Introduction

There are three geographically separated populations of marbled godwits (*Limosa fedoa*) in North America. The largest is the mid-continent population which breeds from central Alberta and Saskatchewan south to central Montana and northern South Dakota. A second breeding population is concentrated in the southwestern James Bay region. The third population breeds on the north side of the Alaska Peninsula somewhere between Ugashik Bay and south to Port Heiden (Gibson and Kessel 1989). This third population was the focus of this study.

Alaska's marbled godwits were recently described as a new subspecies (*L. f. beringiae*) by Gibson and Kessel (1989). Gibson and Kessel found that the Alaska population of marbled godwit was morphologically distinct from mid-continent and James Bay populations. Morphological distinctions include: shorter tarsi, shorter wings, shorter culmens, and more massive bodies.

Marbled godwits were first recorded in Alaska in 1881 at Ugashik on the Alaska Peninsula, but were not observed in the state again until 1967 (Gibson and Kessel 1989). Marbled godwits were rediscovered at Ugashik Bay (57°35'N, 157°42'W) in 1982 and again in 1983 but no nests, eggs or flightless young were located. The nesting ground was speculated to be somewhere above the lower reaches of the King Salmon and Dog Salmon Rivers, and the tidal flats of Ugashik Bay but this was purely speculative (Fig.1). Gibson and Kessel (1989) and North and Tucker (1992) made numerous observations of breeding pairs in this general area. In 1992, breeding pairs and the first egg shell fragments from a successful nest were discovered just above the reaches of the Dog Salmon River, providing the first nesting confirmation in the state. Gibson and Kessel speculated that the breeding range extends from Ugashik Bay at least 30-40 km southwest to Cinder River Lagoon (57°22'N, 158°03'W), and possibly 100 km to Port Heiden (56°55'N, 158°41'W).

Marbled godwits are rare but regular spring migrants in May to southeastern Alaska and numerous observations have been recorded (see North (1992) for complete accounts). Most marbled godwits stage in the Ugashik Bay and Cinder River Lagoon areas in late summer and fall, along with larger numbers of bar-tailed godwits (*Limosa lapponica*) (North 1992). Marbled godwits depart from these areas as late as mid October (Gill et al. 1986, Kessel and Gibson 1978). Observations of marbled godwits during fall migration are rare but migration may begin in mid to late August (North 1992).

The *L. f. beringiae* population is guesstimated to number between 700 and 3,000 birds. The highest count of 1,000 birds was made in 1991 as birds concentrated in staging areas at Cinder River Lagoon and Ugashik Bay. *L. f. beringiae* is thought to winter along the northern Pacific Coast from San Francisco to Washington State, but definitive data is lacking.

General breeding habitat characteristics have been described at the study site by North and Tucker (1992) based on observations of suspected breeding birds. While no actual marbled godwit nests were located, fifteen birds were observed on the ground, flying or vocalizing among several types of habitat. Three major types of habitats, excluding open water, were used: (1) super-saturated *Carex*/dwarf-shrub expanses; (2) moist *Calamagrostis*/dwarf-shrub expanses in the valley, and; (3) glades containing moist *Calamagrostis*/dwarf-shrub expanses within tall shrub habitat of hillsides, and containing more scattered willows than the former habitat type. The majority of marbled godwits were observed on the ground in the moist *Calamagrostis*/dwarf-shrub habitat expanses. No attempt was made to determine habitat preference nor were any quantitative measurements taken to describe habitat requirements.

On 23 June 1992, a marbled godwit nest and two hatched eggshell fragments were discovered in Godwit Valley by a U. S. Fish and Wildlife Service (USFWS) biologist. The nest consisted of a shallow depression 20 cm in diameter and 6 cm deep on a grassy tussock adjacent to a flooded stand of buckbean (*Menyanthes trifoliata*) and horsetail (*Equisetum arvense*) (D. Dewhurst pers. comm.). The nest was sparsely lined with grass and grayish down feathers. No chicks or flightless young were observed but two marbled godwit eggshell fragments were found next to the nest.

During the breeding season, marbled godwits use a variety of wetland types including semipermenant wetlands, and ephemeral, alkali and temporary ponds (Ryan et al. 1984, Stewart 1975). Ryan et al. (1984) found that marbled godwits breeding in east-central North Dakota frequently selected areas with greater wetland abundance and a greater variety of wetland classes than were generally available, thereby increasing the likelihood of preferred habitat components being available throughout the nesting period. Marbled godwits nested in short grass areas at upland sites, while broods and post breeding godwits selected slightly taller vegetation (15-60 cm tall). This taller vegetation may provide antipredatory, thermoregulatory, and foraging benefits, especially for chicks (Jenni et al. 1982). In addition, godwits may use different cover types within or adjacent to individual territories for various types of activities (Ryan 1982).

The social nature of godwits is easily observed on the breeding grounds and is reflected in constant interactions and pursuits among birds, the almost constant flocked state, and the loose colonial nesting habits (Nowicki 1973). Marbled godwits are semicolonial nesters and breeding bird densities of 12.87 pairs km^{-2} have been recorded for godwits nesting in the prairies of North Dakota (Stewart and Kantrud 1972). While a detailed behavioral study of marbled godwits in North Dakota exists (Nowicki 1973), there has been no documentation of behavior for either of the two tundra nesting populations. In addition, extensive data on habitat selection, time and activity budgets of postbreeding birds, nest and territory distribution, period of egg-laying, duration of incubation, clutch size, and nest success are available for the mid-continent population, but no such data exists for the Alaska population.

The objectives of this study were to:

1) determine if any of the cover types, vegetative microhabitat characteristics or physical microhabitat characteristics were different between sites used by marbled godwits and sites where no godwits were observed throughout the breeding season;
2) determine if any of the cover types or microhabitat characteristics differed among sites used for ground display, foraging, nesting, and broodrearing;
3) determine if any of the cover types or microhabitat characteristics used by godwits changed throughout the breeding season;
4) describe time and activity budgets of prebreeding, breeding, nonbreeding summer resident, postbreeding and broodrearing godwits;

Site Description

The suspected breeding ground for *L. f. beringiae* lies on the northcentral portion of the Alaska Peninsula. It extends as a 100 x 50 km strip from Ugashik Bay to Port Heiden (Fig. 2). This region can be described as the coastal plain province which includes those lowland areas from the coast inland to the rolling foothills of the Aleutian Mountain Range. Elevations vary from sea level to a few hundred meters. The landscape is low and flat with little elevational relief. Many large rivers and streams traverse the plain and have low grades, are seasonally sluggish, and follow meandering courses with extensive braided networks (Britton 1966). Surface drainage is poor with internal drainage blocked by permafrost resulting in a variety of permanent and intermittent bodies of water, from small pools to lakes several miles in length (Britton 1966). Wet tundra

dominates in this region with numerous ponds and floating bogs, and extensive microtopographic relief. Irregularities in the surface of the soil of only a few centimeters often produce steep environmental gradients that yield distinguishable communities of plants (Peterson and Billings 1980).

Two main soil types dominate the landscape: tundra soils (Inceptisols) and bog soils (Histisols). Tundra soils underlie cottongrass-dwarf shrub heath and some sedge communities of imperfectly drained habitats (Bliss 1988). Bog soils are dominated by sedge-moss or grass-moss plant communities (Bliss 1988). These poorly drained areas remain saturated all summer and accumulate large quantities of both sedge and moss peat.

The study site selected is the same as that used by North and Tucker (1992) to describe godwit general breeding habitat characteristics. The valley (Godwit Valley) is situated between two low parallel ridges dominated by medium to tall stands of willow (*Salix* spp.), alder (*Alnus* spp.), and cottonwoods (*Populus balsamifera*) (Figs. 3). Large expanses of wet-sedge and moist-bluejoint grass (*Calamagrostis canadensis*) communities dominate the valley landscape forming sedge-bog meadows and bluejoint-shrub meadows (Viereck et al. 1992). A mosaic of other habitat types are interspersed including: large expanses of floating bogs, fresh herb marshes, herb-bog meadows, open tall scrub, ericaceous dwarf scrub, ponds and lakes, streams, grass hummocks, and dry ridges with scattered willows. Other common species include: wet sedge (*Carex* spp.), dwarf willow (*Salix* spp.), dwarf birch (*Betula nana*), bog rosemary (*Andromeda polifolia*), sweet gale (*Myrica gale*), crowberry (*Empetrum nigrum*), *Sphagnum* spp, horsetail, buckbean, marsh fivefinger (*Potentilla palustris*), and nagoonberry (*Rubus arcticus*).

Research Significance

The breeding range of *L. f. beringiae* lies within the State of Alaska Oil and Gas Lease Sale 41 (Deis 1984). This site has a high potential for future oil and gas development (USFWS 1985, North 1992). Past sales have resulted in the lease of 19.4 percent (278,939 acres) of Lease Sale 41 (Alaska Department of Natural Resources 1990). Primary land uses for this area have been identified by the Bristol Bay Regional Management Plan which include: 1) fish and wildlife habitat and harvest, 2) recreation on public lands, and 3) oil and gas exploration and development in uplands on state and private lands (North 1992). The speculated breeding range that extends from

Ugashik Bay to Port Heiden lies entirely on state and private lands. The state has designated areas at Cinder River and Pilot Point (on Ugashik Bay) as Critical Habitat Areas (North 1992), therefore the critical staging areas may be protected from future development. Other possible threats to the breeding grounds include a transpeninsula transportation corridor from Pilot Point to Wide Bay, which has the potential of running through prime godwit breeding habitat (North 1992).

North (1992) proposed evaluating *L. f. beringiae* for listing as a threatened or endangered species. North felt that the listing was justified because of: 1) the taxonomic status of the bird, 2) the restricted breeding range, 3) low total population counts, 4) direct potential threats to its breeding range, 5) inadequate federal regulatory oversight, and 6) lack of population monitoring. It is important to gain a better understanding of the biotic and abiotic components that distinguish marbled godwit breeding habitat. It is equally important to determine the basic reproductive parameters for this subspecies for which very little is known. A more thorough description of habitat requirements and nesting chronology will enable land use planners to make better management decisions regarding development and impact on the Alaska Peninsula.

Methods

Marbled godwits were monitored from blinds, and the position and activity of the birds were recorded. Nests were located by observation and by walking linear transects. Cover types were described and mapped for Godwit Valley. Habitat characteristics were described for specific microsites used by godwits for ground display, foraging, nesting, and broodrearing. A variety of microhabitat features were measured including vegetative structure, floral composition, relief, roughness, water depth, and other site characteristics. These features will be compared between sites where godwits were observed and sites where no godwits were present at any time throughout the breeding season.

Time and Activity Budget

From May through July of 1995 and 1996, marbled godwits were observed during daylight hours through binoculars and a 20-45 x spotting scope. In 1996, birds were observed from one of five non-randomly selected blinds set up on elevated positions in Godwit Valley. The initial order of the rotation sequence for visiting the five blinds was made by using a random permutation of five numbers, and this order was maintained throughout the entire study period. The daylight was

partitioned into 4 equal time blocks: 0600-0900 hours (block 1), 0900-1200 hours (block 2), 1200-1500 hours (block 3), and 1500-1800 hours (block 4); and observations were made for one hour within each block. Focal-switch sampling occurred during the hour interval within each block (Losito et al. 1989). The closest readily visible godwit was selected as the first bird to be sampled in a flock (Altmann 1974). The position and activity of the bird were recorded at alternate 30-sec intervals within the hour observation period. The location of the bird and the date it was observed was recorded on a map of the valley showing dominant cover types. Activity was classified as: (1) foraging; (2) sleeping/resting; (3) comfort movements; (4) walking; (5) wading; (6) calling; (7) wing-up display; (8) ground chasing; (9) nest-scraping; (10) copulation; (11) egg-laying; (12) incubation; (13) distraction display; (14) brooding/care of young; (15) perching; (16) alert-erect posture; (17) fighting; (18) threat display; (19) defense; and (20) flying. Flights were further described as: pursuit, ceremonial, sexual pursuit, figure-8, joint or vertical based on the descriptions of Nowicki (1973). At the end of each time block, boundaries were defined for areas determined to be display grounds, foraging sites, and broodrearing grounds. Breeding status, sex of the observed bird, territory distribution, inter-specific and intra-specific interactions, reactions to potential predators, and flock size and movements were also recorded (Wishart and Sealy 1980).

Nest sites were located by watching pairs as they returned to the nest or by dragging a length of rope between two observers walking linear transects. Each nest was marked in the field. No attempt was made to determine the total nest density for Godwit Valley. To minimize disturbance to the birds, nest-site features were characterized after hatching.

Cover Type

In May of 1996, cover types of Godwit Valley were determined from 1995 and 1996 aerial photographs and ground truthing, and were based on the classification system of Viereck et al. (1992). Each of the cover types was drawn on a map of the study area. The map was used to determine the proportion of each cover type. Cover types were classified from wettest type to driest type. In May and June of 1996, two maps were drawn from each of the five blinds indicating the total area that could visually be assessed to the north and south of each blind. These maps were used for recording the positions of birds for the time and activity budget to determine the cover type at used sites and at sites where godwits were absent throughout the breeding season.

Microhabitat Characteristics

The study area was delimited in the northern end of Godwit Valley by a bog that ran from the northern edge of Godwit Lake to ponded areas just south of Mew Lake. It was delimited in the southern end by the edges of 10 Scaup and Swan Lakes. Two sets of microhabitat measurements were made within the study area to determine the habitat at sites where: (1) godwits were observed foraging, ground displaying, broodrearing or nesting (present sites), and (2) no godwits were observed at any time throughout the breeding season (absent sites). For the first set of measurements (at present sites), sampling points were based on observations made daily within each of the four time blocks. The position of a godwit observed foraging, performing ground displays, or broodrearing was chosen at random from each one hour observation period. One position was chosen for each activity. Sampling took place at the location where the godwit was observed and recorded on the cover type map. Once a position was located in the field, a flag stake was thrown over the observers back to determine the exact location of the sample point. At nest sites, the sample point was centered over the nest cup itself.

For the second set of measurements (at absent sites), a paired sample point was selected 50 m in a random compass direction from the present site sample point. The absent site sample point was moved out an additional 25 m if it was either: (1) inaccessible (i.e., in the middle of a pond or lake) or (2) within 15 m of a nest site or a point where a bird was ever observed on the ground. If a godwit was ever observed using an absent site during the breeding season, then these paired sample points were not included in the analysis.

Vegetative Characteristics

Vegetation at sample points was characterized in a variety of ways. At each sample point, the flora (life forms) and relative coverage of six canopy-coverage categories were assessed using four 20 x 50 cm (0.1 m^2) plots (Daubenmire 1959). These plots were placed at cardinal points 1 dm out from the sample point. At nest sites, four additional 20 x 50 cm plots were placed 5 m out from the sample point. Four vertical density measurements were made at each sample point (with four additional measurements made at nest sites). A 5 mm diameter rod, marked at 1-dm intervals was inserted vertically through the vegetation at the central southern edge of each 20 x 50 cm plot. Litter depth, ground cover type, and the number of contacts made by grass, forb and shrubby vegetation at each 1-dm height interval were recorded (Colwell and Oring 1988).

Physical Characteristics

Physical characteristics at sample points were characterized in a variety of ways. Microhabitat relief was determined by measuring the vertical distance from the highest point of vegetation to the lowest point at the soil, water, or peat surface within a 2 x 2 m (4 m^2) plot centered in random orientation on each sample point (Rodrigues 1994). The variability of relief (or roughness) within the 2 x 2 m plot was assessed using a subjective method adapted from Rodrigues (1994). Sites were assigned to one of three roughness categories (low, medium, or high) based on visual assessment of the plot. Low roughness refers to flat plots which were often inundated with water. Medium roughness refers to plots with one to three ridges or tussocks. High roughness refers to plots with more than three ridges or tussocks. The distance (in meters) from the sample point to the nearest standing water, wetland edge, active conspecific nest, and active shorebird nest was measured. Depth of standing water or depth to peat layer was also measured at each sample point.

Analyses

Analysis of the time and activity budget data will be of a descriptive nature. Multiple histograms will be produced of the total proportion of time the marbled godwits spend in a particular form of activity during the different stages of the breeding cycle.

The data collected at the sample points will be analyzed using logistic regression. This is a retrospective sampling design because sampling is specified at present and absent sites. The response will be treated as a binary random variable either taking on the value of 1 when marbled godwits are present at a site or 0 when they are absent at a site throughout the entire breeding season. Absence of godwits at a site does not imply that they do not use that site. Rather, absence implies that godwits were not observed at a particular site at any time during the breeding season when that site was under observation. The primary goal of this study will be addressed retrospectively by looking at: (1) how the odds of finding marbled godwits is dependent upon the habitat type and habitat characteristics, and (2) how the odds change with changes in the explanatory variables. Possible covariates of the final model may include: wind speed, air temperature, percent cloud cover, precipitation, and stage of the breeding cycle. The Wilcoxon rank sum test will be used to perform nonparametric one-way analyses of rank scores of all response and explanatory variables. Drop in deviance F-tests will be used to compare models and variable combinations for answering the questions of interest.

1996 Results

During the period of 6-10 May 1996, we returned to Cinder River Lagoon (Fig. 4) in an attempt to capture and radio-tag marbled godwits. Unlike the previous year, the weather conditions and low tides in 1996 were perfect for mist netting. The godwits were easily approached to within 10 m and on one occasion, seventeen godwits were successfully herded from about half a kilometer to approximately 10 m from three mist nets. Unfortunately, the birds detected the nets and when we tried to force them in, the birds took to wing and skirted the nets. It was clear that a three-person crew would be unable to adequately funnel the birds into the nets due to the vastness of the tidal flats and the quickly changing tideline.

In the future, other capturing methods should be employed (rocket net guns or other snap traps triggered by remote). The birds are not wary of humans and are easily approached but their eyesight is impeccable and mist nests on a vast tidal flat are easily avoided.

Marbled godwits were observed daily in large feeding flocks on all areas of Cinder River Lagoon. The birds formed loose groups at low tide at the edges of tidal streams about 2 km south of Hanger Creek. Most of the birds were already paired up at the staging lagoon and were observed copulating. Males were observed ground chasing unpaired females in an attempt to break them out of the flocked state. Accurate counts were difficult at low tide because of the bird's distance, but estimates were around 200. This count was considerably lower than the previous year due to the much earlier spring and earlier staging by the godwits. This was confirmed once I reached Godwit Valley two weeks later and found the majority of birds to already be nesting.

We arrived at Godwit Valley on 20 May and commenced to set up camp. We spent the next four days hauling equipment from Lake Camp to the field camp site, and setting up camp. A helicopter had brought the weatherport, tents, bear barrels and fuel to the field camp site during the first week in May.

Between 25-27 May, my assistant and I conducted reconnaissance of the valley (Fig. 5), determined positions for erecting the five observation blinds, randomized the sequence for visitation to the blinds, and created a valley map with dominate cover types from ground truthing. On 28 May, observations and microhabitat sampling began and continued until 12 July. The observation blinds (Fig. 6) worked better than expected and were accepted by the godwits, as well

as the numerous other shorebirds nesting in the valley. In fact, a godwit nest was found approximately 90 m from one of the blinds.

Many godwits were already nesting by the time we arrived at Godwit Valley. The majority of males were paired and territory disputes with unpaired males were common. Copulation was observed on several occasions at the staging grounds and during the first two weeks of observation in Godwit Valley. Copulation was not observed again until 5 July with a pair that presumably lost their nest to predation and were attempting to re-nest. No other pairs were observed re-nesting.

During May and early June, all of the males observed were solitary, either foraging, sleeping/resting, preening, defending mates or territories, or performing elaborate courtship displays to either attract a mate to a particular territory or for pair-bond maintenance. Few females were ever observed during this time since these birds were incubating during the daytime. When females were observed, they were most often seen foraging and the mate was almost always nearby perched on a hummock in an alert posture. Godwit activity was at a peak during the morning and evening nest exchanges, particularly the morning exchange when females flying into their perspective territories elicited chases from neighboring males. The number of aerial courtship flights began to steadily decline by the first week in June.

Chicks began hatching in mid-June and the number and occurrence of aerial predators began to steadily increase. Pairs became intolerant of other godwits or shorebirds in their territories at this time and skirmishes were common. The number of pursuit flights began to increase and ceremonial displays were common. Breeding pairs did not bring their broods out into the large, open communal feeding sites. Rather, they kept their young in dense, tall stands of *Carex* and bluejoint. Both parents broodreared together. Most commonly, one of the pair would guard the chicks while the other foraged nearby. Feeding was almost always restricted to the edges of the wetland expanses and rarely towards the center. A distinct pattern of use was observed for several pairs where they would often be seen broodcaring or foraging in a specific area. Towards the end of the breeding season, it appeared that the male's role became one of defense. Males began to spend more time away from the females and the broods. Males began doing conspicuous high circular flights as early as 21 June which indicated that the male was preparing to leave the female and chicks. Most males began departing the valley during the last week in June and the first week in July. Once the males departed, the females and broods took on a very secretive nature and were rarely seen by the second week in July.

Several potential predators were observed in the valley and actual incidents of predation were observed on several occasions. Potential mammalian predators include: wolves (*Canis lupus*), brown bears (*Ursus middendorffi*), red fox (*Vulpes fulva*), arctic fox (*Alopex logopus*), mink (*Mustela vison*), shorttail weasel (*Mustela erminea*) and wolverine (*Gulo luscus*). Godwits rarely attached caribou (*Rangifer arcticus*) unless the caribou got too close to their nest or chicks. Godwits suffered constant predation and harassment from aerial predators: common ravens (*Corvus corax*), bald eagles (*Haliaeetus leucocephalus*), Northern goshawks (*Accipiter gentilis*), Northern harriers (*Circus cyaneus*), parasitic jaegers (*Stercorarius parasiticus*), sandhill cranes (*Grus canadensis*), mew gulls (*Larus canus*), glaucous-winged gulls (*L. glaucescens*) and short-eared owls (*Asio flammeus*). The primary predator was the common raven followed by the Northern goshawk and Northern harrier. Ravens predated on chicks and eggs, while the raptors took chicks and adults. Gulls mainly took eggs and were not tolerated during the incubation period. They seemed to pose less of a threat to the chicks. Sandhill cranes were only a threat to the chicks during the first two weeks after hatching.

We began nest searches on 8 June and searches were conducted again on 9, 11, 12, 13, 14, 15, 20 and 29 June. A total of four nests was found. The following is a brief summary of what was found: The first nest was found on 12 June (Fig. 7). The female was flushed off the nest which contained four 24-48 hour old chicks. The nest was located on a *Sphagnum/Carex* hummock ridge with a large dwarf shrub component. The nest was lined with moss, horsetail, *Carex* and dwarf shrub leaves, and contained eggshell fragments and a body feather. The second nest was also found on a hummock ridge running west-east. The hummock was surrounded by supersaturated areas of buckbean, sedge, horsetail and clubmoss. The nest was situated approximately 0.5 m from the wetland edge. The female was observed with her brood in an adjacent stand of tall *Carex*. The nest was lined with horsetail, moss, sedges, and dwarf shrub leaves. The third nest was found on a hummock at the edge of a large sedge-bog meadow. It was lined with *Carex*, moss and dwarf shrub leaves. Two down feathers and an eggshell fragment approximately 3 cm long was found in the base of the nest cup. The forth nest was situated on a moss hummock surrounded by standing water on all sides. The nest site was located at the edge of a fresh herb marsh/sedge-bog meadow. It was lined with moss, *Carex*, and dwarf shrub leaves. The nests averaged a diameter of 16.88 cm and a depth of 11 cm. A godwit eggshell that had been predated upon (probably by a gull) was collected on 8 June.

The next step with this project is to get all of the observational and sampling data entered into a database. The microhabitat measurement data collected at sample points will be analyzed using logistic regression. Analysis of the time and activity budget data will be of a descriptive nature.

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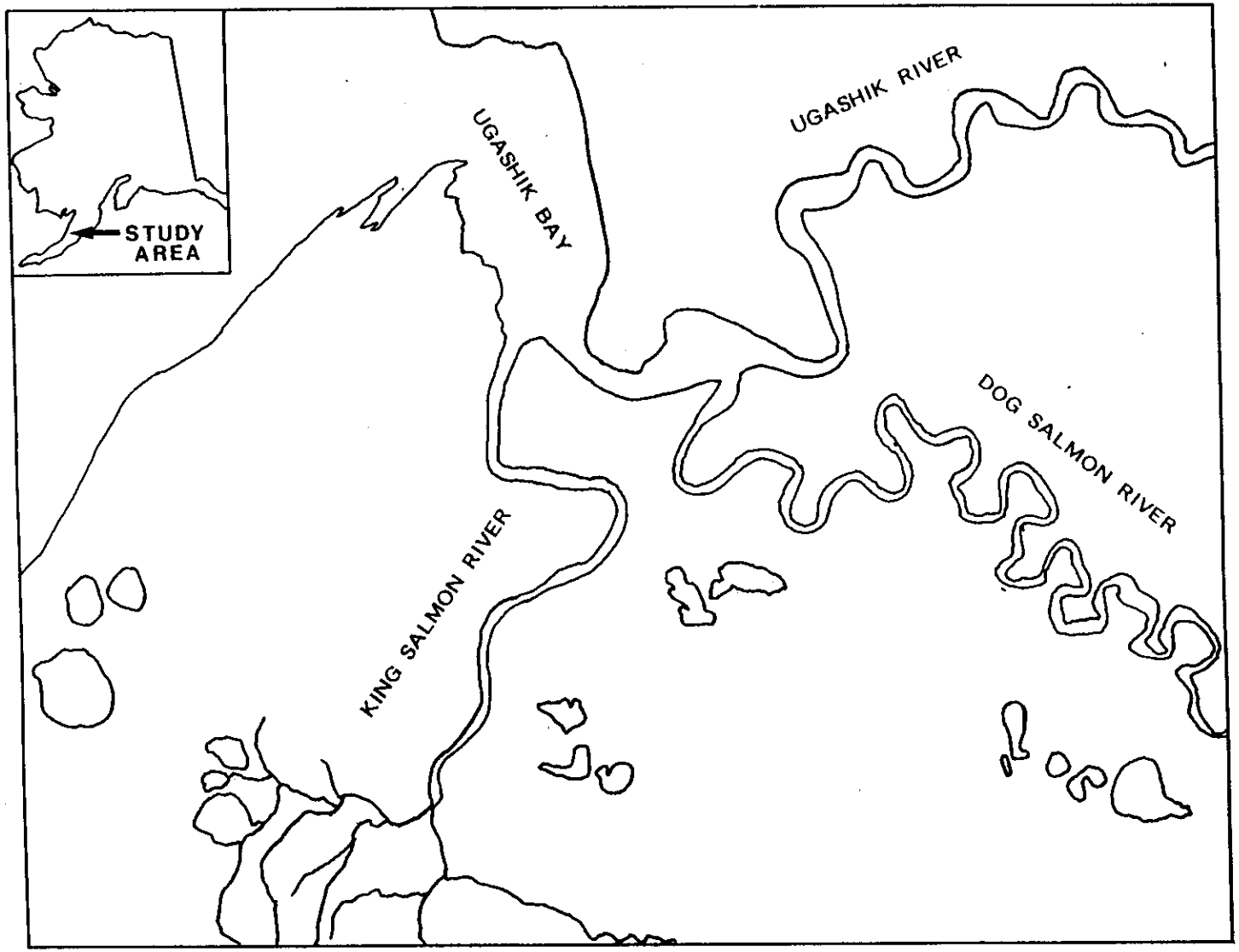

Figure 1. Speculated nesting grounds for marbled godwits above the lower reaches of the King Salmon and Dog Salmon Rivers, and the tidal flats of Ugashik Bay.

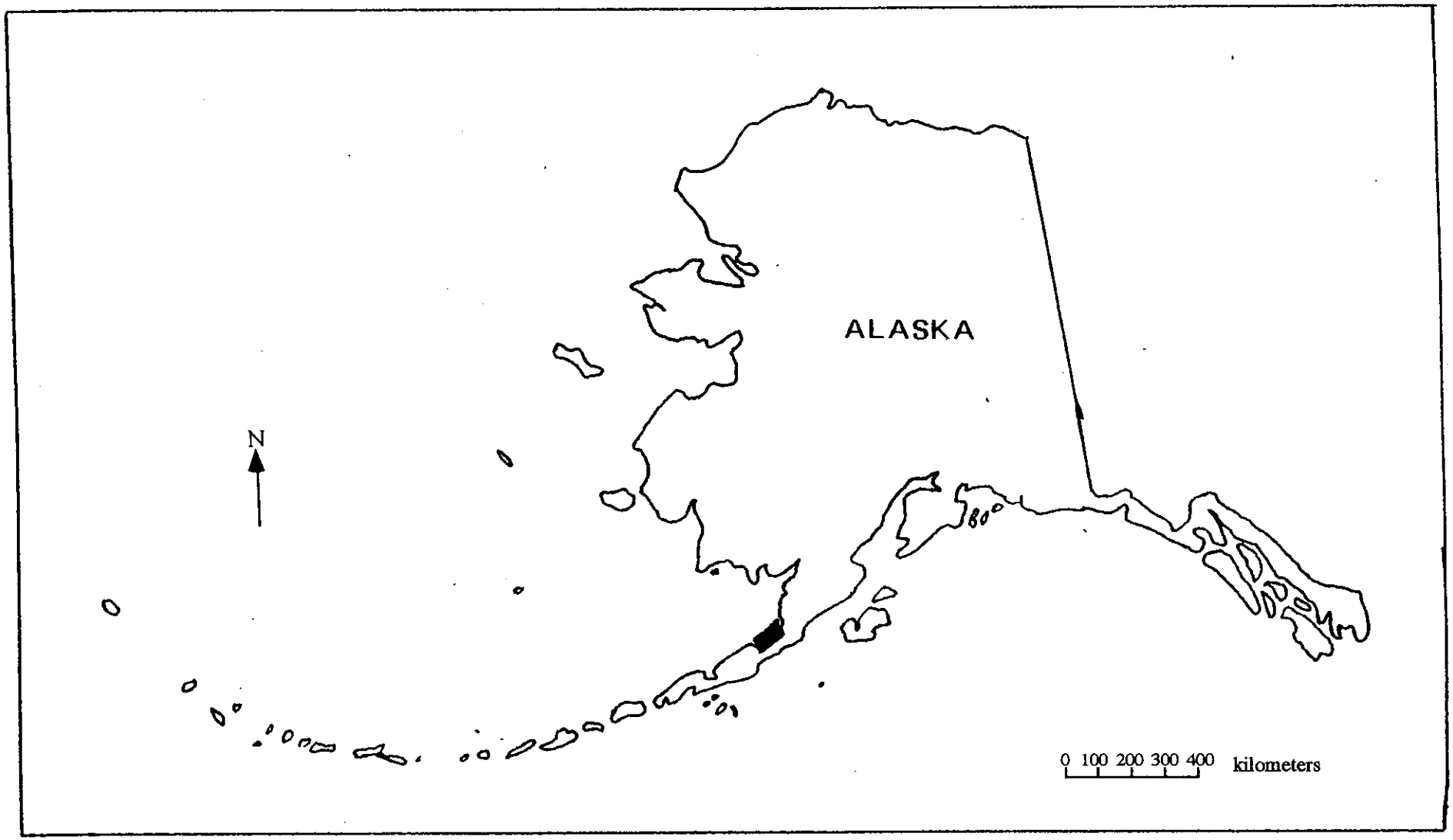

Figure 2. Speculated breeding range for *L. f. beringiae* on the Alaska Peninsula.

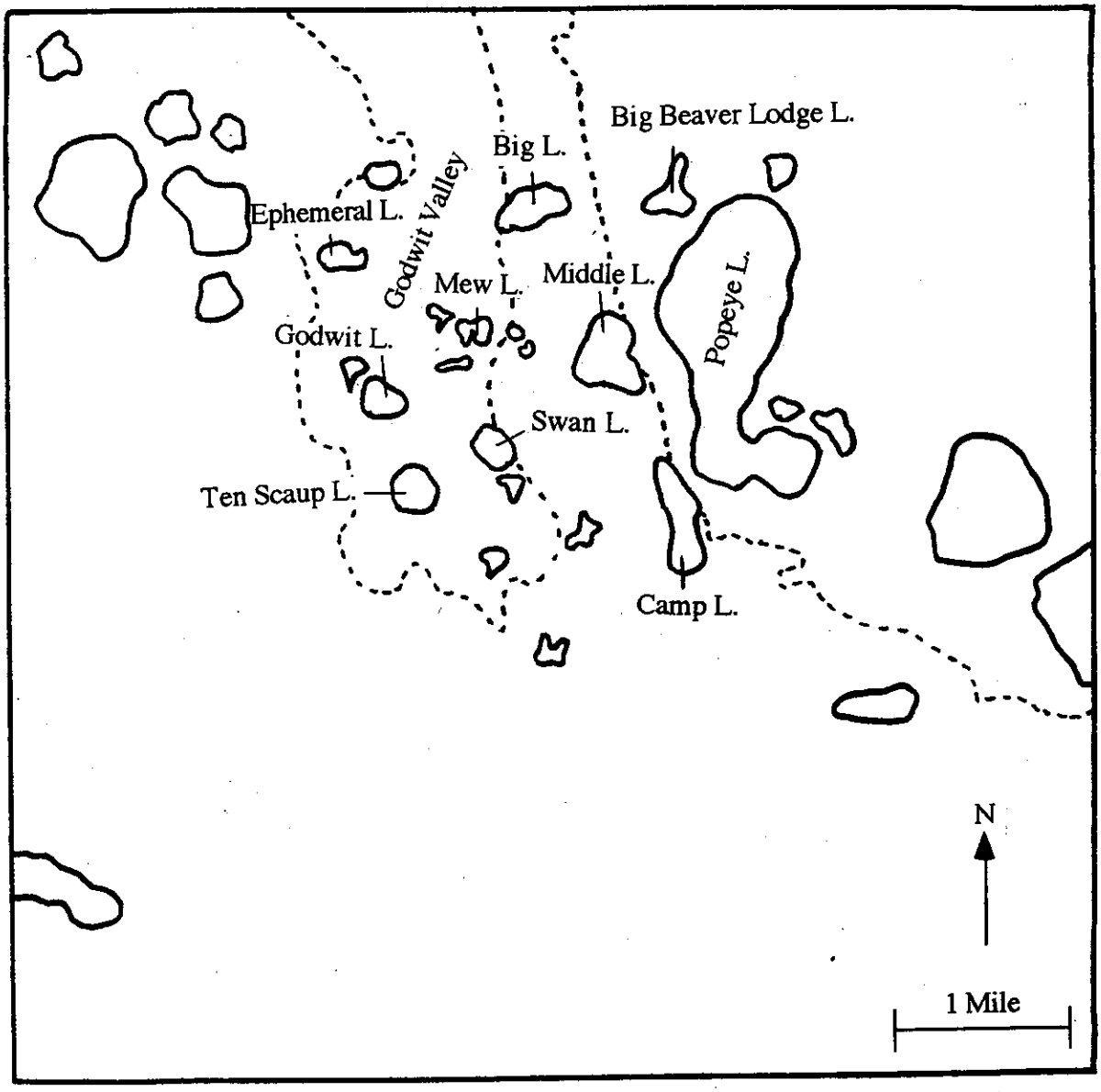

Figure 3. Godwit Valley study site.

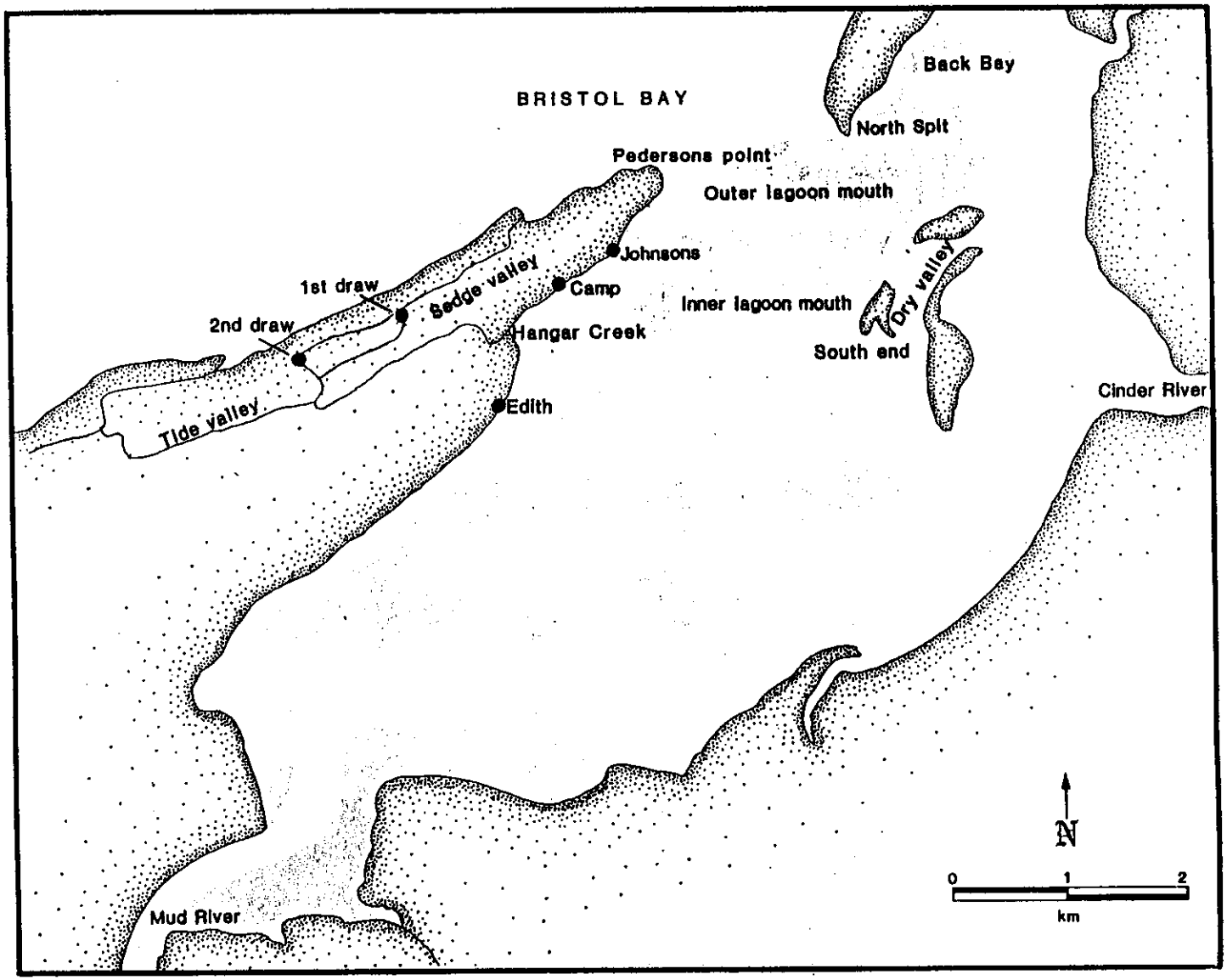

Figure 4. Cinder River Lagoon.

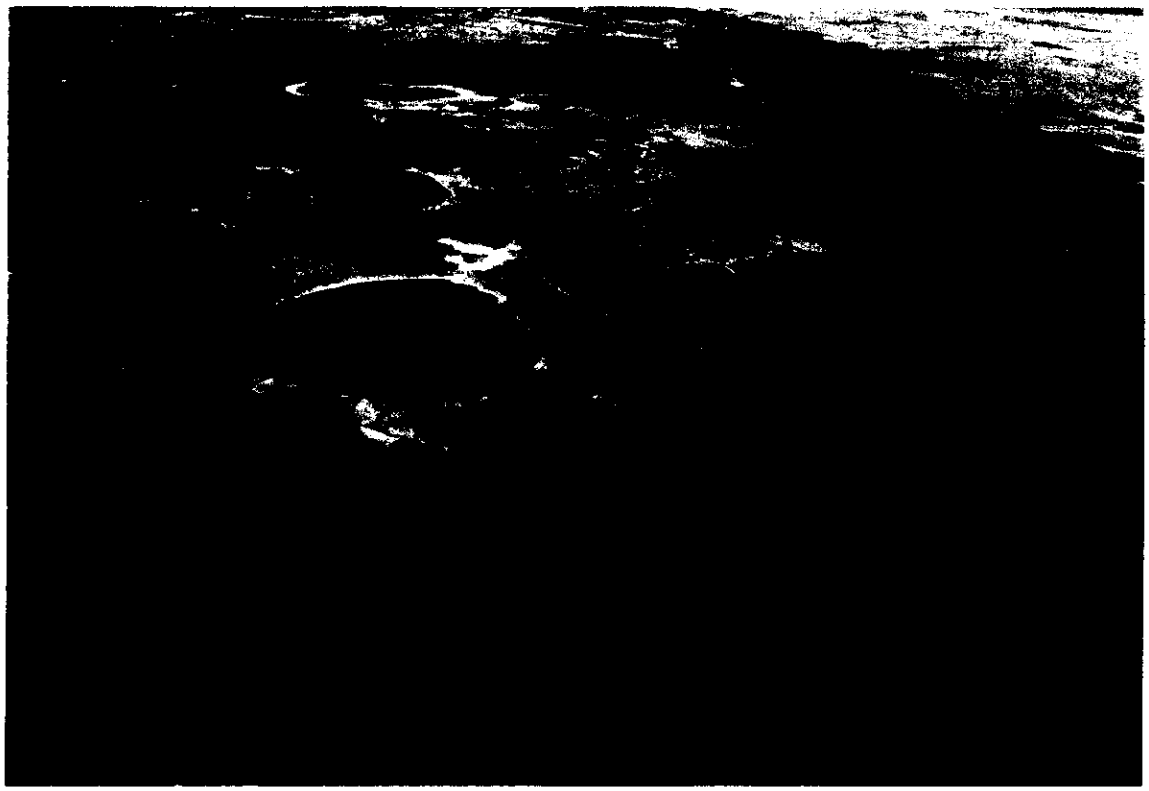

Figure 5. Aerial photograph of Godwit Valley in early May. The two large lakes in the center are 10 Scaup Lake (left) and Swan Lake (right).

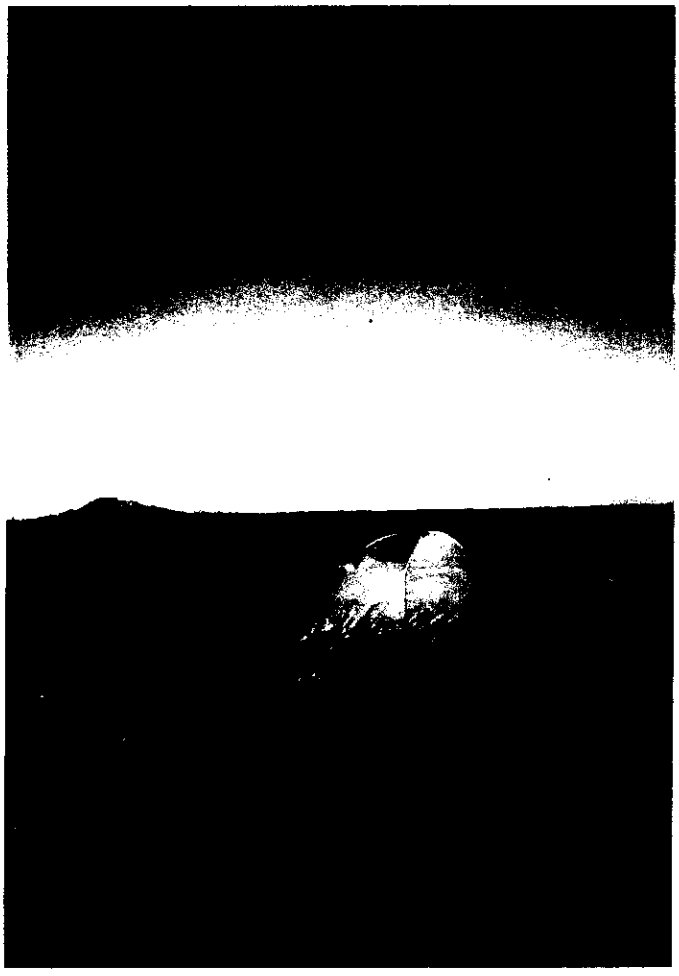

Figure 6. One of five tent blinds for making bird observations.

Figure 7. First marbled godwit nest found in Godwit Valley.