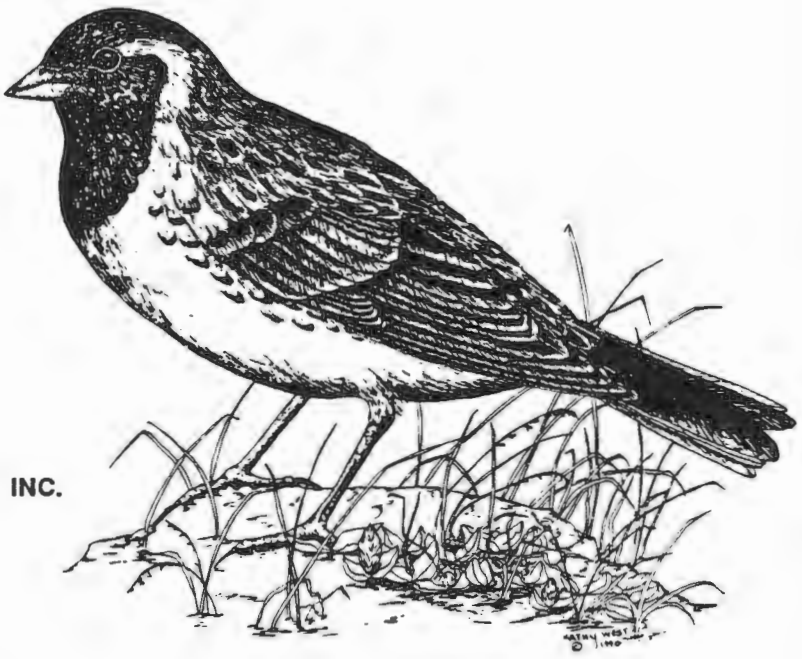
WILDLIFE USE OF DISTURBED HABITATS IN ARCTIC ALASKA

1989 FINAL REPORT



BY

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FOR

BP EXPLORATION (ALASKA) INC.
900 E. BENSON BLVD.
ANCHORAGE, ALASKA 99519

14 SEPTEMBER 1990

WILDLIFE USE OF DISTURBED HABITATS IN ARCTIC ALASKA

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BY

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EXECUTIVE SUMMARY

In summer 1989, BP Exploration (Alaska) Inc. (BPX) and LGL Alaska Research Associates, Inc. (LGL) initiated a study of wildlife use of disturbed habitats in arctic Alaska. This study mapped selected disturbed sites and made observations of bird and mammal use of these sites over a 2-month period. The ultimate goal of this study over the next few years is to assess the impacts of gravel fill and man-made impoundments on the wildlife community and to collect information useful for rehabilitating habitats affected by these kinds of disturbance.

Gravel fill is widely used in oilfield development and past work has substantiated that impounding of water upslope from the fill is common. But responses of wildlife to these changes is poorly documented. Qualitative observations made to date suggest that some animals avoid areas covered by gravel but that others might be attracted by the fill material. Likewise, there may be contrasting responses among wildlife species to impoundment areas; the few quantitative studies made suggest that response may also vary seasonally.

To fill gaps in the existing data, we observed wildlife use of abandoned drilling pads and impoundments; and of tundra, river alluvium, and pond sites undisturbed by man for comparison. These sites were situated mostly in and near the Prudhoe Bay and Kuparuk oilfields on the Arctic Coastal Plain. The observations documented bird and mammal use by 3-min periods during 2-hr observation intervals from mid-June to mid-August. Observations were made on gravel pad, river alluvium, and undisturbed tundra sites that were roughly similar in size; and on impoundments and ponds of similar average sizes. The analyses calculated level of use of sites as average number of species per 2-hr interval and average number of individuals per 3-min period, and type of use as percent of total time animals were engaged in specific activities.

Results of study site analyses and wildlife observations suggested that:

- The extent of wildlife use of gravel pads varied among wildlife species and species groups. Lapland Longspurs used pads more intensively than did other birds, and caribou were the mammals most commonly

observed on pads; these 2 species were the ones most commonly seen in undisturbed areas as well. Waterfowl, shorebirds, arctic foxes, and arctic ground squirrels also commonly used gravel pads.

- Birds as a group used gravel pads more commonly for feeding and resting than for nesting, though a few species relatively rare elsewhere nested on the pads. Lapland Longspurs on pads fed and rested on dry gravel substrates; shorebirds and waterfowl commonly fed and rested on water bodies (reserve pits and flare pits) associated with the pads.

- Mammals as a group often rested and, less often, fed on pads. Caribou, because of their abundance and their tendency to rest for long periods on pads, were the main contributors to this pattern.

- In comparison with natural habitats (i.e. undisturbed tundra and river alluvium), gravel pads attracted more bird species and more individuals per unit time. The differences in bird use between pads and river floodplain gravel (alluvium) were particularly large. The numbers of longspurs using gravel sites, and of shorebirds and waterfowl in and around water bodies (reserve pits and flare pits), were the main reason for these differences.

- Gravel pads also attracted more mammals (both species and individuals) per unit time than did undisturbed tundra or river alluvium, but the differences were not as great as they were for birds. Caribou, because of their abundance, were the primary contributors to these differences.

- The abundance of vegetation on gravel pads appeared to influence levels of use by both birds and mammals, but not greatly. The average number of bird species using pads was similar regardless of the vegetative cover, but numbers of individuals were somewhat greater (due mainly to more Lapland Longspurs feeding) on the more heavily-vegetated pads. As with birds, the average number of mammal species did not vary with level of plant cover. But in

contrast with birds, appreciably more individual mammals (due mainly to the presence of caribou) used unvegetated pads.

- The presence of water bodies at pads (i.e. reserve pits or flare pits) strongly influenced the numbers of bird species using pads but did not influence overall abundance of birds or use by mammals. Shorebirds and waterfowl were the major reasons for the substantially increased number of bird species using pads with water. Because of the large numbers of longspurs (which did not appear to show a preference for pads with water) relative to other species, total numbers of all birds at pads with water were not appreciably different from bird numbers at pads without water.

- In general, birds and mammals using pads spent relatively large proportions of their time feeding (birds) or resting (mammals). In comparison, those on undisturbed tundra spent larger proportions of their time engaged in breeding activities (birds) or in feeding or hunting (mammals).

- Only birds used impoundments; the major species groups were shorebirds (particularly phalaropes) and waterfowl. On average, birds using impoundments spent most of their time feeding, but also devoted considerable time to resting or preening.

- There was a great deal of similarity between bird use of impoundments and their use of natural ponds. For all species combined, there was greater use of impoundments than of ponds, but the differences were small. Numbers of waterfowl alone (both species and individuals) were likewise greater on impoundments. Birds fed equal amounts of time on impoundments and ponds, but rested or preened more on impoundments and nested more commonly on ponds.

- The presence of the emergent grass *Arctophila fulva* seemed to make some difference in how birds used impoundments. In general, more individual birds (but not more species) and more waterfowl (both

species and individuals) used impoundments with *A. fulva* than used those without. But in ponds, neither the average number of species observed nor the average number of individuals seemed to be affected by the presence of *A. fulva*.

- In summary, wildlife use of both gravel fill sites and impoundments was surprisingly high. Gravel pads almost always attracted more species and individuals of the various wildlife groups than did habitats undisturbed by human activity. Impoundments likewise attracted generally more use than did natural ponds, but the differences were not as great or as obvious as they were between gravel pads and natural sites. The types of use that animals made of the disturbed habitats were different from those of pads. Use of disturbed habitats for feeding was greater than expected, and often was more common than at other sites. Bird nesting, also an important activity, was more common in undisturbed habitats for most species, but not all.

- The major recommendations for future work focus on more rigorous experimental testing of selected relationships between wildlife and disturbed habitats. The hypotheses to be tested should be those that enable more accurate assessments of impacts to wildlife populations and more effective guidance for rehabilitation of disturbed sites. Specific studies are recommended.

ACKNOWLEDGEMENTS

This study was funded by BP Exploration (Alaska) Inc. (BPX). We would especially like to thank Debra Beaubien (Environmental Coordinator for BPX) for her promotion, continuing encouragement, and support of this project, and Steve Taylor (BPX Manager for Environmental and Regulatory Affairs) for his support. We also thank Dr. Chris Herlugson and Anne Brown of BPX. Chris made valuable contributions to the logistical coordination of the field effort and suggestions for improving the study. Anne promoted close coordination between LGL scientists and Dr. Jay McKendrick of the University of Alaska. Steve Lombard of BPX provided aerial photographs and maps of the study area. Gwen Turner assisted with information exchange between LGL scientists and Dr. McKendrick. The insight and information provided by Dr. McKendrick was particularly helpful, and we benefitted greatly from a long day in the field with Pete Scorup. The cooperation of all Dr. McKendrick's *Arctophila* field crew in helping with vehicles and other arrangements in the field is deeply appreciated. Additional thanks go to Russell Fraker and Pat Stadille for their assistance in the field. Declan Troy, Terry Carpenter, Terry Schick, Craig Hohenberger, Jo Young, Ken Kertell, and Jeff Wycliffe of the P-Pad and Peat Road studies shared ideas and equipment, and made the summer field effort much more enjoyable. Randall Howard, Rob Dillinger, and Ken Kertell ably assisted in report production and review. Many thanks go to Mark Miller for his assistance in the field and his statistical analysis of the data. He also provided invaluable clerical support in report production. Clerical support by Michele Ulofoshio is also much appreciated. Kathy Taylor provided her usual tireless effort toward data entry. Mike Joyce and others of ARCO kindly provided lodging and support for our field people in the Kuparuk Oilfield area. Finally, special appreciation is extended to Dr. Joe C. Truett for his continual guidance and assistance in all phases of this study from the formulation of the study design to the final document production. His editing skills were invaluable and provided the necessary cohesion during the production of this report.

INTRODUCTION

Activities related to the exploration for and production of petroleum in arctic Alaska often result in disturbances to wildlife habitats. Two of the major kinds of disturbance are the placement of gravel fill and the impoundment of water upslope from the fill (Walker et al. 1986, 1987). Because of the importance of gravel fill in supporting facilities and oilfield transportation, these disturbances invariably accompany oilfield development, becoming more pervasive as activities move from the exploration phase into the production phase.

The potential impacts of these disturbances on wildlife underlie many of the environmental regulations that govern oil development. Both the regulations themselves, and the resulting plans for developing oilfields and mitigating adverse effects, are based on expected responses of animal populations to the kinds of habitat changes involved. For example, a major environmental protection goal of the U.S. Fish and Wildlife Service (FWS) is "to maintain overall wildlife habitat productivity" (FWS 1989).

BP Exploration (Alaska), Inc. (BPX) is currently developing plans to mitigate adverse effects caused by abandoned gravel fill drilling pads. In 1988, BPX developed a comprehensive compliance plan pertaining to abandoned exploration sites, as required by the State of Alaska Solid Waste Management Regulations 18 ACC 60.500 (d). Additionally, the company initiated development of a multi-year Gravel Pad Vegetation Experiment to evaluate various methods of rehabilitating gravel structures associated with oil-related activities on the North Slope of Alaska. BPX may also desire to eventually rehabilitate sites affected by impoundments.

For these rehabilitation plans to be successful, they must be based on a knowledge of how wildlife populations are affected by gravel fill, by the associated impoundments, and by rehabilitation activities of various kinds. At present this knowledge is inadequate for making rational decisions about what rehabilitation should entail. To meet the need for more information, LGL Alaska Research Associates, Inc. (LGL) and BPX initiated in June, 1989, a program

to study the use of arctic Alaska gravel fill sites and impoundments by wildlife. The following report describes the first year of these studies.

OBJECTIVES

This study addressed two major tasks, as follows:

Task 1

Conduct preliminary observational studies of wildlife use of disturbed habitats (e.g., at abandoned gravel well-pads and at impoundments) and of "natural" habitats that resemble habitats at gravel sites and impoundments.

The purpose of these studies is to document wildlife use of disturbed sites and to investigate similarities and differences between such uses and uses of similar "natural" habitats. The observations set the stage for developing firm hypotheses about the relationships between disturbed habitats and wildlife populations--hypotheses that can be more rigorously tested in future years.

Task 2

Develop high-resolution maps and descriptions of selected abandoned well pads and impoundments.

The purpose of the maps and descriptions is to depict features of pads and impoundment areas expected to influence plant colonization and wildlife uses. These features include vegetation distributions, topographic irregularities and thicknesses of gravel pads, and distribution of emergent vegetation and landforms in impoundments. The maps provide a basis from which to interpret observations of wildlife (Task 1) and to portray the existing conditions of abandoned pads and impoundments as a basis for rehabilitation planning.

BACKGROUND AND RATIONALE

This section provides a rationale for conducting the study and a context for understanding it. Definitions of terminology related to disturbance, mitigation, and the influence of both on wild animal populations are as follows, as derived from Jorgenson (1989b), Senner (1989), and Webster's Collegiate Dictionary (1984):

Goals: Purpose for which rehabilitation work is performed (e.g., provision of wildlife habitat).

Rehabilitation: Techniques used to accomplish goals (e.g., restoration or provision of wildlife habitat).

Restoration: Returning disturbed sites to as near their pre-disturbance geobotanical condition as possible.

Habitat: The place where an animal or animals lives. To live in a place implies occupying it for at least part of the time; landscape outside the context of such occupation does not constitute habitat.

Habitat Enhancement: Provision or addition of biophysical features beneficial to a wildlife population or populations in an area.

Mitigation: The alleviation of adverse effects. With respect to a wildlife species, mitigation offsets adverse effects to populations, usually by providing or altering habitat.

Habitat Value: The extent to which an area of landscape benefits a wildlife population or populations.

Regulatory Perspective

A major legal consideration relative to landscape disturbance in arctic Alaska is that many areas there are classified as "wetlands". This brings the assessment and mitigation of disturbance under the purview of an extensive set of regulations designed to preserve the functions and values of wetlands (Senner 1989). These regulations strongly influence current thinking about what is appropriate for rehabilitating disturbed sites such as well pads and impoundments.

The major specified goal of rehabilitation of disturbed sites in arctic Alaska wetlands is to increase the wildlife habitat value of the sites (FWS 1981), as opposed to non-wildlife goals, which are probably inapplicable (Epps 1988). Habitat value for a given wildlife species is considered to be more or less equivalent to the carrying capacity of the environment for that species (FWS

1981). But it is not clear on the basis of existing information that simple approaches to rehabilitation such as removal of gravel pads or draining of impoundments would necessarily improve habitat value or increase carrying capacity. Additional investigation is needed to help quantify the responses wildlife to the habitat changes that result from placement of fill and from various rehabilitation practices.

Habitat Disturbance and Its Effects

This section describes gravel fill and impoundments in the context of development in arctic Alaska. Known responses of wildlife species and groups to these disturbances are summarized.

Gravel Fill

Gravel fill is used to support facilities or vehicular traffic on arctic tundra terrain because it provides a relatively stable, hard work surface and protects the underlying permafrost from thermal degradation. Gravel runways, camp pads, oil drilling pads, and roadways have been used for up to 30 years or more (Brown and Grave 1979, Hanley et al. 1981, Everett et al. 1985), and gravel fill is now in standard use for roadways and facilities support pads (Hanley et al. 1981). Pad or road thickness depends on the weight-bearing capacity required and the expected duration of use (Meehan undated:32). Earlier exploratory well pads were often 0.6 m (2 ft) or less thick (Hanley et al. 1981:127, Walker et al. 1987b:27); most pads and roads in oil fields now are 1.5 m (5 ft) or more thick (Meehan undated:32).

Over time, surfaces of abandoned gravel fill may be invaded by a sparse cover of vegetation (Johnson et al. 1978, Walker et al. 1987b:28). Relatively thin pads or roads sometimes eventually develop topographic patterns on their surfaces that trace the original polygons and ice-wedge troughs beneath them (pers. observ.). Areas immediately adjacent to gravel roads or pads are subject to landscape subsidence or thermokarst (Walker et al. 1987b:30) from alterations in the thermal regime or from flooding.

The Prudhoe Bay Oilfield in Alaska, by all accounts the most densely-developed oilfield in the Arctic, had about 2% (Senner 1989:60) to 4% (Walker et al. 1986) of its area covered by gravel fill by the mid-1980's. Because recent technologies use gravel more efficiently (BP 1989), gravel fill will probably not

cover that proportion of newer fields. In the younger Kuparuk Field west of Prudhoe Bay, for example, gravel fill occupies about 0.8% of the area (Senner 1989:60).

Impoundments

We define impoundments as ponds created by man-caused alterations to the landscape surface. Within the highly-developed Prudhoe Bay region, most instances of impounded water occur where gravel roads and pads block drained thaw-lake basins or other low-lying areas (Brown et al. 1984, Alexander and Miller 1978, Walker et al. 1986, Walker et al. 1987b:30).

The acreage flooded by impoundments usually peaks as snowmelt ends (i.e. mid-June). In the Prudhoe Bay Oilfield, most of the flooded areas drain by mid-summer after road culverts unclog and surface run-off rates subside (Alexander and Miller 1978:19, Klinger et al. 1983, Walker et al. 1987b:30). Over 90% of the area flooded in the Prudhoe Bay region had retained, as of about 1983, rooted vegetation, but vascular plant cover can disappear when impoundments are too deep and persist too long (Walker et al. 1987b:30).

Though the vegetation in temporarily-flooded areas and in shallow, permanently-flooded areas is typically not killed, it is often changed. The most noticeable effect is often an enhanced "greening" of the vegetation during the growing season (Klinger et al. 1983, Walker et al. 1987b:22). Coinciding with this green-up is a deepened thaw in summer (Walker et al. 1987b:32). Increasing depth of thaw in impoundments often leads to some level of thermokarst (i.e. subsidence caused by the melting of ice in soils).

Temporary and permanent impoundments together account for a major proportion of the acreage disturbed in oil development areas. Walker et al. (1986), in a study to determine cumulative landscape impacts in the Prudhoe Bay oilfield from 1969-1983, found that impoundments covered nearly 20% of the landscape in a heavily-developed area, compared with 11% covered by gravel roads and pads, and 35% covered by all kinds of disturbances combined. In the Prudhoe Bay Oilfield as a whole (total area = 300 km^2 or 186 mi^2), 2.8% of the total area was reportedly covered by impoundments (Walker et al. 1986), compared with about 2% (Senner 1989:62) to 4% (Walker et al. 1986) covered by

gravel. Regions not as intensively developed are likely to have much smaller percentages of land flooded.

Effects on Wildlife

Though little research has been done on the effects of gravel fill and impoundments on arctic Alaska wildlife, some data exist. Table 1 shows that the responses of birds and mammals to gravel fill apparently vary among the species and the kinds of use. Some species appear to avoid fill sites, but others are attracted. Similarly, Table 2 suggests that impoundments may also have varying effects that depend on the animal species and the type of use in question. A few species appear to suffer habitat degradation from both types of disturbance, a few others apparently benefit from both kinds of disturbances, and others may be affected very little by either.

The influence of disturbance on vegetation may affect wildlife use because of changes in plant productivity or cover. On gravel fill surfaces, plants establish themselves slowly, and plant cover and productivity may remain low for many years though recovery is often accelerated by man's intervention. Where surface disruptions or impoundments exist, soil warming and thermokarst speed up soil nutrient cycling, and plant cover and productivity may increase (see review by Truett and Kertell 1989).

One plant species that colonizes impoundments, *Arctophila fulva*, may become a significant component in wetland rehabilitation efforts on the North Slope of Alaska. *Arctophila* communities grow in relatively deep water and are considered to be important as feeding sites for waterfowl, perhaps because they commonly sustain high densities of invertebrate prey (Bergman et al. 1977, Derksen et al. 1981). Some authors have suggested that *Arctophila* may be an important component of the Tundra Swans' summer diet (Derksen et al. 1981). These plant communities are also a source of nest material and provide cover for breeding waterfowl such as loons, Brant, Oldsquaw, White-winged Scoter, and King Eider (Derksen et al. 1981)

The physical characteristics of disturbed sites may also influence their use by wildlife. Observations suggest that raised surfaces are commonly used by caribou in ameliorating harassment by insects, and arctic fox and ground squirrel

Table 1. Reported responses of wildlife to gravel fill (roads, pads) on tundra surfaces in Arctic Alaska.

Animal Species or Group	Apparent Animal Response or Activity	Condition of Gravel	Information Source	How Documented
Baird's Sandpiper	Attracted to pad area for nesting	Supported oil-drilling operations	Wright and Fancy 1980	Nest searches on transects within and outside disturbed habitat
Semipalmated, White-rumped and Pectoral Sandpiper, Dunlin, Lapland Longspur	Possibly avoided area for nesting	Supported oil-drilling operations	Wright and Fancy 1980	Nest searches on transects within and outside disturbed habitat
Lapland Longspur	Alighting or perching	Gravel berms and pads	Robus et al. 1986	Plot censuses
Snow Bunting	Attracted to pad area for nesting	Supported oil-drilling operations	Wright and Fancy 1980	Nest searches on transects within and outside disturbed habitat
Geese	Intensity of grazing higher on disturbed plots than on undisturbed tundra; scat density higher on fertilized vs. non-fertilized plots	15-25 cm thick gravel roadway with various sod and fertilizer additions, Kuparuk oilfield	Jorgenson 1989a	Scat counts and visual estimations of % plants eaten on plots
Canada geese	Occasionally observed grazing; some plants suppressed by grazing	.2-1.2 m-thick gravel pad with various seeding and fertilization treatments on plots, Prudhoe Bay oilfield	Jorgenson 1989b	Anecdotal observations and grazing exclosures
Most bird species	Avoided gravel; used nearby habitat more for most activities	Gravel berms and pads	Robus et al. 1986	Plot censuses
Ground squirrels	Denning begins 3-4 years after disturbance	Raised roads and drilling pads, NPR-A	McKendrick 1986	Anecdotal observations
Caribou	"Complete habitat loss"	Not specified	Shideler 1986	Not specified
Caribou	Insect relief resting sites, travel corridors	"Roads and pads"	McKendrick 1986	Anecdotal observations
Caribou	Avoided facility pads during mosquito-induced movements; used them preferentially during oestrid-fly season	Main gravel roads and pads on Kuparuk oilfield	Johnson and Lawhead 1989	Observations from towers,vehicles, and aircraft
Caribou	Percent of leaves and flowers grazed probably higher on all disturbed sites than on natural tundra	15-25 cm thick gravel with various sod and fertilizer additions, Kuparuk oilfield	Jorgenson 1989a	Scat counts and visual estimations of percent plants eaten on plots
Caribou	Occasionally observed grazing; some plants suppressed by grazing	.2-1.2 m-thick gravel pad with various seeding and fertilization treatments on plots, Prudhoe Bay oilfield	Jorgenson 1988b	Anecdotal observations and grazing enclosures
Caribou	Frequently observed on gravel roads and pads and overburden stockpile during insect harassment season	Not specified	Jorgenson 1989b	Not specified
Caribou	Used primarily for movement pathways and insect relief	Not specified	Dames and Moore 1986	Not specified
"Wildlife"	"Complete habitat loss"	Not specified	Walker et al. 1986	Not specified

Table 2. Reported responses of wildlife to impoundments created by gravel fill in Arctic Alaska.

Animal Group or Species	Nature and Timing of Animal Response	Location and Kind of Impoundment	Information Source	How Documented
Lesser Golden-plover, Semipalmated and Buff-breasted Sandpiper, Dunlin, Lapland Longspur	Avoided impoundments in summer	Temporary and permanent impoundments beside West Dock gravel roads, Prudhoe Bay oilfield	Troy 1983	Seasonal abundance in 50 x 50" grid units statistical comparisons
Several shorebird species	Feeding in ephemeral ponds	Reserve pit ponds, Kuparuk oilfield	Robus et al. 1986	Plot censuses
All shorebirds tested except Semipalmated Sandpiper	Sightings less numerous on impounded side of road in summer	Summer roadsides with and without impoundments, West Road, Prudhoe Bay oilfield	Troy 1982	Paired plot censuses
All shorebird nests	Total nests less numerous in roadside areas with impoundments than without	Temporary and permanent, near West Dock road, Prudhoe Bay oilfield	Troy 1982	Paired plot censuses
Most shorebirds, passerines and waterfowl	Apparent avoidance for nesting	Impoundments (mostly permanent) along West Road, Prudhoe Bay oilfield	Troy 1985	Plot censuses
Most shorebirds, passerines and waterfowl except Northern Pintail and phalaropes	Apparent avoidance for non-nesting activities during breeding season	Impoundments (mostly permanent) along West Road, Prudhoe Bay oilfield	Troy 1985	Plot censuses
Greater White-fronted Goose, Northern Pintail, Pectoral Sandpiper	Preferential use over other habitats during post-breeding	Impoundments (mostly permanent) along West Road, Prudhoe Bay oilfield	Troy 1985	Plot censuses
Lapland Longspur	Apparent avoidance during post-breeding	Impoundments (mostly permanent) along West Road, Prudhoe Bay oilfield	Troy 1985	Plot censuses
Northern Pintail, King Eider, Red-necked Phalarope	Attracted to impoundments in summer		Troy 1983	Seasonal abundance in 50 x 50" grid units; statistical comparisons
All waterfowl species tested and Semi-palmated Sandpiper	Sightings more numerous on impoundment side of road in summer	Summer roadsides with and without impoundments, West Road, Prudhoe Bay oilfield	Troy 1982	Paired plot censuses
Geese and shorebirds	Attracted to ponds, early and later summer		Troy 1983	Seasonal abundance in 50 x 50" grid units; statistical comparisons
Greater White-fronted Goose	Feeding in ephemeral ponds	Reserve pit ponds, Kuparuk oilfield	Robus et al. 1986	Plot censuses
Geese	Used as escape habitat during summer molt period	Reserve pits at exploratory drilling sites, NPR-A	McKendrick 1986	Anecdotal observations

dens have been observed on abandoned well-pads (pers. obs). These pads are frequently 1.5 m higher than the surrounding tundra surface and may, in effect, "mimic" naturally-occurring elevated features of the landscape.

It is evident that information collected to date is insufficient to describe how most species populations will respond to these kinds of habitat disturbances. Additional research, therefore, is needed to collect information sufficient to predict impacts and plan habitat rehabilitation.

STUDY AREA

Sites over a broad expanse of the Alaskan arctic slope between the Colville and Sagavanirktok rivers were selected for study (Fig. 1 & 2). These sites included representatives of two kinds of human-caused disturbance--gravel fill and surface impoundments--along with three kinds of "natural" landscapes--tundra, river alluvium, and ponds. A detailed description of each study site appears in Appendix A.

The natural sites were used as "controls" in that we wished to compare what we found on them with what took place in the areas disturbed by man. However, the natural sites were not always true controls in the strictest sense, e.g., their geobotanical qualities might have differed from those originally existing within the disturbed area. Further, they were sometimes slightly different in size or shape from their disturbed counterpart sites. They were selected more for convenience of comparison than for elegance in experimentation. Hereafter we refer to the natural sites as "tundra", "alluvium", "ponds", or "undisturbed" areas.

The study sites were purposely chosen to represent a wide range of several variables we suspected would influence wildlife use. Consequently, gravel fill sites showed differences among themselves in vegetative cover, gravel thickness, distance from the coast, and proximity to river deltas. Alluvial sites were located adjacent to the Sagavanirktok and Kuparuk rivers. Impoundments and ponds showed differences in whether they contained *Arctophila fulva*. Some sites were in close proximity to "active" oilfield facilities; others were located up to 40 kilometers away from such facilities.

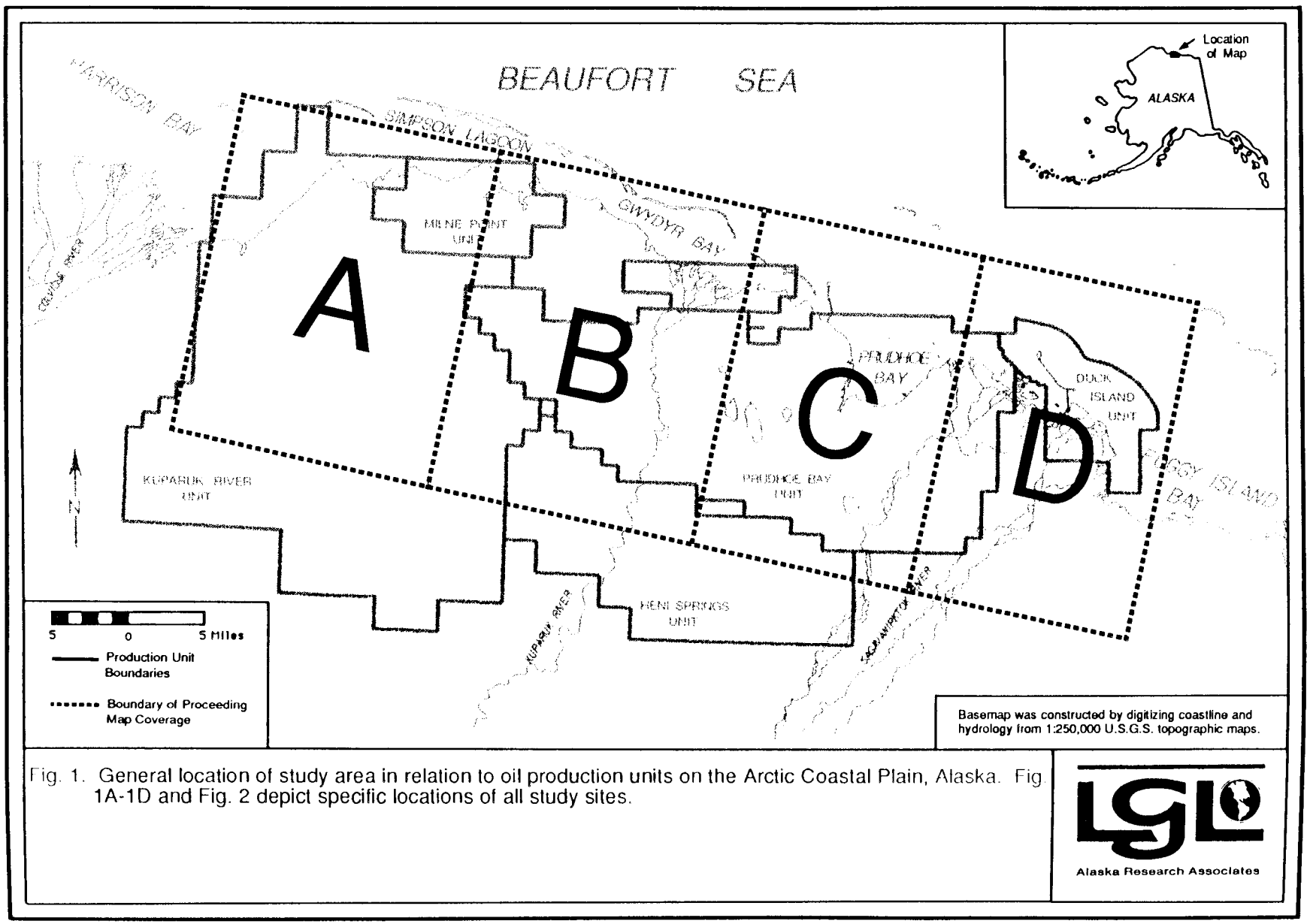


Fig. 1. General location of study area in relation to oil production units on the Arctic Coastal Plain, Alaska. Fig. 1A-1D and Fig. 2 depict specific locations of all study sites.

LGL Alaska Research Associates

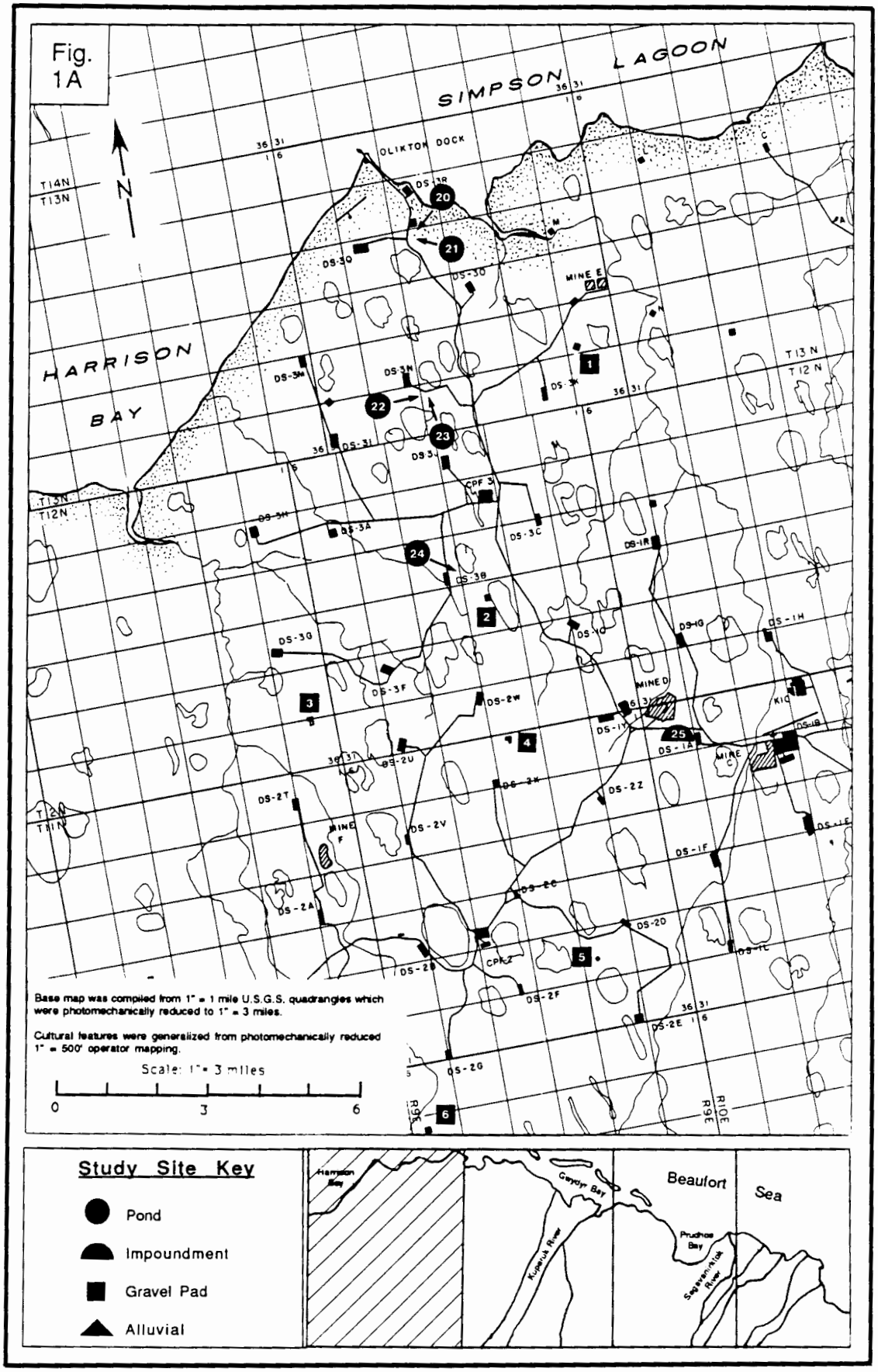


Fig. 1A
SIMPSON LAGOON
HARRISON BAY
OLIKTOK DOCK
MINE E
MINE D
MINE C
MINE F
KIC
CPF 3
CPF 2
T14N
T13N
T12N
T11N
T13 N
T12 N
R9E
R10E
DS-3R
DS-3Q
DS-3N
DS-3M
DS-3L
DS-3K
DS-3J
DS-3H
DS-3A
DS-3C
DS-3B
DS-3G
DS-3F
DS-2W
DS-2U
DS-2T
DS-2V
DS-2A
DS-2B
DS-2G
DS-2F
DS-2E
DS-2K
DS-2Z
DS-2C
DS-2D
DS-1R
DS-1Q
DS-1G
DS-1H
DS-1Y
DS-1A
DS-1B
DS-1E
DS-1F
DS-1C
Base map was compiled from 1" = 1 mile U.S.G.S. quadrangles which were photomechanically reduced to 1" = 3 miles.
Cultural features were generalized from photomechanically reduced 1" = 500' operator mapping.
Scale: 1" = 3 miles
0
3
6
Study Site Key
Pond
Impoundment
Gravel Pad
Alluvial
Harrison Bay
Camden Bay
Beaufort Sea
Prudhoe Bay
Kuparuk River
Sagavanirktok River

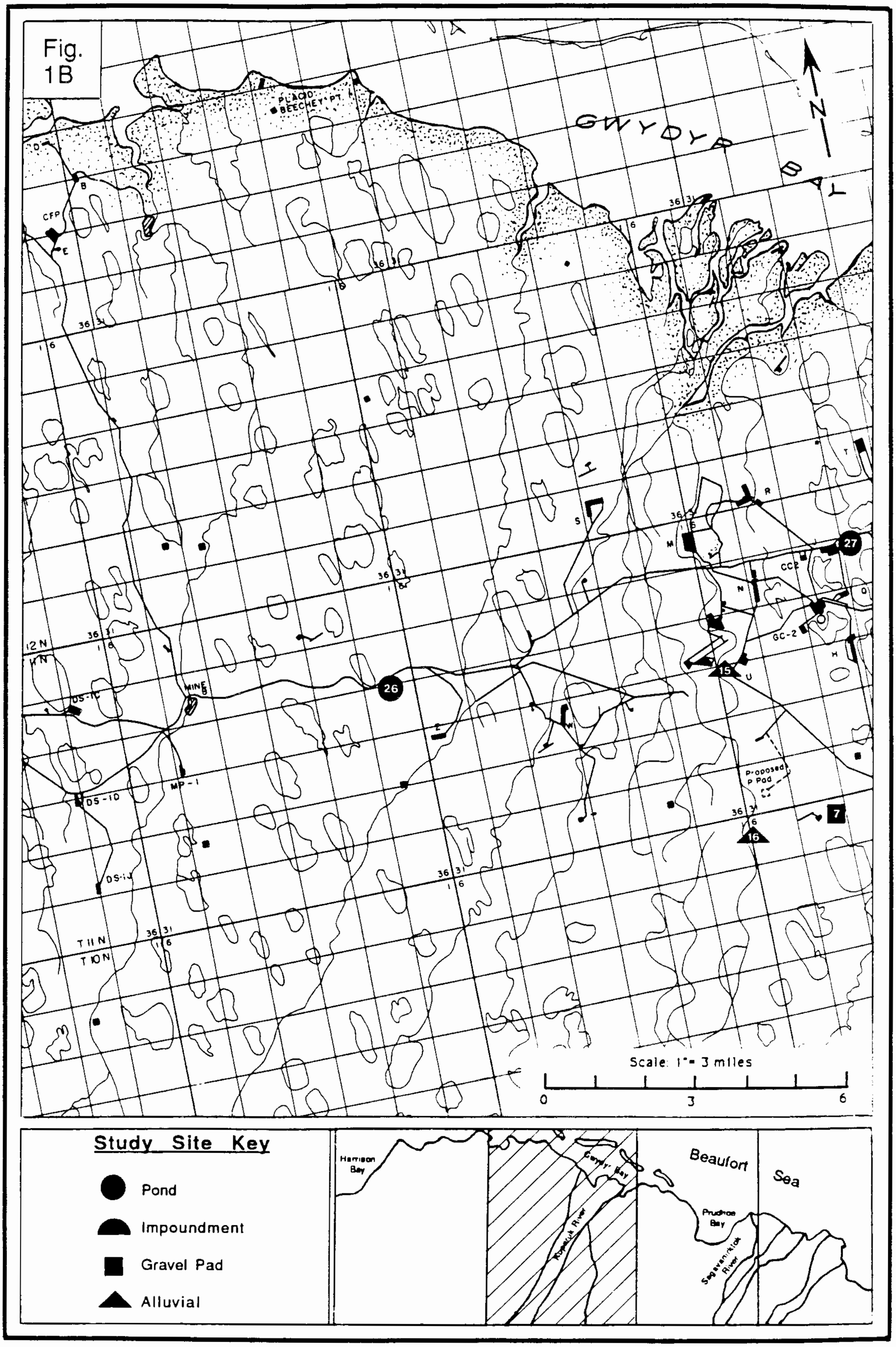


Fig. 1B
PLACID PT.
BEECHEY PT.
GWYDYR BAY
N
CFP
MINE B
DS-1C
DS-10
MP-1
DS-1J
T11N
T10N
Proposed P Pad
CC2
GC-2
26
27
15
16
7
Scale: 1" = 3 miles
0
3
6
Study Site Key
Pond
Impoundment
Gravel Pad
Alluvial
Harrison Bay
Gwydyr Bay
Kuparuk River
Beaufort Sea
Prudhoe Bay
Sagavanirktok River

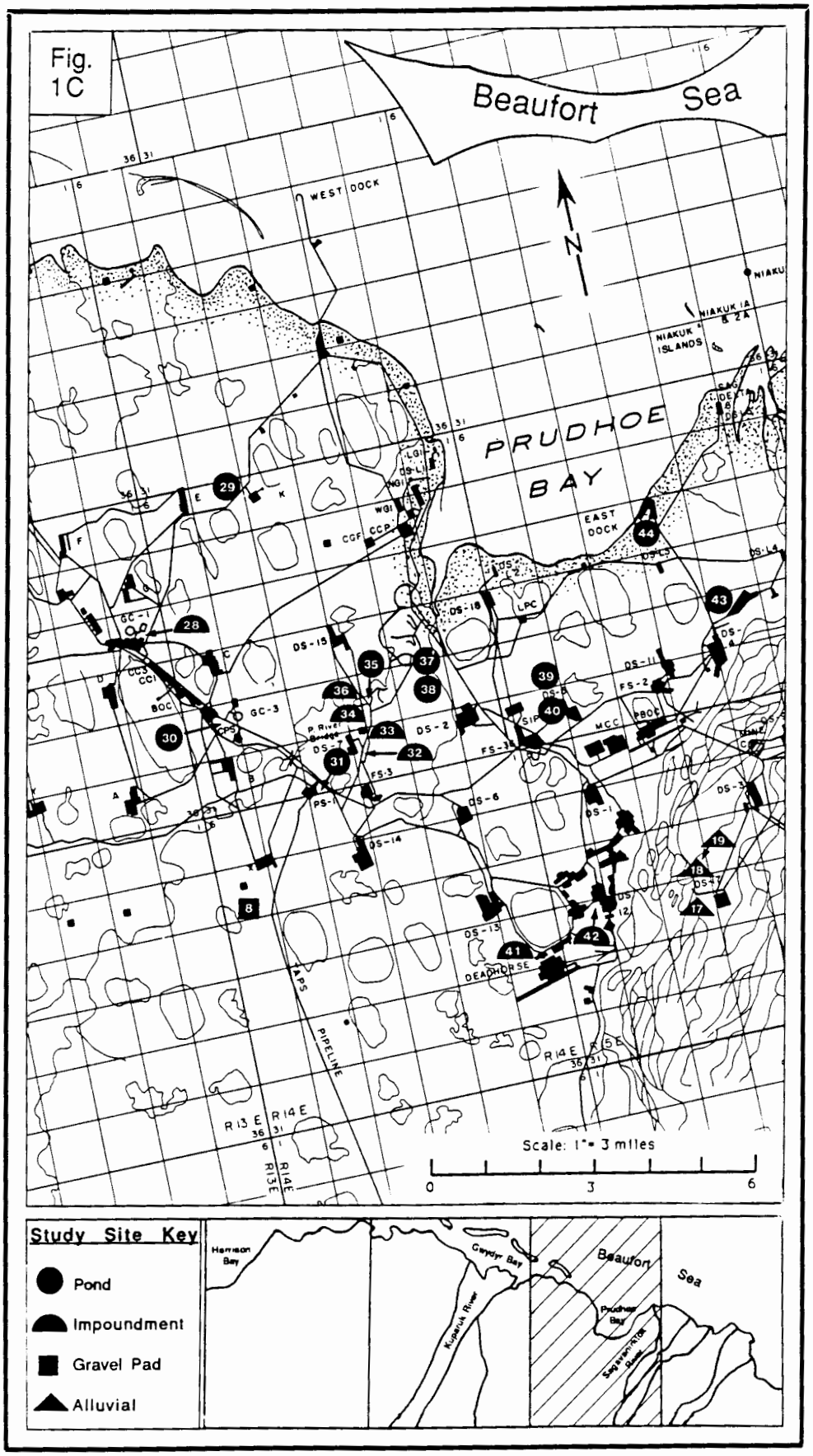


Fig. 1C
Beaufort Sea
WEST DOCK
N
NIAKUK
NIAKUK 1A & 2A
NIAKUK ISLANDS
PRUDHOE BAY
EAST DOCK
LPC
DS-18
DS-15
DS-2
DS-11
DS-6
DS-14
DS-13
DS-1
DS-3
DS-4
DS-7
DS-12
FS-2
FS-3
PBOC
MCC
SIP
CPS
GC-1
GC-3
CCP
CGF
WGI
DEADHORSE
TAPS PIPELINE
R13E R14E
R14E R15E
Scale: 1" = 3 miles
0 3 6
Study Site Key
Pond
Impoundment
Gravel Pad
Alluvial
Harrison Bay
Gwydyr Bay
Kuparuk River
Beaufort Sea
Prudhoe Bay
Sagavanirktok River

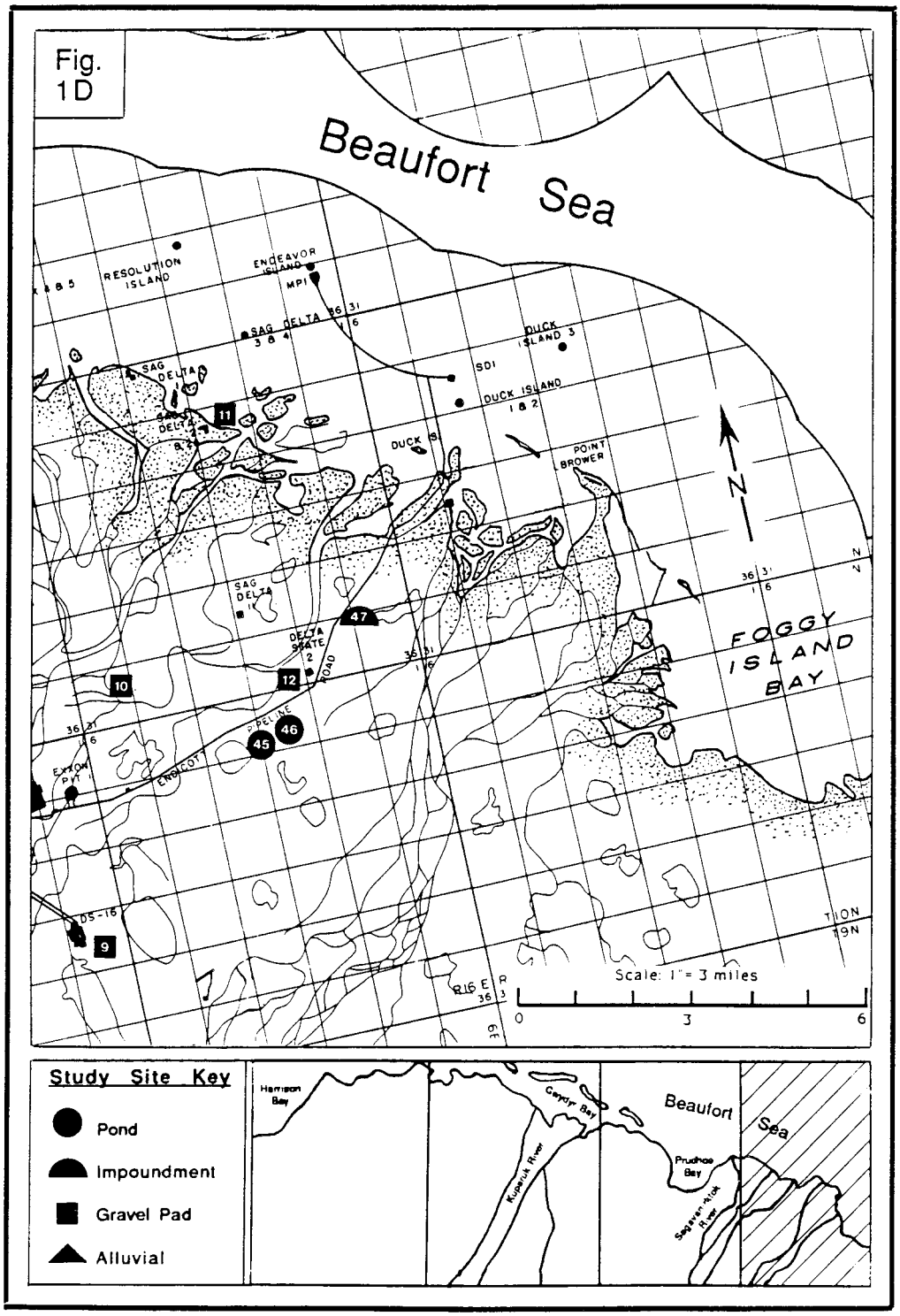


Fig. 1D
Beaufort Sea
RESOLUTION ISLAND
ENDEAVOR ISLAND
MPI
SAG DELTA 36 31 1 6
SAG DELTA 3 8 4
DUCK ISLAND 3
SDI
DUCK ISLAND 1 8 2
DUCK IS
POINT BROWER
SAG DELTA 1
SAG DELTA 2
DELTA STATE 2
ROAD
PIPELINE
ENDICOTT
EXXON PIT
DS-15
9
10
11
12
45
46
47
FOGGY ISLAND BAY
N
36 31 1 6
T10N
T9N
R16E
R
36
31
Scale: 1" = 3 miles
0
3
6
Study Site Key
Pond
Impoundment
Gravel Pad
Alluvial
Harrison Bay
Camden Bay
Beaufort Sea
Prudhoe Bay
Kuparuk River
Sagavanirktok River

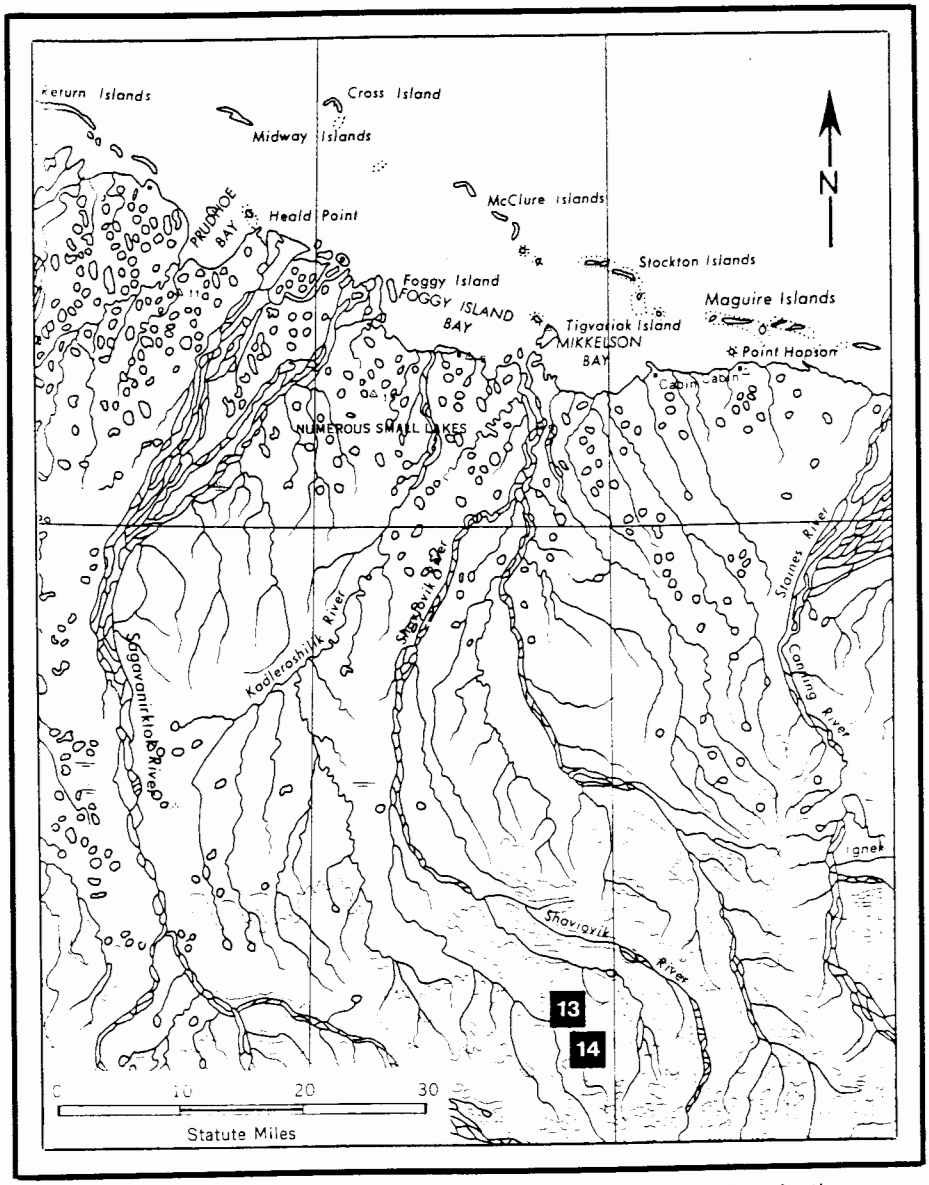


Fig. 2. Location of two abandoned gravel well-pad study sites in the foothills of the Brooks Range, Alaska.

Gravel Sites and Adjacent Tundra

Gravel fill sites included twelve abandoned exploratory well sites located in or near the Kuparuk River, Prudhoe Bay, and Duck Island units (Fig. 1). Two additional abandoned well sites were located in the northern foothills of the Brooks Range (Fig. 2). These fourteen sites were selected because they exhibited wide ranges in age, physiognomic development, and vegetative structure and composition.

Of five gravel alluvium sites, three were located near the Sagavanirktok River and two were located near the Kuparuk River (Fig. 1). These alluvial sites undergo periodic flooding and therefore function as naturally-disturbed gravel sites to compare with gravel pad sites.

Adjacent to each of the gravel pad and alluvium sites, an undisturbed area (delineated by surveyor's stakes) of approximately the same size was used for comparison. Because the gravel pads varied in size, the undisturbed sites also varied in size.

Each alluvial study plot (consisting of river gravel and mixtures of gravel, sand, and silt) measured approximately 100 m x 200 m, and was situated next to an undisturbed tundra plot of similar dimensions. Locations of each of the undisturbed plots with respect to the adjacent disturbed site are shown individually in Appendix A.

Impoundments and Ponds

Nine development-related impoundments were selected as disturbed sites and nineteen natural ponds were chosen as control sites. All of these water bodies were located within the Kuparuk River, Prudhoe Bay, and Duck Island units (Fig. 1). Detailed descriptions of all ponds and impoundments can be found in Appendix A.

All impoundments and ponds studied were relatively small. The study plots, ranging in size from 0.26 ha to 19.03 ha with a mean area of 3.60 ha, included the entire impoundment or pond in most cases. In a few cases, portions of water bodies were used as plots. Some size latitude had to be

accommodated, because few impoundments and ponds that could be conveniently reached were similar in surface area.

METHODS

Classification of Study Sites

Gravel pad and alluvial sites, and ponds and impoundments, were separated into groups based on similarities in geographic location and in site characteristics we thought would affect animal use. These groupings formed the bases for data analyses and hypothesis testing.

Gravel Pads and Alluvial Sites

Gravel pad sites were classified broadly by their geographic location (Table 3). Ten sites were located on the Arctic Coastal Plain of Alaska, two on the Sagavanirktok River Delta, and the remaining two sites were located in the foothills north of the Brooks Range.

The Coastal Plain and River Delta sites were further subdivided into groups according to the extent of vegetative cover and the presence of impounded water associated with the gravel pad. Gravel pads with a total vegetative cover (ocularly estimated) ≥5% were classified as vegetated sites; four sites fell into this class and plant cover ranged from 5-50%. Eight pads exhibited <5% vegetative cover and were classified as unvegetated. Ten gravel pad sites included adjacent reserve pits and/or flare pits which contained permanent water bodies (impoundments). Two of the gravel pad sites contained no impoundments.

Alluvial sites were classified by geographic location. The two sites near the Kuparuk River were called Coastal Plain sites; the remaining three alluvial sites, located within the Sagavanirktok River Delta, were called River Delta sites.

Ponds and Impoundments

We classified ponds and impoundments according to the presence or absence of *Arctophila fulva* (Table 4). Those that contained extensive stands of *Arctophila* were categorized as "with *Arctophila*"; those that had only traces of *Arctophila* or none were called "without *Arctophila*".

Table 3. Classification of gravel pad and alluvial sites with respect to the presence of vegetation and impoundments.

		COASTAL PLAIN SITES					RIVER DELTA SITES					FOOTHILL SITES
		Gravel Pad				Alluvial	Gravel Pad				Alluvial	Gravel Pad
		Vegetated		Unvegetated			Vegetated		Unvegetated			
Site	Site No.	w/ Imp	w/o Imp	w/ Imp	w/o Imp		w/ Imp	w/o Imp	w/ Imp	w/o Imp		
Kemik 1	13											X
Kemik 2	14											X
West Sak 4	6			X								
Hurl State Pad	7			X								
West Sak 11	3			X								
West Sak 17	1			X								
West Sak 9	4			X								
West Sak 3	5			X								
Put State 1	8	X										
Ugnu 1	2	X										
Lake State 1	9		X									
Delta State 2	12	X										
Kuparuk River 1	15					X						
Kuparuk River 3	16					X						
Sag Delta 31-11-16	10							X				
Sag Delta 2 & 2A	11								X			
Sag River 2	18										X	
Sag River 3	17										X	
Sag River 4	19										X	

Table 4. Classification of impoundments and ponds with respect to the presence of *Arctophila fulva,* (ARFU).

Site	Site No.	Impoundments		Ponds	
		w/ ARFU	w/o ARFU	w/ ARFU	w/o ARFU
GC-1 Impoundment	28	X			
BP Discovery Well Impoundment	34	X			
Culvert Lake Coleen	41	X			
Drill Site 15 Pipeline Pond	36	X			
Drill Site 1A Impoundment	25		X		
Drill Site 12 Impoundment	42		X		
Endicott Dry and Summit Impoundments	47		X		
Drill Site 7 Impoundment	32		X		
Drill Site 7 Impoundment (NE)	33		X		
E-2 AFU Pond	45			X	
J-Pad Pond	27			X	
East Dock Pond	44			X	
Kuparuk 55	26			X	
BP Pond	35			X	
Drill Site 5 Pond	39			X	
Oliktok Pond	21			X	
Oliktok Pond North	20			X	
Sand Dune Lake	43			X	
Powerline Pond	30			X	
Non-AFU Pond	46				X
Oliktok 3N Pond	22				X
Oliktok 3N Pond East	23				X
Drill Site 3B	24				X
Transplant Control Pond	38				X
Drill Site 5 Trail Pond	40				X
Vascott Pond	29				X
Lake Carol	31				X
Transplant Pond	37				X

Access to Study Sites

Field work required repeated visits to study sites. Access to all impoundment and pond sites and most of the gravel sites was provided by the existing road network. Road access details are provided in Appendix A. Four of the gravel pad sites were remote and accessible only by helicopter.

Observations of Wildlife Use

Observations of wildlife (birds and mammals) using the study sites were made between mid-June and mid-August. We divided this time interval into four 2-wk periods. The periods were selected to correspond to expected temporal differences in bird activity. Birds were chosen because they are the most common animals using the habitats, and they have better known and defined seasons of activity than do mammals.

- The first period occurred during June 15-30 to coincide with *tundra bird nesting*.

- The next period of observation occurred between July 1 and 15, *after breeding* had occurred in most species, and while others were *brood-rearing*.

- The third period took place July 16-31, when most *shorebirds and waterfowl* had *completed nesting* and were involved in brood-rearing.

- The fourth and final period of observation occurred during the early part of August (1-15) when bird *migrants* commonly moved through the area.

During each of the 4 time periods, an observer visited each study site for 1 day, conducting observations for 2 hours in the morning and again for 2 hours in the afternoon. During each 2-hr interval, the observer scanned the study site repeatedly from a vantage-point blind with the aid of binoculars and a spotting scope. Lengths of scanning periods on pond and impoundment sites were consistent (3 min), with consistent intervals (7 min) between scanning periods. Thus, during each 2-hr interval, the observer scanned the study site 12 times. Because each gravel pad and alluvial site was located adjacent to an undisturbed tundra site visible from the observation point, alternate scans of 3 minutes each

were made on the gravel (disturbed) and undisturbed portions of the sites with a 2-min break between each scan.

As the observer slowly scanned the study site during each 3-min period, he recorded the number of individuals of each species seen; the behavior in which the animal was engaged when first seen; and the vegetation, landform, and microhabitat type being used by each individual when first observed. Each individual's sex and age were recorded when determinable. Three minutes per scan usually allowed for sufficient time to identify all animals present, their activities, and the microhabitats being used. All data were recorded on a standardized field form. Appendix B shows environmental (vegetation, landform, microhabitat) and behavioral descriptors and illustrates the field form used.

During the break between the 2-hr intervals, the observer conducted a reconnaissance of the site for evidence of wildlife sign such as tracks, scat, and grazing. Information thus acquired was entered as notes on the field form.

Wildlife use of each site was expected to be influenced by several microhabitat variables. For example, we expected wildlife to respond to pads or alluvium differently depending on whether vegetation was present or absent, or whether the pad was near the foothills, on the coastal plain, or in a major river delta. Response to impoundments and ponds was expected to be different depending on whether *Arctophila* was present or absent. Thus we allocated sampling effort among sites such that the effects of these important variables could be assessed.

Records of Wildlife Use by Time-lapse Video

To evaluate temporal patterns of wildlife use on a 24-hr basis at a rehabilitated site, we monitored wildlife use at one gravel pad with an automated time-lapse video camera. Lake State #1 (Fig. 1D, Appendix A) was chosen for this because it was easily accessible and is the site of a gravel pad rehabilitation experiment being conducted by ARCO Alaska, Inc.

The video-recording assembly included a GYYR™ TLC1400-DC time-lapse video cassette recorder in conjunction with a SANYO™ color video camera equipped with an 8.5mm wide angle lens (f 1.3) and high-density Super Avilyn

VHS video cassettes (Fig. 3). These components were powered by 4 Powersonic™ 12 volt, 80 amp batteries connected in a parallel sequence. Battery charge was maintained by 4 Solarex™ MSX-53 photovoltaic panels connected in series, directly to the batteries. The solar panel array was oriented at a 15° angle from the gravel pad surface and faced due south. The recorder, camera, and batteries were contained in separate weatherproof aluminum housings, especially constructed and insulated to protect the equipment from extremes in environmental conditions. A protective fence, constructed of 1/2" steel reinforcement bar (rebar) and 2 strands of heavy-gauge wire enclosed the entire system.

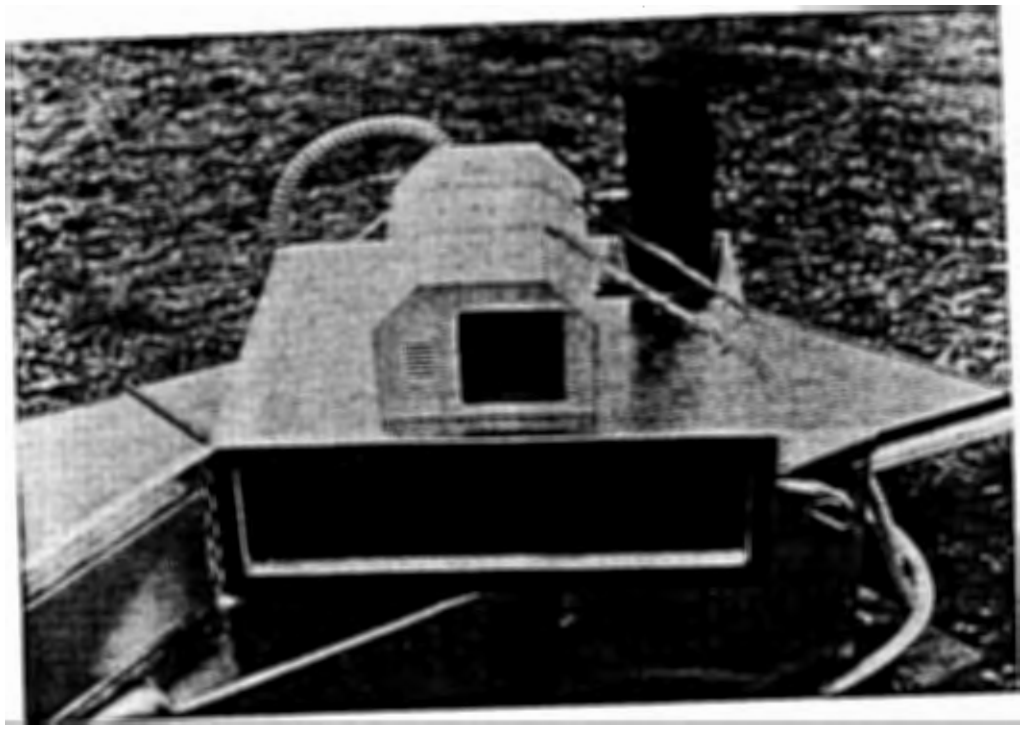
The camera system was in continual operation (24 hr/day) from 18 July - 29 August, and was positioned to provide a view of the majority of the pad. Three different recording modes were employed over the course of the experiment in an effort to assess the effects, if any, that differences in film speed (i.e., pictures/sec.) would have on the system's ability to record wildlife activity. From 18-27 July, the camera system was set to record at the rate of 1 picture every 2 sec. During the next filming cycle from 28 July - 15 August, the camera recorded 1 picture every 4 sec. The third and final cycle occurred during 16 August - 29 August during which photography took place at the rate of 1 picture every 6 sec.

At the end of each filming period, the VHS tape cassette was removed from the recorder and a new cassette was installed. After all filming was completed the tapes were reviewed and analyzed on a color monitor in an effort to identify what animal species were recorded on film, the times they were active, and the types of activity in which they were engaged while on the pad.

Maps and Descriptions of Study Sites

To complement the wildlife observation component of this study, all study sites were mapped in sufficient detail to depict microhabitat features of the sites as a basis from which to interpret animal use of the sites. All of these maps are presented in Appendix A.

At gravel sites, observers sketched maps depicting the surface landform and vegetation components in both the disturbed and undisturbed areas. The



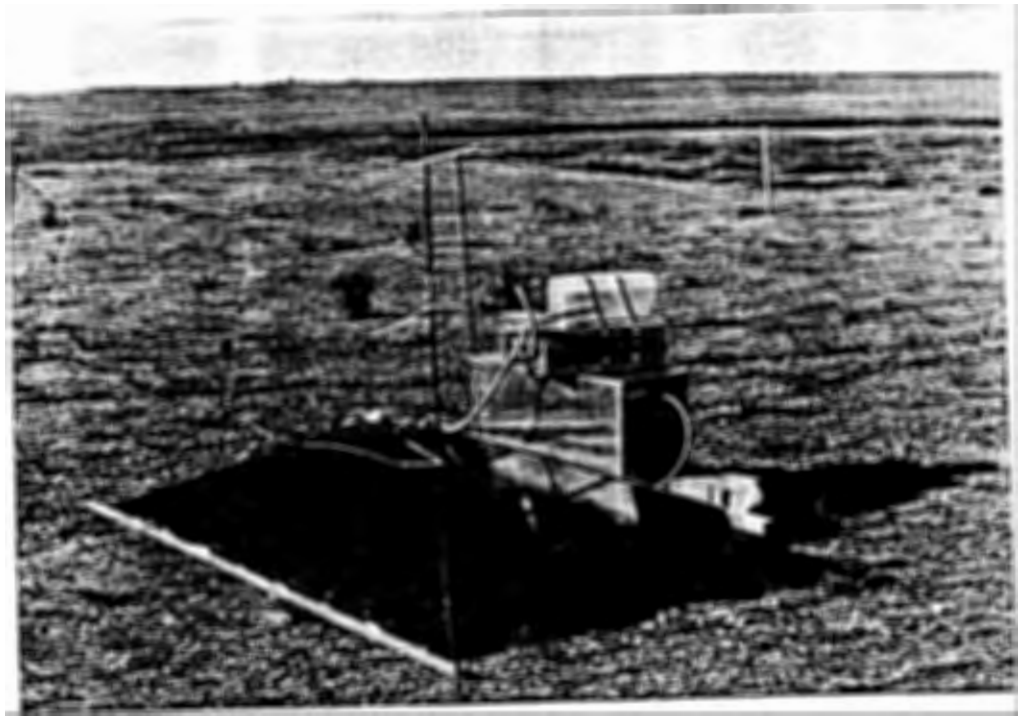


Fig. 3. View of time-lapse video system on Lake State 1 abandoned drilling pad. Top photo is frontal view of camera and recorder in weather-proof housings. Bottom photo shows complete system on the gravel pad.

maps showed the status of vegetative cover, substrate characteristics (e.g., gravel fill thickness and topographic configuration on gravel pad sites), and other biophysical aspects of the sites. Distances were estimated by pacing, and directions were plotted using a hand-held magnetic compass. Later, this information was used in conjunction with both color infra-red (CIR) and color aerial photography and existing geobotanical maps (Walker et al. 1983, 1987c) to produce the final maps.

Maps of 22 of the pond and impoundment sites were produced from existing site maps (McKendrick 1990) in conjunction with ground reconnaissance. Maps of the other 6 were produced using existing aerial photo coverage, ground reconnaissance, and maps (e.g., Walker et al. 1984).

Data Analysis

Prior to the field season, several meetings were held to determine the sufficiency of the proposed data collection scheme and the optimum data structure given the proposed analyses. Field data forms were developed with consideration given to ease of data annotation, consistency with data coding methods, and prevention of data entry errors. During the field season, the data structure and ancillary tables were implemented using ORACLE™ (Oracle Corporation), a relational database management system. Subsequent to the end of the field season, observation data were entered directly from the field data forms into Excel™ (Microsoft® Corporation) spreadsheets. These spreadsheets were then checked line by line for consistency with the field data forms. The complete data set was then transferred to ORACLE™.

Once the database was loaded into ORACLE™, extensive data checking was initiated. This included auditing code consistency and range compliance for each data item. Corrections to field and key entry errors were performed and the consistency and range checks duplicated. All subsequent data analyses were performed in ORACLE™ excepting the statistical tests and graphics. Generally, ORACLE™ was used to group and condense the data for particular views, and then transferred to SYSTAT™ or SYGRAPH™ (Wilkinson 1988) for statistical analysis and graphing.

All data management operations were accomplished using ORACLE's Standard Query Language (SQL) in command file programs. This ensured a complete record of all data management and analysis activities.

Statistical Treatment of Data

Several statistical tests were employed to formally analyze selected data. Given that the objective of the study was to develop hypotheses rather than to test them, however, the applicability of statistical inference was limited to only a few pertinent data sets which could be presumed to satisfy the necessary assumptions. Further, the preliminary nature of the study required that all procedures test for differences alone--that is, no tests were conducted to determine whether the mean of one particular data set was greater than the mean of another set. In general, the data concerning habitat use (i.e. numbers of observations) were distributed asymmetrically and tended to be skewed heavily toward low values with a few exceptionally high outliers. Accordingly, it was appropriate to rely upon nonparametric procedures in all instances. A summary of statistical results is presented in Appendix C.

Bird use of coastal gravel pads was compared to the use of adjacent tundra on the basis of the number of total bird observations made per day (i.e. the sum of the observations noted during the 24 3-minute periods) at each study site. This approach yielded one data point per site per day or, equivalently, per 2-wk study period, and ensured independence among the data points. Separate comparisons were then made for each of the four 2-wk study periods. In addition, use over the summer as a whole was analyzed by summing all of the observations made at each site during the entire study. The data from gravel pads were paired with those from the adjacent tundra and the nonparametric sign test (Zar 1984:386) was used to test for a difference between the mean number of observations on gravel and tundra. The sign test was likewise applied to test for a difference between the mean numbers of observations over the entire summer.

Bird use of ponds was compared with that of impoundments also on the basis of the number of bird observations made per day, and over the entire summer, at each study site. In this group of comparisons, however, the data sets

were not paired and the nonparametric Mann-Whitney test (Zar 1984:139) was utilized to test for a difference in the mean number of observations per time period.

Similarly, bird use of waterbodies with *Arctophila fulva* was compared to that of water bodies without the grass. For this analysis, it was necessary to group ponds and impoundments according to the presence of *Arctophila*. Again, the Mann-Whitney test was applied to detect a difference in mean numbers of bird observations per day as well as over the entire summer.

Coastal gravel pads and undisturbed tundra were further compared with respect to proportional distributions of bird behavior. Proportions compared were numbers of observations per behavioral category as percentages of all observations during the entire study period. Behavioral proportions that were less than 1.0% for both gravel and tundra were categorized as "other". Analysis was via the chi-square test for differences in probabilities (Conover 1980:153).

RESULTS

Here we present data showing how birds and mammals were observed to use gravel pads and impoundments. To make the findings meaningful for assessing impacts, we compare bird and mammal use of the disturbed areas with use of similar-sized areas not disturbed by man. To make the findings useful for mitigation planning, we evaluate the apparent attractiveness of biophysical features (water bodies and vegetation within sites) to animals. In these data presentations, we compare numbers of species and numbers of individual animals that used disturbed and undisturbed sites per unit time. Other possible bases for comparing wildlife use of habitats exist, but these we used seemed valid ways of integrating what society values about wildlife communities. Time constraints prevent our treating separately any but the most abundant or high-profile species or groups.

Because this first year was a pilot study designed to develop hypotheses, and not a tightly controlled experiment, the data collected were not intended for rigorous analysis. Thus, means or percentages are the major bases for comparison. However, standard deviations around mean numbers of species and individuals are shown (Table 5) to give some indication of variability, and

Table 5. Means and standard deviations of data sets collected during observation of wildlife use of disturbed and undisturbed habitats, Arctic Coastal Plain, Alaska, 1989. Unless noted otherwise, "Gravel Pads" indicate coastal plain gravel pads only, and do not include river delta pads.

		Number of Species Observed / 2-hr Interval			Number of Individuals Observed / 3-min Period		
Species Group	Sites Compared	Mean	Std. Dev.	# Intervals	Mean	Std. Dev.	# Periods
All Birds	Tundra	1.58	1.34	78	0.62	0.74	936
	Gravel Pads	2.90	1.92	78	3.00	3.62	936
All Birds	Alluvium	0.75	0.78	40	0.20	0.35	480
	Gravel Pads†	2.62	1.88	94	2.96	4.21	1128
All Birds	Unvegetated Gravel Pads*†	2.09	1.49	64	1.99	3.15	768
	Vegetated Gravel Pads*†	1.93	1.53	30	2.43	4.96	360
All Birds	Gravel with Impoundments†	2.84	1.91	80	3.01	3.61	960
	Gravel without Impoundments	1.36	1.08	14	2.65	6.92	168
All Birds, mid-July through mid-August only	Unvegetated Gravel Pads*†	1.79	1.34	34	2.55	3.30	408
	Vegetated Gravel Pads*†	1.72	1.07	18	3.64	6.14	216
All Birds	Foothill Tundra	1.33	1.50	15	0.17	0.23	180
	Foothill Gravel Pads	1.25	1.00	16	0.44	0.64	192
Waterfowl	Tundra	0.01	0.11	78	0.00	0.02	936
	Gravel Pads	0.35	0.75	78	0.78	2.52	936
Waterfowl	Tundra*	0.01	0.11	78	0.00	0.02	936
	Gravel Pads*	0.14	0.50	78	0.34	1.84	936
Lapland Longspurs, mid-July through mid-August only	Unvegetated Gravel Pads*†	-	-	-	2.05	3.06	408
	Vegetated Gravel Pads*†	-	-	-	3.42	6.21	216
Lapland Longspurs	Unvegetated Gravel Pads*†	-	-	-	1.21	2.40	768
	Vegetated Gravel Pads*†	-	-	-	2.17	5.01	360
All Mammals	Tundra	0.15	0.36	78	0.04	0.14	936
	Gravel Pads	0.31	0.47	78	0.13	0.36	936
All Mammals	Alluvium	0.28	0.51	40	0.09	0.30	480
	Gravel Pads†	0.28	0.45	94	0.15	0.47	1128
All Mammals	Unvegetated Gravel Pads*†	0.28	0.45	64	0.18	0.54	768
	Vegetated Gravel Pads*†	0.23	0.43	30	0.04	0.10	360
All Mammals	Tundra*	0.15	0.36	78	0.04	0.14	936
	Gravel Pads*	0.31	0.47	78	0.12	0.34	936

* sites at which observations on impoundments were excluded.

† including river delta gravel pads.

cont'd

Table 5, continued.

Species Group	Sites Compared	Number of Species Observed / 2-hr Interval Mean	Std. Dev.	# Intervals	Number of Individuals Observed / 3-min Period Mean	Std. Dev.	# Periods
All Mammals	Foothill Tundra	0.07	0.26	15	0.01	0.02	180
	Foothill Gravel Pads	1.13	0.34	16	1.04	0.95	192
Caribou	Tundra	-	-	-	0.03	0.14	936
	Gravel Pads	-	-	-	0.11	0.35	936
Caribou	Alluvium	-	-	-	0.08	0.30	480
	Gravel Pads†	-	-	-	0.13	0.46	1128
Caribou	Alluvium	-	-	-	0.08	0.30	480
	Prudhoe Bay Gravel Pads	-	-	-	0.11	0.50	1092
Caribou	Unvegetated Gravel Pads†	-	-	-	0.17	0.55	768
	Vegetated Gravel Pads†	-	-	-	0.04	0.10	360
All Birds	Impoundments	2.36	1.83	72	1.64	2.21	864
	Ponds	1.43	1.74	152	1.38	3.30	1824
All Birds	Impoundments with ARFU **	2.66	2.13	32	2.08	2.67	384
	Ponds with ARFU	1.55	1.56	80	1.28	1.91	960
All Birds	Impoundments with ARFU	2.66	2.13	32	2.08	2.67	384
	Impoundments without ARFU	2.13	1.54	40	1.29	1.72	480
All Birds	Ponds with ARFU	1.55	1.56	80	1.28	1.91	960
	Ponds without ARFU	1.31	1.93	72	1.49	4.37	864
Waterfowl	Impoundments	0.90	1.31	72	0.92	1.65	864
	Ponds	0.61	0.82	152	0.74	1.33	1824
Waterfowl	Impoundments with ARFU	1.25	1.70	32	1.40	2.02	384
	Ponds with ARFU	0.65	0.81	80	0.85	1.46	960
Waterfowl	Impoundments with ARFU	1.25	1.70	32	1.40	2.02	384
	Impoundments without ARFU	0.63	0.81	40	0.54	1.17	480
Waterfowl	Ponds with ARFU	0.65	0.81	80	0.85	1.46	960
	Ponds without ARFU	0.56	0.84	72	0.63	1.18	864

* sites at which observations on impoundments were excluded.

** ARFU = *Arctophila fulva*

† including river delta gravel pads.

statistical comparisons are presented in some cases (Appendix Table C-1) to suggest how much confidence can be placed on apparent differences between data sets.

Wildlife Use of Gravel Sites

The nature and extent of wildlife use of gravel pads varied among species and species groups. To accommodate some of these differences, we evaluate gravel pad use by several categories: all bird species combined, waterfowl, Lapland Longspur (the most abundant bird), all mammals, and caribou (the most common mammal observed).

All Birds

Observations of all species are combined in this section and, unless otherwise noted, the data represent averages of all observations made during the summer. We compare bird use between gravel pads and natural sites (undisturbed tundra and river alluvium) and evaluate the influence of vegetation and water bodies on bird use of gravel pads. Seasonal and diurnal patterns of use are also discussed. (A listing of all bird species observed during the course of this study can be found in Appendix A.)

Gravel Pads vs. Tundra. More bird species and more individuals were observed to use gravel pads than used nearby tundra sites (Fig. 4). On the pads, the average number of species seen per 2-hr interval was nearly twice that seen on undisturbed tundra. An average of about 5 times as many individual birds visited the pads per 3-min period than visited the undisturbed sites.

Statistical comparisons of gravel pads and undisturbed tundra sites, with respect to levels of bird use, substantiated that mean levels of use over the summer were different at the 95% confidence level ($P < 0.01$, sign test, Appendix Table C-1). When observations were separated into 2-wk observational periods, tests indicated that levels of use between pads and tundra were also different during the second and fourth periods (1-15 July, 1-15 August), but not during the first and third periods (15-30 June, 16-31 July).

There were appreciable differences in bird behavior between pads and adjacent tundra (Fig. 5). Larger percentages of those observed on pads rested and

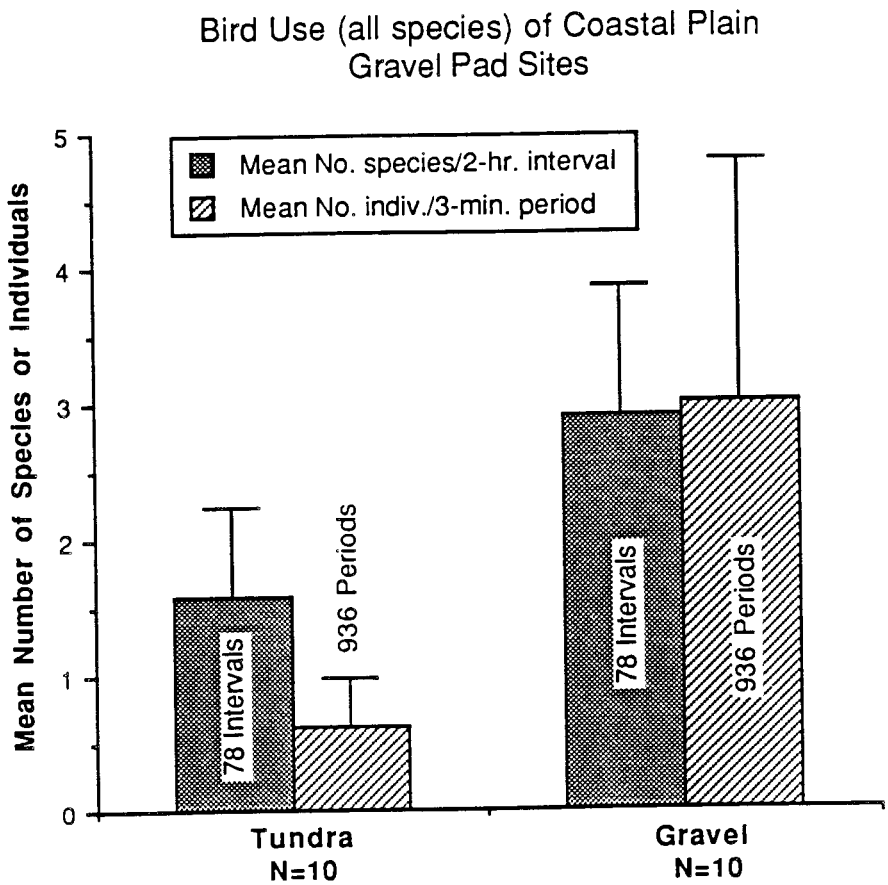


Fig. 4. Observed use by birds (all species combined) of abandoned coastal plain gravel pads compared with their use of nearby tundra areas of similar sizes, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-6.)

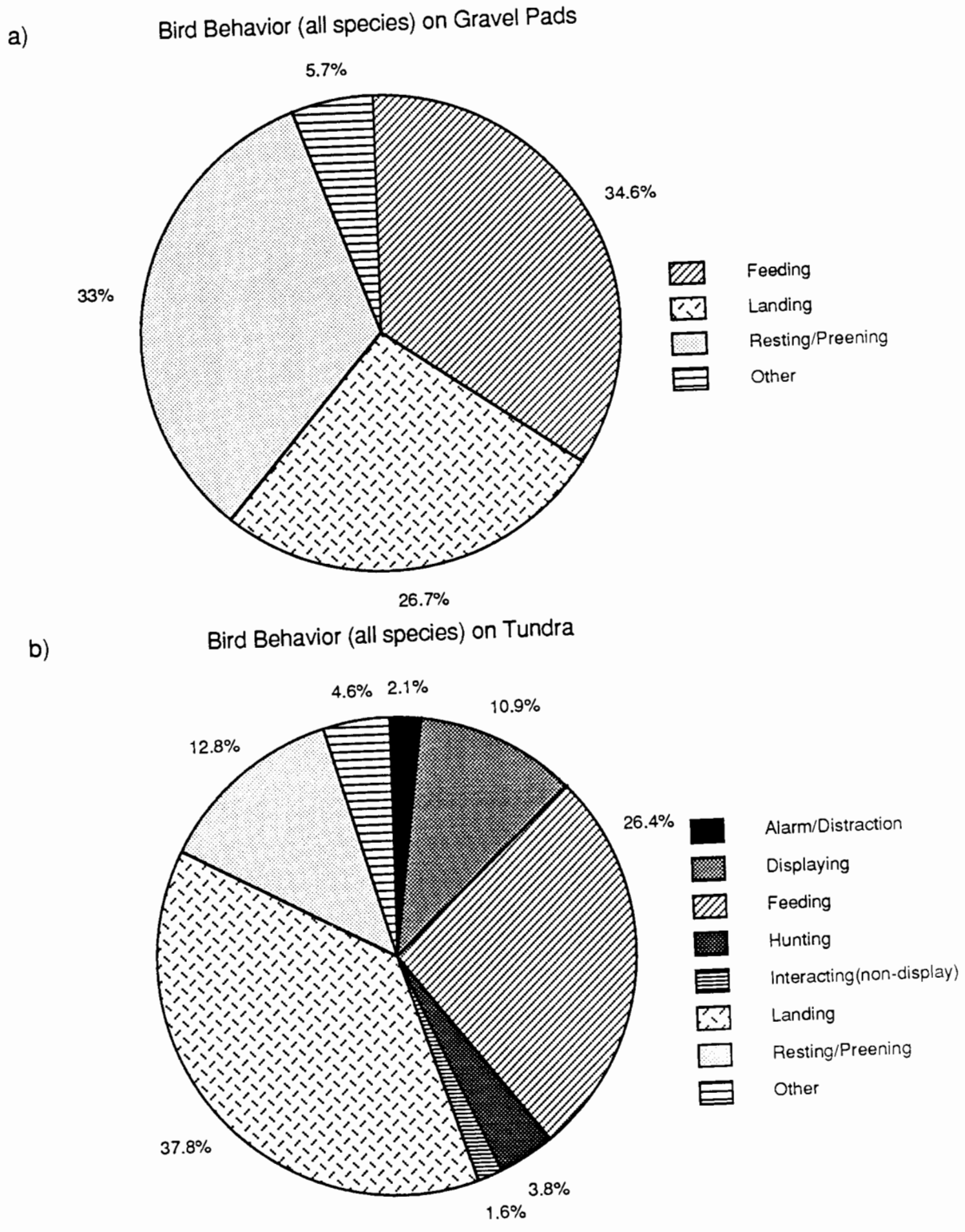


Fig. 5. Observed behavior by birds (all species combined) on abandoned coastal plain gravel pads compared with their behavior on nearby tundra areas of similar sizes, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all birds observed that were engaged in the specified activity when first observed.

fed as opposed to those on tundra. Landing was more commonly observed on tundra, perhaps because other activities tended to be hidden by the vegetation. A greater array of activities took place on tundra than on the pads; most of the activities that were observed on tundra but not on pads seemed to be associated with breeding, nesting, or hunting.

Statistical comparisons (chi-squared) showed that proportions of the time that birds engaged in specific behaviors were different between gravel pads and tundra sites (Appendix Table C-2). On gravel pads, significantly fewer observations were made of displaying, hunting, landing, and alarm reactions than would have been expected if behavior occurred in identical proportions on gravel and tundra, and resting/preening occurred more than would have been expected.

Gravel Pads vs. Alluvium. Considerably more bird species and individuals used gravel pads than used river alluvium sites (Fig. 6). Between 3 and 4 times as many species were seen on pads per 2-hr interval, and approximately 15 times as many individuals were seen per 3-min period. Because alluvium sites were probably somewhat larger than average pad sizes (see Appendix A), these differences may be a conservative estimate.

Bird behavior differed between pads and alluvium (Fig. 7). The proportions of time birds spent landing and resting or preening on pads were greater than those on alluvium. Conversely, birds on alluvium were interacting with other birds twice as often as on pads, and diversity of activities in which birds engaged was greater on alluvium.

Effects of Vegetation. Excluding any use associated with water bodies, we found little difference between vegetated and unvegetated pads in the extent to which they were used by birds. Over the entire summer, both the average bird species using pads per 2-hr interval and the average individual birds per 3-min period were about the same on unvegetated pads as they were on relatively well-vegetated pads (Fig. 8). But during the latter half of summer, the individuals per 3-min period were on average somewhat more numerous on vegetated pads than on unvegetated ones (Fig. 9).

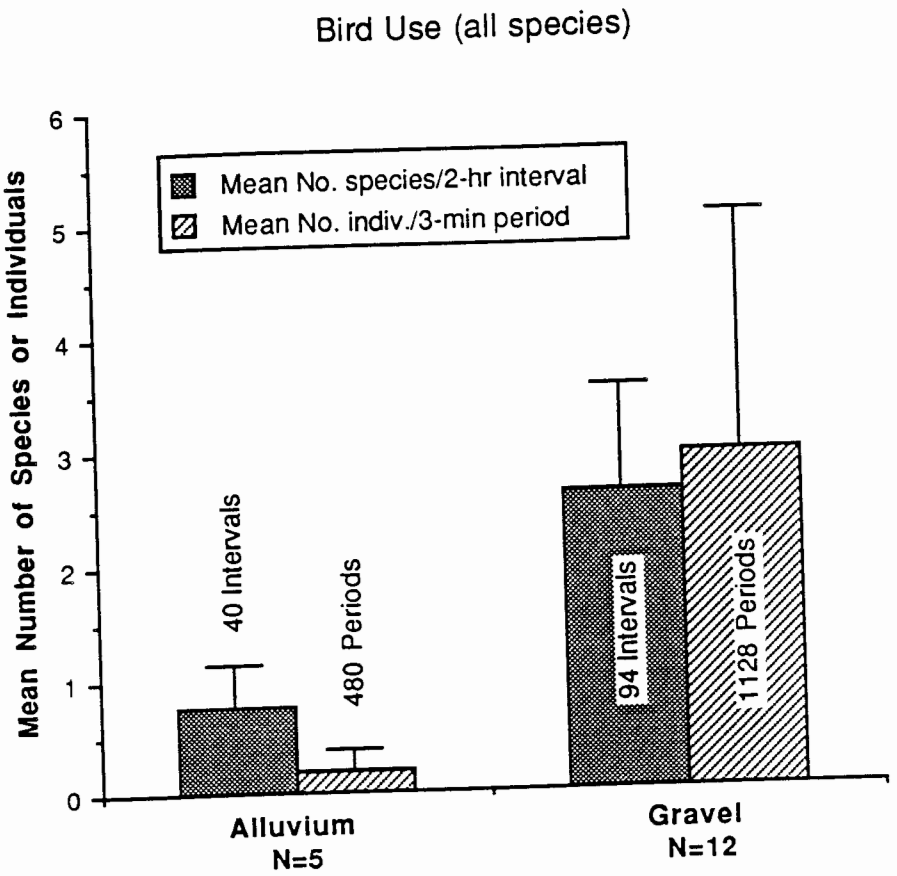


Fig. 6. Observed use by birds (all species combined) of abandoned coastal plain and river delta gravel pads compared with their use of alluvium, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-7.)

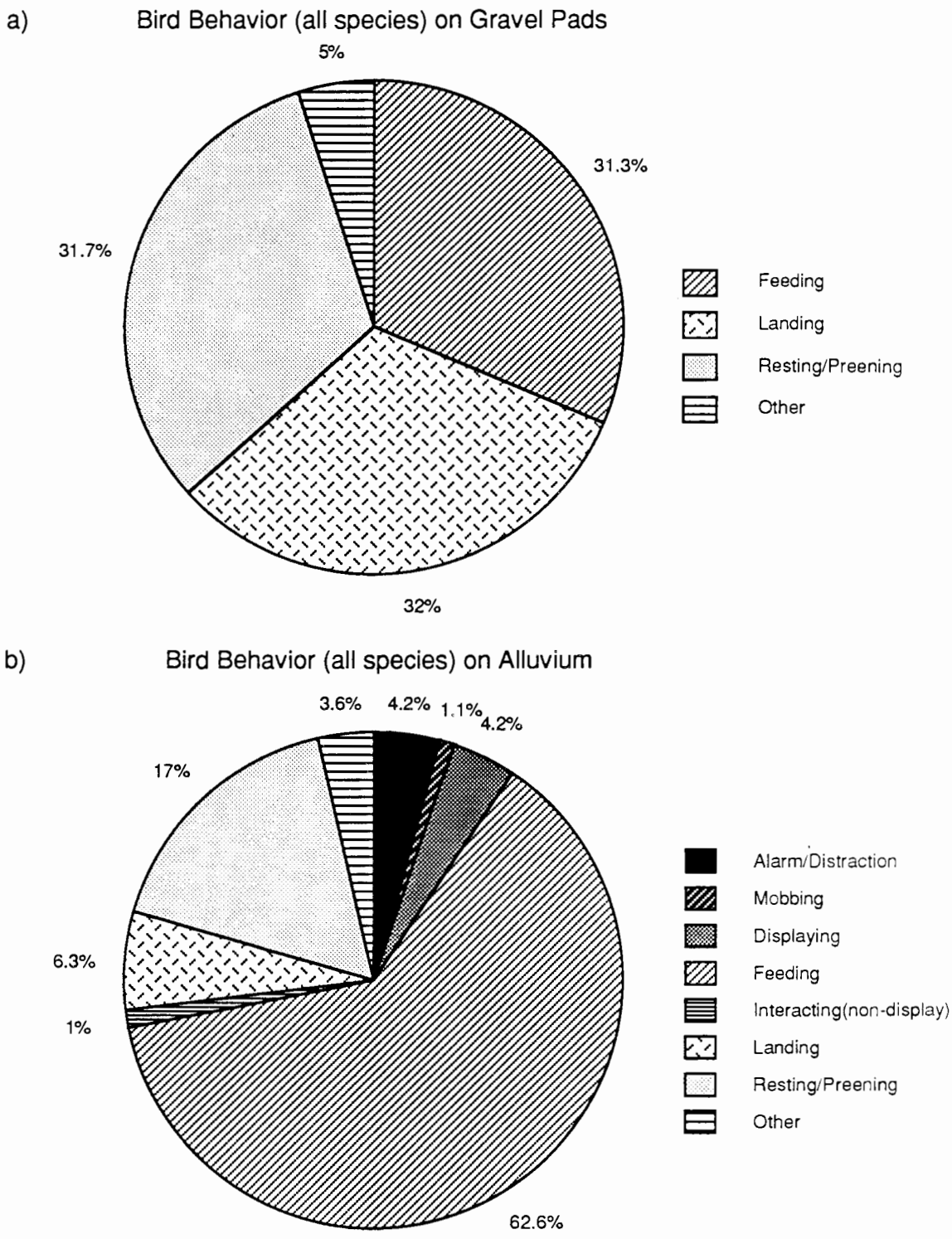


Fig. 7. Observed behavior by birds (all species combined) on abandoned coastal plain and river delta gravel pads compared with their behavior on alluvium, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all birds observed that were engaged in the specified activity when first observed.

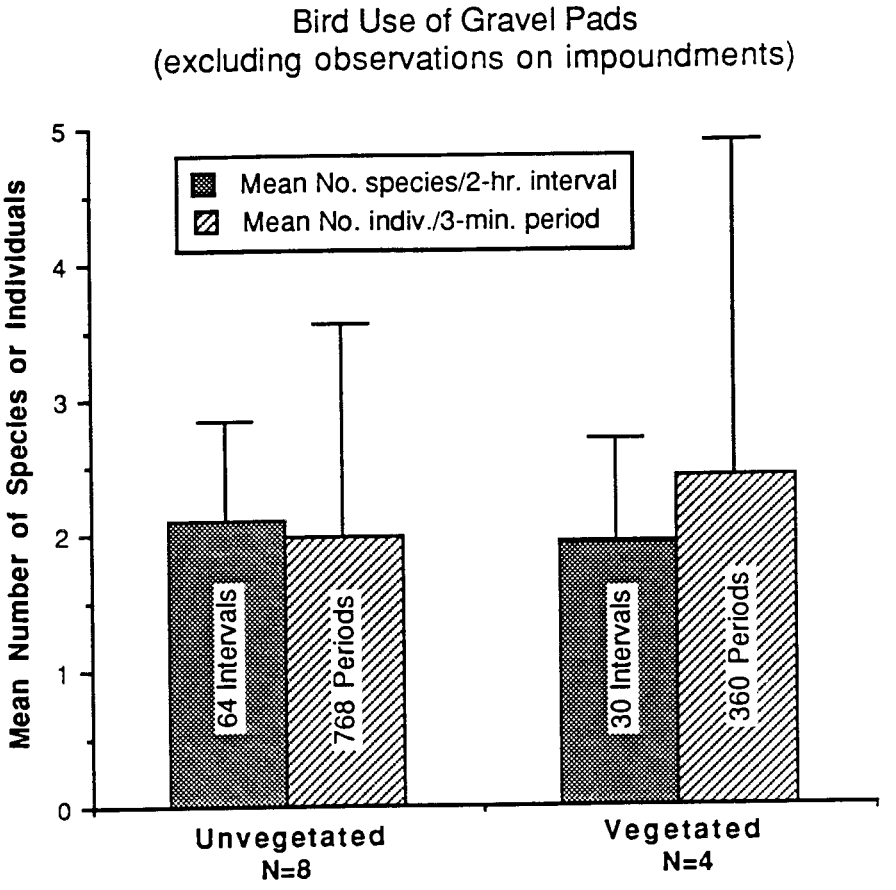


Fig. 8. Observed use by birds (all species combined), excluding observations on impoundments, of abandoned coastal plain and river delta gravel pads with vegetation and without appreciable vegetation, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-8)

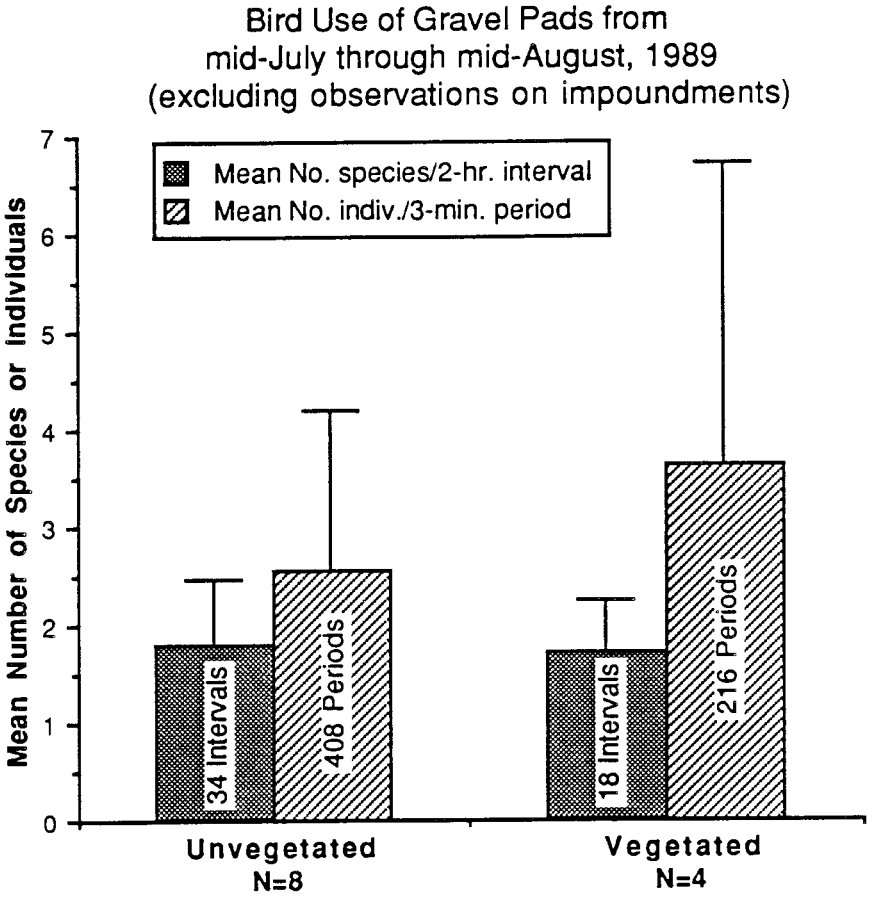


Fig. 9. Observed use by birds (all species combined), excluding observations on impoundments, of abandoned coastal plain and river delta gravel pads with vegetation and without vegetation, during the period from mid-July through mid-August, 1989, only, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-9.)

Bird behavior differed in a few ways between vegetated and unvegetated pads, though differences were not marked. Landing was more common and resting or preening was less common on vegetated pads than on unvegetated ones when summer-long averages were compared. Summer-long percent of time spent feeding appeared similar regardless of whether pads were vegetated or not, and there was not much difference between pad types in the diversity of activities observed (Fig. 10). During the last half of summer, resting and preening seemed more common on vegetated pads than on unvegetated ones, and feeding was less common on vegetated pads (Fig. 11).

Effects of Water Bodies. About twice as many bird species per 2-hr interval used gravel pads with impoundments (i.e., reserve/flare pits) as used those without (Fig. 12). Because only 2 pads did not contain impoundments, our confidence that the diversity of species is greater on pads with impoundments is limited. But because impoundments would be expected to attract some birds (waterfowl and shorebirds) not attracted to gravel alone, logic suggests that a difference should exist.

The presence of impoundments seemed to make little difference in numbers of birds observed per 3-min period. Total numbers of waterfowl and shorebirds using pads were probably swamped to some extent by the large total numbers of Lapland Longspurs (longspurs apparently used pads independently of the presence of water).

Bird use recorded on pads without water bodies was primarily of birds landing, suggesting that each bird spent little time there. In contrast, feeding and resting/preening were the primary uses observed on pads with impoundments (Fig. 13).

Temporal Patterns of Use. A video-taped record of bird use at Lake State 1 Pad suggested considerable variability in seasonal and day-to-day levels of activity (Fig. 14). Between 18 July and 28 August, the number of 1-hr periods during the day in which at least 1 bird was observed to be present varied from 0 to 12. The greatest activity occurred in late July and early August; after that, there seemed to be a gradual but steady decline to the end of August. But the clarity of this seasonal pattern was reduced by much day-to-day variability.

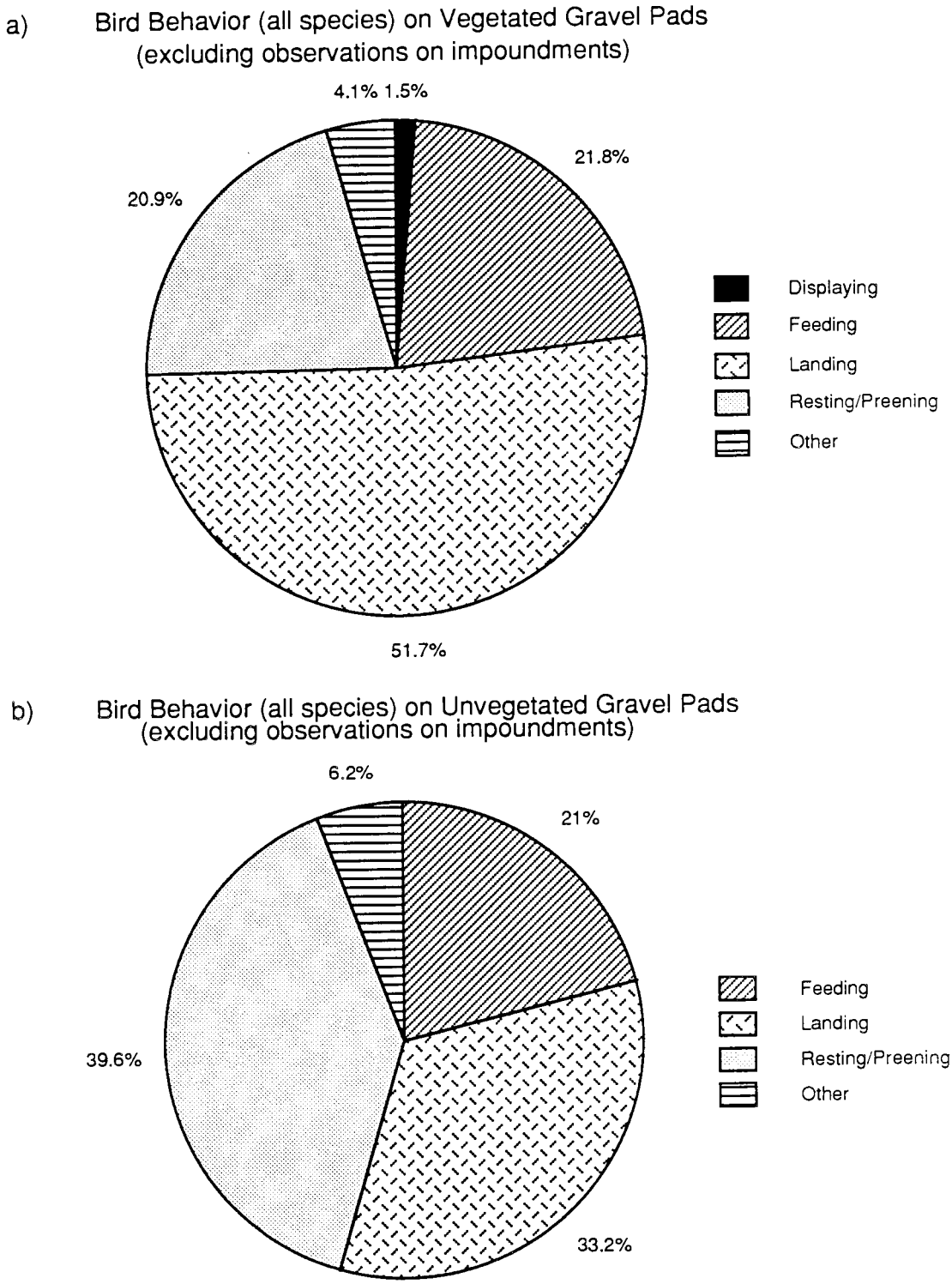


Fig. 10. Observed behavior by birds (all species combined), excluding observations on impoundments, on abandoned coastal plain and river delta gravel pads with vegetation and without appreciable vegetation, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all birds observed that were engaged in the specified activity when first observed.

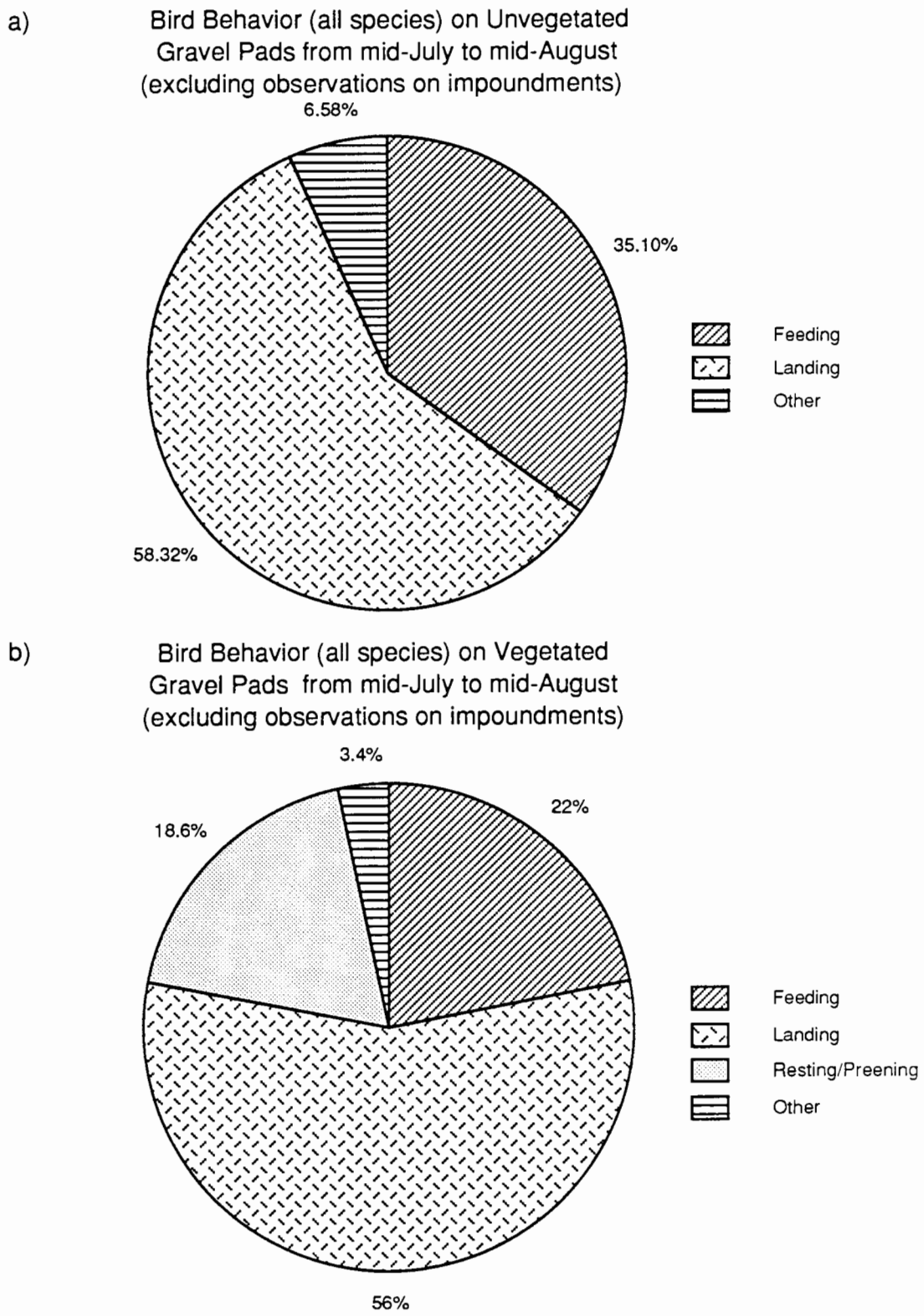


Fig. 11. Observed behavior by birds (all species combined), excluding observations on impoundments, on abandoned coastal plain and river delta gravel pads with vegetation and without vegetation, during the period from mid-July through mid-August, 1989, only, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all birds observed that were engaged in the specified activity when first observed.

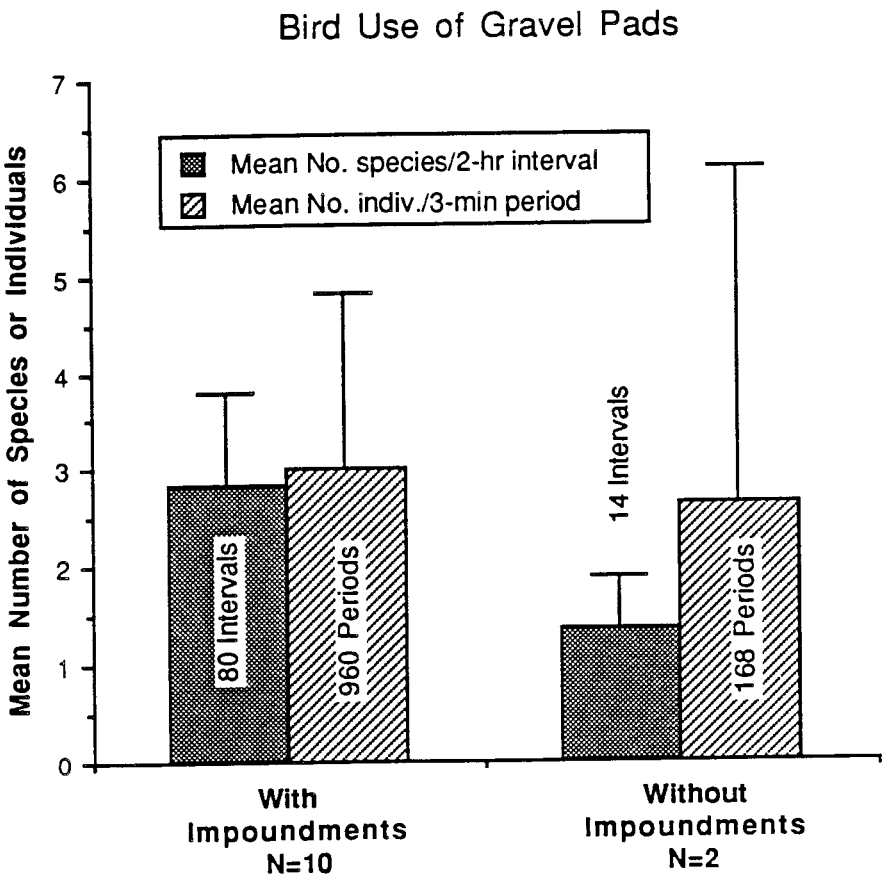


Fig. 12. Observed use by birds (all species combined) of abandoned coastal plain and river delta gravel pads with impoundments and without impoundments, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-10.)

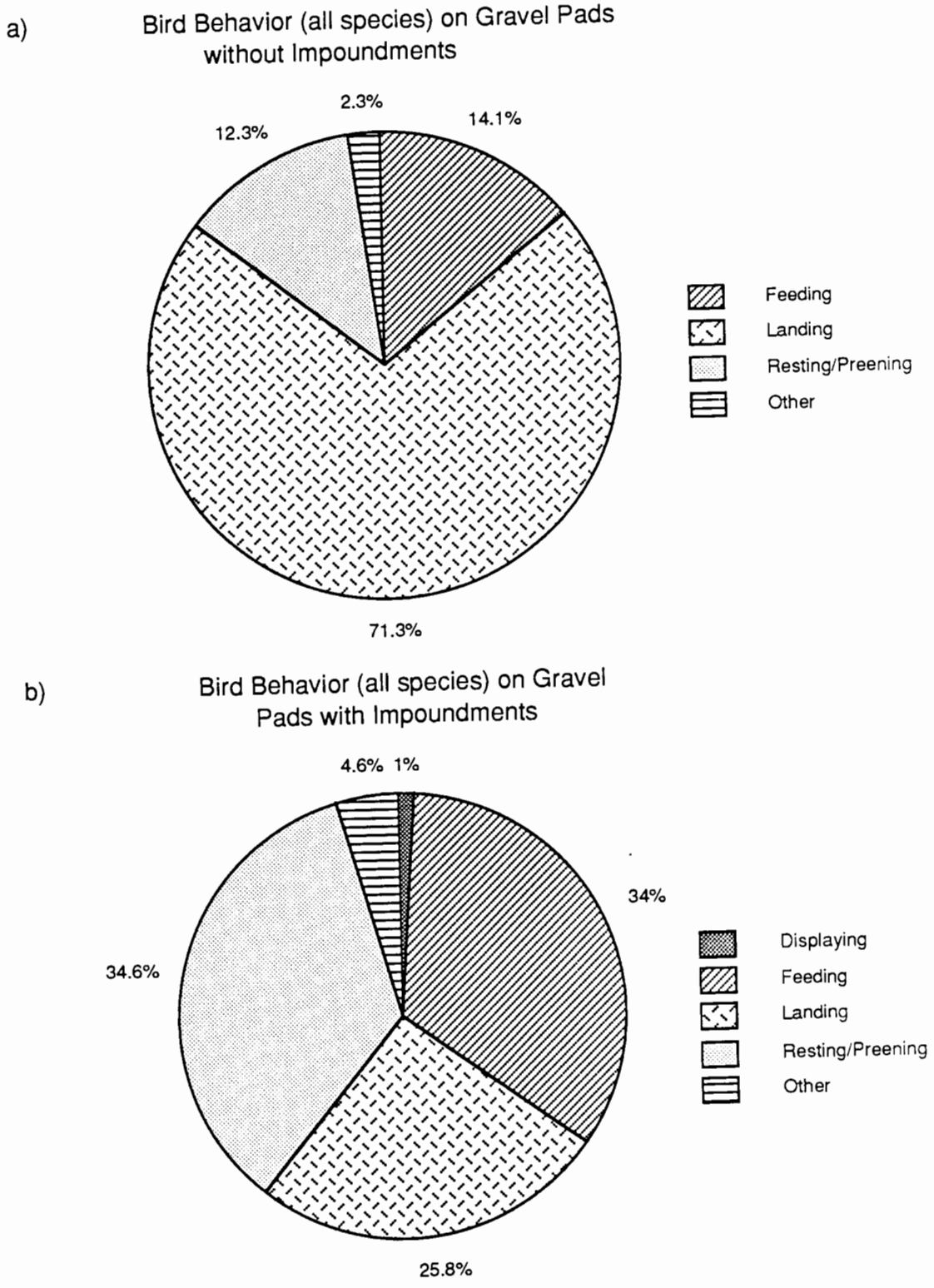


Fig. 13. Observed behavior by birds (all species combined) on abandoned coastal plain and river delta gravel pads with impoundments and without impoundments, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all birds observed that were engaged in the specified activity when first observed.

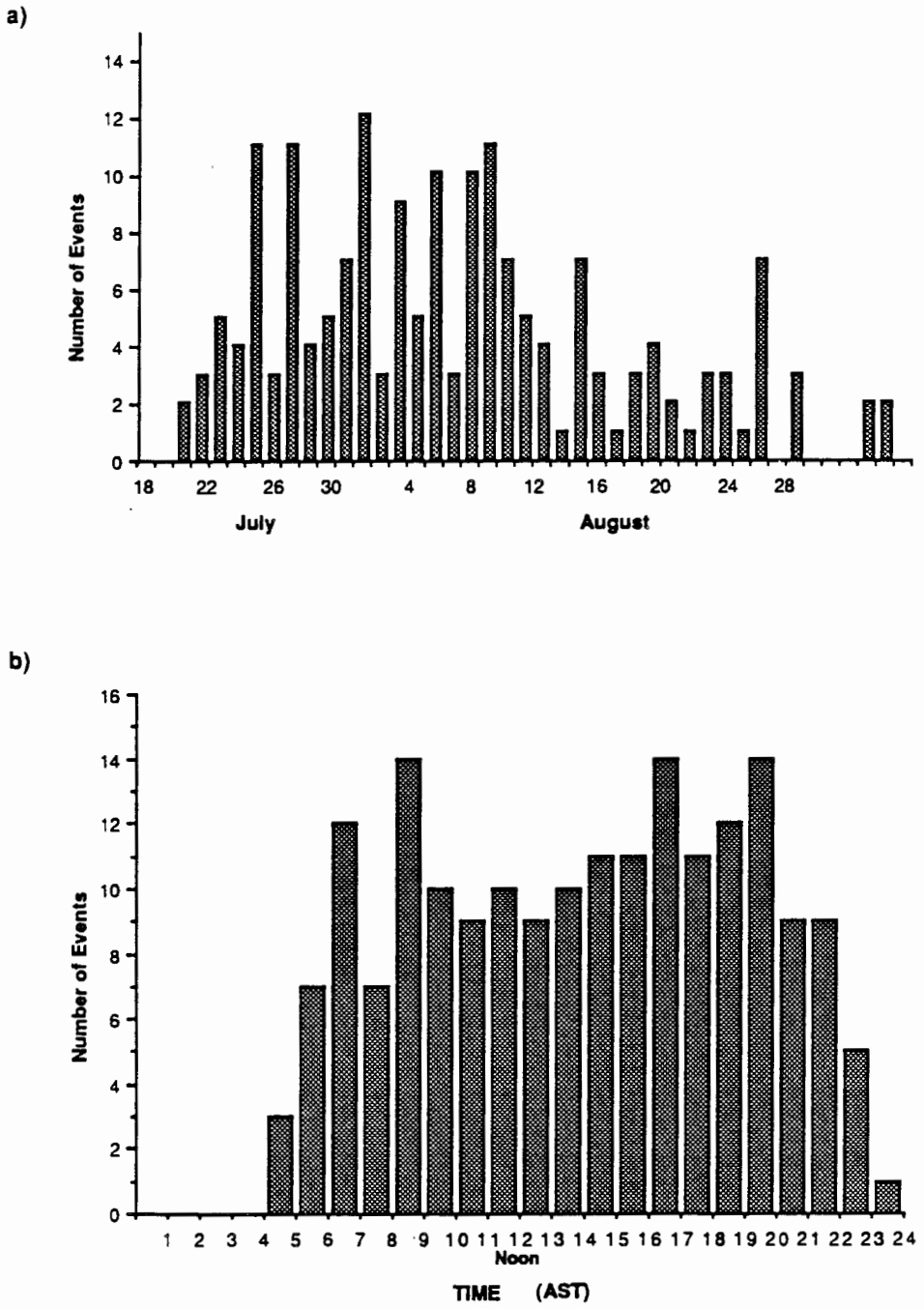


Fig. 14. Seasonal (a) and diurnal (b) pattern of bird (all species) use on gravel pad site Lake State 1 as derived from time-lapse video photography. Number of events in (a) represents the sum of 1-hr periods in which birds were present (for at least a portion of the period) during each day. Number of events in (b) represents the sum of days, totaled over the entire season, in which birds were present during each specific 1-hr period.

At least some bird activity was recorded on Lake State 1 Pad during all hours except between 2400 and 0400 Alaska Standard Time (AST)(Fig. 14); during these hours, increasing darkness (beginning in late July) obscured visibility and may have masked bird activity. On average, the greatest bird activity occurred between 0600 and 2200 AST, and within this time the level of activity each hour (measured as numbers of days birds were present) varied little. "Twilight" periods in morning and evening had relatively little activity and, as noted above, no activity was detected during the 4-hr "night".

Foothill Sites. At the 2 gravel pad sites in the foothills (Fig. 2), the average number of species using the pads per 2-hr. interval and those using adjacent undisturbed sites was very similar (Fig. 15). But the gravel pads attracted more than twice as many individual birds per 3-min period than did the undisturbed tundra.

Birds used gravel pads more often for landing, resting or preening, and for alarm/distraction behavior than nearby tundra (Fig. 16). In contrast, birds spent a higher proportion of their time feeding, hunting, interacting (non-display), and mobbing on tundra as opposed to gravel.

Qualitative Observations. Bird species other than Lapland Lonspurs did not consistently use the gravel substrate at gravel pad sites. However, shorebirds and waterfowl were consistently observed using microhabitats associated with reserve pit and/or flare pit impoundments located at gravel pad sites. Oldsquaws and King Eiders were the most common waterfowl species observed using the open water in these ponds. Shorebirds were often present either on open water (phalaropes) or probing along the mud edges of ponds (sandpipers)

The activities of several bird species using a gravel pad were captured on videotape via time-lapse video photography at the Lake State 1 study site. Snow Buntings, Lapland Longspurs, and Lesser Golden-Plovers were recorded feeding on naturally-vegetated portions of the pad. On several days in late July and again in early August, groups of from 8 to 10 Greater White-fronted Geese and smaller groups of Canada Geese, both sometimes with goslings, were filmed feeding on the naturally-vegetated areas as well as seeded areas. Feeding bouts by goose groups ranged from a few minutes to 2 hours.

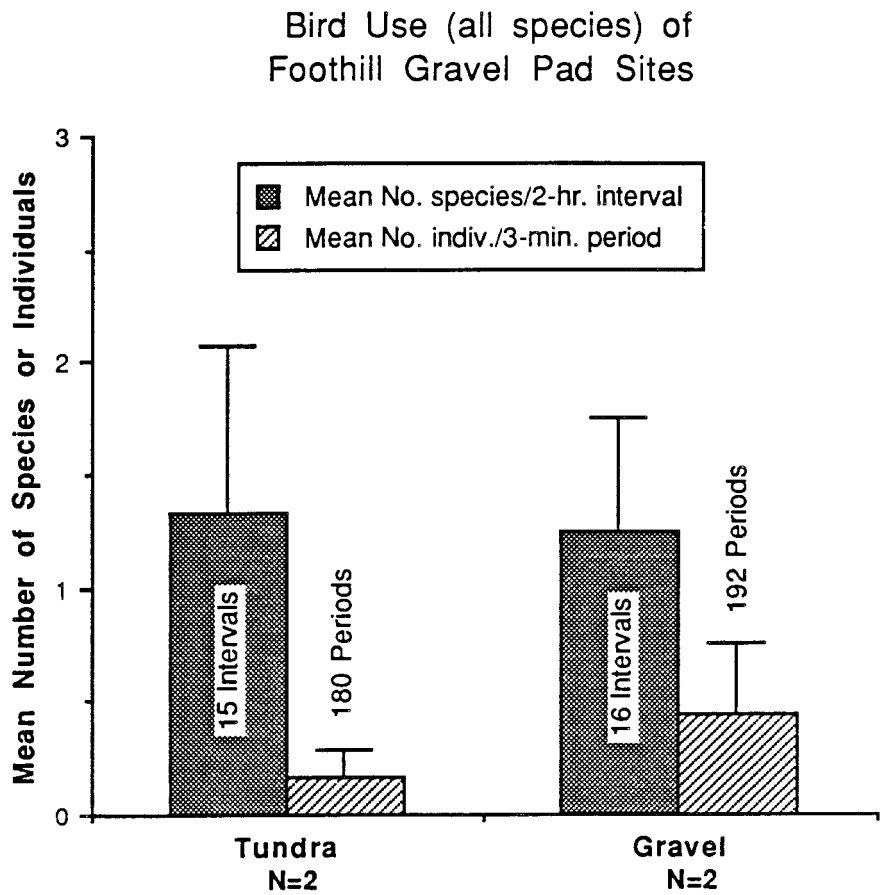


Fig. 15. Observed use by birds (all species combined) of abandoned foothill gravel pads compared with their use of nearby tundra areas of similar sizes, northern Brooks Range, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-11).

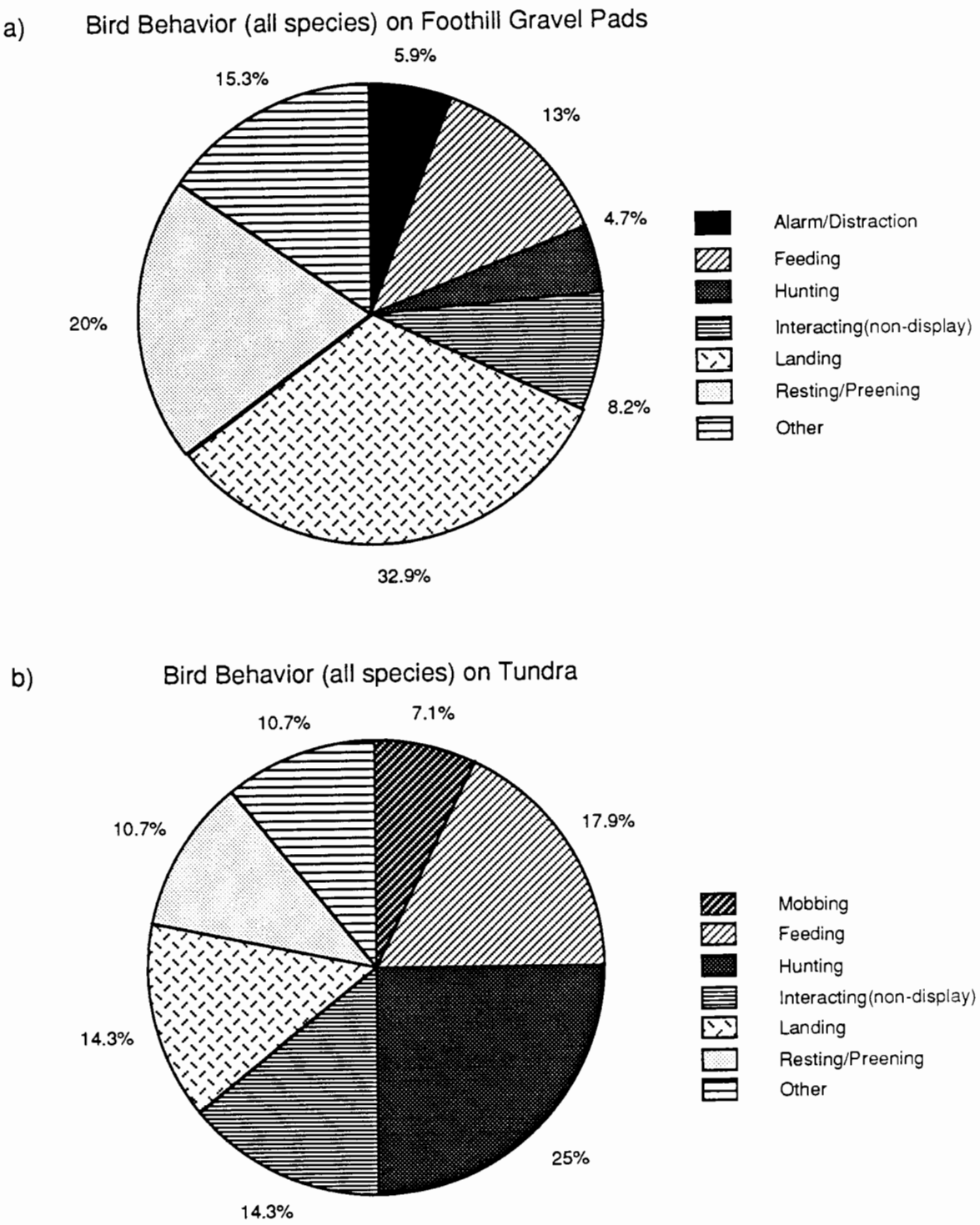


Fig. 16. Observed behavior by birds (all species combined) on abandoned foothill gravel pads compared with their behavior on nearby tundra areas of similar sizes, northern Brooks Range, Alaska. Percentages (a, b) represent proportions af all birds observed that were engaged in the specified activity when first observed.

Waterfowl

Use of gravel pad sites by waterfowl (ducks and geese) is evaluated in this section. Waterfowl use of gravel pads is compared with that of undisturbed tundra sites, and the effects of water bodies associated with gravel pads are evaluated.

King Eider, Brant, and Canada Goose were the only waterfowl species to use the gravel pad sites during regular 2-hr observation intervals (Table 6). Waterfowl use of adjacent undisturbed tundra was, in comparison with their use of gravel pads, almost non-existent (Fig. 17), represented by two individual birds landing. Birds on gravel pads spent almost all their time feeding, resting, or preening (Fig. 18).

We suspect, for several reasons, that most of the waterfowl were attracted to the gravel pads because of the water bodies on them. First, King Eiders seldom go far from water except to nest. Second, when observations of waterfowl on impoundments are excluded from all observations of waterfowl on pads (Fig. 19), the fewer species per 2-hr interval and fewer individuals per 3-min period that result suggest that most of the birds were using the water bodies. Additionally, feeding behavior on pads was much reduced when observations on impoundments are excluded (Fig. 20).

Lapland Longspur

Vegetated vs. Unvegetated Pads: Summer-long. Over the entire season, there was an average of approximately twice as many Lapland Longspurs observed using vegetated pads per 3-min period as were seen using unvegetated pads (Fig. 21). Longspur behavior was not very different between vegetated and unvegetated pads, though small differences were evident in some cases (Fig. 22). Longspurs spent slightly more time landing on vegetated as opposed to unvegetated pads, but about the same amount of time feeding. In contrast, the proportion of time spent resting or preening was somewhat greater on unvegetated pads.

Vegetated vs. Unvegetated Pads: Late Summer. During late summer, when longspurs were generally more abundant than they were over the entire summer, about 1.5 times as many longspurs were seen on vegetated pads as were

Table 6. Summary of all waterfowl observations made during standardized 2-hr intervals at 10 gravel pad sites, 15 June through 15 August, 1989, Arctic Coastal Plain, Alaska.

Species	Site	Date	Microhabitat	Activity
King Eider	West Sak 9	24-Jun	flare/reserve pit levees	5 individuals rested/preened during 6 3-min periods
King Eider	West Sak 9	24-Jun	flare/reserve pit levee	2 individuals rested/preened during 4 3-min periods
King Eider	West Sak 11	25-Jun	reserve pit levee	2 individuals rested/preened during 6 3-min periods
Brant	Ugnu 1	23-Jun	flat, vegetated, gravel pad surface	1 individual fed during 1 3-min period
Canada Goose	Delta State 2	17-Jun	shallow, melt-water pond with no emergent vegetation (located in gravel spray)	2 individuals fed during 1 3-min period
Canada Goose	Delta State 2	17-Jun	moist graminoid tundra, non-patterned ground.	2 individuals landed during 1 3-min period

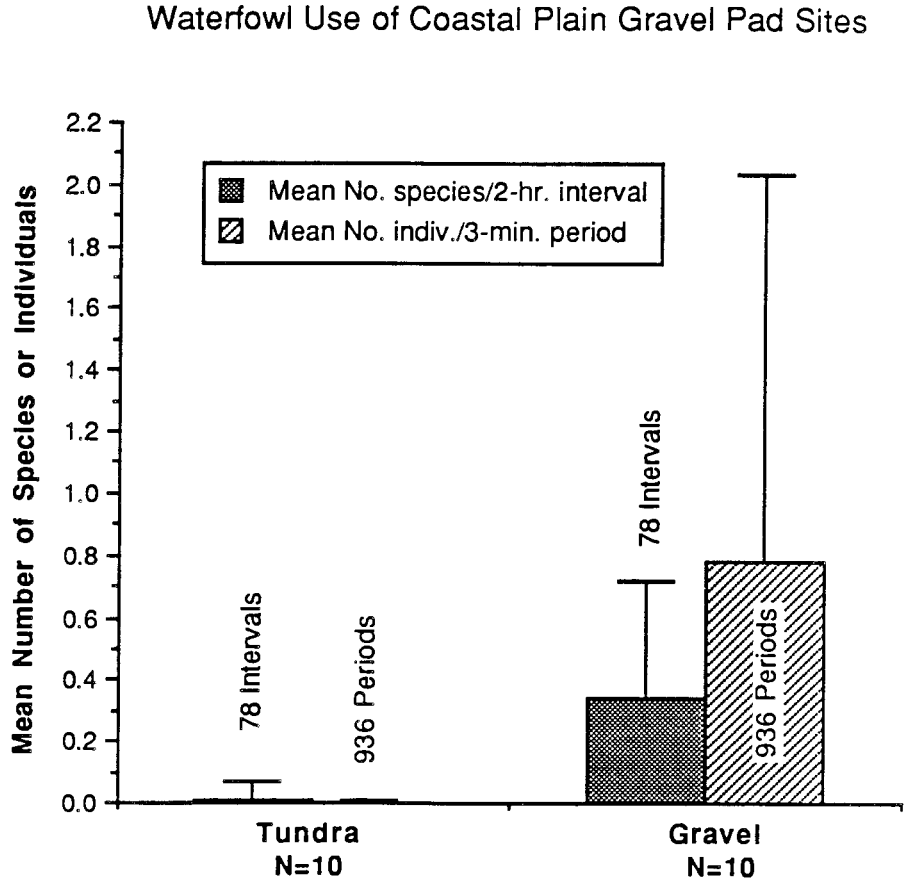


Fig. 17. Observed use by waterfowl of abandoned coastal plain gravel pads compared with their use of nearby tundra areas of similar sizes, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-12.)

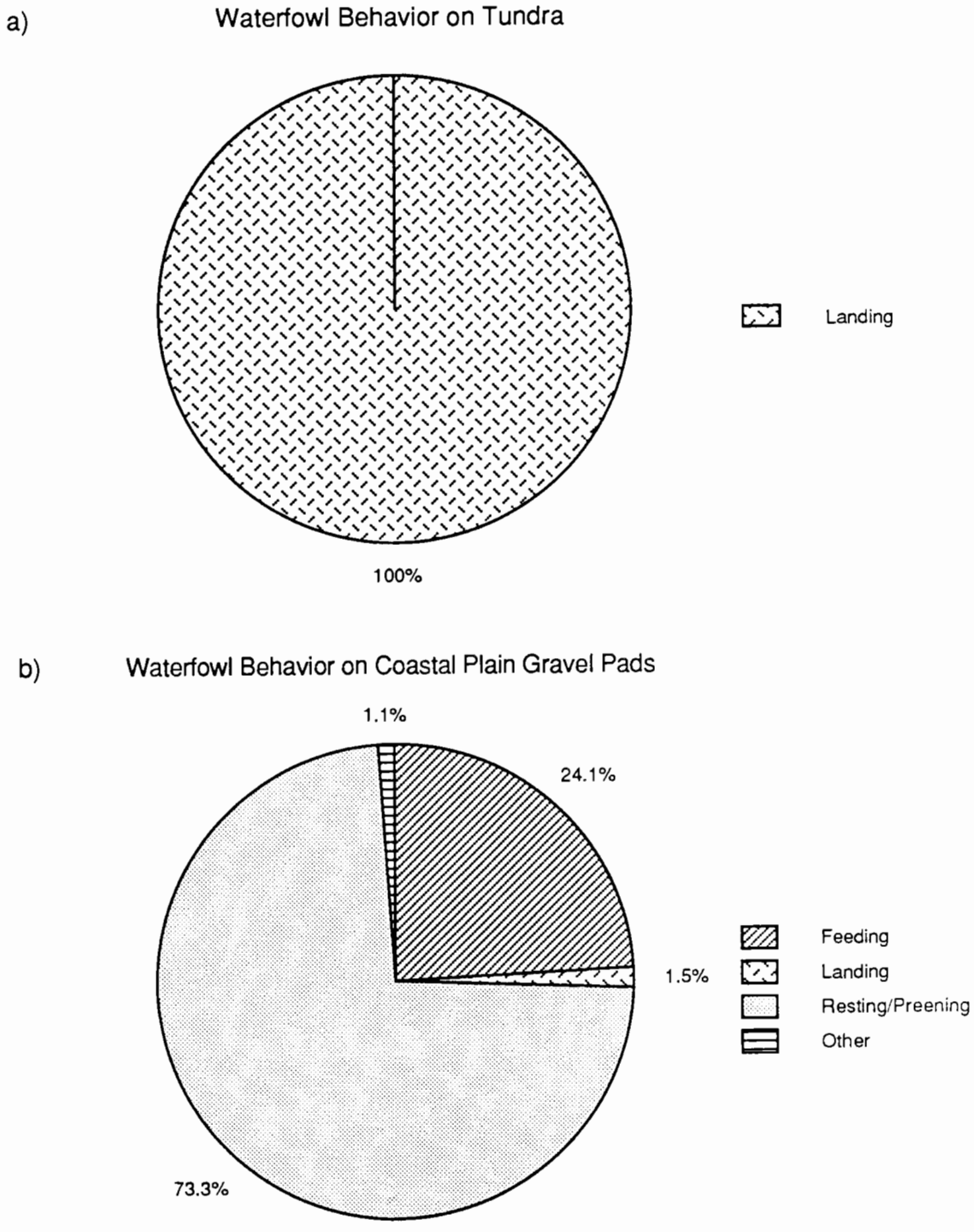


Fig. 18. Observed behavior by waterfowl on abandoned coastal plain gravel pads compared with their behavior on nearby tundra areas of similar sizes, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all waterfowl observed that were engaged in the specified activity when first observed.

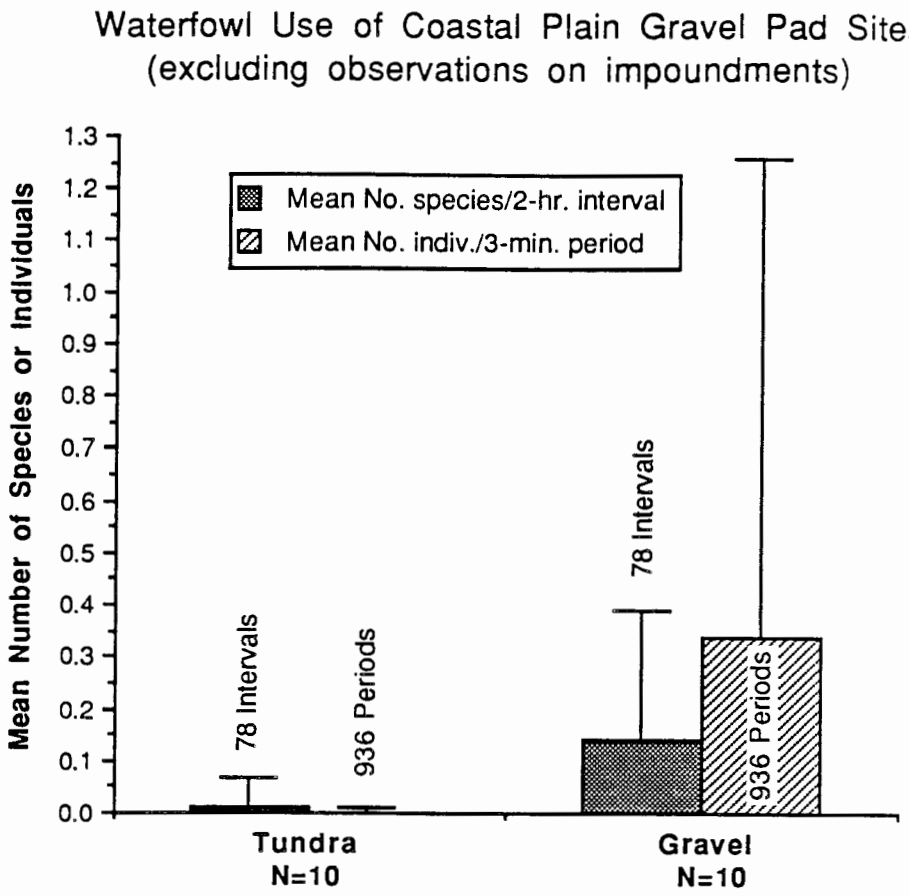


Fig. 19. Observed use by waterfowl, excluding observations on impoundments, of abandoned coastal plain gravel pads compared with their use of nearby tundra areas of similar sizes, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-13.)

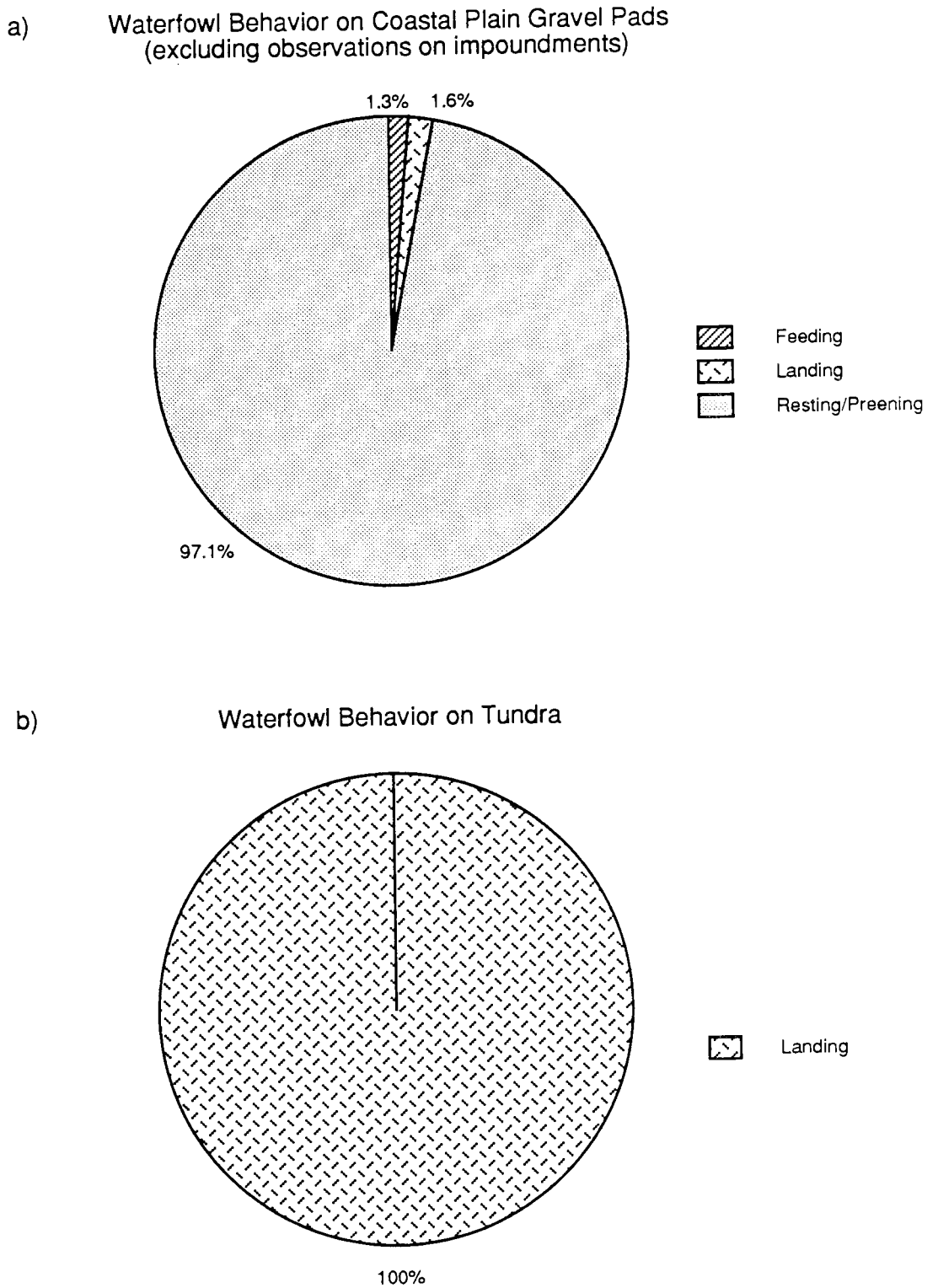


Fig. 20. Observed behavior by waterfowl, excluding observations on impoundments, on abandoned coastal plain gravel pads compared with their behavior on nearby tundra areas of similar sizes, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all waterfowl observed that were engaged in the specified activity when first observed.

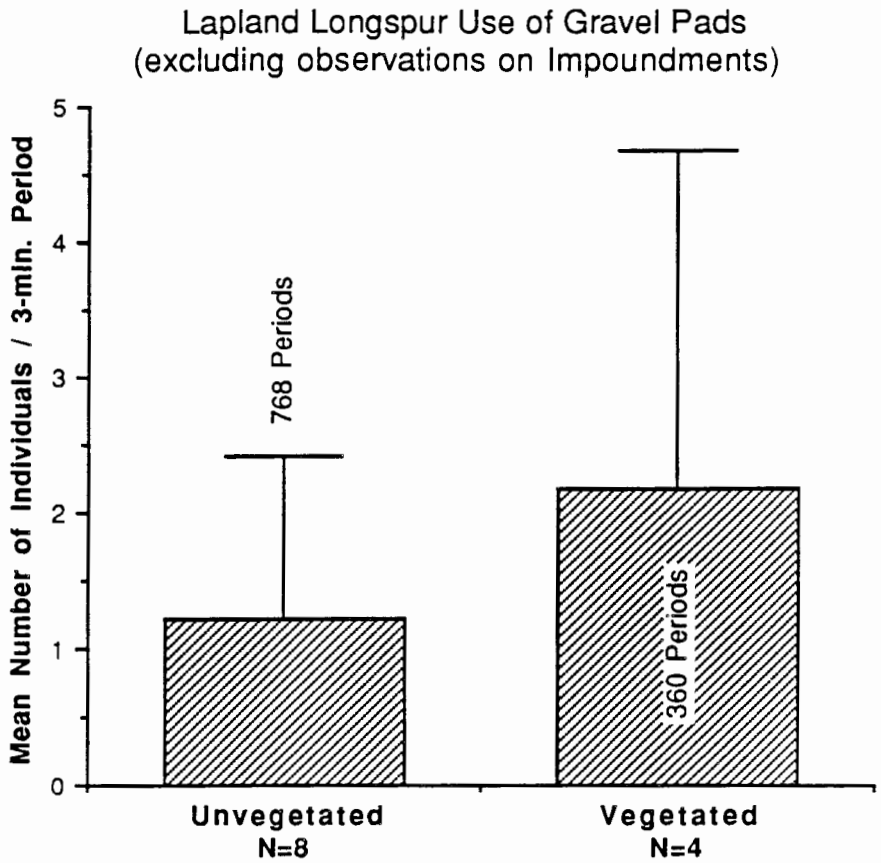
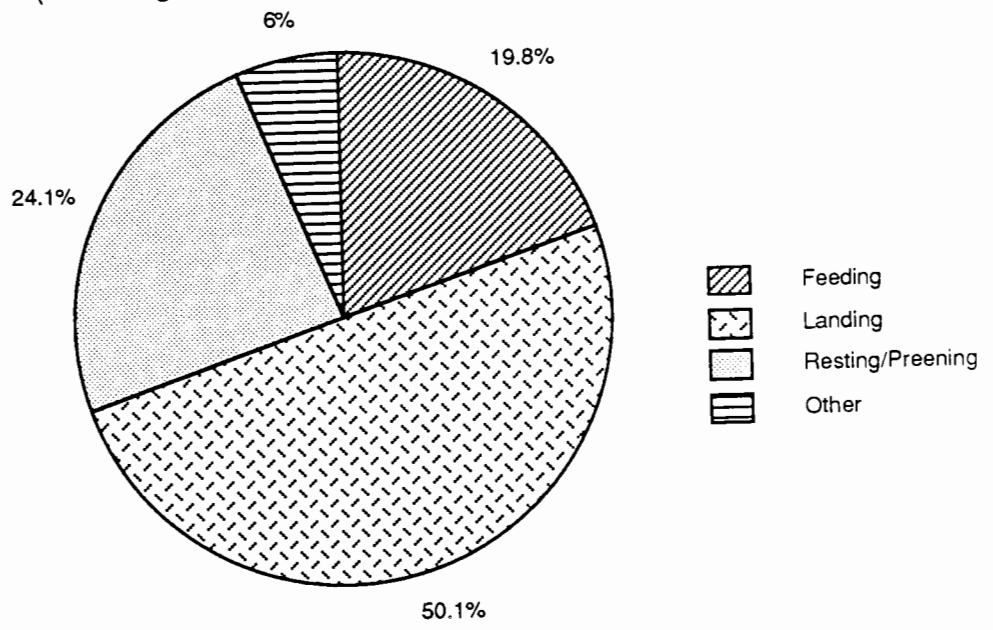


Fig. 21. Observed use by Lapland Longspurs, excluding observations on impoundments, of abandoned coastal plain and river delta gravel pads with vegetation and without appreciable vegetation, during the period from mid-July through mid-August, 1989, only, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-14.)

a) Lapland Longspur Behavior on Unvegetated Gravel Pads
(excluding observations on impoundments)



b) Lapland Longspur Behavior on Vegetated Gravel Pads
(excluding observations on impoundments)

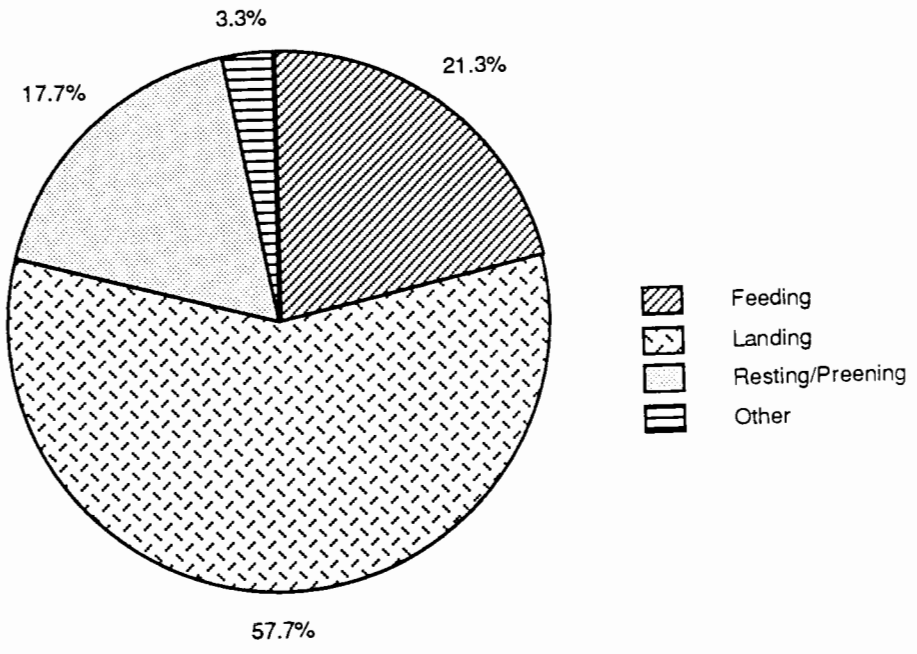


Fig. 22. Observed behavior by Lapland Longspurs, excluding observations on impoundments, on abandoned coastal plain and river delta gravel pads with vegetation and without appreciable vegetation, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions af all birds observed that were engaged in the specified activity when first observed.

seen on unvegetated pads (Fig. 23). As with the summer-long behavior comparisons, there were no major differences in longspur behavior between vegetated and unvegetated pads during late summer (Fig. 24). The proportion of time spent feeding on both pad types was almost identical, as was the diversity of activities. Landing was more common on vegetated pads; resting or preening was more common on unvegetated pads.

Qualitative Observations. Lapland Longspur was the only bird species that consistently used gravel pads. On most pads, few observations were made of this species early in the season. Longspur activity increased from mid- to late summer as individuals formed flocks. Many of these birds were juveniles. These flocks were observed on both gravel pads and adjacent tundra, but the birds seemed to have a preference for pads. Longspurs rapidly moved from one spot to another, feeding and preening; they used well heads and associated structures as perches.

Time-lapse video photography of longspur activity on Lake State 1 Pad provided qualitative information of bird activity. Groups of about 10 to 15 longspurs frequently fed in mid-summer on the naturally-vegetated portion of the pad, directly in front of the camera. They were apparently consuming seeds produced by several small forbs such as *Draba* sp., *Braya purpurascens*, and *Cochlearia officinalis* (Cruciferea) and *Minuartia arctica* and *Sagina intermedia* (Caryophyllaceae), which are prolific seed producers. This type of activity occurred throughout the day but was most evident in the early morning hours.

More site-specific qualitative observations of Lapland longspurs can be found in Appendix A.

All Mammals

Mammal observations made during 2-hr intervals are combined in this section. We compare mammal use between gravel pads and natural sites (undisturbed tundra and alluvium) and evaluate the influence of vegetation and water bodies on mammal use of gravel pads. (A listing of all mammal species observed during the course of this study can be found in Appendix A.)

Gravel pads vs. Tundra. Similarly to birds, more mammal species and more individuals were observed to use gravel pads than used nearby tundra sites

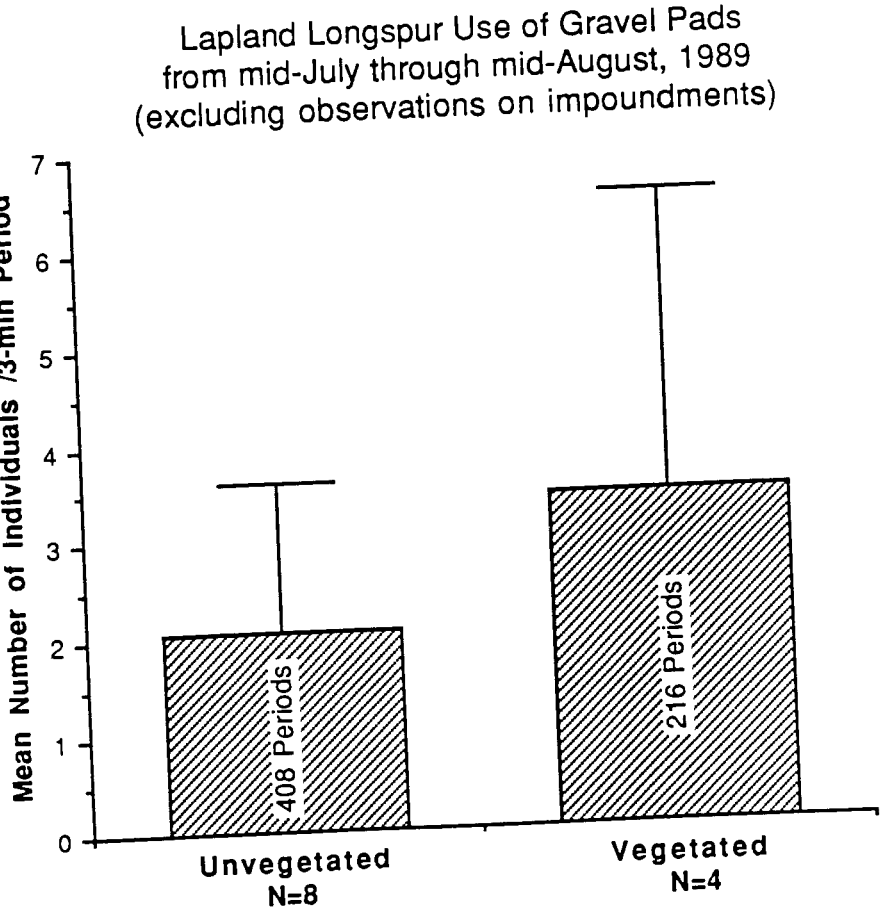
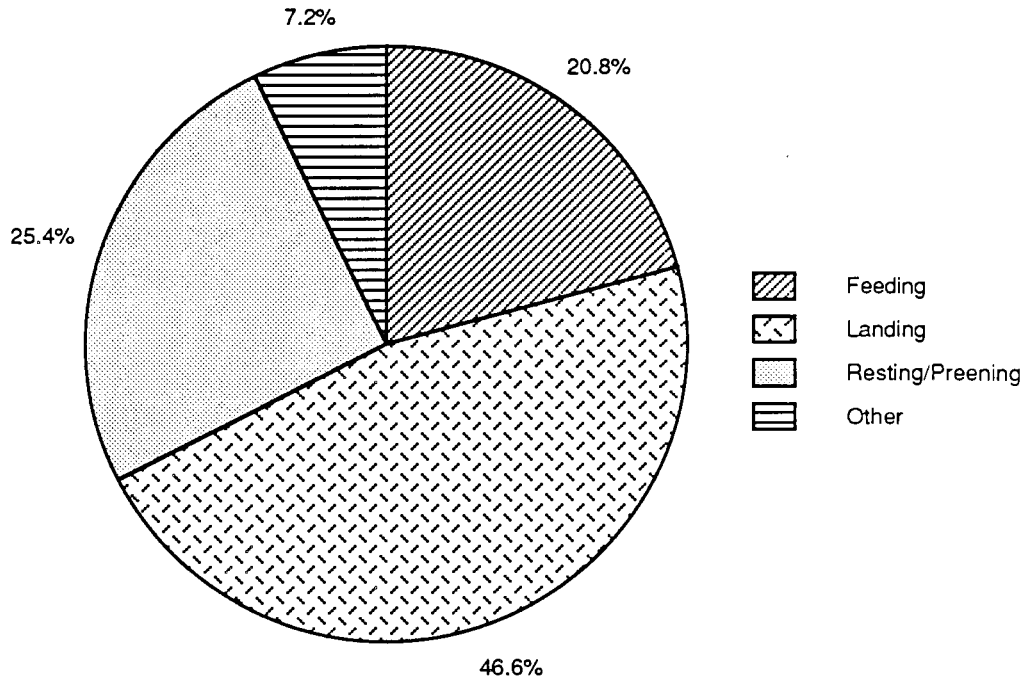


Fig. 23. Observed use by Lapland Longspurs, excluding observations on impoundments, of abandoned coastal plain and river delta gravel pads with vegetation and without appreciable vegetation, during the period from mid-July through mid-August, 1989, Arctic Coastal Plain, Alaska. (For further information on data variability, see Appendix C, p. C-15).

a) Lapland Longspur Behavior on Unvegetated Gravel Pads from mid-July to mid-August, 1989 (excluding observations on impoundments)



b) Lapland Longspur Behavior on Vegetated Gravel Pads from mid-July to mid-August (excluding observations on impoundments)

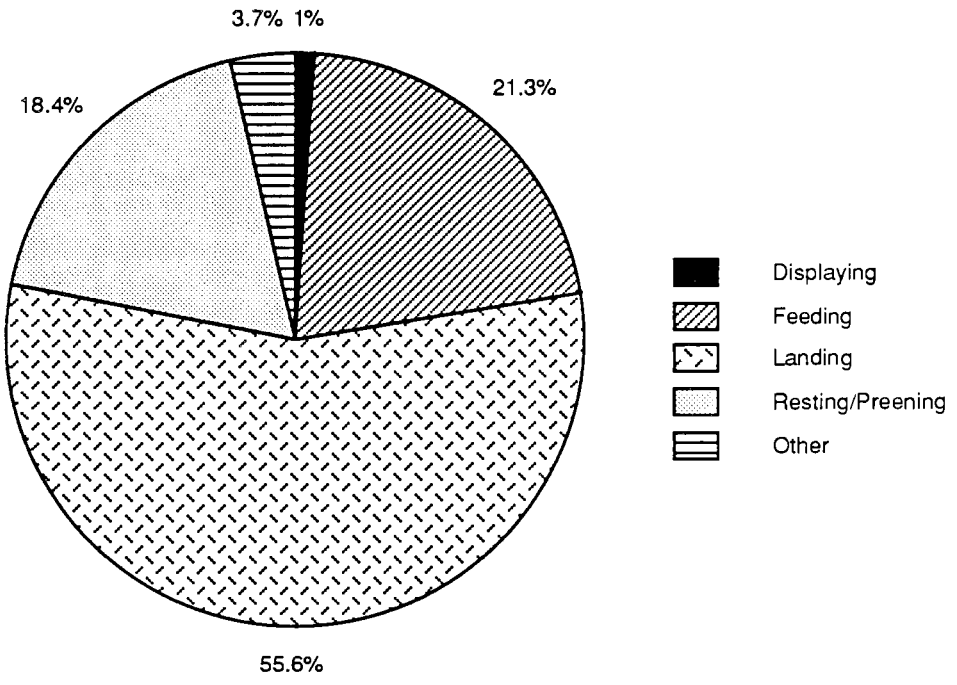


Fig. 24. Observed behavior by Lapland Longspurs, excluding observations on impoundments, on abandoned coastal plain and river delta gravel pads with vegetation and without appreciable vegetation, during the period from mid-July through mid-August, 1989, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions af all birds observed that were engaged in the specified activity when first observed.

(Fig. 25). The average number of species seen per 2-hr interval on the pads was twice that seen on undisturbed tundra, and approximately 3 times as many individuals were seen per 3-min period on the pads as on tundra.

There were negligible differences in some forms of behavior between the pad and tundra plots, and substantial differences in others (Fig. 26). Mammals spent about the same amount of time walking or running on both gravel and tundra plots, but they spent twice as much time hunting (hunting behavior was recorded only for Arctic foxes) and 2.5 times as much time feeding (caribou were the major contributors) on tundra as on the pads. In contrast, the primary activity on the pads was resting; mammals were engaged in this behavior 3 times more often on the pads than on tundra.

Gravel pads vs. Alluvium. There was little average difference between gravel pads and alluvium in the number of mammal species observed per 2-hr interval, but about 1.5 times as many individuals per 3-min period used gravel pads (Fig. 27).

Differences in observed behavior between the two site types were considerable (Fig. 28). The proportion of time mammals spent walking or running on the alluvium was over 3 times that which occurred on gravel pads. Similarly, mammals were engaged in feeding behavior on alluvium almost 3 times as much as on pads. Resting comprised about 66% of the total observed behavior on gravel pads as opposed to only about 5% on alluvium.

Effects of Vegetation. The average number of mammal species seen per 2-hr period was about the same for both vegetated and unvegetated gravel pads. However, over 4 times as many individuals per 3-min period were observed using unvegetated pads (Fig. 29).

Mammal behavior was markedly different between the two pad types (Fig. 30). The proportions of time spent feeding and hunting on vegetated pads were approximately 6 and 7 times, respectively, greater than on unvegetated pads. Mammals spent much more time resting and walking or running on unvegetated pads than on vegetated pads.

Effects of Water Bodies. To evaluate the effects of water bodies (i.e., reserve pits and flare pits) associated with gravel pads on mammal use of these

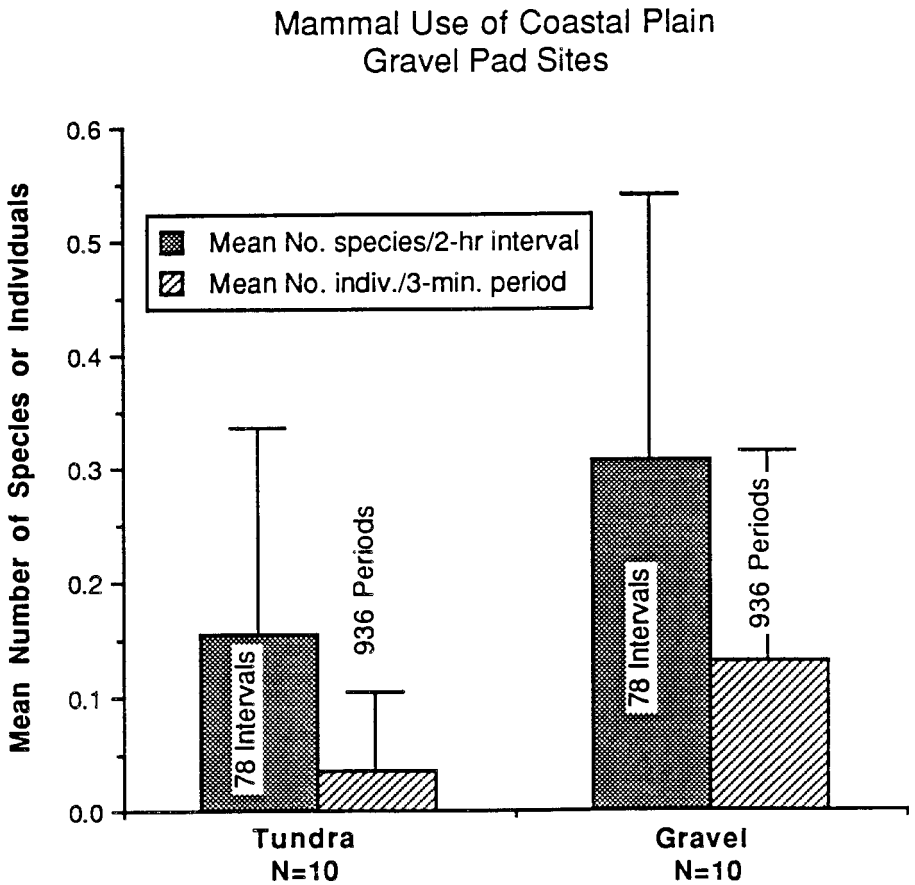


Fig. 25. Observed use by mammals (all species combined) of abandoned coastal plain gravel pads compared with their use of nearby tundra areas of similar sizes, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-16.)

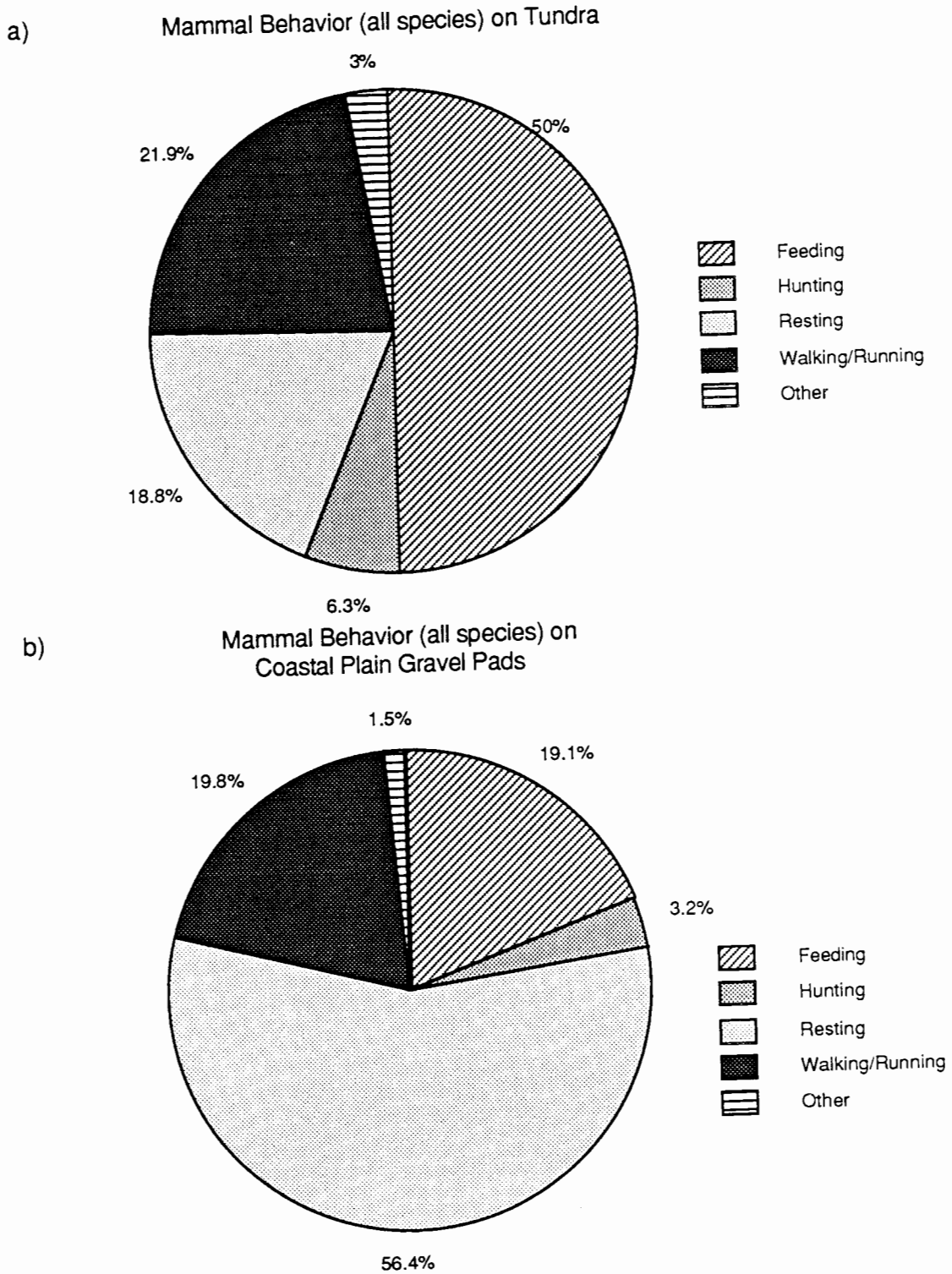


Fig. 26. Observed behavior by mammals (all species combined) on abandoned coastal plain gravel pads compared with their behavior on nearby tundra areas of similar sizes, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all mammals observed that were engaged in the specified activity when first observed.

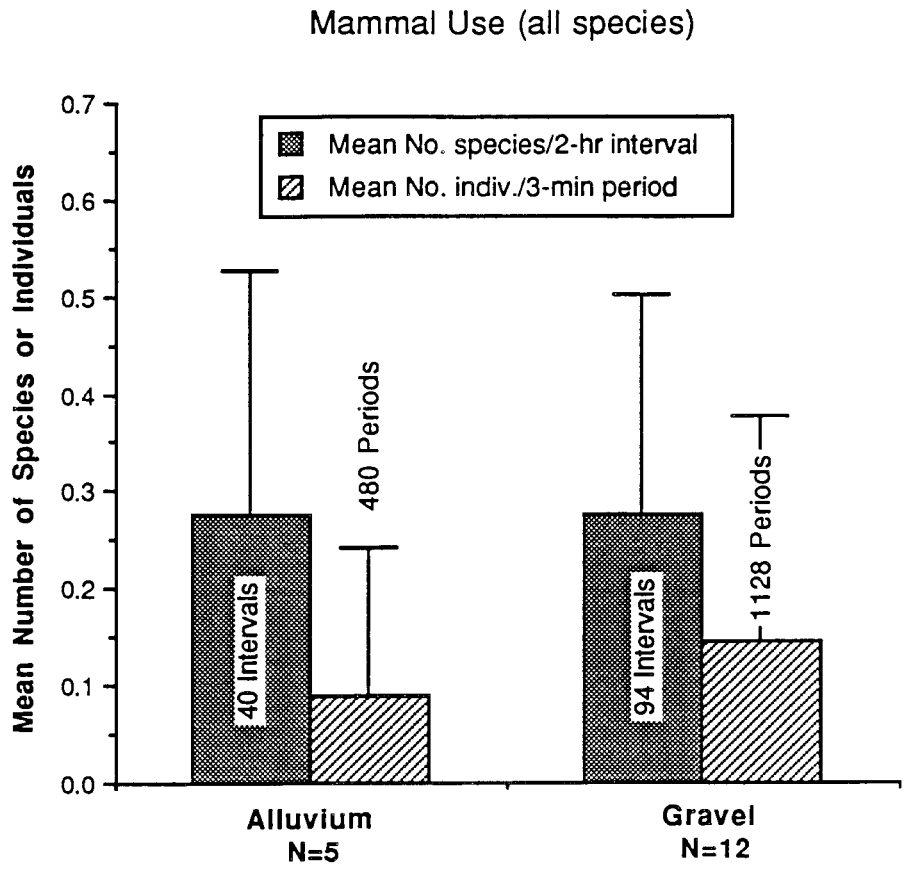


Fig. 27. Observed use by mammals (all species combined) of abandoned coastal plain and river delta gravel pads compared with their use of alluvium, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-17.)

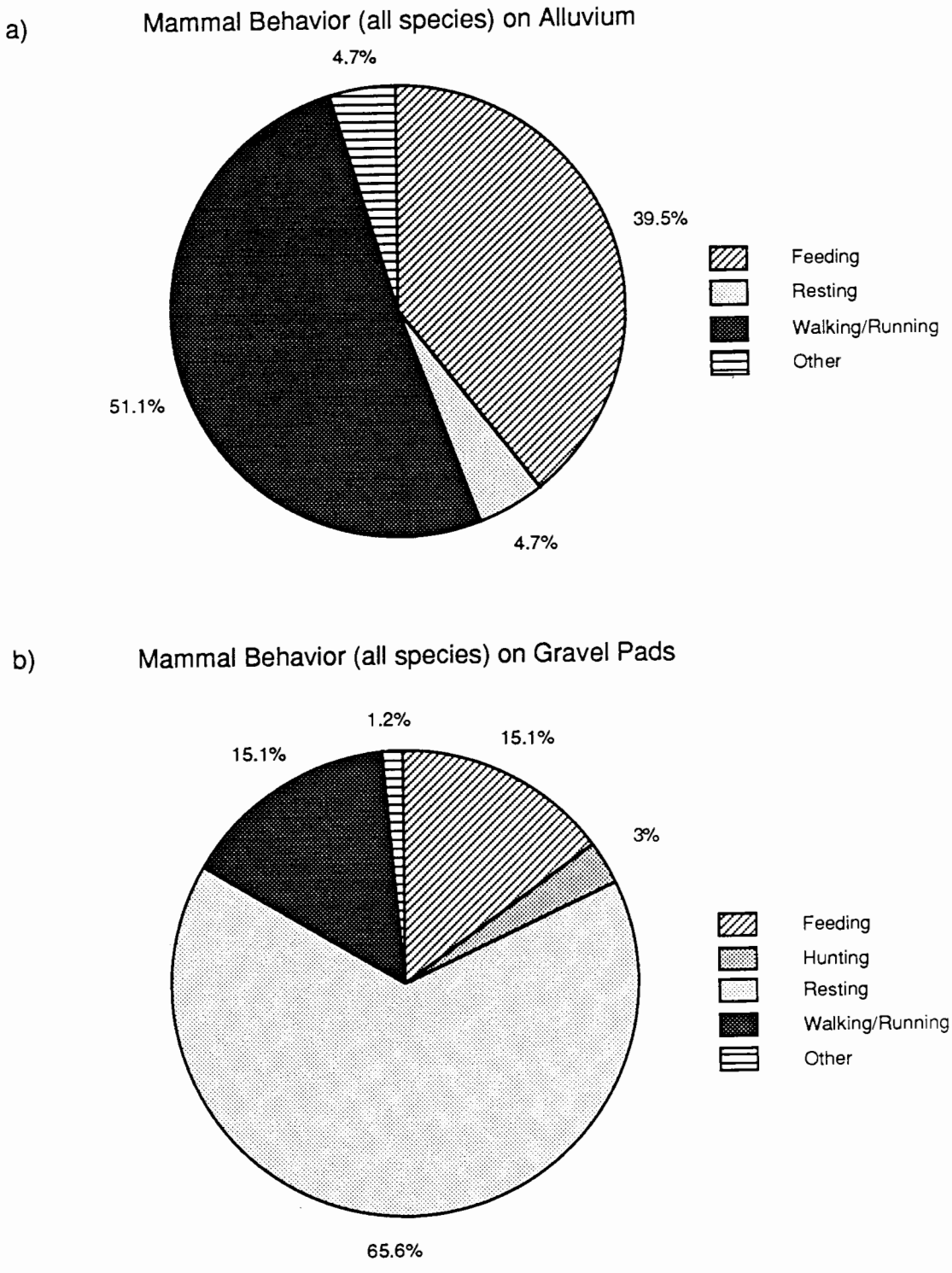


Fig. 28. Observed behavior by mammals (all species combined) on abandoned coastal plain and river delta gravel pads compared with their behavior on alluvium, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all mammals observed that were engaged in the specified activity when first observed.

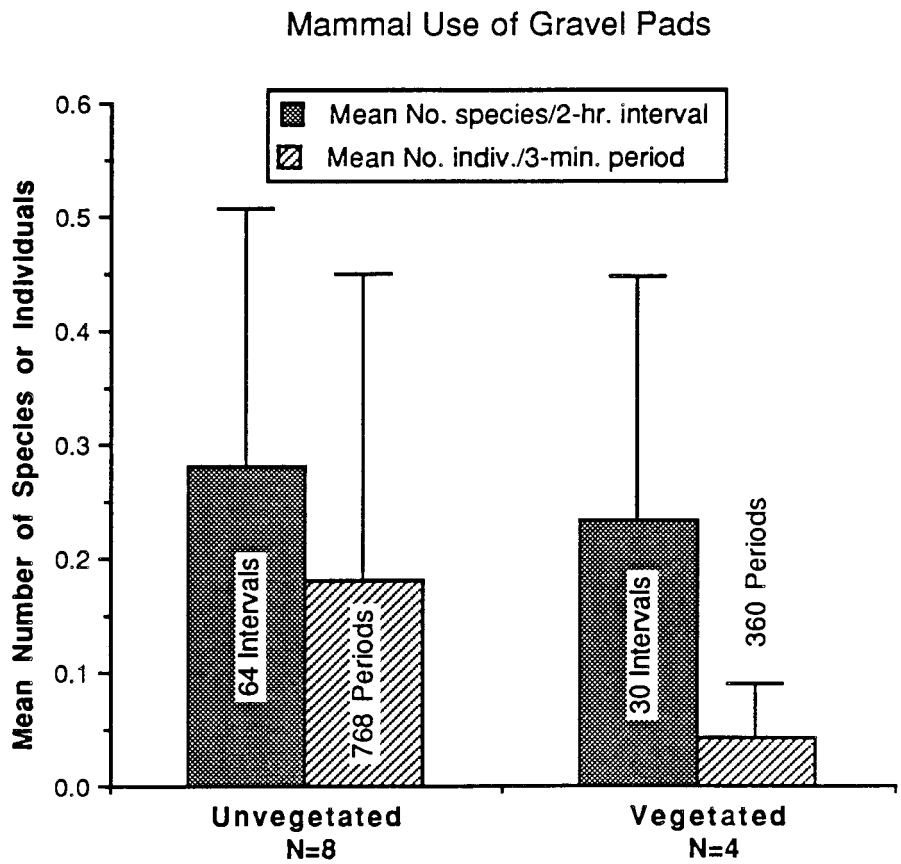
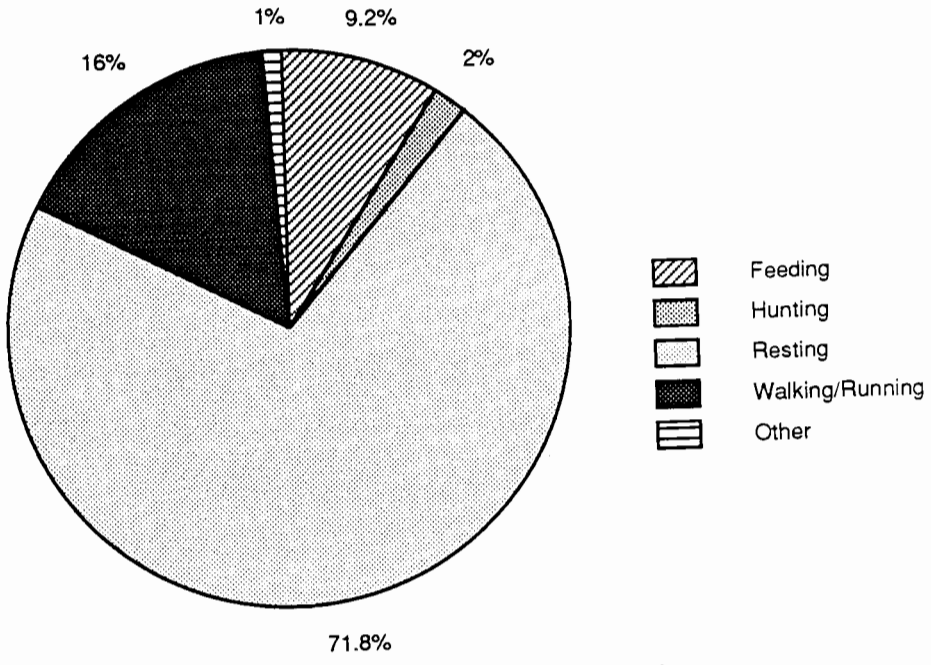


Fig. 29. Observed use by mammals (all species combined), excluding observations on impoundments, of coastal plain and river delta gravel pads with vegetation and without appreciable vegetation, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-18.)

a) Mammal Behavior (all species) on Unvegetated Gravel Pads
(excluding observations on impoundments)



b) Mammal Behavior (all species) on Vegetated Gravel Pads
(excluding observations on impoundments)

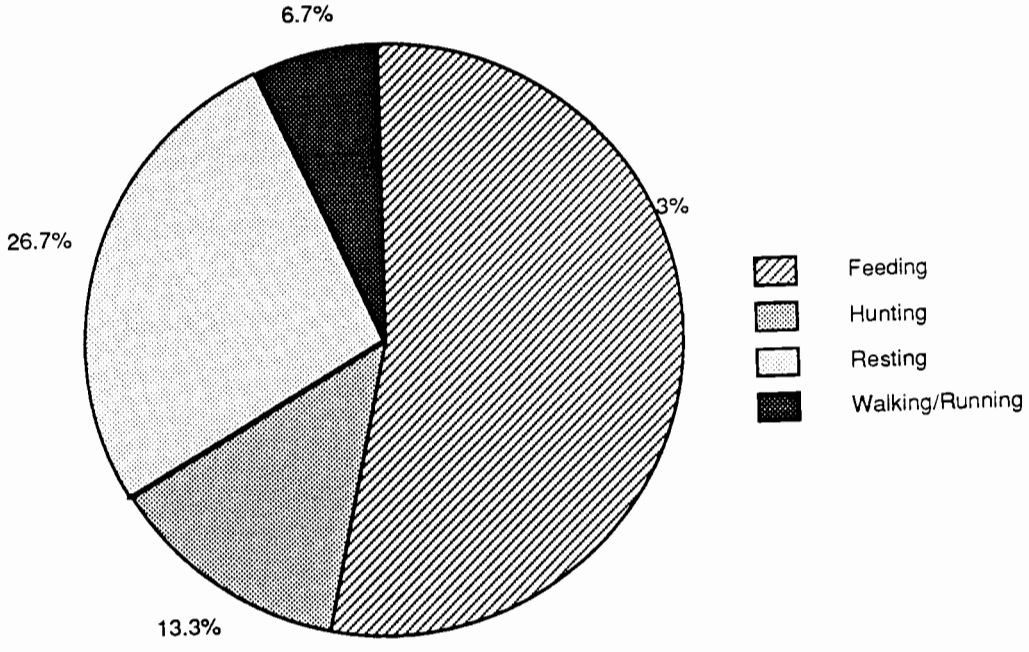


Fig. 30. Observed behavior by mammals (all species combined), excluding observations on impoundments, on coastal plain and river delta gravel pads with vegetation and without appreciable vegetation, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all mammals observed that were engaged in the specified activity when first observed.

sites, we can compare use of gravel pads including observations on impoundments (Figs. 25 & 26) with the use of gravel pads excluding observations on impoundments (Figs. 31 & 32). There was virtually no difference in species per 2-hr interval or in the average number of animals per 3-min period between the two types. Similarly, there was no difference in proportions of mammal behavior exhibited on gravel pads when observations on impoundments were excluded from the analysis.

Foothill Sites. On average, more mammal species and many more individuals were observed using the gravel pads as opposed to the tundra (Fig. 33). Arctic ground squirrels were by far the most numerous of the mammal species using the pads.

Resting was the dominant behavior exhibited by mammals on gravel pads (Fig. 34). The next most important behavior shown was alarm or distraction; most of this type of activity can be attributed to ground squirrels that were frequently seen and heard alarming. Feeding and walking or running were also displayed by mammals to a certain extent. The only mammal species seen on the tundra plot during the observation periods was an Arctic ground squirrel and the behavior it was engaged in was undeterminable.

Caribou

Gravel Pads vs. Tundra. On the pads, the average number of caribou seen per 3-min period was approximately 4 times that seen on undisturbed tundra (Fig. 35). Caribou behavior differed in some ways between gravel pads and tundra (Fig. 36). Caribou were involved in feeding 3 times more often on tundra than on pads, while resting behavior was about 3.5 times greater on pads than on tundra. The proportion of time spent walking or running was about equal for both pad and tundra plots.

Gravel Pads vs. Alluvium. The average number of caribou observed per 3-min period on the pads was about 1.5 times that observed on alluvium (Fig. 37). There were marked differences in observed caribou behavior on alluvium vs. gravel pads (Fig. 38). Caribou on alluvium were walking or running 3 times more often as on pads and feeding about 2.5 times as often. There were no

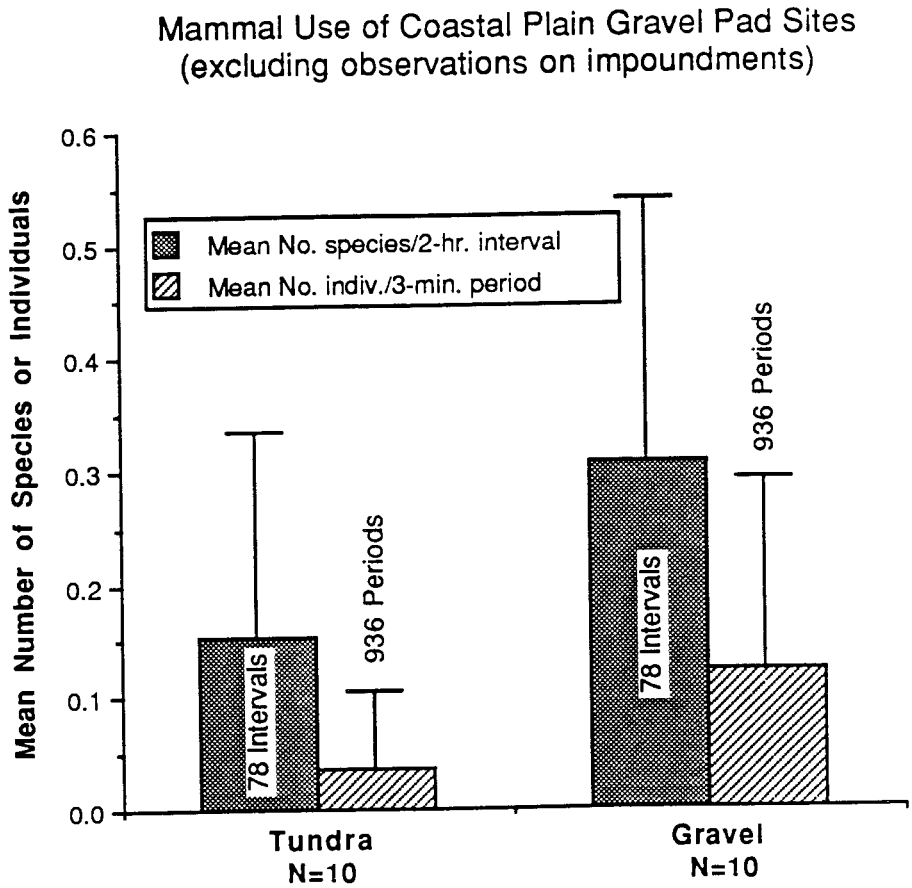


Fig. 31. Observed use by mammals (all species combined), excluding observations on impoundments, of coastal plain gravel pads compared with their use of nearby tundra areas of similar sizes, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-19.)

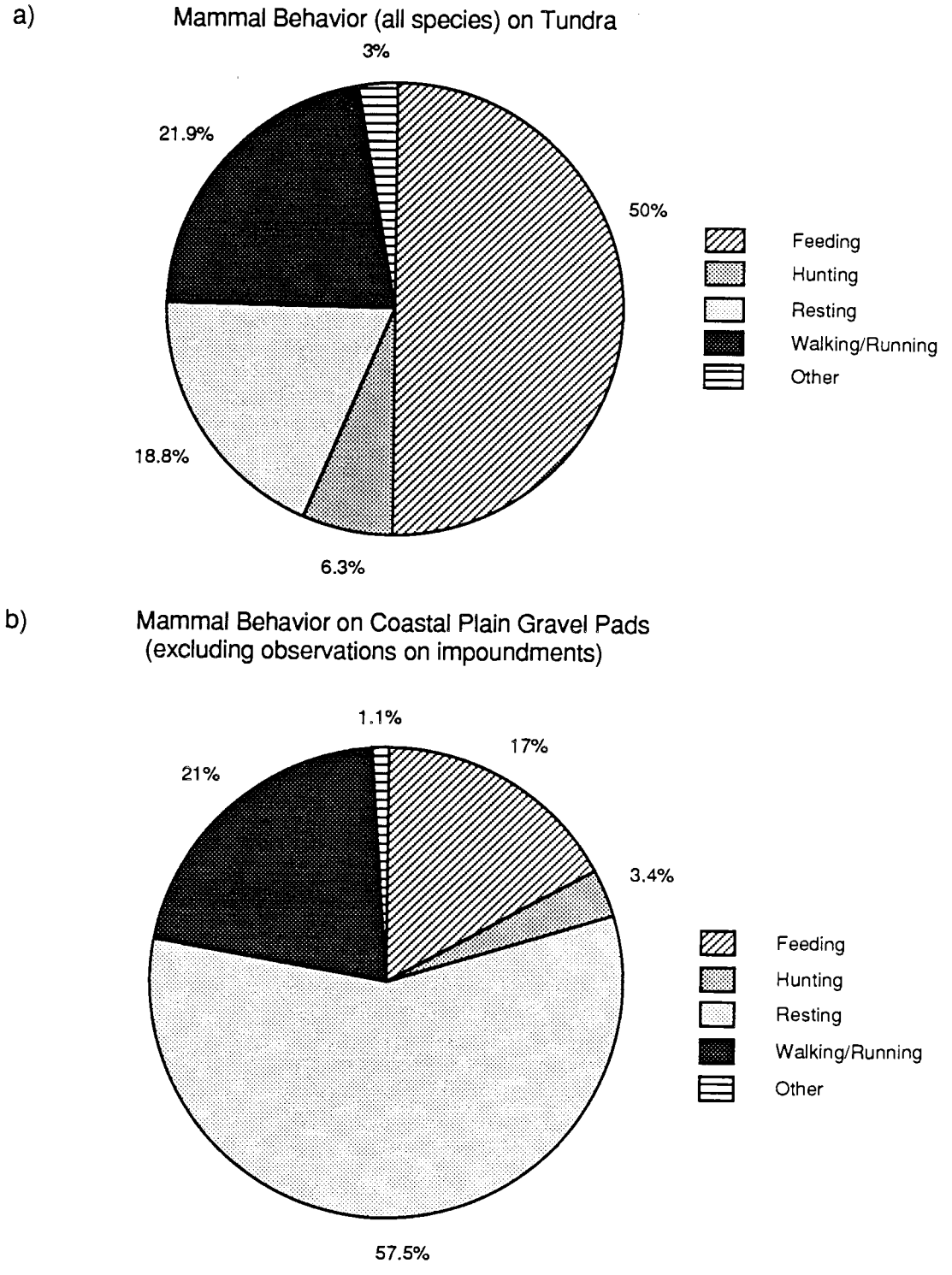


Fig. 32. Observed behavior by mammals (all species combined), excluding observations on impoundments, on coastal plain gravel pads compared with their behavior on nearby tundra areas of similar sizes, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all mammals observed that were engaged in the specified activity when first observed.

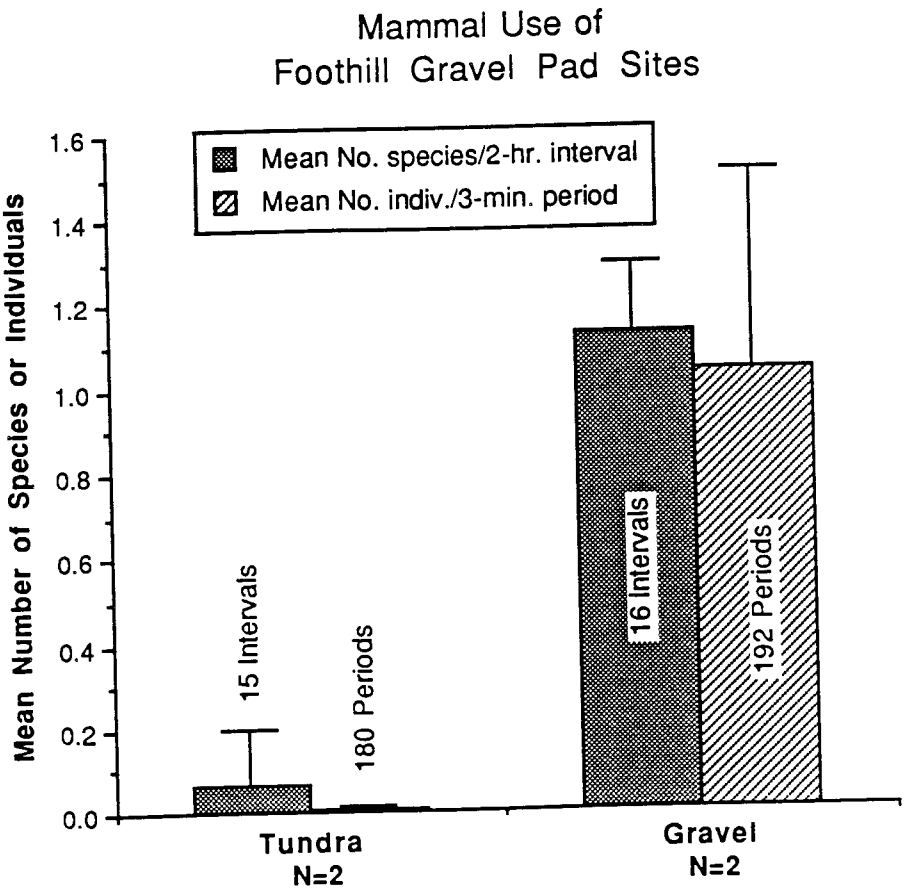


Fig. 33. Observed use by mammals (all species combined) of abandoned foothill gravel pads compared with their use of nearby tundra areas of similar sizes, northern Brooks Range, Alaska. (For further information on data variability, see Appendix C, p. C-20).

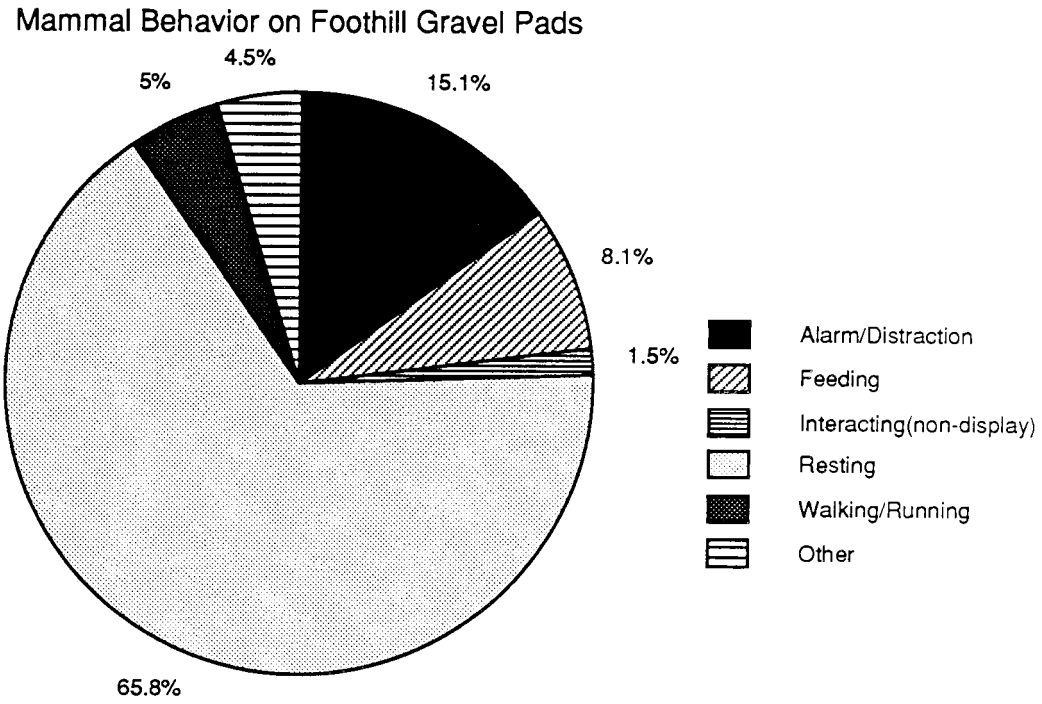


Fig. 34. Observed behavior by mammals (all species combined) on abandoned foothill gravel pads, northern Brooks Range, Alaska. Percentages (a, b) represent proportions af all birds observed that were engaged in the specified activity when first observed.

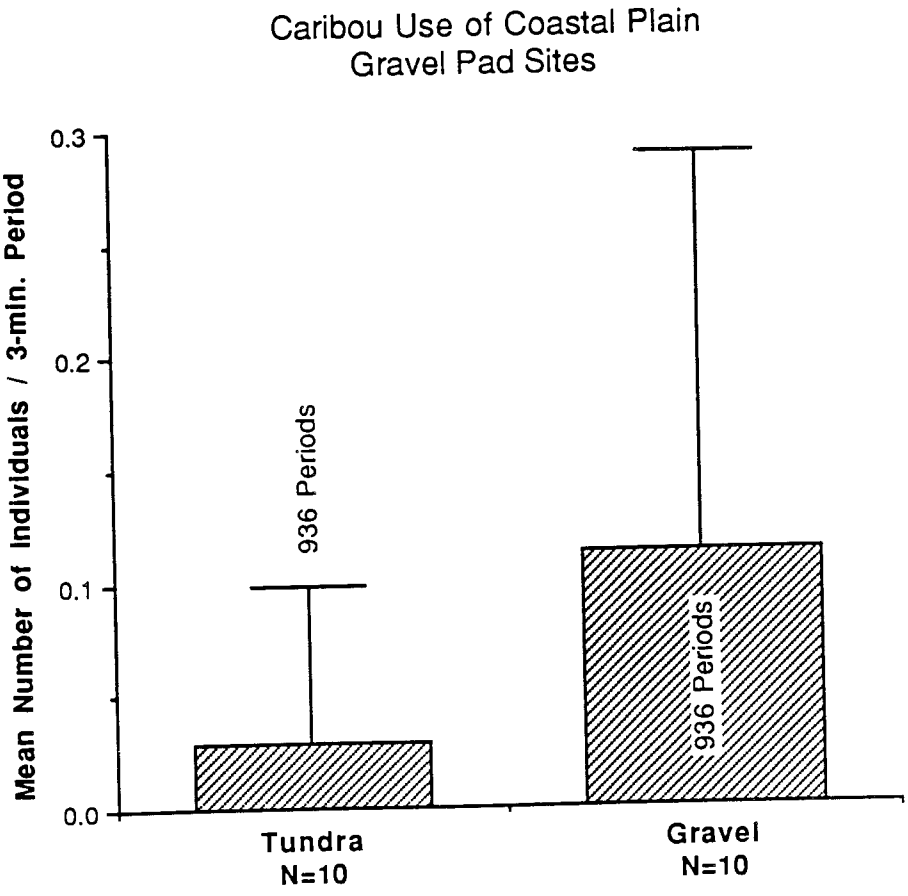


Fig. 35. Observed use by caribou of abandoned coastal plain gravel pads compared with their use of nearby tundra areas of similar sizes, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-21.)

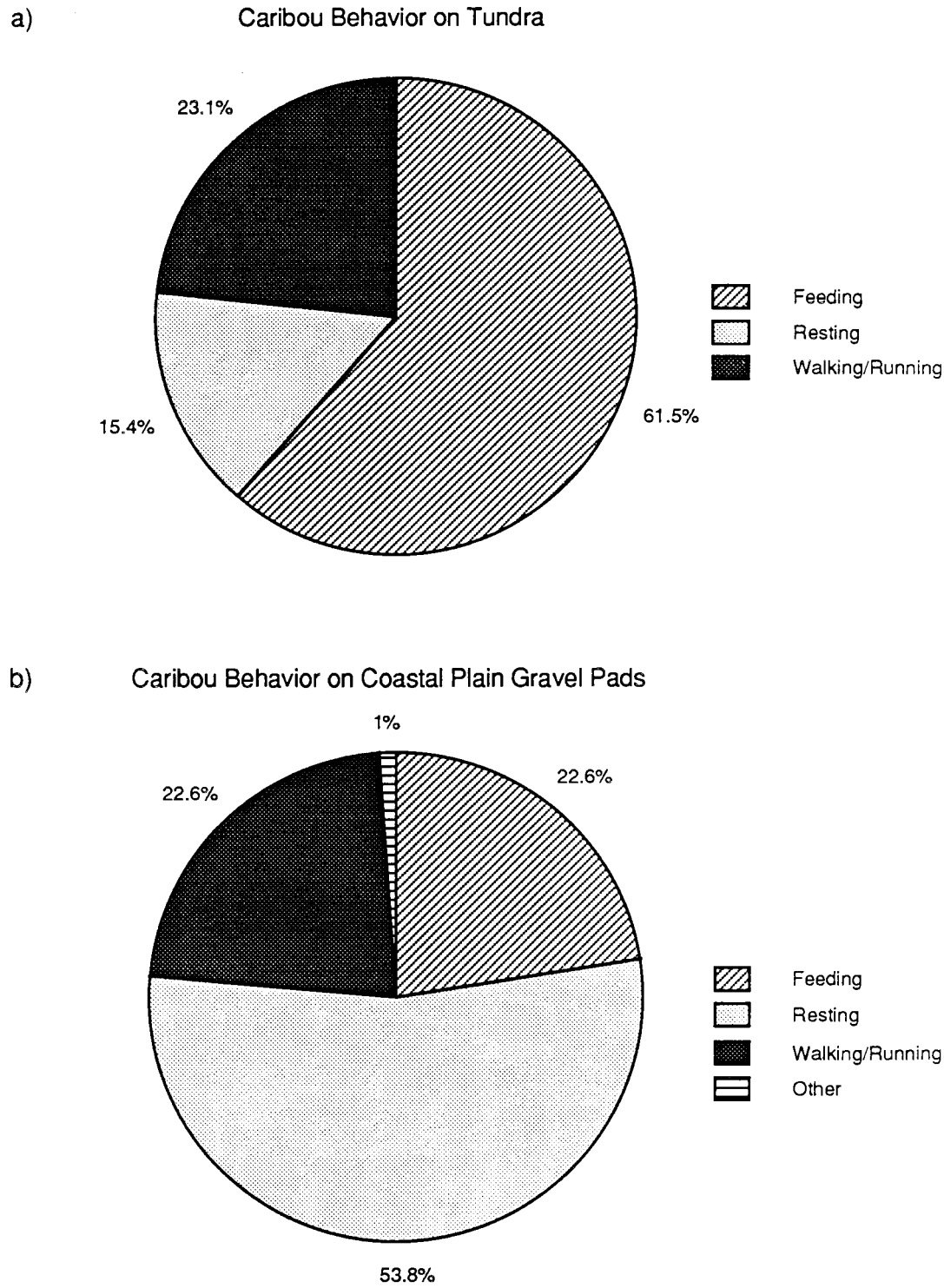


Fig. 36. Observed behavior by caribou on abandoned coastal plain gravel pads compared with their behavior on nearby tundra areas of similar sizes, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all caribou observed that were engaged in the specified activity when first observed.

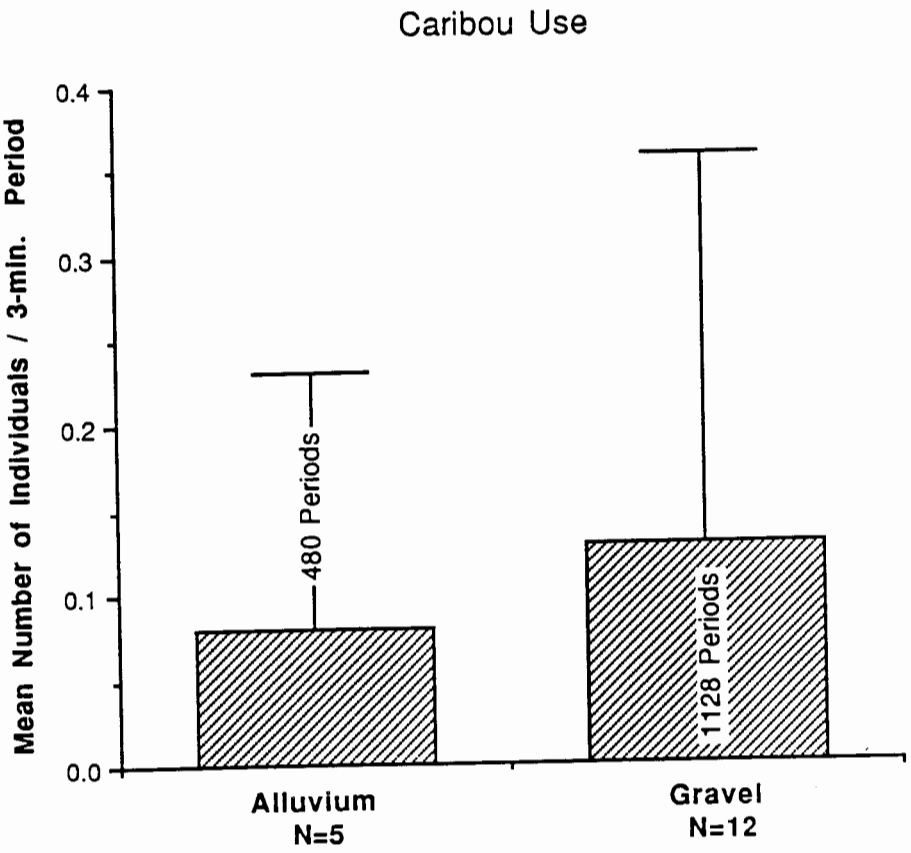


Fig. 37. Observed use by caribou of abandoned coastal plain and river delta gravel pads compared with their use of alluvium, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-22.)

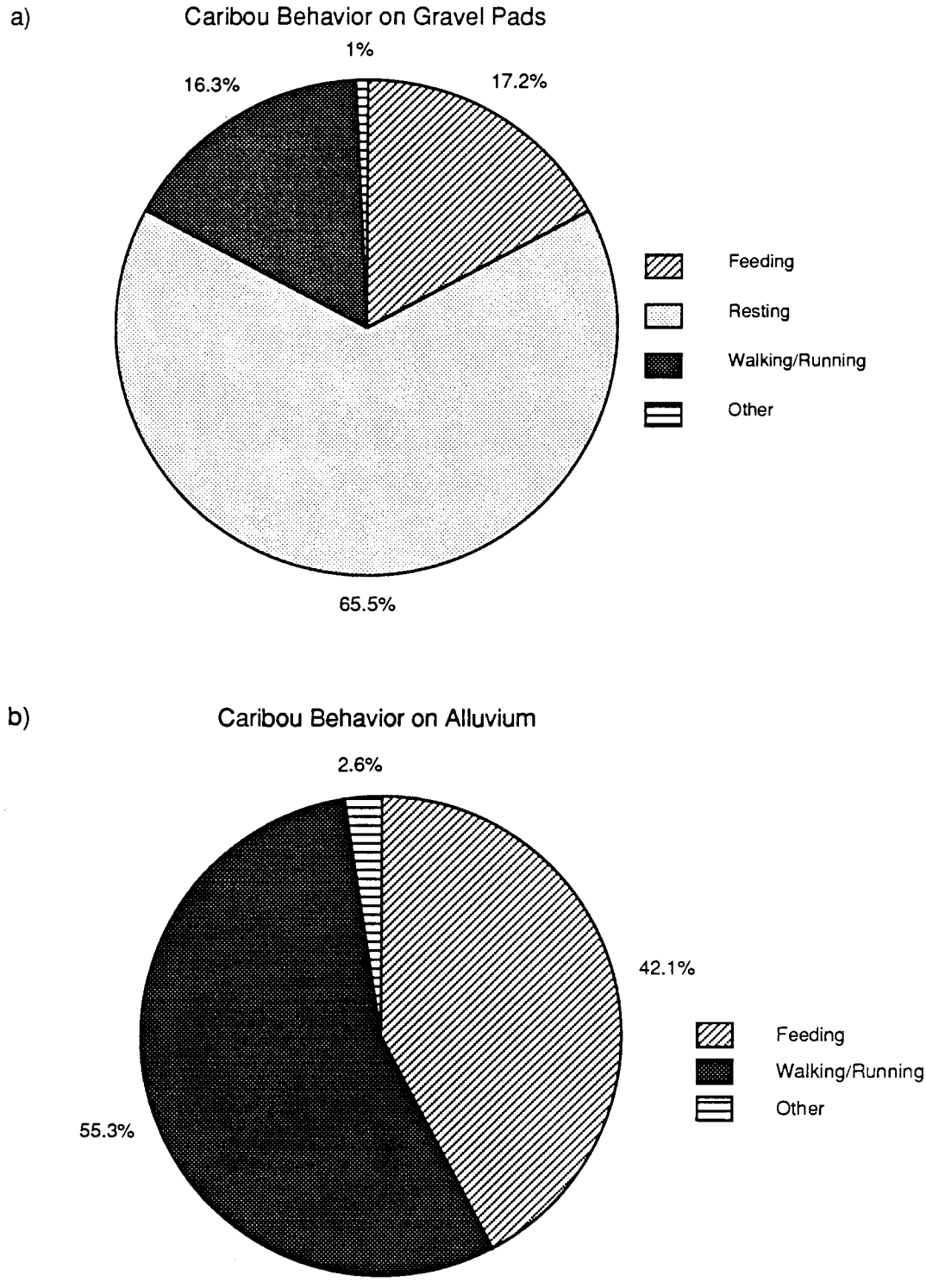


Fig. 38. Observed behavior by caribou on abandoned coastal plain and river delta gravel pads compared with their behavior on alluvium, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all caribou observed that were engaged in the specified activity when first observed.

observations of caribou resting on alluvium, but approximately 66% of the total observations of behavior on gravel pads constituted this behavior.

During midsummer, observers began to see much larger numbers of caribou west of the Kuparuk River than on the east side. Groups of up to several thousand animals were observed scattered throughout the Kuparuk Oilfield. Much smaller aggregations and fewer total numbers were observed in the Prudhoe Bay oilfield east of the Kuparuk River.

Since all five alluvial study sites are also located east of the Kuparuk River, we excluded gravel pad sites west of the Kuparuk River in one analysis to try to reduce the potential bias caused by this uneven distribution of caribou. Figure 39 shows that the average number of caribou seen per 3-min period on Prudhoe Bay pads was about 1.4 times that seen on alluvium, not much different from our initial comparison that included all pad sites (Fig. 37). Likewise the proportions of time caribou were engaged in the various activities were very similar to those over all the pad sites (Fig. 40). These comparisons indicate that bias introduced by uneven caribou distributions probably was small.

Effects of Vegetation. There were substantial differences in levels of caribou use between vegetated and unvegetated pads, and also some major differences in behavior between the two pad types (Figs. 41 & 42). Approximately 4 times as many individuals visited unvegetated gravel pads per 3-min period as visited the vegetated pads. Caribou were observed resting on unvegetated gravel pads about 2.5 times more, in proportion to other activities, than on vegetated pads. In contrast, the proportion of time caribou on vegetated pads engaged in feeding was at least 4 times greater than the proportion of time they fed on unvegetated pads. There was no appreciable difference between the two pad types in the proportion of time caribou spent walking or running.

Temporal Patterns of Use. The video-tape record of wildlife on Lake State 1 Pad suggests some trends in caribou activity over time (Fig. 43). Despite day-to-day variability in amount of caribou use of the pad, there seemed to be two perceptible seasonal peaks in activity. The first period occurred during late July and the second during the early part of August. From mid- to late August, caribou activity on the average tapered off.

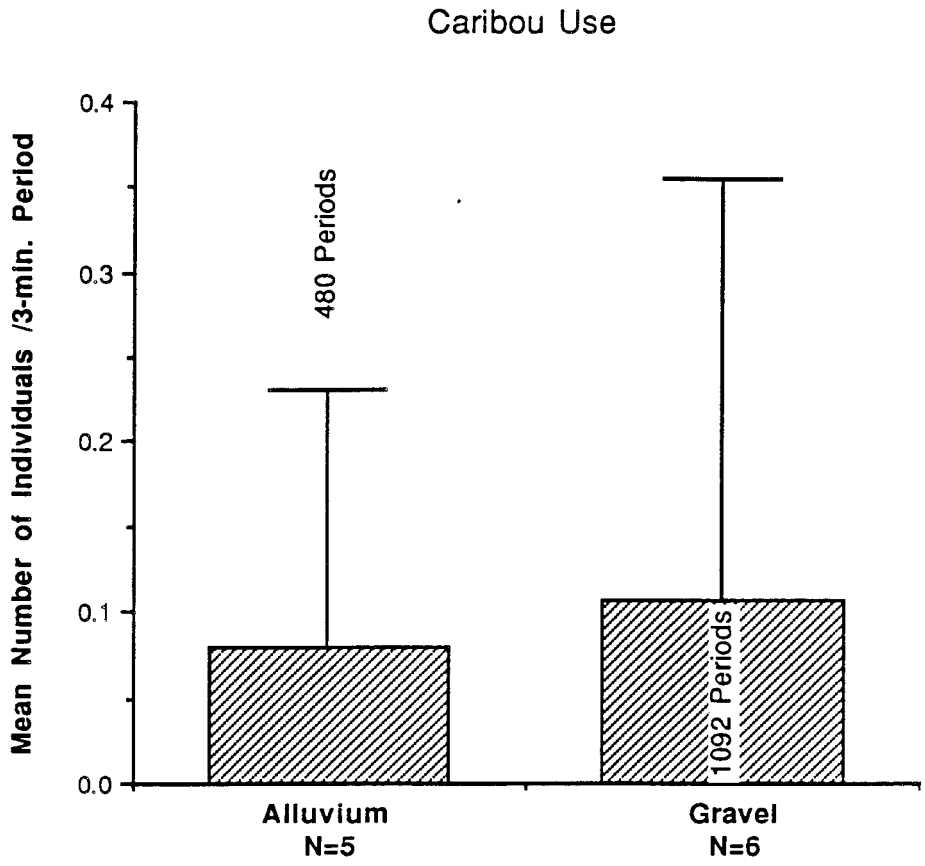


Fig. 39. Observed use by caribou of abandoned coastal plain gravel pads (excluding those sites west of the Kuparuk River) compared with their use of alluvium, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-23.)

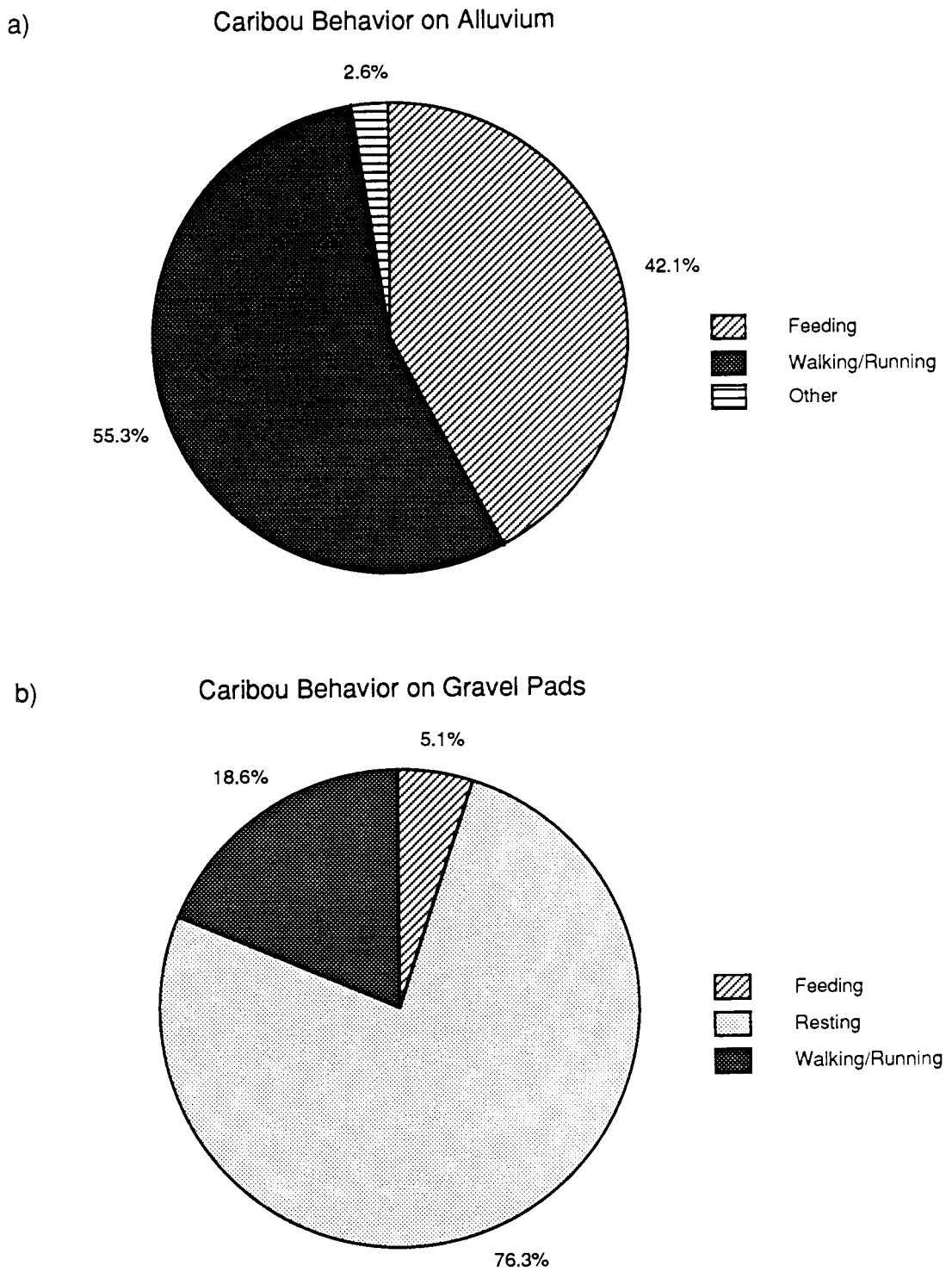


Fig. 40. Observed behavior by caribou on abandoned coastal plain gravel pads (excluding those sites west of the Kuparuk River) compared with their behavior on alluvium, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all caribou observed that were engaged in the specified activity when first observed.

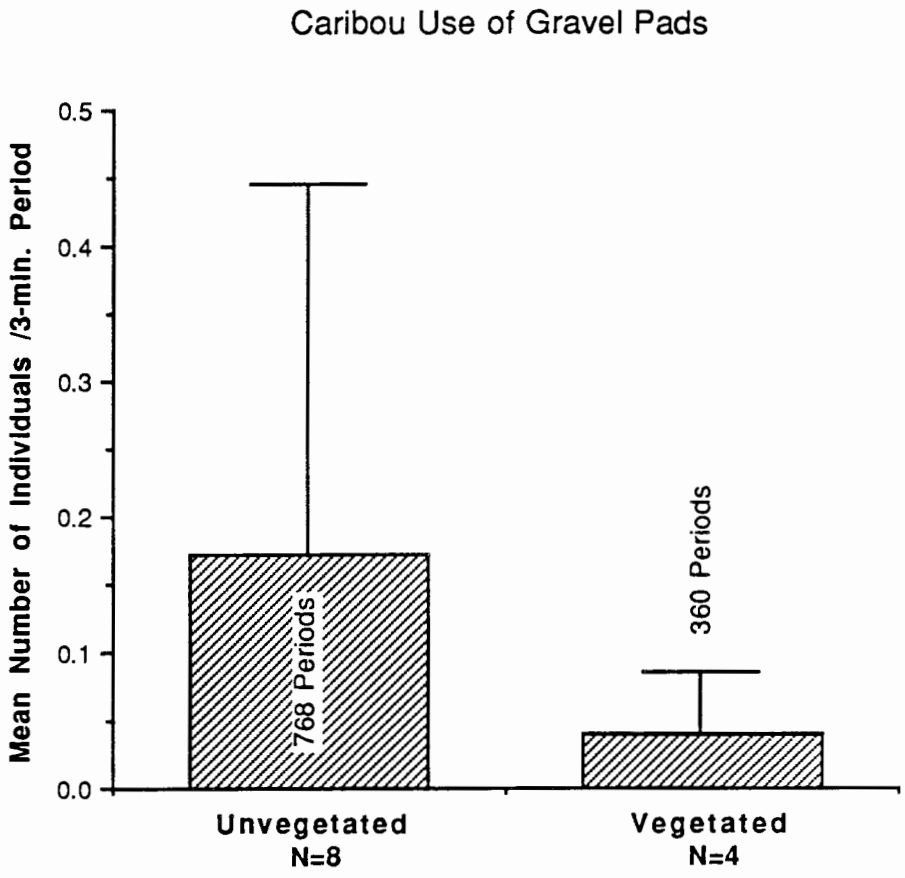


Fig. 41. Observed use by caribou of abandoned coastal plain and river delta gravel pads with vegetation and without appreciable vegetation, Arctic Coastal Plain. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-24.)

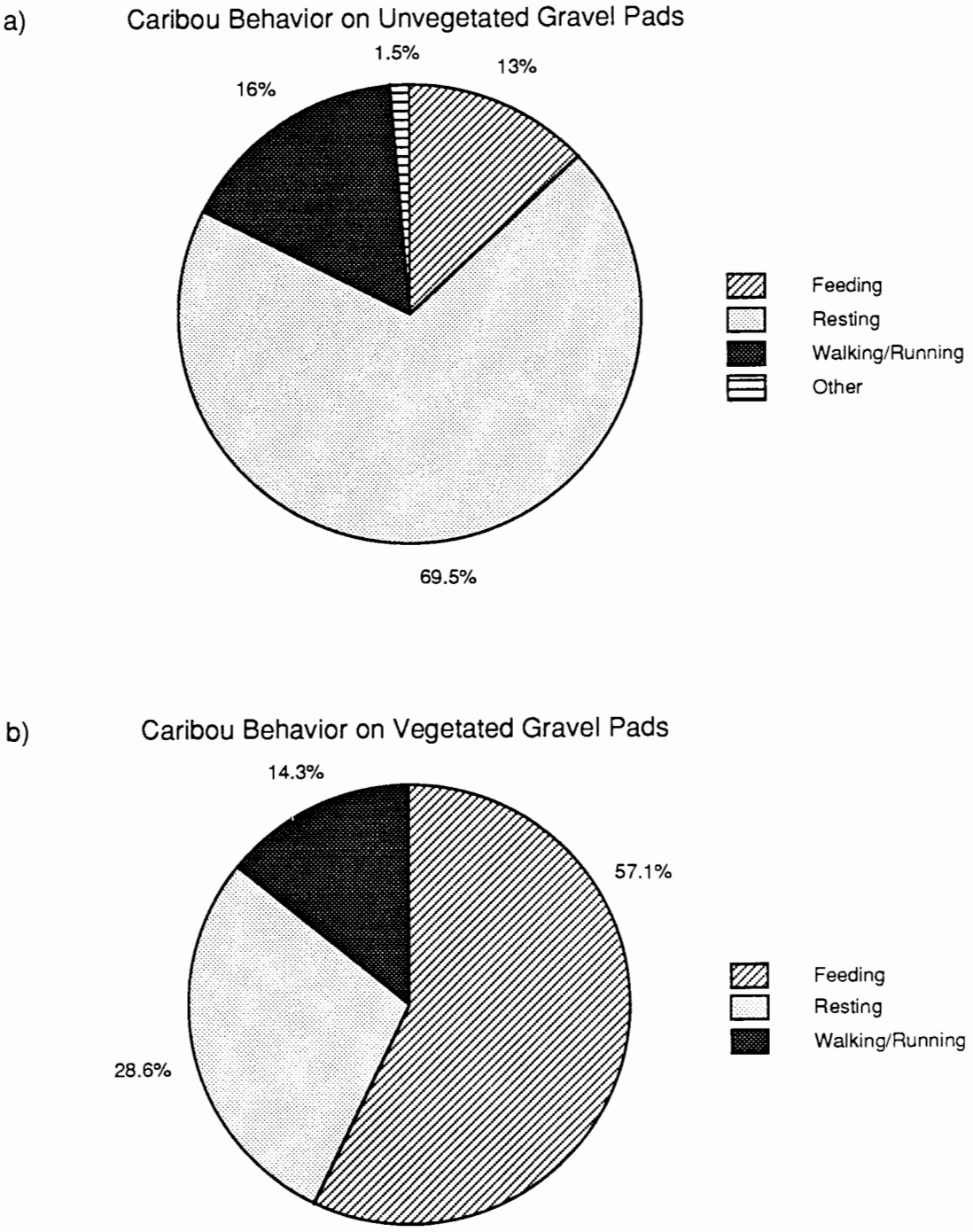


Fig. 42. Observed behavior by caribou on abandoned coastal plain and river delta gravel pads with vegetation and without appreciable vegetation, Arctic Coastal Plain. Percentages (a. b) represent proportions of all caribou observed that were engaged in the specified activity when first observed.

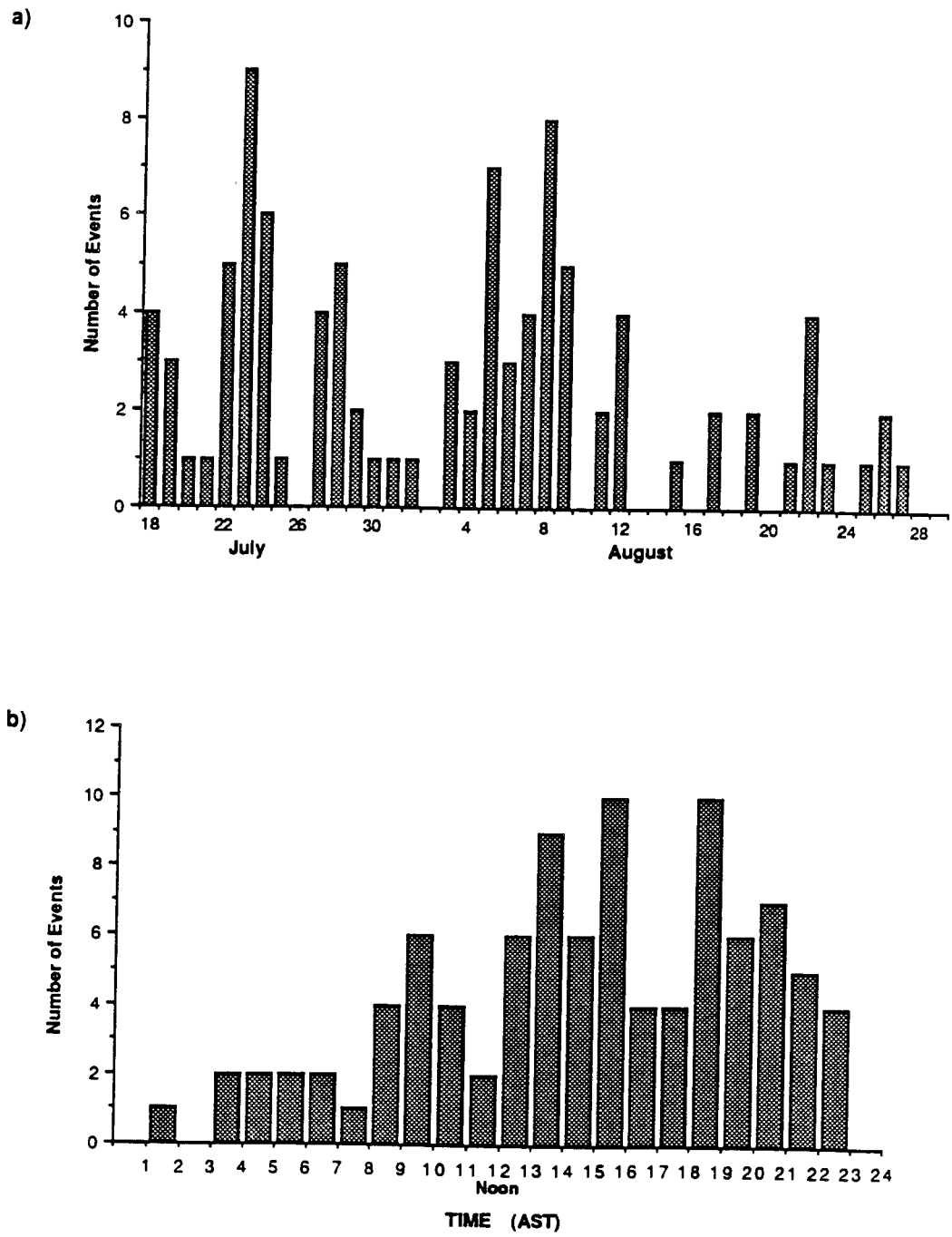


Fig. 43. Seasonal (a) and diurnal (b) pattern of caribou use on gravel pad site Lake State 1 as derived from time-lapse video photography. Number of events in (a) represents the sum of 1-hr periods in which caribou were present (for at least a portion of the period) during each day. Number of events in (b) represents the sum of days, totaled over the entire season, in which caribou were present during each specific 1-hr period.

During the filming period (18 July to 29 August) the number of 1-hr periods during the day in which at least 1 caribou was present ranged from 0 to 9 (Fig. 43). Caribou activity on the pad was detectable during all but 3 hours of the day. The greatest activity occurred between the hours of 1200 and 1600 hours and between 1800 and 2200 hours AST. A smaller pulse of activity was observed during the hours of 0800 and 1100.

Qualitative Observations. Caribou were the most numerous and the most consistently observed of any mammal. They were observed throughout the entire season on tundra, gravel pads, and alluvium. On gravel pads, caribou spent most of their time standing and resting, but on alluvium they spent a large proportion of the time feeding, primarily on several of the *Artemisia* species. These vigorous forb species had succulent stems, leaves, and flowers, and were abundant on alluvium. Most individual plants were heavily grazed.

Analysis of the time-lapse video photography showed caribou to be involved in feeding, resting, and walking on the gravel pad at Lake State 1. On many occasions, from 1 to 5 caribou could be seen feeding on selected seeded grasses on the pad in apparent preference to unseeded areas nearby. Feeding bouts by individuals extended up to 1.25 hours. Single bulls were common and in several instances could be seen lying on the pad for up to an hour at a time.

Wildlife Use of Impoundments and Ponds

Birds were essentially the only animals observed utilizing impoundments and ponds. Of the various bird groups present on the Arctic Coastal Plain, waterfowl and shorebirds were observed in association with these water bodies more often than any of the other birds. These two bird groups used ponds and impoundments in different ways.

To describe and compare bird use of these water bodies, we show pond and impoundment use by 1) all bird species combined and 2) waterfowl only. The descriptors for levels of use are mean number of bird species seen per 2-hr interval and mean number of individuals seen per 3-min period. Types of use are described as proportions (percentages) of the time that birds observed were engaged in specific activities.

All Birds

Observations of all bird species are combined in this section. Bird use of natural ponds and man-caused impoundments are compared and we evaluate the influence of the emergent grass *Arctophila fulva* on bird use of these water bodies.

Impoundments vs. Ponds. There were about 1.5 times as many bird species observed per 2-hr interval on impoundments as were observed on ponds (Fig. 44). Slightly more individuals were seen per 3-min period on impoundments than on ponds. Statistically, however, there was no significant difference at the 95% level (Mann-Whitney U-test) between impoundments and ponds with respect to mean numbers of bird observations per day (Appendix Table C-1). This was the case for each of the four 2-wk observational periods, as well as for the summer as a whole.

As can be seen from Figure 45, birds spent over half their time on both site types feeding, and there was no appreciable difference between the two types in the average proportion of time spent feeding. The proportion of time birds were engaged in resting or preening was, on average, greater on impoundments than on ponds. Nesting and incubation activity was much more pronounced on ponds (nesting/incubation was <1% of the activity on impoundments and is therefore masked under the behavior category "other").

Impoundments w/*Arctophila* vs. Ponds w/*Arctophila*. On impoundments with *Arctophila*, both the average number of species seen per 2-hr interval and the average number of individuals seen per 3-min period were a little over 1.5 times that seen on ponds with *Arctophila* (Fig. 46). The proportions of time birds were involved in the various behavior categories on impoundments in which *Arctophila* was present differed little from those on ponds with *Arctophila* (Fig. 47)

Impoundments w/*Arctophila* vs. Impoundments w/o *Arctophila*. There were on average slightly more species seen per 2-hr interval on impoundments with *Arctophila* than on impoundments without *Arctophila*. Individuals were

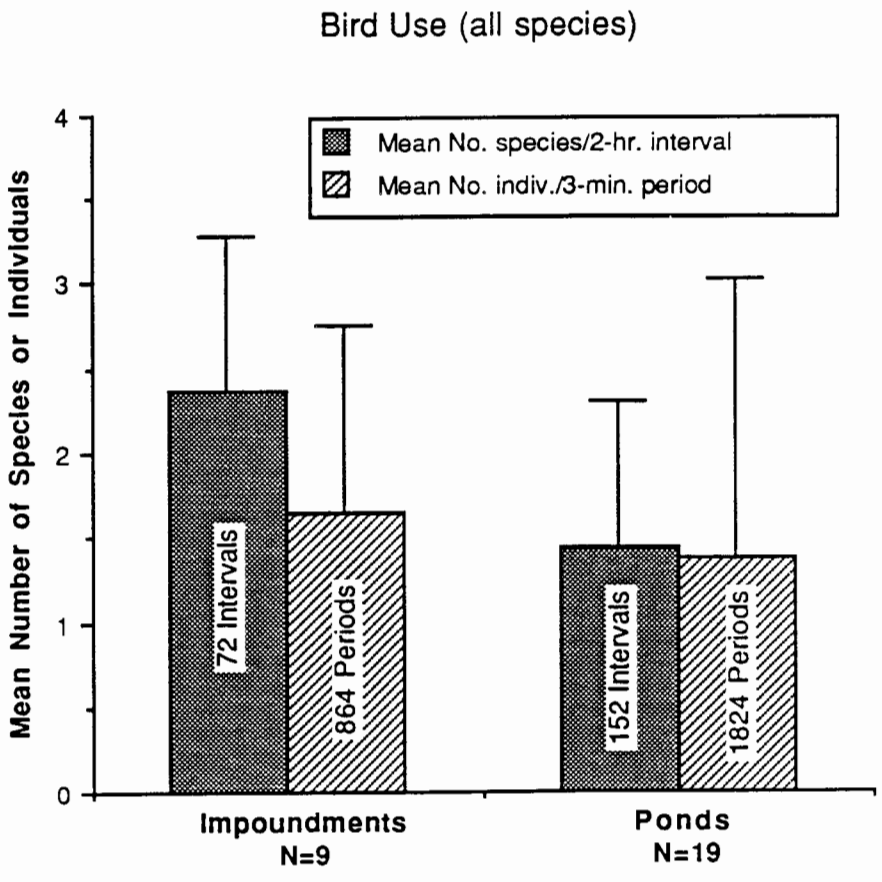


Fig. 44. Observed use by birds (all species combined) of impoundments compared with their use of natural ponds, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-25.)

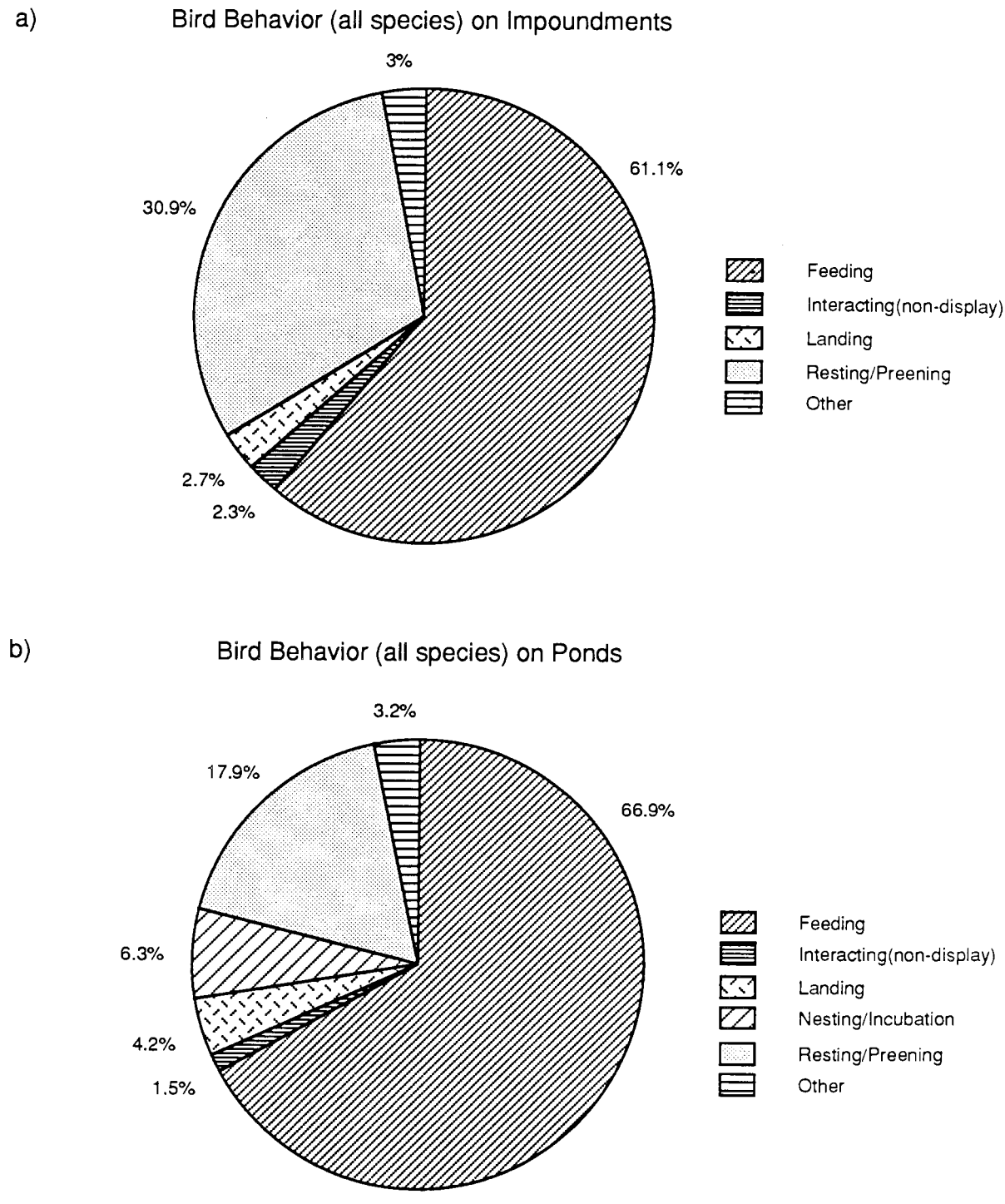


Fig. 45. Observed behavior by birds (all species combined) on impoundments compared with their behavior on natural ponds, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all birds observed that were engaged in the specified activity when first observed.

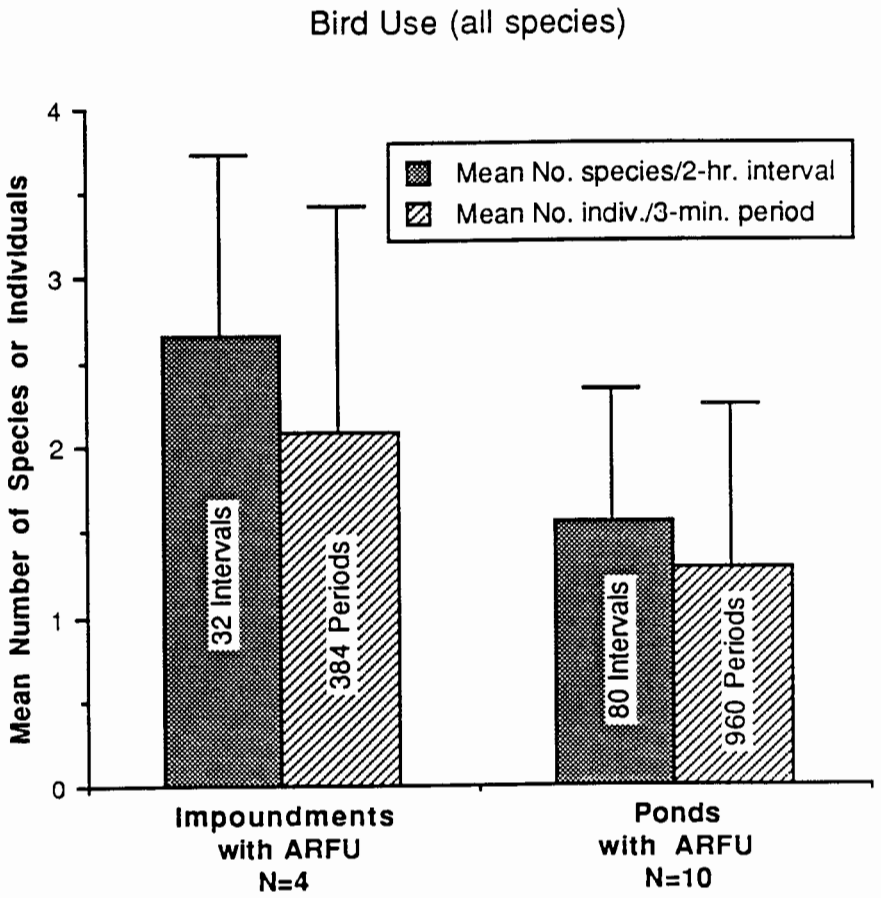


Fig. 46. Observed use by birds (all species combined) of impoundments with *Arctophila fulva* (ARFU) compared with their use of natural ponds with ARFU, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-26.)

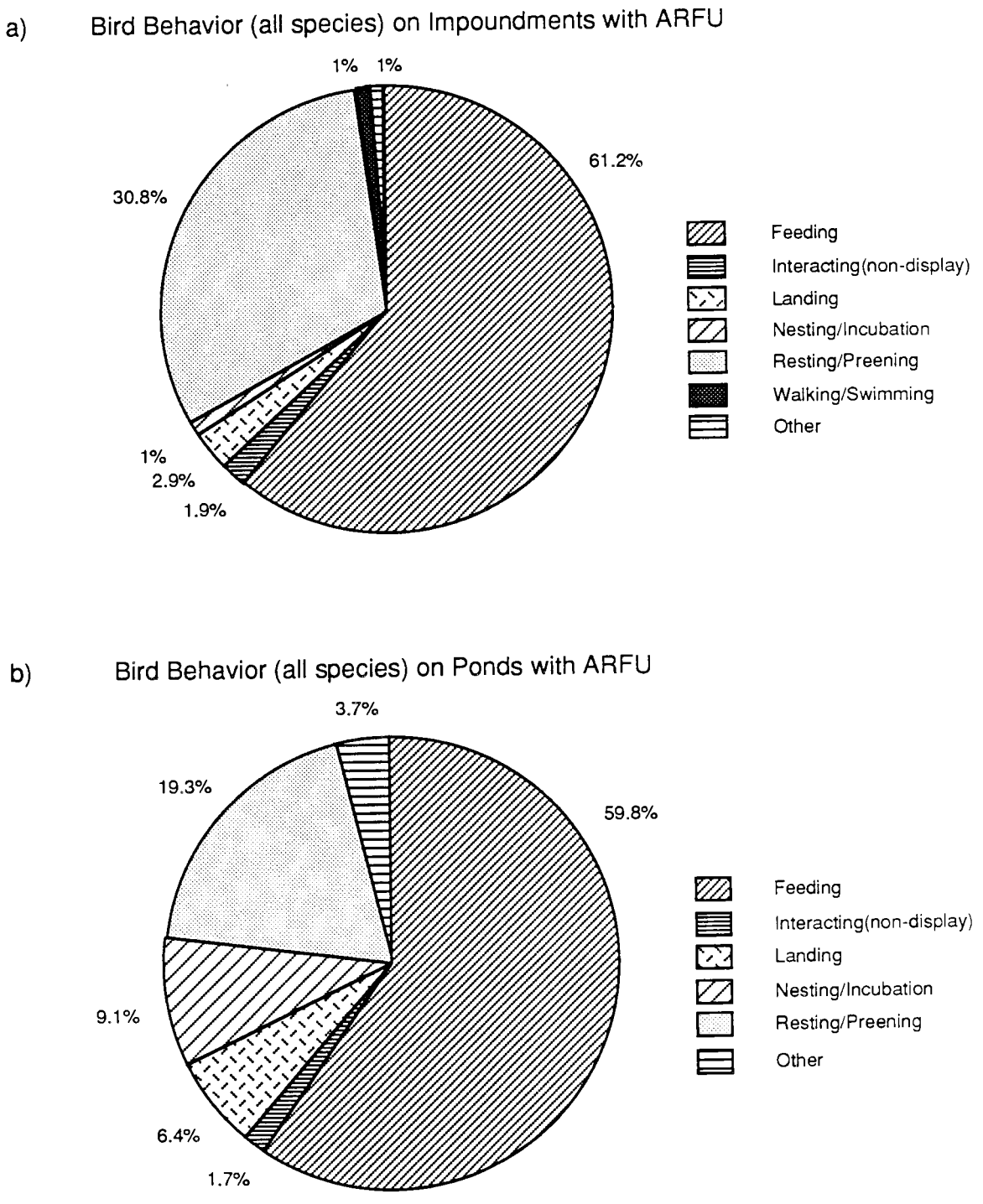


Fig. 47. Observed behavior by birds (all species combined) on impoundments with Arctophila fulva (ARFU) compared with their behavior on natural ponds with ARFU, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all birds observed that were engaged in the specified activity when first observed.

seen about 1.5 times more often per 3-min period on impoundments with *Arctophila* than on those without (Fig. 48).

There were no major differences between the 2 impoundment types in the proportions of time birds engaged in the various behaviors (Fig. 49). Birds spent most of their time feeding (61%) and resting or preening (31%) on both site types.

Ponds w/*Arctophila* vs. Ponds w/o *Arctophila*. The presence of *Arctophila* apparently had little influence on levels of bird use of ponds. The average number of species observed and the average number of individuals observed did not differ greatly between the *Arctophila* ponds and the non-*Arctophila* ponds (Fig. 50).

Bird behavior, however, did differ in some ways between the two pond types (Fig. 51). Birds spent less time feeding but more time landing and nesting or incubating on ponds with *Arctophila* than on ponds without *Arctophila*. The proportion of time birds spent interacting was about equal on both pond types.

Overall Effects of *Arctophila fulva*. No statistical differences were found when mean levels of use by all birds (individuals) were compared between all water bodies (impoundments and ponds) with *Arctophila* and all water bodies without *Arctophila* (Mann-Whitney U-test, Appendix Table C-1). This held true whether use was averaged over the entire summer or separated into the 4 2-wk observational periods.

Waterfowl

Waterfowl observed included ducks, geese, and swans. Comparisons of their levels of use and behavior on ponds and impoundments with *Arctophila* and those without *Arctophila* follow as presented above for all birds.

Impoundments vs. Ponds. On impoundments as a whole, there were on average about 1.5 times as many species of waterfowl observed per 2-hr interval as on ponds (Fig. 52). The average number of individuals seen per 3-min period was also somewhat higher on impoundments.

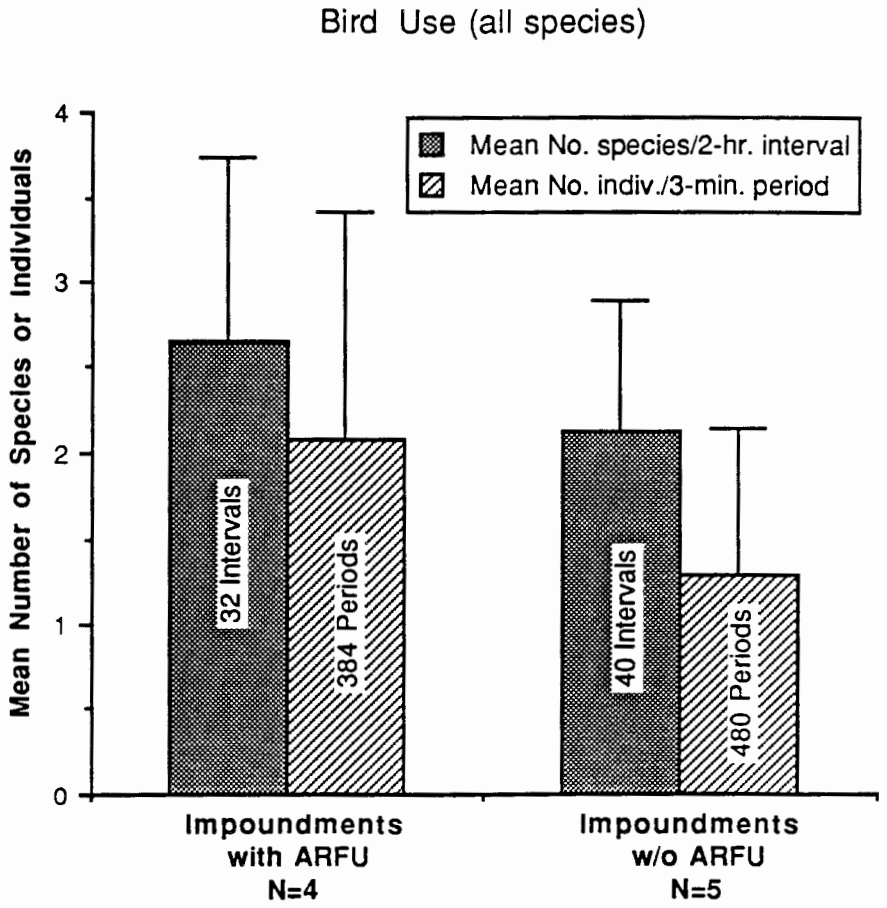


Fig. 48. Observed use by birds (all species combined) of impoundments with *Arctophila fulva* (ARFU) compared with their use of impoundments without ARFU, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-27.)

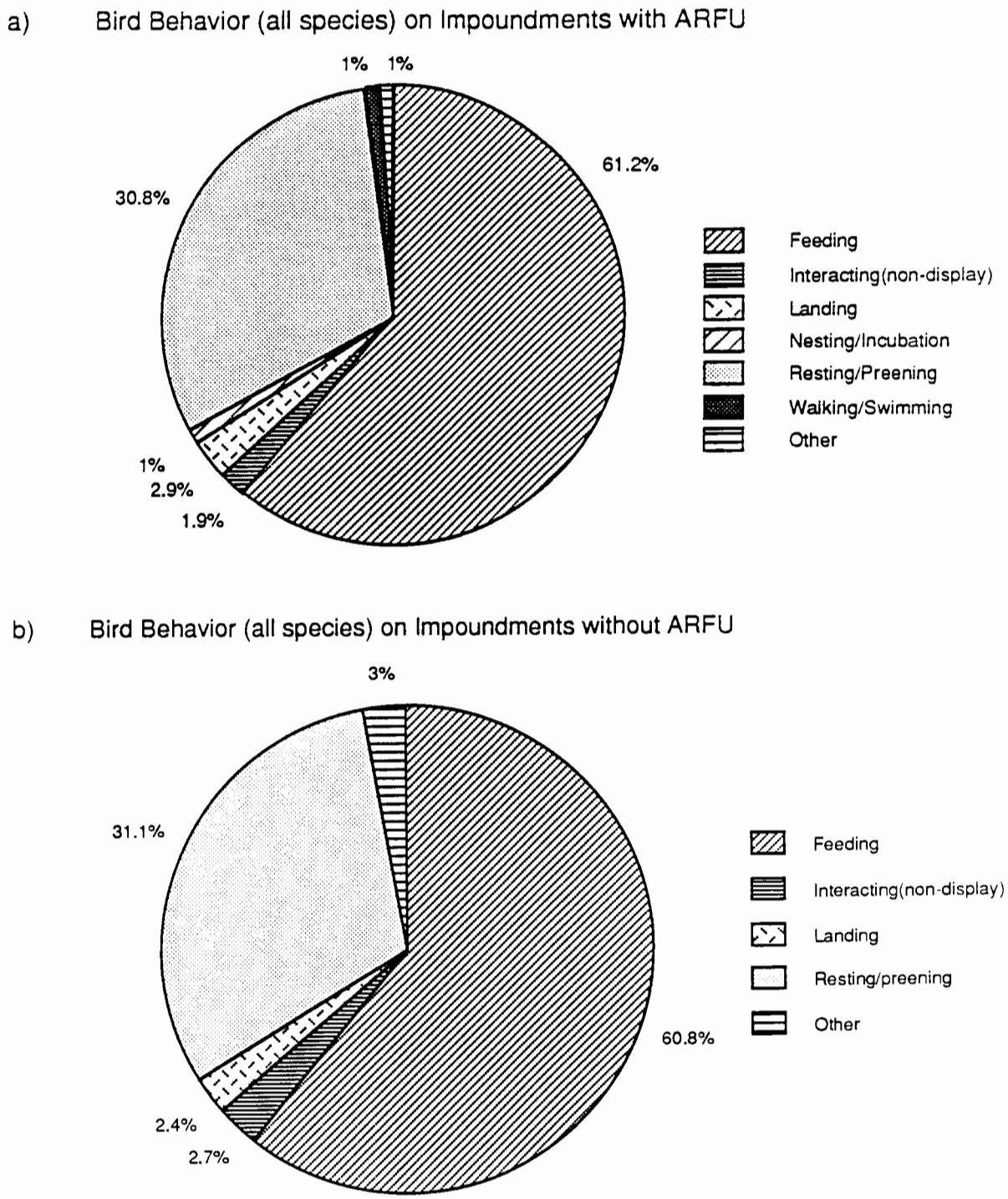


Fig. 49. Observed behavior by birds (all species combined) on impoundments with Arctophila fulva (ARFU) compared with their behavior on impoundments without ARFU, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions af all birds observed that were engaged in the specified activity when first observed.

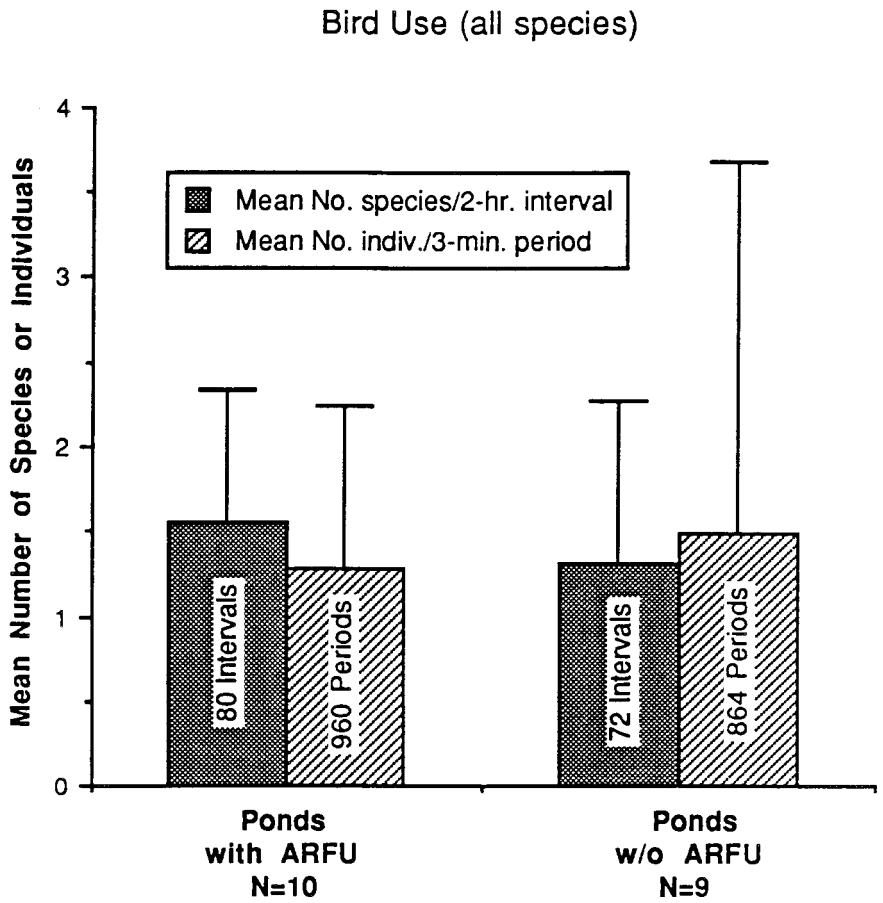


Fig. 50. Observed use by birds (all species combined) of ponds with *Arctophila fulva* (ARFU) compared with their use of ponds without ARFU, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-28.)

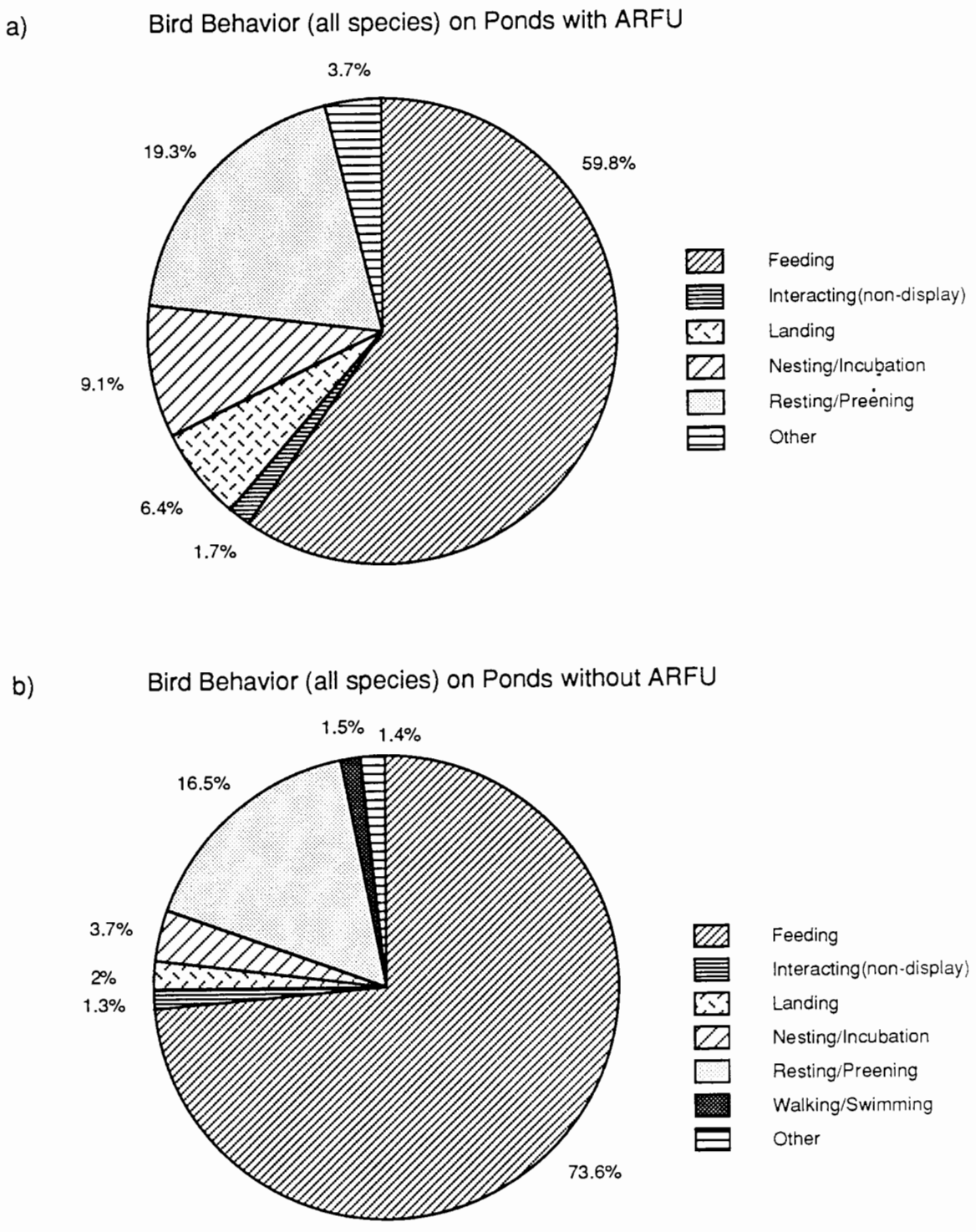


Fig. 51. Observed behavior by birds (all species combined) on ponds with Arctophila fulva (ARFU) compared with their behavior on ponds without ARFU, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all birds observed that were engaged in the specified activity when first observed.

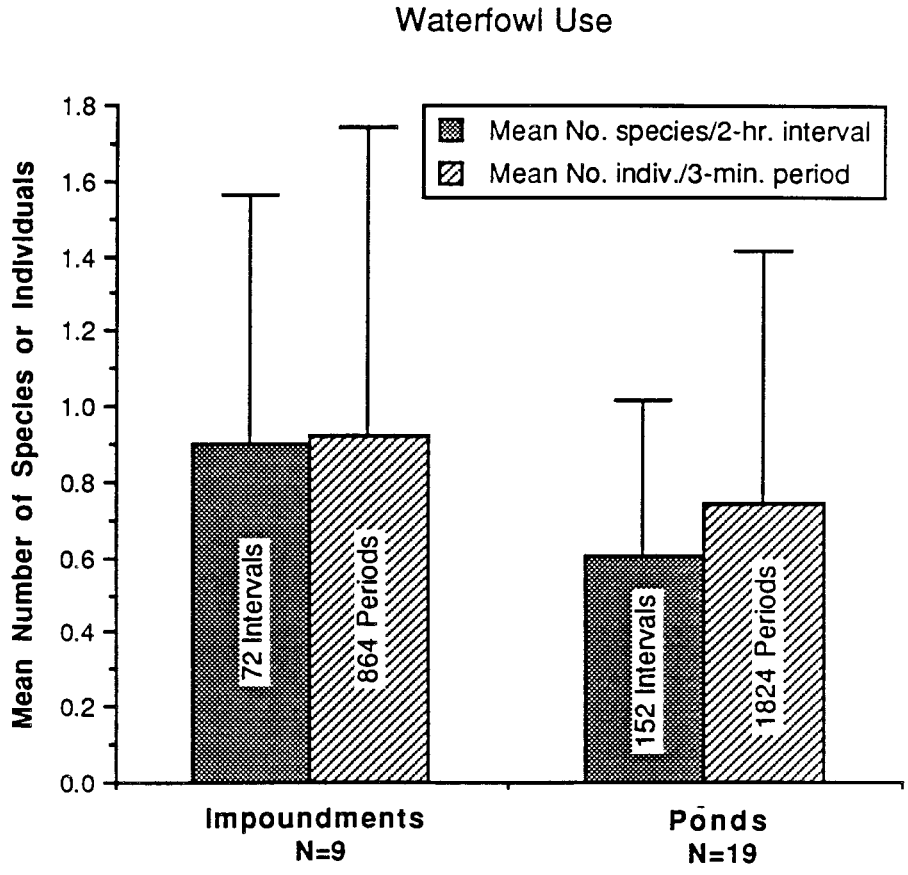


Fig. 52. Observed use by waterfowl of impoundments compared with their use of natural ponds, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-29.)

Feeding was the major activity exhibited by waterfowl on both types of water bodies, comprising about 58% of all behavior observed for both site types (Fig. 53). The proportion of time waterfowl spent resting or preening was somewhat higher on impoundments than on ponds, and waterfowl were observed nesting or incubating much more of the time on ponds than on impoundments.

Impoundments w/*Arctophila* vs. Ponds w/*Arctophila*. Impoundments with *Arctophila* were used by more waterfowl species and by more individuals than ponds with *Arctophila*. On average, almost twice as many species were seen per 2-hr interval on impoundments with *Arctophila* than on ponds with *Arctophila* (Fig. 54). The average number of individuals seen per 3-min period on impoundments with *Arctophila* was approximately 1.5 times greater than on ponds that contained this grass.

Feeding was the dominant behavior displayed by waterfowl on those water bodies that contained *Arctophila*; approximately 60% of the total observed behavior on both site types involved feeding activity (Fig. 55). Waterfowl spent a higher percentage of their time resting or preening on impoundments with *Arctophila* than on ponds with *Arctophila*, but the opposite was true for time spent nesting or incubating.

Impoundments w/*Arctophila* vs. Impoundments w/o *Arctophila*.

Impoundments with *Arctophila* were used by waterfowl to a greater extent than were impoundments without *Arctophila* (Fig. 56). On impoundments with *Arctophila*, the average number of species observed per 2-hr interval was twice that observed on impoundments without *Arctophila*. The average number of individuals seen per 3-min period on impoundments with *Arctophila* was about 2.5 times that observed on impoundments without *Arctophila*.

As with previous comparisons, there was a negligible difference between site types in the proportion of time waterfowl spent feeding (Fig. 57). However, slightly more time was spent resting or preening on impoundments without *Arctophila* than on impoundments with *Arctophila*. The diversity of activities in which waterfowl were engaged was greater on impoundments with *Arctophila*.

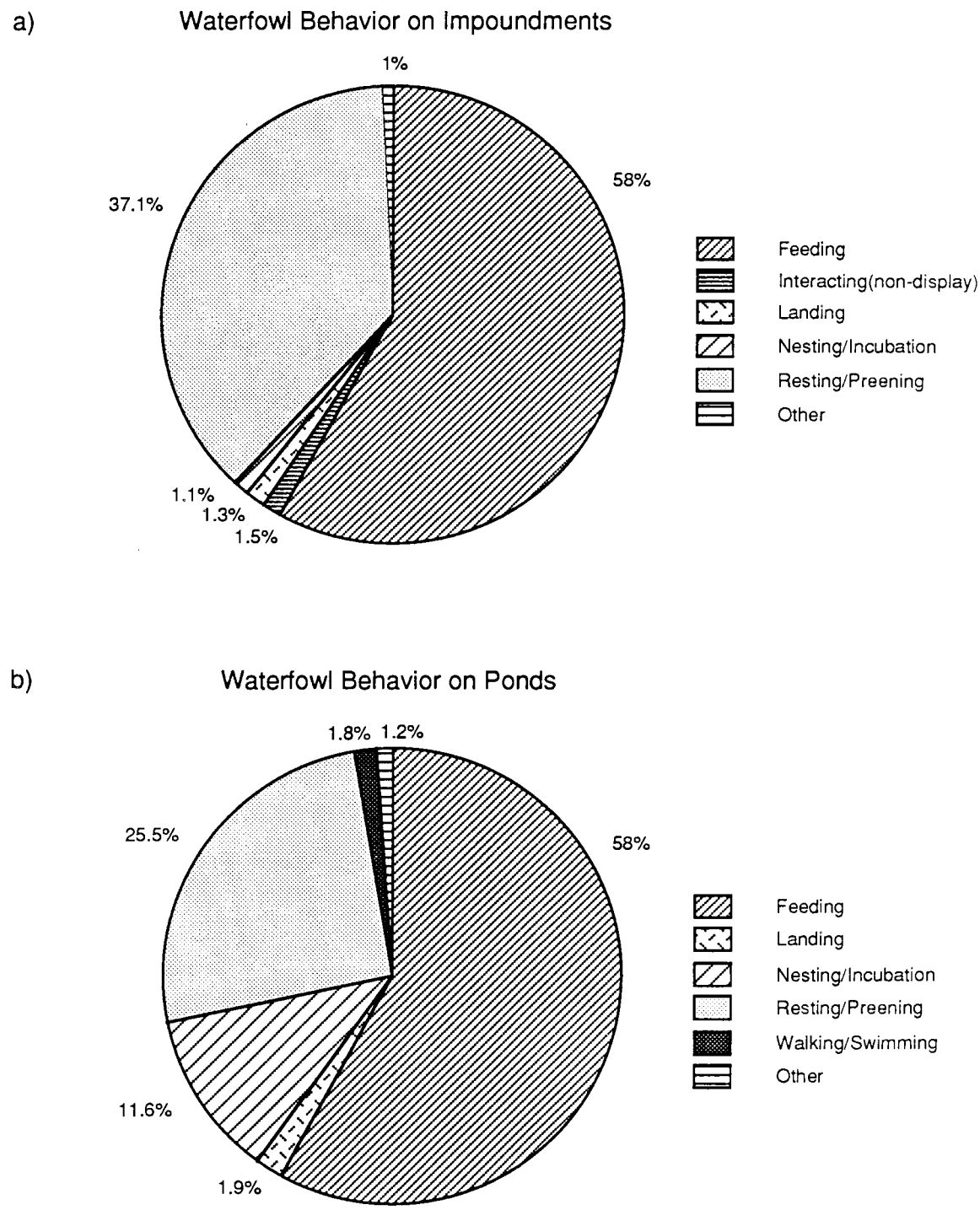


Fig. 53. Observed behavior by waterfowl on impoundments compared with their behavior on natural ponds, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all waterfowl observed that were engaged in the specified activity when first observed.

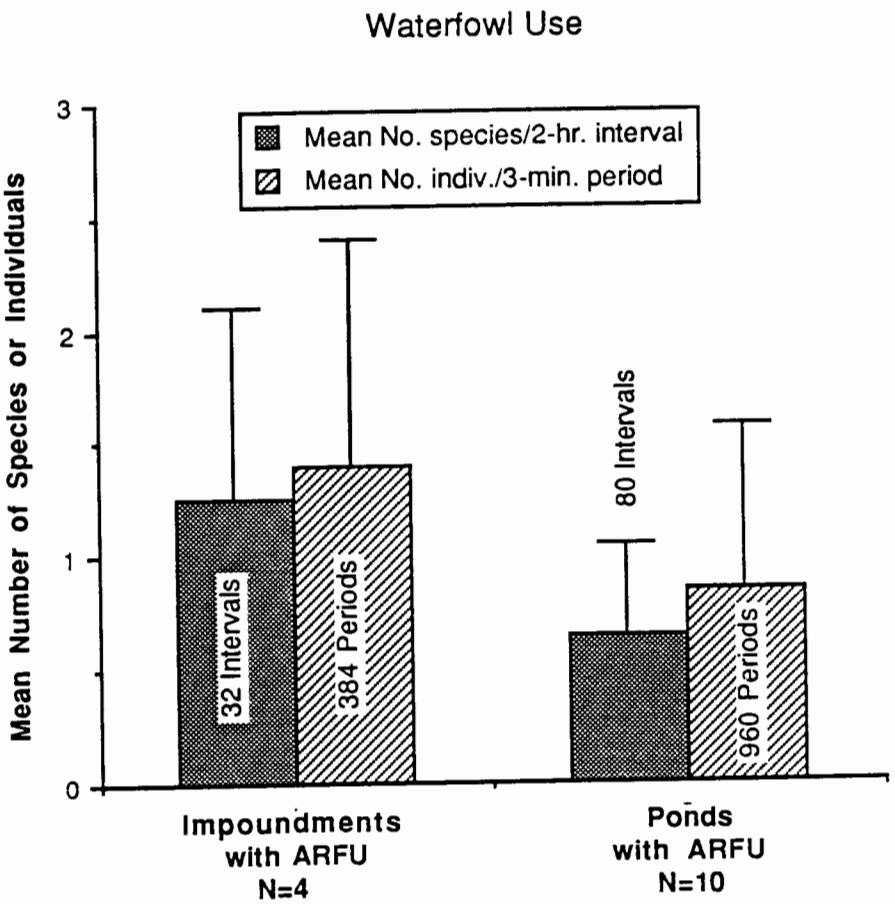


Fig. 54. Observed use by waterfowl of impoundments with *Arctophila fulva* (ARFU) compared with their use of ponds with ARFU, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-30.)

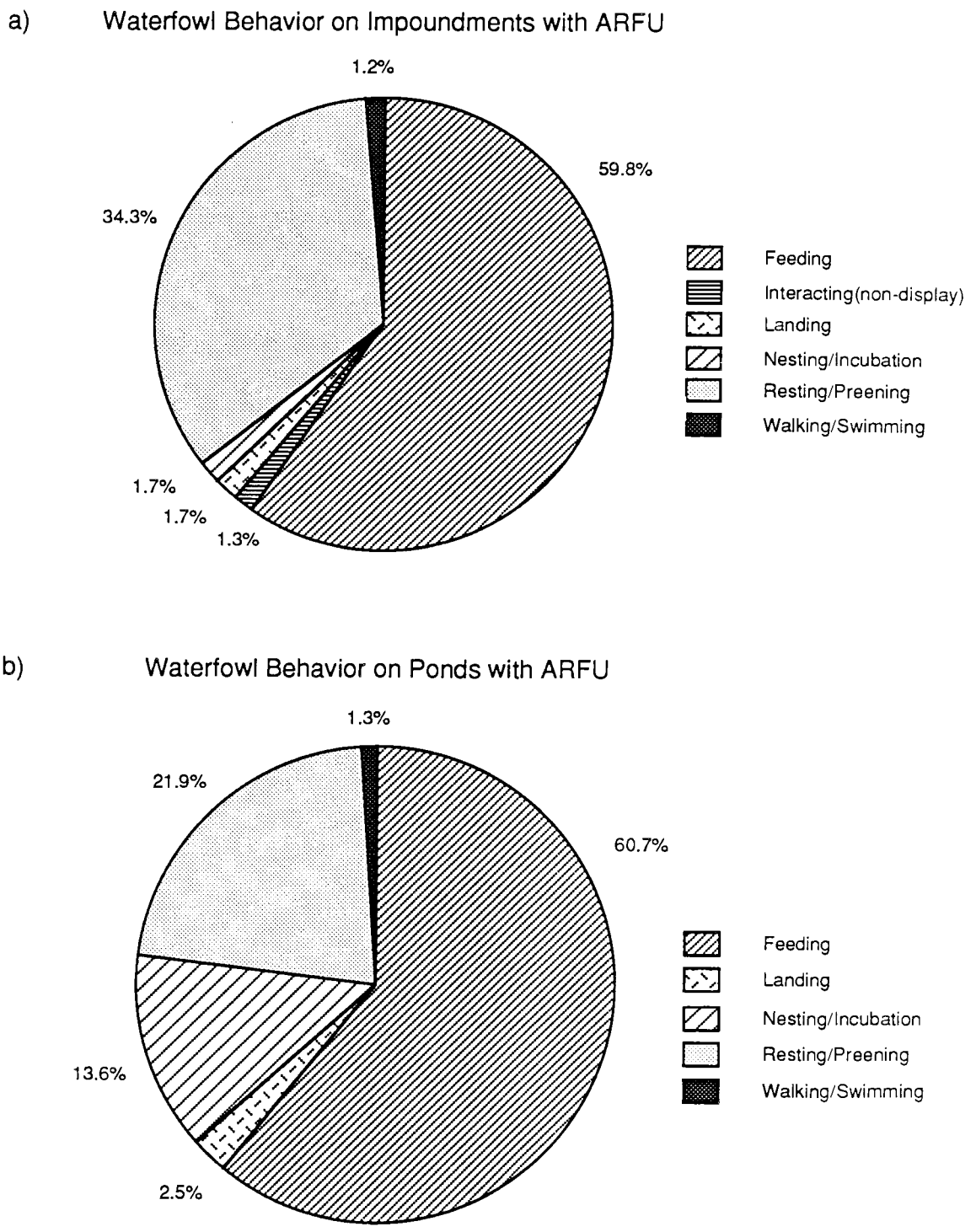


Fig. 55. Observed behavior by waterfowl on impoundments with Arctophila fulva (ARFU) compared with their behavior on ponds with ARFU, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all waterfowl observed that were engaged in the specified activity when first observed.

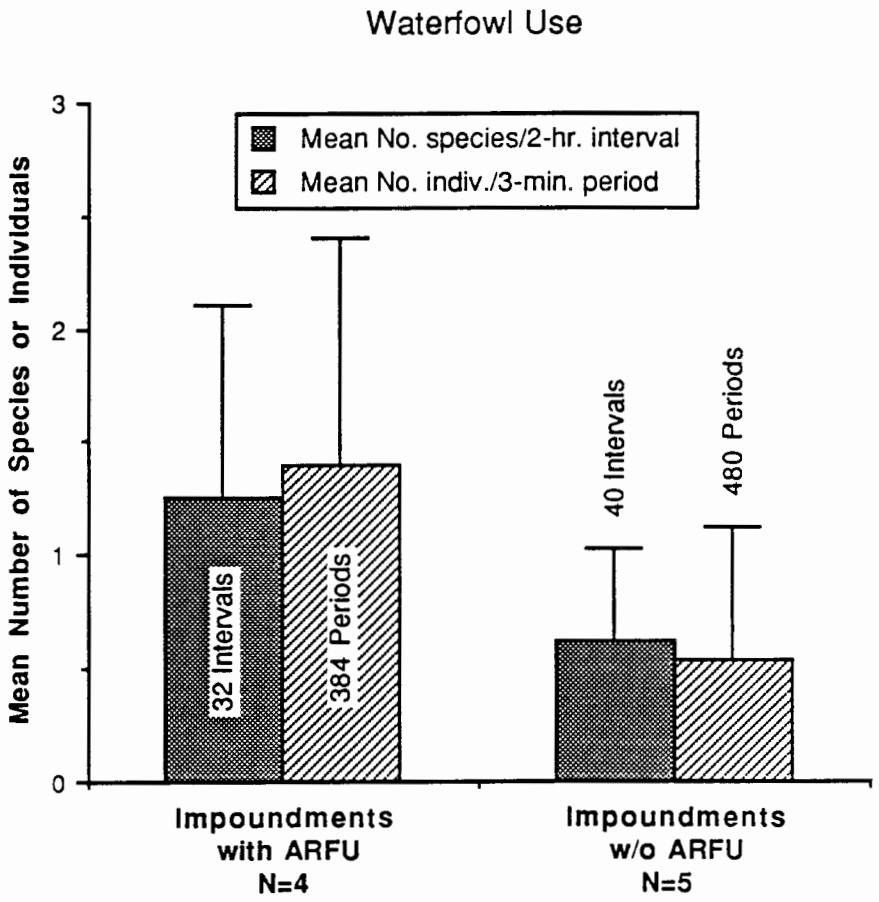


Fig. 56. Observed use by waterfowl of impoundments with *Arctophila fulva* (ARFU) compared with their use of impoundments without ARFU, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-31.)

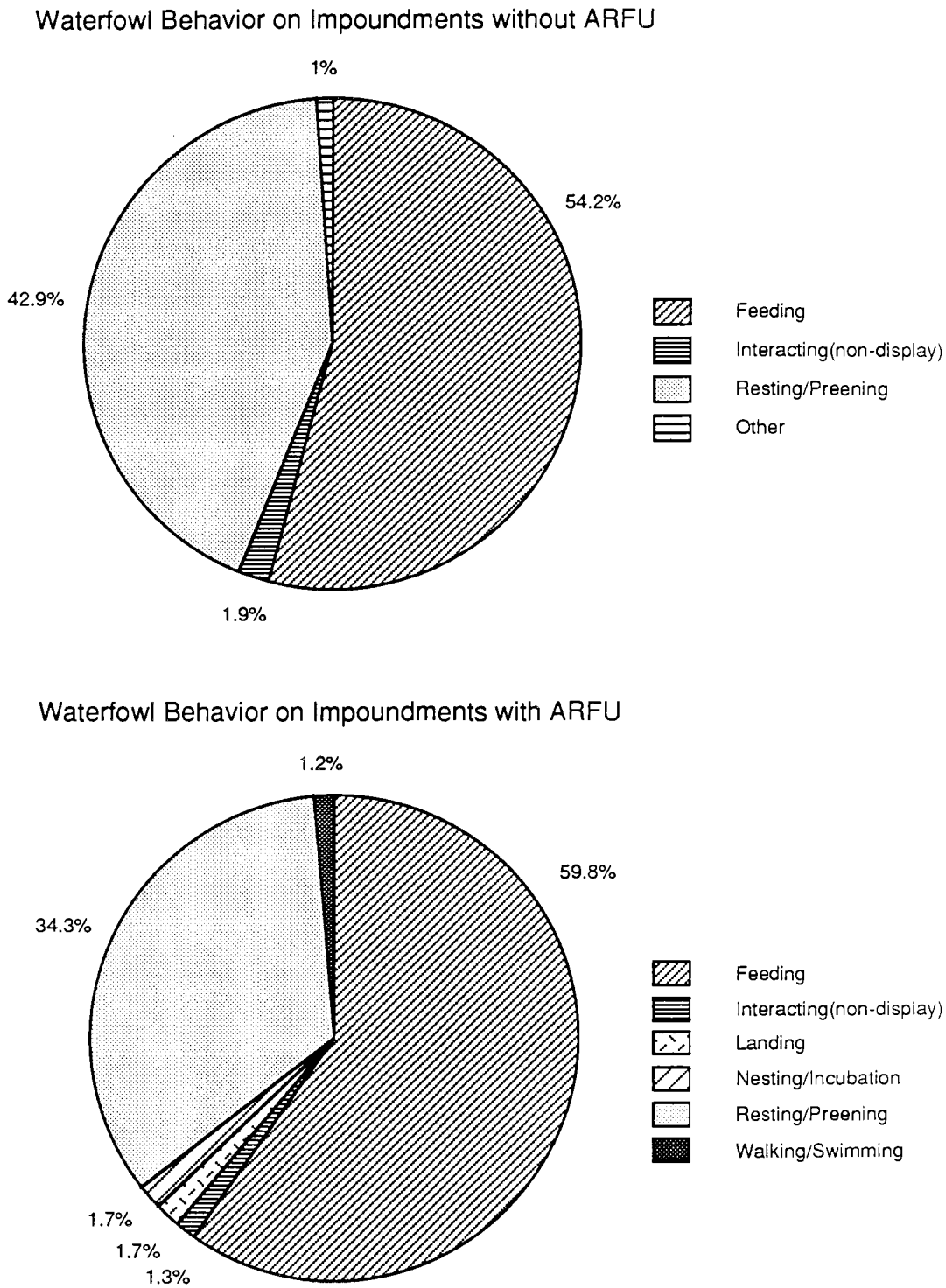


Fig. 57. Observed behavior by waterfowl on impoundments with Arctophila fulva (ARFU) compared with their behavior on impoundments without ARFU, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all waterfowl observed that were engaged in the specified activity when first observed.

Ponds w/*Arctophila* vs. Ponds w/o *Arctophila*. The average number of waterfowl species observed using each pond type was comparable between ponds with *Arctophila* and those without (Fig. 58). In contrast, ponds with *Arctophila* were visited by more individuals per 3-min period than were ponds without *Arctophila*. Feeding, landing, and nesting or incubating activities were more common on ponds with *Arctophila*, but walking or swimming and resting or preening were more common on ponds without *Arctophila* (Fig. 59).

DISCUSSION

Gravel Sites

Clearly, abandoned gravel drilling pads are used by both birds and mammals. How confident are we that the observed levels and comparisons of use accurately reflect reality? Are there clear patterns to or causes for the uses observed, and do they reflect what other observers have found?

When we compared levels of animal use between gravel pads and natural habitats, we found a few statistically significant differences between the two habitat types. In all cases in which differences were statistically significant, gravel pads received higher mean levels of use than natural habitats. In other cases as well, there were often appreciable (though not statistically significant) differences in mean levels of use, and likewise in these cases the gravel pads received higher levels of use than did natural habitats.

The application and meaning of statistical tests in this study need discussion. This first year's studies were not designed as rigorous tests for specific relationships or differences, but rather to examine a broad array of possible influences on animal use. Thus, there was high variability among samples, and several relationships or differences we examined this year that were not statistically significant may prove to be so when tested by more tightly controlled experiments.

A few factors clearly contributed to the high variability among samples. For example, large temporal variation in levels of animal use were common, but in most of our analyses we typically lumped data from all 4 time periods (i.e. 15-30 June, 1-15 July, 16-31 July, 1-15 August) and thus probably introduced more variability than if each time of year had been tested separately. Also, there were

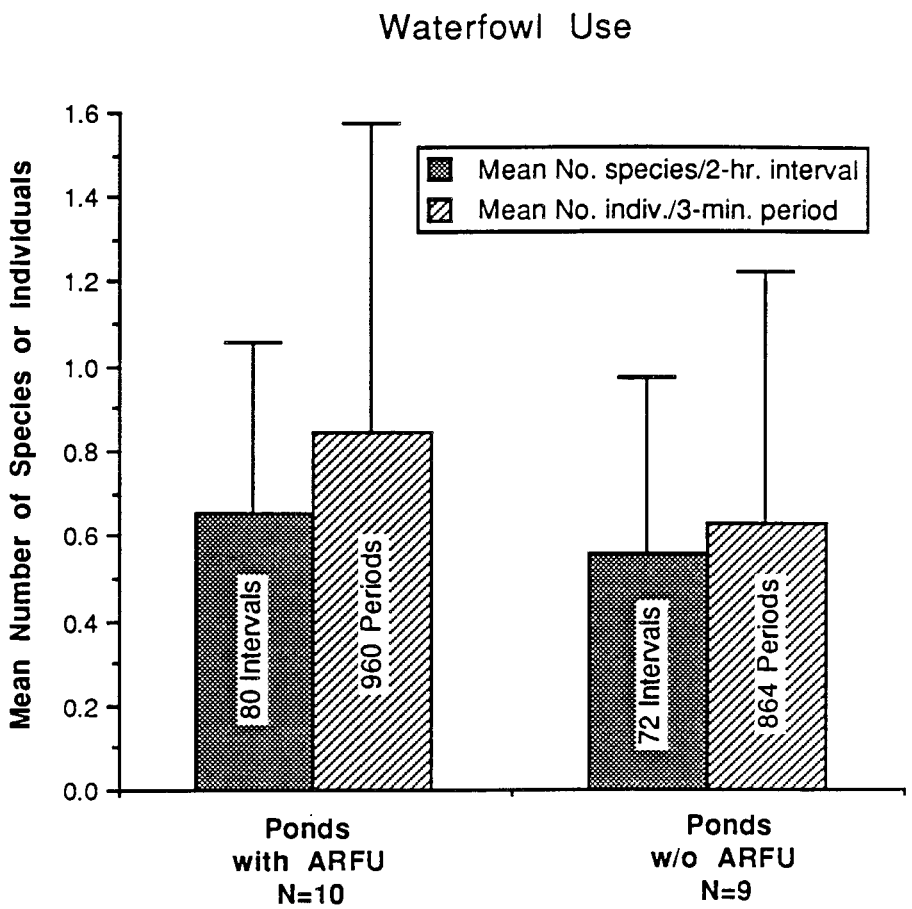


Fig. 58. Observed use by waterfowl of ponds with *Arctophila fulva* (ARFU) compared with their use of ponds without ARFU, Arctic Coastal Plain, Alaska. Error bars extend 0.5 standard deviations above means. (For further information on data variability, see Appendix C, p. C-32.)

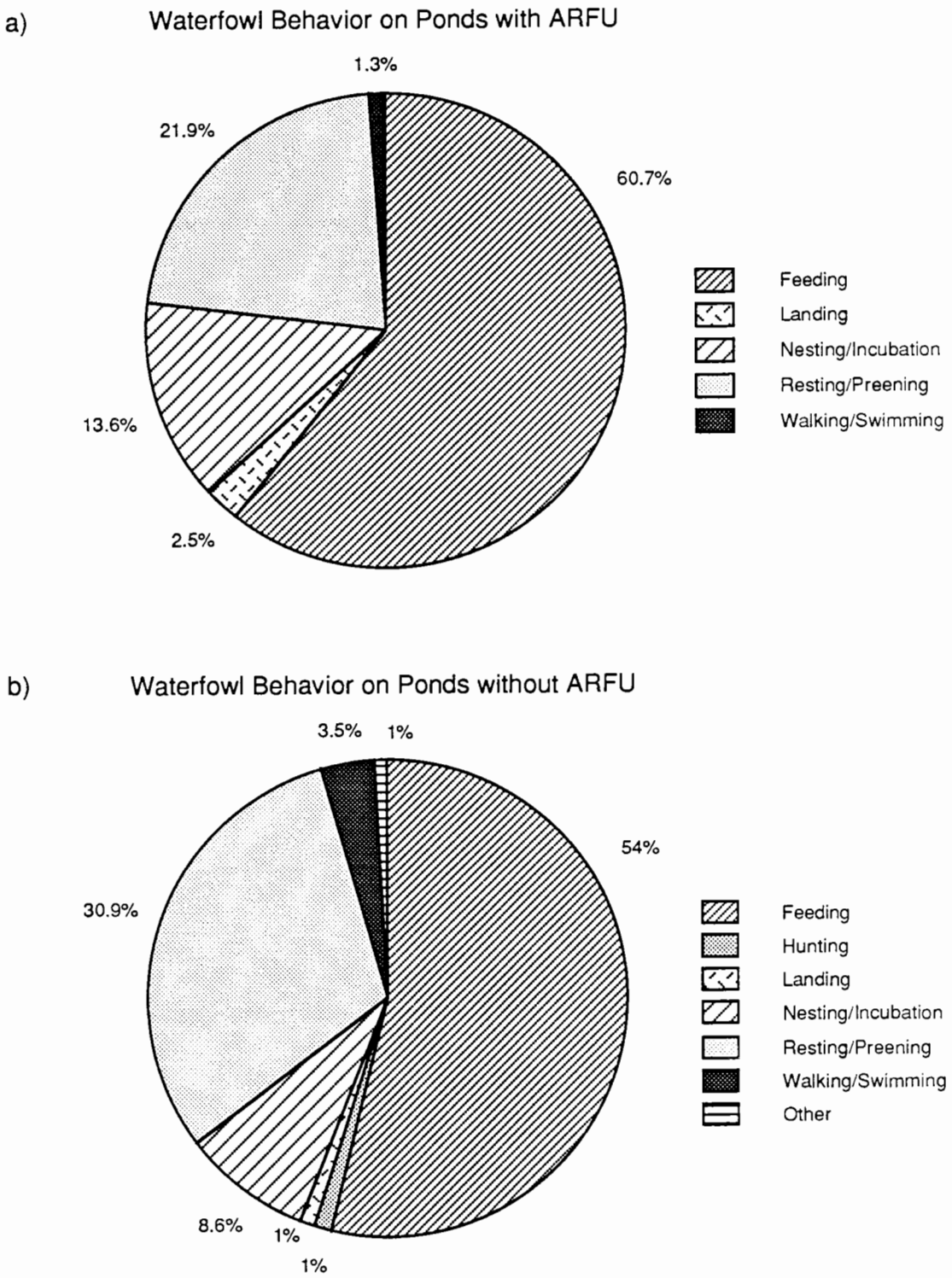


Fig. 59. Observed behavior by waterfowl on ponds with Arctophila fulva (ARFU) compared with their behavior on ponds without ARFU, Arctic Coastal Plain, Alaska. Percentages (a, b) represent proportions of all waterfowl observed that were engaged in the specified activity when first observed.

large variations in biophysical qualities of gravel pads, and birds and mammals responded to some of these differences; thus tests made by lumping data from all pads were weakened. Finally, distributions of some species were spatially patchy, which would have required large sample sizes under any circumstances to validly test for differences or relationships.

When analyzing levels of animal use, we designated mean numbers of species or individuals observed per unit time as the points of comparison. We evaluated levels of use within 5 animal groups: all birds, waterfowl, Lapland Longspur, all mammals, and caribou. Different patterns in levels of use appeared, depending on the group evaluated and several biophysical habitat factors.

When all bird species were combined, numbers of both species and individuals observed per unit time were greater on gravel pads than in natural habitats. With respect to comparisons between pads and undisturbed tundra, poorer visibility on the tundra plots may have accounted for some of this difference, but searches of the tundra plots made routinely after each observation bout suggested that invariably few birds escaped being seen on these plots despite the vegetative cover. With respect to river alluvium, described by some authors as a natural "analog" to gravel fill (Bishop and Chapin 1989), the alluvium attracted fewer species and far fewer individuals than did pads. There was equal (or better) visibility on the alluvium than on pads, and the large observed differences between the two were therefore relatively unbiased.

The presence of water on pads (usually in reserve pits or flare pits) was a major factor contributing to the attractiveness of the pads to birds. When water was absent, Lapland Longspurs were the only birds to commonly use the pads. When water was present, numbers of waterfowl and shorebirds using the pads increased; these two groups probably used gravel pads primarily because of the water bodies associated with them.

When all birds were considered, the extent of vegetative cover seemed to have little effect on the average level of use. But Lapland Longspurs (the most abundant species) clearly used vegetated pads more heavily than they used unvegetated ones. It is likely that the effects of water on pads masked the effects of vegetation when all uses were not separated by species or group.

Feeding by birds (all species combined) seemed to be more common on pads than on tundra, but breeding activities were greater on tundra. However, there were a few instances of bird species that were not present in adjacent tundra nesting on gravel pads.

Most of the mammal species seen (caribou, arctic fox, arctic ground squirrel) were essentially as visible on tundra as they were on gravel pad and alluvial sites. The one exception was lemmings, which were extremely difficult to see in vegetated areas. Few were seen on either gravel substrates or tundra, but it is likely that most in tundra sites went undetected. Thus, the data we collected more nearly represent the use patterns of mammals other than lemmings than they reflect use by all species.

Use by mammals resembled that of birds in that, when observations of all mammal species were combined, the levels of their use of gravel pads generally exceeded their use of natural sites. Both the numbers of species and the numbers of individuals seen on pads were substantially greater than on tundra; only the number of individuals was greater on pads when compared with alluvium.

Time spent feeding and hunting by mammals tended to be proportionally greater on undisturbed tundra and alluvium sites than on pads, and resting was more common on pads. The large amount of resting on pads was largely attributable to the behavior of caribou, the most commonly observed mammal.

The level of use of gravel pads by mammals seemed generally unaffected by the extent of vegetative cover or by water associated with the pads, with the exception that many more individuals used unvegetated pads than used vegetated ones. The frequent use of unvegetated pads for resting by caribou was apparently the major contributor to this difference. Why caribou rested on unvegetated pads more than vegetated ones is unclear; it is possible that unvegetated pads (which tended to be thicker than vegetated pads) might have offered better relief from insect harassment. These pads lack the vegetative substrate that might provide habitat for insects such as mosquitos.

Several trends in the uses of gravel pads by birds and mammals were apparent; however, there was large seasonal variability in overall level of use, particularly with respect to birds. Level of use (measured by numbers of

individuals per 3 min period) on gravel pads was dominated by one species of bird (e.g., Lapland Longspur) and one mammal (e.g., caribou). Mean level of use per unit time, measured either as total number of species or total number of individuals, tended to be higher on gravel pads than on river alluvium or on undisturbed tundra and to be affected by the presence of water (in the case of birds) and less so by vegetative cover. In general, both birds and mammals on pads spent relatively large proportions of their time feeding or resting; birds on undisturbed tundra spent large proportions of time in breeding activities (e.g. nesting, displaying, etc.).

The available literature offers at least some information, mostly from anecdotal observations, that we can compare with what we found (See Table 1). A few bird species, such as Baird's Sandpiper and Snow Bunting have been found by others to selectively nest in disturbed sites such as around gravel fill, though most species avoid gravel for nesting (Wright and Fancy 1980, Troy and Carpenter 1989). Robus et al. (1986) reported that most bird species avoided gravel and used nearby habitats more, but they saw Lapland Longspurs commonly alighting or perching on gravel. In our study, longspurs were frequently observed perching on elevated structures on gravel pads (e.g. well-heads, pilings, gravel mounds) and were also observed feeding on gravel pads.

Geese and caribou have been commonly observed feeding on vegetated gravel pads, sometimes in preference to undisturbed tundra (Jorgenson 1989a,b). We also documented similar activity using time-lapse video-photography. Kiera (1979) observed Brant feeding on the seed-heads of *Braya purpurascens* on disturbed areas, such as old roads, around Prudhoe Bay. Caribou use of gravel roads for travel corridors, and road beds and pads for insect relief, has been commonly observed (Roby 1978, Hanson 1981, Dames and Moore 1986, McKendrick 1986, Johnson and Lawhead 1989, Jorgenson 1989b, LGL pers. obs.).

In summary, our results indicate that both birds and mammals use gravel pads, often in greater numbers and kinds of species than use habitats undisturbed by man. Further, some species under some circumstances use them more commonly for the life-support function of feeding than they use habitats not disturbed by man, though birds tend to use them less for the life-support function of nesting. The use patterns that are beginning to emerge have important implications for impact assessment and mitigation planning.

Impoundments and Ponds

The results of our observations suggest that there is a great deal of similarity between bird use of impoundments and bird use of natural ponds, though some differences probably exist. Did our intensity of sampling give us much confidence that the mean levels of use we found are accurate? Exactly how are impoundments different from natural water bodies in how birds use them?

Our data do not provide a complete picture of impoundment use, for several reasons. First, we selected for observation those impoundments that retained water throughout summer. These are undoubtedly not representative of all impoundments in oil development areas, for as Walker et al. (1987b:30) point out, many impoundment areas are ephemeral and drain by midsummer. Second, there was considerable variation among impoundments in their size, amount of emergent vegetation, and other biophysical qualities (as there was in ponds). Third, as we saw for animal use of gravel pads, our sampling was designed to look for potential effects on bird use of several different factors, thus the statistical confidence we have in any one of the several relationships examined is not great.

We compared several aspects of bird use of impoundments with their use of ponds, but found no statistical differences between the two in any of the cases. There well may have been some real differences as suggested by differences in mean use; these will have to be tested by more focused studies. As with our analyses of wildlife use of gravel pads, we designated mean numbers of bird species or individuals per unit time as the basis for assessing levels and types of use.

When we compared mean numbers of all birds seen (i.e. levels of use) on impoundments with those seen on ponds, more species and individuals typically used impoundments. This was generally true whether comparisons were between all impoundments and all ponds or between only those impoundments and ponds with *Arctophila fulva*. The presence of *Arctophila* seemed to make little difference in levels of bird use in ponds, but more individual birds used impoundments with *Arctophila* vs. those without.

There were similarities as well as differences between impoundments and ponds in the proportions of time birds were engaged in various activities. Birds fed an equal proportion of time in impoundments and ponds, but rested or preened more on impoundments and nested more commonly on ponds. The status of *Arctophila* in impoundments made little difference in how the birds used the impoundments, with the exception that birds fed and nested more on ponds with *Arctophila* than on ponds without.

With respect to levels of use by waterfowl only, impoundments again attracted more species and individuals than did ponds. Generally, more waterfowl species and individuals used water bodies with *Arctophila* (whether the water bodies were impoundments or ponds) than used those without, except in one case: the presence or absence of *Arctophila* made little difference in the number of individual waterfowl that used ponds.

Mean levels of use, whether by all birds or by waterfowl only, tended to be greater on impoundments than on natural ponds. Foraging activities (by all birds as well as by waterfowl alone) dominated the observation periods on both ponds and impoundments, and there was little difference between ponds and impoundments in the proportion of time spent foraging. Birds rested and preened proportionally more on impoundments and nested or incubated more on ponds. Whether *Arctophila* was present or absent in impoundments had little influence on behavior, but when *Arctophila* was present in ponds more time was spent feeding (presumably on aquatic invertebrates) and nesting than on other activities.

There is little in the existing literature that allows us to compare bird use between impoundments and ponds. However, several authors, notably Troy (1982, 1985), documented bird use of impoundments (See Table 2). Not all of the results of these studies can be compared with our data without qualification, because of between-study differences in impoundment type, permanence, and location; and because of differences in how bird use was measured.

Some comparisons, however, seem warranted. As our data suggest, impoundments often have been observed by others to attract feeding shorebirds and waterfowl (Troy 1982, 1985; Robus et al. 1986). Nesting shorebirds of several

species may tend to avoid the vicinities of impoundments (Troy 1982, 1985), which is not surprising considering that fluctuating water levels in many impoundments (See BACKGROUND AND RATIONALE, this report) could prevent birds from successfully nesting near or in impoundments. Some species of waterfowl and shorebirds, after nesting is finished, seem to prefer feeding in impoundments rather than in natural water bodies (Troy 1985). More study will be needed to confirm whether or not, and why, impoundments provide better feeding habitat for some species than do ponds.

CONCLUSIONS

General conclusions with respect to the use of abandoned gravel drilling pads and impoundments by wildlife are as follows:

- Abandoned gravel drilling pads are used commonly by birds and mammals. In our study numbers of species and individuals using gravel pads were actually higher than those on adjacent tundra in most cases. Further, the kinds of uses were not always inconsequential; animals often fed on vegetation growing on gravel pads and birds even sometimes nested on gravel.

- The species of animals using pads, and the amount and kind of use seemed dependent, to some extent, on the presence of water, the amount of vegetative cover, and the presence of various structures on the pads. However, some species (e.g. Lapland Longspur, caribou) often used rather barren, waterless pads.

- The use of impoundments by birds was not much different from their use of ponds. Birds seemed to feed somewhat more in impoundments, but may have nested less there than in ponds. In terms of bird use, impoundments may function much the same as ponds in many ways.

- There was considerable variability in animal use among both the gravel pads and the impoundments studied. This variability, coupled with seasonal variability in use, made statistical comparisons between disturbed

and undisturbed sites difficult. But even so, some tests (e.g. comparing gravel with tundra) showed that levels of use of the disturbed habitats were significantly greater than those of the undisturbed habitats; none showed the converse.

LITERATURE CITED

Alexander, V., and M. C. Miller. 1978. Effects of the pipeline haul road on nearby ponds and lakes across Alaska's north slope. Unpublished annual progress report, U.S. Energy Research and Development Admin. Rep. No. RLO-2229-T9-2. 51pp.

Bergman, R. D., R. L. Howard, K. F. Abraham, and M. W. Weller. 1977. Water birds and their wetland resources in relation to oil development at Storkersen Point, Alaska. USDI Fish & Wildl. Serv. Resource Publ. No. 129, Washington, D.C.

Bishop, S. C., and F. S. Chapin, III. 1989. Patterns of natural revegetation on abandoned gravel pads in arctic Alaska. J. Applied Ecology 26 (In Press).

BP (BP Exploration [Alaska] Inc.). 1989. Alaska wetlands and energy development. Report by Environment/Regulatory Affairs Dept., BP Exploration (Alaska) Inc., Anchorage. 28pp.

Brown, J., and N. A. Grave. 1979. Physical and thermal disturbance and protection of permafrost. CRREL Rep. SR79-5. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH. 43pp.

Brown, J., B. E. Brockett, and K. E. Howe. 1984. Interaction of gravel fills, surface drainage, and culverts with permafrost terrain. CRREL Rep. No. 84-11. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH.

Conover, W. J. 1980. Practical nonparametric statistics. Second ed. Wiley, New York, NY. 493pp.

Dames and Moore. 1986. Kuparuk rehabilitation studies. Final report to ARCO Alaska, Inc., Anchorage, by Dames and Moore, Anchorage, Alaska.

Derksen, D. V., T. C. Rothe, and W. D. Eldridge. 1981. Use of wetland habitats by birds in the National Petroleum Reserve, Alaska. USDI Fish & Wildl. Serv. Resour. Publ. No. 141. Washington, D.C.

Eberhardt, L. E., W. C. Hanson, J. L. Bengston, R. A. Garrett, and E. E. Hanson. 1982. Arctic fox home range characteristics in an oil-development area. J. Wildl. Manage. 46:183-190.

Epps, A. C. 1988. Can national wetland / mitigation legislation apply to Alaska? If not, why not? P. 291-293. In: J. A. Kusler and M. C. Quammon (eds.) Proc. National Wetlands Symp: Mitigation of Impacts and Losses. Assoc. State Wetland Managers, Inc., Berne, NY. 460 pp.

Everett, K. R., B. M. Murray, D. F. Murray, A. W. Johnson, A. E. Linkeur and P. J. Webber. 1985. Reconnaissance observations of long-term natural vegetation recovery in the Cape Thompson region, Alaska, and additions to the checklist of flora. CRREL Rep. No. 85-11. U.S. Army Cold Regions Research and Engineering Laboratory. Hanover, NH. 76pp.

FWS (USDI Fish and Wildlife Service). 1981. U.S. Fish and Wildlife Service Mitigation Policy. Fed. Reg. 46(15):7644-7663. Washington, D. C.

FWS (USDI Fish and Wildlife Service). 1989. Technical guidance to U.S. Army Corps of Engineers on revision of Abbreviated Processing Procedure. 30pp.

Hanley, P. T., J. E. Hemming, J. W. Morsell, T. A. Morehouse, L. E. Leask, and G. S. Harrison. 1981. Natural resource protection and petroleum development in Alaska. USDI Fish & Wildl. Serv. Biol. Serv. Program Rep. FWS/OBS-80/22, Washington, D.C.

Hanson, W. C. 1981. Caribou (Rangifer tarandus) encounters with pipelines in northern Alaska. Can. Field-Nat. 95: 57-62.

Hemming, C. R. 1988. Aquatic habitat evaluation of flooded north slope gravel mine sites (1986-1987). Alaska Dept. of Fish and Game Tech. Report No. 88-1.

Johnson, A. W., B. M. Murray, and D. F. Murray. 1978. Floristics of the disturbances and neighboring locales. P. 30-40. In: D. E. Lawson, J. Brown, K. R. Everett, A. W. Johnson, V. Komarkova, B. M. Murray, D. F. Murray and P. J. Webber (eds.). Tundra disturbances and recovery following the 1949 exploratory drilling, Fish Creek, northern Alaska. CRREL Report No. 78-28. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH.

Johnson, C. B., and B. E. Lawhead. 1989. Distribution, movements, and behavior of caribou in the Kuparuk Oilfield, summer, 1988. Report by Alaska Biological Research, Inc., Fairbanks, Alaska to ARCO Alaska, Inc., Anchorage.

Jorgenson, M. T. 1988a. Rehabilitation studies in the Kuparuk Oilfield, Alaska, 1987. Report to ARCO Alaska, Inc., and Kuparuk River Unit, Anchorage, by Alaska Biological Research, Inc., Fairbanks, Alaska.

Jorgenson, M. T. 1988b. Revegetation of the Lake State 1 exploratory well site, Prudhoe Bay Oilfield, Alaska, 1987. Report to ARCO Alaska, Inc., and Kuparuk River Unit, Anchorage, by Alaska Biological Research, Inc., Fairbanks, Alaska.

Jorgenson, M. T. 1989a. Rehabilitation studies in the Kuparuk Oilfield, Alaska, 1988. Report to ARCO Alaska, Inc., and Kuparuk River Unit, Anchorage, by Alaska Biological Research, Inc., Fairbanks, Alaska.

Jorgenson, M. T. 1989b. An overview of rehabilitation research in the Kuparuk Oilfield. Report to ARCO Alaska, Inc., and Kuparuk River Unit, Anchorage, Alaska, by Alaska Biological Research, Inc., Fairbanks.

Klinger, L. F., D. A. Walker, M. D. Walker, and P. J. Webber. 1983. The effects of a gravel road on adjacent tundra vegetation. In: Prudhoe Bay Waterflood Project, environmental monitoring program, 1982. U.S. Army Corps of Engineers, Alaska District, Anchorage.

McKendrick, J. D. 1986. Recording of tundra plant responses. Vol. III. In: Final wellsite cleanup on National Petroleum Reserve-Alaska. Report by Nueva Reclamation Company, Inc. to U.S. Geological Survey, Office of the National Petroleum Reserve in Alaska. Contract No. 14-08-001-21787.

McKendrick, J. D. 1990. *Arctophila* feasibility study, 1989 annual report. Report by University of Alaska, Fairbanks, to BP Exploration (Alaska), Inc., Anchorage.

Meehan, R. Undated. Oil development in northern Alaska: a guide to the effects of gravel placement on wetlands and waterbirds. U.S. Environmental Protection Agency, Environmental Research Lab., Corvallis, Oregon.

Robus, M. A., S. M. Murphy, R. M. Burgess, and B. A. Anderson. 1986. Natural revegetation and bird use of three disturbed sites in the Kuparuk Oilfield, Alaska, 1985. Report to ARCO Alaska, Inc., Anchorage, by Alaska Biological Research, Fairbanks, Alaska. 75pp.

Roby, D.D. 1978. Behavioural patterns of barren-ground caribou of the Central Arctic herd adjacent to the Trans-Alaska Oil Pipeline. MS. Thesis, Univ. Alaska, Fairbanks. 200pp.

Senner, R. G. B. 1989. Effects of petroleum operations in Alaskan wetlands. Report to ARCO Alaska, Inc., and BP Exploration (Alaska) Inc., Anchorage, by Robert Senner and Company, Anchorage, Alaska. 138pp.

Troy, D. M. 1982. Prudhoe Bay Waterflood Project bird monitoring program. Report to U.S. Army Corps of Engineers, Alaska District, Anchorage, by LGL Alaska Research Associates, Inc., Fairbanks.

Troy, D. M. 1983. Prudhoe Bay Waterflood environmental monitoring project: tundra bird monitoring program. Report by LGL Alaska Research Associates, Inc., Anchorage, Alaska.

Troy, D. M. 1985. Prudhoe Bay Waterflood environmental monitoring project. Report to Envirosphere Company, Anchorage, by LGL Alaska Research Associates, Inc., Anchorage.

Troy, D. M., and T. A. Carpenter. 1989. The fate of birds displaced by P-Pad, Prudhoe Bay, Alaska: the distribution of nesting birds prior to pad construction. Report to BP Exploration (Alaska) Inc., Anchorage, by LGL Alaska Research Associates, Inc., Anchorage. 42pp.

Truett, J. C., and K. Kertell. 1989. Effects of habitat disturbance on arctic wildlife--a review and analysis. Report by LGL Alaska Research Associates, Inc., Anchorage, for BP Exploration (Alaska) Inc., Anchorage, Alaska. 61pp.

Walker, D. A., K. R. Everett, P. J. Webber, and J. Brown. 1980. Geobotanical atlas of the Prudhoe Bay region, Alaska. CRREL Rep. No. 80-14, U.S. Army Corps of Engineers, Hanover, NH.

Walker, D. A., K. R. Everett, and P. J. Webber. 1983. Geobotany. Chapter 2 In: D. M. Troy (ed.) Prudhoe Bay Unit -- Eileen West End environmental studies program, summer 1982. Report to Sohio Alaska Petroleum Co., Anchorage, by LGL Alaska Research Associates, Inc., Fairbanks.

Walker, D. A., M. D. Walker, N. D. Lederer, and P. J. Webber. 1984. The use of geobotanical maps and automated mapping techniques to study the historical changes in the Prudhoe Bay Oil Field, Alaska. Final report to USDI Fish & Wildl. Serv., Habitat Resources Section, Anchorage, Alaska, by Inst. of Arctic and Alpine Res. Univ. of Colorado, Boulder.

Walker, D. A., E. F. Binnian, N. D. Lederer, E. A. Nordstrand, M. D. Walker, and P. J. Webber. 1986. Cumulative landscape impacts in the Prudhoe Bay Oil Field, 1949-1983. Final report to USDI Fish & Wildl. Serv., Habitat Resources Section, Anchorage, Alaska, by Inst. of Arctic and Alpine Res., Univ. of Colorado, Boulder.

Walker, D. A., P. J. Webber, E. F. Binnian, K. R. Everett, N. D. Lederer, E. A. Nordstrand, and M. D. Walker. 1987a. Cumulative impacts of oil fields on northern Alaskan landscapes. Science 238:757-761.

Walker, D. A., D. Cate, J. Brown, and C. Racine (eds.). 1987b. Disturbance and recovery of arctic Alaskan tundra terrain. CRREL Report No. 87-11. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH. 70pp.

Walker, D. A., P. J. Webber, N. D. Lederer, and M. D. Walker. 1987c. Terrain and vegetation of the Department of Energy R4D research site, Imnavait Creek, Alaska. Classification and Mapping. Report by Plant Ecology Lab., Inst. of Arctic and Alpine Res., Univ. of Colorado, Boulder.

Wilkinson, L. 1988. Sygraph. Systat Inc., Evanston, IL. 923pp.

Wright, J. M., and S. G. Fancy. 1980. The response of birds and caribou to the 1980 drilling operation at the Point Thomson #4 well. Report to Exxon Company, USA, by LGL Ecological Research Associates, Inc. 62pp.

Zar, J. H. 1984. Biostatistical analysis. Second ed. Prentice Hall, Englewood Cliffs, NJ. 718pp.

APPENDIX A

Study Site Descriptions

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INTRODUCTION

This part of LGL's Terrestrial Studies Program for BPX provides detailed descriptions of all sites at which wildlife observations were made in summer, 1989. The kinds of sites described are (1) gravel well-pads and adjacent undisturbed tundra, (2) river alluvium sites and adjacent undisturbed tundra, and (3) impoundments and ponds. Included are site maps, verbal descriptions of biophysical features of the sites, and summaries of wildlife use. Some information from descriptions of ponds and impoundments was taken from McKendrick (1986).

As outlined in the methods section of this report, observations were conducted at each site for a period of 4 hours per day on four seperate occasions during the study. The only exception was at Lake State 1 gravel pad site where observations were conducted on three occasions instead of four.

A list of all wildlife species observed during the study can be found in Table A-2. For a quick reference to the vascular plant taxa found on gravel pad and alluvial study sites, see Table A-3.

Vegetation type and landform descriptions (Appendix Table A-1) use terminology after Walker et al. (1983). Other potentially unfamiliar terms used in these descriptions include the following:

- Thermokarst - surface subsidence caused by subsurface thaw
- Pad - the usually-raised gravel substrate from which drilling operations took place
- Reserve Pit - the sump where drilling muds and fluids were discharged during drilling. Berms surrounding these and the flare pits (below) are of gravel or overburden
- Flare Pit - the sump within which any natural gas that escaped to the surface during drilling was burned off

- Observer Station - the point from which standardized observations of wildlife were made during 2-hr intervals
- Casual Observations - wildlife activities noted outside the context of the standard 2-hr observation intervals
- Forb - broad-leaved, herbaceous plant
- Overburden - soil, often highly organic, removed from the tundra surface and heaped into mounds or berms
- Graminoids - grasslike plants, including grasses and sedges
- Gravel Spray - thin surface sheets or traces of gravel, usually occurring near margins of fill
- Shallow Pond - water depth generally less than 1 m, usually easy to wade
- Deep Pond - water depth generally greater than 1 m

SITE 1: WEST SAK 17

Location and Access

West Sak 17 (Fig. A-1) is located in the Kuparuk Unit in Sec. 26, T13N, R9E approximately 1.6 km northeast of Drill Site 3K. There is no road access to the pad, but it can be seen from the gravel road about 1.6 km beyond the access road to Drill Site 3K. From there it is a short walk southeastward across tundra to the site.

Description: Disturbed Area

The well was spudded on January 24, 1981, and suspended on March 4, 1981. The pad dimensions are approximately 115 m x 80 m and the gravel thickness varies from about 1 to 2 m. A gravel ramp at the southwest corner of the pad tapers to the tundra level. No thermokarsting is evident on the pad itself, other than on the gravel ramp. The well head is located on the east-central portion of the pad. A large-diameter section of culvert is buried vertically in the gravel surrounding the well head.

A reserve pit attached to the east side of the pad was filled with water during the early part of the summer. By July 20 the water level had receded, exposing extensive areas of mud on the south side. A flare pit south of the pad was also filled with water, but only trace amounts of mud became exposed during the summer. This pit also contained disturbed tundra with dense vegetation, some of which was emergent. Both pits are enclosed by gravel berms.

Description: Undisturbed Area

The undisturbed portion of the study site consisted of the tundra immediately east of the reserve pit. This was an area of moist tussock tundra with little relief; the primary landform was low-relief high-centered polygons. There was a small area of wet strangmoor in the northwest corner.

Observer Station

The observation point was located on the gravel at the southeast corner of the reserve pit. From here, most of the pad and the gravel levees around the pits could be seen. Most of the open water inside both the reserve pit and the flare pit could also be seen. Observations were made on June 21, July 7 and 20, and August 3.

Wildlife Observations

Few observations of caribou were made on the pad; however, caribou tracks were scattered over the pad surface. A trail on the north part of the pad indicated relatively heavy use by caribou in this area. One caribou was observed feeding on vegetation in the flare pit on August 3.

No waterfowl were observed on the pad, but the flare pit was used extensively by Oldsquaws during the first two observation periods. One pair of Oldsquaws spent two entire days (June 21 and July 7) resting and feeding in areas of open water and emergent vegetation.

Shorebirds used the area throughout the summer. The most heavily used areas were the flare and reserve pits. The flare pit was used for feeding particularly by phalaropes and, during the last two periods when water levels in the reserve pit dropped, several species of shorebirds fed continually by probing in exposed mud. Shorebirds were commonly seen perched on levees around the pits and on the gravel pad surface. No nests were found on the pad but 3 Dunlin nests and 2 Semipalmated Sandpiper nests were located within 50 m of gravel. Three nests were found close to the south side of the flare pit, and the presence of an adult Red-necked Phalarope with a downy chick in a wet area on the south side of the flare pit levee indicated that this bird also nested in the immediate area.

Lapland Longspur use was less extensive than at some other sites. There were few observations early in the season. Late-season activity centered around the well head where perched birds were easily seen. Longspurs were also seen resting,

preening, and feeding on the gravel pad surface, on the levee around the reserve pit, and on the mud inside the reserve pit.

SITE 2: UGNU #1

Location and Access

Ugnu 1 (Fig. A-2) is located in the Kuparuk Unit in Sec. 22, T12N, R9E, about 2.4 km south of CPF-3. There is no road access to the site. The best access point is from the gravel road about 1.6 km south of CPF-3. From here the site can be reached in about 40 min on foot.

Description: Disturbed Area

The well was spudded on approximately February 1, 1969, and suspended on June 1, 1969. There was occasional drilling activity at the site to at least March, 1978. A "plug and abandon" date of March 14, 1986, is on record.

The boundaries of this pad are not well defined because of the gradual gradation of pad edges into adjacent tundra. The dimensions of the main portion of the pad are approximately 90 m x 100 m. Small areas of thin gravel extend beyond this area on the north, south, and west sides of the pad. Nowhere is the gravel very thick; it is less than 0.5 m in the thickest areas. This gravel generally has smaller particle sizes and a higher percentage of sand and silt than do other sites in this study. Thermokarsting is well developed over the entire pad, forming deep, water-filled troughs in some areas. The well head is located on the southeast portion of the pad and consists of a pipe embedded in the gravel. Debris in the area includes scattered pieces of wood and metal, small sections of pipe, electrical cord, and cement. Wood pilings about 0.5 m high are located in most of the areas marked "debris" in Fig. A-2.

The site has been extensively colonized by many plant species; the vegetative cover is approximately 60%. *Carex aquatilis* and *Eriophorum* spp. are the primary

colonizers in the wet area around thermokarst troughs. Many grass and forb species are present on the drier areas.

A large reserve pit to the east of the pad is filled with water. A mound of overburden is present on the east side of this pit.

Description: Undisturbed Area

The undisturbed area of the study site consisted of moist graminoid tundra immediately to the west of the pad. The landform was high-centered polygons.

Observer Station and Schedule

The observation point was on the southwest corner of the pad. The surface of the pad was obscured by dense vegetation, making observations difficult. Only casual observations were made at the reserve pit and the overburden mound. Observations were made on June 23, July 9 and 24, and August 7.

Wildlife Observations

Caribou were frequently observed on the pad. Their behavior included feeding, resting, and moving through the area. On one occasion an adult laid down in a thermokarst trough on the pad and was often totally concealed from view. This same behavior had been noted the previous day at a different study site (West Sak 3) when an adult caribou concealed itself by reclining in the gravel depression around the well head.

Other mammals were scarce. An arctic fox adult with a kit passed through the study area on July 9, and one lemming was observed in the undisturbed portion.

One observation of a Brant feeding on vegetation growing on the gravel was the only observation of waterfowl using the gravel pad. However, Oldsquaws and King Eiders were observed swimming in the reserve pit. Waterfowl scat and tracks were common in the pit.

Shorebird activity was extensive in the study area, particularly on the grave pad, during all observation periods. Sandpipers were observed displaying, feeding and resting on the gravel pad. A number of birds landed, but their subsequen activities could not be observed because they disappeared into vegetation Phalaropes often landed in wet areas of thermokarst troughs, presumably to feed One Semipalmated Sandpiper nested on the gravel pad on top of a high-centered polygon in a small clump of grasses and *Carex* sp. measuring about 0.5 x 1.0 m in diameter. No nests were found in the undisturbed portion of the study site, bu four Semipalmated Sandpiper nests were found on other areas of tundra adjacent to the pad. The pilings on the east side of the pad were used as perches by Ruddy Turnstones. A turnstone nest was found on a barren area north of the reserve pit, and an adult with a downy chick was observed on the mound of overburden on July 9.

In addition to shorebirds, Lapland Longspurs and Snow Buntings commonly used the pad. As with shorebirds, their behavior included displaying, resting, and feeding, and a number of birds disappeared as they landed in areas of thick vegetation on the gravel pad. Various kinds of debris such as pilings, pieces of wood, steel reinforcement bar (rebar), stakes, and pipe were often used as perches. The center of activity appeared to be the area around the pilings and well head where there was an abundance of perches. Three longspur nests were found on the gravel pad. Two of these nests were in small clumps of *Carex* sp.-- one was on the side of a thermokarst trough and the other was on top of a high-centered polygon near a trough. The third nest was in a clump of *Eriophorum* sp. at the very southern edge of the gravel pad on top of a well-vegetated, high-centered polygon.

Other species observed using the area were Rock Ptarmigan resting on the gravel pad surface and a Snowy Owl which used debris at the well head and the mound of overburden as perches.

SITE 3: WEST SAK 11

Location and Access

West Sak 11 (Fig. A-3) is located in the Kuparuk Unit in Sec. 36, T12N, R8E, about 2.7 km southwest of Drill Site 3F. There is no road access to the pad but it can be seen with binoculars from a point where a stream intersects the gravel road southwest of Drill Site 3F. The site is about 45 min on foot from this point.

Description: Disturbed Area

The well was spudded on January 4, 1978, and suspended on February 24, 1978.

The pad dimensions are about 130 m x 90 m and gravel thickness varies from about 0.6 to 1.3 m. A gravel ramp tapers from the pad to the tundra on the northern part of the pad. Moderate thermokarsting is evident on the southern portion of the pad, less so on the northern portion, and least evident in the northeast corner. Some thermokarst troughs contained water throughout the summer. The well head is located on the east-central portion of the pad. A section of large-diameter culvert is embedded vertically in the gravel and surrounds the well head. Resting on this culvert is a wooden platform with a metal railing about 1 m high. A series of timbers attached to the pad by metal supports surrounds this platform and extends to the north. Many forb and grass species are distributed uniformly over the pad surface, but overall vegetative cover is less than 1%.

A reserve pit to the east of the pad, filled with water and mud, approximates the size of the pad. A flare pit to the south is slightly smaller and is filled with water and disturbed tundra. The exposed mud in the reserve pit is partially vegetated; mud in the flare pit is more extensively vegetated. Both pits are surrounded by gravel levees. As summer progressed the water level dropped in both pits and more mud became exposed.

Description: Undisturbed Area

The undisturbed portion of the study site consisted of tundra immediately north of the pad. The southern part was moist graminoid tundra, and its land-form was low-relief, high-centered polygons and strangmoor. The northern part rose in elevation and was composed of moist tussock tundra; the land-form was high-centered polygons.

Observer Station and Schedule

The observation point was located on the northeast corner of the pad. Most of the pad could be seen but observations of animals on the southern thermokarsted area were more difficult than elsewhere. Most of the gravel levees around the reserve and flare pits could be seen, along with most of the area inside the reserve pit. Much of the inside of the flare pit was obscured from view. Observations were made on June 26, July 13 and 27, and August 10.

Wildlife Observations

Caribou were observed on the pad only during the last observation period, but the presence of tracks and scat indicated caribou use at the site throughout the summer. Many tracks were preserved in the mud of the reserve and flare pits, and tracks were also scattered over the pad surface. A distinct trail was on the levee between the two pits and, as evidenced by many caribou tracks, had considerable use.

Other mammal use was less obvious. There was fox scat near the debris around the well head, and an arctic ground squirrel was present on June 26.

During the first two observation periods, waterfowl were observed using the water impounded in the reserve and flare pits. More waterfowl were seen in the reserve pit, possibly due to its proximity to the observation point. The Oldsquaws fed extensively in the pits and also used the pits for resting and preening. King Eiders were seen resting and preening. Three Greater White-fronted Geese landed in the flare pit and eventually walked over the west levee where they began

feeding on tundra vegetation. No waterfowl were observed during the last two observation periods.

Shorebirds were observed using the reserve pit and, to a lesser extent, the gravel pad. They used the gravel edges and the exposed mud of the reserve pit for feeding and resting. Two Pectoral Sandpipers were observed feeding for a short period on the south-central and northeast areas of the gravel pad. Aerial displays were also observed over the gravel pad, the reserve pit, and the flare pit.

Lapland Longspurs used the area during all observation periods; their numbers increased during the last half of the season. Their activities centered around the well head and associated debris, where they engaged in feeding, resting and preening behavior. Flights back and forth from the well head area to nearby tundra or gravel pad surfaces were common. On August 10, longspurs were observed feeding over the entire surface of the pad.

Other bird observations were few. They included Sabine's Gull on the reserve pit and Rock Ptarmigan using the debris at the well head as a perch.

SITE 4: WEST SAK 9

Location and Access

West Sak 9 (Fig. A-4) is located in the Kuparuk Unit in Sec. 3, T11N, R9E, about half-way between Drill Site 2X and Drill Site 2W. It is readily visible to the north of Drill Site 2X from which it can be reached in about 20 min on foot.

Description: Disturbed Area

The well was spudded on March 2, 1978, and suspended on April 9, 1978.

The pad dimensions are approximately 130 m x 100 m, and gravel thickness varies from approximately 1 to 1.5 m. A small gravel ramp tapers from the pad to the tundra on the north part of the pad. Thermokarsting on the southwest

quadrant of the pad is extensive, and some thermokarst troughs are filled with water. Other areas of the pad exhibit little or no thermokarst activity. The well head is located on the east-central part of the pad and is surrounded by wooden planks and timbers fastened to the pad by metal supports.

There is high plant species diversity but low vegetative cover on the pad surface. Total vegetative cover on the pad is about 1%. Colonization is more pronounced in thermokarsted areas.

A reserve pit east of the pad is filled with water and is similar in size to the pad. A flare pit south of the reserve pit is slightly smaller than the reserve pit and is also filled with water. Both pits are surrounded by gravel levees. There is virtually no plant colonization associated with these pits. Large mounds of overburden 6 to 7 m high are present to the east of each pit.

Description: Undisturbed Area

The undisturbed portion of the study site, immediately north of the pad, was primarily wet graminoid tundra. The landform was discontinuous low-centered polygons, strangmoor, and frost-boil tundra.

Observer Station and Schedule

The observation point was located to the northeast corner of the pad. From here, most of the pad could be seen although observations in the thermokarsted areas were somewhat restricted. The gravel levees around the pits and the entire reserve pit could also be seen. Part of the flare pit was obscured from view. Observations were made on June 4, July 10 and 25, and August 8.

Wildlife Observations

Caribou were observed on the pad on a few occasions. Those on the pad generally stood or rested, though a few fed. Scat and tracks were scattered over the pad surface, on the levees around the reserve and flare pits, and on the overburden. A young male caribou used the northernmost overburden mound as a resting area on one occasion.

Waterfowl were observed in the reserve and flare pits on all visits to the site. Pacific Loons, Oldsquaws, and King Eiders were feeding extensively in both pits, but most observations were made in the reserve pit due to its proximity to the observation point. Twelve King Eiders were present on July 10, and a female with six young were feeding the entire day on August 8. A few observations of Brant were made, and a pair of Greater White-fronted Geese with two downy young was on the gravel levee south of the flare pit on July 10.

The most obvious shorebird activity was displaying on the pad by Buff-breasted Sandpipers and aerial displays by Pectoral and Semipalmated sandpipers. A number of birds were observed feeding at the edges of reserve or flare pits, and Red-necked Phalaropes fed on the surface of the water. A few individuals used the gravel pad for resting or preening; two Pectoral Sandpipers were noted feeding on the pad. No nests were found on the pad but one Semipalmated Sandpiper and one Pectoral Sandpiper nested in the undisturbed portion of the study area.

Lapland Longspurs were least active on the pad during the first half of the season, but their activity increased sharply in late summer. A good portion of their activity was centered around the well head and the surrounding timbers which were often used as perches. Longspurs often moved back and forth from the timbers to the pad surface. Longspurs were seen landing and feeding on all parts of the pad during the last two observation days. There were often rapid movements of flocks from the pad area to perches at the well head and back.

Other significant observations included the use of the perches around the well head by Rock Ptarmigan. Also, an immature Golden Eagle used the northernmost mound of overburden as a perch.

SITE 5: WEST SAK 3

Location and Access

West Sak 3 (Fig. A-5) is located in the Kuparuk Unit in Sec. 26, T11N, R9E, about 1.3 km southwest of Drill Site 2D. There is no road access to the pad but it can be seen from the gravel road west of Drill Site 2D and can be reached in 5 min on foot.

Description: Disturbed Area

The well was spudded on March 22, 1975, and suspended on April 26, 1975. The "plugged and abandoned" date is March 14, 1986.

The pad dimensions are approximately 70 m x 160 m. Gravel thickness on the eastern and southern portions is about 0.6 m. Two gravel ramps taper to the tundra surface; one is in the northeast corner and one is on the south side of the pad. A thicker raised area of gravel on the west side of the pad extends from the north side to the south about 80% the length of the pad. This gravel has a thickness of about 1.5 m. Moderate thermokarsting is evident on the thinner areas of the pad, but little thermokarsting occurs on the thicker areas. Water was present in thermokarst troughs. The well head is characterized by a pipe embedded vertically into a depression about 0.5 m deep in the gravel, located on the west central part of the pad. A number of wooden stakes delineate a revegetation study site on the raised portion of the gravel pad. This area was fertilized in 1986 (Jorgenson 1988).

Vegetative cover on the pad is less than 1%, even in the fertilized area. Several grass and forb species are colonizing the thermokarst troughs.

There is a reserve pit on the west side of the pad and a flare pit to the north. A third pit, possibly another flare pit, is adjacent to the southeast edge of the pad. All pits are surrounded by gravel levees which have been breached to allow water to escape. The flare pit to the southeast contains a large mound of overburden in the center, approximately 1.7 m high. The mound is sparsely vegetated and is surrounded by water and partially-disturbed, vegetated tundra. A smaller mound of overburden in the center of the north flare pit was fertilized and seeded in 1986

as part of a revegetation study (Jorgenson 1988). This area is now heavily vegetated and is surrounded by water and partially-disturbed tundra. The reserve pit has a large mound of mud and cuttings which was seeded in 1986 (Jorgenson 1988). This area is sparsely vegetated and is surrounded by water and partially-disturbed tundra.

Description: Undisturbed Area

The undisturbed portion of the study site consisted of tundra located adjacent to the northeastern section of the pad. It was composed of moist graminoid tundra and moist tussock tundra. The landform was primarily low-relief high-centered polygons.

Observer Station and Schedule

The observation point was located on the mound of overburden in the southeast flare pit. From this vantage point, the entire pad and the gravel levees around the flare pits could be seen. The reserve pit was concealed behind the gravel pad and only casual observations were made within it. Observations were made on June 22, July 7 and 23, and August 6.

Wildlife Observations

Caribou were observed on the pad during the last two observation periods. Most observations were of resting individuals including one which laid in the depression of gravel around the well head for approximately 1 hr. Another caribou fed extensively in the vegetation in the north flare pit. Tracks were scattered around the pad and were especially evident in the reserve and flare pits.

Waterfowl were observed at all reserve and flare pits, but many of these were casual observations. On June 22, a Snow Goose and two Greater White-fronted Geese, which were resting on the gravel levee around the north flare pit, flew away as the observer approached the study site. On several occasions Oldsquaws and Greater White-fronted Geese landed in the reserve pit, which could not be viewed from the observation point. Waterfowl tracks and scat were present in all reserve and flare pits.

Shorebirds observed were mainly preening or displaying. Buff-breasted Sandpipers used both the lower and elevated portions of the gravel pad for display purposes. Pectoral Sandpipers also displayed over the gravel pad surface. The levees around the eastern reserve pit and the flare pit served as resting and preening areas for Pectoral and Semipalmated sandpipers and Lesser Golden-Plovers. An adult and juvenile Dunlin were exploring the raised area of the pad on July 23. No shorebirds nested on the pad but a Semipalmated Sandpiper nest was found about 15 cm off the gravel levee on the south side of the southeast flare pit; a Pectoral Sandpiper nested in the same area about 1 m from the gravel levee. Both nests were successful.

Lapland Longspurs were seen throughout the study period. Numbers increased over the course of the season and longspurs were very common on August 6. Early in the season observations were mainly of individuals landing, resting, or preening on the gravel pad or levees around flare pits. The pipe at the well head was occasionally used as a perch. The southeast flare pit had high use during the latter half of the summer when feeding was a major activity. Longspurs frequently landed on the mound of overburden, the levee around the reserve pit, and the vegetated area inside. This vegetated area seemed to be a center of activity as birds moved back and forth between it and adjacent tundra and the gravel pad surface. One longspur nested in the undisturbed portion of the study site in moist tussock tundra, but this nest was destroyed by a predator.

SITE 6: WEST SAK 4

Location and Access

West Sak 4 (Fig. A-6) is located in the Kuparuk Unit in Sec. 7, T10N, R9E, approximately 2.4 km east southeast of Drill Site 2K. There is no road access to the pad. It can be seen with binoculars from Drill Site 2K, and can be reached in about 40 min on foot.

Description: Disturbed Area

The well was spudded on January 20, 1979, and plugged and abandoned on February 16, 1979.

The original dimensions of the pad were approximately 75 m x 160 m. There was a reserve pit to the west and flare pits to the north and east. Gravel from the levees has been pushed into the centers of the pits creating mounded areas. Some gravel from the pad itself may also have been pushed into the large mound of gravel now covering the reserve pit. (This area is delineated by a dashed line in Fig. A-6.) Gravel thickness of the pad ranges from less than 1 m to about 2 m; the thickest parts are in the former reserve pit. There are extensive areas of gravel spray on the western, northwestern, and southeastern sides of the pad. Thermokarsting is evident on the thinner portions of the pad; some troughs are filled with water. Large depressions in the mounded gravel over the old reserve pit also contain water. The well head is located just north of the pad center.

The total vegetative cover for the entire pad is approximately 4%. The thin thermokarsted area is approximately 15 to 20% vegetated; colonizing species include graminoids (*Carex* spp., *Eriophorum* spp., several grass species), and a number of forb species. The mounded portions of the pad are about 1% vegetated. The highly vegetated areas on the gravel spray are composed of graminoids and many forb species.

Description: Undisturbed Area

The undisturbed portion of the study area consisted of the tundra immediately south of the pad. The area was composed primarily of moist and wet graminoid tundra. The landform was discontinuous low-centered polygons and strangmoor. The plot also had scattered areas of frost-boil tundra.

Observer Station and Schedule

The observation point was located on the south side of the pad on the mounded gravel over the old reserve pit. Most of the gravel pad, along with parts of the mounds of gravel at the flare pits, could be seen. Some areas of spray and

some areas of the pad near the well head were obscured from view. Observations were made on June 25, July 12 and 26, and August 9.

Wildlife Observations

Caribou were observed on the pad on a few occasions. Most behavior was limited to standing and resting, but some feeding on *Eriophorum* sp. was noted. Caribou scat and tracks were scattered over the surface of the pad, and were also common in the southeast flare pit and other wet areas where they were more readily preserved.

No waterfowl were observed on the pad, but scat and tracks were found. In the southeast flare pit and in other wet areas of the pad, tracks and scat from ducks and/or geese occurred; scat and tracks of Tundra Swan were found in the north flare pit area.

Most shorebird activity was limited to an occasional bird using the pad for short periods. However, during the early part of the season Buff-breasted Sandpipers used the mounded gravel for display purposes.

Lapland Longspurs were the most abundant bird species on the pad. During the early part of the season small numbers used all parts of the pad for resting, preening, feeding, and displaying. The pipe at the well head was consistently used as a perch, and one bird would often displace another from it. One longspur nest was found on July 12 on the south side of the pad in a clump of *Eriophorum* sp. Adult longspurs were observed feeding their young with insects which were gathered from areas both on and off the pad. On August 9, larger numbers of longspurs were flocking onto the pad and seemed to prefer it over adjacent tundra areas. Their activities consisted of rapid movements as they flew, landed, hopped, and fed on the pad.

Rock Ptarmigan also used the pad on occasion.

SITE 7: HURL STATE

Location and Access

The Hurl State site (Fig. A-7) is located in the Prudhoe Bay Unit in Sec. 5, T10N, R13E, approximately 2.1 km southeast of P-Pad. There is no road access to the pad but it can be reached in about 30 min on foot from P-Pad.

Description: Disturbed Area

Two wells have been drilled on this pad. The first was spudded on May 11, 1969, and has a "plugged and abandoned" date of April 4, 1980. The second well was spudded on January 6, 1981, and was suspended on February 18, 1981.

The pad dimensions are about 60 m x 180 m and gravel thickness averages approximately 1.6 m. A gravel road from the airstrip enters the pad on the north side. The pad surface is flat with thermokarsting evident only in a small area at the west end where there is a water-filled trough. The well heads are located south and east of the pad center; one consists of a pipe embedded in the ground, and the other is a "christmas tree" with a railing around it. A shallow cement structure located east of the pad center is covered. A fairly extensive area of thin gravel and gravel spray surrounds much of the pad, particularly on the southern and eastern sides. Several small water bodies, possibly the remains of an old reserve pit, are present in this area. A large intact reserve pit adjacent to the southeast end of the pad was filled with mud and water. Another small pit to the east was also filled with water.

Very little vegetation was present on the gravel surface; total cover was less then 1%. Thick patches of *Eriophorum* sp. were colonizing some areas of gravel spray on the south side, and *Arctophila fulva* was present in the pond to the south.

Description: Undisturbed Area

The undisturbed portion of the study site consisted primarily of wet graminoid tundra to the southwest of the pad. The landform was non-patterned ground.

Observer Station and Schedule

The observation point was located on the west side of the pad. The pad and part of the gravel spray and associated water could be seen. The large reserve pit and the thin gravel and gravel spray to the east could not be seen. Observations were made on June 28, July 12 and 27, and August 12.

Wildlife Observations

Caribou were observed standing, resting, and moving across the pad on several occasions. A few feeding observations were made early in the season. Caribou were observed standing and lying down in the area of the "christmas tree" in particular, where many tracks and much scat were seen. Tracks were also noted in other areas of the pad, particularly in the areas of thin gravel and gravel spray and in the reserve pit.

Arctic foxes were observed on the pad on July 12 and July 27. They appeared to be hunting as they passed through the area.

No waterfowl were observed on the gravel pad; however, scat was present on the thin gravel areas near water bodies. A pair of Oldsquaws was seen in the reserve pit, and on two occasions Canada Geese landed on thin gravel near water.

Little shorebird activity was observed on the gravel pad surface, but shorebirds made extensive use of the areas around water bodies on the south side of the pad. During the final observation period on August 12, activity levels were high. Pectoral Sandpipers were particularly common, but several other species were also observed landing and probing in the mud around the pond edges.

Lapland Longspur activity was minimal until the final observation period on August 12. At this time observations of birds landing, resting, preening, and feeding were made on the gravel pad surface and gravel pad bank.

Common Ravens and Snow Buntings were also observed using the gravel pad on several occasions. On two occasions ravens used the "christmas tree" and the associated railing as a perch.

SITE 8: PUT STATE #1

Location and Access

Put State #1 (Fig. A-8) is in the Prudhoe Bay Unit in Sec. 7, T10N, R14E, about 0.6 km southwest of X pad. There is no road access to the pad but it can be seen with binoculars from X pad, and can be reached in approximately 30 min on foot.

Description: Disturbed Area

The well was spudded on May 12, 1969, and suspended on July 1, 1979. The status now appears to be "plugged and abandoned."

The pad dimensions are approximately 70 m x 160 m. Gravel thickness averages about 1.3 m, varying from about 1 to 1.6 m. Topography is fairly uniform, but some areas exhibit mild thermokarsting. No water was present in thermokarst troughs. The well head is located slightly north of the pad center and consists of a pipe imbedded in a gravel mound. A group of wood pilings is embedded in parts of the western portion of the pad. An old peat road passes through the area just north of the study site.

A wide diversity of plant species is uniformly distributed over the pad surface; total vegetative cover is approximately 10%. One *Festuca* sp. is quite dense over the entire pad surface. Mosses are colonizing the thermokarst troughs, and *Carex aquatilis* is growing on the thinner areas of gravel around the edges of the pad. *Salix* spp. and a number of forb species are also common.

A reserve pit bordering the northwest edge of the pad is filled with water surrounded by overburden/peat. This pit is being colonized by *Eriophorum vaginatum, Carex aquatilis,* and *Arctophila fulva.* Another pit bordering the southwest part of the pad is also filled with water surrounded by overburden (mostly peat) and is being colonized by *Carex* sp. and *Eriophorum* sp.

Description: Undisturbed Area

The undisturbed portion of the study site is composed of moist and wet graminoid tundra adjacent to the eastern pad edge. The predominant landform is high-centered polygons; non-patterned ground and low-centered polygons also occur. Thermokarst troughs are filled with water, and *Dryas* sp. characterize the tops of high-centered polygons.

Observer Station and Schedule

The observation point was located on the southeastern portion of the pad. Most of the pad could be seen but the reserve pits were not observed. Observations were made on June 26, July 11 and 26, and August 10.

Wildlife Observations

Caribou were observed standing or resting on the pad, or running across the pad. One caribou appeared to use the gravel mound at the well head as a vantage point. Caribou scat and tracks were scattered throughout the pad.

Arctic foxes were present on the pad on several occasions. Activities included passing through the area and digging in gravel in the area around the well head. Other evidence of fox activity included diggings in the peaty overburden of the northwest reserve pit, where several goose wings were found (evidence of probable predation). Fox scat was noted in several areas.

No waterfowl were observed using the study area; however, scat was scattered across the pad surface.

Shorebirds were observed in small numbers resting, preening, feeding, and displaying on the pad. The most significant observation was of a Baird's Sandpiper which nested in a clump of *Dryas integrifolia* on the southwest part of the pad.

Lapland Longspurs were observed in small numbers early in the season but on August 10 activity levels increased dramatically. Longspurs were observed resting, preening, and feeding in vegetated areas of the pad, and particularly on and

around the gravel mound at the well head. A longspur nest was found in some vegetation on the peat-rich overburden surrounding the northwest reserve pit.

SITE 9: LAKE STATE #1

Location and Access

Lake State 1 (Fig. A-9) is located in the Prudhoe Bay Unit in Sec. 18, T10N, R15E, approximately 0.3 km east of Drill Site 16. There is no road access to the pad. It can be seen from Drill Site 16 and can be reached in about 5 min on foot.

Description: Disturbed Area

The well was spudded on March 22, 1969, and was officially "plugged and abandoned" on January 25, 1981, although activity probably stopped well before this date.

The pad dimensions are approximately 105 m x 55 m. Gravel thickness is about 0.7 m. Areas of thin gravel and gravel spray are present beyond the northern, western, and eastern sides of the pad. A small area of gravel is connected to the northeast edge of the pad by a gravel berm. No observations were made on a gravel area southwest of the pad. Thermokarsting is not evident, and one small pool of water was present on the western part of the pad. A number of areas of standing water existed in the thin gravel. The well head is located south of the pad center and consists of a pipe embedded in the gravel.

This site is the object of an ARCO Alaska, Inc. revegetation study which was initiated in 1986 (Jorgenson 1988). The entire area was fertilized and specific plots were seeded with Tundra Blue Grass (*Poa glauca*) and Arctared Fescue (*Festuca rubra*). These areas are highlighted with dashed lines on Fig. A-9. The pads are currently about 20% vegetated; seeded areas are more heavily colonized than non-seeded areas. Primary forb colonizers include *Sagina intermedia, Draba* spp., and *Cochlearia officinalis*. No reserve pit is evident in the area.

Description: Undisturbed Area

The undisturbed portion of the study site included primarily wet graminoid tundra northwest of the gravel pad. The landform was low-centered polygons and discontinuous low-centered polygons.

Observer Station and Schedule

The observation point was located on the northwest edge of the pad. Observations were made at this pad and the small pad to the northeast on July 5, 18, and 30.

Wildlife Observations

No mammals were observed on the pad but caribou scat and tracks were present. Time-lapse video-photography, conducted during this study, revealed considerable use of the site by caribou (see RESULTS in body of this report).

Waterfowl were likewise observed only during time-lapse photography studies. In addition, waterfowl scat was found over much of the gravel pad surface and the presence of egg shells on the pad indicated possible nest predation in the area.

Observations of shorebirds included birds on the gravel pad surface and at the edges of water bodies. Again, time-lapse studies produced further evidence of shorebird use of the pad.

Lapland Longspurs were most abundant on July 30 when a number of birds were observed feeding in vegetated areas of the pad.

SITE 10: SAG DELTA 31-11-16

Location and Access

Sag Delta 31-11-16 (Fig. A-10) is located in the Prudhoe Bay Unit in Sec. 31, T11N, R16E, in the Sag River Delta about 6.5 km east-northeast of the Prudhoe Bay runway. Access to this site was by helicopter.

Description: Disturbed Area

The well was spudded on March 7, 1969, and suspended on April 18, 1969.

The pad is irregularly shaped, covering an area approximately 130 m x 90 m. The gravel is thickest (about 0.5 m) on the south and west sides. It has been spread out over the area to the north and east where a large area of gravel spray is present. A small patch of gravel separated from the pad is present to the southeast. Some areas of light thermokarsting are evident, and shallow furrows caused by heavy equipment are present. A number of pools existed in the spray area; some were ephemeral, appearing after periods of rain. The well head is located on the south-central pad and is surrounded by a heavy wooden fence. A number of heavy timbers are attached to the pad east of the well head. Debris south of the pad consisted of collapsed metal drums and pieces of pipe and wood.

Vegetation on the gravel is limited to scattered sedges, grasses, and forbs covering less than 1% of the pad surface. The gravel spray area is relatively heavily vegetated, particularly around areas where water persisted; the vegetation here consists of *Carex* spp., *Eriophorum* spp., grasses, and many forb species.

Description: Undisturbed Area

The undisturbed portion of the study area consisted primarily of moist graminoid and prostrate shrub tundra northwest of the pad. The landform was non-patterned ground and low-relief high-centered polygons.

Observer Station and Schedule

The observation point was located on the northern edge of the gravel spray. Most of the pad could be seen although observations were sometimes obscured by vegetation. Observations were made on July 6 and 22 and August 5 and 17.

Wildlife Observations

Mammals observed in the study area included an arctic fox and arctic ground squirrels. A fox passed through the area once, lingering around the well head before continuing on. Ground squirrel activities were confined to the undisturbed portion of the study area; squirrels were particularly numerous around a small mound in the northwest corner. Caribou tracks were scattered over the pad and were most abundant in the gravel spray.

No waterfowl were observed using the gravel pad, but their tracks and scat were present in wet areas of gravel spray. In addition to smaller tracks of ducks and/or geese, larger tracks and scat of swans were also present.

Shorebird use of the pad was limited to a few observations of birds landing or feeding for brief periods late in the season. Limited activity was also observed in the undisturbed portion of the study site.

Lapland Longspurs were observed throughout the study period and were particularly abundant on August 5 when several hundred birds passed through the area. Peak numbers were reached in the morning but the activity continued into the afternoon. As they passed through, longspurs would linger on the gravel pad surface, rapidly moving about while they fed, rested, and preened. Many birds which moved from the gravel pad to adjacent tundra returned to the gravel, seeming to prefer it. Walking around the perimeter of the pad at mid-day, the observer noted many more longspurs on the pad than on adjacent tundra surrounding it. The birds were using all parts of the pad including the bare gravel and vegetated spray, and were most obvious when using wooden perches around the well head.

The fence around the well head was also used as a perch also by other species. Snow Buntings were often in mixed flocks with longspurs. In addition, Snowy Owl and Peregrine Falcon perched at the well head fence.

SITE 11: SAG DELTA 2 & 2A

Location and Access

Sag Delta 2 and 2A (Fig. A-11) is located in the Prudhoe Bay Unit in Sec. 10, T11N, R16E, about 4.8 km southwest of the Endicott Main Production Island. Access to this site was by helicopter.

Description: Disturbed Area

Two wells were drilled at this site. The first was spudded on January 6, 1977, and plugged and abandoned on April 26, 1977. The second was spudded on November 27, 1977, and suspended on December 27, 1977.

The pad dimensions are approximately 90 m x 165 m. Gravel thickness is approximately 1.5 m. Some shallow thermokarsting was evident on the northern portion of the pad, but there was no standing water in the thermokarst troughs. The well head is located southeast of the center of the pad and is surrounded by timbers and other debris. The pad was sparsely vegetated by several species of forbs and grasses.

A reserve pit immediately to the east approximates the size of the pad. It is filled with standing water, mud/cuttings, and partially-disturbed tundra. A flare pit to the south of the reserve pit is about half its size and contains water and partially disturbed tundra. Vegetation is colonizing both pits.

Description: Undisturbed Area

The undisturbed portion of the study area, west of the gravel pad, was composed of tundra. The area was primarily coastal barrens; the landform was low-relief high-centered polygons.

Observer Station and Schedule

The observation point was located on the northwest corner of the pad. Most of the pad could be seen quite well, but the reserve and flare pits could not be seen. Observations were made on July 3 and 22 and August 5 and 17.

Wildlife Observations

Caribou were observed on the pad and adjacent tundra on July 3; they fed on the tundra and rested on the pad. Tracks and scat were scattered over much of the pad surface but were most abundant around the edges of the pad.

The only other mammal observed on the pad was an arctic fox that walked across the pad on July 22. It investigated some diggings that appeared to be remnants of arctic ground squirrel activity. No ground squirrels were seen during the study period.

No shorebirds were observed on the gravel pad, but on August 5, well over 100 individuals of several species were observed in the reserve pit. The pit could not be seen from the observation point and this was a casual observation made at mid-day. Shorebirds could be heard in the reserve pit during the entire course of the day.

Lapland Longspurs were observed during the entire field season, but most observations were on August 5. Longspurs were feeding on the gravel pad and perching on the debris around the well head. Activity in the undisturbed tundra also increased on August 5.

SITE 12: DELTA STATE 2

Location and Access

Delta State 2 (Fig. A-12) is located just outside the east end of the Prudhoe Bay Unit in Sec. 35, T11N, R16E. It is visible from the Endicott road about 8.0 km east of Duck Island gravel pit and can be reached in 5 min on foot.

Description: Disturbed Area

The well was spudded on March 5, 1975, and suspended on May 17, 1975.

The pad dimensions are approximately 75 m x 175 m. The gravel is approximately 0.5 m thick. Much of the gravel has been spread over the area; it has filled two flare pits, one each on the north and east sides of the pad. The reserve pit on the west side has also been partially filled in with gravel but primarily contains water and mud. Areas of gravel spray are present on both the east and west sides of the pad. No thermokarsting is evident, but shallow furrows caused by heavy equipment are present. There are a number of small ephemeral pools on the pad surface and in the areas of gravel spray. The well head is located northwest of pad center.

The pad was sparsely vegetated; total plant cover was approximately 1%. Most of the vegetation occurred around the edges of the pad. The gravel spray was characterized by heavily vegetated areas of disturbed tundra.

Description: Undisturbed Area

The undisturbed portion of the study area consisted of primarily wet graminoid tundra to the northeast of the pad. The landform was non-patterned ground.

Observer Station and Schedule

The observation point was located on gravel spray at the northeast edge of the pad. Most of the pad as well as the gravel at the flare pits could be seen. Neither the reserve pit and the area to the west, nor the gravel spray south of the

eastern flare pit could be seen. Observations were made on June 17, July 5 and 18, and August 2.

Wildlife Observations

The only mammal observations were of an arctic fox which spent almost two hours sleeping on gravel on the east side of the pad near the gravel spray, and an arctic ground squirrel that passed through the undisturbed area. However, caribou tracks and scat were abundant over all parts of the pad. Fox scat was also present in several areas.

The only waterfowl observed using the area were Canada Geese and Tundra Swans. The Canada Geese were feeding on vegetation in the wet gravel spray area northwest of the observation point. The Tundra Swans spent at least several hours in wet gravel spray south of the east flare pit. These were casual observations of the swans made outside of the regular observation periods. There were also many waterfowl tracks and scat around the perimeter of the pad in wet areas and around the reserve pit, including swan scat near the north flare pit.

Shorebirds were active throughout the study period but the area received particularly heavy use on August 2. Semipalmated Sandpipers and a few Red-necked Phalaropes consistently fed around the edges of pools on the pad and in gravel spray. A male Red Phalarope that nested east of the undisturbed areas also used these same pools for feeding earlier in the season. Lesser Golden-Plovers and a Semipalmated Plover were seen feeding on the gravel pad surface.

Lapland Longspurs were also active in the area. Activities included resting, preening, displaying, and feeding on both the unvegetated gravel pad surface and the vegetated areas of gravel spray. A pair of longspurs nested on the south side of the undisturbed area. The adults made frequent food gathering trips to the gravel spray south of the east flare pit.

SITE 13: KEMIK #1

Location and Access

Kemik #1 (Fig. A-13) is located in the northern foothills of the Brooks Range approximately 72 km southeast of Franklin Bluffs in Sec. 17, T1N, R20E, U.M. There is no road access and the site was reached by helicopter.

Description: Disturbed Area

The well was spudded on January 1, 1971, and suspended on June 17, 1972.

The pad dimensions are approximately 45 m x 180 m. Gravel thickness is about 1 m. An area of thin gravel and gravel spray extends beyond the pad to the east and leads to the road and an old airstrip. Thermokarsting is well pronounced on a large portion of the gravel pad but there was no standing water in the troughs. The well head is located slightly northeast of the pad center and is surrounded by various kinds of debris including timbers, several types of pipe, and a group of metal drums.

Densely vegetated areas are present among the pieces of debris around the well head and in the area immediately to the east. Vegetation is widely distributed over the rest of the pad but is more abundant in the thermokarst troughs. The thin gravel also exhibited dense vegetative cover.

A reserve pit made of overburden is adjacent to the pad on the north side. It is dry with heavy vegetative cover on the south side and thermokarsting on the north side.

Description: Undisturbed Area

The undisturbed portion of the study site was moist low shrub tundra dominated by *Salix* spp. The area was slightly sloping with an area of disturbance on the north side characterized by a section of exposed peat. Some thermokarsting was also evident.

Observer Station and Schedule

The observation point was located on the eastern edge of the pad. The thick areas of gravel could be seen, but no observations were made on the spray to the west or in the reserve pit. Observations were made on July 2 and 21 and August 4 and 16.

Wildlife Observations

Moose were seen on the pad and in the reserve pit but only as casual observations. Tracks and scat of moose and caribou were present on the pad and reserve pit. A number of shrubs on the pad and in the reserve pit showed evidence of browsing.

Arctic ground squirrels were observed during all observation periods. Burrows lined the rim of the reserve pit. Activity was observed over the entire pad, but was centered around the area of debris and the well head.

Passerine species active on the pad included Lapland Longspur and Savannah Sparrow. Much of the activity centered around the debris and well head; at other times birds landed in shrubs and on the gravel pad surface. Little activity was noted in the undisturbed portion of the study site but visibility was partly obscured by dense vegetation.

SITE 14: KEMIK #2

Location and Access

Kemik 2 (Fig. A-14) is located in the northern foothills of the Brooks Range approximately 72 km southeast of the Franklin Bluffs in Sec. 6, T1S, R21E, U.M. Access was by helicopter.

Description: Disturbed Area

The well was spudded on January 31, 1975, and plugged and abandoned May 16, 1975.

The dimensions of the pad are approximately 130 m x 180 m. This includes the area formerly occupied by the reserve pit adjacent to the northwest edge of the pad. The gravel over the southern portion of the pad is approximately 1.0 m thick. In the northeastern part of the pad, the gravel is about 0.5 m and in the northwest it is mounded to almost 2 m where it covers the old reserve pit. A small area of gravel spray is present south of the pad and an old flare pit, covered with a thin layer of gravel, is attached to the northeast corner. Little thermokarsting is evident other than in the thin gravel in the northeast portion of the pad where water is present in some troughs. Some small pools of water are also present in the northwestern portion of the pad where gravel tapers down to the tundra level. The well head is located to the northwest of the pad center where a pipe protrudes from a mound of gravel.

The pad exhibits a great degree of plant colonization; total plant cover is approximately 50%. Dominant species include *Artemisia* spp., *Salix* spp., *Epilobium angustifolium,* and *Arctagrostis latifolia.*

Description: Undisturbed Area

The undisturbed portion of the study site consisted of tundra west of the gravel pad. Moist dwarf shrub tundra dominated; *Betula nana, Sphagnum* spp., and *Rubus chamaemorus* were common plant species. The landform included low-relief, high-centered, and discontinuous low-centered polygons.

Observer Station

The observation point was located on the west-central pad edge. Much of the pad surface was obscured by heavy vegetation. Observations were made on July 2 and 21 and August 4 and 16.

Wildlife Observations

Adult male moose were observed feeding on the pad on several occasions. Moose scat was distributed throughout, and caribou and bear scat was also present.

The most commonly observed mammal was arctic ground squirrel. All ground squirrels observed were on the pad; none were in the undisturbed area. As many as eight individuals were seen on one occasion, but the actual number present could have been substantially higher because visibility was obscured by dense vegetation. Activities included resting and feeding on all areas of the pad. Burrows were located in several areas.

Lemmings were also seen. These observations were made as the observer walked across the pad and were most common in the thin gravel in the northeast and along the east and southwest edges of the pad. Some areas on the pad had well-developed lemming runways.

No waterfowl were observed in the area, and shorebird activity was limited to observations of two species, Least Sandpiper and Semipalmated Plover. Least Sandpipers were observed in the undisturbed portion of tundra on July 2. On July 21 they were observed on the pad where adults and juveniles spent most of the day. Because of the thick vegetation, observation of behavior was difficult and birds were usually seen perched on shrubs or the well head. A Semipalmated Plover was also present on the pad and on an area of mud to the north.

Passerine species using the gravel pad included Lapland Longspur, Redpoll, and Savannah Sparrow. Birds were usually perched on shrubs or landing in vegetated areas.

Several avian predators, including Short-eared Owls and Long-tailed Jaegers, actively hunted in the area, particularly around the edges of the gravel pad. Both of these species were observed capturing lemmings. A Peregrine Falcon made a swooping flight above the pad surface on one occasion, but the purpose of this movement was unclear. Rough-legged Hawks and Gyrfalcons were also observed

in the general area but their activities did not seem to be associated with the gravel pad.

SITE 15: KUPARUK RIVER 1

Location and Access

Kuparuk River 1 (Fig. A-15) is located in the Prudhoe Bay Unit in Sec. 19, T11N, R13E, approximately 0.5 km southwest of U-Pad. It can be accessed from the gravel road southwest of U-Pad which dead ends at the Kuparuk River. The southeast corner of the study site is approximately 90 m from a point on the gravel road 230 m northeast of the Kuparuk River.

Description: Disturbed Area

The disturbed area consists of exposed alluvial gravel of the Kuparuk River. The dimensions of the alluvium are approximately 200 m x 100 m. Surface relief is varied, with a mound of gravel located on the north central part of the site and two parallel furrows about 50 m to the south. Dunes of mixed sand and gravel about 1 m high occur on the south part of the site. There is a small body of water in the northwest corner. Total vegetative cover is approximately 10%, most of which is concentrated in an area of riparian shrub on the western side. Dominant species include *Salix* spp., *Dryas* spp., *Artemisia* spp., and *Epilobium latifolium.*

Description: Undisturbed Area

The undisturbed portion of the study site included tundra to the east of the alluvium. The dimensions were approximately 200 m x 100 m. The dominant vegetation types were dry prostrate shrub and moist graminoid tundra. Landforms included mainly reticulate and non-patterned ground; there were small areas of mixed high and low-centered polygons and strangmoor in the south. A small disturbed area of exposed gravel was centrally located and was bisected by vehicle tracks.

Observer Station and Schedule

The observation point was located on the alluvium near the border of the undisturbed area about 50 m south of the northern boundary of the site. Observations were made on June 29, July 13 and 28, and August 11.

Wildlife Observations

Caribou were observed in the study area on June 29, July 28, and August 11. More caribou were observed on the alluvial gravel than on adjacent tundra. Caribou did not linger but were observed for short periods as they passed through the area. On June 29, a group of 20 caribou were observed feeding on *Artemisia* spp. on the alluvial area. Caribou were observed in the undisturbed area only on August 11. Tracks and scat were abundant over the entire alluvial area.

Arctic ground squirrel was the only other mammal observed on the study site. Observations were limited to a few individuals which passed through the area. Arctic fox were not seen but scat was present in the alluvium.

Waterfowl were not observed on the study site, but tracks were present in the alluvium.

Baird's Sandpiper was the only shorebird observed on the alluvium. This species was also seen on the undisturbed area. Lesser Golden-Plover was the only other shorebird observed, and a pair nested in the undisturbed area. Most activity occurred on June 29; very few observations occurred after this date.

Lapland Longspurs were the only passerines observed using the study site. They were present in both the alluvium and tundra areas. Activities included landing, resting, and feeding.

SITE 16: KUPARUK RIVER 3

Location and Access

Kuparuk River 3 (Fig. A-16) is located in the Prudhoe Bay Unit in Sec. 6, T10N, R13E, approximately 1.1 km west southwest of the Hurl State airstrip. A gravel road from the Hurl State airstrip dead ends at the Kuparuk River. The study site includes alluvium and undisturbed tundra north of this road as it intersects the river.

Description: Disturbed Area

The disturbed area consisted of exposed alluvial gravel of the Kuparuk River. The dimensions were approximately 200 m x 90 m. The alluvium was flat with little relief. Primary plant species included *Dryas integrifolia, Salix* spp., *Artemisia* spp., scattered *Carex* spp., and various forb species. Water was present on the eastern part of the plot adjacent to the undisturbed portion on the study site. Snow and ice were present early in the season along an embankment separating the alluvium from the undisturbed area.

Description: Undisturbed Area

The undisturbed portion of the study site included tundra to the east of the alluvium. An embankment at the western edge adjacent to the river was characterized by a band of dry prostrate shrub tundra on reticulate patterned ground. The remaining portion was composed of moist and wet graminoid tundra. The land form was primarily strangmoor and discontinuous low-centered polygons. Three small water bodies were also present.

Observer Station and Schedule

The observation point was located in the center of the study site on tundra near the embankment at the river edge. Observations were made on June 28, July 12 and 27, and August 12.

Wildlife Observations

Only one caribou was observed on the alluvium. Two sets of tracks were present on June 28, and no new tracks were observed later in the season. Small numbers of caribou were observed on the undisturbed portion of the study site on July 27 and August 12. They were observed feeding and resting as they passed through the study plot. A high of five individuals was present on August 12.

Arctic ground squirrels were observed once on the alluvium, but were present throughout the summer on the undisturbed area. Their activity centered around the embankment of dry prostrate shrub adjacent to the river where they were observed feeding and resting. Burrows were located in several areas on the embankment.

A pair of Oldsquaws was present in the alluvial area on June 28. They landed on water and were present for a short period. No other waterfowl were observed on the study site.

Lapland Longspur was the only passerine observed in the study area. They were active in small numbers on the tundra of the undisturbed area throughout the summer. No longspurs were observed on the alluvium.

SITE 17: SAG RIVER 3

Location and Access

Sag River 3 (Fig. A-17) is located in the Prudhoe Bay Unit in Sec. 21, T10N, R15E, approximately 0.6 km west of Drill Site 17. A gravel road from Drill Site 17 crosses a peat road before reaching the Sagavanirktok River. The southeast corner of the site is approximately 150 m northeast of this point.

Description: Disturbed Area

The disturbed area consisted of alluvial gravel and sand of the Sagavanirktok River. The dimensions of the gravel area were approximately 200 m x 100 m. The site was primarily flat with mild undulations. Water was present on the east side. Most of the vegetation occurred on the northern half of the site and on sandy areas at the southern end. Dominant species include *Artemisia* spp., *Stellaria* spp., *Oxytropis* spp., and *Epilobium latifolium*.

Description: Undisturbed Area

The undisturbed area consisted of tundra east of the alluvium. The dimensions were approximately 200 m x 100 m. An old peat road passed through the eastern and southern part of the site. The primary vegetation type was moist graminoid tundra; the landform was low-centered polygons. An area of dry prostrate shrub tundra on hummocky terrain was associated with the river bank.

Observer Station and Schedule

The observation point was located in the center of the study site on the hummocky terrain of the river bank. Observations were made on June 25, July 10 and 25, and August 9.

Wildlife Observations

Two caribou were observed feeding on the alluvial area on August 9, and one was feeding on the adjacent tundra on July 25. On August 9, a group of 9 caribou that were in the general area but not on the study site, spent most of the time feeding in alluvial areas as opposed to tundra. Tracks were scattered over the alluvium and *Artemisia* spp. had been heavily grazed.

Other evidence of mammal use included ground squirrel burrows in the river bank and fox scat near the observation point. An arctic fox passed through the alluvial area on August 9.

Oldsquaw was the only waterfowl species observed on the study site. On two occasions, birds used the open water in the alluvial area for brief periods of feeding and resting or preening.

Shorebirds were observed in the alluvial area both on open water and feeding at the water's edge, although few observations were made. No shorebirds were observed on the undisturbed area, but a Semipalmated Sandpiper nested there.

Lapland Longspurs were observed in small numbers in both alluvial and tundra areas. Few observations were made and there appeared to be little use of the area by longspurs.

SITE 18: SAG RIVER 2

Location and Access

Sag River 2 (Fig. A-18) is located in the Prudhoe Bay Unit in Sec. 21, T10N, R15E, approximately 0.6 km west of Drill Site 17. A gravel road from Drill Site 17 crosses a peat road before reaching the Sagavanirktok River. The east corner of the site is immediately south of Sag River 3 (Site 17).

Description: Disturbed Area

The disturbed area consisted of gravel alluvium of the Sagavanirktok River. The dimensions were approximately 200 m x 100 m. It was irregular in shape with some gravel areas extending into the undisturbed portion of the study site. Water of the Sag River occupied a portion of the plot. Dominant plant species included *Artemisia* spp., *Stellaria* spp., *Salix* spp., *Oxytropis* spp., and *Epilobium latifolium.*

Description: Undisturbed Area

The undisturbed portion of the study plot consisted of tundra southeast of the alluvium. The dimensions were approximately 200 m x 100 m. It was irregularly shaped with two small tundra streams passing through the eastern

portion. The vegetation type was dry prostrate shrub tundra; the landform was reticulate and non-patterned ground.

Observer Station and Schedule

The observation point was located on undisturbed tundra adjacent to alluvium near the center of the study plot. Observations were made on June 25, July 10 and 25, and August 9.

Wildlife Observations

Two caribou were observed feeding briefly on vegetation on the alluvium on August 9. No other caribou were observed on the study plot. Fresh caribou tracks were observed on the alluvium on July 10.

On August 9 an Arctic ground squirrel was observed briefly both on the disturbed and undisturbed portions of the study site. Fox scat was present in the western corner of the alluvium, and a fox was hunting in the area between morning and afternoon observation periods on July 25.

Two Oldsquaws were feeding in open water briefly on June 25. No other waterfowl were observed in the area. Waterfowl tracks and scat were present on the alluvium and tundra near the observation point.

Shorebirds were observed in both disturbed alluvium and undisturbed tundra on June 25. Two Semipalmated Sandpipers were feeding along the edge of the river water in the central part of the alluvial plot. Up to three Buff-breasted Sandpipers were observed feeding, preening, and displaying on the southeastern portion of the undisturbed tundra. On August 9 two Common Snipes were observed briefly on gravel in the alluvial plot.

Lapland Longspurs were observed through much of the season. They were feeding, resting, preening, and displaying on the undisturbed tundra. A maximum of seven longspurs was observed on August 9. No longspurs were observed using the alluvium.

SITE 19: SAG RIVER 4

Location and Access

Sag River 4 (Fig. A-19) is located in the Prudhoe Bay Unit in Sec. 16, T10N, R15E, approximately 1.3 km east northeast of Drill Site 17. It can be reached from the gravel road between drill sites 17 and 3. It lies 914 m at a bearing of 302° from the second expansion loop in the flow-line northeast of Drill Site 17.

Description: Disturbed Area

The disturbed area consisted of alluvium of the Sagavanirktok River. The dimensions were approximately 200 m x 110 m. The site was uniformly flat and was composed of gravel and sand. An intermittent watercourse ran through the middle of the site. The vegetation complex was similar to that at Sag River 3 (Site 17); conspicuous species included *Salix* spp., *Epilobium latifolium*, *Artemisia* spp., and *Dryas integrifolia*. There was a noticeable absence of the common *Draba* spp. and *Arabis* spp. which had been observed to colonize gravel pads at exploratory well sites.

Description: Undisturbed Area

The undisturbed portion of the study site consisted of tundra southeast of the alluvium. The dimensions were approximately 200 m x 90 m. The area was composed of dry prostrate shrub tundra on reticulate patterned ground adjacent to the alluvium, and moist graminoid tundra on non-patterned ground to the southeast.

Observer Station and Schedule

The observation point was located near the center of the study plot on tundra adjacent to the alluvium. Observations were made on June 26, July 11 and 26, and August 10.

Wildlife Observations

Caribou and arctic ground squirrel were observed only on undisturbed tundra. One caribou was feeding briefly on July 11, and ground squirrels were observed on June 26 and August 10.

Two Oldsquaws were observed for much of the afternoon on July 26 in open water on the alluvial plot. The pair was feeding, resting, and preening.

Small numbers of shorebirds were observed both in the alluvium and on the undisturbed plot. Single Semipalmated Sandpipers feeding briefly on June 26 and July 26 were the only shorebirds observed using the alluvium. Two Lesser Golden-Plovers feeding on July 26 were the only shorebirds observed in the undisturbed plot.

A few Lapland Longspurs were observed feeding, resting, preening, and displaying on the alluvium on June 26 and August 10. None were observed using the undisturbed tundra.

SITE 20: OLIKTOK POND NORTH

Location and Access

Oliktok Pond North (Fig. A-20) is located in the Kuparuk Unit in Sec. 16, T13N, R9E, approximately 50 m north of Oliktok Pond (Site 21).

Description

Oliktok Pond North is shallow with abrupt margins, has a surface area of approximately 0.3 ha, and is surrounded by tundra. Sparse stands of *Arctophila fulva* were present near the north and south margins of the pond. Individual *Arctophila* and *Carex aquatilis* plants were scattered around the rest of the pond.

Observer Station and Schedule

The observation point was located on the gravel road about 40 m east of the south end of the pond. Oliktok Pond (Site 21) was also observed from this point. Most of the pond could be clearly observed with the exception of the area immediately beyond the west bank which was obscured from view. Observations were made on July 4 and 16 and August 1 and 15.

Wildlife Observations

Wildlife use of this pond was restricted to a few observations of shorebirds. Dunlin, Lesser Golden-Plover, and Semipalmated Sandpiper were observed feeding around the pond edge, and Red-necked Phalaropes were feeding in open water. A Rock Ptarmigan was observed feeding on the tundra at the pond edge, but this activity may not have been related to the pond. All observations of wildlife were made on July 4 and 16. Although no waterfowl were present during observation periods, exposed *Arctophila* shoot-tops showed evidence of grazing.

SITE 21: OLIKTOK POND

Location and Access

Oliktok Pond (Fig. A-20) is located in the Kuparuk Unit in Sec. 16, T13N, R9E, approximately 3.4 km south of the Oliktok Dock. It is on the east side of the gravel road adjacent to the access road to Drill Site 3Q.

Description

Oliktok Pond is shallow with a surface area of approximately 0.4 ha. It is part of the *Arctophila* Feasibility Project (McKendrick 1988). Gravel from Oliktok Road borders the western side of the pond, forming a mud/gravel bank. The remaining portion is surrounded by tundra. Dense, emergent *Carex aquatilis* was present on the southern part of the pond. A narrow stand of *Arctophila fulva* was growing

immediately north of the *Carex*. Another small stand of *Arctophila* was present at the north end of the pond, and a few individual *Arctophila* plants were scattered around the pond margin.

Observer Station and Schedule

The observation point was located on the gravel road above the north end of the pond. This was also the observation point for Oliktok Pond North (Site #20). Observations were made from a parked vehicle on July 4 and 16 and August 1 and 15.

Wildlife Observations

Waterfowl were observed on July 4 and 16. A pair of Oldsquaws was feeding in open water on July 4 for several hours. On July 16 a male and four female Spectacled Eiders were observed for several hours feeding as they moved around the perimeter of the pond. They rested briefly at the mud/gravel bank of the western pond edge and continued to feed during the morning observation period. They flew from the area just prior to the beginning of the afternoon observations. There was no evidence of waterfowl grazing on emergent vegetation, but scat was present in several locations on the pond bank.

Shorebirds were observed in small numbers during all four observation periods but most observations occurred on July 4 and 16. Red-necked Phalaropes were observed feeding in open water and in areas of emergent vegetation. Semipalmated Sandpipers were observed feeding along the western and northern pond edges where gravel and mud was exposed. Very few shorebirds were present on August 1 and 15.

SITE 22: OLIKTOK 3N POND

Location and Access

Oliktok 3N Pond (Fig. A-21) is located in the Kuparuk Unit in Sec. 33, T13N, R9E. It is on the southwest side of the road approximately 0.6 km southeast of Drill Site 3N.

Description

Oliktok 3N Pond is large with a surface area of approximately 6.4 ha and is part of the *Arctophila* Feasibility Project. The northeastern part of the pond is adjacent to the gravel road accessing Drill Site 3N; the remaining portion is surrounded by tundra. It is deep with abrupt margins around much of the perimeter. A deep, narrow channel on the east side connects this pond with Oliktok 3N Pond East (Site 23). A channel and two bays extend beyond the south edge of the pond. These areas were beyond the limit of the study site and are marked with a dotted line on the site map. Flowlines from Drill Site 3N are mounted on support structures which are embedded in the northeast end of the pond. Emergent *Carex aquatilis* was virtually absent, although a few scattered plants were present around the pond margin. *Arctophila fulva* was not present.

Observer Station and Schedule

The observation point was located on tundra at the northeast edge of the pond, immediately south of the flowlines. This was also the observation point for Oliktok 3N Pond East (Site 23). Observations were made on June 27, July 11 and 28, and August 11.

Wildlife Observations

Pacific Loons were active in the general area during the entire summer, but were observed on this pond only late in the season, on July 28 and August 11. A pair spent much of these days feeding, resting, and preening on open water. They had nested unsuccessfully at Oliktok 3N Pond East (Site 23) and used the channel between the two ponds to move from one to the other.

One to 2 Greater White-fronted Geese were observed on the southwest portion of the pond near the bank on June 27 and July 11. These geese fed in open water and rested on the bank. No other waterfowl were observed on the pond; however, many tracks were present in the mud borders of the bays on the southern end.

Pectoral Sandpipers were common in the area. Three nests were located within 50 m of the west bank of the pond. However, few observations of birds feeding around the pond edge were made. Two Red-necked Phalaropes and a single Lesser Golden-Plover were the only other shorebirds noted using the area.

SITE 23: OLIKTOK 3N POND EAST

Location and Access

Oliktok 3N Pond East (Fig. A-21) is located in the Kuparuk Unit in Sec. 33, T13N, R9E. It is approximately 0.6 km southeast of Drill Site 3N. It is immediately east of Oliktok 3N Pond (Site 22).

Description

Oliktok 3N Pond East is deep and has a surface area of approximately 1.9 ha. It is surrounded by tundra on the north and east. Beyond the southern end is a wet, marshy area. On the west it is separated from Oliktok 3N Pond (Site 22) by a narrow peninsula. The two ponds are connected by a narrow channel. Another peninsula divides the southern portion of the pond. Trace amounts of emergent *Carex aquatilis* were distributed around the pond margin; *Arctophila fulva* was not present.

Observer Station and Schedule

The observation point was located approximately 35 m northwest of the north end of the pond. This was the same observation point used for Oliktok 3N Pond (Site 22). Observations were made on June 27, July 11 and 28, and August 11.

Wildlife Observations

A pair of Pacific Loons was present for much of the summer. They nested unsuccessfully on the west side of the peninsula which divided the southern portion of the pond. The pair was observed feeding, resting, and preening on open water, and they occasionally moved through the channel to Oliktok 3N Pond (Site 22). No other waterfowl were observed on the pond but tracks and scat of ducks and/or geese were present around the perimeter.

There were few observations of shorebirds and passerines on the pond. A Black-bellied Plover and a Snow Bunting were observed at the pond edge.

SITE 24: DRILL SITE 3B POND

Location and Access

Drill Site 3B Pond (Fig. A-22) is located in the Kuparuk Unit in Sec. 16, T12N, R9E. It is immediately east of the gravel road at Drill Site 3B.

Description

Drill Site 3B Pond is elongated with a surface area of approximately 4.6 ha. It is surrounded by tundra on the north and south, and a pond system to the east. A band of disturbed tundra about 30 m wide was present on the west side between the pond and the gravel road. This area was flooded early in the season. Mud became exposed as the water level dropped. Trace amounts of emergent *Carex aquatilis* were dispersed around the edges of the pond.

Observer Station and Schedule

The observation point was located on the gravel road above the western part of the pond. Observations were made on June 28, July 14 and 29, and August 12.

Wildlife Observations

Pacific Loons were present throughout the summer. A pair had a nest which was unsuccessful in the southwestern part of the pond. Loons were present much of the time feeding, resting, and preening on open water. They used all parts of the pond.

Other waterfowl and shorebirds used the wet bays and flooded tundra on the west side of the pond. King Eiders, Northern Pintails, and Greater White-fronted Geese were feeding and resting in this area early in the season. As the water level dropped, shorebirds were commonly observed feeding in exposed mud and tundra. Numbers of individuals were higher than at most other sites in this study.

SITE 25: DRILL SITE 1A IMPOUNDMENT

Location and Access

Drill Site 1A Impoundment (Fig. A-23) is located in the Kuparuk Unit in Sec. 5, T11N, R10E. It is immediately north of the gravel pad at Drill Site 1A.

Description

Drill Site 1A Impoundment is a shallow, irregularly shaped impoundment. The portion of this impoundment that was observed was bordered on the north by a pipeline and on the west by a powerline. The southern border was a continuation of a line formed by the northern edge of Drill Site 1A pad. The eastern boundary was formed by a line from the observation point to a patch of vegetated tundra immediately west of the expansion loop in the pipeline. This portion of the impoundment had a surface area of approximately 1.7 ha. Dense emergent *Carex aquatilis* was present over much of the north-central portion of the pond. Small areas of exposed mud appeared in late summer when water levels dropped. Small vegetated islands were present on the western part of the impoundment. Aquatic invertebrates were common is some areas.

Observer Station and Schedule

The observation point was located on the Drill Site 1A gravel pad approximately 30 m east of the northwest corner. Observations were made on June 29, July 15 and 31, and August 13.

Wildlife Observations

A pair of King Eiders was present on June 30. They spent the entire morning and afternoon observation periods resting on one of the vegetated islands on the west side of the impoundment. A Greater White-fronted Goose spent the afternoon observation period feeding on *Carex* and resting in the northwest corner of the pond. No other waterfowl were observed during the study.

Shorebirds were present in small numbers throughout the summer. Red-necked Phalaropes were observed feeding on open water and often disappeared into emergent *Carex*. Baird's Sandpipers were feeding at the gravel edges of the impoundment on June 30. Semipalmated Sandpipers were observed later in the season probing in exposed mud.

SITE 26: KUPARUK 55 POND

Location and Access

Kuparuk 55 Pond (Fig. A-24) is located in Sec. 13, T11N, R11E, on the south side of the Prudhoe Bay Oilfield Spine Road approximately 24.0 km west of the BPX Base Operations Camp (BOC).

Description

Kuparuk 55 is a large, deep pond and is part of the *Arctophila* Feasibility Project. The observed area consisted of a portion (13.9 ha) of the pond at the north end. The pond has a well-defined rim and had a band of shallow, emergent *Carex aquatilis* around the perimeter. Beyond the *Carex* in deeper water, *Arctophila fulva* formed a dense cover. A large area of open water was present in the center of the pond. The Kuparuk Oil Sales Line passes through the northern edge of the pond outside the area observed.

Observer Station and Schedule

The observation point was located on the northeast rim of the pond about 60 m south of the Spine Road. The area observed included emergent vegetation on the northeast side of the pond and open water beyond. Emergent vegetation on the west side of the pond was not included. Observations were made on June 29, July 15 and 31, and August 13.

Wildlife Observations

Pacific Loons were present during all observation periods. A pair nested in dense *Arctophila* on the southeast edge of the observed area. The loons were observed feeding, resting, and preening on open water and in emergent *Arctophila*. Several other loons were usually present further south outside the area observed.

Northern Pintails were observed during much of the season. Observations were difficult because pintails were usually concealed in emergent *Arctophila* or *Carex*. A pair of Oldsquaws was observed feeding in open water on June 29.

Shorebirds were present much of the season but observation was obscured by dense emergent vegetation. Red-necked Phalaropes were active in emergent *Carex* and *Arctophila* but seemed to prefer areas of *Carex*. Most observations were of birds landing and disappearing into vegetation. Pectoral Sandpipers were also present in the area but remained in drier areas on the rim of the pond.

SITE 27: J PAD POND

Location and Access

J Pad Pond (Fig. A-25) is located in the Prudhoe Bay Unit in Sections 9 and 10, T11N, R13E, approximately 7.1 km west of the BOC. It lies immediately east of the J Pad access road, and south of the Spine Road.

Description:

The areal extent of J Pad Pond was approximately 5.0 ha. The pond is part of the *Arctophila* Feasibility Project, and is deep with abrupt edges. Thick stands of *Arctophila fulva* were located around the pond perimeter. A channel in the southeast connects J Pad Pond to another pond system to the east. Gravel roads are immediately adjacent to the northwest part of the pond. Three culverts allow water to pass under these roads. The rest of the pond is surrounded by tundra.

Observer Station and Schedule

The observation point was located on the J Pad rear access road approximately 140 m south of the Spine Road. The area observed was limited by the channel in the southeast end of the pond and is marked with a dotted line on the site map. Observations were made on June 27, July 14 and 29, and August 13.

Wildlife Observations

Waterfowl were present throughout the summer. Pacific Loons were observed during all observation periods. They were observed feeding, resting, and preening in open water in the central part of the pond, and to a lesser extent in emergent *Arctophila*. A nest located on a small peninsula in the northwest part of the pond was inactive on July 29 and may have failed. Tundra Swans had a nest east of the J Pad Pond and spent much of the day on July 14 feeding in open water and emergent vegetation near the shoreline on the northwest part of J Pad Pond. A Northern Pintail landed and disappeared in thick emergent *Arctophila* on August 13.

SITE 28: GC-1 IMPOUNDMENT

Location and Access

GC-1 Impoundment (Fig. A-26) is located in the Prudhoe Bay Unit in Sec. 13, T11N, R13E, immediately north of Gathering Center 1 (GC-1). It lies on the north side of the GC-1 Spur Road to the flare pit.

Description

GC-1 Impoundment is a large area of impounded water with an areal extent of approximately 19.0 ha. It is surrounded by gravel roads and levees. The northeast end of the area observed is bounded by the back of a flare pit; it is marked by a dotted line on the site map (Fig. A-26). The impoundment continues beyond this point. Most of the impoundment was covered by dense emergent *Carex*

aquatilis. A small area of open water on the south-central portion contained *Arctophila fulva* in several locations around the perimeter. A fence from the access road to the flare pit bisects the open water and continues through the emergent *Carex* on the eastern portion of the impoundment.

Observer Station and Schedule

The observation point was located on the gravel road south of the impoundment adjacent to the open water. Observations in much of the impoundment were obscured by dense emergent vegetation. Observations were made on June 27, July 14 and 29, and August 13.

Wildlife Observations

Waterfowl were present in small numbers. Two adult Pacific Loons spent much of the day on August 13 feeding a chick in areas where *Arctophila* was present. Prior to this, loons had been observed on only one other occasion. An eider (species unknown) was observed on a nest in emergent *Carex* on the western part of the impoundment June 27, but was not seen after this date. A Northern Pintail and two Canada Geese were also observed feeding in areas with emergent vegetation on June 27.

Shorebirds were observed in small numbers on June 27 and July 29. Red-necked Phalaropes were observed feeding on open water or landing in emergent vegetation. A Semipalmated Sandpiper was feeding at the edge of the impoundment.

SITE 29: VASCOTT POND

Location and Access

Vascott Pond (Fig. A-27) is located in the Prudhoe Bay Unit in Sec. 5, T11N, R14E, between E Pad and K Pad. It lies on the northwest side of the road approximately 200 m southwest of the access road to K Pad.

Description

Vascott Pond is a shallow pond with a surface area covering approximately 1.0 ha. It is part of the *Arctophila* Feasibility Project. *Arctophila fulva* was transplanted here in 1986 and was still present in the areas of transplant during this study. Nevertheless, it was classified as a pond without *Arctophila* due to the sparseness of the transplants. The pond is adjacent to the road on the south side and is otherwise surrounded by tundra.

Observer Station and Schedule

The observation point was located on the gravel turn-out at an expansion loop about 40 m east of the southeast corner of the pond. Observations were made on June 24, July 9 and 24, and August 8.

Wildlife Observations

Waterfowl were observed on the pond on two occasions. A Greater White-fronted Goose rested briefly at the pond edge on June 24, and two Pacific Loons were feeding and resting for 40 min on July 9.

Shorebirds were also present in small numbers. Most observations were made on August 8 when White-rumped and Pectoral sandpipers were active around the pond edge.

SITE 30: POWERLINE POND

Location and Access

Powerline Pond (Fig. A-28) is located in the Prudhoe Bay Unit in Sec. 30, T11N, R14E, between the Central Power Station and Gathering Center 3 (GC-3). It lies about 100 m from the northeast side of the Spine Road immediately east of the gathering lines from GC-3.

Description

Powerline Pond is a shallow pond with abrupt edges and covers a surface area of approximately 1.4 ha. It is part of the *Arctophila* Feasibility Project. *Arctophila fulva* was sparsely distributed on the northern, eastern, and southern parts of the pond. The gathering lines from GC-3 are adjacent to the western side, and another pond is separated from the northern part by a band of tundra.

Observer Station and Schedule

The observation point was located on tundra approximately 30 m east of the north end of the pond. Observations were made on June 24, July 9 and 24, and August 8.

Wildlife Observations

A pair of Pacific Loons was present from July 9 to the end of the study. They nested on a small island on the west-central portion of the pond. On August 8 the adults were observed feeding at least one chick.

The only shorebird species observed on the pond was Red-necked Phalarope. Scattered observations of individuals were made through most of the observation periods. Most observations were of birds feeding in areas of open water near emergent *Arctophila*.

SITE 31: LAKE CAROL

Location and Access

Lake Carol (Fig. A-29) is located in the Prudhoe Bay Unit in Sec. 33, T11N, R14E, approximately 400 m east of Pump Station 1. It lies about 50 m southwest of the Spine Road. The ARCO Flowline passes through the north end of the pond.

Description

Lake Carol is a shallow pond with abrupt edges and a surface area covering approximately 0.6 ha. It is part of the *Arctophila* Feasibility Project. *Arctophila fulva* was transplanted here in 1986, but it was not present in the areas of transplant during the summer of 1989.

Observer Station and Schedule

The observation point was located on tundra about 30 m east of the southeast part of the pond. Observations were made on June 23, July 8 and 23, and August 7.

Wildlife Observations

The only birds observed on this pond were Northern Pintails on July 8. Two adults and five young were resting and feeding in open water and around the pond edge for about 40 min. A single adult remained for much of the day.

SITE 32: DRILL SITE 7 IMPOUNDMENT

Location and Access

Drill Site 7 Impoundment (Fig. A-30) is located in the Prudhoe Bay Unit in Sec. 34, T11N, R14E, east of Drill Site 7. It lies on the east side of the Oxbow Road opposite the east pad at Drill Site 7.

Description

Drill Site 7 Impoundment is surrounded by gravel roads. It is large with a surface area covering approximately 7.9 ha. This impoundment is part of the *Arctophila* Feasibility Study. *Arctophila fulva* was transplanted in three locations in 1986 and 1987. During the summer of 1989, small stands of *Arctophila* were present but very sparse; the impoundment was classified as one without *Arctophila*. The Drill Site 15 flowlines border the eastern part of the impoundment.

Observer Station and Schedule

The observation point was located at the north end of the impoundment on the gravel road at the intersection of the Oxbow Road and the Drill Site 15 pipeline construction road. Waterfowl could be identified over the entire impoundment; shorebirds could not be identified south of the northernmost expansion loop in the Drill Site 15 flowline. Observations were made on June 23, July 8 and 23, and August 7.

Wildlife Observations

Oldsquaws were observed feeding in open water on June 23 and July 23. A King Eider was also feeding in open water on June 23. No other waterfowl were observed on the impoundment.

Scattered observations of shorebird activity were also made. Red-necked Phalaropes, Baird's Sandpipers, and Semipalmated Sandpipers were observed feeding on the gravel along the pond edge.

SITE 33: DRILL SITE 7 IMPOUNDMENT (NE)

Location and Access

Drill Site 7 Impoundment (NE) (Fig. A-30) is located in the Prudhoe Bay Unit in Sec. 34, T11N, R14E. It is immediately east of Drill Site 7 Impoundment (Site 32).

Description

Drill Site 7 Impoundment (NE) is a large impoundment. It is bordered on the west by the gravel road between the Lisburne flowline and the Drill Site 15 flowline. The east and south margins are bordered by tundra. The area observed included only the portion east of a line from the bend in the Lisburne flowline to a peninsula on the south side of the impoundment. The areal extent of the observed area was approximately 8.2 ha. This impoundment is part of the *Arctophila* Feasibility Project. *Arctophila fulva* was transplanted north of the bend in the Lisburne flowline in 1987. Sparse *Arctophila* was present in the area of transplanting. Sparse emergent *Carex aquatilis* was present along the east shoreline.

Observer Station and Schedule

The observation point was located on the gravel road at the intersection of the Oxbow Road and the Drill Site 15 pipeline construction road. This also served as the observation point for Drill Site 7 Impoundment (Site 32). Observations were made on June 23, July 8 and 23, and August 7.

Wildlife Observations

Waterfowl were observed on Drill Site 7 Impoundment (NE) through much of the summer. Pacific Loons were observed feeding on open water on June 23, and July 8 and 23. Two adult Tundra Swans with four young were feeding in open water on July 23. An Oldsquaw was active briefly in emergent vegetation along the shoreline on June 23. Five Northern Pintails were resting near the bank on July 8.

Shorebirds were observed on July 8 and 23. Red-necked Phalaropes were the most commonly observed species. They were observed feeding in emergent vegetation and open water. Baird's and Semipalmated sandpipers were observed feeding along the pond edge, particularly along the gravel road bank.

SITE 34: BP DISCOVERY WELL IMPOUNDMENT

Location and Access

BP Discovery Well Impoundment (Fig. A-31) is located in the Prudhoe Bay Unit in Sec. 27, T11N, R14E, immediately south of the access road to BP Discovery Well. It can be reached from Drill Site 7 by proceeding north on the Oxbow Road and taking the first road to left (north). BP Discovery Well Impoundment is on the west side of this road about 1.1 km north of the Oxbow Road.

Description

BP Discovery Well Impoundment is relatively shallow with a surface area covering approximately 3.1 ha. It is bordered by the BP Discovery Well access road on the north and the Drill Site 15 pipeline construction road on the east. The Drill Site 15 flowlines are on the eastern part of the impoundment adjacent to the road. This impoundment is part of the *Arctophila* Feasibility Project. *Arctophila fulva* was sparsely distributed around the edges. Emergent *Carex aquatilis* was dense on the western and southern portion of the impoundment.

Observer Station and Schedule

The observation point was located on the BP Discovery Well access road above the northeastern corner of the impoundment. Observations were made on June 22, July 7 and 22, and August 6.

Wildlife Observations

Waterfowl were observed during the first half of the summer. Up to four Greater White-fronted Geese and two Canada Geese were feeding in emergent vegetation on June 22. Also on this date, a pair of Oldsquaws was feeding in open water. Three Tundra Swans were observed feeding and resting both in emergent vegetation and open water for much of the day on July 7.

Most shorebird observations were made on July 7. Red-necked Phalaropes were feeding and resting near emergent vegetation around the impoundment edge. A Dunlin and a Semipalmated Sandpiper were also observed for a brief period feeding around the impoundment edge. A few other shorebird observations were also made on July 22.

SITE 35: BP POND

Location and Access

BP Pond (Fig. A-32) is located in the Prudhoe Bay Unit in Sec. 27, T11N, R14E, approximately 70 m south of the Putuligayuk (Put) River. It lies on the east side of the Drill Site 15 access road about 0.5 km north of the Oxbow Road.

Description

BP Pond is a small, shallow pond with a surface area covering approximately 0.6 ha. The eastern and western ends lie within a few meters of gravel roads. The northern and southern margins are surrounded by tundra. This pond is part of the *Arctophila* Feasibility Project. *Arctophila fulva* was dense over much of the surface; an area of open water was present in the center and on the north side. Observations were sometimes obscured by dense *Arctophila*. Small amounts of emergent *Carex aquatilis* were also present around the perimeter.

Observer Station and Schedule

The observation point was located on the Drill Site 15 access road above the western edge of the pond. Observations were made on June 30, July 15, and August 2 and 15.

Wildlife Observations

Waterfowl were present only on July 15. One Oldsquaw landed and remained at the pond for about 30 min.

Shorebirds were active in small numbers throughout much of the summer. Most activity occurred on August 15 when up to five Red-necked Phalaropes were observed feeding in emergent *Arctophila*. A few phalaropes were also observed earlier in the summer along with Semipalmated Sandpipers, which were feeding around the pond edge.

SITE 36: DRILL SITE 15 PIPELINE IMPOUNDMENT

Location and Access

Drill Site 15 Pipeline Impoundment (Fig. A-33) is located in the Prudhoe Bay Unit in Sec. 27, T11N, R14E, approximately 1.3 km south of Drill Site 15. It lies on the west side of the Drill Site 15 access road immediately south of the first expansion loop north of the Put River.

Description

Drill Site 15 Pipeline Impoundment has a surface area covering approximately 1.3 ha and is part of the *Arctophila* Feasibility Project. *Arctophila fulva* was present over much of the surface. Dense areas of *Arctophila* occurred on the north, west, and southwest portions of the impoundment. *Arctophila* was sparsely distributed over the remaining portion.

Observer Station and Schedule

The observation point was located on the gravel at the expansion loop overlooking the north side of the impoundment. Observations were made on June 22, July 7 and 21, and August 6.

Wildlife Observations

Most waterfowl observations were made on June 22. Two Red-throated Loons spent the entire day feeding in areas with both dense and sparse emergent *Arctophila* on the western part of the impoundment. Up to four King Eiders were also present for part of the day. The only other observations of waterfowl were on July 21 when a Red-throated Loon was present for a brief period in the afternoon.

Shorebirds were observed through much of the summer. Red-necked Phalarope was the most consistently observed species. Most phalarope observations were made on July 7 and 21. They were observed feeding, resting, and preening in emergent *Arctophila*, open water, and at the impoundment edge. Areas of consistent feeding were located in the south-central portion of the impoundment and near the gravel bank at the expansion loop. One Semipalmated Sandpiper feeding at the impoundment edge near the gravel road was the only other shorebird observed.

SITE 37: TRANSPLANT POND

Location and Access

Transplant Pond (Fig. A-34) is located in the Prudhoe Bay Unit in Sec. 26, T11N, R14E, approximately 3.0 km northeast of Drill Site 7. It can be reached by proceeding north from Drill Site 7 on the Oxbow Road, continuing northeast for approximately 1.5 km, and turning on the Lisburne Pipeline Construction Road, a

gravel road to the right. The pond is located 0.6 km down this road on the south side.

Description

Transplant Pond is a small, shallow pond with a surface area covering approximately 0.3 ha. It had been drained as late as 1972. After 1973, drainage was blocked and this pond developed. It is part of the *Arctophila* Feasibility Project and in 1985, *Arctophila fulva* was transplanted into this pond. In 1989, a few plants were observed scattered over the surface. Due to the sparseness of the transplants, this pond was classified as being without *Arctophila*. *Carex aquatilis* was also sparsely distributed around the pond edges.

Observer Station and Schedule

The observation point was located approximately 40 m southeast of the southern edge of the pond. From here both Transplant Pond and Transplant Control Pond (Site 38) could be observed. Observations were made on June 20, July 4 and 19, and August 3.

Wildlife Observation

Few observations of wildlife use at this pond were made. Two Semipalmated Sandpipers were feeding at the pond edge on July 19, and a Lapland Longspur was feeding briefly on July 4. Scat from caribou, fox, and microtine rodents were present around the pond perimeter.

SITE 38: TRANSPLANT CONTROL POND

Location and Access

Transplant Control Pond (Fig. A-34) is located in the Prudhoe Bay Unit in Sec. 26, T11N, R14E. It lies about 50 m south of Transplant Pond (Site 37). Access to this pond is described in Site 37: Transplant Pond "Location and Access".

Description

Transplant Control Pond is irregularly shaped and covers a surface area of approximately 0.7 ha. The pond is shallow with abrupt edges and is part of the *Arctophila* Feasibility Project. Sparse emergent *Carex aquatilis* was scattered around the perimeter of the pond. *Arctophila fulva* was not present.

Observer Station and Schedule

The observation point was located approximately 50 m east of the northern lobe of the pond. From here, both Transplant Control Pond and Transplant Pond (Site 37) could be observed. Observations were made on June 20, July 4 and 19, and August 3.

Wildlife Observations

Waterfowl were observed on Transplant Control Pond during the first three observation periods. A pair of Oldsquaw was feeding and resting on June 20 during the morning and afternoon. A single Oldsquaw was present on July 19. A Northern Pintail was resting at the pond edge on July 4. On July 19, two Pacific Loons were present during the afternoon. Waterfowl scat was present in two locations at the pond bank.

Shorebird activity was limited to observations of a Lesser Golden-Plover on July 20. This bird was observed feeding at the pond edge.

SITE 39: DRILL SITE 5 POND

Location and Access

Drill Site 5 Pond (Fig. A-35) is located in the Prudhoe Bay Unit in Sec. 31, T11N, R15E, approximately 250 m northwest of the northwest corner of Drill Site 5 pad. It can be seen from the gravel pad and can be reached in 5 min on foot.

Description

Drill Site 5 Pond is irregular in shape and covers a surface area of approximately 4.5 ha. It is part of the *Arctophila* Feasibility Project. A narrow band of emergent *Carex aquatilis* was present along the north and south edges. *Arctophila fulva* was dense on the northern, eastern, and southern parts of the pond and extended about 50 m from the shoreline into the pond. The western and central portions of the pond were open water. Aquatic invertebrates were common along the shoreline. On June, 20 small blocks of ice were floating in the pond center.

Observer Station and Schedule

The observation point was located on tundra about 100 m south of the pond. Drill Site 5 Trail Pond (Site 40) could also be observed from this point. Observations were made on June 20, July 4 and 19, and August 3.

Wildlife Observations

Waterfowl were observed during much of the summer. Pacific Loons were present on June 20, July 4, and August 3. One to three individuals were observed feeding, resting, and preening both in open water and emergent *Arctophila*. On July 4, two Northern Pintails and a Tundra Swan were observed feeding in emergent *Arctophila*.

SITE 40: DRILL SITE 5 TRAIL POND

Location and Access

Drill Site 5 Trail Pond (Fig. A-35) is located in the Prudhoe Bay Unit in Sec. 31, T11N, R15E, approximately 110 m west of the northwest corner of Drill Site 5 pad. It is about 50 m southeast of Drill Site 5 Pond (Site 39).

Description

Drill Site 5 Trail Pond has a surface area of approximately 1.4 ha and is part of the *Arctophila* Feasibility Project. Very sparse emergent vegetation consisted of a small stand of *Arctophila* near the south shore and *Carex aquatilis* scattered around the pond margin. Aquatic invertebrates appeared to be less common than in Drill Site 5 Pond (Site 39). Ice covered about 50% of the pond surface on June 20.

Observer Station and Schedule

The observation point was located on tundra approximately 100 m west of the pond. Drill Site 5 Pond (Site 39) was also observed from this point. Observations were made on June 20, July 4 and 19, and August 3.

Wildlife Observations

Pacific Loon and Canada Goose were the only species observed at Drill Site 5 Trail Pond. Two loons were observed resting, preening, and feeding on open water on June 20. A single loon fed briefly on July 19. A single Canada Goose was present briefly on June 20.

SITE 41: CULVERT LAKE COLEEN

Location and Access

Culvert Lake Coleen (Fig. A-36) is located in the Prudhoe Bay Unit in Sec. 24, T10N, R14E, approximately 1.1 km northwest of Deadhorse. The lake is on the left (west) side of the road from Deadhorse to Drill Site 13.

Description

Culvert Lake Coleen is a shallow pond with a surface area of approximately 4.9 ha and is part of the *Arctophila* Feasibility Project. Early in the season the area

was flooded and the surface area was greater. Dense *Arctophila fulva* covered much of the surface, but there were several areas of open water. Sparse *Carex aquatilis* was also scattered along the pond margin. A culvert on the east side supplied water from Lake Coleen. The culvert lies beneath a gravel road which forms much of the eastern boundary of the pond.

Observer Station and Schedule

The observation point was located on the gravel road approximately 30 m southeast of the culvert. The pond could be seen from this point but observations were sometimes obscured by dense *Arctophila*. Observations were made on June 21, July 6 and 20, and August 4.

Wildlife Observations

Waterfowl were present during most of the observation periods, and species richness was greater than at most sites in this study. Much of the activity was observed in open water; fewer observations were made in emergent *Arctophila*, but this may have been due to the poor visibility in dense vegetation. Feeding observations included diving by Pacific Loons, Spectacled Eiders, and Oldsquaws; and dabbling by Northern Pintails, Green-winged Teal, and Northern Shoveler. *Carex* and *Arctophila* near the road showed signs of heavy grazing. A Pacific Loon appeared to be nesting in dense emergent vegetation on the northern part of the pond on June 21, but was not observed after this date. A pair of Brant with four young was present on July 6.

Shorebirds were also observed feeding around the pond edge, in shallow areas of emergent vegetation, and in open water. They were active throughout the summer. The species observed most consistently was Red-necked Phalarope. Other species included Black-bellied Plover, Stilt Sandpiper, and Semipalmated Sandpiper.

SITE 42: DRILL SITE 12 IMPOUNDMENT

Location and Access

Drill Site 12 Impoundment (Fig. A-37) is located in the Prudhoe Bay Unit in Sec. 19, T10N, R15E, approximately 350 m southwest of Drill Site 12. It lies on the southeast side of the road from Lake Coleen to Drill Site 12.

Description

Drill Site 12 Impoundment is bordered by the road to Drill Site 12 on the north and northwest and by a gravel pad on the east. Wet tundra, which was flooded early in the season, surrounds the western and southern borders. A small area of tundra borders the northeast edge of the impoundment. The impoundment has an irregular shape with an areal extent of approximately 1.7 ha. Most of the surface area was open water during the study, although stands of emergent *Carex aquatilis* were located in several areas.

Observer Station and Schedule

The observation point was located on elevated tundra near the western edge of the pond. Observations in the northeastern portion were obscured by emergent vegetation. Observations were made on June 21, July 6 and 20, and August 5.

Wildlife Observations

Waterfowl were most active on June 21 and July 6. Up to seven Northern Pintails were feeding primarily in areas with emergent *Carex*, but also in open water. Two Oldsquaws were resting at the pond edge on June 6.

Red-necked Phalarope was the only shorebird species observed consistently during the season. Phalaropes were observed feeding, resting, and preening on open water and in emergent vegetation. Most activity occurred on June 21 and July 6, and was reduced in late season.

SITE 43: SAND DUNE LAKE

Location and Access

Sand Dune Lake (Fig. A-38) is located in the Prudhoe Bay Unit in Sec. 26, T11N, R15E, approximately 3.4 km south of East Dock. It lies about 50 m east of the gravel road to East Dock.

Description

Sand Dune Lake is a shallow pond with a surface area of approximately 1.6 ha. A small area in the center was open water; *Arctophila fulva* formed dense emergent vegetation over the rest of the surface.

Observer Station and Schedule

The observation point was located on tundra about 20 m north of the pond. Observations were made on June 18, July 3 and 17, and August 1.

Wildlife Observations

One Oldsquaw was observed feeding briefly in open water on June 18. No other wildlife was observed at this pond during the summer. However, a Red-throated Loon concealed itself in dense *Arctophila* on September 5, several weeks after the period of observation had ended.

SITE 44: EAST DOCK POND

Location and Access

East Dock Pond (Fig. A-39) is in the Prudhoe Bay Unit in Sec. 15, T11N, R15E, immediately south of the East Dock facility. It lies west of the East Dock road approximately 150 m north of the road to Drill Site L5.

Description

East Dock Pond is a small, circular pond with a surface area of approximately 3.7 ha. *Carex aquatilis* was growing adjacent to the eastern and southern shoreline. Beyond this, *Arctophila fulva* was dense on the northern, eastern and southern parts of the pond and extends about 50 m into the water from the shoreline. The western and central portions of the pond were open water. Two small areas of open water in the northeastern part of the pond were surrounded by *Arctophila fulva* and the gravel shoreline formed by the East Dock pad. Aquatic invertebrates were common along the shoreline.

Observer Station and Schedule

The observation point was located on the gravel pad above the northeast shoreline of the pond. The blind was placed to the west of a gravel mound. The entire pond could be observed, although the thick *Arctophila* sometimes concealed birds. Observations were made on June 18, July 2 and 17, and August 1.

Wildlife Observations

Waterfowl were consistently present on East Dock Pond. A pair of Pacific Loons was active for most of the day on June 18. Their activity centered around the thick emergent *Arctophila* and adjacent open water on the northern part of the pond. The loons were observed feeding, resting, and preening. During the break between morning and afternoon observation periods, the pair was observed copulating on the northwest bank of the pond.

Northern Pintails were also present on June 18 for most of the day. They remained in thick *Arctophila* on the southeastern part of the pond where most of their behavior consisted of feeding.

Two Oldsquaws were present briefly on June 18. They were observed resting at the pond edge and flew off at the beginning of the afternoon observation period. Eight Mallards landed in emergent *Arctophila* early in the afternoon observation period of August 1. They were immediately concealed by the vegetation and were not seen during the remaining portion of the observation period.

Shorebirds were active throughout the summer. Red-necked Phalaropes were observed feeding primarily in areas of emergent *Arctophila,* but also in open water. Phalaropes were present throughout the season. Baird's and Semipalmated sandpipers were occasionally observed feeding around the pond edge.

SITE 45: E-2 ARFU POND

Location and Access

E-2 ARFU Pond (Fig. A-40) is located on open access land in Sec. 3, T10N, R16E, approximately 10.4 km east of the Endicott security checkpoint. It is approximately 90 m south of the Endicott Spine Road. It can be seen from the Spine Road beyond an area of sand dunes. It is immediately west of E-2 Non-ARFU Pond (Site 46).

Description

E-2 ARFU Pond is shallow with abrupt edges and covers a surface area of approximately 2.7 ha. It is part of the *Arctophila* Feasibility Project. Dense stands of *Arctophila fulva* were located around much of the perimeter. The center of the pond was open water. *Carex aquatilis* was present near the shore.

Observer Station and Schedule

The observation point was located on tundra about 40 m north of the east end of the pond. This also served as the observation point for E-2 Non-ARFU Pond (Site 46). Observations were made on June 17, and July 1, 16, and 31.

Wildlife Observations

Waterfowl were observed on the pond in small numbers. A pair of Oldsquaws was present on open water briefly on June 17. Tundra Swans were observed briefly on July 1 and 16.

Shorebirds were observed on the pond only on July 16. A Red-necked Phalarope was feeding in open water during the afternoon.

SITE 46: E-2 NON-ARFU POND

Location and Access

E-2 Non-ARFU Pond (Fig. A-41) is located on open access land in Sec. 3, T10N, R16E. It is immediately east of E-2 ARFU Pond (Site 45).

Description

E-2 Non-ARFU Pond has a surface area covering approximately 1.6 ha and is part of the *Arctophila* Feasibility Project and emergent vegetation was absent during this study.

Observer Station and Schedule

The observation point was located on tundra approximately 80 m northwest of the western end of the pond. This also served as the observation point for E-2 ARFU Pond (Site 45). Observations were made on June 17, and July 1, 16, and 31.

Wildlife Observations

A Red Phalarope was observed feeding briefly on open water on June 17. No other observations of wildlife use were made during the summer.

SITE 47: ENDICOTT DRY AND SUMMIT IMPOUNDMENTS

Location and Access

Endicott Dry and Summit impoundments (Fig. A-42) are located on open access land in Sec. 35, T11N, R16E. They are on the southeast side of the Endicott Spine Road approximately 1.6 km northeast of the Delta State 2 Pad (Site 12). A gravel "caribou crossing" over the pipeline borders the southwest side of Summit Impoundment. Endicott Dry Impoundment is immediately to the northeast and is bordered by the Endicott Spine Road.

Description

Endicott Dry Impoundment and Summit Impoundment are two small, shallow impoundments covering a combined surface area of approximately 0.4 ha. The two impoundments were treated as one study site. They are part of the *Arctophila* Feasibility Project. *Arctophila fulva* was not present; small amounts of emergent *Carex aquatilis* were present in both impoundments. The Endicott flowline passes through both impoundments.

Observer Station and Schedule

The observation point was located on the gravel of the "caribou crossing" at the southwest end of Summit Impoundment. Observations were made on June 17, and July 1, 16, and 31.

Wildlife Observations

Waterfowl were observed only on June 17. Two Oldsquaws were observed briefly feeding and resting on open water. However, waterfowl tracks were present around the edges of the impoundments.

Shorebirds were observed throughout the summer. Most observations were made on July 31. Up to seven Semipalmated Sandpipers were observed feeding, resting, and preening around the edges of the impoundments. Smaller numbers of Semipalmated Sandpipers had been observed earlier in the summer.

Few mammals were active around the impoundments. Several arctic ground squirrel burrows were located on the embankment between the two impoundments. A ground squirrel appeared to drink from the pond on one occasion. Caribou tracks were observed around the edges of the impoundments.

Table A-1. Summary of the vegetation types and surface form units used in classifying tundra plots (after Walker et al. 1983). This information is displayed in fractional form on the maps, with the vegetation code in the numerator and the surface form code in the denominator.

VEGETATION		SURFACE FORM	
Code	Dominant Vegetation	Code	Dominant Surface Form
1	Riparian shrub tundra	1	High-centered polygons, center-relief > 0.5 m
1a	Riparian prostrate shrub, forb, grass tundra	2	High-centered polygons, center-relief ≤ 0.5 m
2	Dry prostrate shrub, crustose lichen tundra	3	Low-centered polygons, center-relief > 0.5 m
3	Moist sedge, prostrate shrub tundra	4	Low-centered polygons, center-relief ≤ 0.5 m
3a	Moist tussock sedge, prostrate shrub tundra	5	Mixed high- and low-centered polygons
4	Wet sedge tundra	6	Frost-scar tundra
5	Aquatic sedge tundra	7	Strangmoor and/or discontinuous low-centered polygons rims
5a	Aquatic grass tundra	8	Hummocky terrain associated with steep slopes
6	Riverine barrens	9	Pingo
7	Moist snowbank dwarf shrub tundra	10	Non-patterned ground or with pattern occupying < 20%
Dd	Heavily disturbed tundra with debris, gravel, vehicle tracks, thermokarst, etc.	11	Reticulate pattern
		12	Active sand dune
		A	Floodplain alluvium

Table A-2. Wildlife species observed during study of disturbed and undisturbed habitats, Arctic Alaska, 1989.

Birds		Birds (cont'd)	
Scientific Name	Common Name	Scientific Name	Common Name
Gavia pacifica	Pacific Loon	*Tryngites subruficollis*	Buff-breasted Sandpiper
Gavia stellata	Red-throated Loon	*Stercorarius pomarinus*	Pomarine Jaeger
Cygnus columbianus	Tundra Swan	*Stercorarius parasiticus*	Parasitic Jaeger
Anser albifrons	Greater White-fronted Goose	*Stercorarius longicaudus*	Long-tailed Jaeger
Branta canadensis	Canada Goose	*Larus hyperboreus*	Glaucous Gull
Branta bernicla	Brant	*Larus thayeri*	Thayer's Gull
Anas platyrhynchos	Mallard	*Xema sabini*	Sabine's Gull
Anas crecca	Green-winged Teal	*Sterna paradisaea*	Arctic Tern
Anas acuta	Northern Pintail	*Circus cyaneus*	Northern Harrier
Anas clypeata	Northern Shoveler	*Buteo lagopus*	Rough-legged Hawk
Aythya marila	Greater Scaup	*Falco peregrinus*	Peregrine Falcon
Somateria spectabilis	King Eider	*Lagopus mutus*	Rock Ptarmigan
Somateria fischeri	Spectacled Eider	*Lagopus lagopus*	Willow Ptarmigan
Clangula hyemalis	Oldsquaw	*Asio flammeus*	Short-eared Owl
Charadrius semipalmatus	Semipalmated Plover	*Nyctea scandiaca*	Snowy Owl
Pluvialis squatarola	Black-bellied Plover	*Corvus corax*	Common Raven
Pluvialis dominica	Lesser Golden-Plover	*Anthus spinoletta*	Water Pipit
Limosa lapponica	Bar-tailed Godwit	*Motacilla flava*	Yellow Wagtail
Phalaropus lobatus	Red-necked Phalarope	*Passerculus sandwichensis*	Savannah Sparrow
Phalaropus fulicaria	Red Phalarope	*Calcarius lapponicus*	Lapland Longspur
Limnodromus scolopaceus	Long-billed Dowitcher	*Plectrophenax nivalis*	Snow Bunting
Calidris himantopus	Stilt Sandpiper	*Carduelis flammea*	Common Redpoll
Gallinago gallinago	Common Snipe		
Arenaria interpres	Ruddy Turnstone	Mammals	
Calidris alpina	Dunlin		
Calidris pusilla	Semipalmated Sandpiper	*Dicrostonyx groenlandicus*	Collared Lemming
Calidris minutilla	Least Sandpiper	*Spermophilus parryii*	Arctic Ground Squirrel
Calidris fuscicollis	White-rumped Sandpiper	*Alopex labopus*	Arctic Fox
Calidris bairdii	Baird's Sandpiper	*Rangifer tarandus*	Caribou
Calidris melanotos	Pectoral Sandpiper	*Alces alces*	Moose

Table A-3. Checklist of vascular plant taxa found on gravel pads and alluvium during study of disturbed and undisturbed habitats, Arctic Alaska, 1989.

SPECIES	Site: West Sak 3	West Sak 4	West Sak 9	West Sak 11	West Sak 17	Put State 1	Hurl State Pad	Ugnu 1	Delta State 2	Sag Delta 31-11-16	Sag Delta 2	Kemik 1	Kemik 2	Lake State 1	Sag River 2	Sag River 3 & 4	Kup River 1	Kup River 3
Graminoids																		
Agropyron macrourum	X											X					X	
Agropyron yukonense																	X	
Alopecurus alpinus		X				X				X				X			X	
Arctagrostis latifolia	X					X			X	X		X	X	X		X	X	
Bromus Pumpellianus	X					X						X					X	
Calamagrostis canadensis																	X	
Carex aquatilis		X			X	X		X		X						X	X	
Carex Biglowii																	X	
Carex capitata		X								X							X	
Carex rotundata																		
Carex sp.	X	X	X	X		X	X											
Deschampsia caespitosa										X				X		X	X	X
Elymus arenarius										X								
Eriophorum angustifolium								X										
Eriophorum vaginatum	X								X						X	X	X	X
Festuca baffinensis						X			X					X		X		
Festuca brachyphylla	X							X				X						
Festuca rubra								X									X	
Festuca vivipara						X		X		X	X						X	
Hierchloe alpina								X										
Juncus arcticus		X				X	X			X		X	X		X		X	
Juncus sp.								X										
Kobresia myosuroides												X						
Luzula arctica	X																	
Luzula multiflora								X										
Luzula tundricola								X										
Poa arctica				X							X	X					X	
Poa glauca												X						
Poa lanata								X										
Poa sp.	X							X		X								
Puccinellia Langeana														X				
Puccinellia sp.	X			X					X									
Trisetum spicatum				X		X				X		X		X			X	X

cont.

Table A-3. Cont.

SPECIES	Site: West Sak 3	West Sak 4	West Sak 9	West Sak 11	West Sak 17	Put State 1	Hurl State Pad	Ugnu 1	Delta State 2	Sag Delta 31-11-16	Sag Delta 2	Kemik 1	Kemik 2	Lake State 1	Sag River 2	Sag River 3 & 4	Kup River 1	Kup River 3
Forbs																		
Androsace septentrionalis												X						
Arabis arenicola	X									X		X		X				
Armeria maritima						X				X						X	X	
Artemisia alaskana																X		
Artemisia arctica	X															X	X	
Artemisia borealis						X				X	X			X		X	X	X
Artemisia glomerata						X										X	X	X
Artemisia Tilesii		X					X			X	X	X				X	X	X
Artemisia sp.							X		X			X	X				X	
Aster sibiricus										X			X		X		X	
Astragalus alpinus	X								X					X				
Astragalus sp.		X																
Braya humilis		X		X														
Braya pilosa			X						X		X				X			
Braya purpurascens			X	X										X				
Braya sp.	X	X																
Cardamine sp.										X								
Cerastium Beeringianum		X				X		X	X			X		X			X	X
Chrysanthemum integrifolium		X	X	X			X		X	X				X		X	X	X
Cochlearia officinalis								X						X	X	X		
Crepis nana		X	X				X						X					X
Descurainia sophoides												X						
Draba alpina	X		X	X		X			X	X								X
Draba cinerea	X	X				X		X										X
Draba hirta								X										
Draba lactea	X	X	X			X	X	X	X								X	X
Draba macrocarpa				X	X				X									
Draba sp.								X						X				
Epilobium angustifolium													X					
Epilobium latifolium		X	X	X		X	X		X			X	X	X		X	X	X
Equisetum arvense														X				
Equisetum pratense		X										X	X			X	X	X
Equisetum variegatum												X						
Erigeron grandiflorus						X											X	
Erysimum sp.												X						
Eutrema Edwardsii	X	X	X		X									X				
Gentiana propinqua												X					X	
Hedysarum Mackenzii																X		
Hedysarum sp.		X										X	X					
Lupinus sp.													X					
Melandrium apetalum	X	X	X	X	X	X	X		X					X		X	X	

cont.

Table A-3. Cont.

SPECIES	West Sak 3	West Sak 4	West Sak 9	West Sak 11	West Sak 17	Put State 1	Hurl State Pad	Ugnu 1	Delta State 2	Sag Delta 31-11-16	Sag Delta 2	Kemik 1	Kemik 2	Lake State 1	Sag River 2	Sag River 3 & 4	Kup River 1	Kup River 3
Forbs (cont.)																		
Minuartia arctica										X				X				
Minuartia obtusiloba			X	X		X				X		X	X			X	X	X
Minuartia sp.		X															X	
Oxyria digyna							X											X
Oxytropis arctica							X		X							X		X
Oxytropis dellexa																	X	
Oxytropis Maydelliana	X																	
Oxytropis nigrescens																		X
Oxytropis sp.						X						X	X				X	
Papaver Hultenii		X				X												
Papaver lapponicum	X	X															X	X
Papaver Macounii		X		X					X							X		X
Papaver sp.			X											X				X
Parrya nudicalis	X			X		X	X			X								
Pedicularis Kanei						X										X		
Pedicularis sudetica																	X	
Pedicularis sp.										X								
Polemonium boreale							X										X	
Polygonum bistorta		X															X	
Polygonum viviparum	X	X				X		X						X		X	X	
Potentilla Hookeriana											X							
Potentilla pulchella								X										
Potentilla uniflora						X						X					X	
Ranunculas nivalis								X										
Sagina intermedia		X						X						X		X		
Saussurea angustifolia				X					X									
Saussurea viscida		X																
Saxifraga caespitosa														X				
Saxifraga cernua		X	X	X	X			X	X									
Saxifraga hieracifolia			X			X												
Saxifraga hirculus	X		X			X	X	X									X	
Saxifraga oppositifolia	X	X	X	X		X			X					X		X	X	
Saxifraga tricuspidata										X		X						
Sedum rosea										X								
Senecio atropurpureus								X										
Senecio resedifolius										X								X
Silene acaulis		X	X							X				X			X	X
Solidago multiradiata		X											X		X			
Stellaria Edwardsii			X					X										
Stellaria monantha	X			X								X			X	X	X	
Stellaria sp.												X		X				
Tripleurospermum phaeocephalum			X															
Wilhelmsia physodes							X									X	X	

cont.

Table A-3. Cont.

SPECIES	Site																	
	West Sak 3	West Sak 4	West Sak 9	West Sak 11	West Sak 17	Put State 1	Hurl State Pad	Ugnu 1	Delta State 2	Sag Delta 31-11-16	Sag Delta 2	Kemik 1	Kemik 2	Lake State 1	Sag River 2	Sag River 3 & 4	Kup River 1	Kup River 3
SHRUBS																		
Dryas integrifolia	X	X	X			X							X	X		X	X	X
Potentilla fruticosa												X						
Salix arctica								X						X			X	
Salix fuscedscens									X									
Salix glauca													X					X
Salix ovalifolia								X						X		X		
Salix reticulata			X			X							X					
Salix rotundifolia			X			X	X									X	X	
Salix sp.	X	X				X		X		X	X	X						X
Sherperdia canadensis												X						

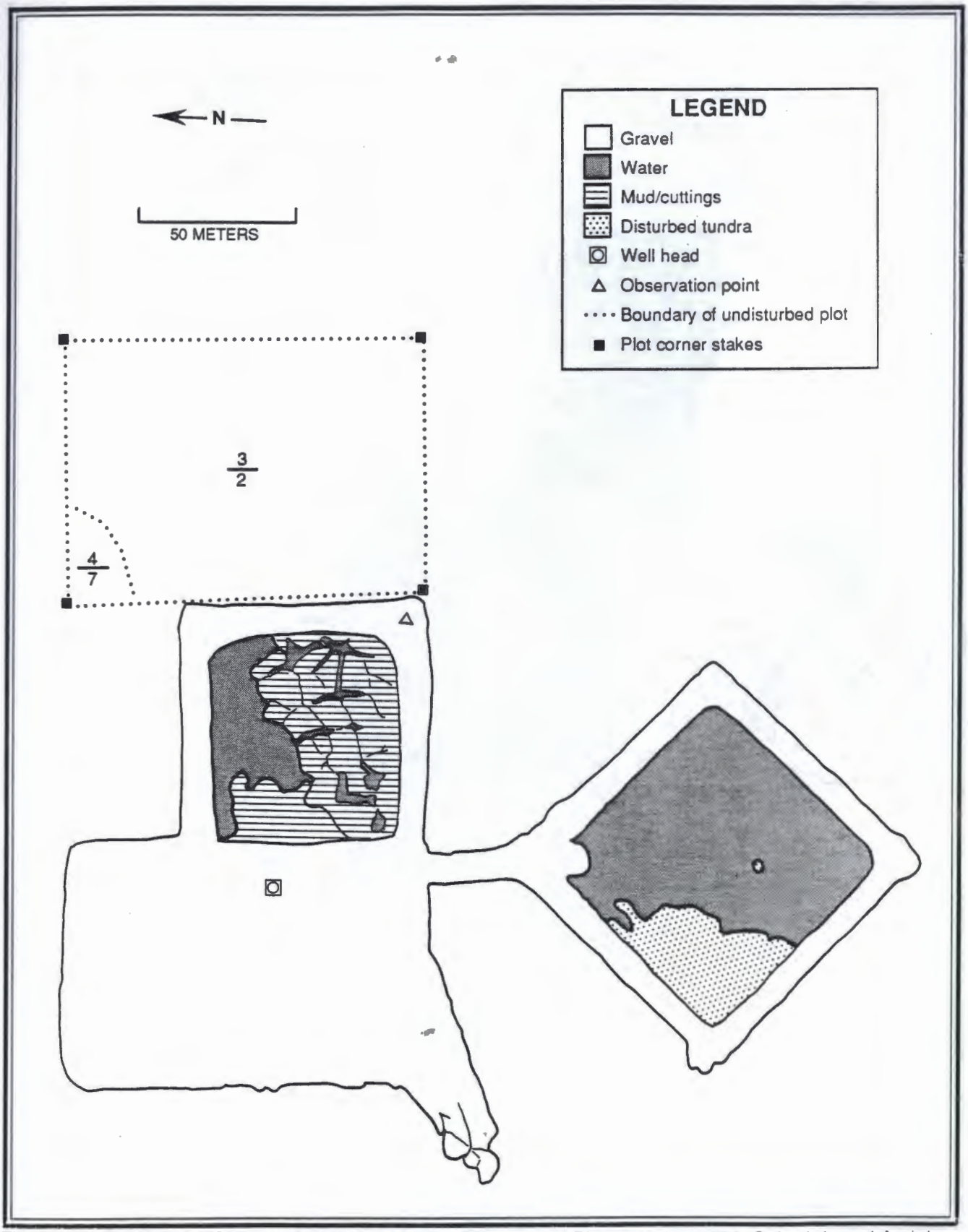


Fig. A-1. West Sak 17 (Site 1). Produced from Exploration Well Photography, 1989, Color Infrared Aerial Photography, 1:500. (Photography by Aeromap U.S., Anchorage, AK.)

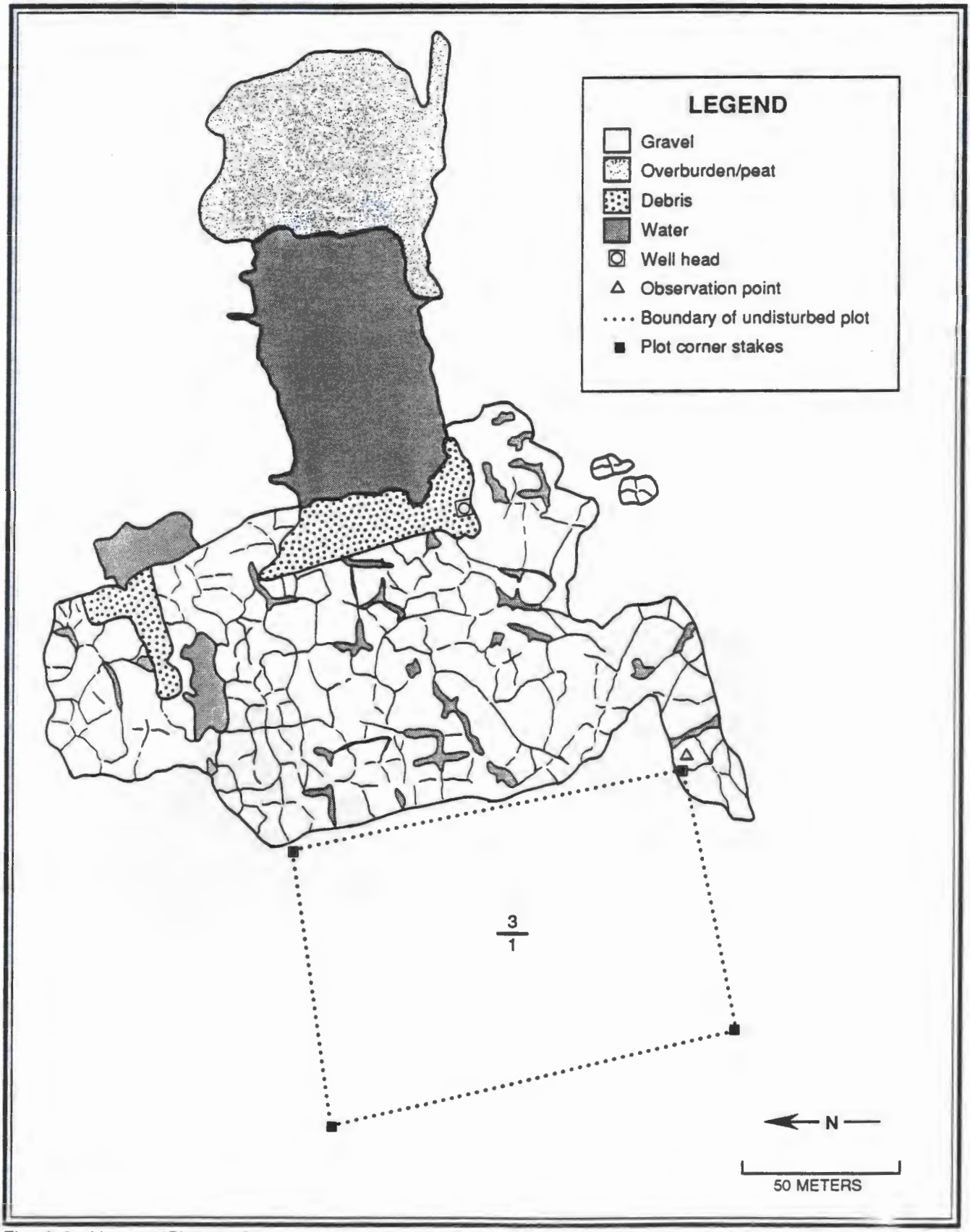


Fig. A-2. Ugnu 1 (Site 2). Produced from Exploration Well Photography, 1989, Color Infrared Aerial Photography, 1:500. (Photography by Aeromap U.S., Anchorage, AK.)

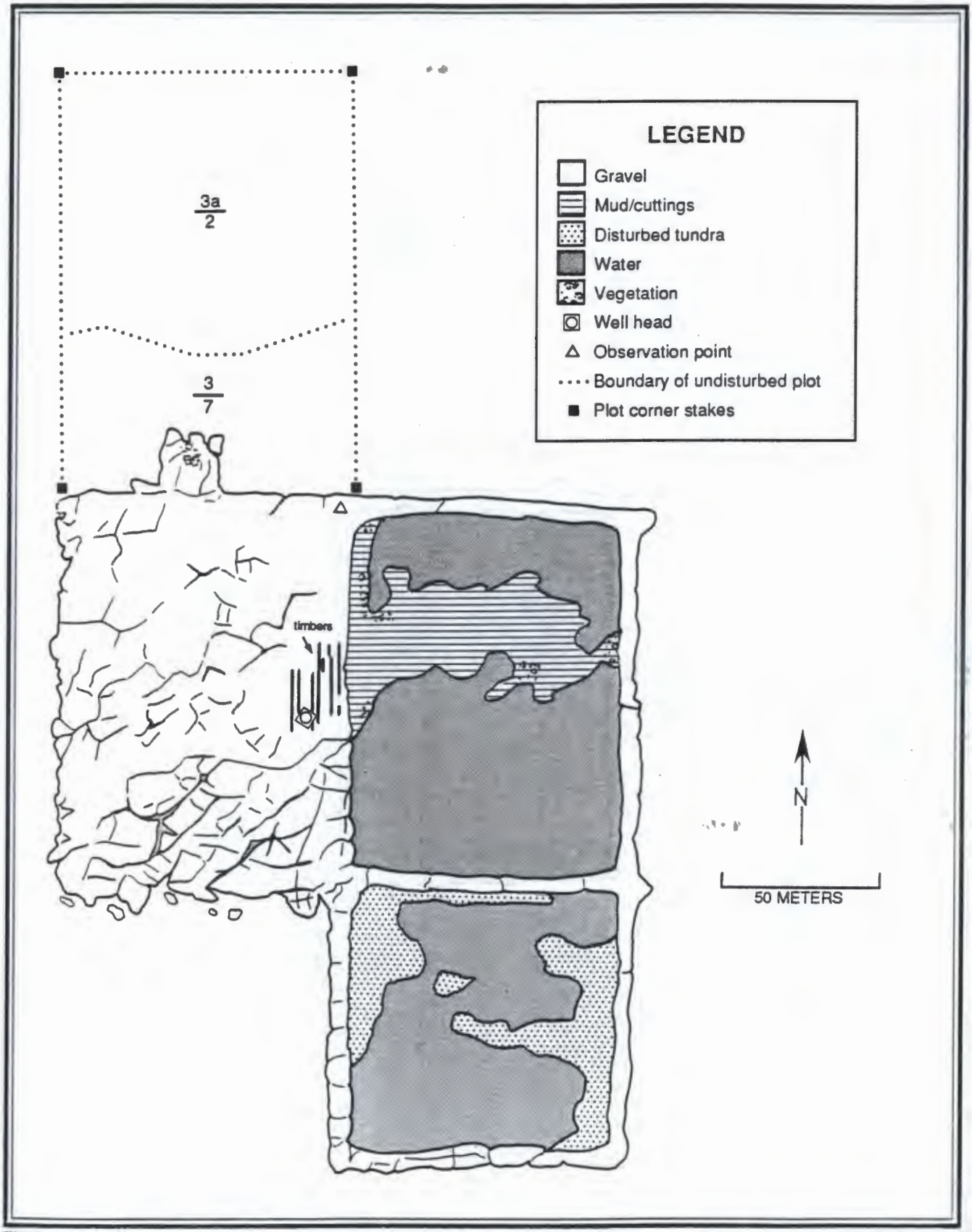


Fig. A-3. West Sak 11 (Site 3). Produced from Exploration Well Photography, 1989, Color Infrared Aerial Photography, 1:500. (Photography by Aeromap U.S., Anchorage, AK.)

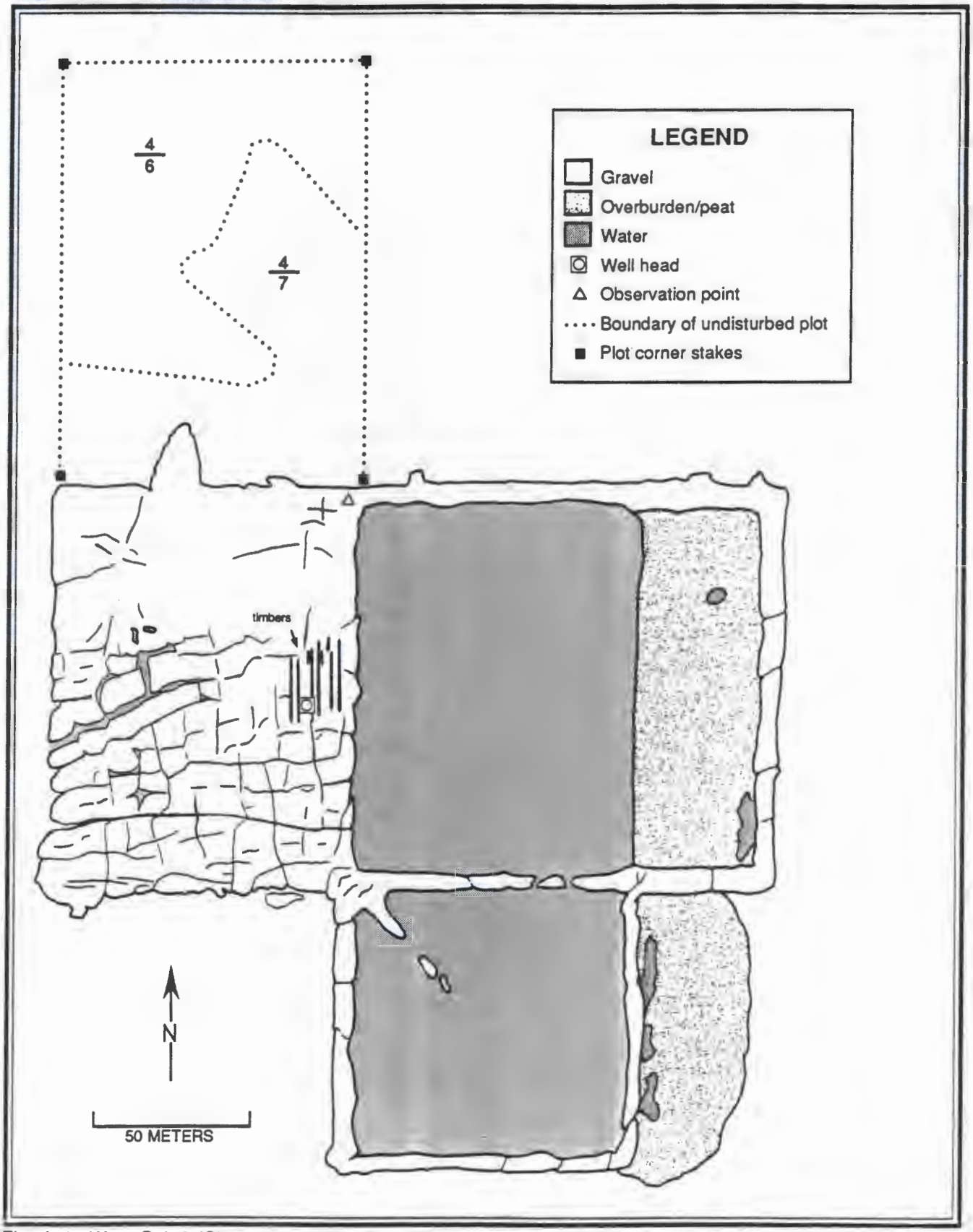


Fig. A-4. West Sak 9 (Site 4). Produced from Exploration Well Photography, 1989, Color Infrared Aerial Photography, 1:500. (Photography by Aeromap U.S., Anchorage, AK.)

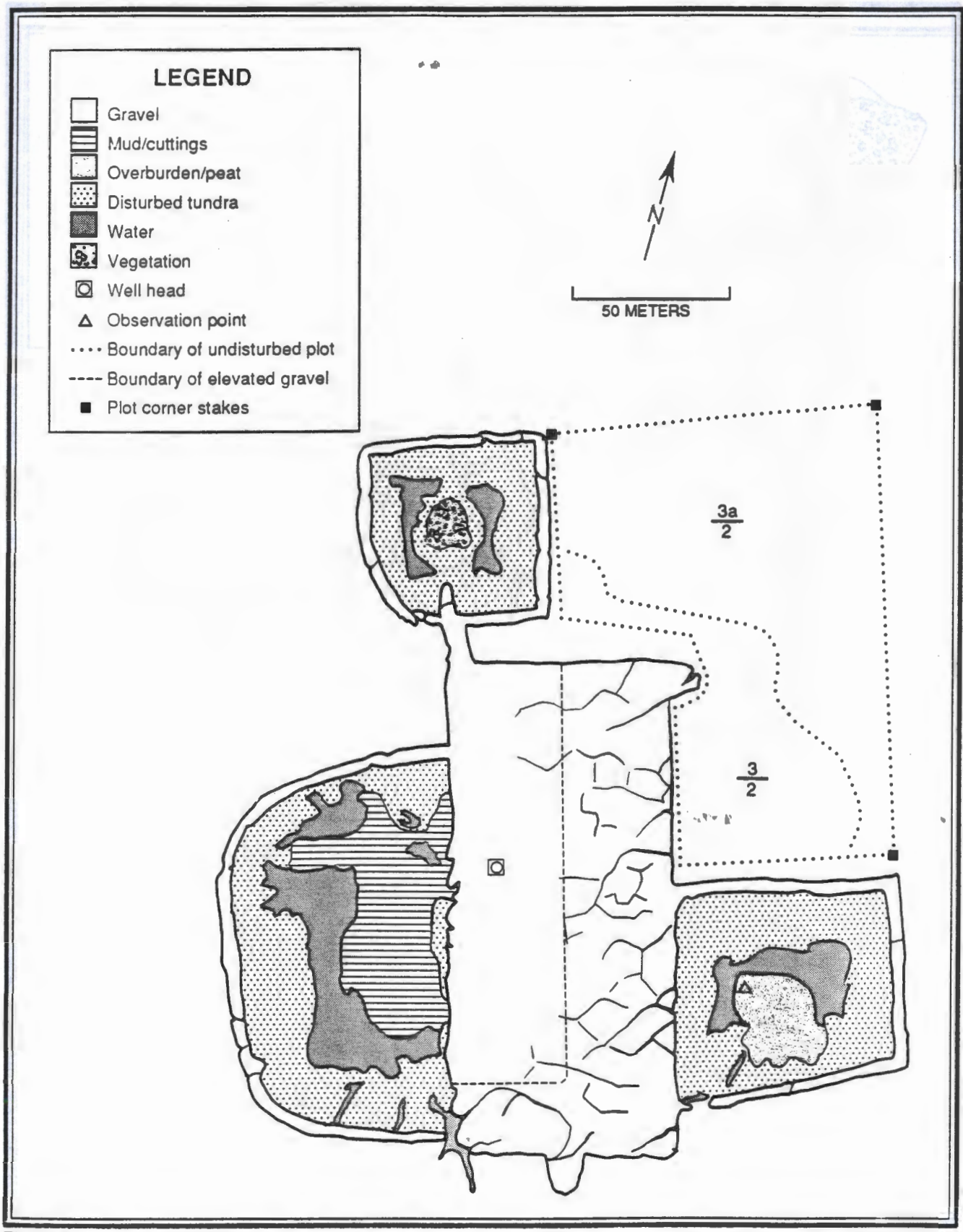


Fig. A-5. West Sak 3 (Site 5). Produced from Exploration Well Photography, 1989, Color Infrared Aerial Photography, 1:500. (Photography by Aeromap U.S., Anchorage, AK.)

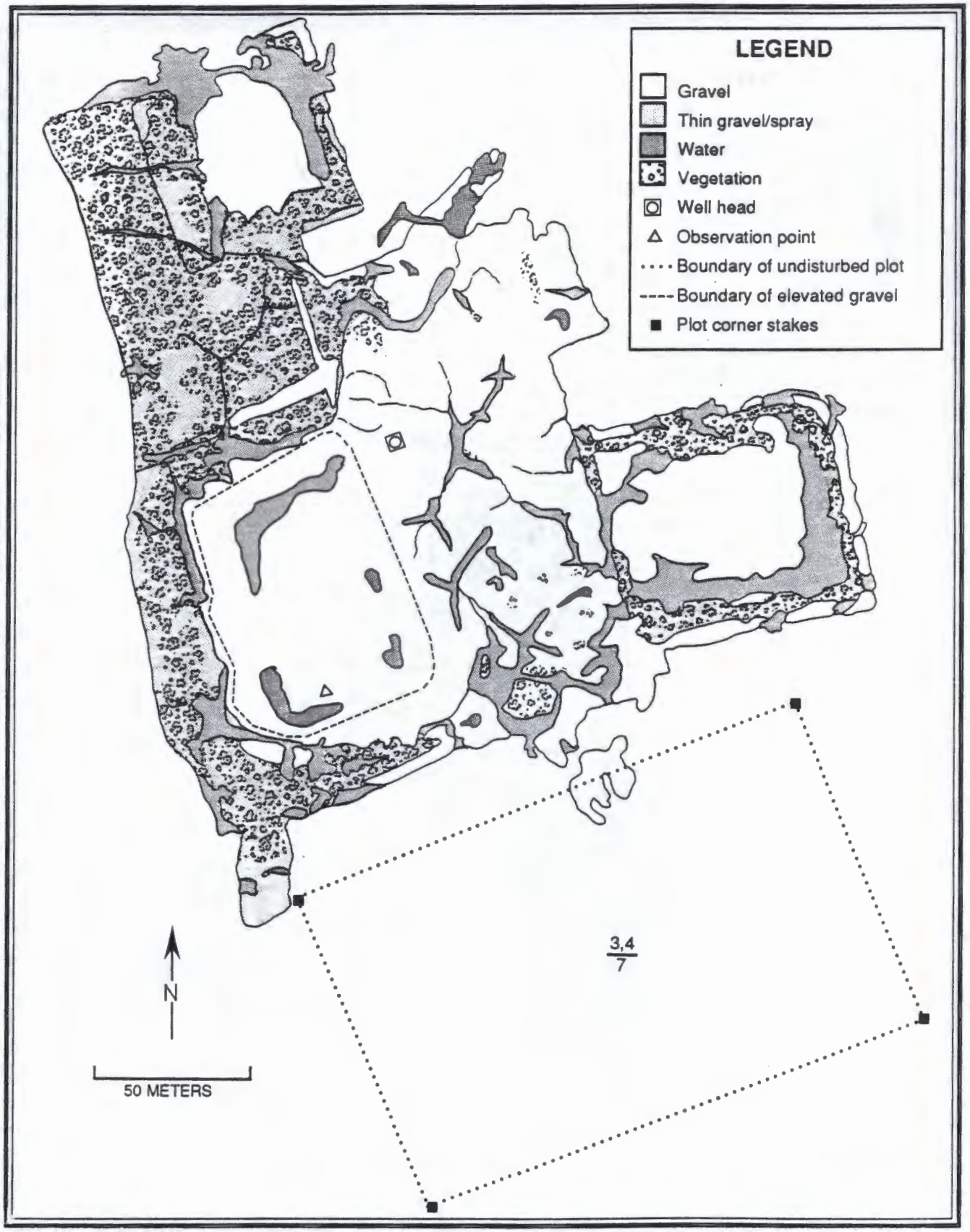


Fig. A-6. West Sak 4 (Site 6). Produced from Exploration Well Photography, 1989, Color Infrared Aerial Photography, 1:500. (Photography by Aeromap U.S., Anchorage, AK.)

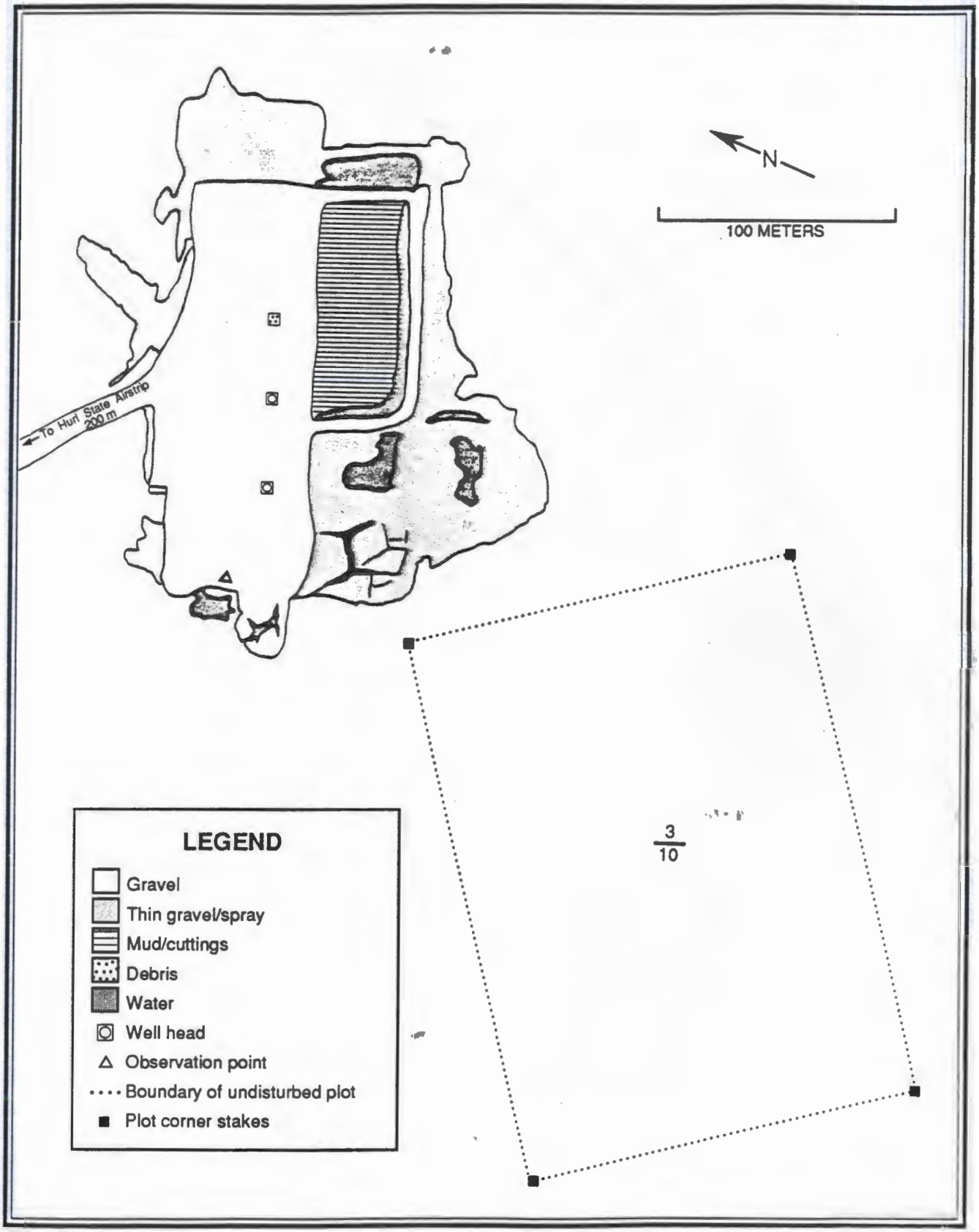


Fig. A-7. Hurl State (Site 7). Produced from Prudhoe Bay Color Infrared Aerial Photography. 1988. 1:500. flightline 33, frame 12. (Photography by Aeromap U.S., Anchorage, AK.)

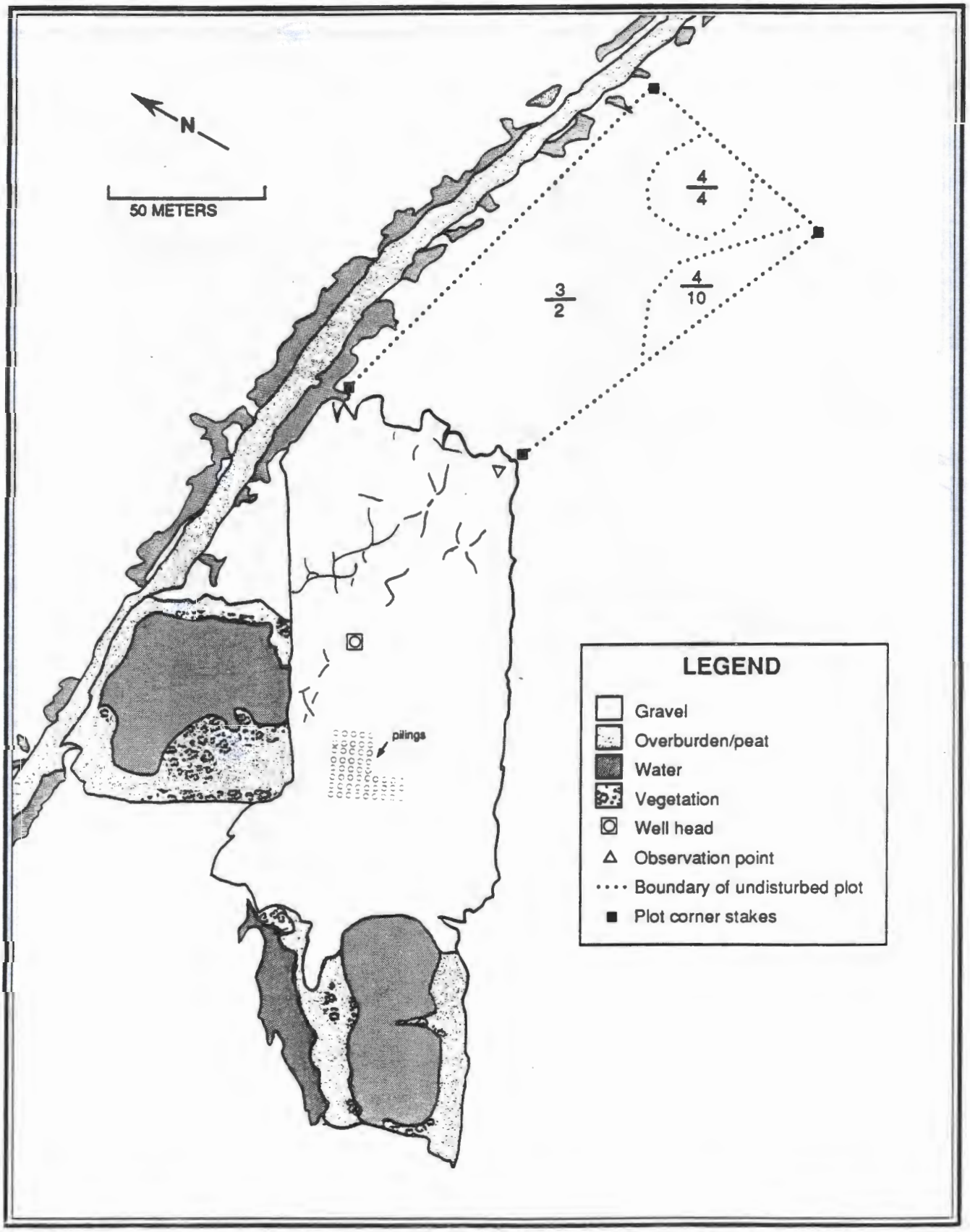


Fig. A-8. Put River 1 (Site 8). Produced from Prudhoe Bay Color Infrared Aerial Photography. 1988. 1:500. flightline 16, frame 15. (Photography by Aeromap U.S., Anchorage, AK.)

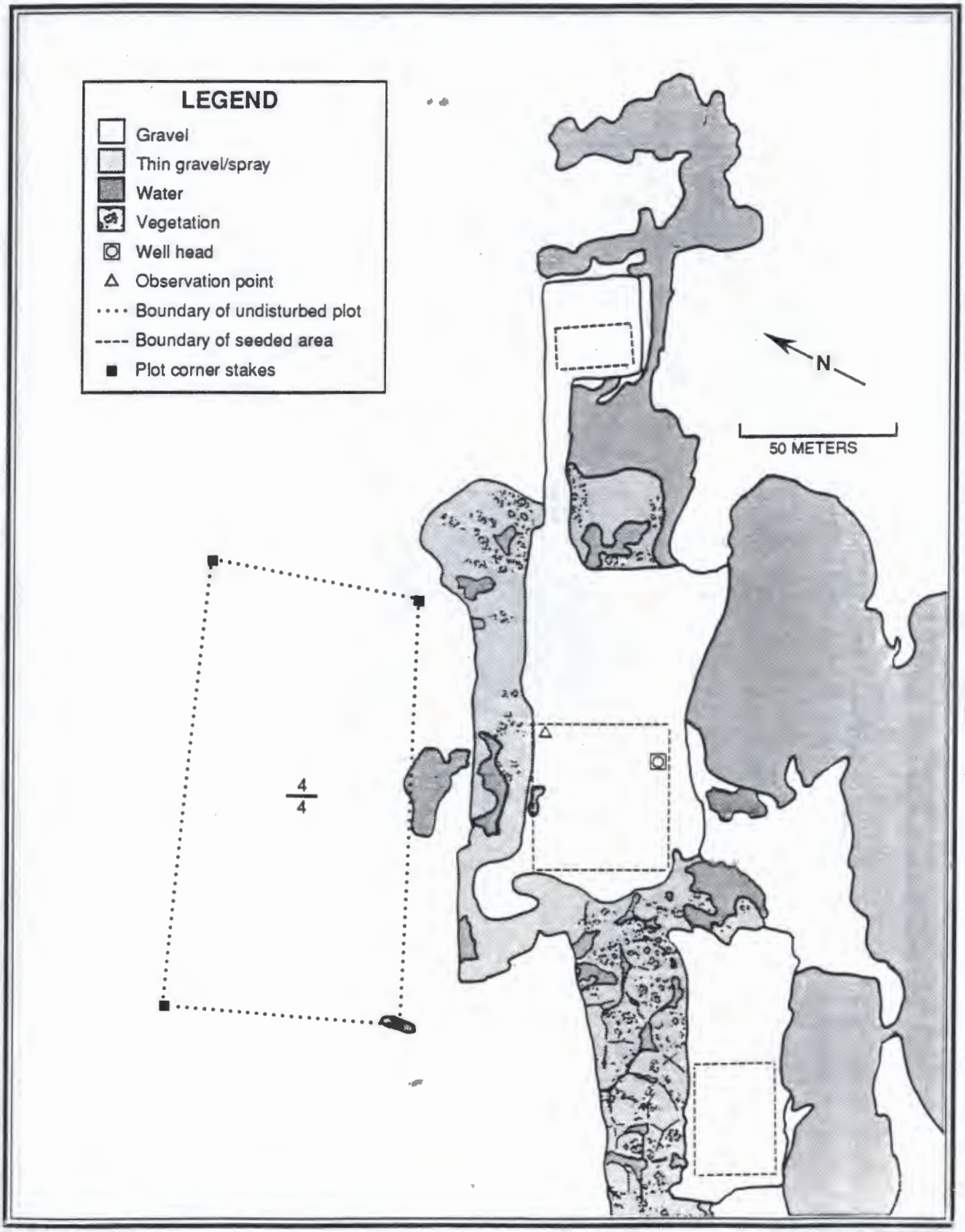


Fig. A-9. Lake State 1 (Site 9). Produced from Prudhoe Bay / Duck Island Color Infrared Aerial Photography, 1989, 1:500, flightline 53, frame 6. (Photography by Aeromap U.S., Anchorage, AK.)

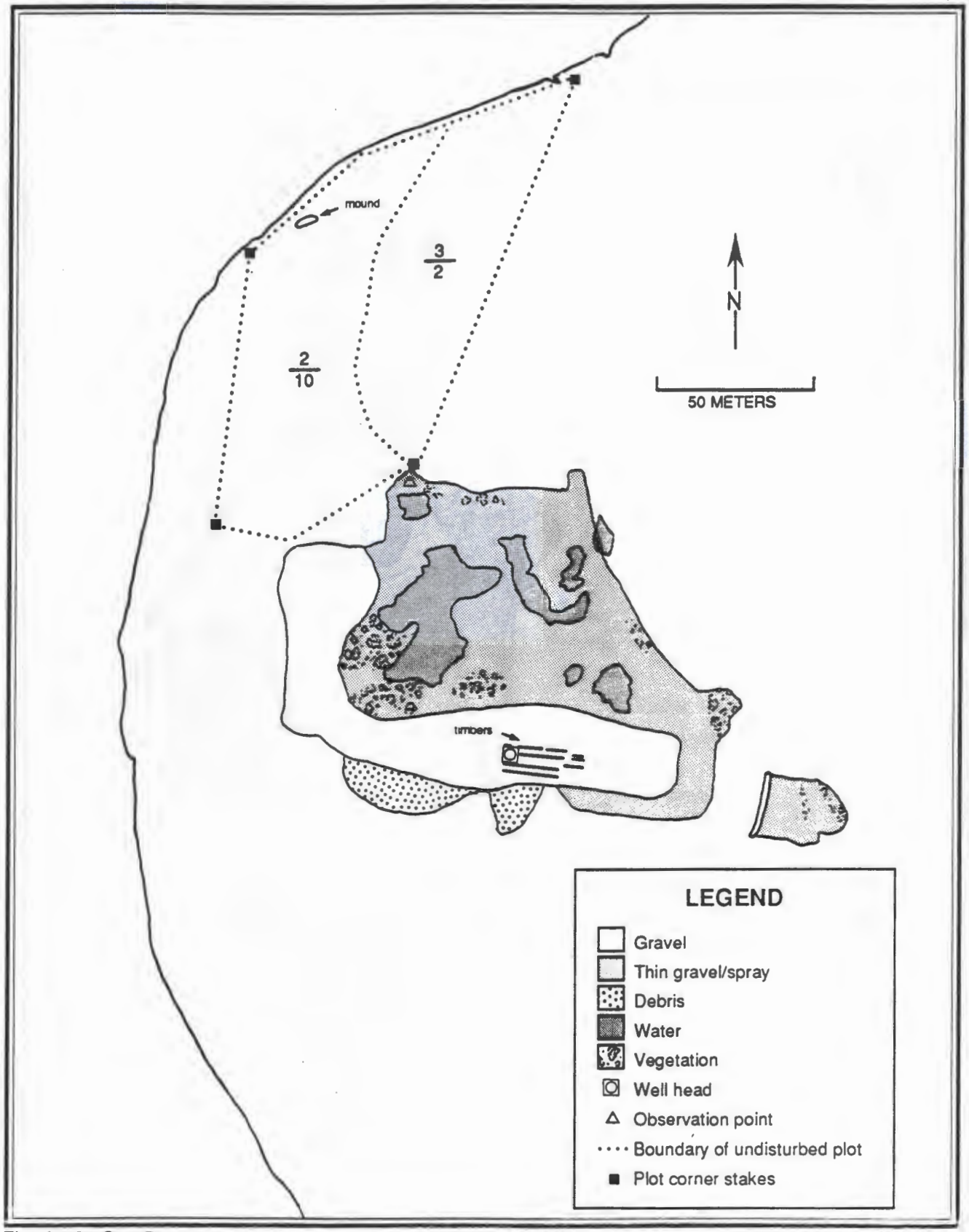


Fig. A-10. Sag Delta 31-11-16 (Site 10). Produced from Exploration Well Photography, 1989, Color Infrared Aerial Photography, 1:500. (Photography by Aeromap U.S., Anchorage, AK.)

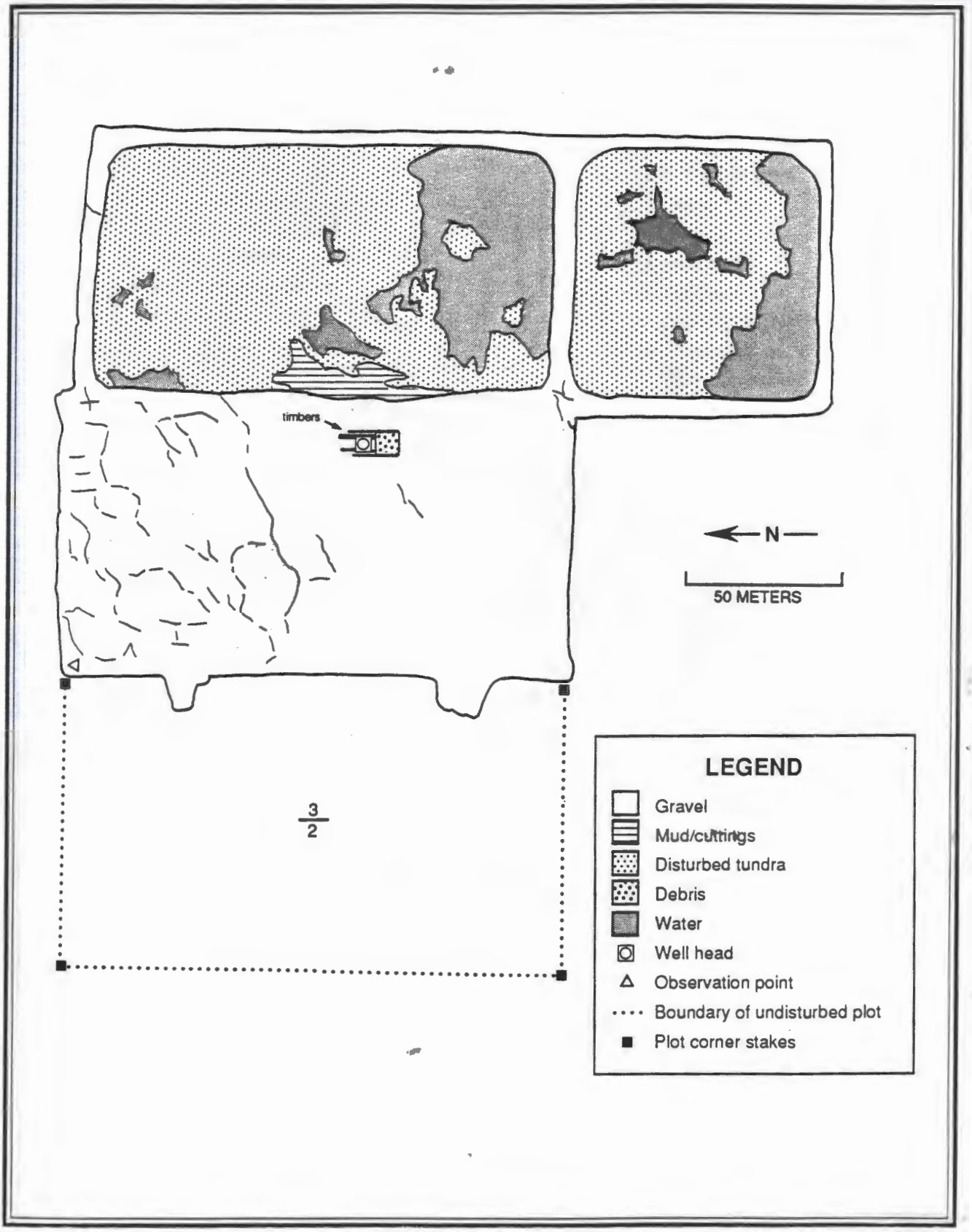


Fig. A-11. Sag Delta 2 & 2a (Site 11). Produced from Exploration Well Photography, 1989, Color Infrared Aerial Photography, 1:500. (Photography by Aeromap U.S., Anchorage, AK.)

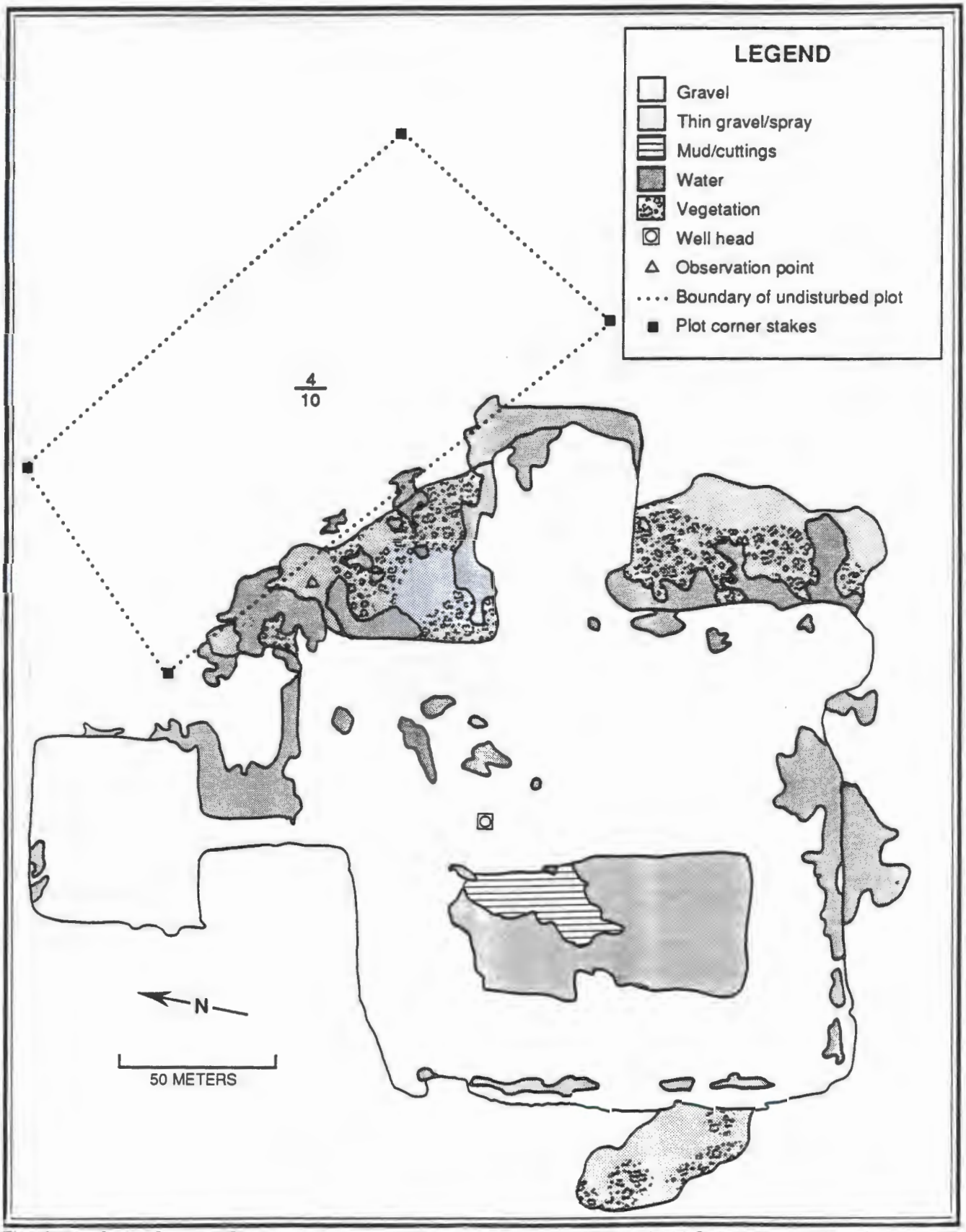


Fig. A-12. Delta State 2 (Site 12). Produced from Prudhoe Bay / Duck Island Color Infrared Aerial Photography, 1989, 1:500, flightline 39, frame 4. (Photography by Aeromap U.S., Anchorage, AK.)

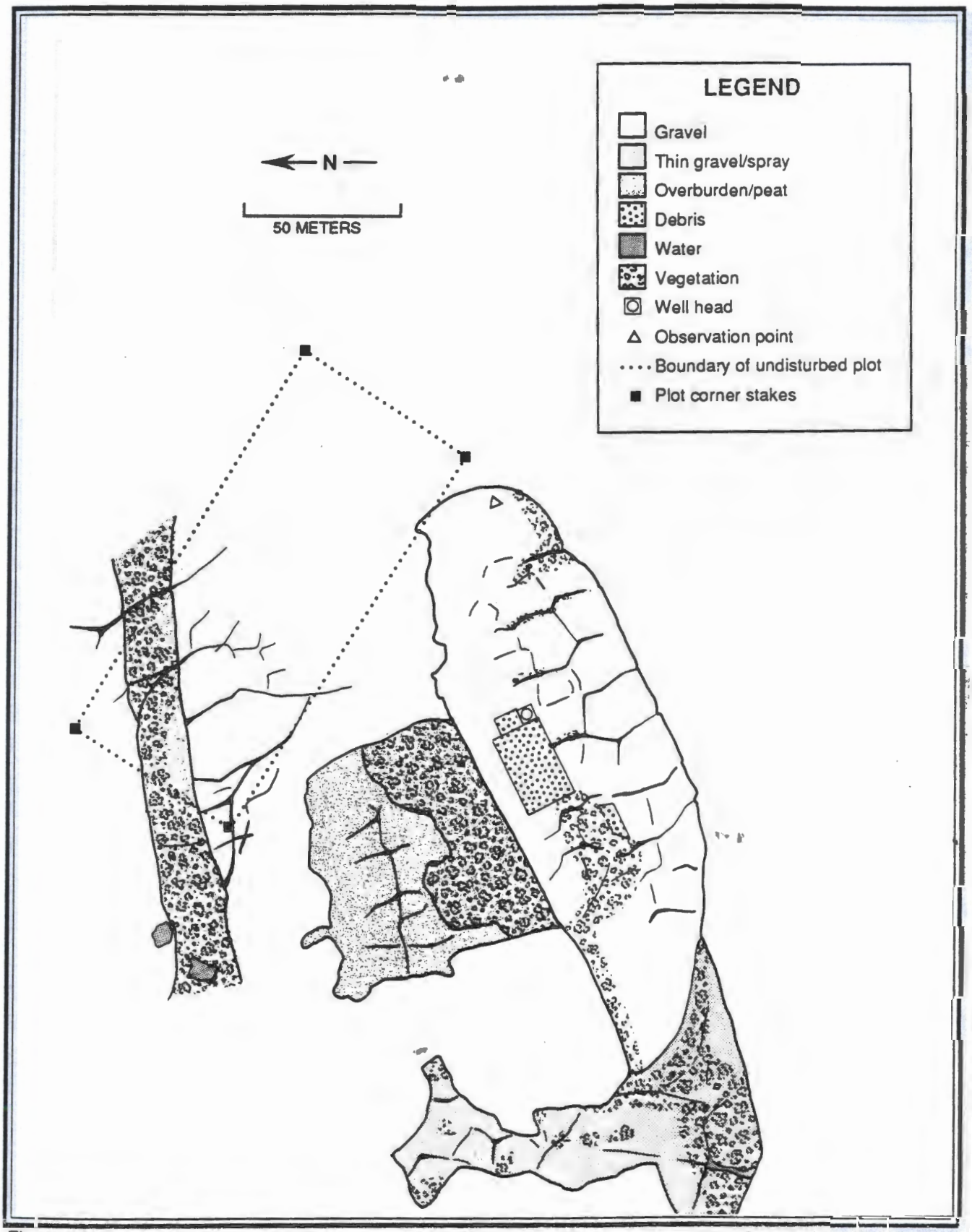


Fig. A-13. Kemik 1 (Site 13). Produced from Exploration Well Photography, 1989, Color Infrared Aerial Photography, 1:500. (Photography by Aeromap U.S., Anchorage, AK.)

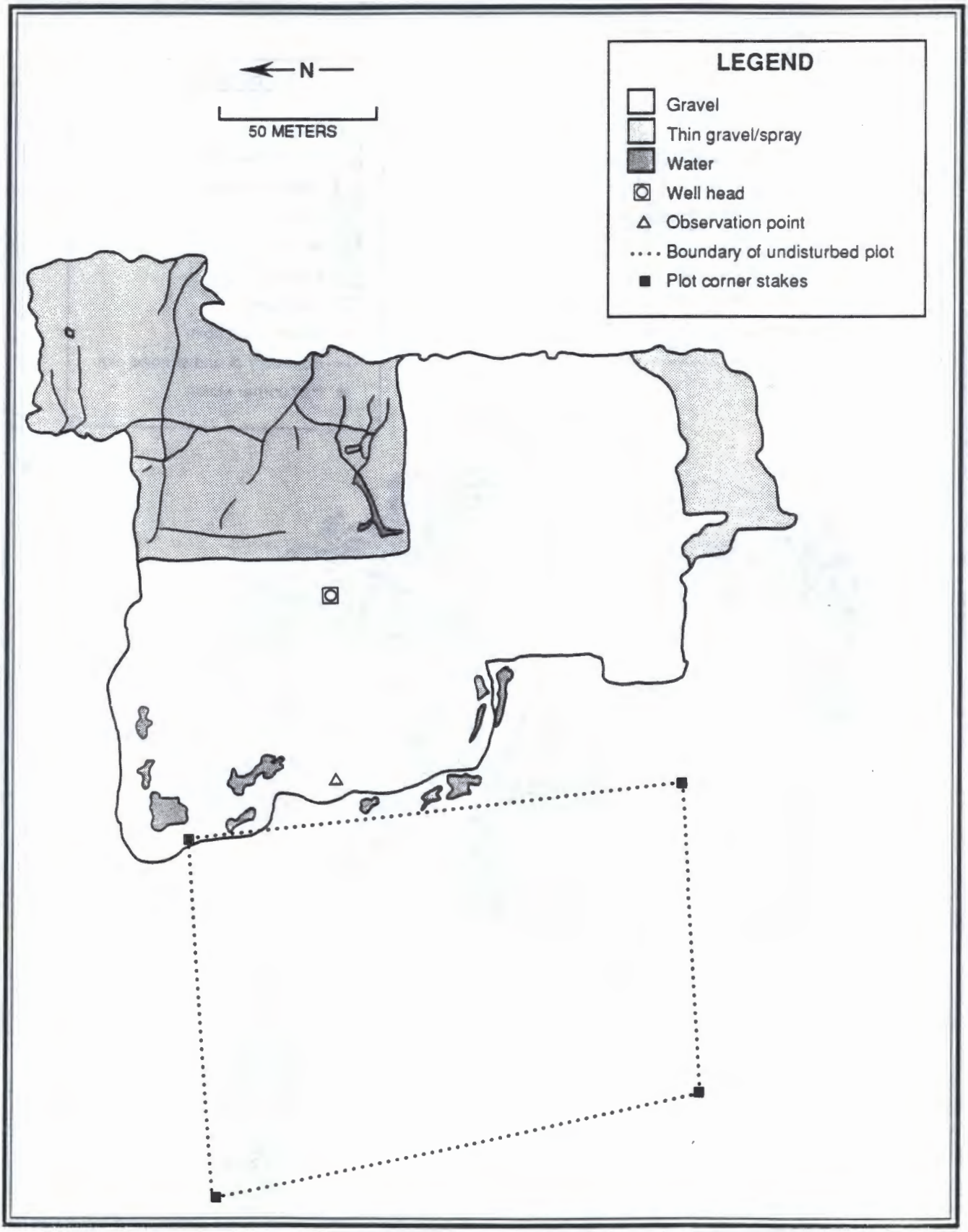


Fig. A-14. Kemik 2 (Site 14). Produced from Exploration Well Photography, 1989, Color Infrared Aerial Photography, 1:500. (Photography by Aeromap U.S., Anchorage, AK.)

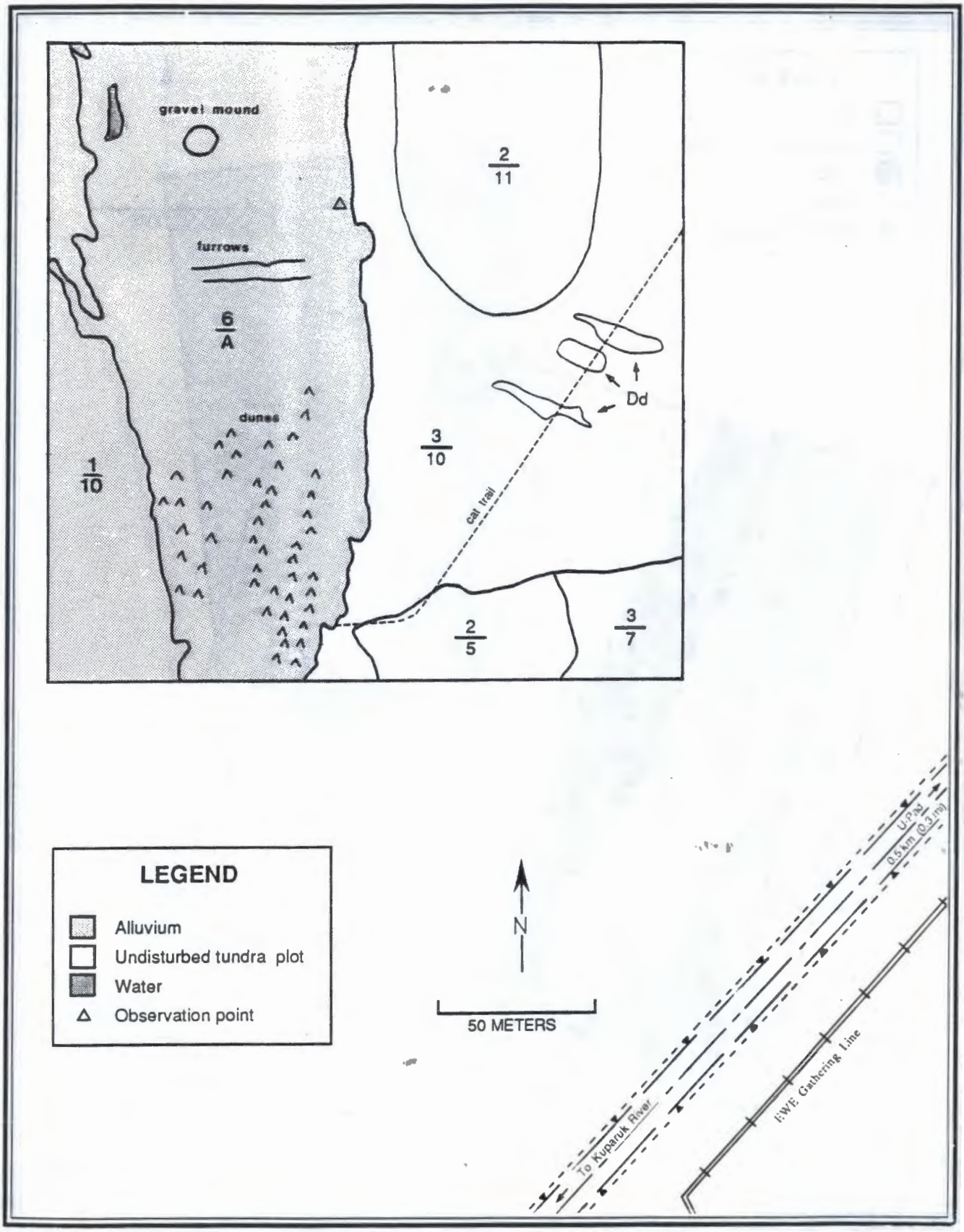


Fig. A-15. Kuparuk River 1 (Site 15). Produced from Prudhoe Bay Color Infrared Aerial Photography, 1988. 1:500, flightline 26, frame 4. (Photography by Aeromap U.S., Anchorage, AK.)

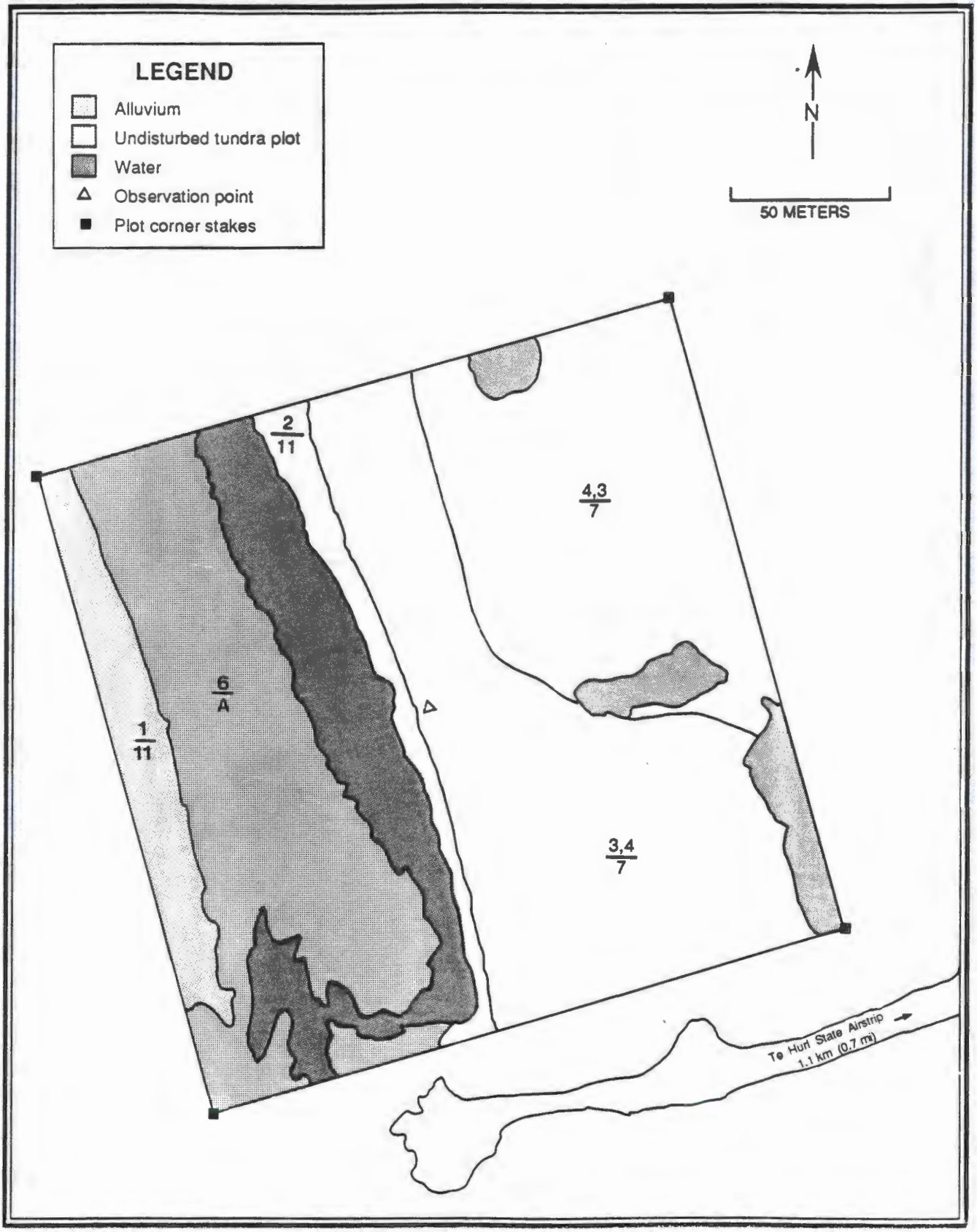


Fig. A-16. Kuparuk River 3 (Site 16). Produced from Prudhoe Bay / Duck Island Color Aerial Photography, 1989, 1:1500, flighline 12, frame 24. (Photography by Aeromap U.S., Anchorage, AK.)

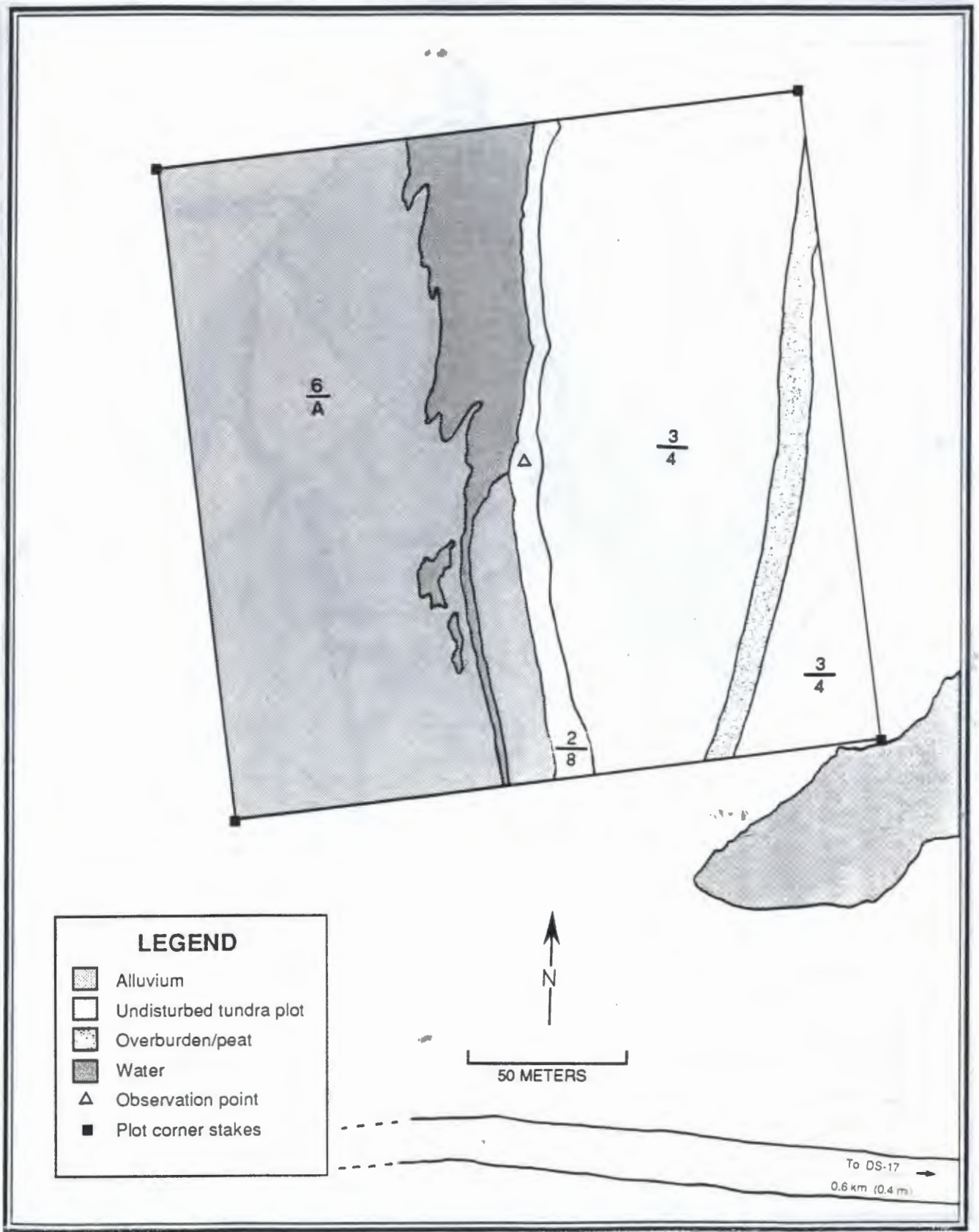


Fig. A-17. Sag River 3 (Site 17). Produced from Prudhoe Bay / Duck Island Color Infrared Aerial Photography, 1989, 1:500, flightline 54, frame 3. (Photography by Aeromap U.S., Anchorage, AK.)

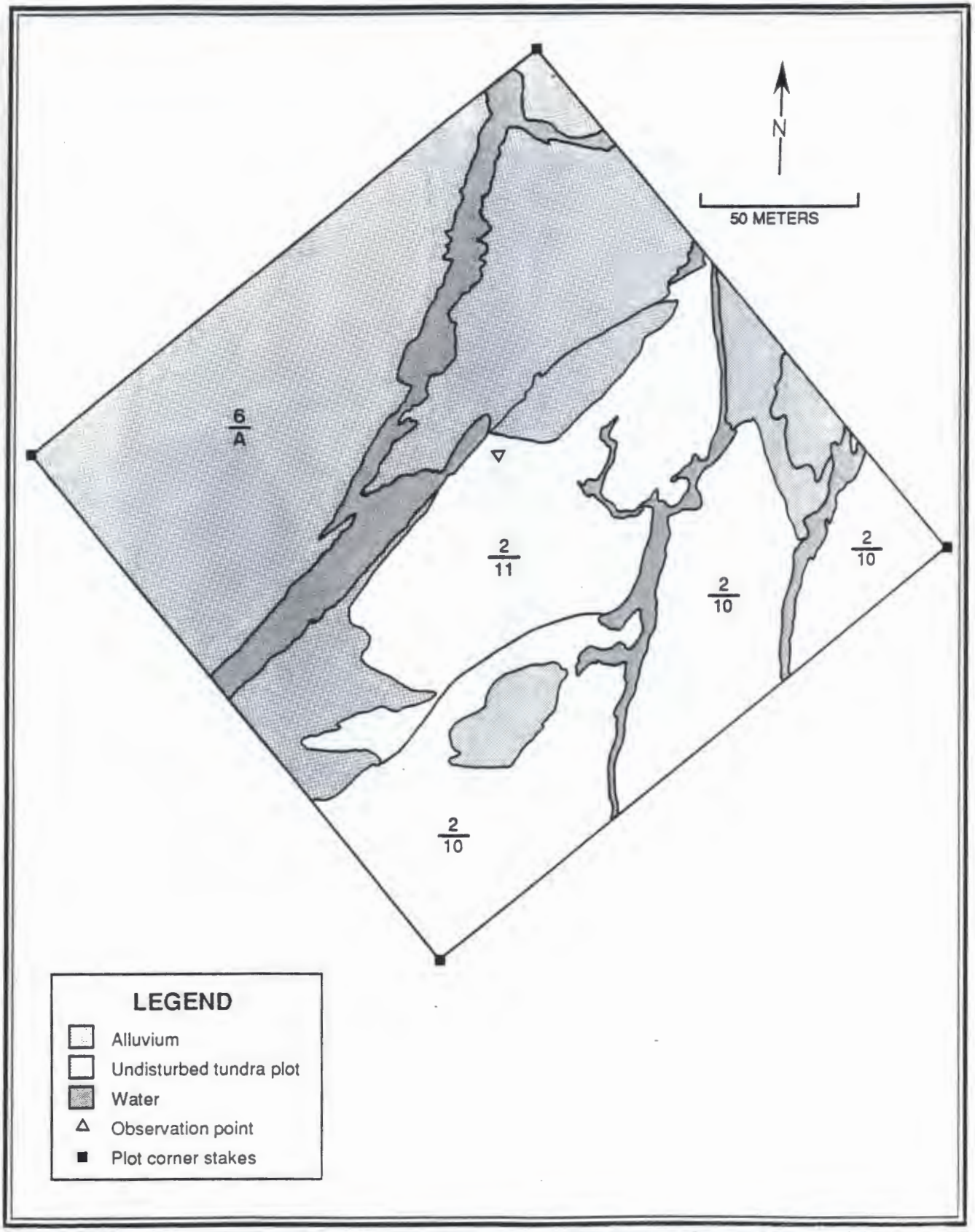


Fig. A-18. Sag River 2 (Site 18). Produced from Prudhoe Bay / Duck Island Color Infrared Aerial Photography, 1989, 1:500, flightline 54, frame 4. (Photography by Aeromap U.S., Anchorage, AK.)

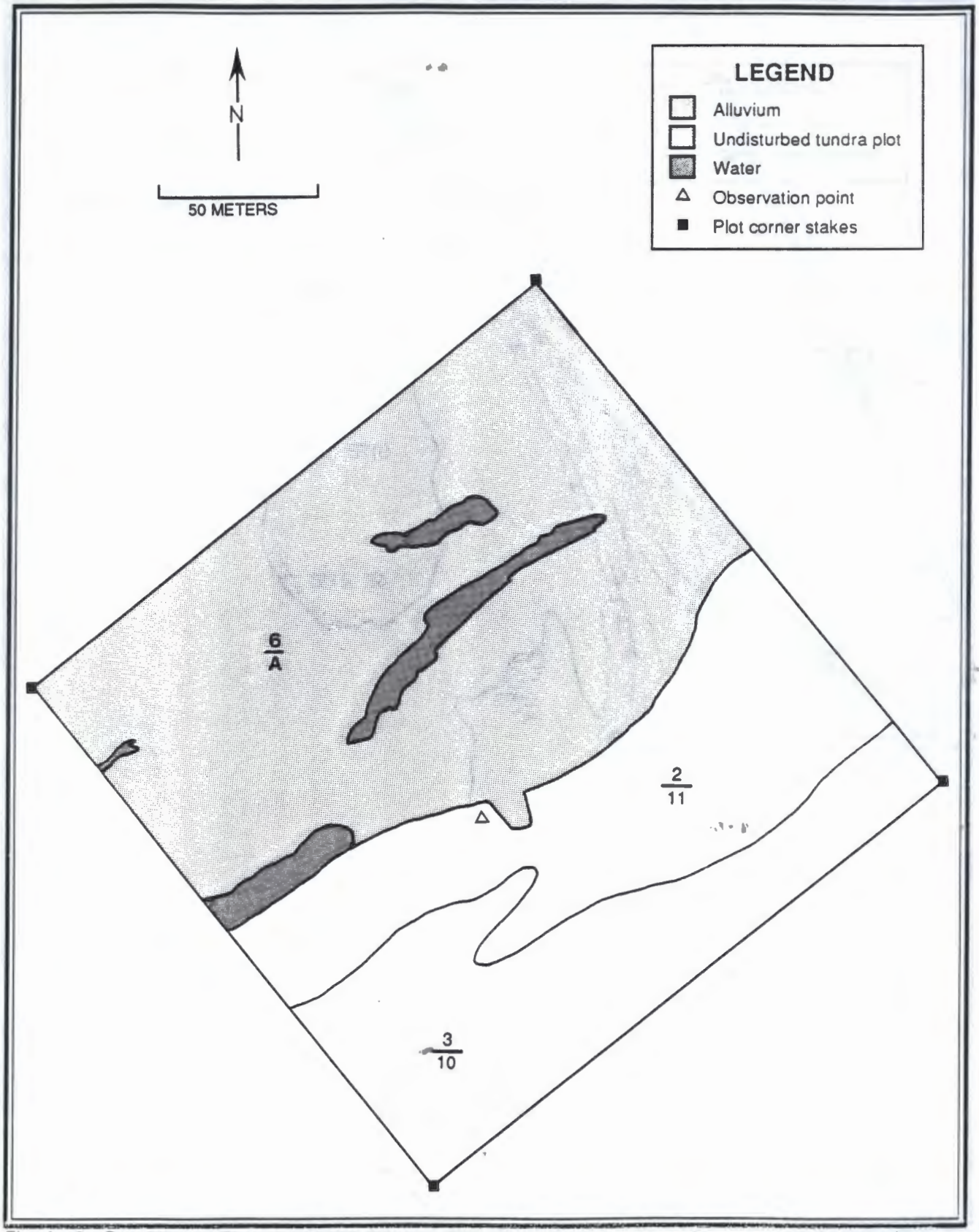


Fig. A-19. Sag River 4 (Site 19). Produced from Prudhoe Bay / Duck Island Color Aerial Photography, 1989, 1:1500, flighline 9, frame 17. (Photography by Aeromap U.S., Anchorage, AK.)

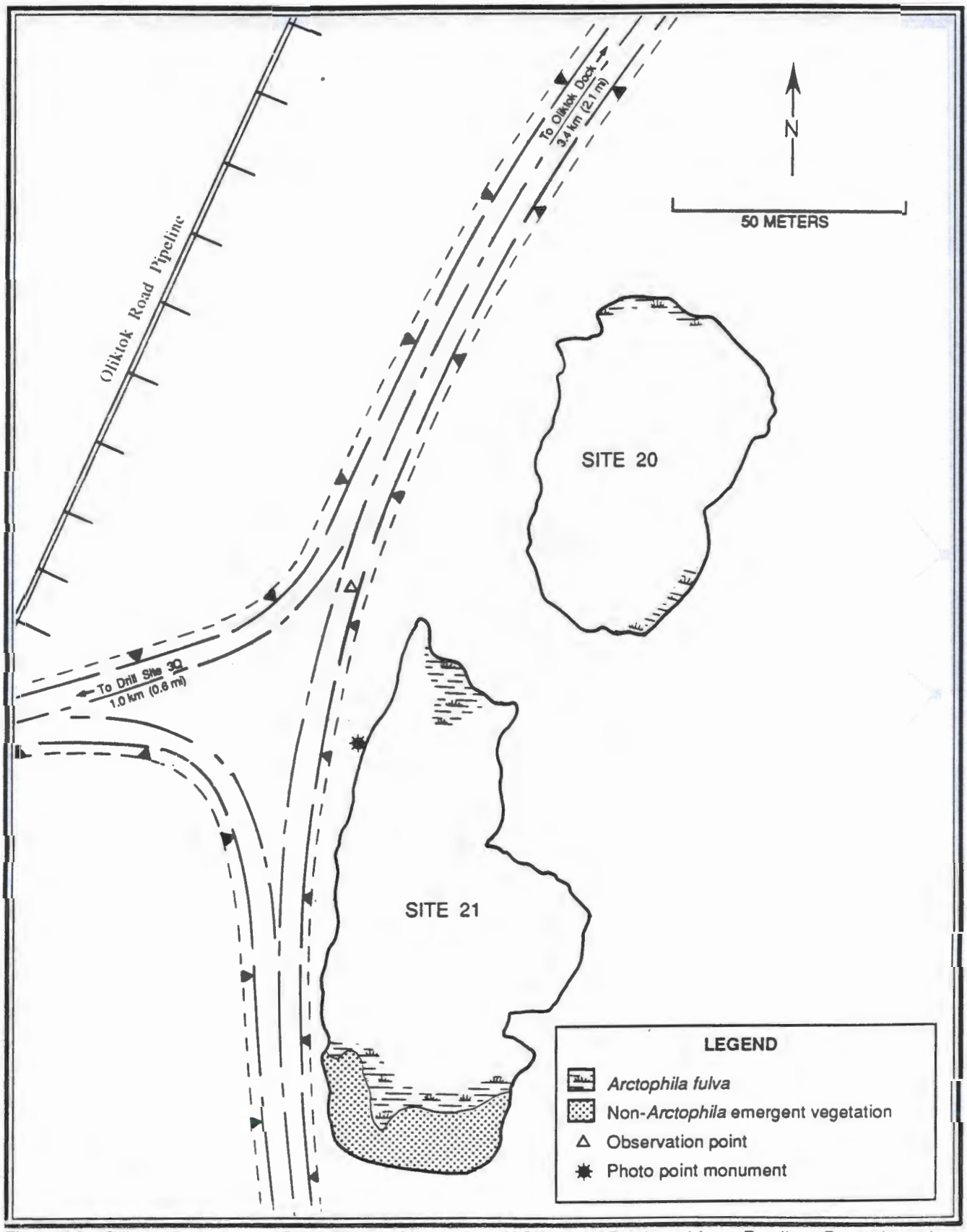


Fig. A-20. Oliktok Pond North (Site 20) and Oliktok Pond (Site 21). Produced from Prudhoe Bay Infrared Aerial Photography, 1986, 1:500, flightline 12, frame 9. (Photography by Aeromap U.S., Anchorage, AK.)

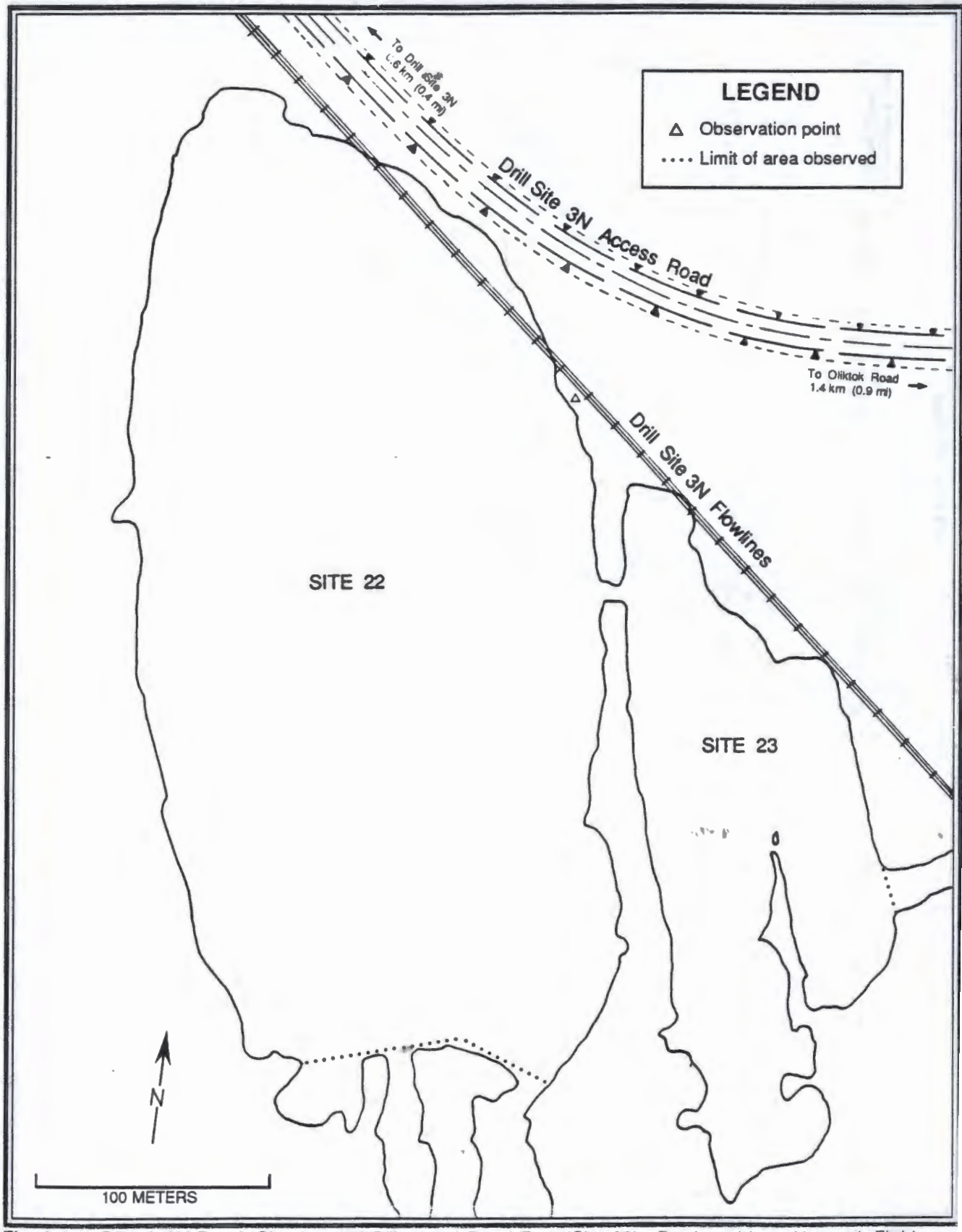


Fig. A-21. Oliktok 3N Pond (Site 22) and Oliktok 3N Pond East (Site 23). Produced from Kuparuk Field Color Aerial Photography, 1988, 1:1500, flightline 10, frame 15. (Photography by Aeromap U.S., Anchorage, AK.)

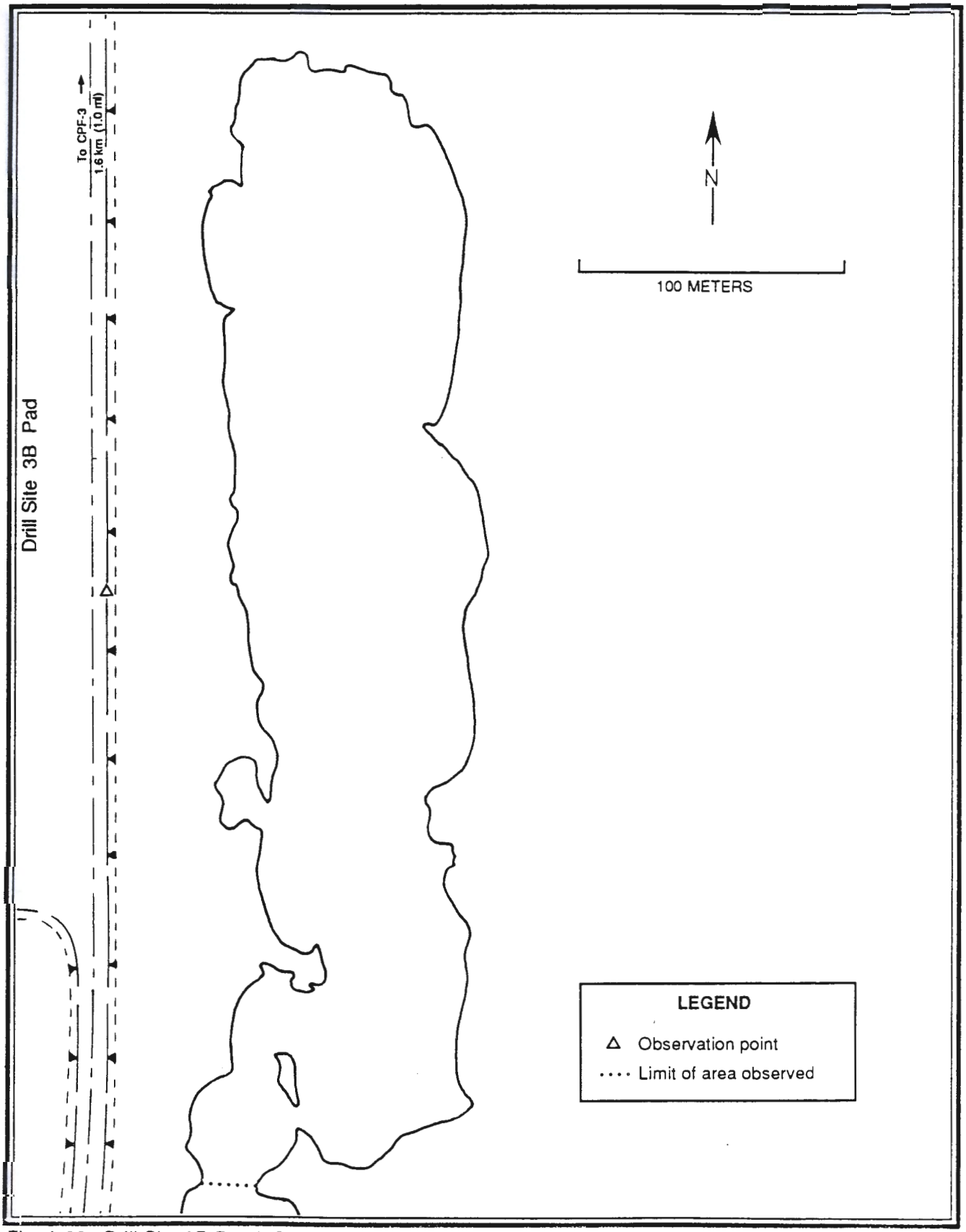


Fig. A-22. Drill Site 3B Pond (Site 24). Produced from Kuparuk Field Facility Photography, 1988. 1:500 flightline 3B, frame 2. (Photography by Aeromap U.S., Anchorage, AK.)

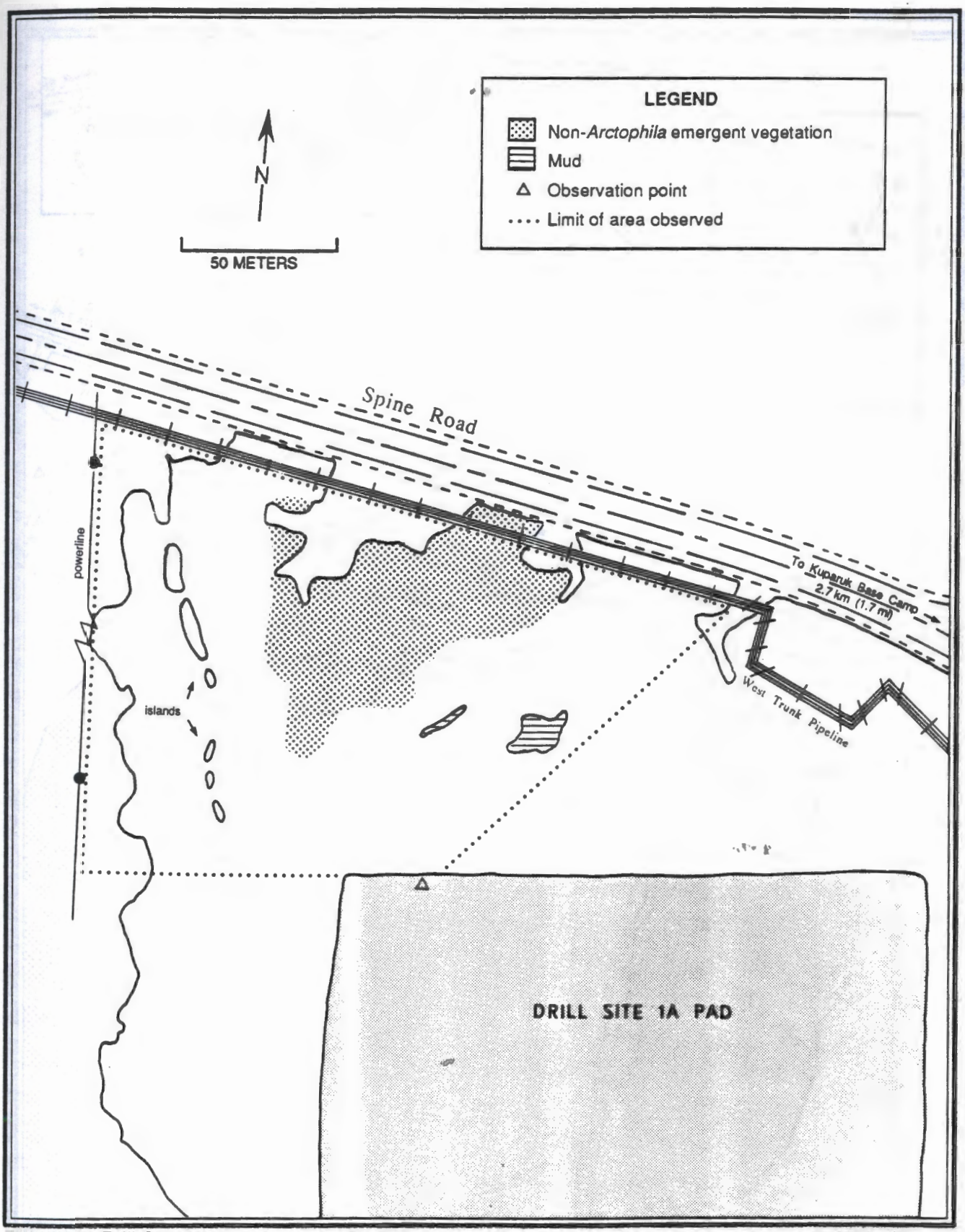


Fig. A-23. Drill Site 1A Impoundment (Site 25). Produced from Prudhoe Bay / Duck Island Color Aerial Photography, 1989, 1:1500, flighline 13, frame 38,31. (Photography by Aeromap U.S. Anchorage, AK.)

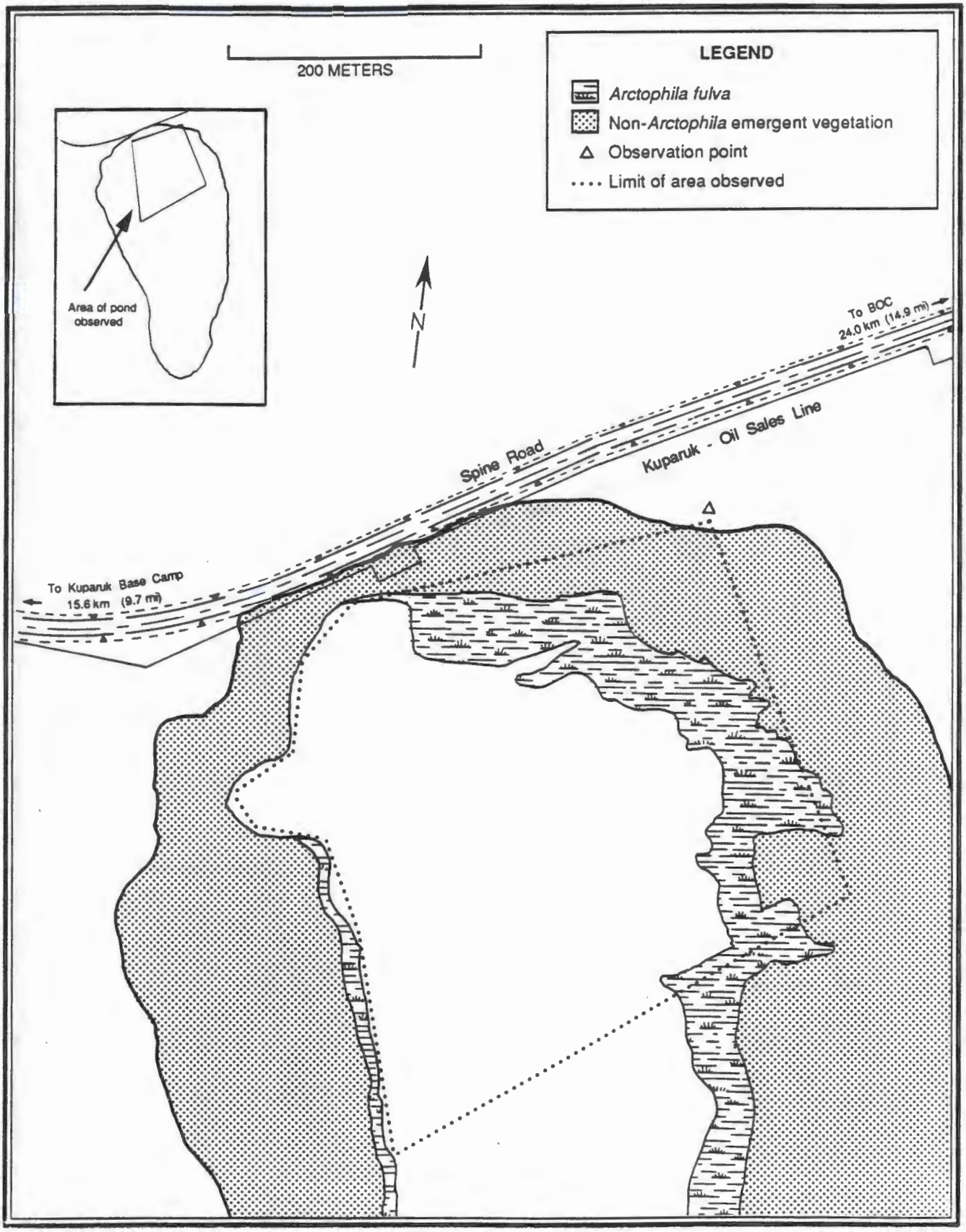


Fig. A-24. Kuparuk Pond (Site 26). Produced from Prudhoe Bay / Duck Island Color Aerial Photography. 1989, 1:1500, flighline 11, frame 30. (Photography by Aeromap U.S., Anchorage, AK.)

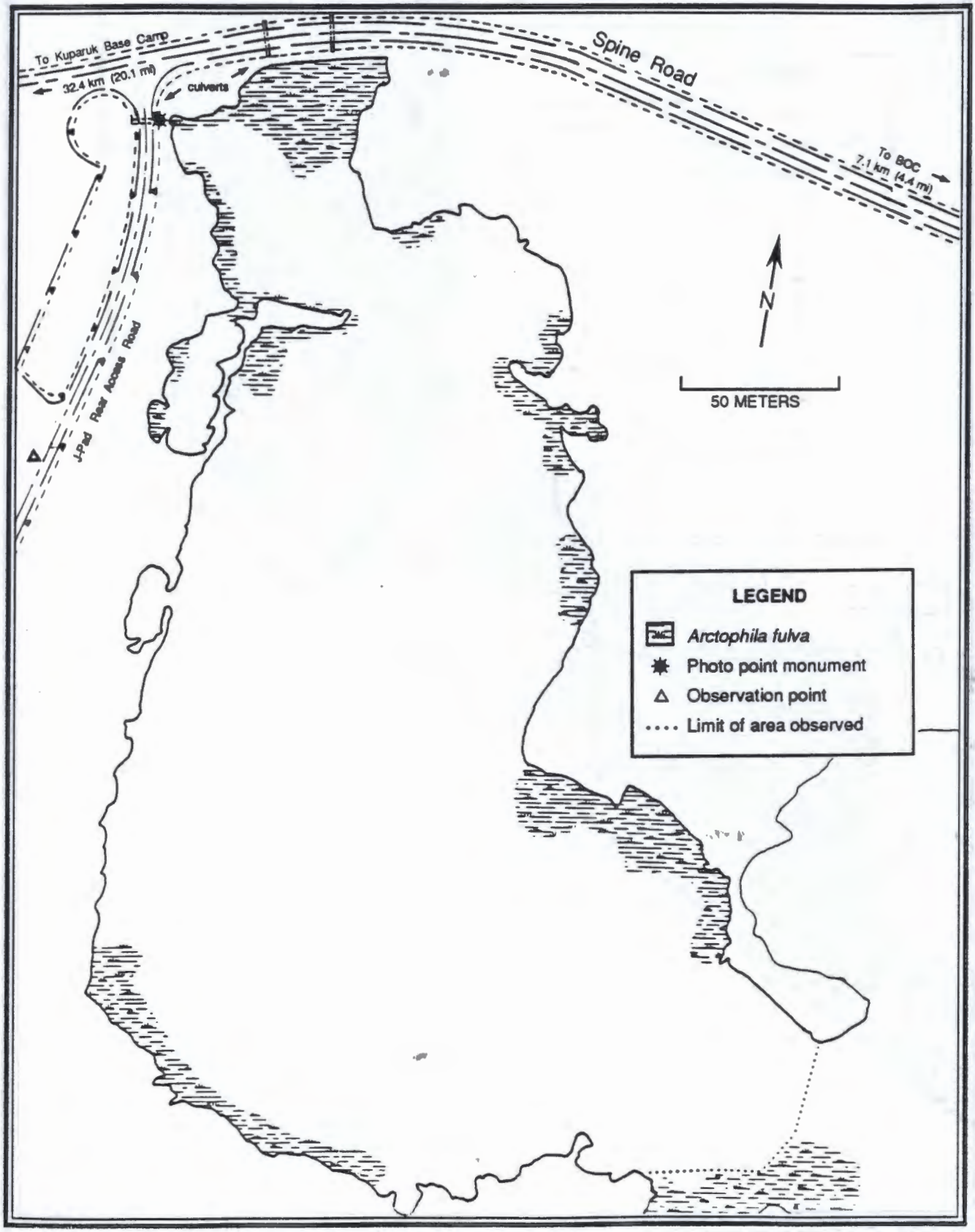


Fig. A-25. J Pad Pond (Site 27). Produced from Prudhoe Bay / Duck Island Color Infrared Aerial Photography, 1989, 1:500, flightline 50, frame 3. (Photography by Aeromap U.S., Anchorage, AK.)

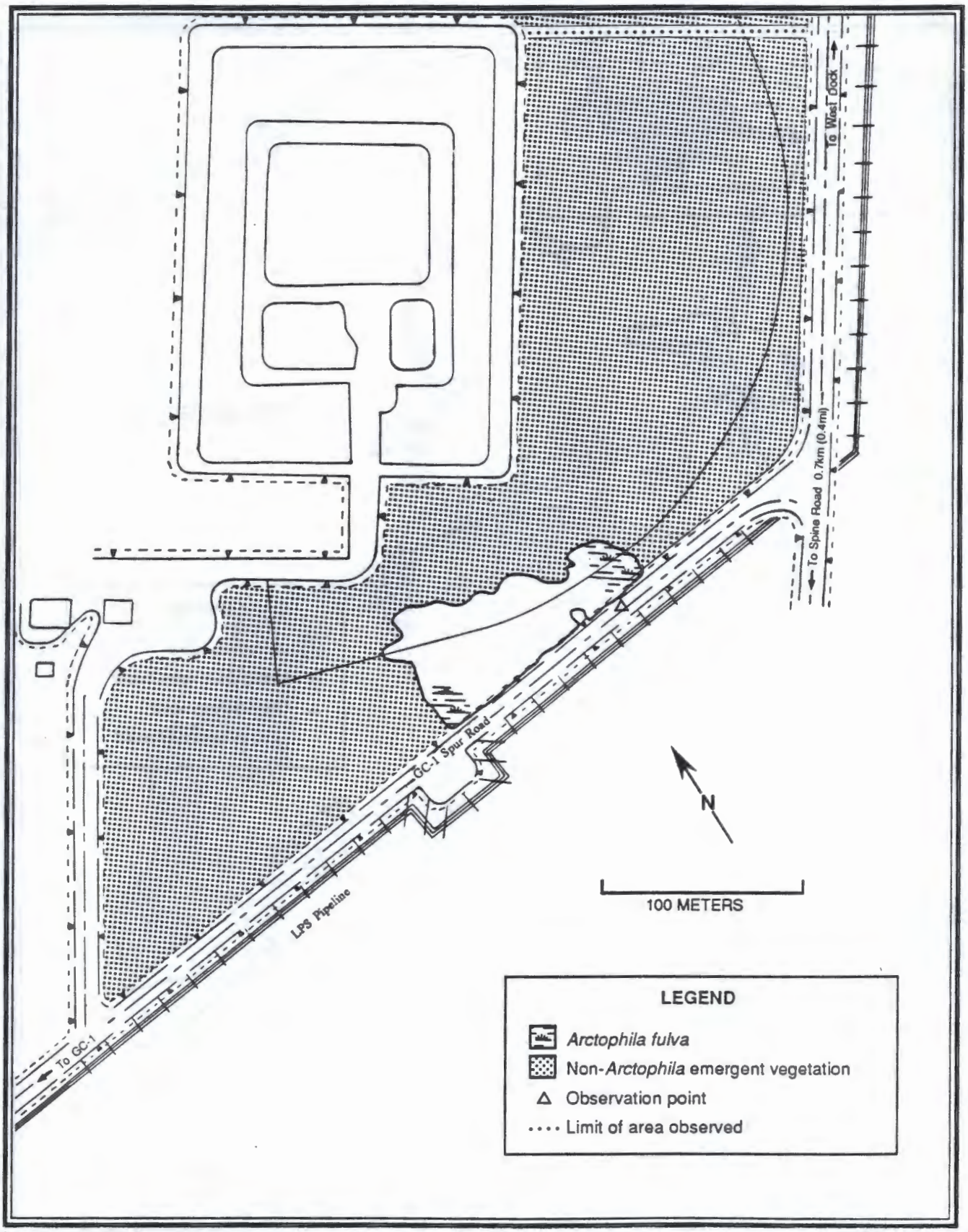


Fig. A-26. GC-1 Impoundment (Site 28). Produced from Prudhoe Bay Color Infrared Aerial Photography, 1988, 1:500, flightline 23 frames 6 and 7. (Photography by Aeromap U.S., Anchorage, AK.)

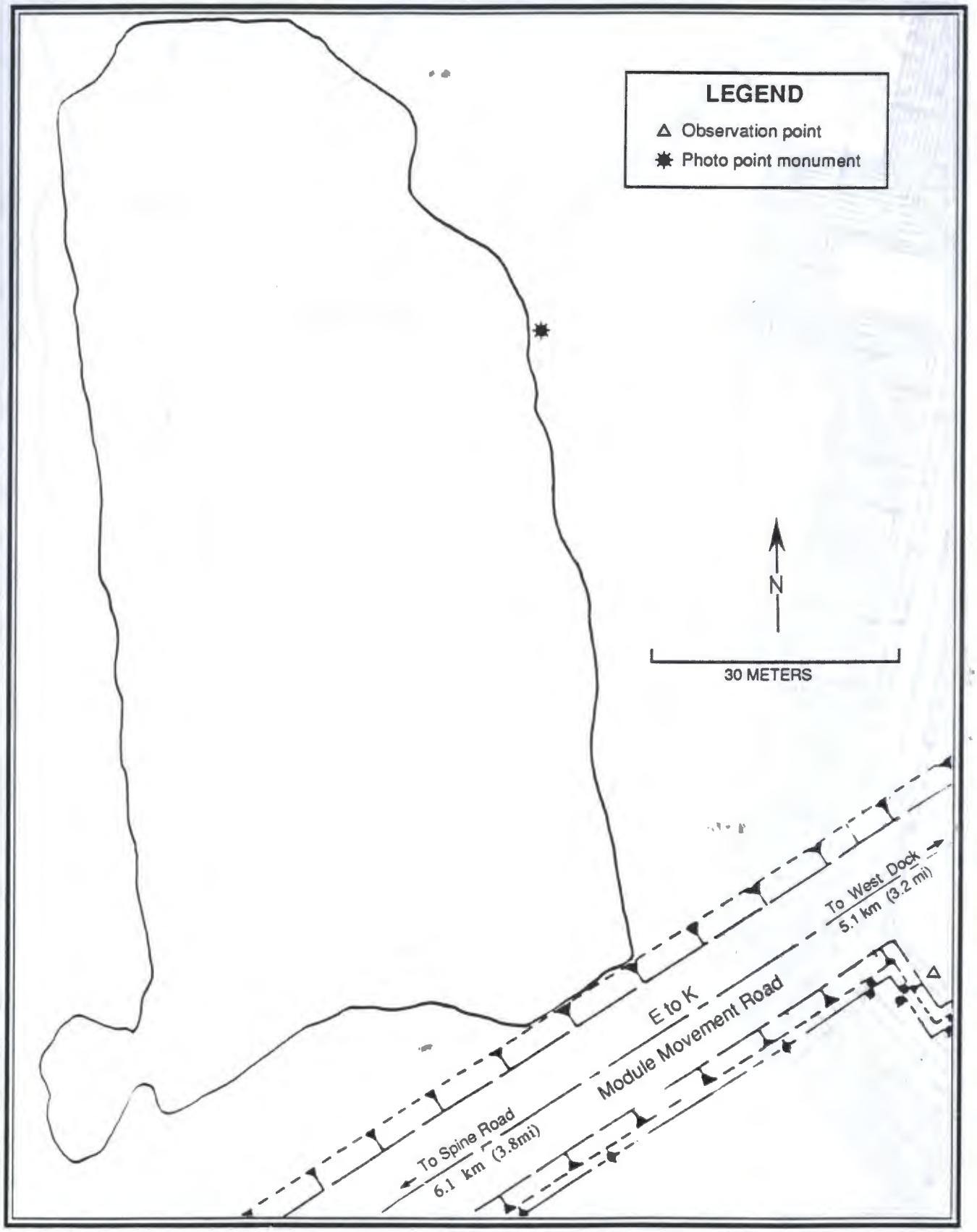


Fig. A-27. Vascott Pond (Site 29). Adapted from McKendrick (1990).

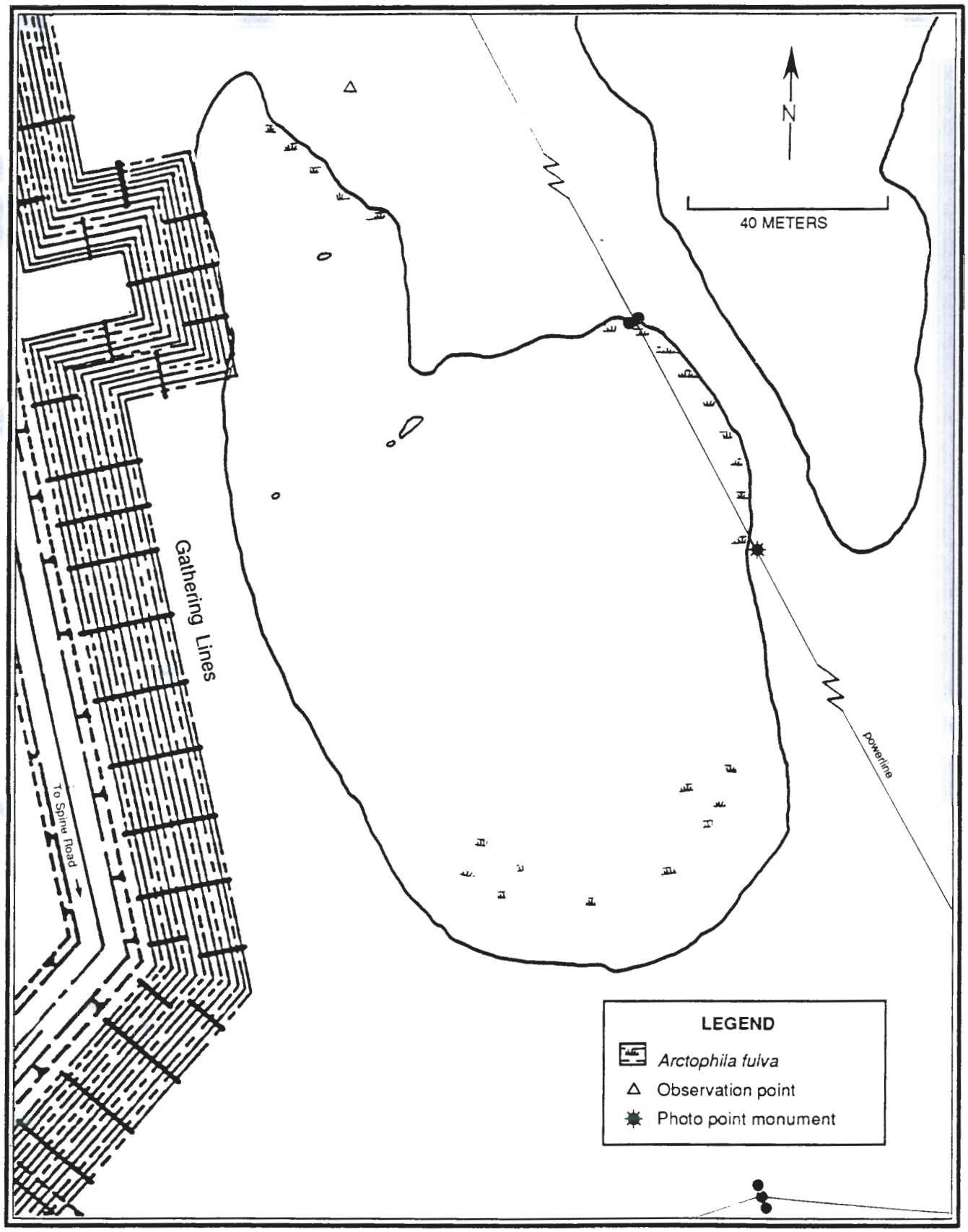


Fig. A-28. Powerline Pond (Site 30). Adapted from McKendrick (1990).

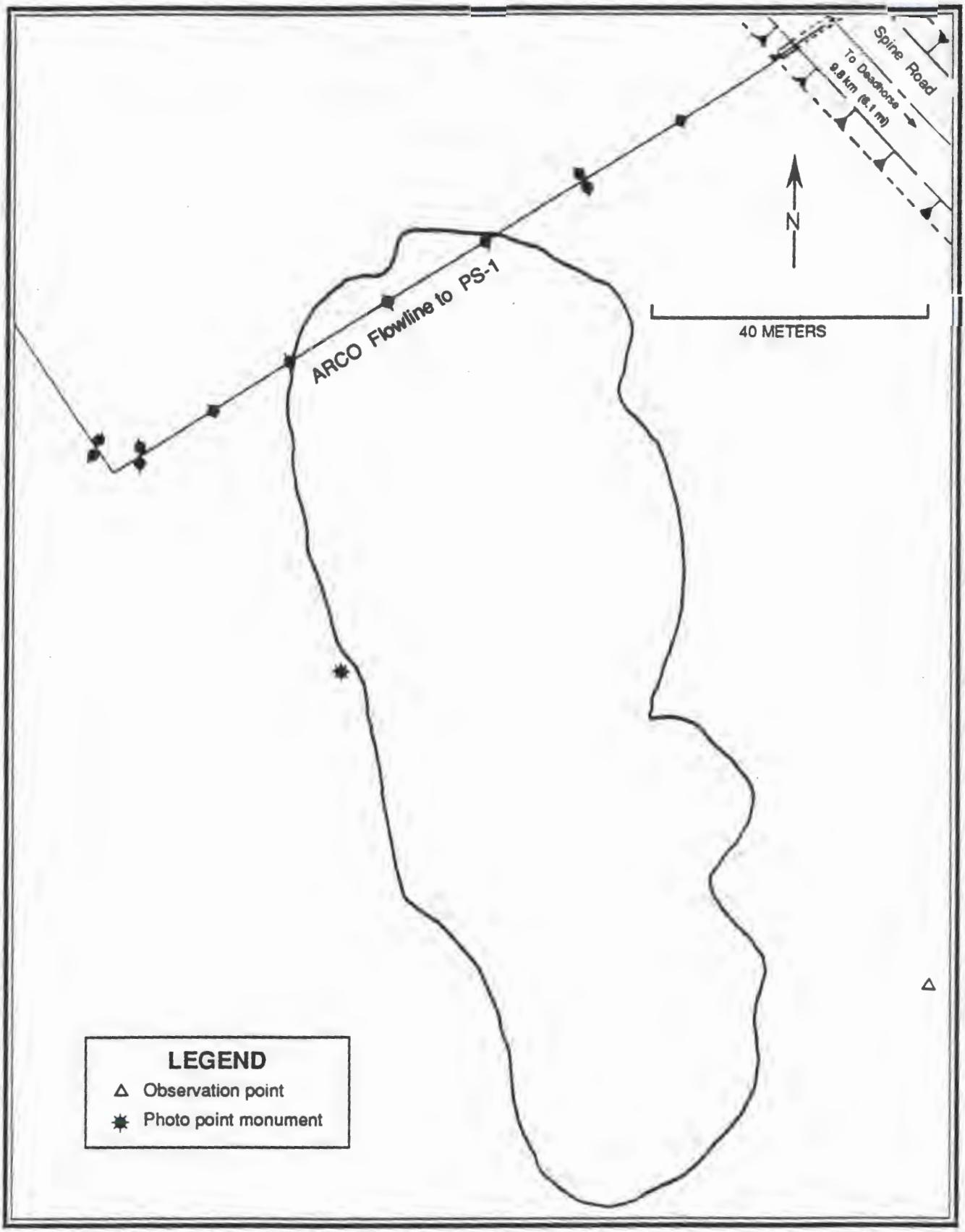


Fig. A-29. Lake Carol (Site 31). Adapted from McKendrick (1990).

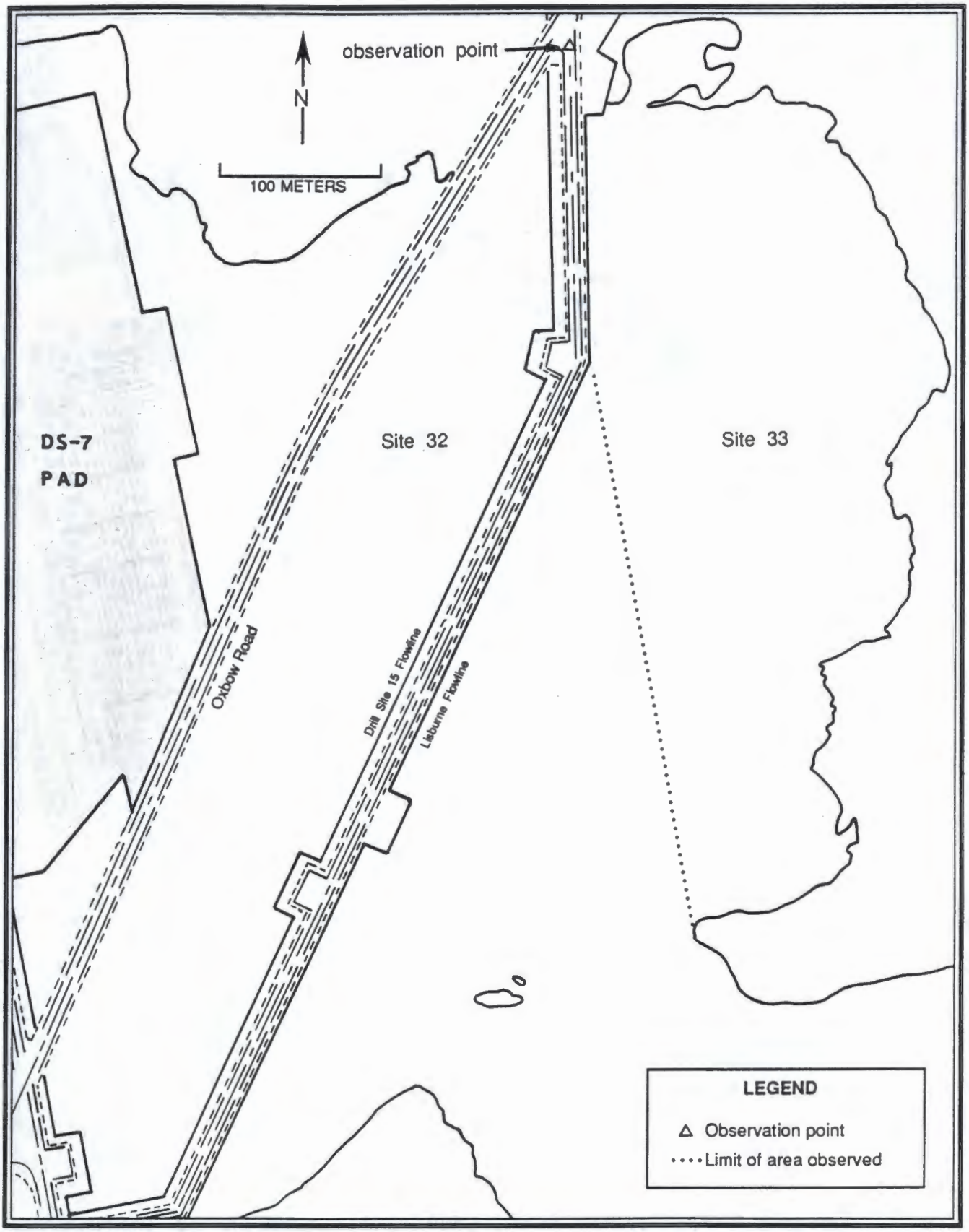


Fig. A-30. Drill Site 7 Impoundment (Site 32) and Drill Site 7 Impoundment Northeast (Site 33). Adapted from McKendrick (1990).

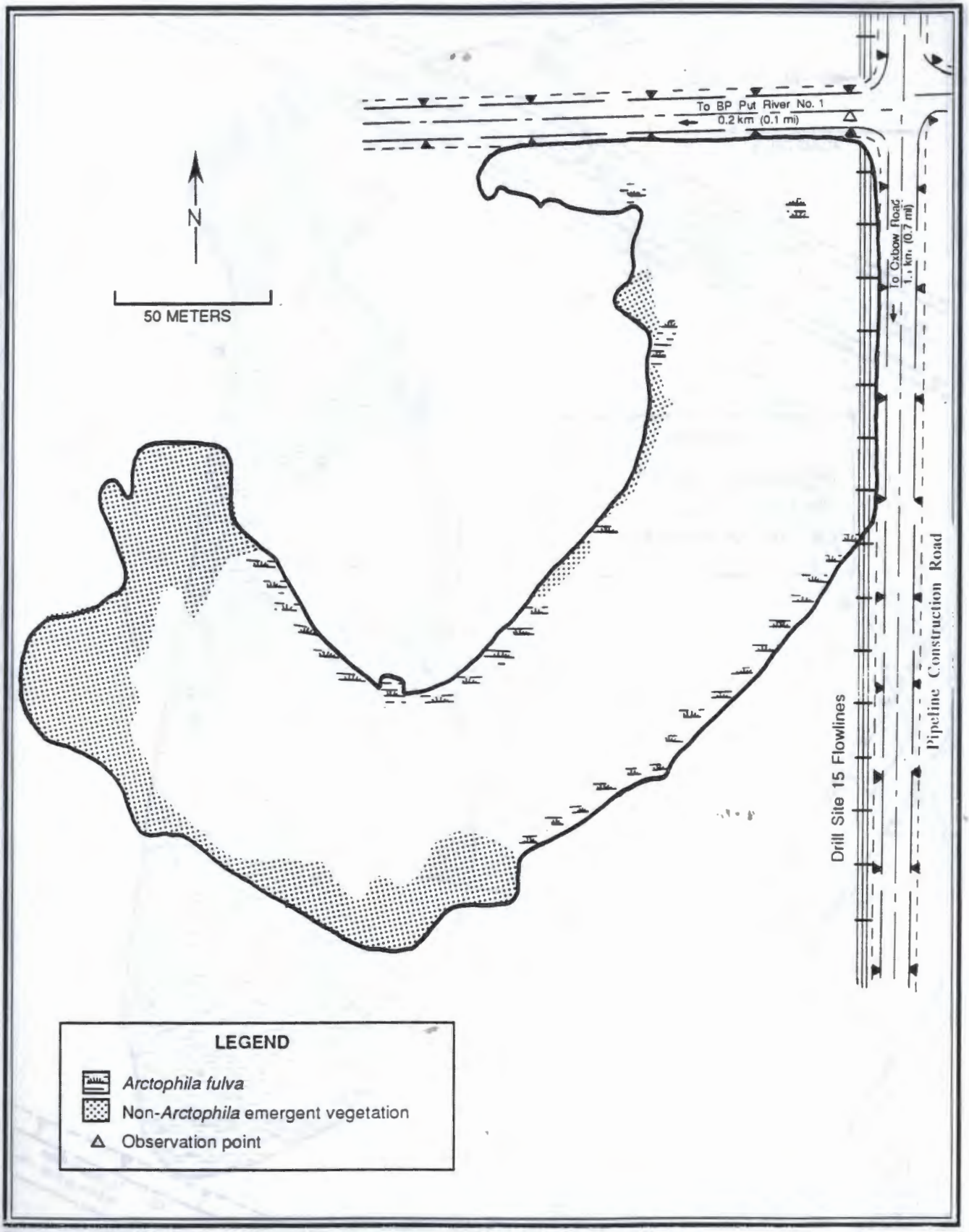


Fig. A-31. BP Discovery Well Impoundment (Site 34). Produced from Prudhoe Bay Color Infrared Aerial Photography, 1988, 1:500, flightline 15, frame 5. (Photography by Aeromap U.S., Anchorage AK.)

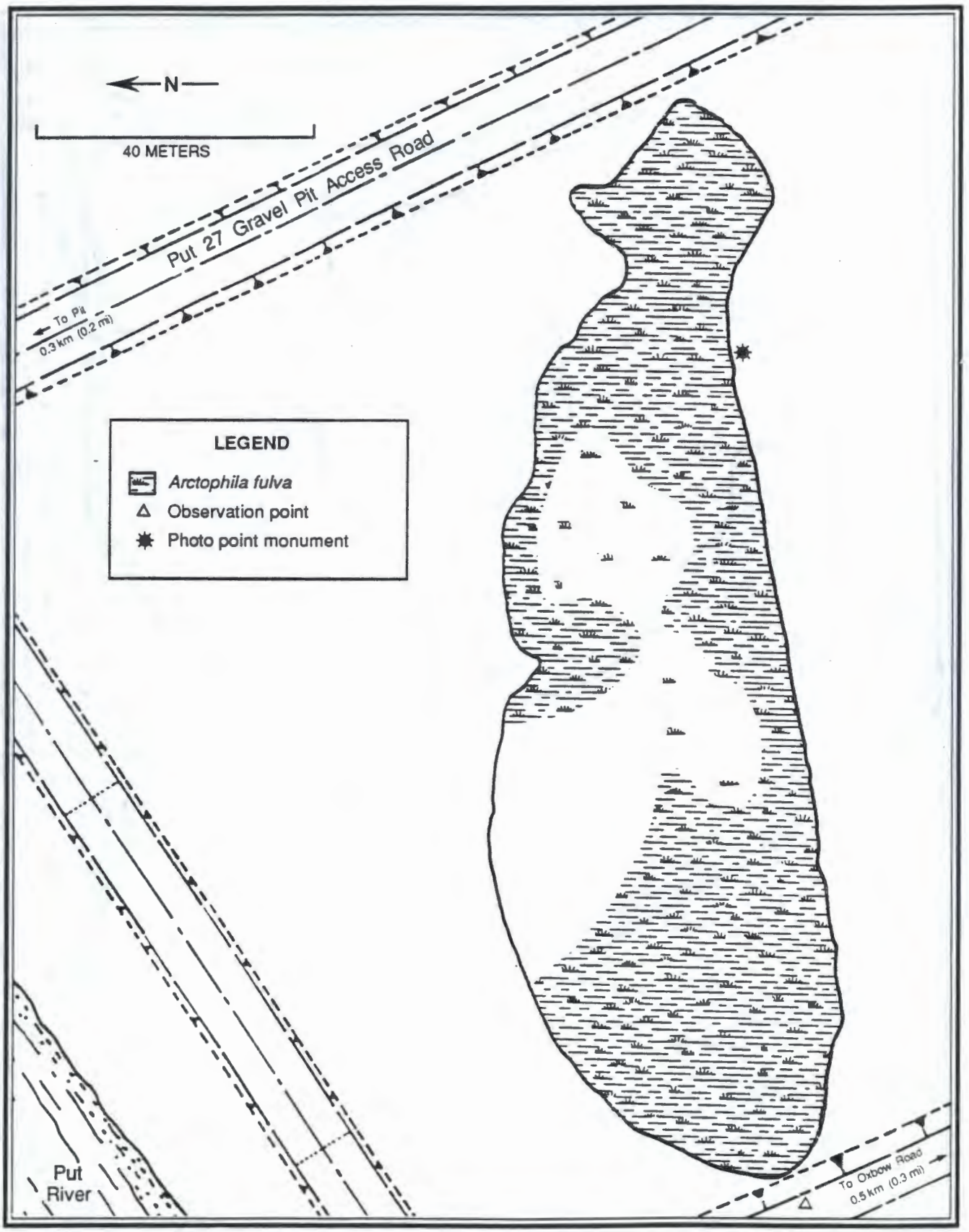


Fig. A-32. BP Pond (Site 35). Adapted from McKendrick (1990).

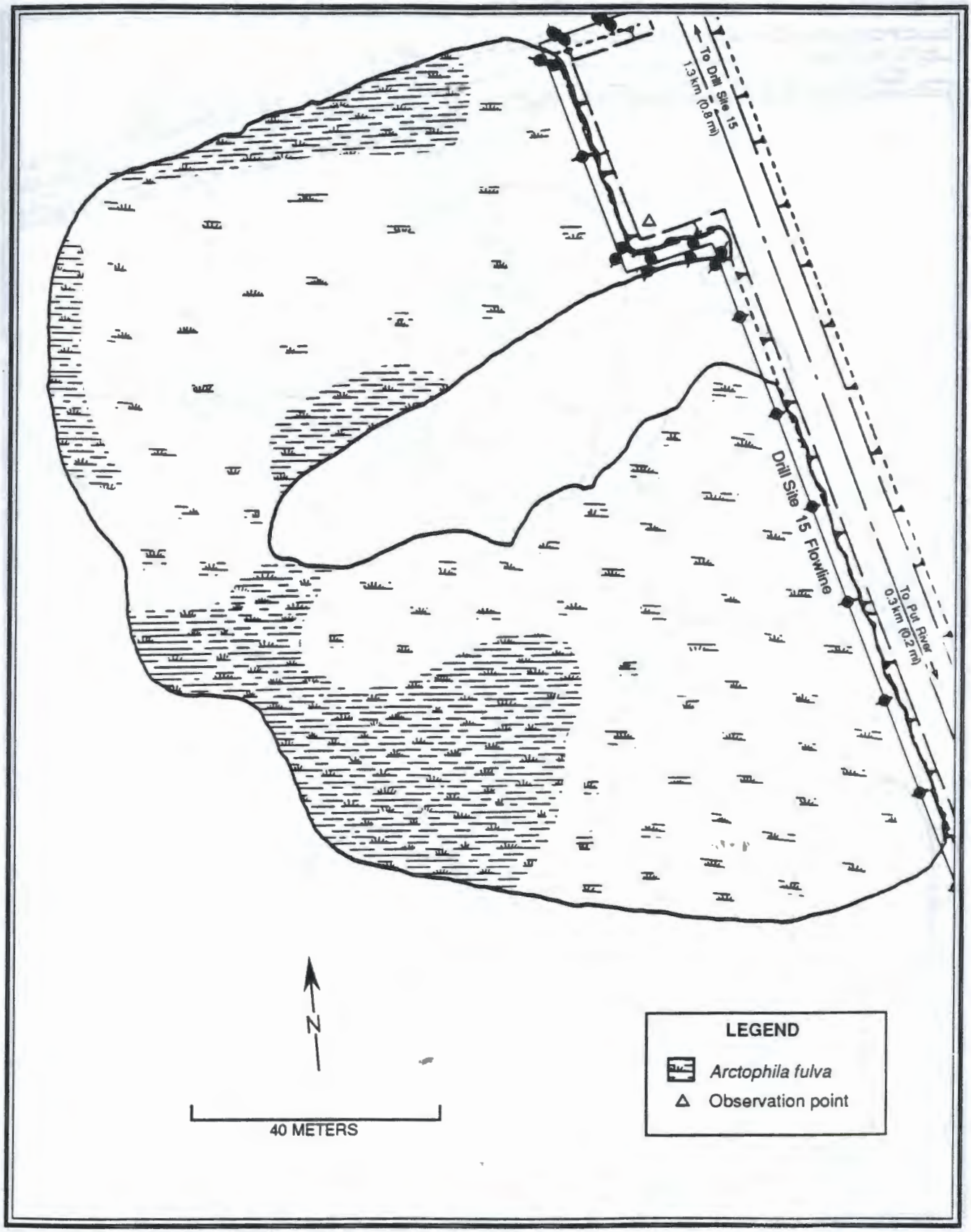


Fig. A-33. Drill Site 15 Pipeline Impoundment (Site 36). Adapted from McKendrick (1990).

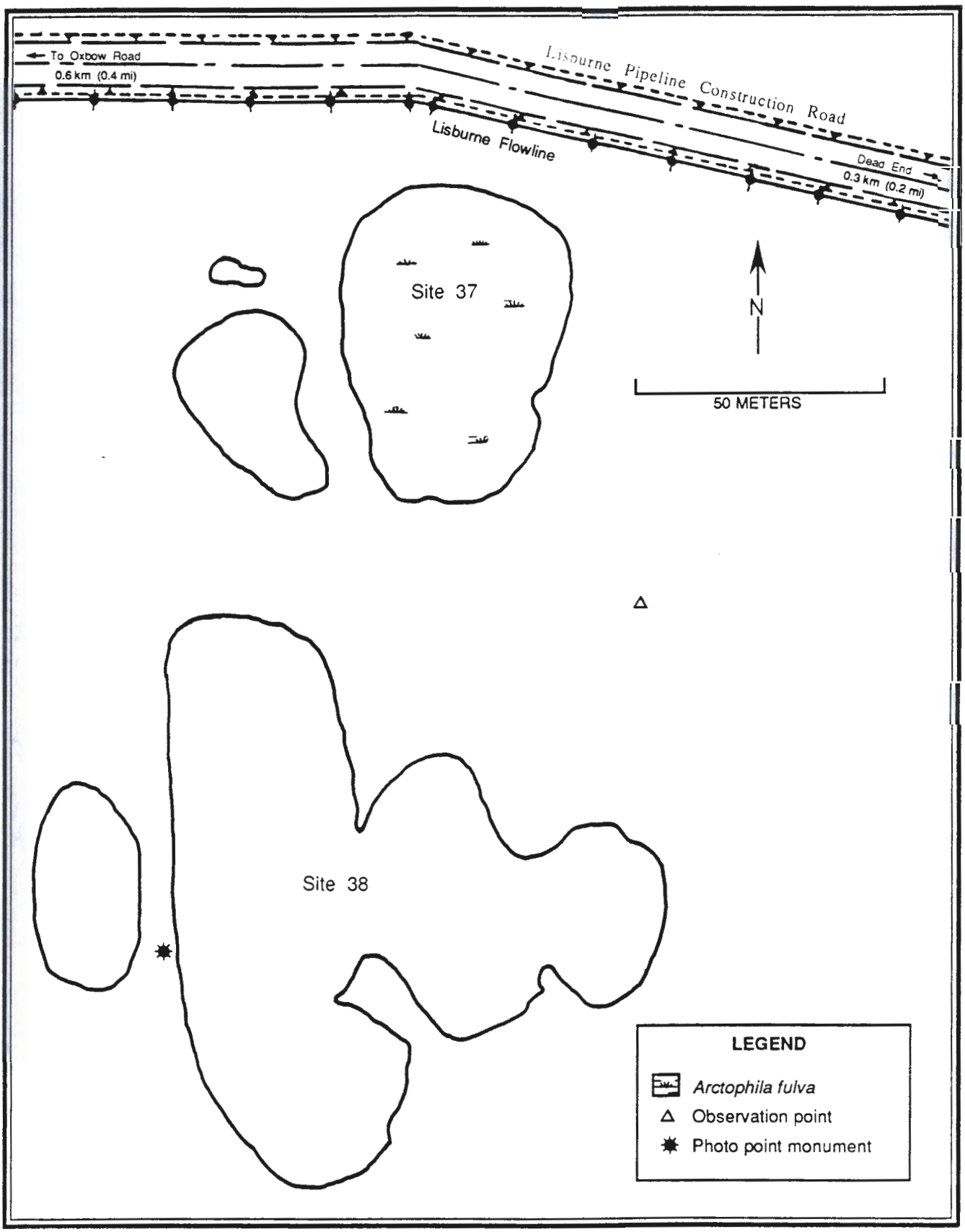


Fig. A-34. Transplant Pond (Site 37) and Transplant Control Pond (Site 38). Adapted from McKendrick (1990).

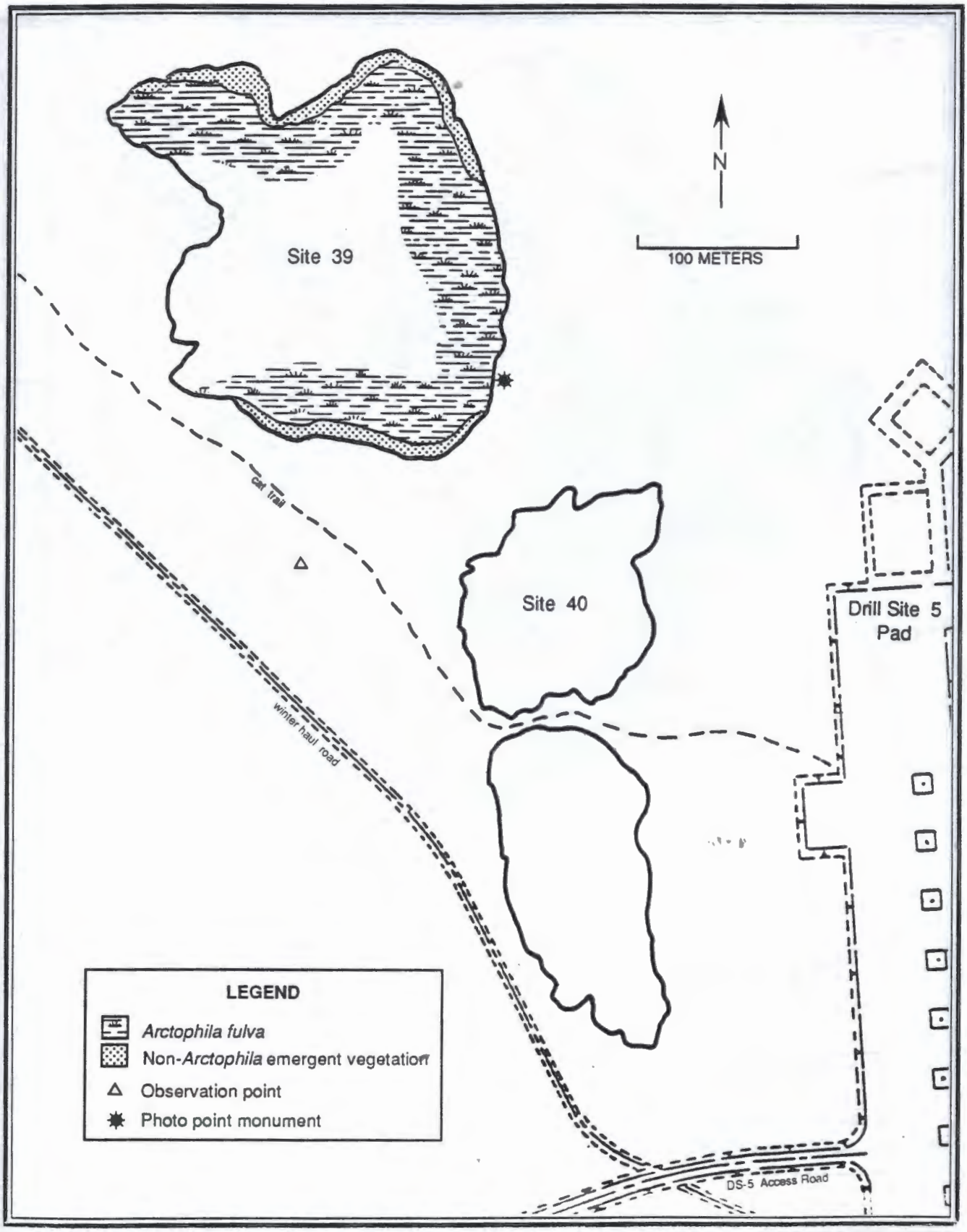


Fig. A-35. Drill Site 5 Pond (Site 39) and Drill Site 5 Trail Pond (Site 40). Adapted from McKendrick (1990)

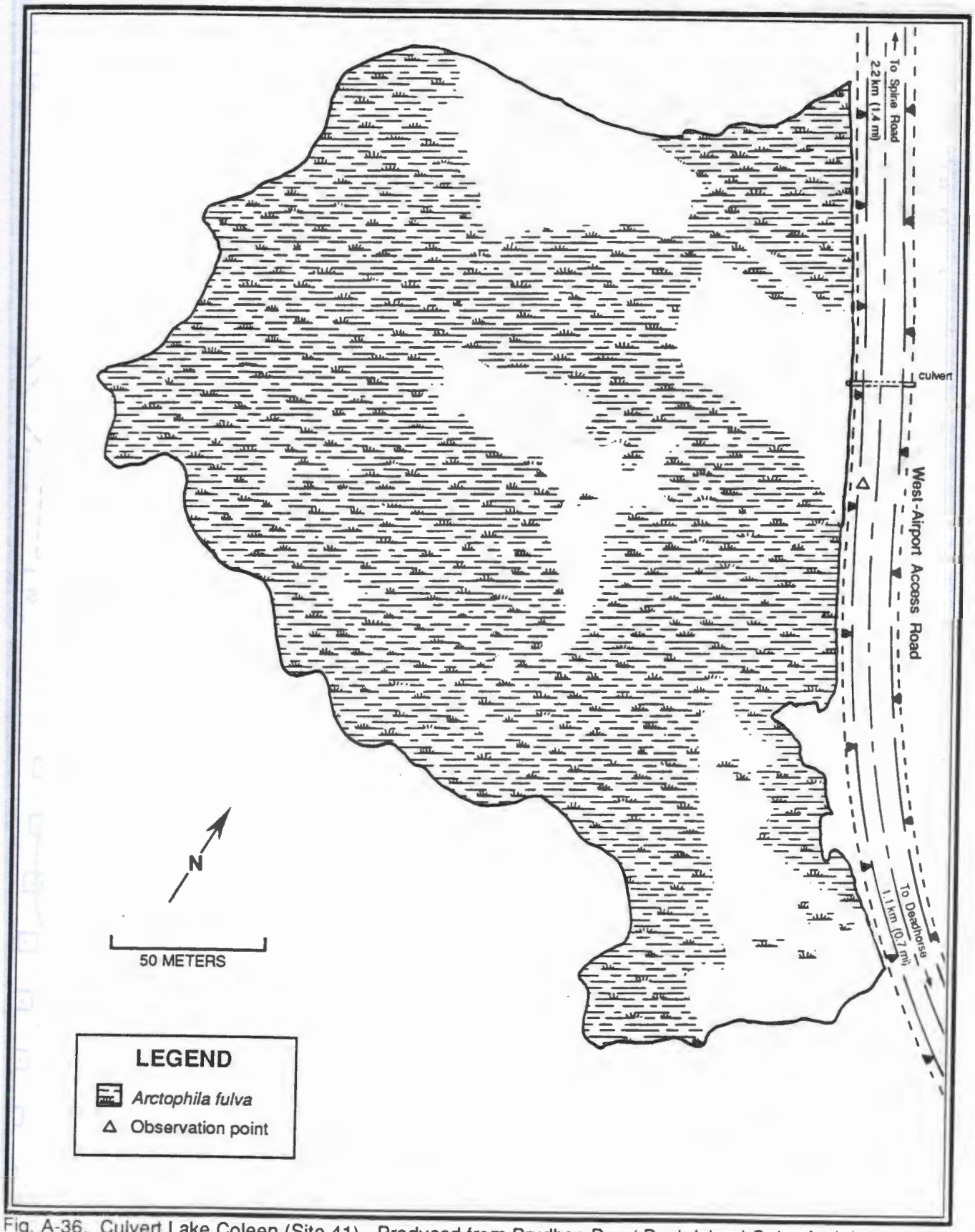


Fig. A-36. Culvert Lake Coleen (Site 41). Produced from Prudhoe Bay / Duck Island Color Aerial Photography, 1989, 1:1500, flighline 11, frame 14. (Photography by Aeromap U.S., Anchorage, AK.)

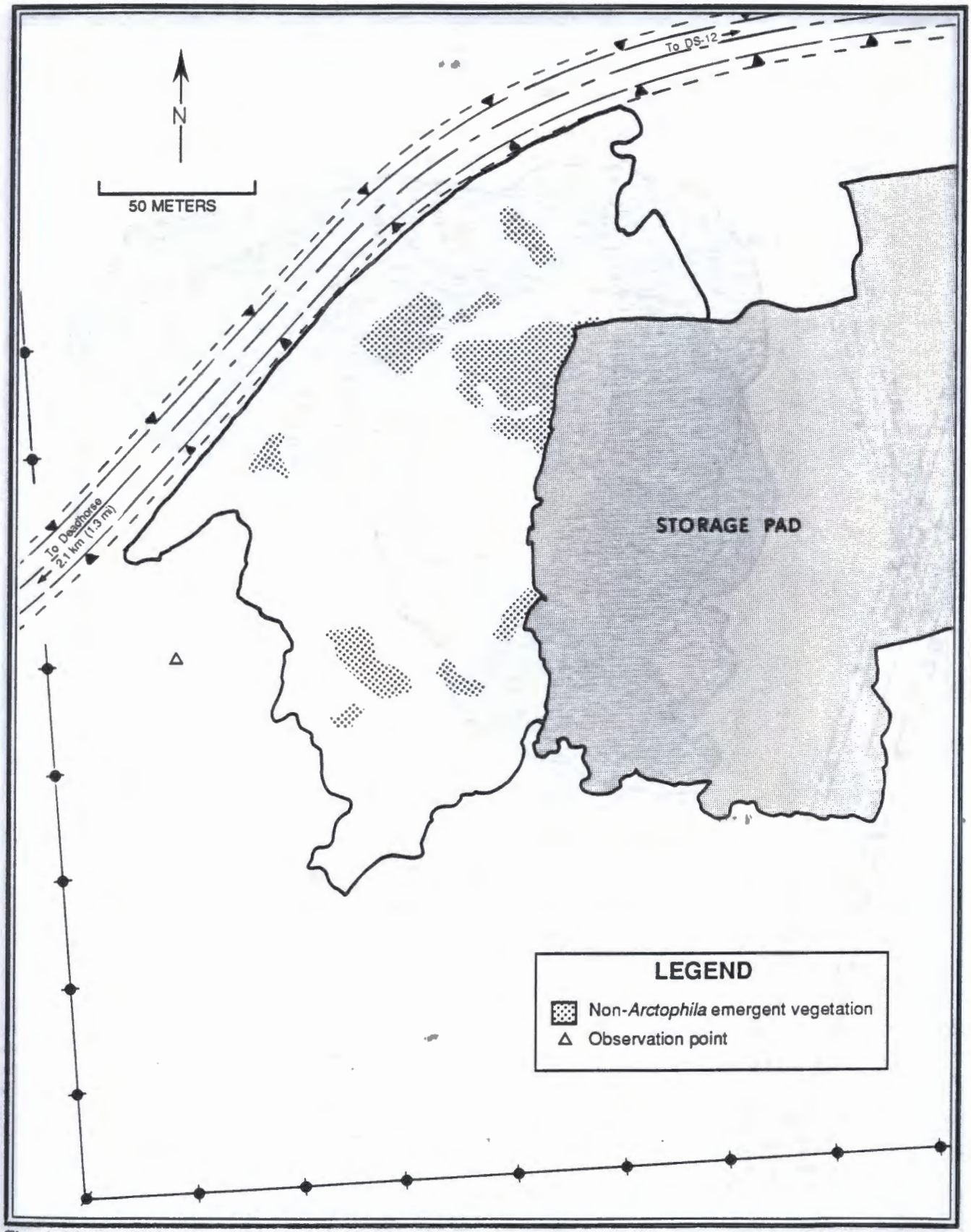


Fig. A-37. Drill Site 12 Impoundment (Site 42). Produced from Prudhoe Bay Color Infrared Aerial Photography, 1988, 1:500, flightline 12, frame 10. (Photography by Aeromap U.S., Anchorage, AK.)

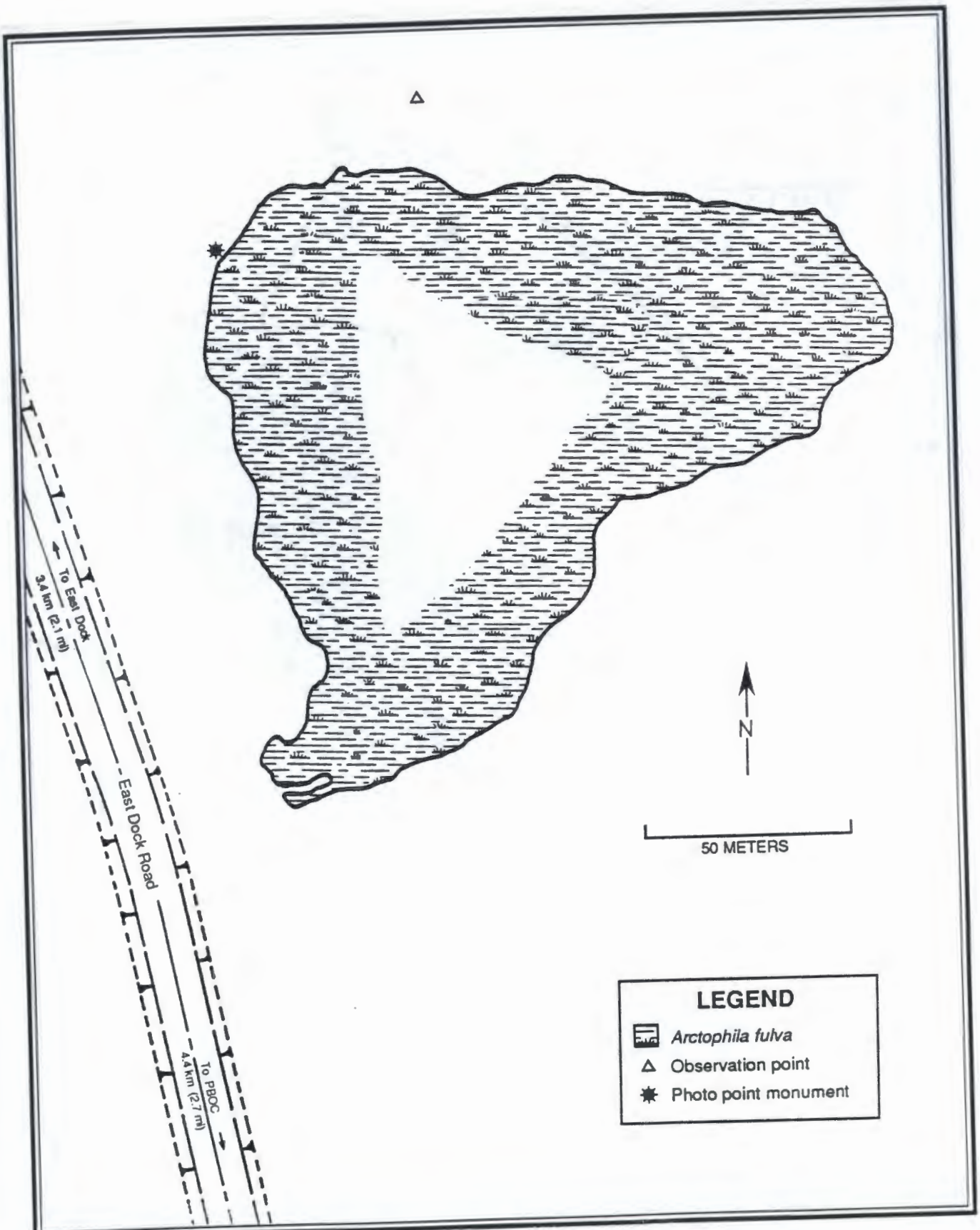


Fig. A-38. Sand Dune Lake (Site 43). Adapted from McKendrick (1990).

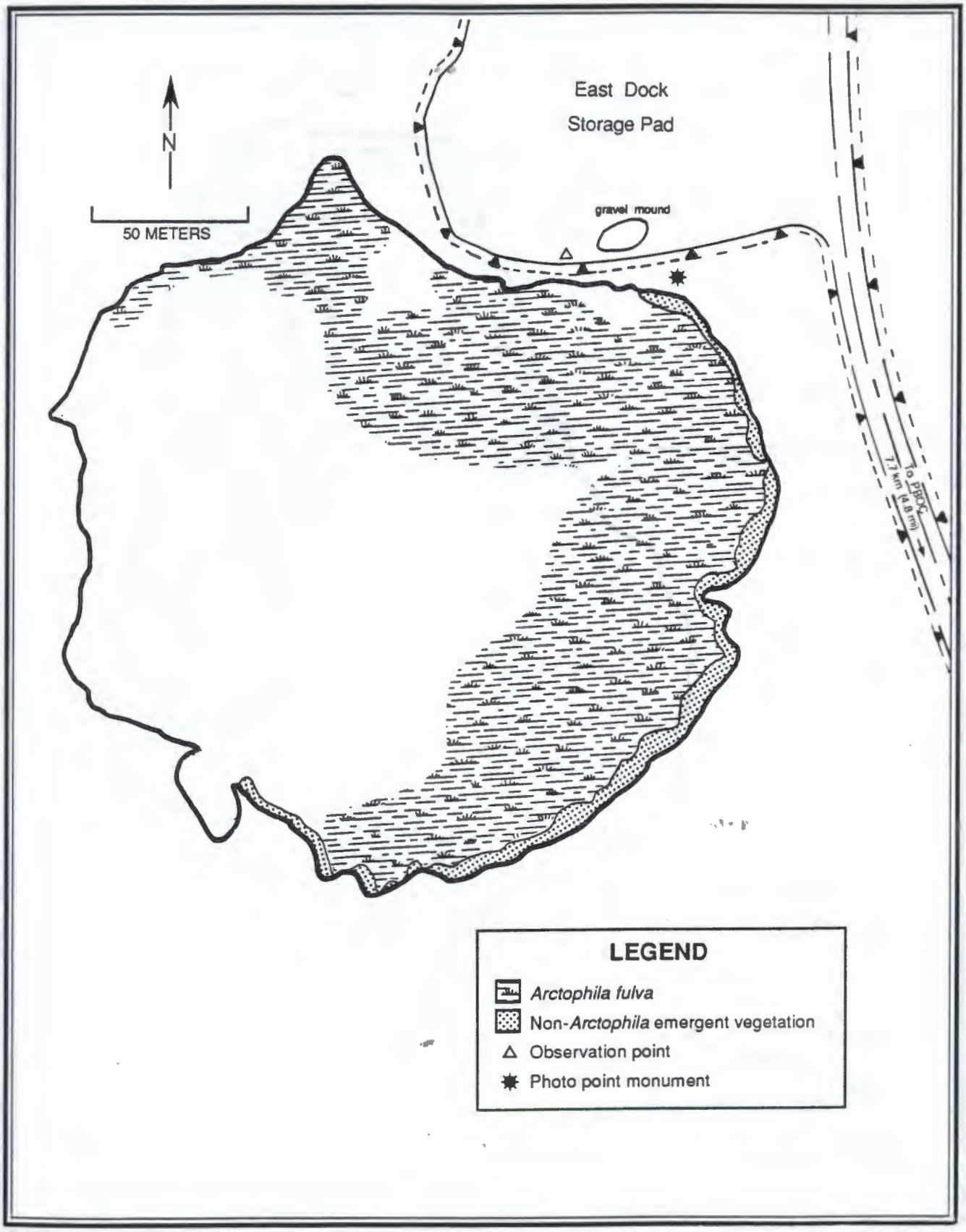


Fig. A-39. East Dock Pond (Site 44). Produced from Prudhoe Bay Color Infrared Aerial Photography, 1988. 1:500, flightline 3, frame 3. (Photography by Aeromap U.S., Anchorage, AK.)

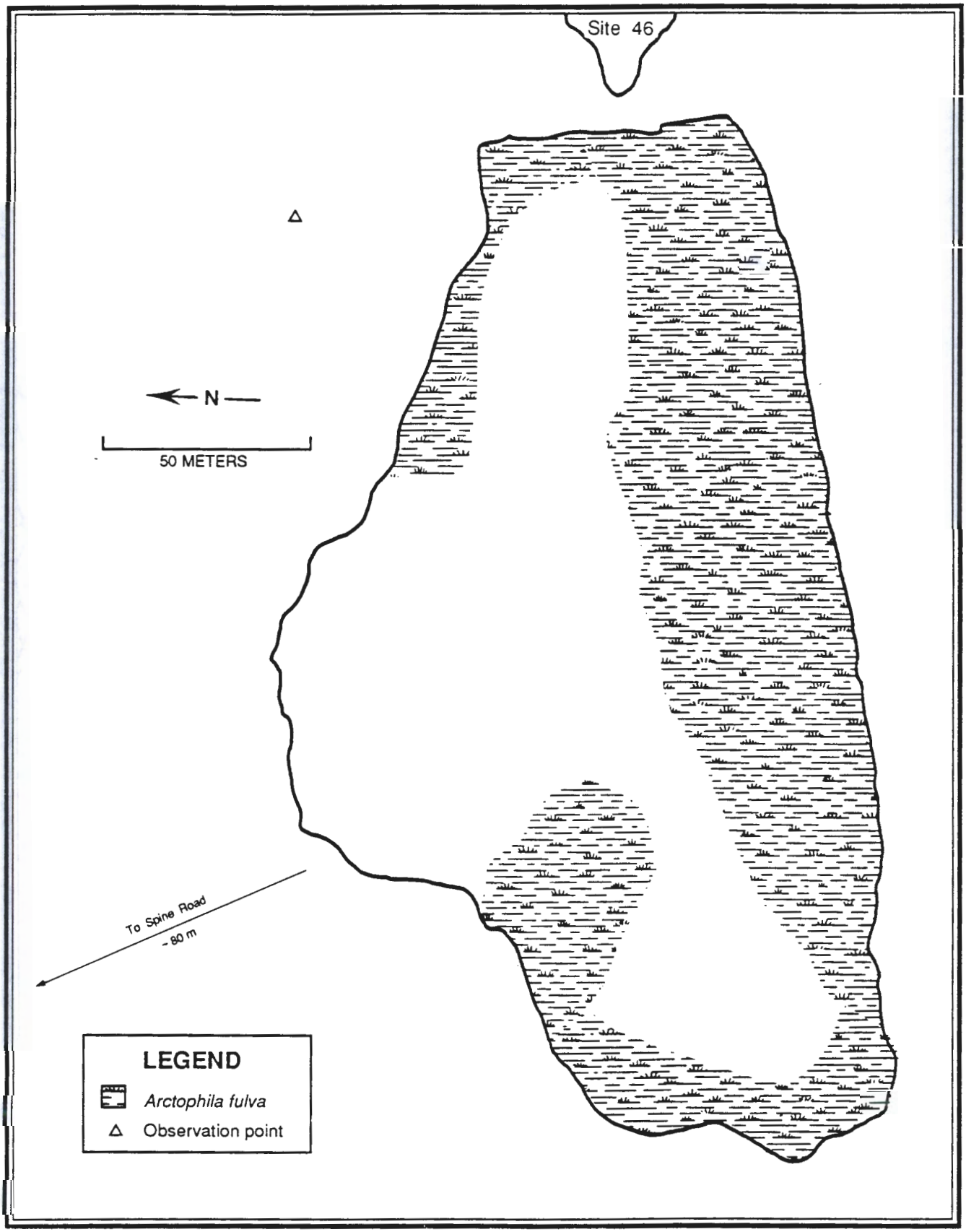


Fig. A-40. ARFU Pond (Site 45). Adapted from McKendrick (1990).

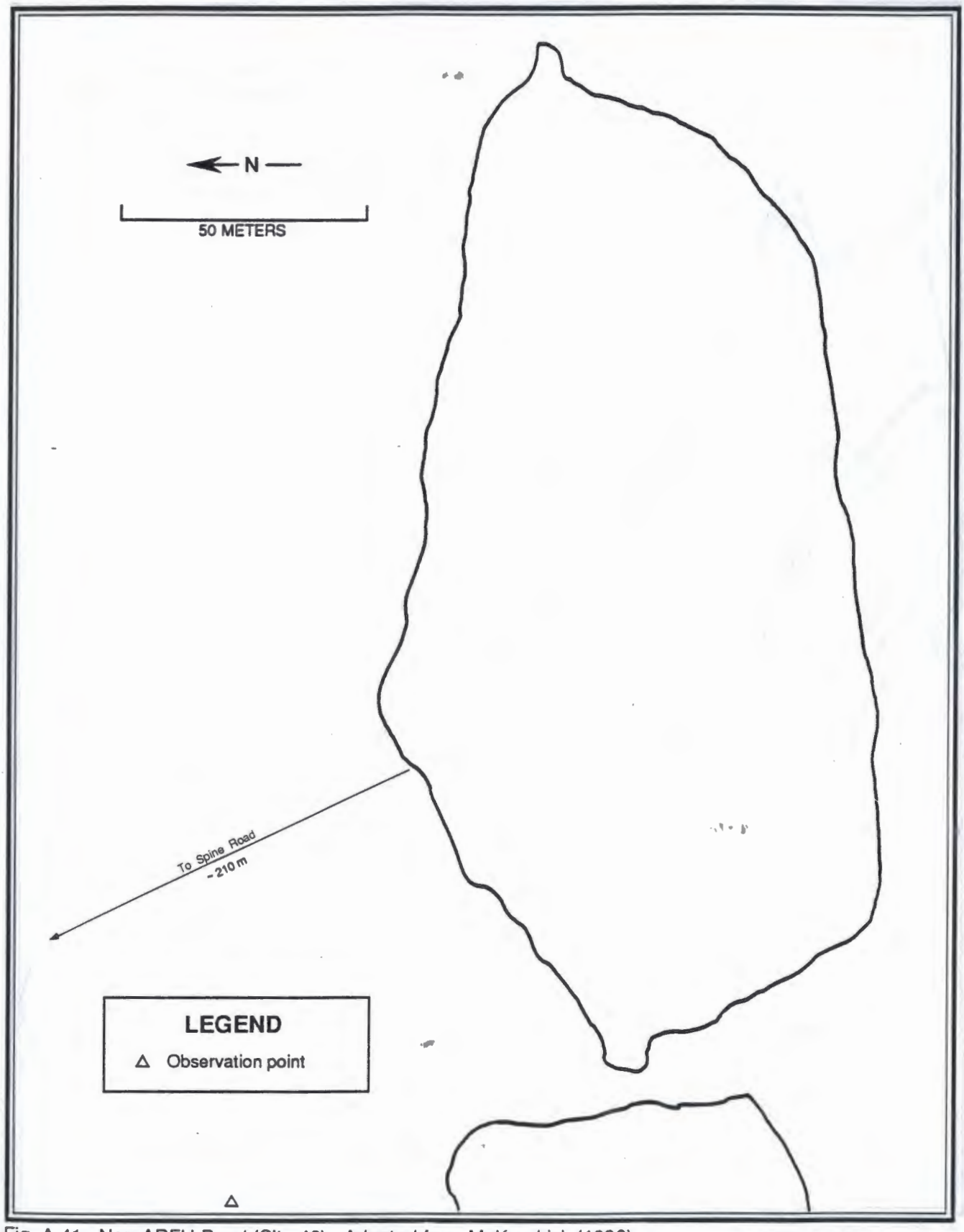


Fig. A-41. Non-ARFU Pond (Site 46). Adapted from McKendrick (1990).

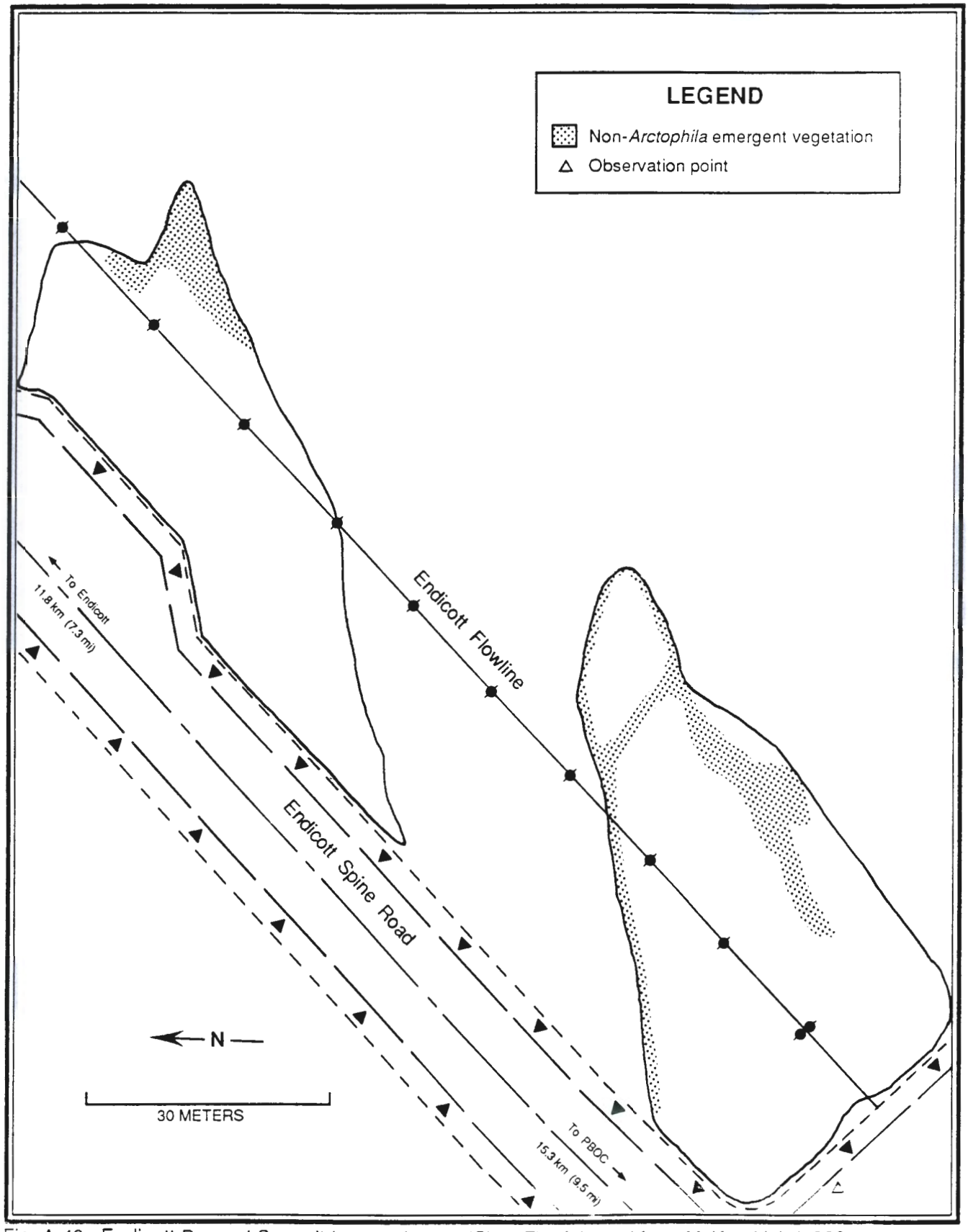


Fig. A-42. Endicott Dry and Summit Impoundments (Site 47). Adapted from McKendrick (1990)

APPENDIX B

Environmental and Behavioral Descriptors and Field Forms Used to Record Observations of Wildlife Using Study Plots

Environmental and behavioral descriptors used to record observations of animal use.

VEGETATION

DPS	Dry prostrate shrub tundra
MGT	Moist graminoid tundra
WGT	Wet graminoid tundra
WST	Wet saline graminoid tundra
ACE	Aquatic graminoid tundra (*Carex, Eriophorum)*
AAR	Aquatic graminoid tundra (*Arctophila*)
COB	Coastal barrens
BSP	Barren of sand covered peat
WTR	Water
IMP	Impounded water caused by man-made structures
SNI	Snow/Ice
DST	Disturbed
MTT	Moist tussock tundra
UNK	Unknown/not applicable

SURFACE-FORM

HCP	High-centered polygons
LCP	Low-centered polygons
MCP	Mixed high- and low-centered polygons
FBT	Frost-boil tundra
STR	Strangmoor and/or discontinuous low-centered polygons
HUM	Hummocky terrain associated with steep slopes
PGO	Pingo
NPG	Non-patterned ground
RET	Reticulate pattern on creek banks, ridges, or inactive dunes
PNE	Pond (shallow, no emergent vegetation)
PWE	Shallow pond/lake with *Carex* or *Arctophila*
LAK	Lake (too deep to wade)
STR	Stream
FTP	Flat-top polygon (low-relief high-centered polygon)
PRS	Peat road surface
PRD	Peat road ditch
PRB	Peat road bank
GPS	Gravel pad surface
GPB	Gravel pad bank
GPD	Gravel pad ditch
GRS	Gravel road surface
GRB	Gravel road bank
GRD	Gravel road ditch
ALL	Alluvium
OVB	Overburden
UNK	Unknown/not applicable

MICROHABITAT

RIM	Low-centered polygon rim or strangmoor ridge
TRO	Polygon trough
BAS	Polygon basin
IWP	Ice wedge pool (thermokarst pit)
TUS	Tussock
HUM	Hummock
FRB	Frost boil
OPW	Open water
EMV	Emergent vegetation
SNI	Snow/Ice
MEW	Melt water
FLV	Flat-vegetated
FLB	Flat-barren
PPL	Pipeline
ISV	Isolated vegetation
ISL	Island
PEB	Pond edge/bank
DST	Disturbed
GRR	Gravel roadside
STK	Stake (plot marker)
UNK	Unknown/not applicable

BEHAVIOR

DI	Displaying
NI	Nesting/incubation
AD	Alarm/distraction
FD	Feeding
RP	Resting/preening/standing
FS	Flushed
FL	Flying
IN	Interacting (non-display)
LD	Landing
HU	Hunting
AT	Attracted from off plot (mobbing)
TR	Transport
UN	Unknown

SIGN

SC	Scat
TR	Tracks
GR	Grazing
RE	Remains

SITE ______________ Page ____ of ____

DATE __|__|__|__|__|__ (m m d d y y) CONTROL/DIST [ ] OBSERVER ______________

Time: Start __|__|__|__ End __|__|__|__

WEATHER: Temp. __|__ Wind __|__|__|__ Cloud Cover __|__|__

Species Name	Ind	HABITAT			No. Seen	BEH	SEX		AGE			B	COMMENTS
		VEG	LND	MCR			M	F	AD	SUB	Fled		

SITE _____ Page ____ of ____

CONTROL/DIST ☐ OBSERVER _____

DATE _____ (m m d d y y)

Time: Start _____ End _____

COMMENTS:

APPENDIX C

Statistical Analyses and Distributions of Selected Data

INFERENTIAL STATISTICAL ANALYSES

Relatively few data sets were subjected to inferential analysis due to the limited objectives of the study. As mentioned earlier, the study was not designed with the stated purpose of testing hypotheses. Thus, those data sets chosen were selected for their ability to give a broad impression of pertinent trends, and because it was possible to convert them into an appropriately testable format.

Bird use of coastal plain gravel pads was compared with that of adjacent tundra by analyzing differences between mean numbers of bird observations per day and over the summer. During the second and fourth 2-wk study periods, as well as during the summer as a whole, there was a statistically significant difference between the mean numbers of bird observations noted on gravel and tundra (Table C-1).

Similar analyses compared ponds to impoundments, and waterbodies with *Arctophila fulva* to waterbodies without *A. fulva*. In neither case did the compared habitat types differ with respect to the mean number of bird observations per time period, irrespective of the time period under consideration (Table C-1).

Coastal plain gravel pads and undisturbed tundra were also compared with respect to proportions of bird behavior observed on them over the length of the summer (Table C-2). In addition to the general conclusion that proportions of bird behavior on gravel and tundra are significantly different, several specific differences are apparent. On gravel pads, fewer observations were made of displaying, hunting, landing, and alarming/distracting behaviors than would have been expected if behavior occurred in identical proportions on gravel and tundra. Resting/preening accounted for a higher proportion of bird behavior on gravel pads than would have been expected. The large discrepancies between observed and expected frequencies in each of these five behavioral categories were enough individually to conclude that gravel pads and tundra differ with respect to bird behavior. Discrepancies in feeding and interacting behaviors were relatively less important, quantitatively.

Table C-1. Statistical analysis of bird use by habitat type. For each habitat comparison, the analysis tested for a difference between mean numbers of bird observations per day, (i.e. for 24 3-min periods), and for the entire summer, (96 3-min periods). Observations were made at each site one day per each of the 4 observational periods.

2-Wk Observational Period	Coastal Gravel Pads versus Undisturbed Tundra		Ponds versus Impoundments		Ponds/Impoundments with ARFU versus Ponds/Impoundments w/o ARFU	
	P	n	P	n	P	n
1	0.51	9	0.05<P<0.10	19 / 9	> 0.20	14 / 14
2	0.02 *	10	> 0.20	19 / 9	> 0.20	14 / 14
3	0.18	9	> 0.20	19 / 9	> 0.20	14 / 14
4	< 0.01 *	10	> 0.20	19 / 9	> 0.20	14 / 14
Entire Summer	< 0.01 *	10	0.05<P<0.10	19 / 9	> 0.20	14 / 14
	(sign test)		(Mann-Whitney)		(Mann-Whitney)	

* significant difference at alpha = 0.05.

Table C-2. Frequencies of bird behavior on gravel pads and tundra. Data are numbers of actual observations per behavioral category, and what would have been expected if behaviors had occurred in the same proportions on both types of habitat. Behaviors are ranked by their contribution to the overall chi-square statistic.

	Gravel Pads		Tundra		
Behavior	Observed	Expected	Observed	Expected	Chi-square Contribution
Displaying	27	74	63	16	172.77 *
Hunting	4	22	22	5	81.59 *
Resting / Preening	907	810	74	171	66.66 *
Landing	734	787	219	166	20.37 *
Alarming / Distracting	13	21	12	4	16.22 *
Feeding	949	910	153	192	9.64
Interacting	20	24	9	5	3.72
Other	93	100	28	21	2.74
	n = 2747		n = 580		Chi-square = 373.71
					df = 7
					P < 0.01

* chi-square contributions that, alone, would have made test significant.

DESCRIPTION OF VARIABLE DISTRIBUTIONS

In order to better describe the variability of the data concerning wildlife use of disturbed and undisturbed habitats, bivariate scatter/boxplots were generated with the computer package SYGRAPH (Wilkinson 1988:188) and are included following Fig. C-1. Each pair of plots corresponds to a specific habitat-use comparison addressed in the text, and appears in the same sequence. The individual graphs are simple scatter diagrams which plot the number of distinct species observed per two-hour interval by the average number of individuals observed per 3-minute period during that same interval. Opposite the axes, data variability is summarized by boxplots. A notational explanation of the boxplots themselves is presented in Fig. C-1.

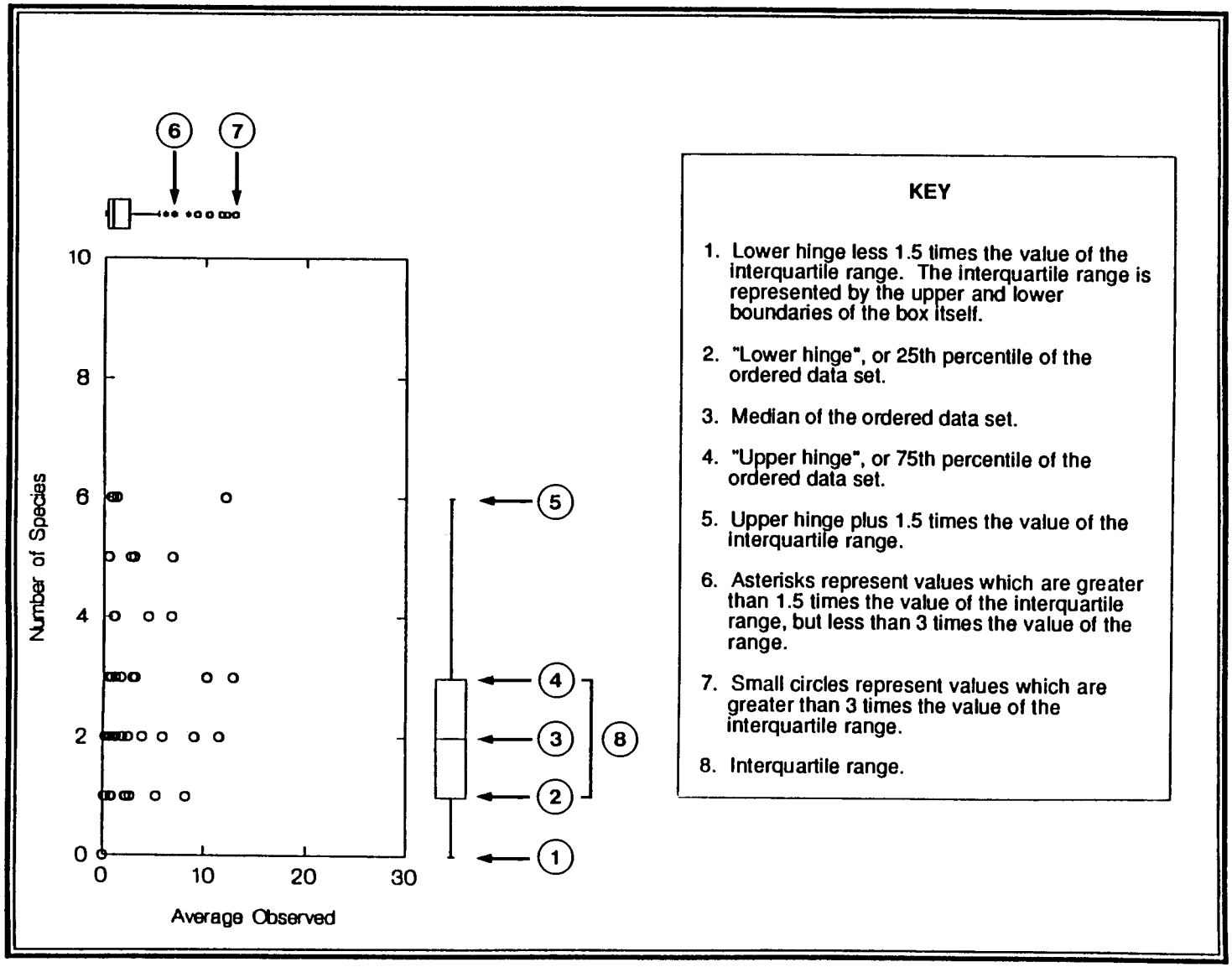
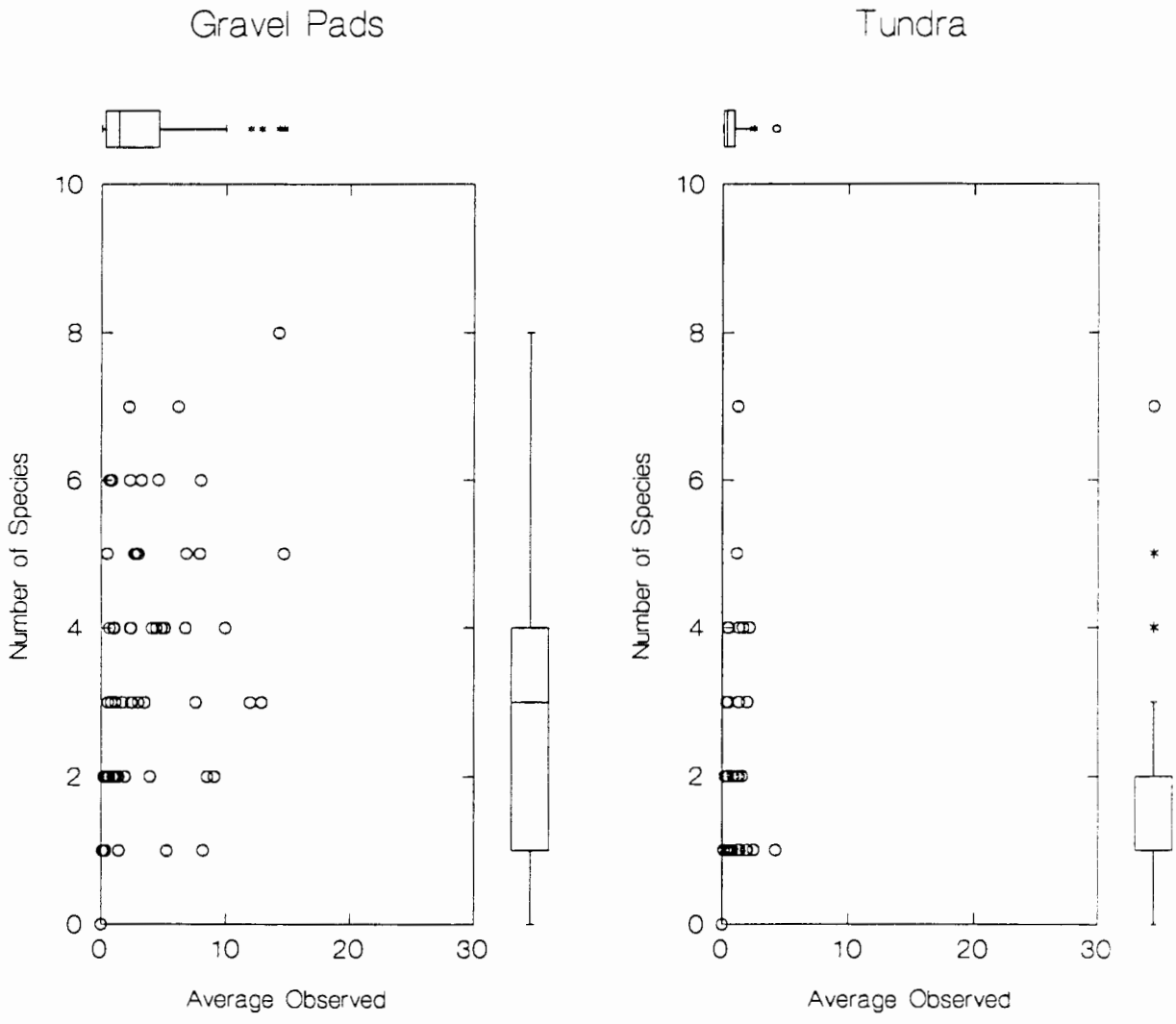
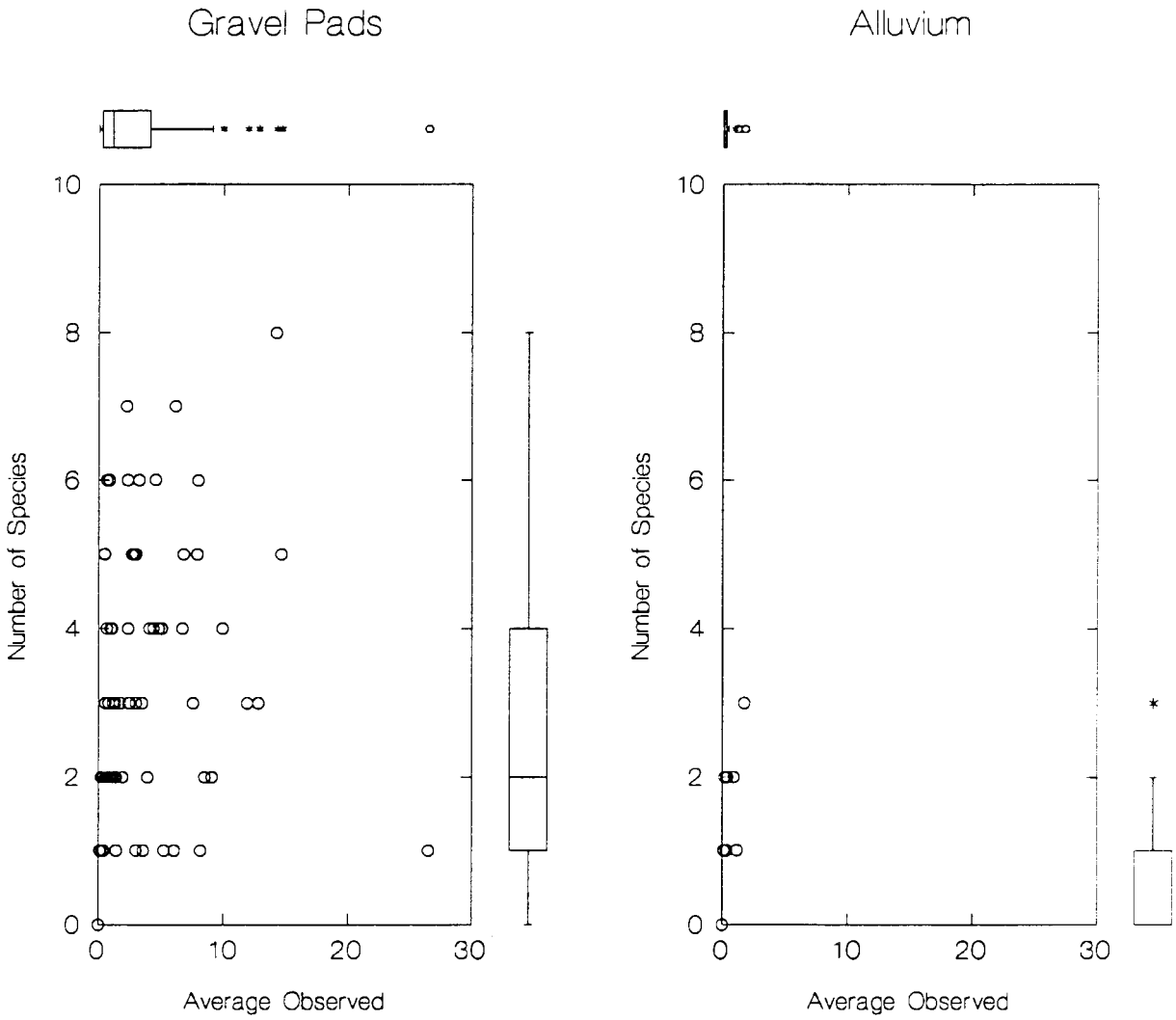


Fig. C-1. Notational key to boxplots which graphically describe the variability of data concerning wildlife use of disturbed and undisturbed habitats.

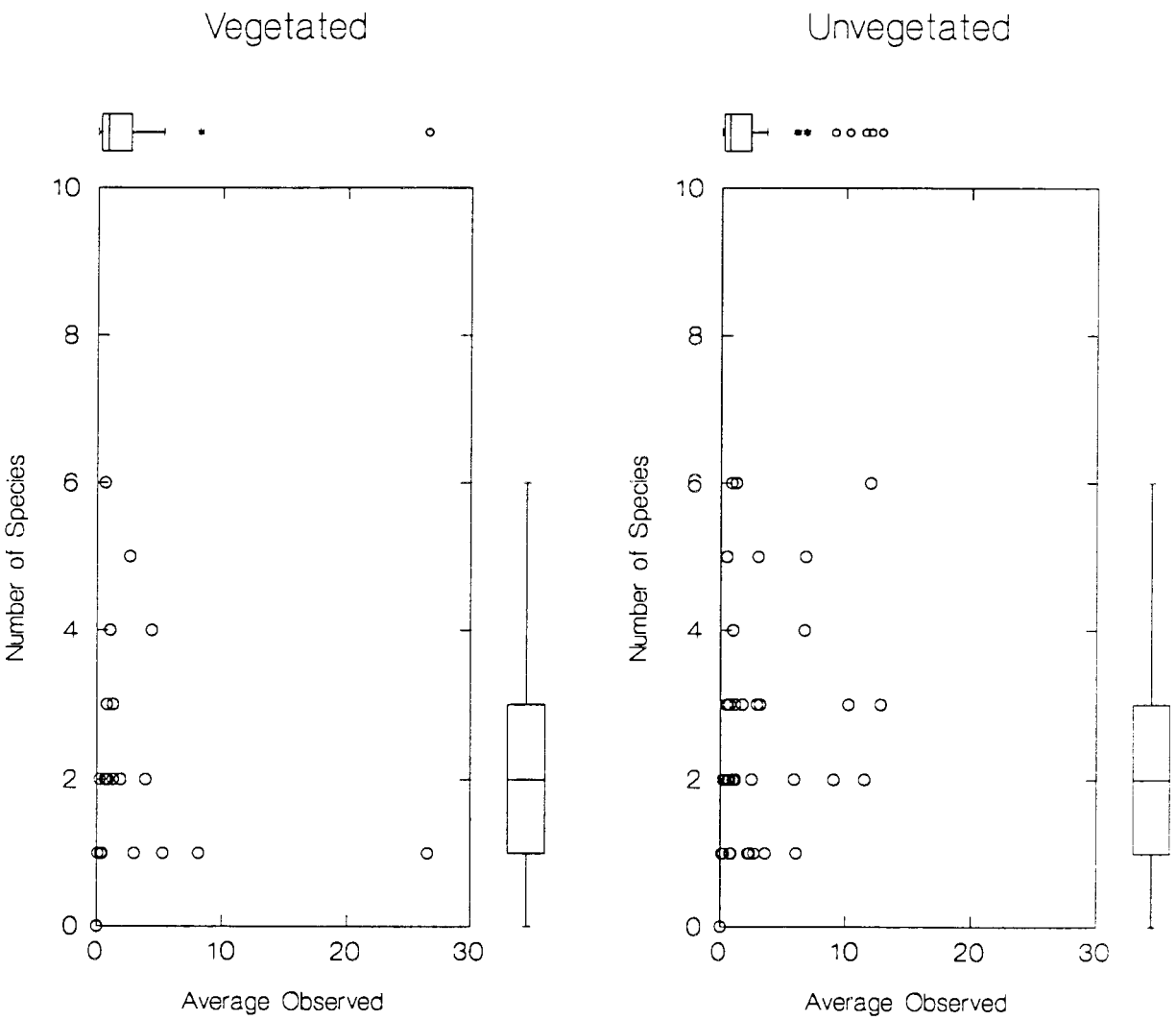
Bird Use of Coastal Gravel Sites



Bird Use of Coastal Gravel Pads and Alluvium

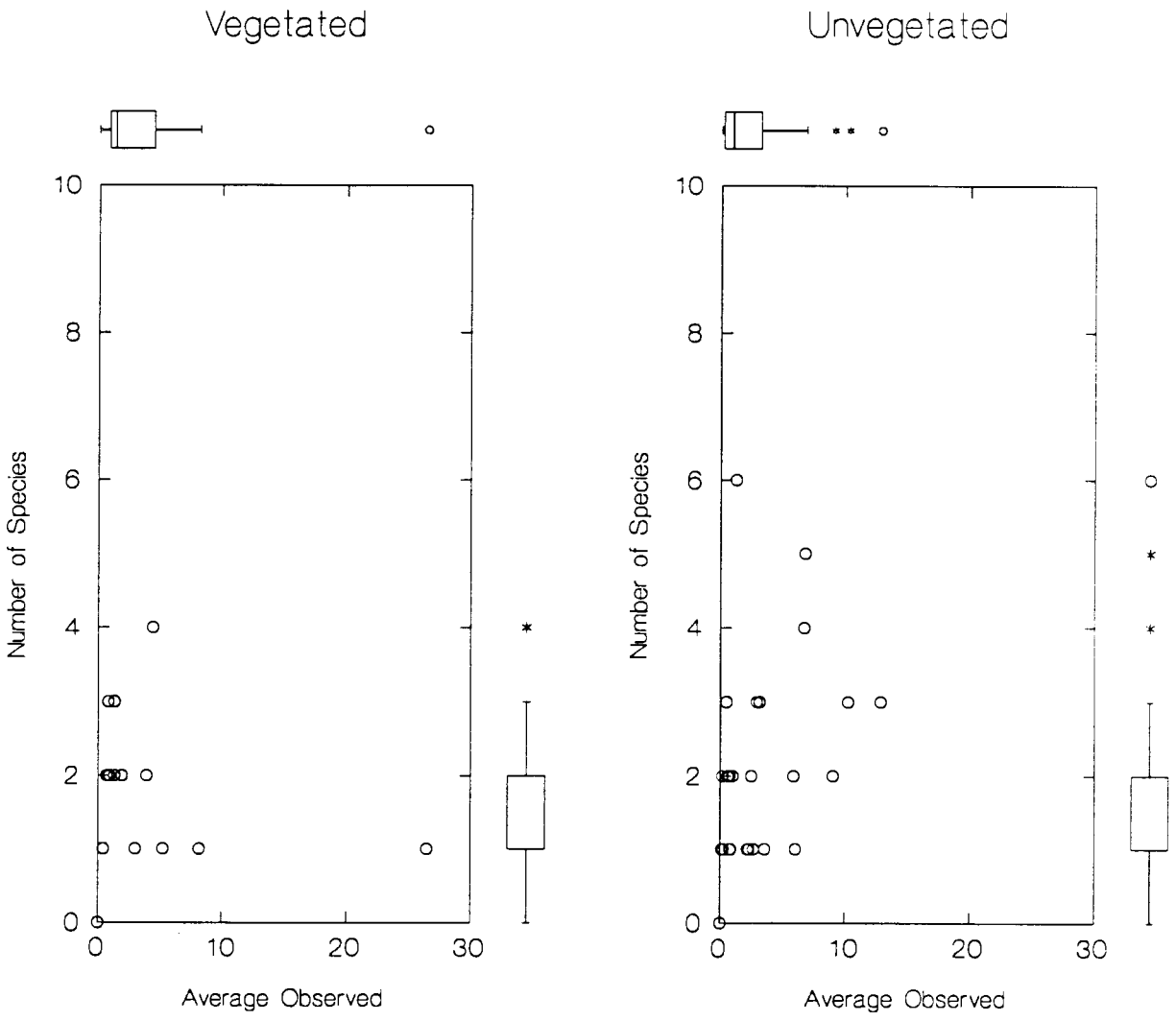


Bird Use of Gravel Pads
excluding observations on impoundments

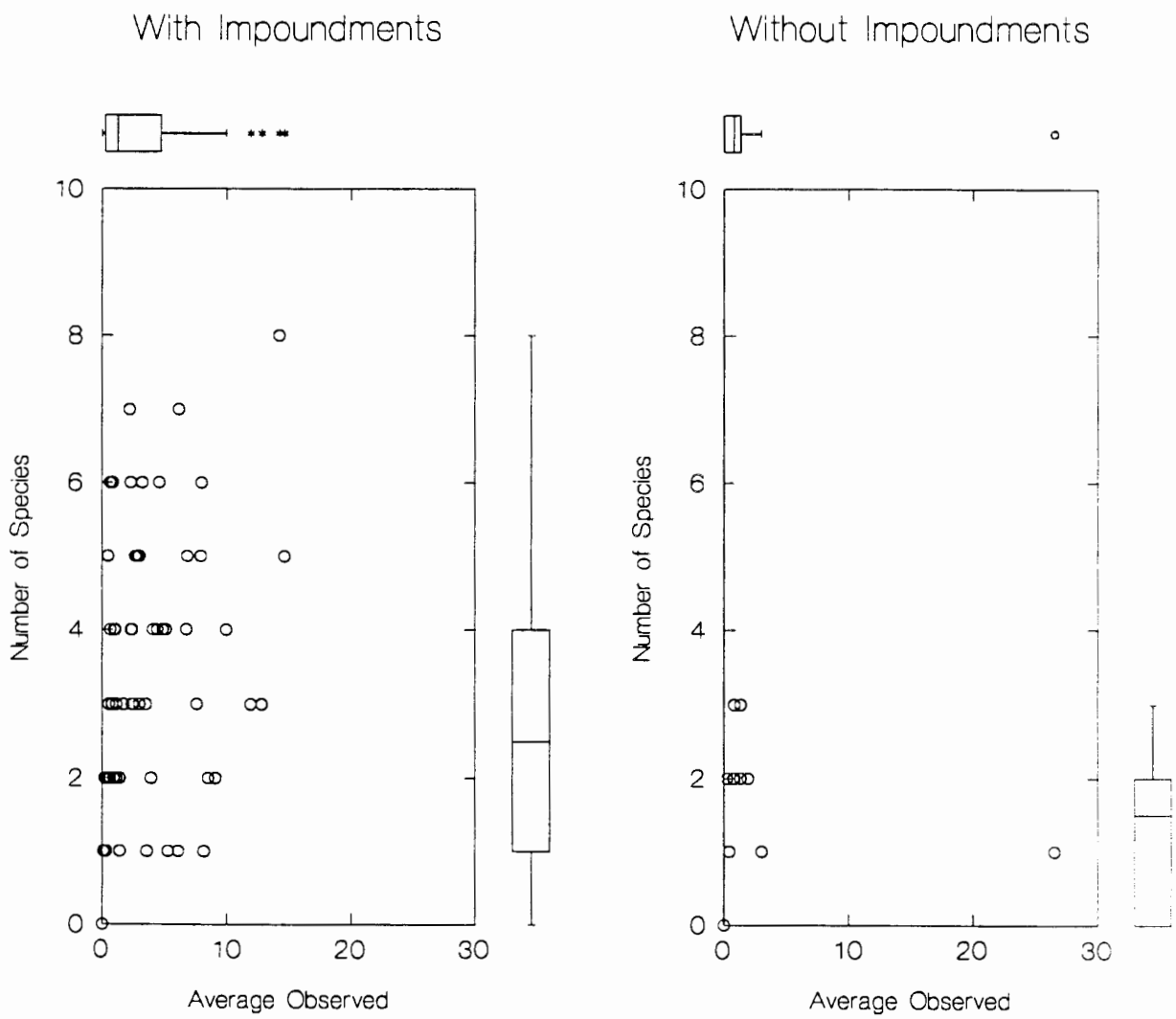


Bird Use of Gravel Pads

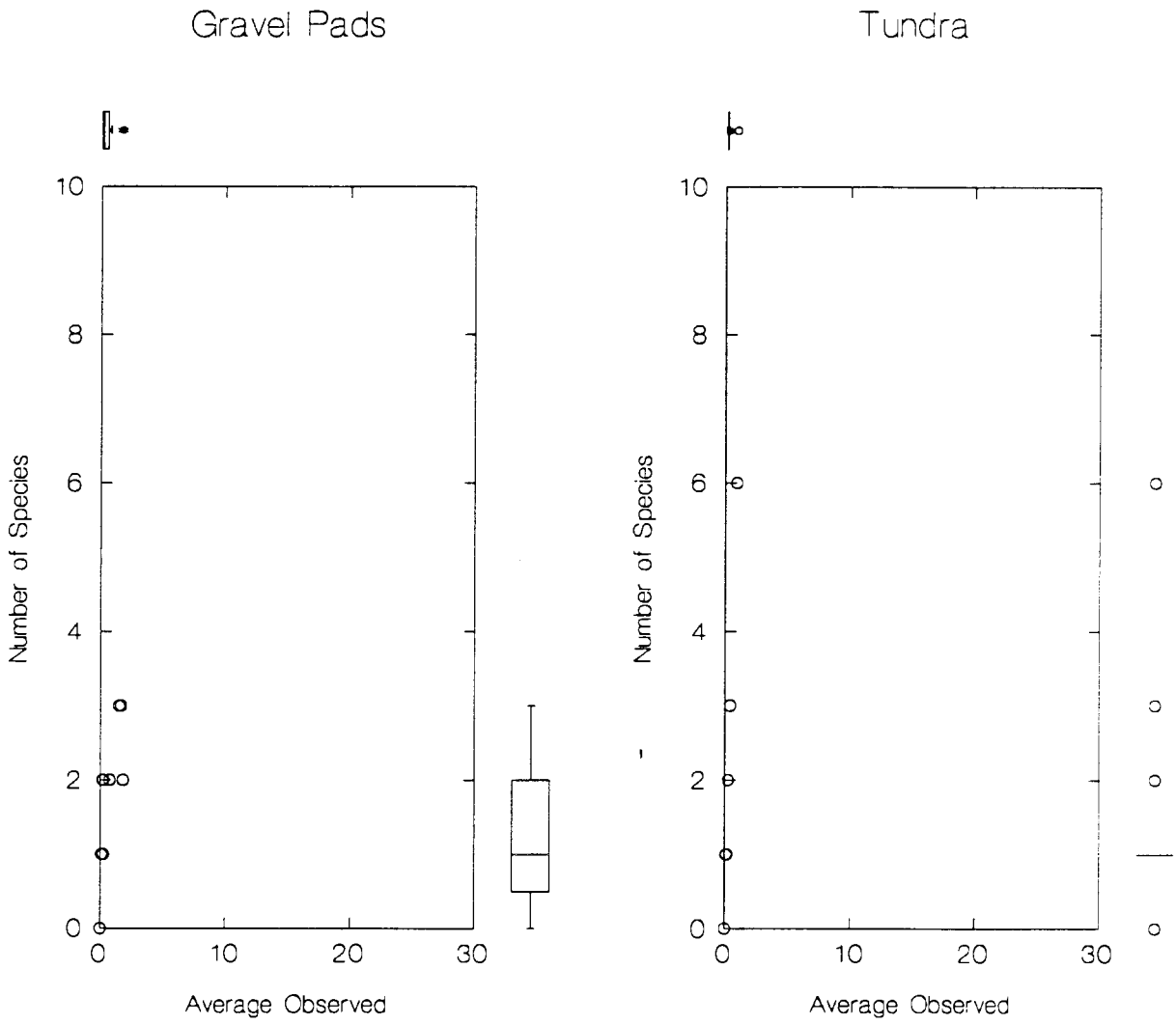
from mid-July to mid-August
excluding observations on impoundments



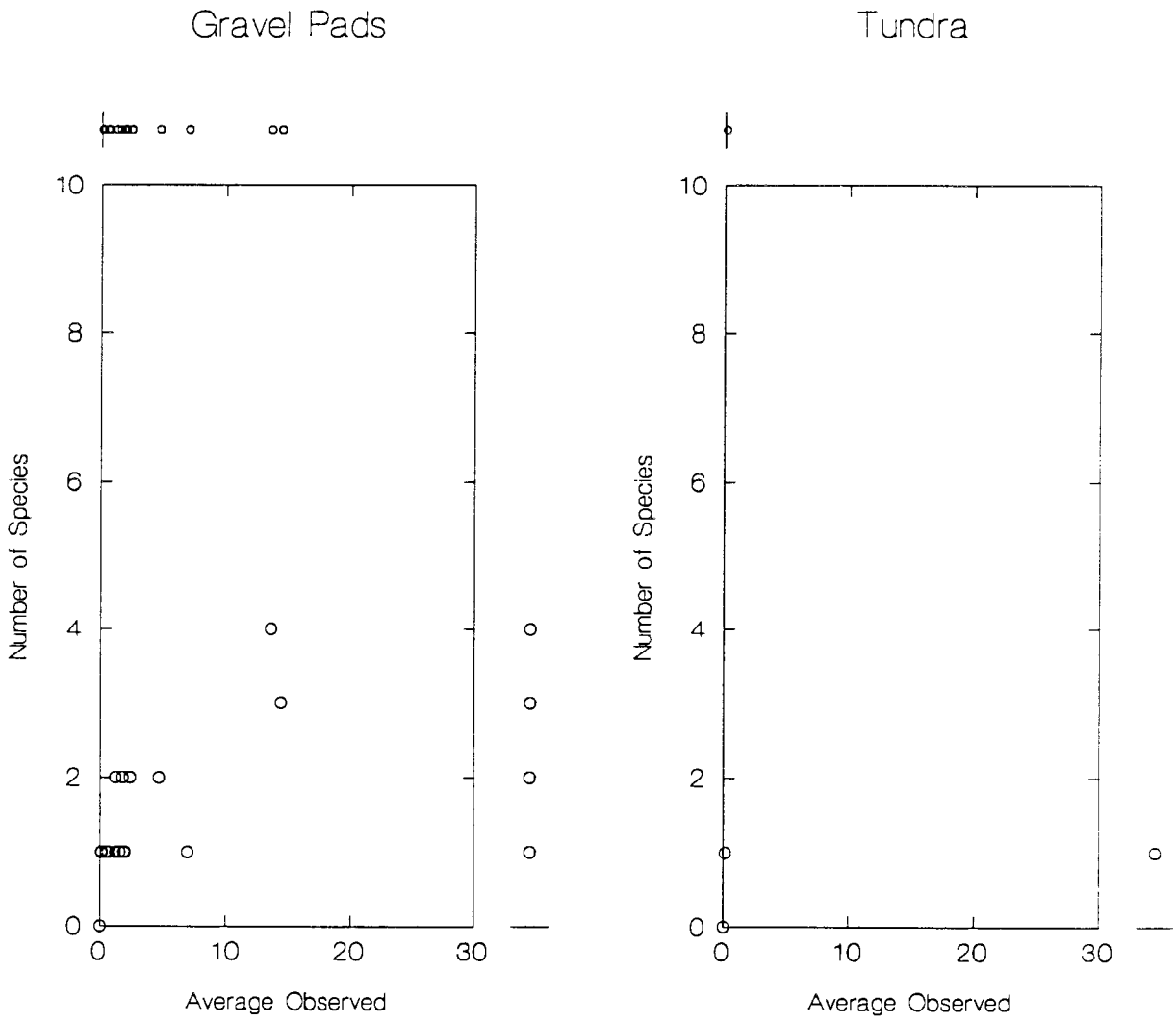
Bird Use of Gravel Pads



Bird Use of Foothill Gravel Pad Sites

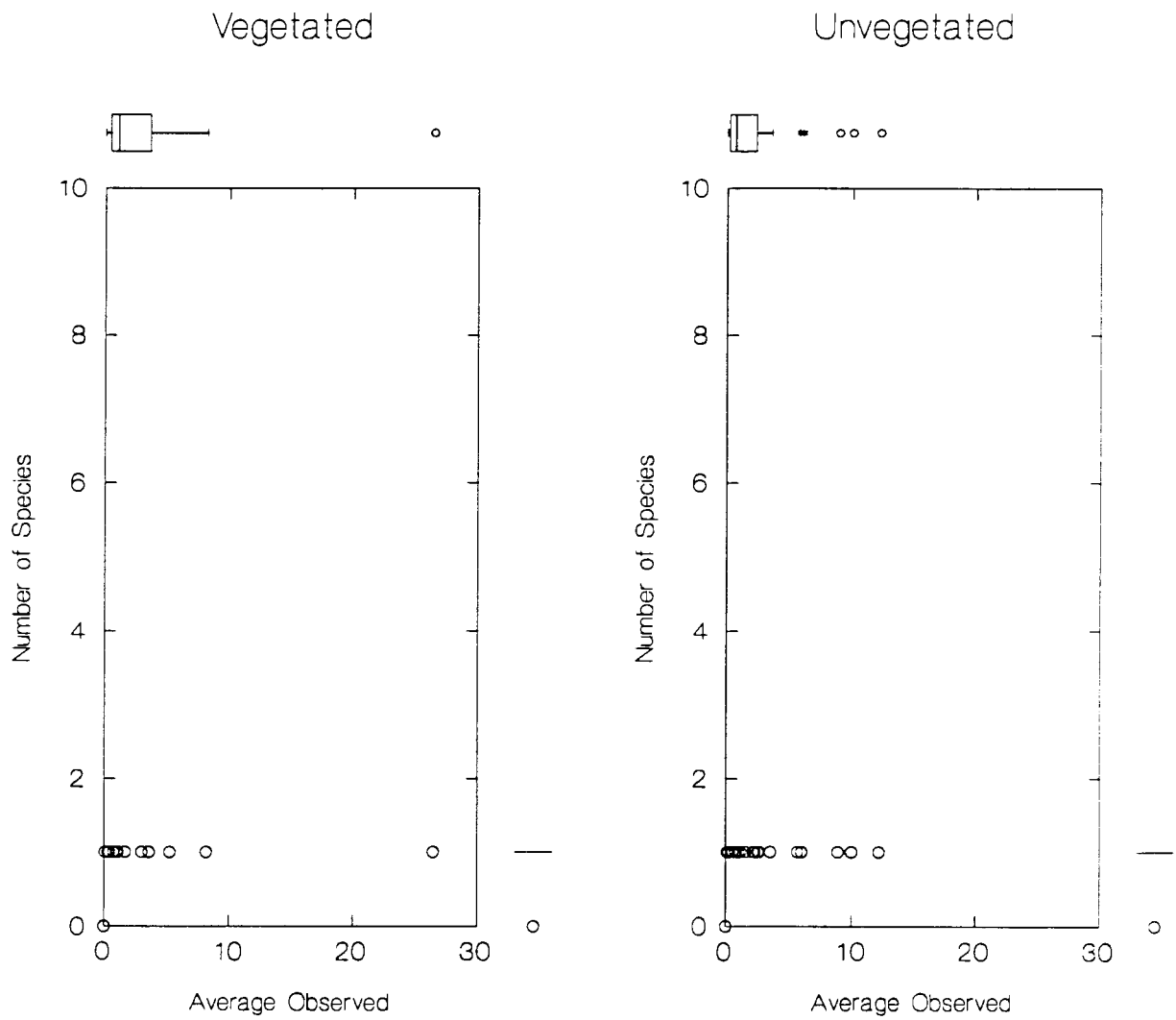


Waterfowl Use of Coastal Gravel Pad Sites

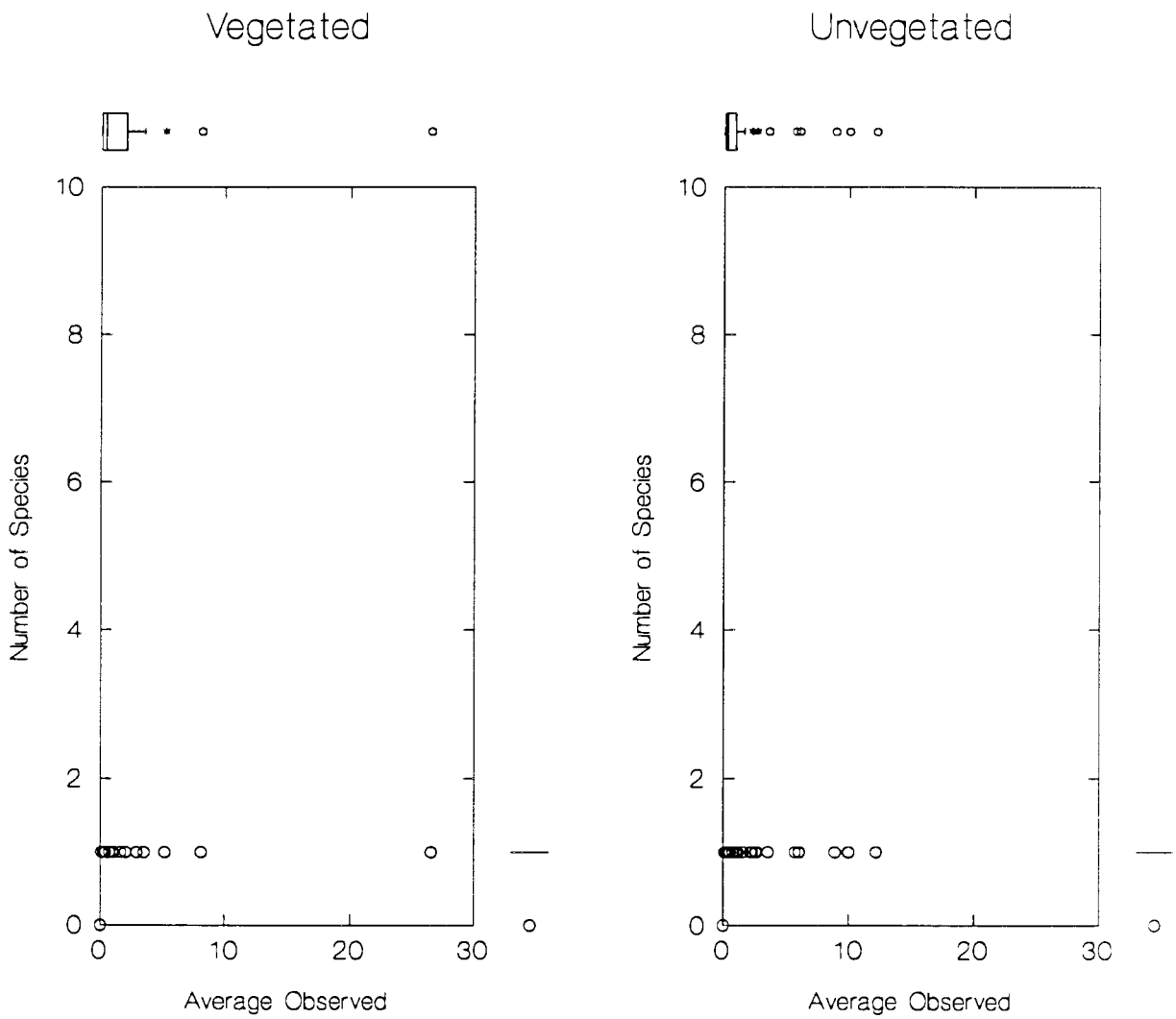


Lapland Longspur Use of Gravel Pads

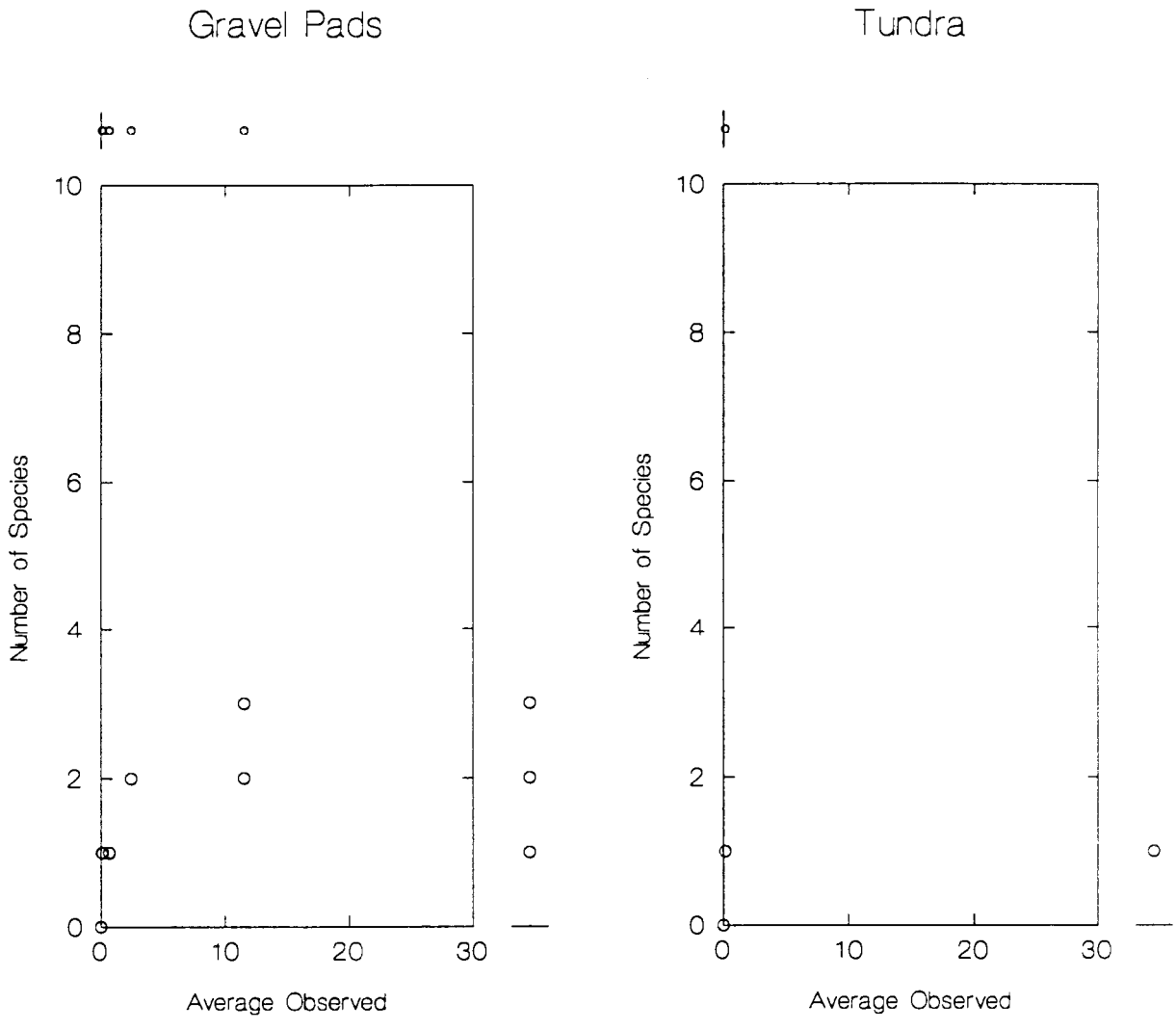
from mid-July to mid-August
excluding observations on impoundments



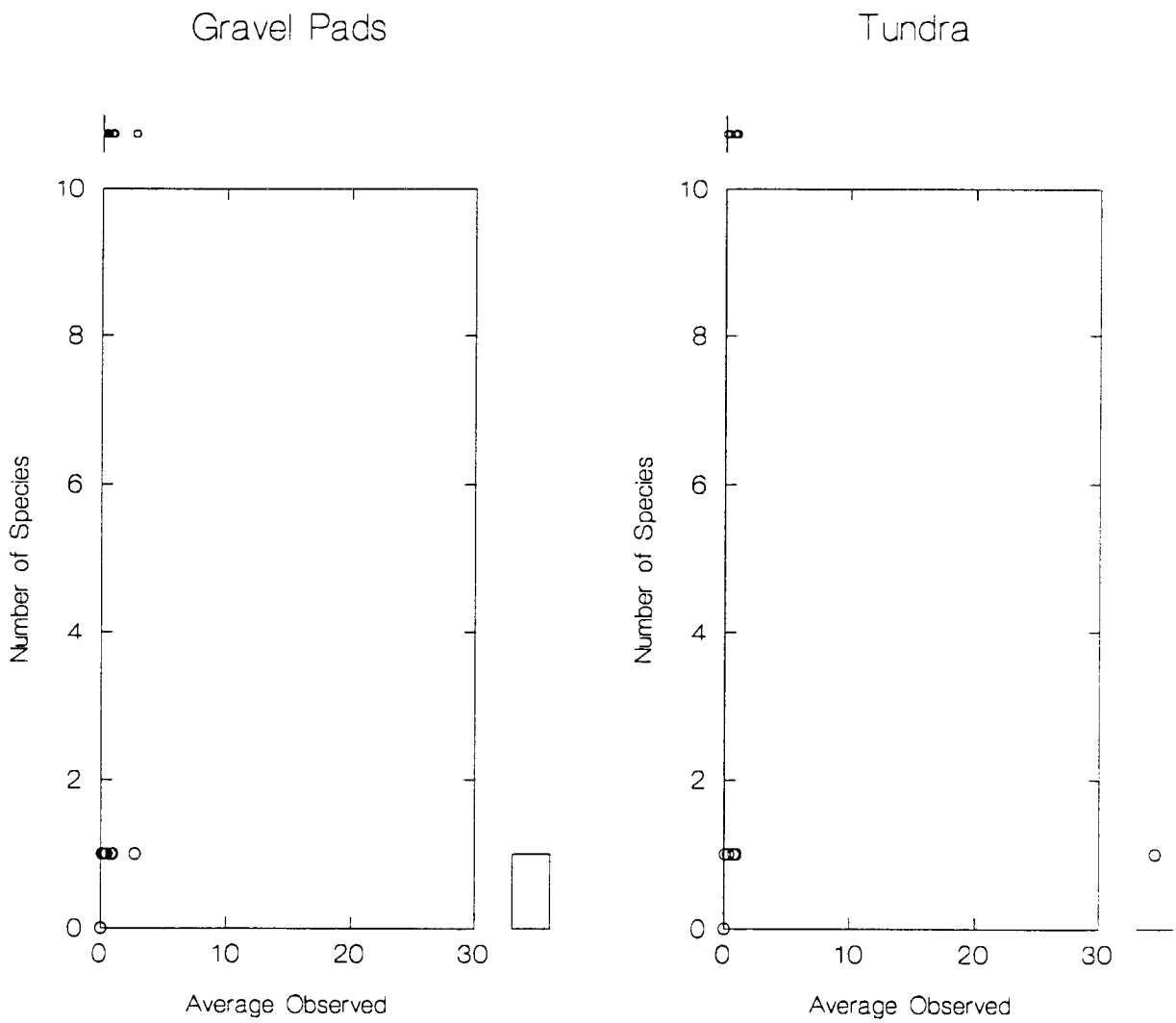
Lapland Longspur Use of Gravel Pads
excluding observations on impoundments



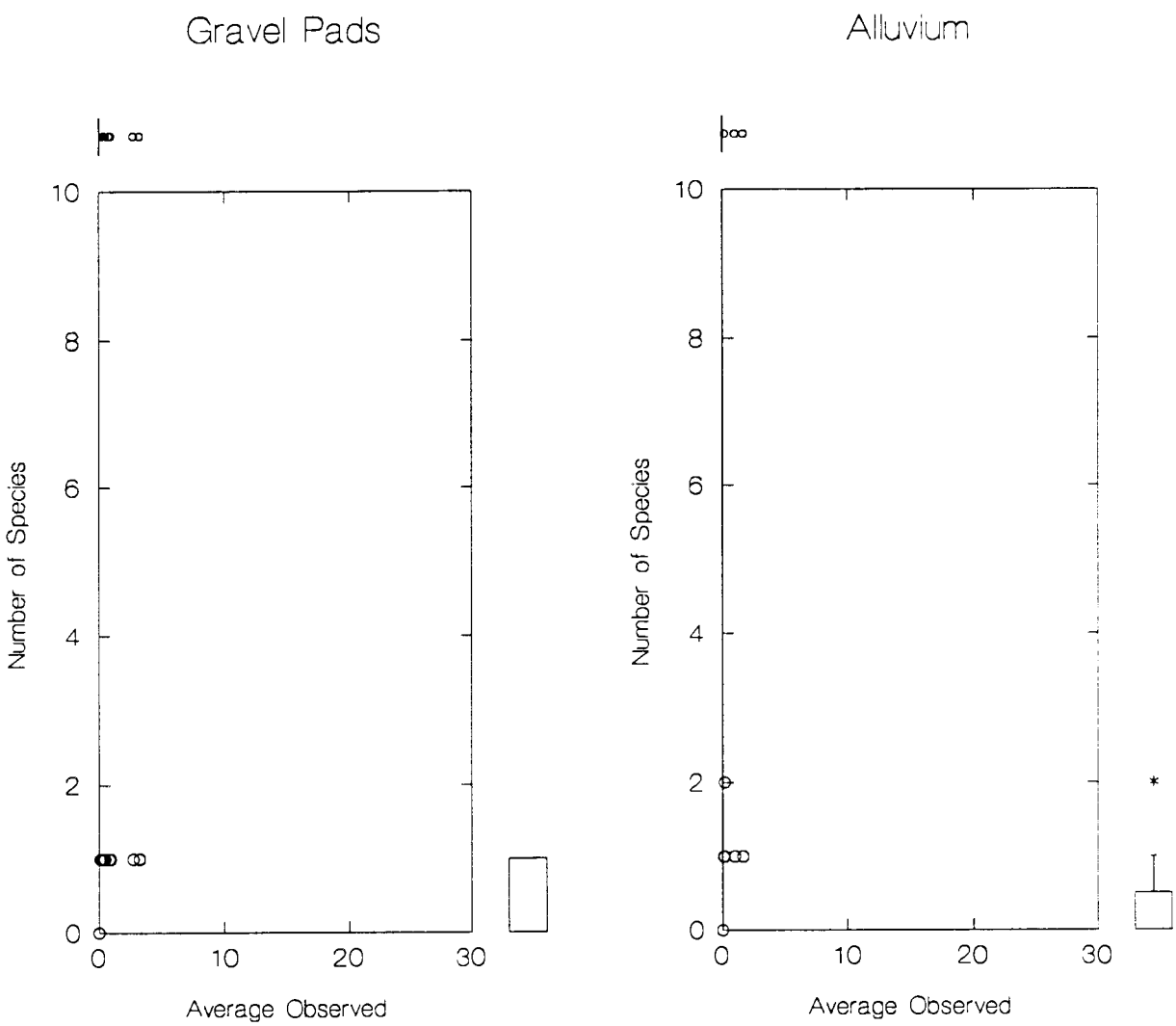
Waterfowl Use of Coastal Gravel Pad Sites
excluding observations on impoundments



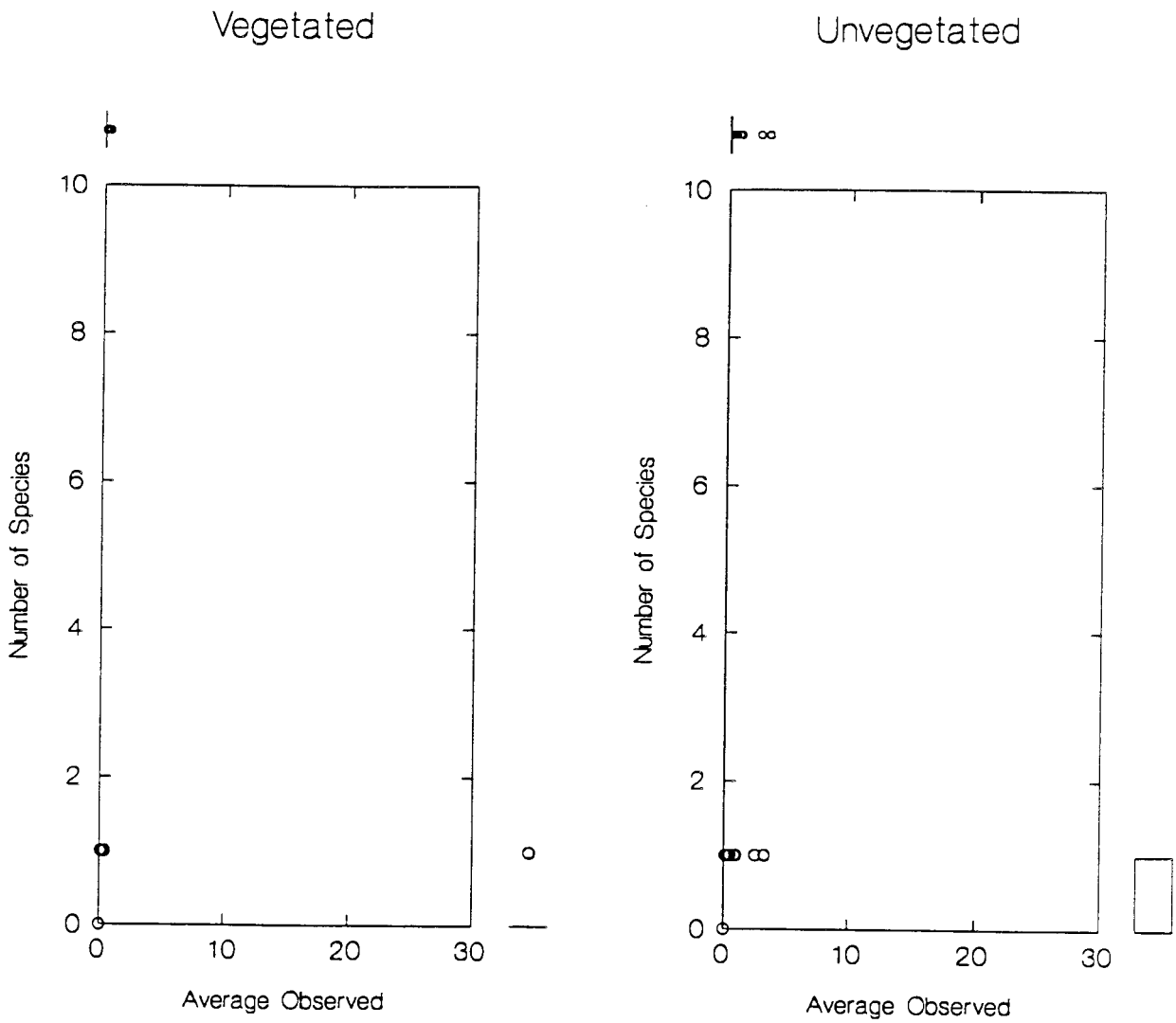
Mammal Use of Coastal Gravel Sites



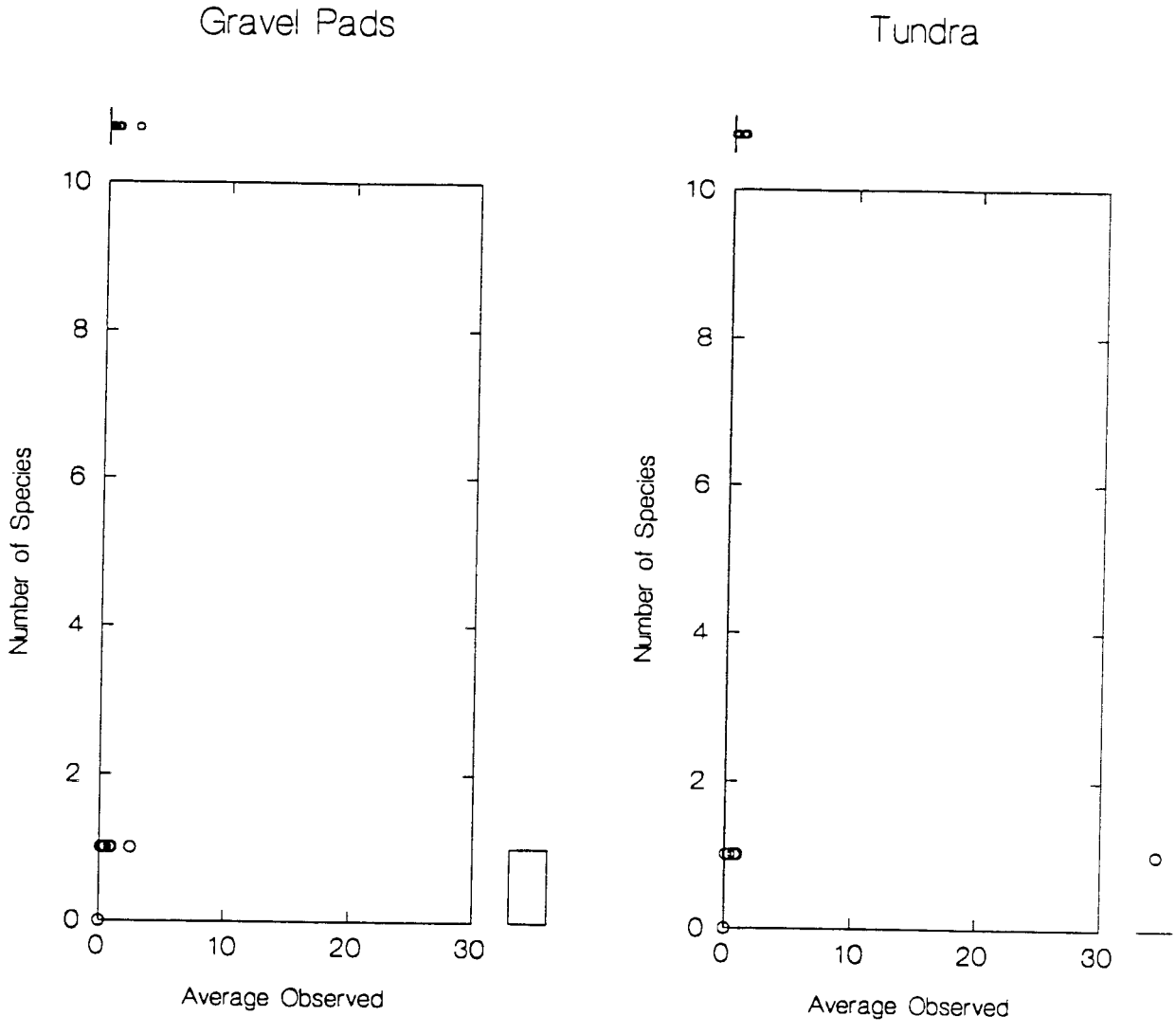
Mammal Use of Gravel Pads and Alluvium



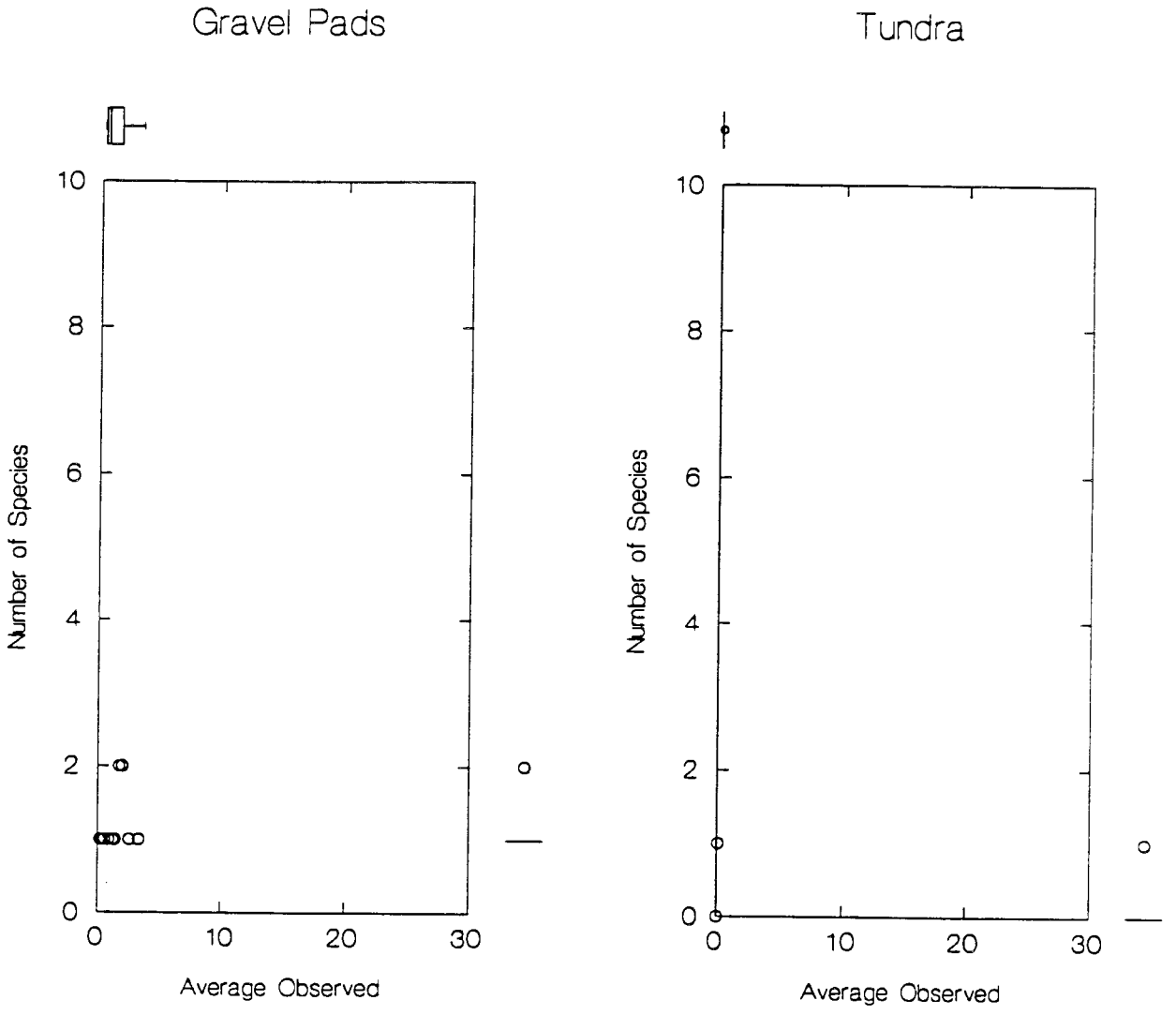
Mammal Use of Gravel Pads
excluding observations on impoundments



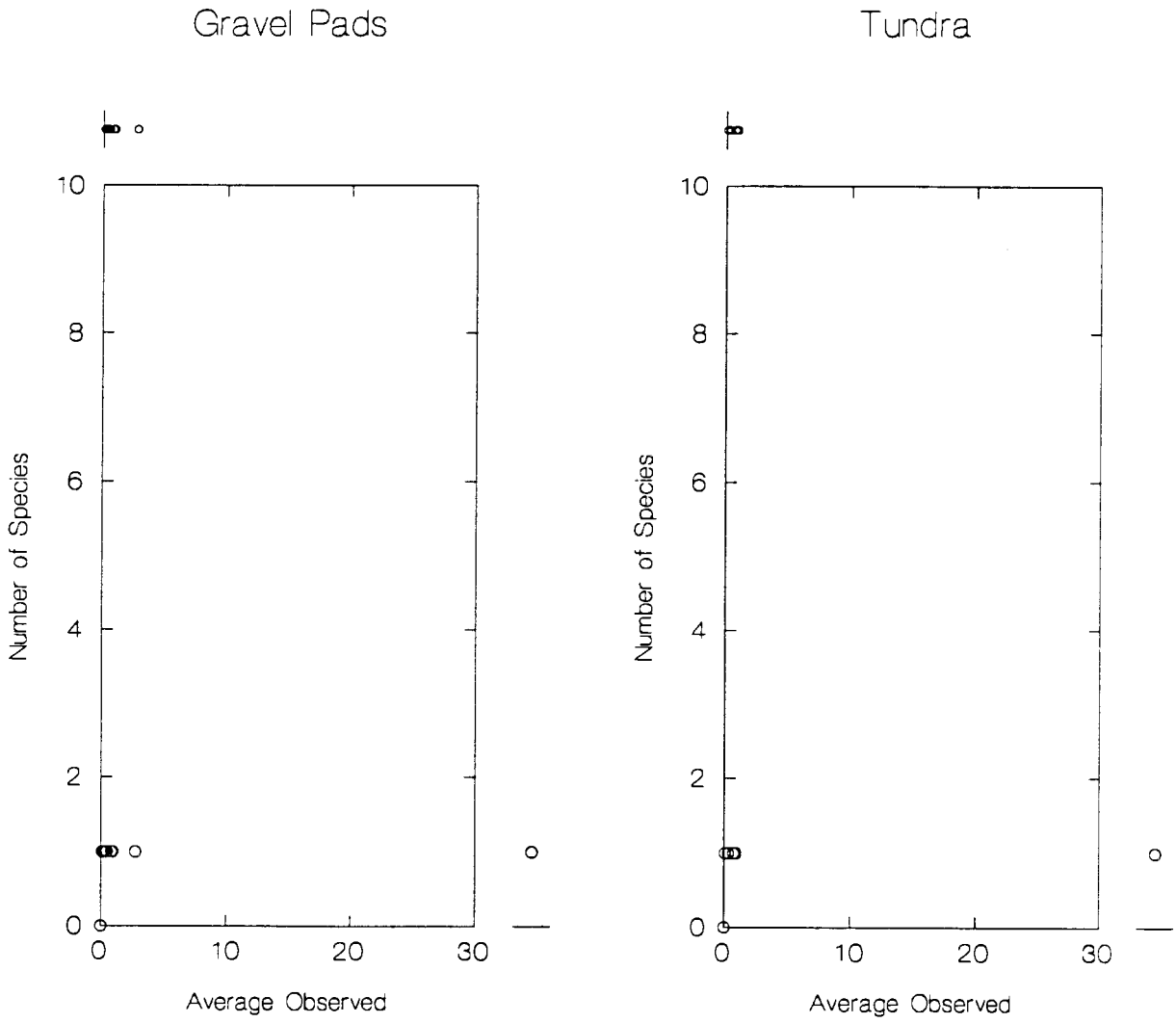
Mammal Use of Coastal Gravel Pad Sites
excluding observations on impoundments



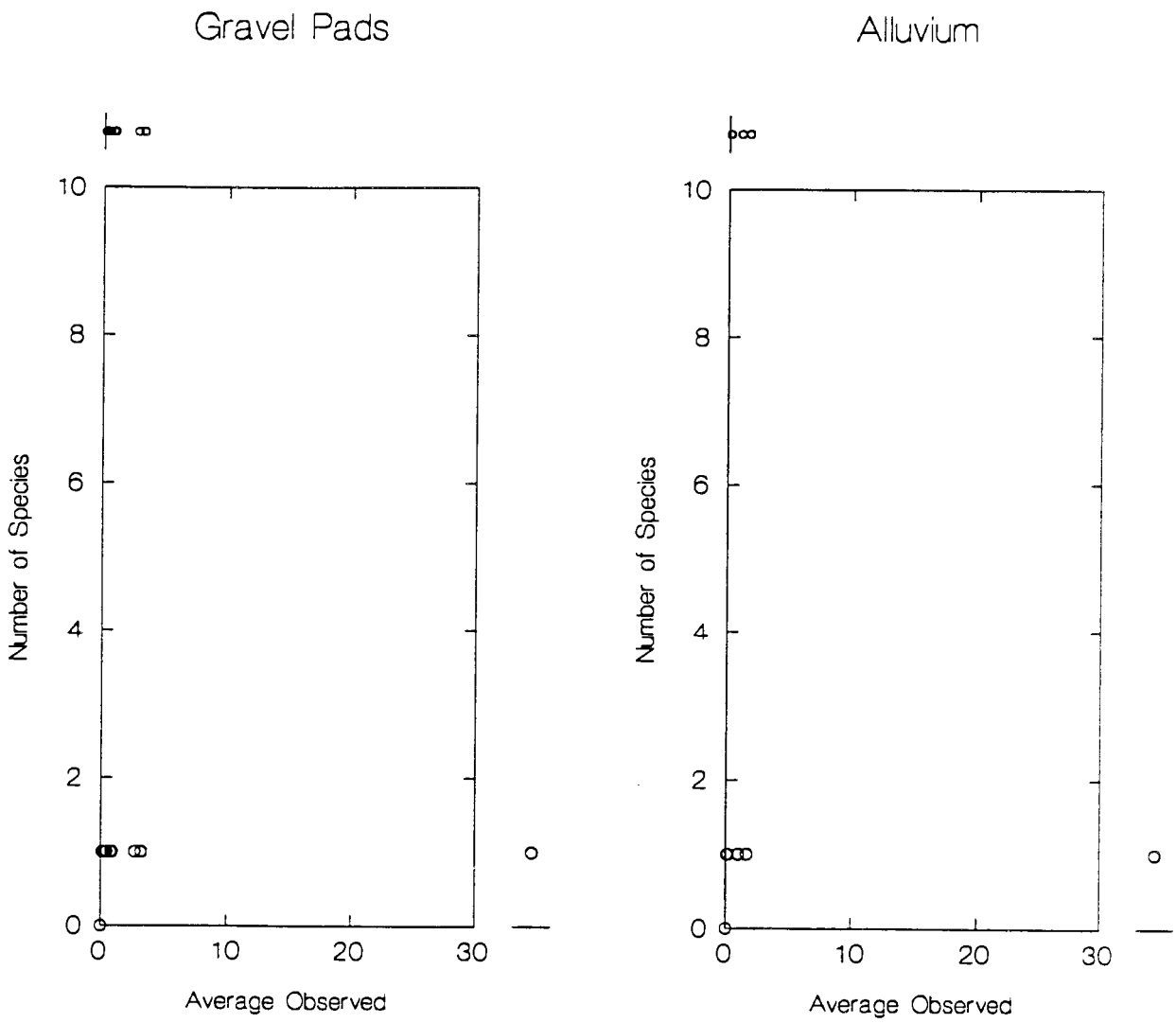
Mammal Use of Foothill Gravel Pad Sites



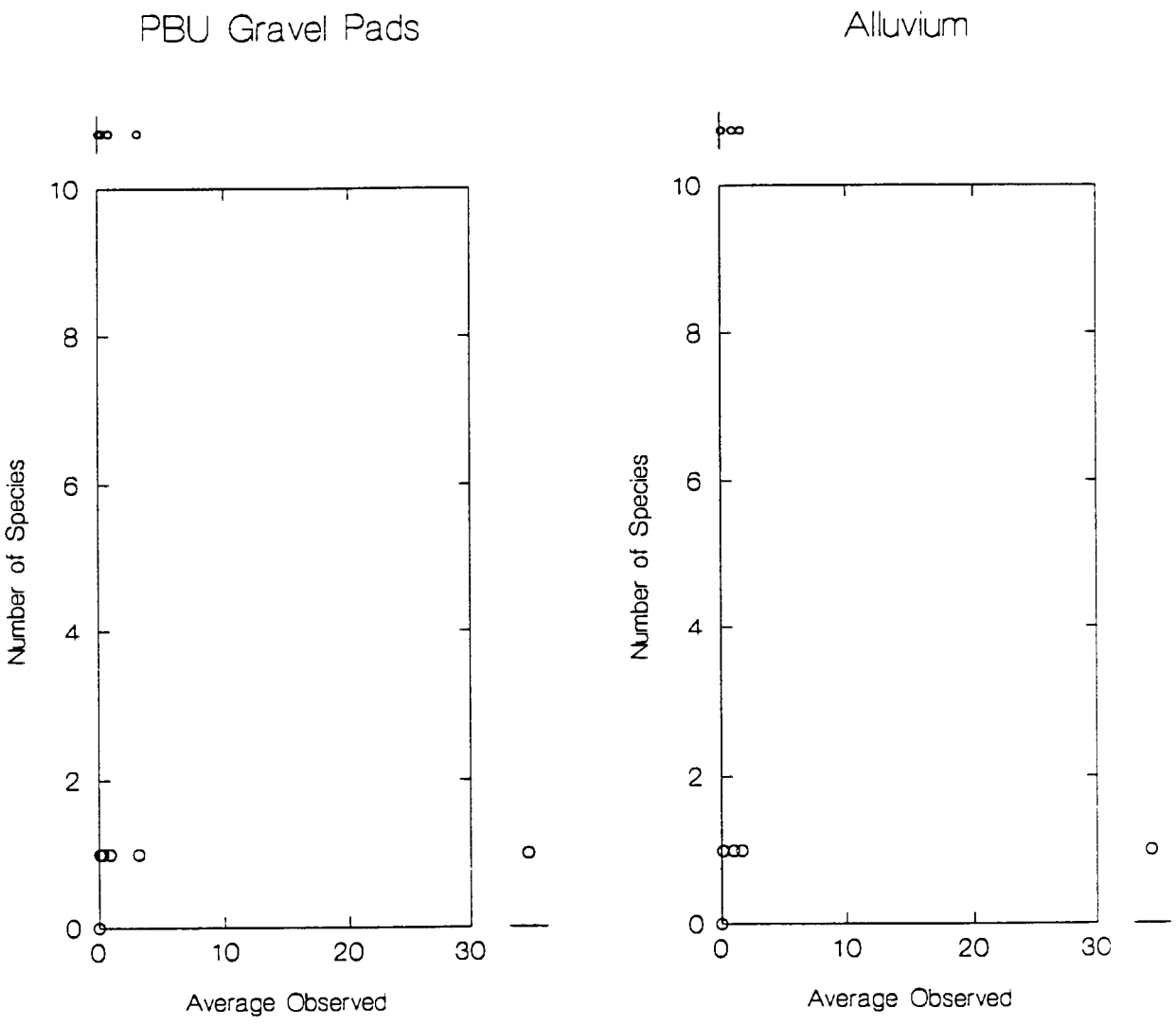
Caribou Use of Coastal Gravel Pad Sites



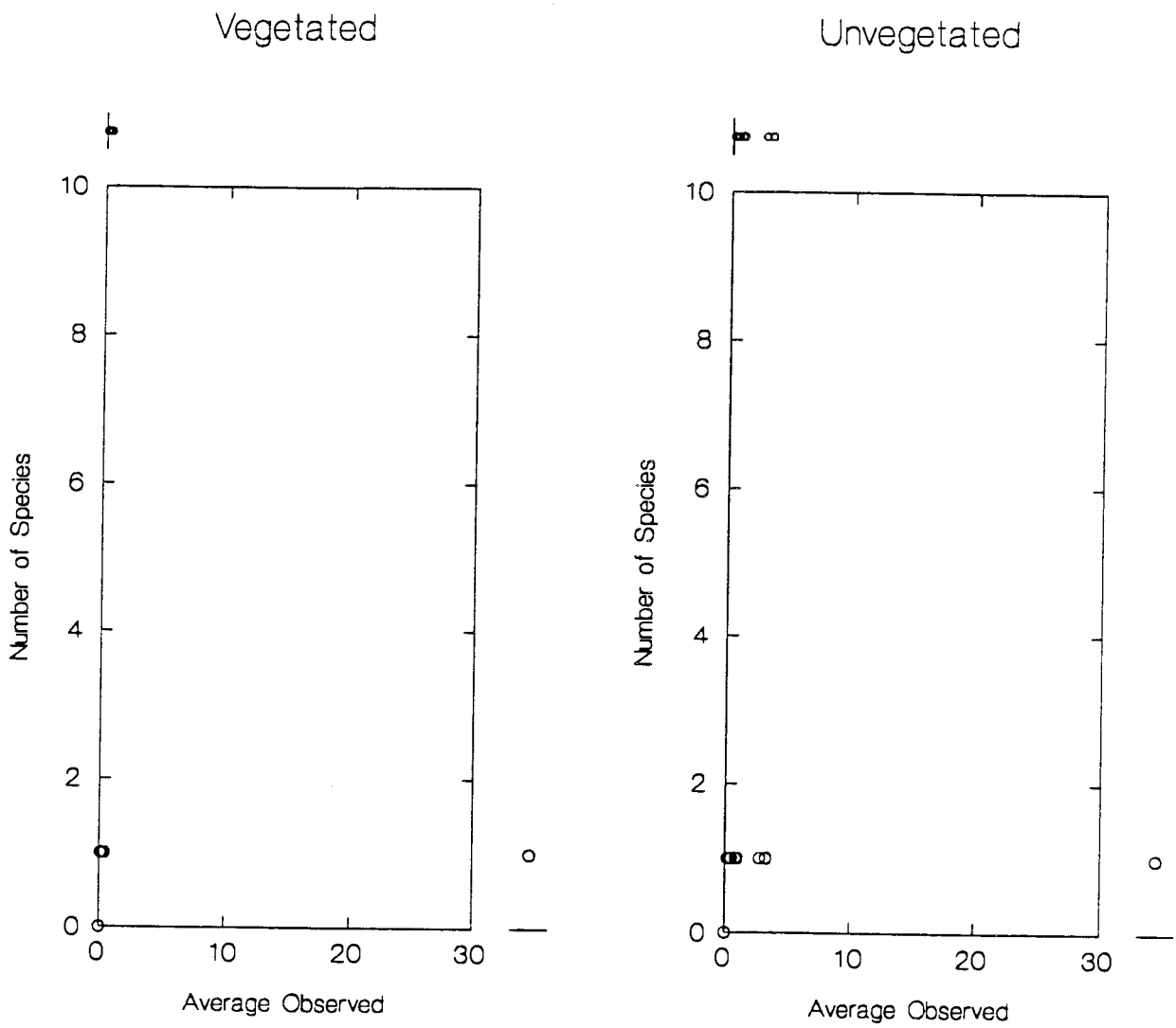
Caribou Use of Gravel Pads and Alluvium



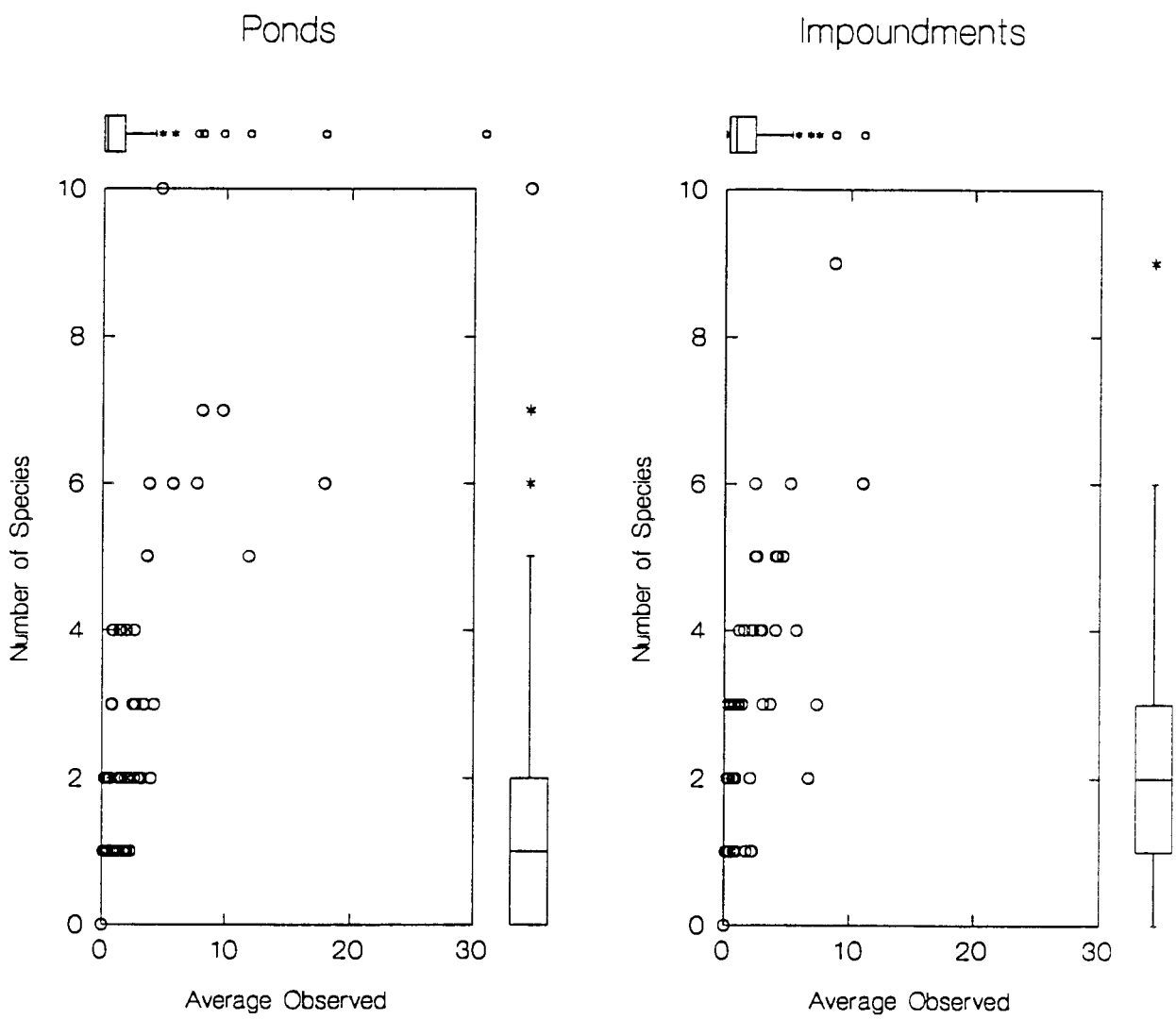
Caribou Use of PBOC Gravel Pads and Alluvium



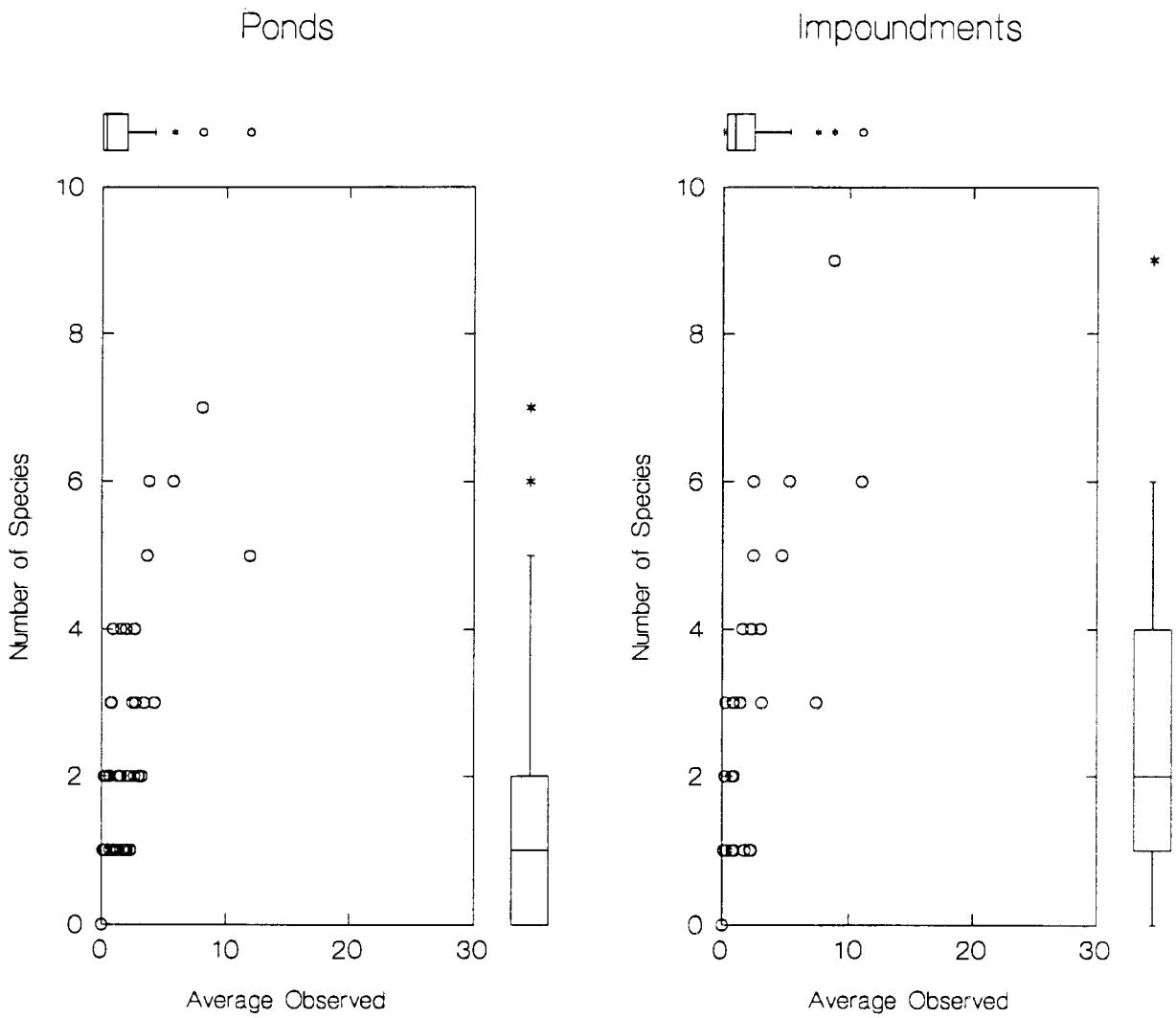
Caribou Use of Gravel Pads



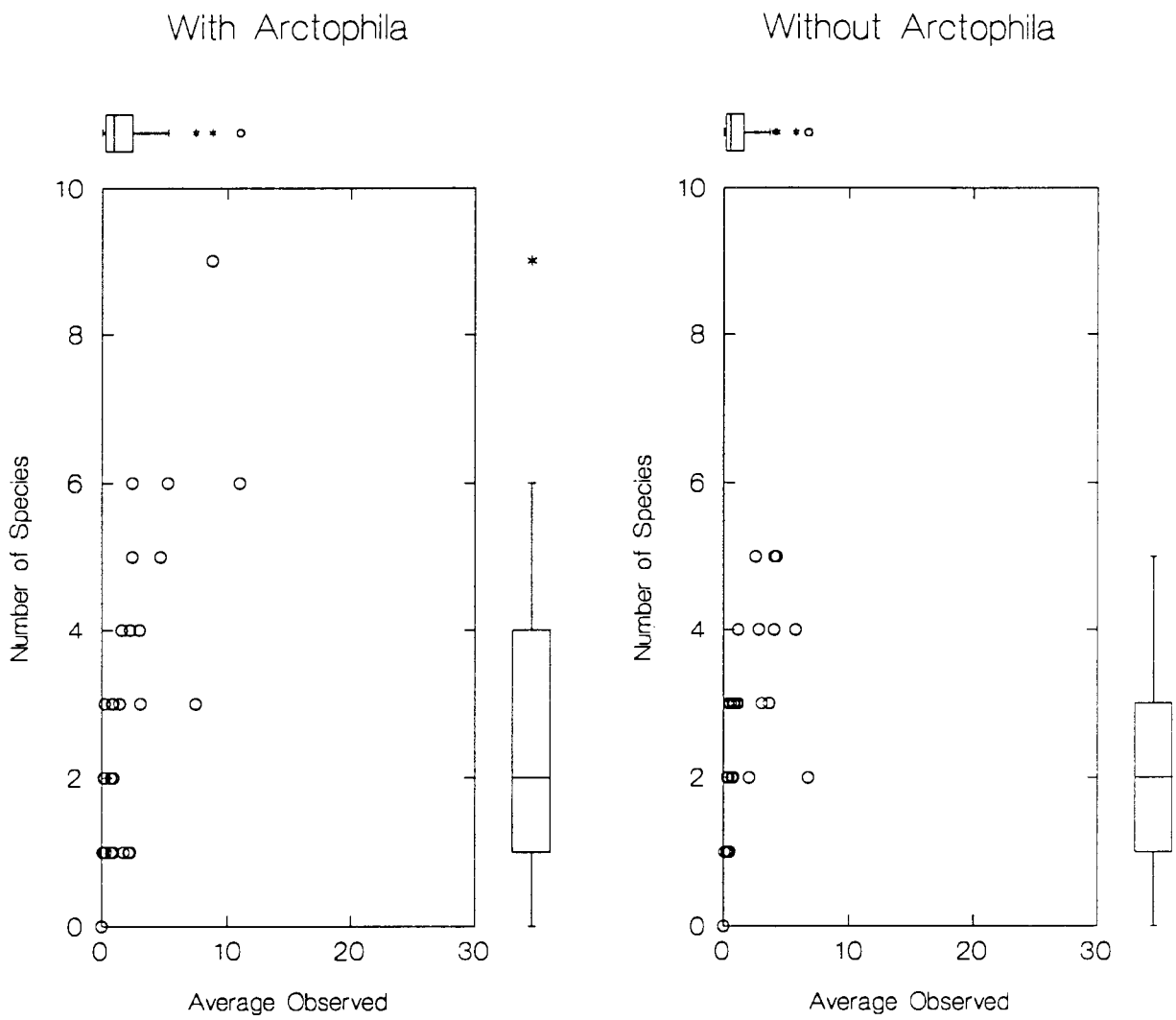
Bird Use of Ponds and Impoundments



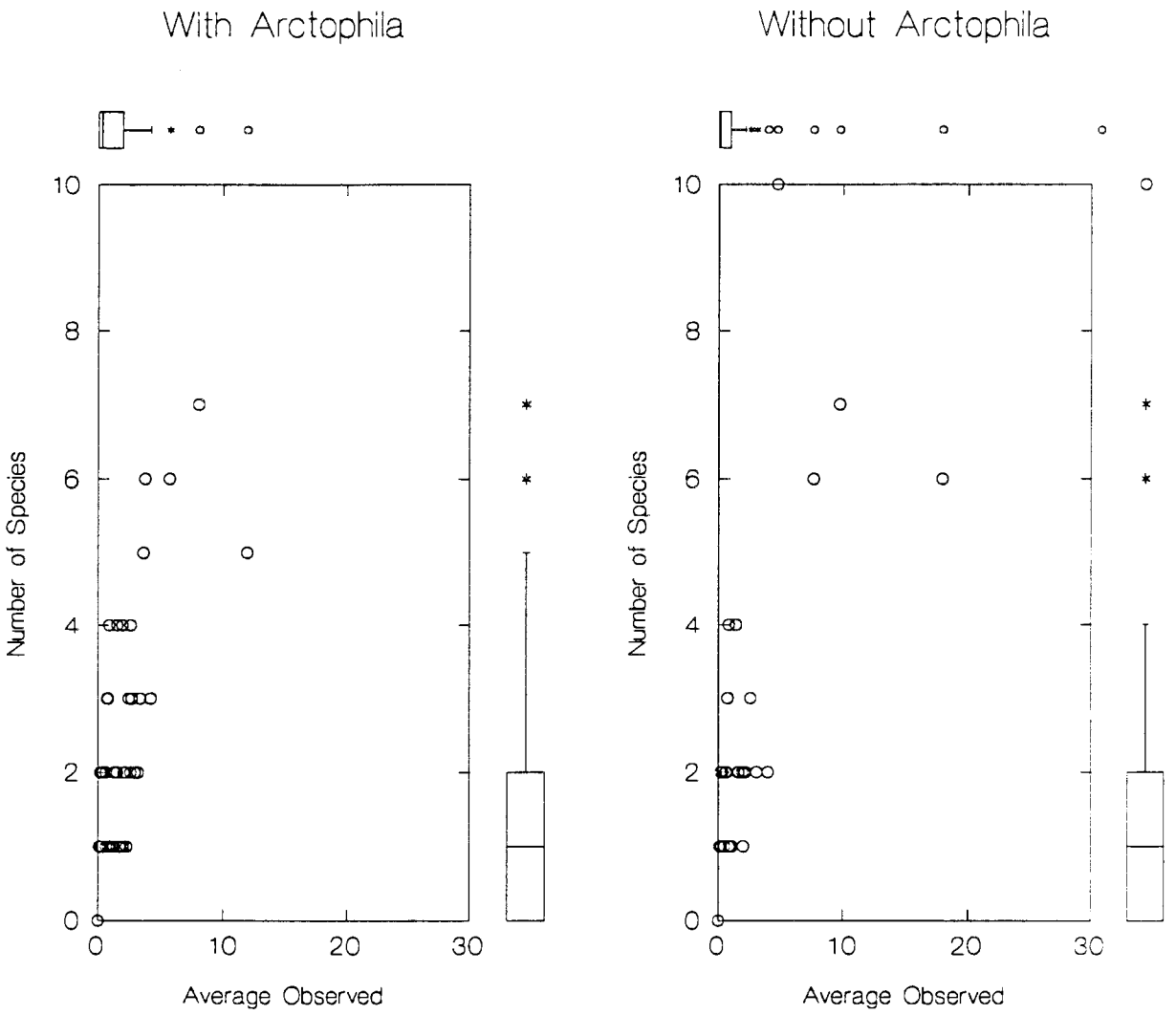
Bird Use of Ponds and Impoundments
(with Arctophila)



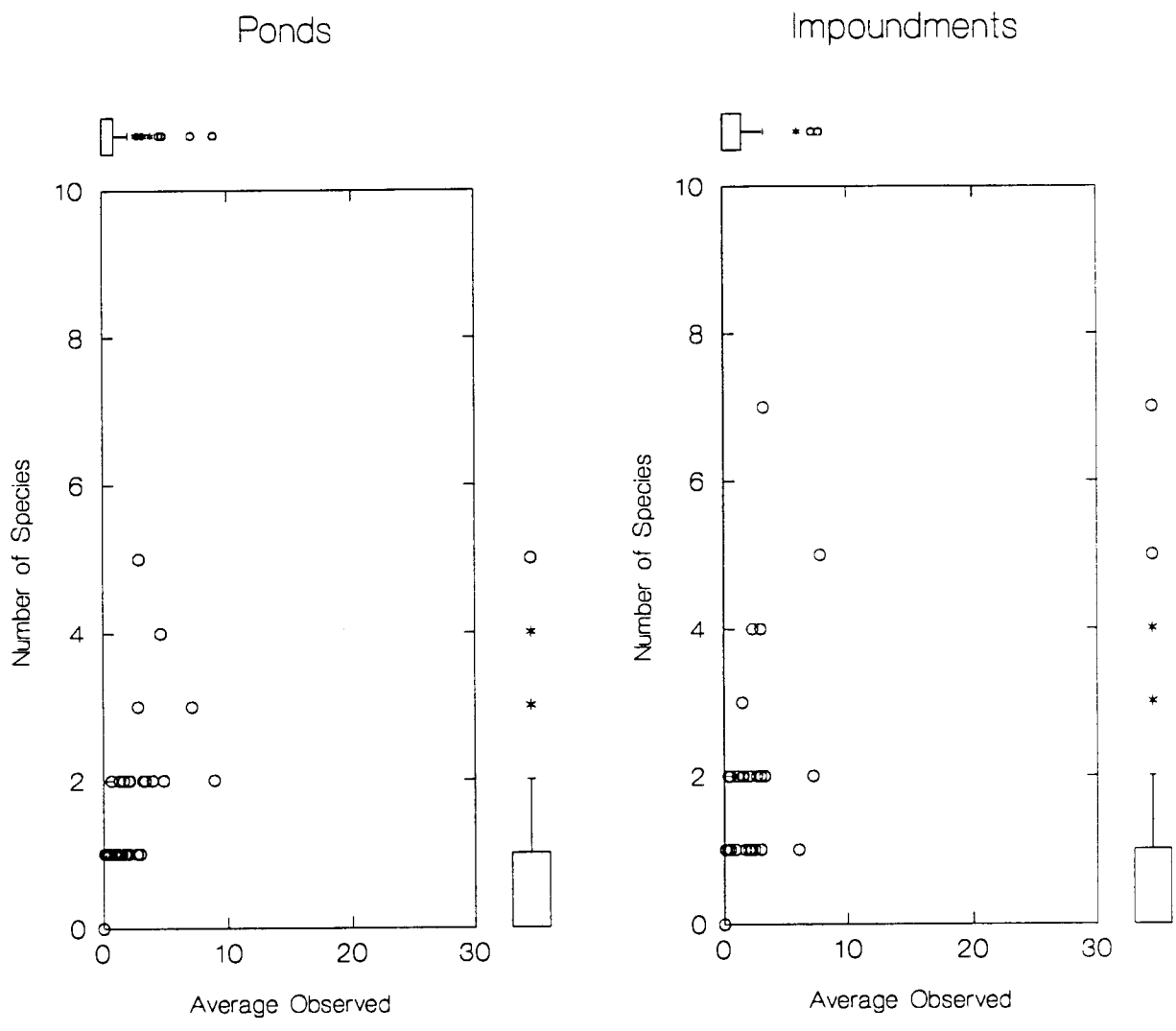
Bird Use of Impoundments



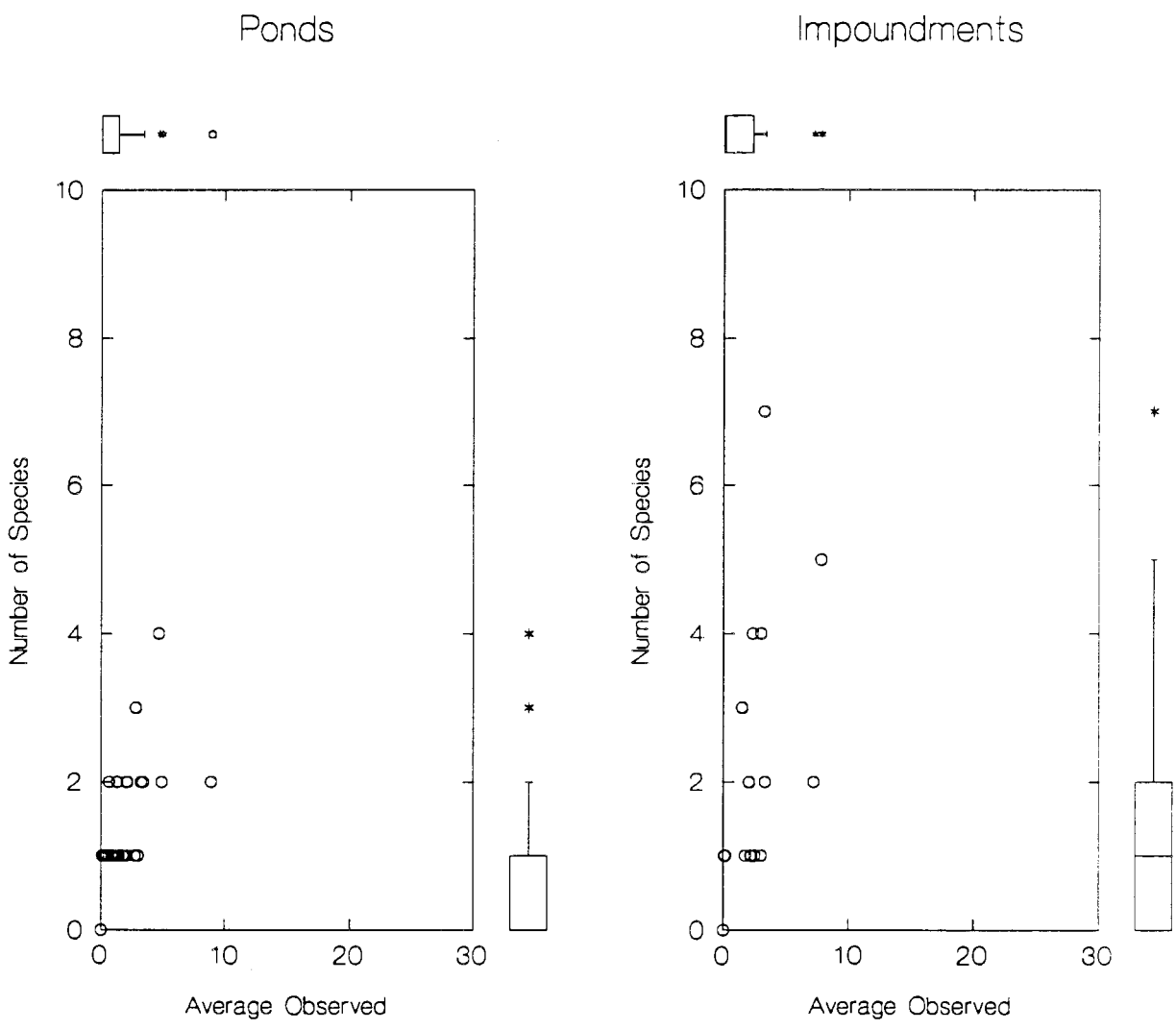
Bird Use of Ponds



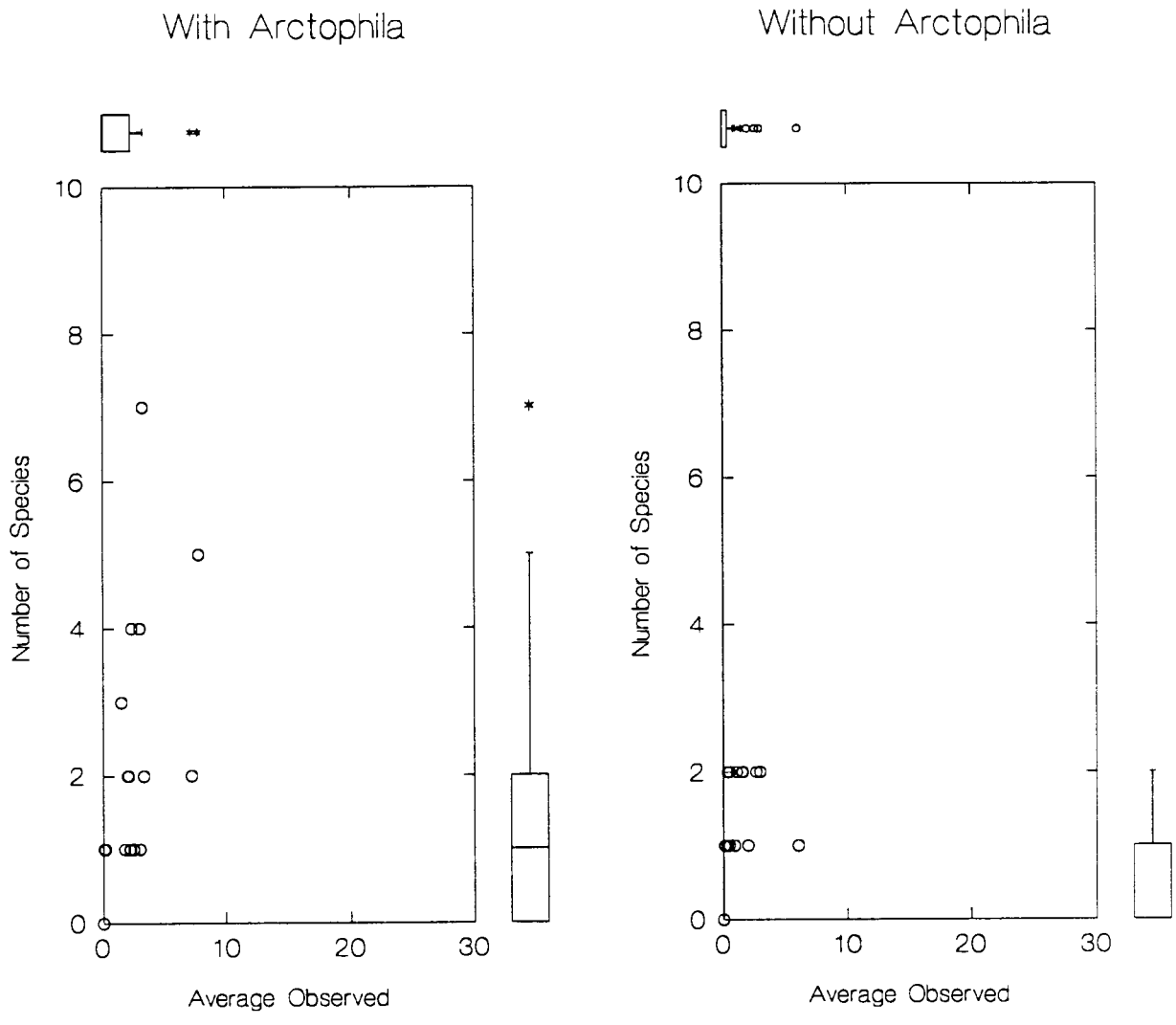
Waterfowl Use of Ponds and Impoundments



Waterfowl Use of Ponds and Impoundments
(with Arctophila)



Waterfowl Use of Impoundments



Waterfowl Use of Ponds