocky Shorelines

Sandy beaches are a common feature of these eroded islands, especially along the south shores, and they are an important habitat type for curlews, golden-plovers, turnstones and, to a lesser degree, tattlers (Amerson, Jr. et al.1982). There are approximately 21 miles (53 km) of coralline beaches in American Samoa, and many remain undeveloped, although sand-mining has depleted natural beaches in some areas. These beaches also are important for nesting sea turtles. In particular, the beaches bordering lagoons at Rose Atoll and Swains Island are important wintering habitat for Bristle-thighed Curlews (Amerson, Jr. et al. 1982). Another important habitat is the rocky shoreline where most of American Samoa's Wandering Tattlers over-winter. The use, distribution, and actual numbers of shorebirds in these habitats remains unclear and better quantitative data are needed to assess conservation needs. The beaches and dunes of Rose Atoll and Swains Island are known to support Bristle-thighed Curlews, but overall shorebird use on these remote islands is poorly documented.

Estuaries, Littoral Forests, Mangroves, Flats

There are few estuaries in American Samoa and those that exist are small as a result of short, steep watersheds on the high islands. On Tutuila, Nu`uuli Pala Lagoon is an embayment with extensive mudflats near its upper end. This area provides important shorebird habitat. Other areas, notably the Leone Pala on Tutuila and the Aunu`u wetlands have mudflats that are used by shorebirds. Mangroves reach their eastern limit in American Samoa. Mangrove forests are found only on Tutuila and Aunu`u and are characterized by red mangrove, grasses and sedges. The largest mangrove forest remaining in American Samoa (100 acres [40 ha]) is located at Nu`uuli Pala. Amerson, Jr. et al. (1982) recorded good numbers of golden-plovers and tattlers in mangrove forests. Much of American Samoa's mangrove forests have been degraded or destroyed by humans. The Nu`uuli Pala forest contains a unique plant community that has almost disappeared from American Samoa (Amerson, Jr. et al 1982). Protection of the remaining forests should be coupled with protection of surrounding wetlands and lagoon mudflats.

The littoral forests of American Samoa support a surprising number of shorebirds including golden-plovers and tattlers (Amerson, Jr. et al.1982). This forest type has been mostly cleared by humans for rural development and settlements, and as a result has become a threatened habitat. As with mangroves, the clearing of this forest type may have had detrimental impacts to shorebird numbers, but the impact remains undocumented. Littoral forests are dominated by lau fala (*Pandanus*), *Pisonia,* or futu (*Barrintonia*). The dominant tree depends on the substrate and soils. Protection of remaining littoral forests and possible reforestation is an important conservation action.

Grasslands of Importance to Shorebirds

Similar to other Pacific Islands, ornamental grasslands, grazed areas, lawns, runway edges, and parks support Pacific Golden-Plovers. Village lands are of particular importance for golden-plovers (Amerson, Jr. et al.1982). Large pastoral lands, such as those that occur in the Hawai`ian Islands, do not exist in American Samoa.

Shorebird Species

Only seven species of shorebirds have been recorded in American Samoa, although undoubtedly others have occurred (Appendix 4). The most common are Pacific Golden-Plover, Wandering Tattler, and Ruddy Turnstone. Bristle-thighed Curlews are regular winter visitors on Rose Atoll and Swains Island, and have been recorded from Nu`uuli Pala Lagoon on Tutuila, and from Aunu`u. The golden-plover, tattler, and turnstone can be found in a variety of habitats. Amerson, Jr. et al. (1982) conducted an inventory and have provided the only estimates of these species in American Samoa. They estimated 4,500 Pacific Golden-Plovers, 900 Wandering Tattlers, and 550 Ruddy Turnstones. These numbers are small relative to total USPI populations, except for Wandering Tattlers.

American Samoa Subregional Population and Habitat Goals

The population status of migrant shorebirds in American Samoa is poorly known. As with Hawai`i and the Marianas, common species wintering in the islands exploit a variety of habitats.

- Determine the population size and trends in abundance of shorebirds and identify critical habitats for long-term protection and monitoring, emphasis on Pacific Golden-Plover, Wandering Tattler, and Bristle-thighed Curlew

- Determine, the breeding origin, migration routes and turnover rates for golden-plovers and Wandering Tattlers

Habitat Status, Threats, and Management Goals

A major issue facing America Samoa's marine and coastal resources is non-point source pollution. Tutuila's coastal environments and coral reefs have shown degradation as a result of landfill contamination, oil spills, pesticide runoff, industrial waste, and incineration (USFWS 1996). Human sewage disposal and waste disposal from piggeries contaminate nearshore resources and estuaries, including Nu`uuli Pala Lagoon. In 1993, a commercial fishing vessel (the Jin Shiang Fa) ran aground at Rose Atoll and dumped more than 100,000 gallons (378,500 liters) of diesel fuel and 2,500 lbs (1,134 kg) of ammonia onto the reef, causing widespread damage in the lagoon (USFWS 1996). Although oil spills of this nature are not common in Pacific atolls, a single occurrence can be catastrophic to the ecosystem.

The USFWS estimates that nearly 25 percent of historic wetlands have been lost in American Samoa. The highest percentage of wetland loss has been in littoral and mangrove forests (Amerson, Jr. et al. 1982). Most of the losses are the result of reclamation projects in conjunction with the development of Pago Pago Harbor and human settlements. Protection of remaining habitats on Nu`uuli Pala Lagoon and the Aunu`u wetlands are important to conservation of wintering shorebirds in American Samoa. Habitat restoration efforts could be investigated on the high islands. The wetlands of American Samoa historically supported two rare species, the Spotless Crake (*Porzana tabuensis*), and the Pacific Black Duck (*Anas superciliosa*) rediscovered in the early 1990s (USFWS pers. comm.). The Spotless Crake was rediscovered in a coastal wetland in the mid-1980s (Engbring and Engilis 1988), but now is known to occur in American Samoa only on the summit of Ta`u Island. The Pacific Black Duck occurs in low numbers in wetlands on Manu`a and Aunu`u. The cultural importance of wetlands, both in maintaining the natural biota and cultivated wetland practices, should be built into agencies' efforts to conserve wetlands.

Introduced mammalian predators hinder conservation efforts in American Samoa. The Polynesian rat has been eradicated from Rose Atoll, but persists on Swains Island. Cats have been liberated on Swains Island to address the rat problem and their impact on nesting seabirds and migrant shorebirds is unknown. Cats, dogs, pigs, and rats occur on the high islands.

- Protect existing wetlands, placing an emphasis on Nu`uuli Pala, Aunu`u, and Swains lagoon

- Evaluate restoration potential for wetlands that support shorebirds

- Work with farmers to provide protection for wintering shorebirds that use aquaculture fields

- Identify important remaining littoral and mangrove forests and seek their protection

- Restore littoral and mangrove forests where feasible

- Eradicate all introduced mammals from Swains Island

- Establish a monitoring program for the early detection of introduced mammals on predator free islands and a response plan for quick eradication in the event predators are introduced

Monitoring Priorities

- Develop a standardized biannual waterbird monitoring program for American Samoa that includes migrant shorebirds, with initial emphasis on curlews, golden-plovers, and tattlers

- Monitor shorebird response to habitat restoration to support an adaptive management approach to wetland and tidal flat conservation

- Monitor for contaminants and spills on beaches, wetlands, and tidal flats that are important for shorebirds

- Work with local authorities to assess damage and outline restoration needs

Research Priorities

- Assess species richness, abundance, trends in abundance, and habitat use of migratory shorebirds (emphasis should be placed on variation in abundance and habitat use of golden-plovers, Bristle-thighed Curlews, and Wandering Tattlers)

- Determine if land crabs accumulate toxins harmful to humans when exposed directly or secondarily to rodenticides

- Examine limiting factors for shorebirds using lagoon systems

- Develop habitat-based GIS data layers to compare the distribution of important shorebird habitats with the distribution of human activities and conservation projects

- Develop a coordinated strategy to create and enhance habitats that can be used by migrant shorebird and resident waterbird species

Education Priorities

- Educate developers, economic planners, and the public about the importance of littoral forests, mangroves, wetlands, and beaches in maintaining Samoan wildlife

- Educate the public about migratory shorebirds

- Develop primary and secondary school curricula on shorebird migration, emphasize connectivity of American Samoa with Alaska, Siberia, and the rest of Oceania

- Involve schools and the public in a monitoring program for golden-plover, *e.g.* expand Kolea Watch and the shorebird sister schools program

Implementation and Coordination

Conservation and restoration of shorebird habitats in American Samoa requires close cooperation and coordination with the Government of American Samoa and the agencies and individuals responsible for environmental protection and planning for economic development in the territory. The USFWS has developed a multi-agency partnership with the Government of American Samoa to develop a coastal ecosystem restoration and enhancement program. Key to cooperative efforts on behalf of shorebirds is the improvement of information about wetlands, shorebird use, and other native wetland-dependent species. Protection of low coral islands and atolls is paramount not only for shorebirds but also breeding seabirds, sea turtles, and maintenance of coral reefs. Coastal conservation efforts have become established in American Samoa through the American Samoa Coastal Management Program, the Department of Marine and Wildlife Resources, and the American Samoa Environmental Protection Agency. Shorebird conservation should be incorporated into coastal conservation planning strategies.

Central Pacific Islands Subregion

Description of the Subregion

U.S. possessions in the Central Pacific are scattered across millions of square kilometers of ocean and include islands in three different archipelagos: Howland and Baker Islands (Phoenix Archipelago), Jarvis Island, Kingman Reef, and Palmyra Atoll (Line Archipelago), Wake Atoll (Marshall Archipelago), and Johnston Atoll (Figure 1). The combined land area of these islands is only 12.9 mi^2 (33.4 km^2) (Table 7). All are arid islands with low annual rainfall except Palmyra, which supports a dense rain forest. Human habitation is restricted to military installations on Johnston and Wake, and a small civilian population on Palmyra. The military base at Johnston is closing and USDOD is currently working with contractors and USFWS to remove buildings and contaminants from the atoll. The USFWS manages Howland, Baker, Jarvis, Kingman Reef, Johnston, and Palmyra NWRs as part of the Pacific Remote Islands National Wildlife Refuge Complex. The largest island at Palmyra is not included in the NWR and it is owned and managed by The Nature Conservancy; USFWS manages the submerged lands and the rest of Palmyra's emergent lands.

Johnston Atoll. USFWS Photo

Shorebird Habitats

Wetlands of Importance to shorebirds

There are no natural wetlands in this subregion.

Beaches of Importance to Shorebirds

Beaches, especially on uninhabited islands, are an important resource for shorebirds. Most of these islands are so small that they consist almost entirely of beach strands with associated dunes. Only Palmyra has dense littoral forests (comprised of *Pisonia* trees), which are used by shorebirds. The other islands support short grasses and sparse shrubs.

Margins of Lagoons

Atoll lagoons are a common feature in this subregion and their margins offer habitat for migrant shorebirds, particularly curlews and golden-plovers. Those of noted importance for shorebirds include the lagoon margins and intertidal flats at Palmyra and lagoon margins at Wake and Johnston.

TABLE 7. Characteristics of Primary Islands in the Central Pacific Islands Subregion.

Island/Atoll	Size	Max Elevation	Archipelago	Characteristics
Howland	1.6 km^2	3m	Phoenix	coral island, fringe reef, herbaceous and shrub vegetation
Baker	1.4 km^2	8m	Phoenix	coral island, fringe reef, herbaceous and shrub vegetation
Jarvis	6.7 km^2	7m	Line	coral island, fringe reef, herbaceous vegetation sandy coral island w/ fringe reef
Kingman		1m	Line	no appreciable land, no vegetation on narrow emergent island
Palmyra	11.9 km^2	2m	Line	50 islets surrounding two lagoons, *Pisonia* and coconut forests and herbaceous vegetation
Wake	9.0 km^2	7m	Marshall	3 islets on atoll, forests, shrubs, and herbaceous cover
Johnston	2.8 km^2	5m		2 islets, 2 man made islands, herbaceous vegetation triangular atoll-like reef

Source: www.doi.gov/oia/facts2000 and www.cia.gov/cia/publications/factbook.

Shorebird Species

Thirty-five species of shorebirds have been recorded in this subregion, and it is of primary importance for the Bristle-thighed Curlew and Pacific Golden-Plover. Other species occurring regularly include Ruddy Turnstone, Sanderling, Wandering Tattler, Gray-tailed Tattler, and Bar-tailed Godwit. Few estimates of shorebird abundance exist because these islands are extremely isolated and visited only rarely by biologists. More than 200 Bristle-thighed Curlews have been recorded at Palmyra (USFWS 1992), and fewer than 50 have been observed at Howland and Baker (Marks and Redmond 1994). Eleven curlews were counted on Johnston Island during the 1999 Christmas Count conducted by the USFWS (NAS 2000, 2001). Although the total wintering population of Bristle-thighed Curlews in the Central Pacific Islands remains virtually unknown, the limited data from this region indicate that these islands provide important habitat for this species. The Tuamotu Sandpiper has not been recorded from the USPI in this region, but the type specimen was collected at Kiritimati Island (Kiribati), in the Line Islands. Palmyra and Jarvis are also located in the Line Islands and these two islands, along with other Central Pacific Islands, should be evaluated as potential sites for establishing additional populations of this rare shorebird.

Central Pacific Islands Subregional Population and Habitat Goals

The population status of migrant shorebirds in the Central Pacific Islands is unknown. The abundance and distribution of shorebirds, and their habitat use, in the region should be documented. Of particular interest is the status and distribution of the Bristle-thighed Curlew.

- Determine the population size and trends of wintering Bristle-thighed Curlews and identify important habitats for long-term protection and monitoring

- Assess population size and trends of other regularly wintering species of shorebirds

Habitat Status, Threats, and Management Goals

Similar to other subregions covered in this plan, the Central Pacific Islands provide a variety of habitats used by wintering shorebird species. Pacific Golden-Plovers forage in anthropogenic habitat on lawns, tarmacs of military fields, and they roost on rooftops. They also use beaches, wetlands, and other natural habitats. Upland and beach habitats are priorities for protection on developed islands. Protection of beaches and lagoon edges that support wintering Bristle-thighed Curlews (*e.g.*, Wake and Palmyra) should be emphasized. Many islands in this subregion have experienced major alterations of their natural environments as a result of military activities during and since World War II. Nuclear tests, military dumping, munitions storage and removal remain a concern, particularly on Johnston and Wake islands. Groundwater and nearshore pollution from these storage facilities is suspected but not documented. Daily sewage discharges are a regular occurrence on Johnston and Wake islands, despite modernization of facilities in the early 1990s (USFWS 1996). Sources of contamination on Howland and Baker have been linked to WWII and post-war military activities. Chemical weapons and nuclear materials were stored at Johnston Atoll. These munitions at Johnston have recently been destroyed and cleanup is underway. Ground contamination by dioxins and PCB-containing fuel is high in places, and three aborted thermonuclear warheads resulted in plutonium contamination of the entire atoll (USFWS 1996).

Introduced species are a major problem in this subregion. Over the past 25 years, USFWS has eradicated rats and cats from all islands in the subregion, except for Wake and Palmyra. In 2004, a collaborative effort by the Endangered Species Recovery Council, Wildlife Management International of New Zealand, and Marine Endeavors, completed a project to eradicate cats from Wake. Initial surveys are very promising, and follow-up surveys over the next few years will determine if all of the cats were removed. Complete eradication of rats and cats at Wake and rats at Palmyra are high priorities. Introduced scale insects and ants at Palmyra are attacking the Pisonia forest on Palmyra and the effects on shorebirds are unknown.

- Remove introduced mammals from Wake and Palmyra

- Develop interdiction programs to prevent reintroduction of predators

- Eliminate or control introduced scale insects at Palmyra and limit the potential for introduction to other islands in the region

- Eliminate contaminant sources from military/ island base resources

Monitoring Priorities

- Monitoring priorities are similar to those in American Samoa. Lack of knowledge about shorebird numbers, habitat use, and threats limit our ability to develop conservation priorities

- Develop a monitoring program to assess shorebird species diversity, abundance and variation in abundance, distribution, population trends, and habitat use. Focus on Pacific Golden-Plover and Bristle-thighed Curlew

- Monitor for contaminants on beaches, in lagoons, and on tidal flats

- Monitor the response of curlews to predator eradication at Wake and Palmyra

Research Priorities

- Work with the international shorebird community to collect basic information on the ecology of the Tuamotu Sandpiper in Polynesia and determine if suitable habitat exists on U.S. Islands to establish and sustain Tuamotu Sandpiper populations

- Work with the international shorebird community to collect basic information on the ecology of the Tuamotu Sandpiper in Polynesia and determine if suitable habitat exists on U.S. Islands to establish and sustain Tuamotu Sandpiper populations

- Study the ecology of the Bristle-thighed Curlew on low and coral islands and atolls with emphasis on Palmyra

- Investigate the effects of introduced scale insects on the habitat and shorebird populations at Palmyra.

- Develop strategies to control or eradicate introduced invertebrates with initial emphasis on scale insects and ants

Education Priorities

- Education of USDOD personnel on shorebird ecology, threats (predators and disturbance) and important habitats: beaches, dunes, and lagoons

- Work with The Nature Conservancy to develop an education and outreach program regarding shorebirds, their ecology, and importance of predator free islands

Implementation and Coordination

Howland, Baker, and Jarvis Islands; Johnston and Palmyra Atolls; and Kingman Reef are part of the Pacific Remote Islands NWR Complex. Wake Atoll is a military installation. USFWS and The Nature Conservancy jointly own Palmyra Atoll. Efforts to clean contaminated sites are being addressed by the USFWS and USDOD. Removal of rats and cats is a priority for nesting seabirds as well as wintering shorebirds. USGS is working with the USFWS to investigate control of scale insects at Palmyra.