

BRISTLE-THIGHED CURLEW

TAXONOMY

Scientific name: *Numenius tahitiensis* (Gmelin, 1789)

Common name: Bristle-thighed Curlew

Family: Scolopacidae

Taxonomic comments:

Whimbrel (*Numenius phaeopus*) generally accepted as the closest relative of *N. tahitiensis* (Marks et al. 2002).



DESCRIPTION

Basic description: A medium-sized shorebird.

General description: A large brownish shorebird with a moderately long decurved bill, striped head, and tawny unbarred rump. The stiff feathers on the thighs and flanks are not easily seen in the field (NGS 1983).

Diagnostic characteristics: Differs from the Whimbrel (*Numenius phaeopus*) in being tawnier and by having a tawny unbarred rump, less streaking on the breast, and a paler bill. Bill is much shorter than that of Long-billed (*Numenius americanus*) and Far eastern Curlews (*Numenius madagascariensis*), longer, thicker, and more curved than in Eskimo Curlew (*Numenius borealis*; which averages 7 cm shorter).

Length (cm): 44

Weight (g): 400

Reproduction:

Spring migrants usually arrive singly or in groups of two, occasionally in flocks. Males often precede mates by 1–6 days. Females rarely observed before mates in same year. Nest building begins within 1–3 days of arrival. At Nulato Hills (1987–1991), most nests initiated during last two weeks of May with successful nests hatching from 15–30 June. At Neva Creek, median clutch initiation was 24–31 May, about two weeks after arrival of females. Late clutches (initiated 9–18 June) attributed to late arriving females rather than renesting attempts. Median hatching dates 22–28 June with only a few nests hatching in July. Between 95–100% of pairs hatched nests within 8–10 days in two early years and 21–22 days in one late year at Neva Creek. Second brood per season not known to occur (Marks et al. 2002).

Clutch size is typically four eggs (Kyllingstad 1948, McCaffery and Peltola 1986) which are incubated by both sexes for 24–25 days (McCaffery and Gill 1992). In the Nulato Hills, Yukon Delta National Wildlife Refuge, 80 percent of nests beneath tundra willows hatched, whereas only about 33 percent of nests in the open were successful. Curlew nests constructed near nest sites of aggressively defensive Long-tailed Jaegers (*Stercorarius longicaudus*) were more successful than those in more isolated areas (McCaffery and Gill 1992). Seven of 9 nests examined by McCaffery and Peltola (1987) in the Nulato Hills were lost to predation.

Chicks are precocial and leave the nest within 12 hours of hatching. Young can fly when 21–24 days old (Lanctot et al. 1995). When 1–4 weeks old, juveniles congregate in brood aggregations (Lanctot et al. 1995). These groups typically remain intact until juveniles depart for staging areas in early August. Brood aggregations generally consist of fewer than 20 juveniles, but can contain up to 30 (McCaffery and Gill 1992, Lanctot et al. 1995). Brood groups studied by Gill et al. (1990) contained an average of 6.5 young (range = 1–12) from a minimum of 1–3 different broods. However, aggregations can include young from as many as 10 broods (Lanctot et al. 1995). Brood aggregations are tended by up to 14 parent birds, sometimes even if the aggregation does not contain any of their own young (Gill et al. 1990, McCaffery and Gill 1992, Lanctot et al. 1995). Brood aggregations move up to two kilometers per day (McCaffery and Gill 1992). Males attend aggregations 10–14 days longer than females (Gill et al. 1990). Brood aggregations often include young of other birds such as Bar-tailed Godwit (*Limosa lapponica*), American Golden-Plover (*Pluvialis dominica*), Pacific Golden-Plover (*Pluvialis fulva*), Whimbrel, Long-tailed Jaeger, and Western Sandpiper (*Calidris mauri*; Lanctot et al. 1995). Curlews become reproductively mature in their third year (Marks 1993).

Ecology:

Breeding territories encompass approximately 0.5–1.5 km² (Gill et al. 1990) and average densities range from 0.45 birds per km² in early July to 0.04 birds per km² in late July (Gill and Handel 1987). Territory size varies with topography, particularly configuration of drainages, and is smaller for southern population (40–100 ha in Nulato Hills) than for northern population (150–275 ha at Neva Creek). During incubation, adults at Neva Creek regularly travel from nesting territories to communal feeding and roosting areas up to 7 km away. Adults with broods move away from nesting sites, traveling on average 0.3–1.0 km in first week, 0.5–1.6 km (up to 4.4 km) in second and third weeks, and 0.6–1.0 km (up to 2.6 km) in fourth and fifth weeks (Lanctot et al. 1995).

On staging grounds, gathers in communal nocturnal roosts (in shallow water ponds) of up to approximately 120 individuals (Tibbitts 1990). The average diurnal flock size on the staging grounds is 3.1 birds (range 1–33; Handel and Dau 1988). Flock size in nonbreeding habitat ranges from a few to more than 100 individuals (Pratt et al. 1987). While on the Pacific islands, many birds lose so many primaries and secondaries during molt that they become flightless for about two weeks; during molt, birds are extremely secretive by day, hiding in dense vegetation (Marks 1993). Adults molt from July through December and juveniles throughout the year (Marks et al. 1990, Marks 1993). Estimated annual survivorship for wintering birds is 80–90% (Marks 1992). The oldest known individual was one killed on Laysan Island that had been banded 23 years, 10 months earlier (Marks 1992).

On breeding grounds, known predators of adults include Gyrfalcon (*Falco rusticolus*); of eggs, Parasitic Jaeger (*Stercorarius parasiticus*) and Common Raven (*Corvus corax*); and of chicks, red fox (*Vulpes vulpes*), Northern Harrier (*Circus cyaneus*), Gyrfalcon (*Falco rusticolis*), Sandhill Crane (*Grus canadensis*), and Long-tailed Jaeger (Marks et al. 2002)

Forms temporary associations with American and Pacific Golden-Plover (*Pluvialis dominica* and *P. fulva*), Whimbrel, Bar-tailed Godwit, Western Sandpiper and Long-tailed Skua (*Stercorarius longicaudus*). Curlews and other larger-bodied species commonly attack-mobbed predators

together, whereas smaller-bodied species generally give alarm calls and circle predators (Lanctot et al. 1995).

Migration:

Flies at least 4,000 km nonstop between Alaska and the northern end of the nonbreeding range in the northwestern Hawaiian Islands. Apparently most curlews residing in the Central and South Pacific fly over Hawaii during northward and southward migrations, undertaking nonstop flights of more than 6,000 kilometers twice each year (one of the longest nonstop flights known for any bird) (Marks et al. 2002). Birds departing the Laysan Islands leave in small flocks (1-22 individuals, mean = 10.7), 25 percent of which are in the company of Pacific Golden-Plovers. Most birds that remain year-round on the Pacific islands are subadults (Marks and Redmond 1994b).

Most northbound migrants arrive at breeding areas in Alaska during first three weeks of May. At Mountain Village, Alaska, the southern end of breeding range, first birds seen 9–18 May from 1944–1947. More recently, first arrivals 3–6 May 1988–1991 in Nulato Hills, 32 km north of Mountain Village, and 8–18 May 1990–1992 at Neva Creek, suggesting earlier arrival for southern population (Marks et al. 2002).

From June–August, gathers on the coastal lowlands of the Seward Peninsula, the coastal fringe of the Yukon-Kuskokwim Delta and the Nushagak Peninsula of Bristol Bay, Alaska, prior to southward migration over ocean (R. Gill, pers. comm. 1998). Birds spend from a few weeks to two months on the staging grounds (Handel and Dau 1988, Gill 1998). Limited information suggests length of stay on Yukon Delta staging area is 2–3 weeks, where birds fatten on fruits that provide energy to fuel southward migration. Juveniles head for staging grounds slightly after adults and leave Alaska from mid-August to early September, unaccompanied by their parents (Marks et al. 2002).

Food:

Breeding and staging: Upon arrival on breeding grounds, consumes previous summer's black crowberries (*Empetrum nigrum*), lingonberries (*Vaccinium vitis-idaea*), and bog cranberries (*Vaccinium oxycoccus*), less frequently bog blueberries (*Vaccinium uliginosum*) and alpine bearberries (*Arctostaphylos alpina*); also spiders, beetles, moths, and butterflies. Previous year's berry crop dwindles as season progresses; by early summer curlews switch to blueberry flowers (available in good quantities for 2–3 weeks in June-early July). Insects are probably the most important food for parents and young chicks. By mid-July, adults and older chicks move to areas with plentiful ripening bog blueberries. Migrants on Yukon Delta eat bog blueberries, black crowberries, cloudberries, and a variety of aquatic and terrestrial insects (Marks et al. 2002). After snow melts, shallowly probes tundra for invertebrates, picks individual fruits and flowers off low and prostrate shrubs, occasionally snatches insects off lake surfaces or out of air, shakes pupae out of cocoons, and searches for invertebrates by pulling up and vigorously thrashing small clumps of lichen and moss (clumps then tossed to ground and examined). Fall staging birds pick berries and glean insects from dwarf shrubs and probe wet meadows, mudflats, slough banks, and bases of water plants for invertebrates (Gabrielson and Lincoln 1959, Gill et al. 1990, McCaffery 1990, Marks et al. 2002).

Non-breeding: Forages principally in terrestrial habitats consuming spiders, land crabs, insects, seabird eggs, lizards, and carrion (Marks 1993). Food too large to be swallowed whole, such as ghost crabs (*Ocypode laevis*, *O. ceratophthalma*), are thrown against the ground until broken. Throws pieces of coral against Black-footed (*Phoebastria nigripes*) and Laysan Albatross (*P. immutabilis*) eggs to break them open and eat them. Smaller, thinned-shelled eggs of shearwaters (*Puffinus* spp.), petrels (*Pterodroma* spp.), and terns (*Sterna* spp.) are broken open by pecking or picking them up and dropping them to the ground (Marks and Hall, 1992). Also eats eggs of frigate birds (*Fregata* spp.) and boobies (*Sula* spp.; Johnsgard 1981). Stomach contents of 14 curlews collected in Polynesia contained vegetation, crustaceans, insects, gastropods, and scorpions (Johnsgard 1981).

Phenology:

Diurnal.

Habitat:

Breeding: Breeds in the low, mountainous regions northeast of the lower Yukon River (Nulato Hills) and uplands of the Seward Peninsula, Alaska (Handel and Dau 1988, Marks et al. 2002). Physiography markedly different between Seward Peninsula and Nulato Hills; latter characterized by lower relief, gentler slopes, more complex drainage patterns, and smaller areas of specific habitats (Marks et al. 2002). Breeding areas encompass a mosaic of subarctic and arctic tundra habitats including: low shrub/tussock tundra (*Betula nana*, *Empetrum nigrum*, *Ledum palustre*, *Vaccinium* spp., *Salix* spp.), mixed shrub thicket/tundra (*Salix* spp., *Betula nana*, and *Alnus crispa* over tussocks), tall shrubs (*Salix alexensis*, typically along water courses), and shrub meadow/tundra (species similar to low shrub/tussock tundra but lower and with more bare ground). Sedge (*Carex aquatilis*, *C. bigelowii*, *Eriphorum* spp.) and lichen meadows, though a small fraction of the overall land area, are also important habitats.

Habitat use changes during the breeding season. During pre-nesting, curlews tend to be found primarily in shrub meadow/tundra (33%) and low shrub/tussock (47%); during nesting the birds shift their activities mostly to shrub meadow/tundra; and during brood rearing, adults attending young increase their use of sedge meadows. Younger broods tend to use habitats with a moderate level of tussocks and shrub cover; after fledging they prefer sedge and lichen meadows (Gill et al. 1990).

Foraging microhabitat: Forages primarily in dwarf-shrub meadow tundra on slopes and ridges. Also forages in wetlands and medium-shrub (0.5-1.0m tall) habitats including marshy streambeds, stream shorelines, shallow lakes, moss or grass/sedge understory along margins (rarely interiors) of willow thickets, and lingonberry and Labrador tea (*Ledum* spp.) understory around dwarf birch thickets. On staging grounds, foraging birds most common in tundra/meadow mosaic (Marks et al. 2002).

Staging: Stages on the coastal fringe of the Yukon-Kuskokwim Delta and coastal lowlands of the Seward Peninsula, Alaska. Staging habitats include sedge and graminoid meadows and upland tundra (Handel and Dau 1988). Annual variation in standing crop of fruits of black crowberry and ericaceous shrubs appears to be a major determinant of habitat use. Southward migrants on central

Yukon Delta roost at night in shallow brackish pond edges surrounded by large wet-sedge meadows (Marks et al. 2002).

Non-breeding: Winters primarily throughout Polynesia in the Central and South Pacific. Unique among migratory shorebirds in that entire population is confined to islands during nonbreeding season (Marks et al. 1990). Subadults may remain in the Pacific until they are nearly three years old (Collar et al. 1992). Uses ocean terraces or reef flats, ocean beaches, inter-islet channels, lagoon sand beaches, lagoon coral reefs, mudflats, saltpans, coconut groves, and vegetated clearings (Pratt et al. 1987, Gill and Redmond 1992). In a quantitative study of habitat usage, birds were associated principally with saltpans (36%) and inter-islet channels (27%; Gill and Redmond 1992). During molt, flightless birds take shelter during the day in dense stands of bunchgrass (*Eragrostis variabilis*) (Marks et al. 1990). In the Tuamotu Archipelago, curlews were found on all atolls surveyed, regardless if atoll was rat-free or rat-infested. Most birds were detected in coastal habitats either on the ocean (44%) or lagoon shores (41%; Tibbitts et al. 2003).

STATUS

Global rank: G2 (1997-03-11)

Global rank reasons:

Breeding population of only 3,200 pairs; total population does not exceed 10,000 individuals. Wintering populations threatened by significant habitat loss, predation, and disturbance.

State rank: S2B (2004-05-12)

State rank reasons:

Alaska breeding populations less than 3,200 pairs. Limited breeding range; nests only in two relatively small, disjunct regions; the Andreafsky Wilderness near the north Yukon Delta and on the central Seward Peninsula. Protected throughout most of breeding range. Population status and trends unknown. Level of threat in Alaska minimal.

DISTRIBUTION AND ABUNDANCE

Range:

Global range:

Breeding: Breeds in remote mountainous regions of western Alaska in 2 locations: the Andreafsky Wilderness Area northeast of the Yukon River mouth, and on the northcentral Seward Peninsula (McCaffery and Peltola 1986, Kessel 1989, Gill et al. 1990, Marks et al. 2002). Nonbreeding individuals occur on coastal tundra from Kotzebue Sound south to Hooper Bay.

Migration: Critical staging areas in Alaska include the coastal portions of the central and southern Yukon-Kuskokwim River Delta. The only currently known critical stopover site south of Alaska is the northwestern Hawaiian Islands. Other possible migration stopover areas include the southern Line Islands, and the Phoenix or Marshall Island groups (Marks et al. 2002)).

Non-breeding: On islands and atolls of French Polynesia in the Pacific Ocean (Gill and Redmond 1992). Pacific islands including the Hawaiian Islands (common) to the southern Pacific, including

the Marshall Islands southeast to Fiji, Tonga, Samoa, and the Marquesas and Tuamotu islands (less common) (Marks et al. 2002).

State range:

Breeding: Nests only in Alaska, and is found in only two relatively small, disjunct regions; the Andreafsky Wilderness near the north Yukon Delta and on the northcentral Seward Peninsula; populations are separated by about 300 km (Marks et al. 2002). Southern population occurs in southern Nulato Hills and on the northern Yukon Delta from near Mountain Village to about 125 km north. Northern population is located on central Seward Peninsula from Ear Mountain east to Bering Land Bridge National Park and Preserve and south to Coffee Dome and Grantley Harbor. Not known to breed elsewhere, although possible breeding north of Kotzebue Sound suggested by sporadic June records of single birds in the Mulgrave Hills and western Baird Mountains, and by small flocks of birds in late summer on shores of Cape Krusenstern; recent survey at these locations during peak breeding season failed to detect curlews. Late-summer staging grounds from southern Yukon River Delta to Kuskokwim River and inland about 20 km. Distribution within region patchy; generally more birds found in south and central areas than in north (Marks et al. 2002)

Migration: Critical staging areas in Alaska include the coastal portions of the central and southern Yukon-Kuskokwim River Delta. Casual migration stopover sightings in mid- to late May on the Aleutian Islands, including Attu, Amchitka, Shemya, and Adak. Small numbers reported almost every year on Pribilof Islands in mid-May. A few records 9–19 May from Izembek Lagoon on north side of Alaska Peninsula. Small numbers regularly recorded in early May in northern Gulf of Alaska (Middleton Island, Kachemak Bay, 900–1,100 km east of breeding range; Isleib and Kessel 1973, Gill et al. 1988, Marks et al. 2002). These birds are probably storm waifs (Gill et al. 1988, Mlodinow et al. 1999).

During post-breeding period in July and August, small numbers recorded along northern and southern coasts of Seward Peninsula, including Safety Sound, Cape Espenberg, Lopp Lagoon, Kobuk River mouth near Kotzebue, near Nome, and near Cape Krusenstern (Marks et al. 2002). During fall, have been observed feeding on the tundra on the Nushagak Peninsula (MacDonald 2000).

Abundance:**Global abundance:**

Total population is approximately 10,000 birds (range 7,500–11,800; Morrison et al. 2001). Total breeding population is among the smallest of all North American shorebirds, estimated at only 3,200 breeding pairs based on surveys of suitable habitat in the two Alaska breeding areas; approximately 60% in Nulato Hills and 40% on Seward Peninsula (Marks et al. 2002). A third population may exist north of Kotzebue, but is believed to number fewer than 100 pairs. Migration counts have recorded a maximum of 5,000 birds at post-breeding staging areas on the Yukon-Kuskokwim Delta of western Alaska (USFWS 1987). Breeding population, as of the early 1990s, was estimated at about 7000; population trend is unknown (Collar et al. 1992).

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population may exist north of Kotzebue, but is believed to number fewer than 100 pairs. Migration counts have recorded a maximum of 5000 birds at post-breeding staging areas on the Yukon-Kuskokwim Delta of western Alaska (USFWS 1987).

Trends:

Global trend:

No data are available on historic or recent trends in the breeding population. Residents of Rangiroa Atoll in the Tuamotu Archipelago of French Polynesia have reported declining numbers of wintering birds in recent years (Gill and Redmond 1992). Fossil evidence suggests that the birds were once common on the main Hawaiian Islands, yet today they are uncommon during migration and rarely overwinter there (Marks and Redmond 1994a). It is unclear, however, whether these observations represent population declines or shifts in island use.

State trend:

No data are available on historic or recent trends in the size of the breeding population; needs study. Unknown whether current nesting success adequate to maintain population stability (Marks et al. 2002).

EXISTING PROTECTION

Global protection:

Designated as a Species of Concern by the U.S. Fish and Wildlife Service as of January 1995. The wintering range of the species includes an area the size of the continental United States with multinational jurisdiction (France, New Zealand, United States, Great Britain, and several independent island nations such as Kiribati and Tuvalu). There is currently no international protection program in effect.

State protection:

Protected under the Migratory Bird Treaty Act of 1918. Land protection exists for those portions of southern breeding grounds (50%) and autumn staging grounds (40%) that occur within the Andreafsky Wilderness Area and the Yukon Delta National Wildlife Refuge (NWR), respectively; one quarter occur on private lands just south of the wilderness area (Marks et al. 2002). Uncommon in the Togiak NWR in the fall (MacDonald 2000). Main fall staging area on the Yukon-Kuskokwim Delta has been designated a site in the Western Hemisphere Shorebird Reserve Network (WHSRN), and 2 other locations have been nominated as WHSRN sites, the Andreafsky Wilderness and the central Seward Peninsula (Alaska Shorebird Working Group 2004).

CHALLENGES

Global challenges:

Breeding: Apparently no immediate anthropogenic threats to breeding habitat (Gill and Handel 1987, Marks et al. 2002). However, resurgence in gold mining on the Seward Peninsula could potentially affect habitat. Travel across the tundra in heavy machinery by mining personnel can lead to localized habitat damage (Lanctot 1990). Oil/mineral exploration is presently not a serious threat due to the precedence of the financially important Bering Sea fisheries resource; however,

oil/mineral exploration may one day replace fisheries as the most economically important commodity in the region (R. Gill, pers. comm. 1998).

Potential predators on the breeding grounds include Golden Eagles (*Aquila chrysaetos*), Rough-legged Hawks (*Buteo lagopus*), Northern Harriers (*Circus cyaneus*), Merlins (*Falco columbarius*), Short-eared Owls (*Asio flammeus*), Long-tailed Jaegers, Short-tailed Weasels (*Mustela erminea*), red foxes, and brown bears (*Ursus arctos*; McCaffery 1990, Lanctot et al. 1995). Common Ravens, Parasitic Jaegers, and Gyrfalcons are confirmed predators (McCaffery 1990, Lanctot et al. 1995). Open dumps in villages near the Yukon-Kuskokwim Delta have resulted in an unnaturally high population of Common Ravens, known predators of curlew eggs and chicks.

Staging: Subsistence hunting poses a threat to birds on the Yukon-Kuskokwim Delta. Hunter surveys indicate a substantial increase in the take of large shorebirds by Native Americans. Because hunter survey forms do not distinguish between curlews, whimbrels and Bar-tailed Godwits, the extent of curlew harvest is unknown, but estimated from 2002 reports to be between 90 and 100 birds (*vide* B. McCaffery in R. Gill, pers. comm. 2004).

Non-breeding: Threatened by a variety of introduced potential predators including rats (*Rattus* spp.), mongoose (*Herpestes auropunctatus*), feral pigs (*Sus scrofa*), dogs (*Canis familiaris*), and cats (*Felis catus*). Nonbreeding birds are most susceptible to predation during molt and are readily captured at this time by human subsistence hunters (Marks et al. 1990, Marks and Redmond 1994a). The presence of curlews on atolls in the Tuamotu Archipelago suggests they are resilient to the occurrence of Pacific rats and to the alteration of native habitats. However, lack of data on their historic numbers at these sites makes it difficult to assess the full affect of altered conditions (Tibbitts et al. 2003). Birds are also hunted and captured on steel hooks baited with pieces of coconut (*Cocos nucifera*; Gill 1998). Habitat is being lost to development of tourist facilities (Marks and Redmond 1994a).

State challenges:

Also see Global challenges.

Disturbance at nest and roost sites: Most breeding grounds are difficult to access. Initially, disruption to nesting birds by birders was thought to be a problem (Gill et al. 1988 in Marks et al. 2002), but high dispersion of nests and subsequent knowledge of seasonal nesting behavior and response to humans suggest this is not a threat (Gill 1991 in Marks et al. 2002). On autumn staging grounds in Alaska, studies revealed that birds flushed when low-flying aircraft (66 m above ground) were near; most birds circled behind plane and landed in general area where flushed (Marks et al. 2002).

Direct human/research impacts: Human presence and/or recapture of adults in brood-rearing areas elicits antipredator behaviors from adults; if prolonged, young broods are vulnerable to exposure from the elements (Marks et al. 2002)

Subsistence harvest: Subsistence harvest of large shorebirds has dramatically increased along the central Yukon-Kuskokwim Delta coastline over the last several years for unknown reasons (McCaffery 2003). Because hunter survey forms do not distinguish between curlews (*N. tahitiensis*

and *N. phaeopus*) and Bar-tailed Godwits (*Limosa lapponica*) the extent of curlew harvest is unknown, but estimated from 2002 reports to be between 90 and 100 birds (*fide* B. McCaffery in R. Gill, pers. comm. 2004). Historic harvest of adults and eggs by indigenous people in western Alaska is likely but not confirmed (McCaffery and Gill 2001). This species may have been included in annual subsistence harvest of "large shorebirds" on Yukon Delta from 1995–1998 (Wentworth and Seim 1996, Wentworth and Wong 1999 in Marks et al. 2002).

RESEARCH AND INVENTORY NEEDS

Global research needs:

Management research needs: Determine conservation status and the ecological requirements that may be limiting curlew populations (Handel and Dau 1988). Also determine the extent of breeding and staging areas, annual survivorship of various age groups, reproductive success and sources of mortality to eggs and chicks, breeding population distinctness using DNA analysis, habitat specificity during molt, the effects of exotic mammalian predators and subsistence hunting on the distribution of wintering birds, routes and timing of migration, locations of principal wintering areas, migratory stopover points, and survival rates of birds on islands with predators versus predator-free islands. Population estimates and trends should be refined using techniques such as mark-resighting, breeding chronology needs to be better defined, and a better technique to readily determine age and sex of birds in the field should be developed (Gill and Handel 1990, Marks and Redmond 1994b).

Biological research needs: Future studies should identify concentrations of wintering birds, determine whether migratory stopover sites exist between Hawaii and the southern end of the wintering grounds, and determine how human subsistence hunting and human commensal predators affect winter habitat use and population trends. In addition, a subset of wintering populations should be monitored regularly. Islands and atolls that support most wintering curlews need to be identified and protected (Marks and Redmond 1994a).

State research needs:

Determine conservation status and the ecological requirements that may be limiting curlew populations (Handel and Dau 1988). Determine the extent of breeding and staging areas, annual survivorship of various age groups, reproductive success and sources of mortality of eggs and chicks, breeding population distinctness using DNA analysis, habitat specificity during molt, and the effects of increased predation by ravens and subsistence hunters. Population estimates and trends should be refined using techniques such as mark-resighting, breeding chronology needs to be better defined, and a better technique to readily determine age and sex of birds in the field should be developed (Gill and Handel 1990, Marks and Redmond 1994b).

Global inventory needs:

Determine, as best possible, the historic distribution and size of non-breeding population of curlews. Expand the search for breeding sites in the Kotzebue area north of the Seward Peninsula.

State inventory needs:

Establish a monitoring program to determine current population trends and to detect future changes. Expand the search for breeding sites in the Kotzebue area north of the Seward Peninsula. Identify

requisite resources, i.e. food, nesting grounds, staging grounds. Identify possible threats during all phases of annual cycle.

CONSERVATION AND MANAGEMENT NEEDS

Global conservation and management needs:

Best managed by preserving breeding and wintering habitat and eliminating predators in the wintering habitat. Designate important atolls in the Tuamotu Archipelago as World Heritage Sites to help raise the profile of these sites and encourage local communities to become involved in their welfare and upkeep (Tibbitts et al. 2003). A large obstacle in French Polynesia is convincing locals that birds are an important resource and worthy of protecting (Pierce et al. 2003, Tibbitts et al. 2003). Public outreach and education, promoting eco-tourism, and consulting and discussing ecological issues with government leaders, traditional leaders, and landowners may help raise general awareness of the value of biodiversity (Tibbitts et al. 2003). Collaborative efforts should focus on providing technical expertise, logistical support, and funding to evaluate the suitability of islands and atolls for restoration and to carry out restorative work. (Tibbitts et al. 2003).

Maintenance of predator-free islands and establishment and enforcement of regulations prohibiting harvest within the wintering range is critical (Marks and Redmond 1994b, Marks et al. 1990).

Important migration stops may exist in the Central Pacific; identification and protection of these sites is needed (Marks and Redmond 1994). Some breeding and staging habitat is protected within the Yukon Delta National Wildlife Refuge.

State conservation and management needs:

Identify land use patterns and prospective use on breeding and staging grounds. Assist local governments in properly maintaining and cleaning up waste disposal sites in St. Mary's and Mountain Village (Alaska Shorebird Working Group 2000). Most (80%) of northern breeding range occurs on lands owned by the State of Alaska; all breeding areas should be considered for designation as sites of hemispheric importance within the Western Hemisphere Shorebird Reserve Network (WHSRN) and managed under cooperative agreements involving all major landowners (Palmisano 1993).

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