Part Two: Post-breeding Use of Abandoned Gravel Pads

Objectives

- To compare levels and kinds of post-breeding bird use among several microhabitat types in disturbed and undisturbed terrain at and near abandoned gravel pads
- To describe microhabitats preferred by post-breeding tundra bird species at abandoned gravel pads and in undisturbed areas

Methods

Site Selection and Plot Set-up

Of the fourteen sites selected for the nesting study, we focused on a subset of four to conduct the post-breeding observational study on and near the gravel pads. Each of these sites had patches of distinct microhabitat types which could be compared on the basis of bird use. At each site, we established a plot within each of three to five distinguishable microhabitats. At least one gravel plot and one tundra plot were established at each site; other plots were set up in disturbed areas such as reserve pits, impoundments, or gravel berms. Some plots also included various types (e.g., seeded or naturally colonized) or degrees (e.g., sparse to dense) of vegetative cover. We tried to standardize plot size within each site, but size sometimes varied due to the limited availability of a particular microhabitat type. Each plot was established such that the microhabitat within the plot was as homogeneous as possible. We erected an elevated observation blind at each site to provide a clear view of all study plots at that site.

We also made maps of the observational sites using 1"= 150' CIR aerial photographs (see Appendix B). The purpose of these maps was to illustrate the spatial relationships among the various plots and microhabitats at each site.

Data Collection

Observations were made from 17 July to 13 August to coincide with the period when most nesting had been completed and fall staging was beginning. Observations were made at each site every other day from 17-31 July (Table 8).

Table 8. Dates of observations at disturbed study sites, Prudhoe Bay, Alaska, 1990.

Date	Term Well C	Storage Pad	Delta State	Lake State 1(A)	Lake State 1(B)
17-Jul	X	X			
18			X	X	
19	X	X			
20			X	X	
21	X	X			
22			X	X	
23	X	X			
24			X	X	
25	X	X			
26			X	X	
27	X	X			
28			X	X	
29	X	X			
30			X	X	
31	X	X			
1-Aug					
2					
3				X	X
4	X	X			
5				X	X
6					
7				X	X
8				X	X
9				X	X
10				X	X
11				X	X
12				X	X
13				X	X

After 31 July, Delta State 2 was dropped from the study because very few birds were using the site. At the same time, a second set of plots was set up at Lake State 1 because of the high level of use there. On 5 August, Term Well C and Storage Pad were also dropped from the study because few birds were present, and simultaneous observations were made daily by two observers at Lake State 1 only.

Observation periods were 2.5 hour (hr) each in the morning and afternoon. During each 2.5-hr period, the observer slowly scanned a study plot for three minutes (min) with binoculars and with the naked eye. During a two-min period following each scan, data from the scan were recorded. Then the observer shifted to the next plot for three min, recorded data during the following two min, and so on. Because each site had at least three plots, it took 15 min (five min per plot) to complete one cycle of the plots. For all sites that had more than three plots, it was possible to scan two adjacent plots at the same time such that the 15-min cycle was maintained. Thus, each plot at each site was scanned ten times during each 2.5-hr observation period (20 times per day).

We recorded the number of individuals of each species per scan, their behavior (feeding, resting/preening, interacting, hunting, or walking/swimming), and habitat features (e.g., vegetation type, landform, microhabitat) used by the observed individuals. For birds landing on the plot during a three-min scanning period, the behavior recorded was the behavior first observed after about ten seconds. Birds flying over the plot but not landing on it were not recorded.

Data Analysis

Observational data were compared only among plots within sites, and compared data were all gathered during the same 2.5-hr observation periods. This reduced the effects of variability induced by spatial and temporal differences among samples. Given the limited number of available abandoned gravel pads and the unique character of each of them, it was not feasible to observe replicates of each plot (microhabitat) configuration. In most cases, observations of bird use of plots within a given site constituted repeated measures of the same experimental units (the plots), and data (such as use levels) thus gathered were not appropriate for statistical analyses (see Hurlbert 1984).

Several criteria were used to compare bird use among plots within each of the disturbed study sites. Mean numbers of observations and species per 2.5-hour period were calculated to measure the levels of bird use. Since plots

sometimes varied in size (due to a limited amount of specific microhabitat available), an adjusted level of use was calculated which reduced numbers of observations per period to a standard plot size (the smallest plot at each site). Thus, the adjusted values for level of use represent the number of observations per unit area per unit time. We compared species richness among plots; species diversity among plots was compared on the basis of Shannon's diversity index. We also compared plots with respect to proportions of bird behavior observed on them for Lapland Longspur, because it was the most common species, and for all other species combined. Finally, we made comparisons by reporting how the total number of observations on each plot was distributed among the species that occurred there.

Results

In this section, we compare bird use among plots within each of the disturbed study sites. Levels of use and levels adjusted to a standard plot size (Table 9), species diversity, behavior (for Lapland Longspurs and for all other species combined), and species distribution among plots are compared. Physical characteristics of plots, such as gravel thickness, extent of thermokarsting, amount of vegetation, presence of water/mud, and type of tundra, are also compared among plots within a given site (Table 10 and Appendix B).

At most of the observational study sites, birds were less visible on tundra plots than on other plots because of concealing vegetation. However, searches of the tundra plots made routinely after each observational period suggested that invariably few birds escaped being seen despite the plant cover. Thus, relative comparisons of levels of bird use among plots are valid irrespective of differences in visibility. Behaviors of birds observed on tundra plots were more difficult to discern than was the presence of birds, and comparisons of behaviors among plots should be qualified accordingly.

Term Well C

The highest mean number of observations per 2.5-hr period occurred on the berm; the lowest number occurred on the tundra plot (Fig. 2a). The range in the total numbers of observations was from 14 on the tundra plot to 192 on the berm. The 2 plots containing water (i.e., the reserve pit and the pond) had slightly lower numbers of observations than the berm. Half of the observations on the gravel plot occurred during one 2.5-hr observation period; if these data

Table 9. Means and standard deviations of numbers of observations and species per 2.5-hr period on study plots at Prudhoe Bay, Alaska, 1990. Values for adjusted means are given in a separate column where plot sizes vary within a site.

Site	Plot	# Periods	Number of Observations			Number of Species	
			Mean	SD	Adjusted Mean	Mean	SD
Term Well C	Gravel	18	4.4	9.3	2.1	.7	.6
	Reserve Pit	18	8.4	15.4	4.0	1.5	1.3
	Berm	18	10.7	10.1	10.7	1.2	.7
	Tundra	18	.8	1.2	.4	.6	.8
	Pond	18	6.3	7.6	3.0	1.6	1.3
Storage Pad	"Wet" Thermokarsted Gravel	18	5.6	5.6		1.3	1.0
	"Dry" Thermokarsted Gravel	18	5.6	6.4		.9	.6
	Tundra	18	5.9	4.4		1.2	.7
Delta State 2	Gravel	14	.8	1.1		.5	.7
	Reserve Pit	14	7.1	7.7		1.8	1.2
	Tundra	14	1.4	1.8		.8	.7
Lake State 1(A)	Seeded Gravel	32	4.8	3.9	1.7	1.1	.7
	Unseeded Gravel	32	11.2	8.4	3.9	1.6	.6
	"Road"	32	12.3	14.9	12.3	1.2	.8
	Gravel Spray	32	22.4	12.4	10.5	2.9	1.3
	Tundra	32	.9	1.7	.3	.4	.6
Lake State 1(B)	Seeded Gravel	18	3.4	4.0	3.4	.9	.7
	Unseeded Gravel	18	19.1	20.6	19.1	1.7	.6
	Impoundment	18	13.2	14.3	3.5	3.1	1.6
	Tundra	18	1.0	2.4	.2	.4	.7

Table 10. Plot size and physical characteristics at disturbed gravel sites, Prudhoe Bay, Alaska, 1990. (See Appendix B for detailed plot descriptions.)

Site	Plot	Area (m)	Characteristics
Term Well C	Gravel	3000	Thick gravel, no vegetation
	Reserve Pit	3000	Water-filled, mud edge
	Berm	1440*	Mixed gravel and overburden, vegetated (graminoids)
	Tundra	3000	Moist graminoids, strangmoor
	Pond	3000*	Water-filled, partial mud edge
Storage Pad	"Wet" Thermokarsted Gravel	3900	Moderately thick gravel, wet troughs, "lush" plant colonization
	"Dry" Thermokarsted Gravel	3900	Moderately thick gravel, dry troughs, "sparse" plant colonization
	Tundra	3900	Moist graminoids, mixed high and low-centered polygons
Delta State 2	Gravel	5000	Moderately thick gravel, no vegetation
	Reserve Pit	5000	Water-filled, mud edge
	Tundra	5000	Moist and wet graminoids, non-patterned ground
Lake State 1 (A)	Seeded Gravel	1800	Moderately thick gravel, dense cultivars (fertilized)
	Unseeded Gravel	1800	Moderately thick gravel, sparse natural colonization (fertilized)
	"Road"	625*	Thin gravel, natural colonization, moderate cover
	Gravel Spray	1330*	Thin gravel, wet thermokarst troughs, natural colonization, dense cover
	Tundra	1800	Moist and wet graminoids, non-patterned ground
Lake State 1 (B)	Seeded Gravel	392	Thin gravel, dense cultivars (fertilized)
	Unseeded Gravel	392	Thin gravel, dense natural colonization (fertilized)
	Impoundment	1475*	Water and mud filled
	Tundra	1800	Moist and wet graminoids, non-patterned ground

* indicates areas approximated using a planimeter. (Others were measured in the field.)

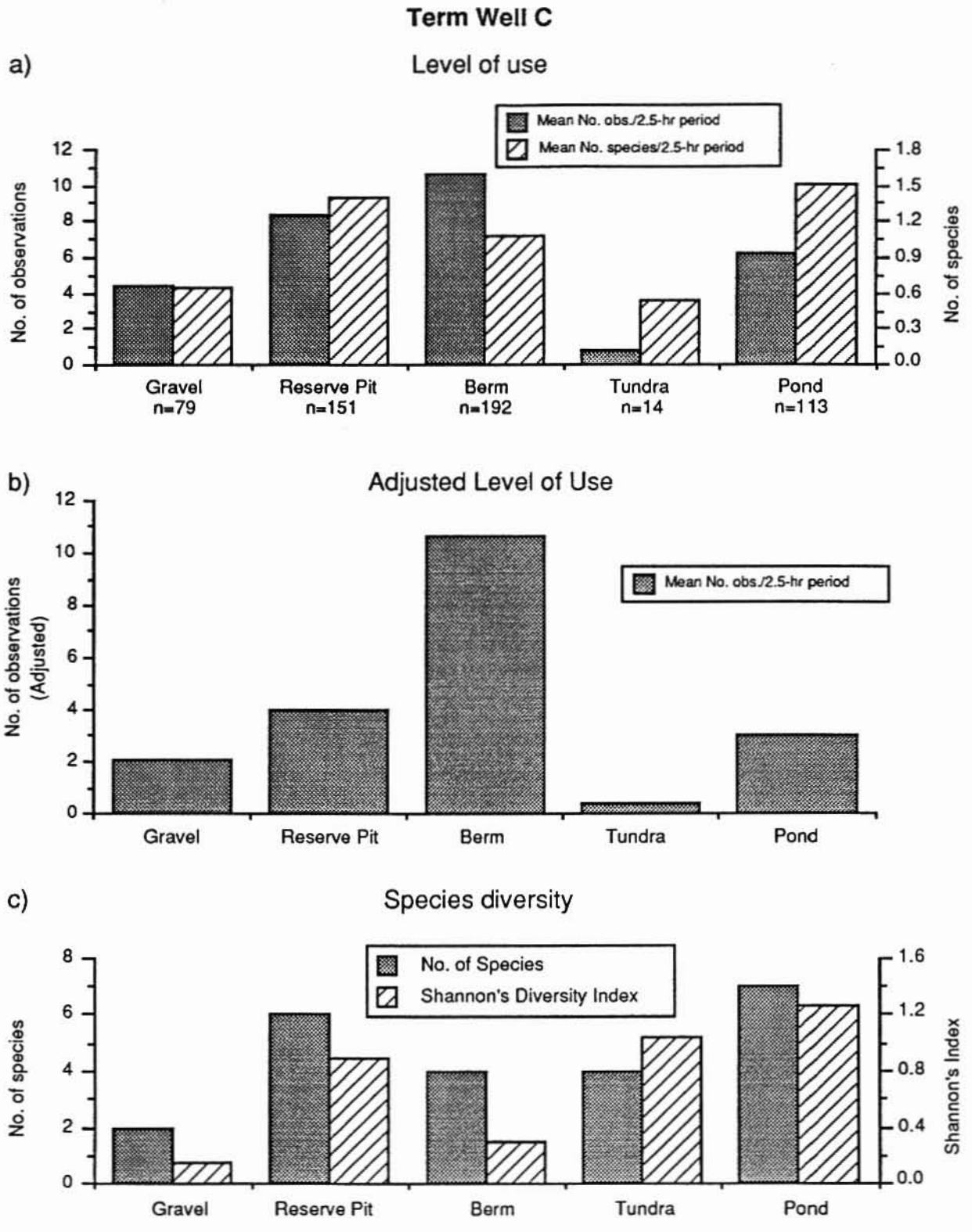


Fig. 2. Levels of bird use (a), levels of use adjusted to standard plot size (b), and species diversity (c) on study plots at Term Well C, Prudhoe Bay, Alaska, 1990. In (a), n is the total number of observations. The gravel, reserve pit, and berm plots represent disturbed habitats; the tundra and pond plots are undisturbed habitats.

are disregarded, the level of use on the gravel plot would approach the low level of use observed on the tundra plot. When the level of use is adjusted to the size of the smallest plot (berm, Table 10), the numbers of observations on all other plots are reduced by almost 50 percent (Fig. 2b).

The mean numbers of species observed per 2.5-hr observation period were highest on the reserve pit and pond plots. These plots attracted more shorebirds than did other plots; Semipalmated Sandpiper was the most commonly observed species on the reserve pit, and Red-necked Phalarope was the most commonly observed species on the pond (Table 11). In addition, 2 gull species were observed at the pond. The numbers of species per observation period were lowest on the gravel and tundra plots.

Table 11. Relative abundances of bird species (percent of total) on individual study plots and on all study plots combined at Term Well C, Prudhoe Bay, Alaska, 1990.

	Study Plot					
Species	Gravel	Reserve Pit	Berm	Tundra	Pond	All Plots
Lapland Longspur	97	15	93	64		52
Semipalmated Sandpiper		72	1		18	24
Red-necked Phalarope		8			58	14
Pectoral Sandpiper		2	4		11	4
Redpoll	3		3	14		2
Stilt Sandpiper		3			1	1
Glaucous Gull					5	1
Sabine's Gull					5	1
Willow Ptarmigan				14		<1
Black-bellied Plover					2	<1
Baird's Sandpiper		1				<1
Parasitic Jaeger				7		<1

The pond and the reserve pit also had the highest numbers of species during the entire study period (Fig. 2c), with 6 and 7, respectively. The berm and tundra plots each had 4 species, and 2 species were observed on the gravel plot.

Species diversity (Shannon's index) was greatest on the pond and slightly lower on the tundra and reserve pit (Fig. 2c). Although the number of species on the berm was equal to that on the tundra, the diversity index was lower on

the berm because of the disproportionate abundance of longspurs (Table 11). The diversity index was low on the gravel plot for the same reason.

Bird behaviors did not occur in the same proportions on each plot at Term Well C. Most of the observations of Lapland Longspurs around the edges of the reserve pit and on the berm were of birds feeding (Fig. 3a). On the gravel plot, longspurs tended to gather near the well head, and most observations there were of birds resting/preening. On the tundra plot, we were able to detect the presence of birds, but their behavior was often concealed by vegetation. This accounts for the high percentage of "other" behavior. No longspurs were observed at the pond plot. Longspurs represented 52 percent of the total number observations of all species on all plots combined (Table 11).

Feeding was the most frequently observed behavior on the reserve pit and pond plots of birds other than longspurs (Fig. 3b). These other species were predominantly Semipalmated Sandpipers and Red-necked Phalaropes (Table 11). Numbers of observations of non-longspurs were low on the gravel, berm, and tundra plots.

Storage Pad

At this site, the mean numbers of observations per 2.5-hr period were almost identical for all three plots (Fig. 4a). The mean number of species per 2.5-hr period was highest on the "wet" thermokarsted gravel plot and lowest on the "dry" thermokarsted gravel plot, but differences were small. (Because all plots were the same size, no adjustment to level of use was necessary.)

For the entire study period, species richness ranged from 6 in the "wet" thermokarst to 4 on the "dry" thermokarst; 5 species occurred on the tundra plot (Fig. 4b). The species diversity index was low on all plots due to the high percentage of longspurs (Table 12).

There was little difference in types of bird behaviors on the study plots at Storage Pad. For Lapland Longspurs, feeding was the most common behavior on all plots (Fig. 5a). Much of the "other" behavior in each plot was the result of birds whose presence was detected but whose behavior was concealed by thermokarst troughs or vegetation. Longspurs represented 92 percent of the total number of observations on all plots combined (Table 12).

For bird species other than longspurs, feeding was observed more often on the gravel pad plots than on the tundra plot (Fig. 5b). However, this apparent difference may not be meaningful because numbers of observations were low.

Term Well C

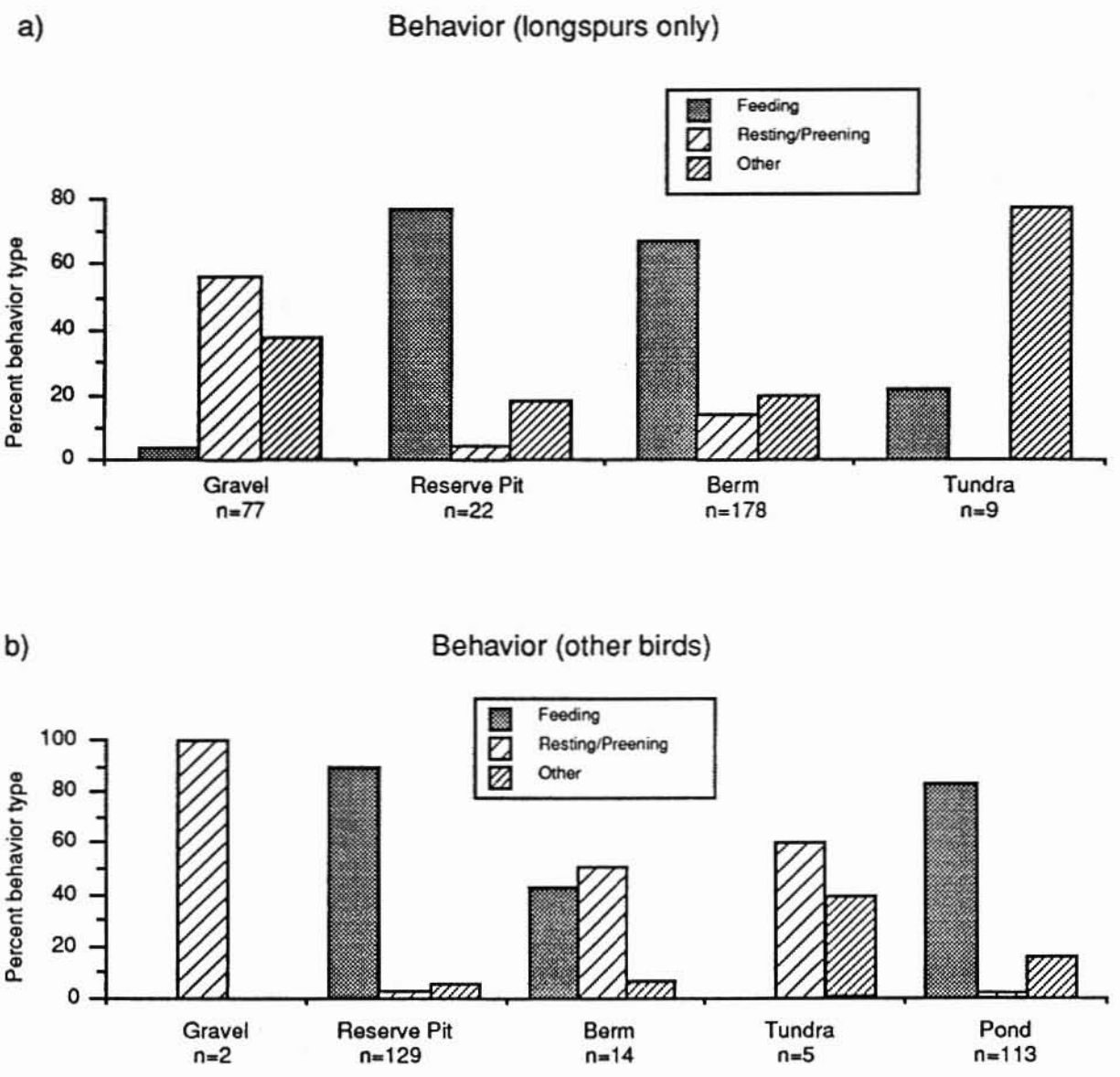


Fig. 3. Proportions of behavior for Lapland Longspurs (a), and for all other bird species (b) on study plots at Term Well C, Prudhoe Bay, Alaska, 1990. (n is the total number of observations.) The gravel, reserve pit, and berm plots represent disturbed habitats; the tundra and pond plots are undisturbed habitats.

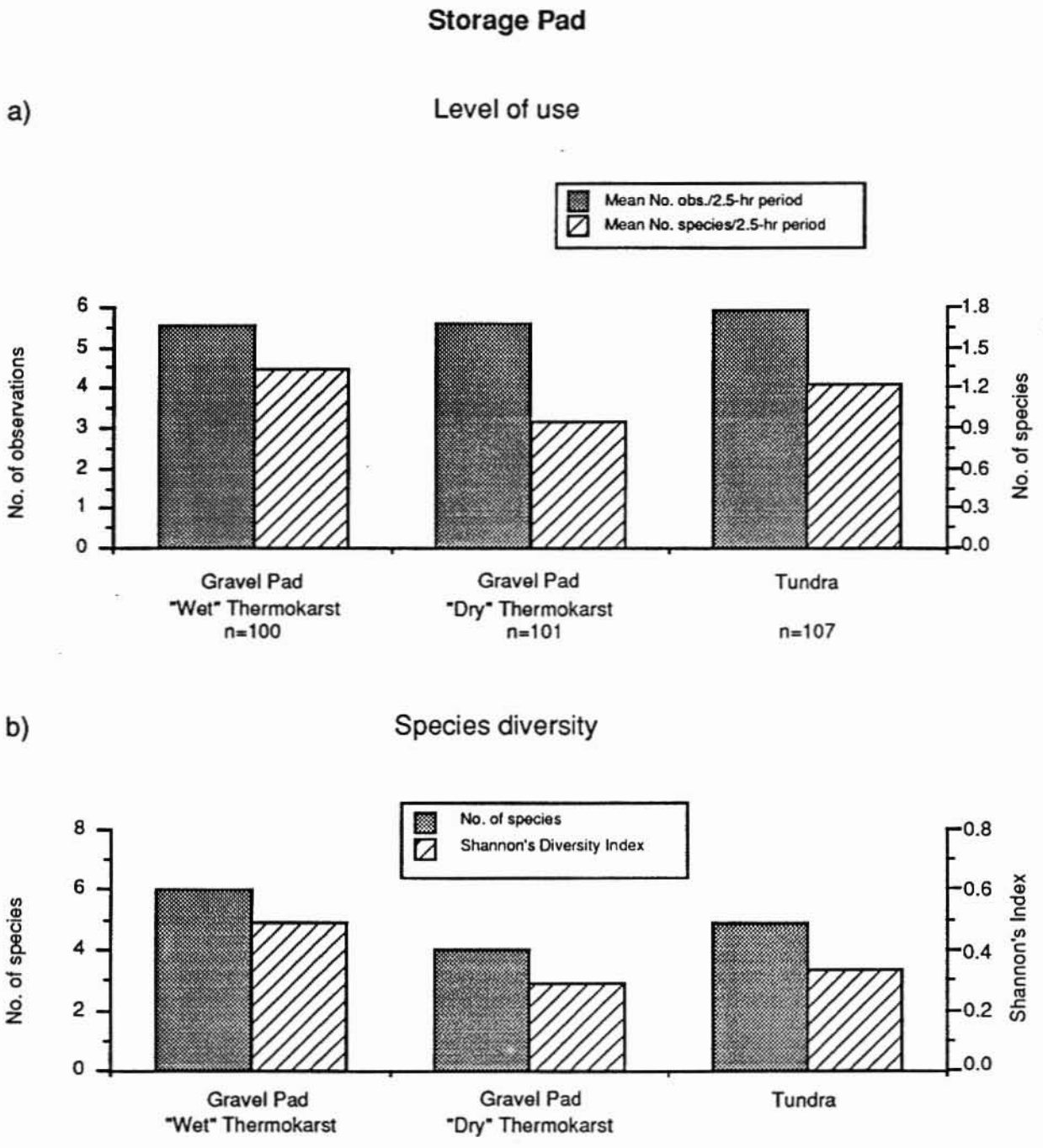


Fig. 4. Level of bird use (a), and species diversity (b) on study plots at Storage Pad, Prudhoe Bay, Alaska, 1990. "Wet" and "dry" thermokarst are gravel pad plots. In (a), n is the total number of observations.

Storage Pad

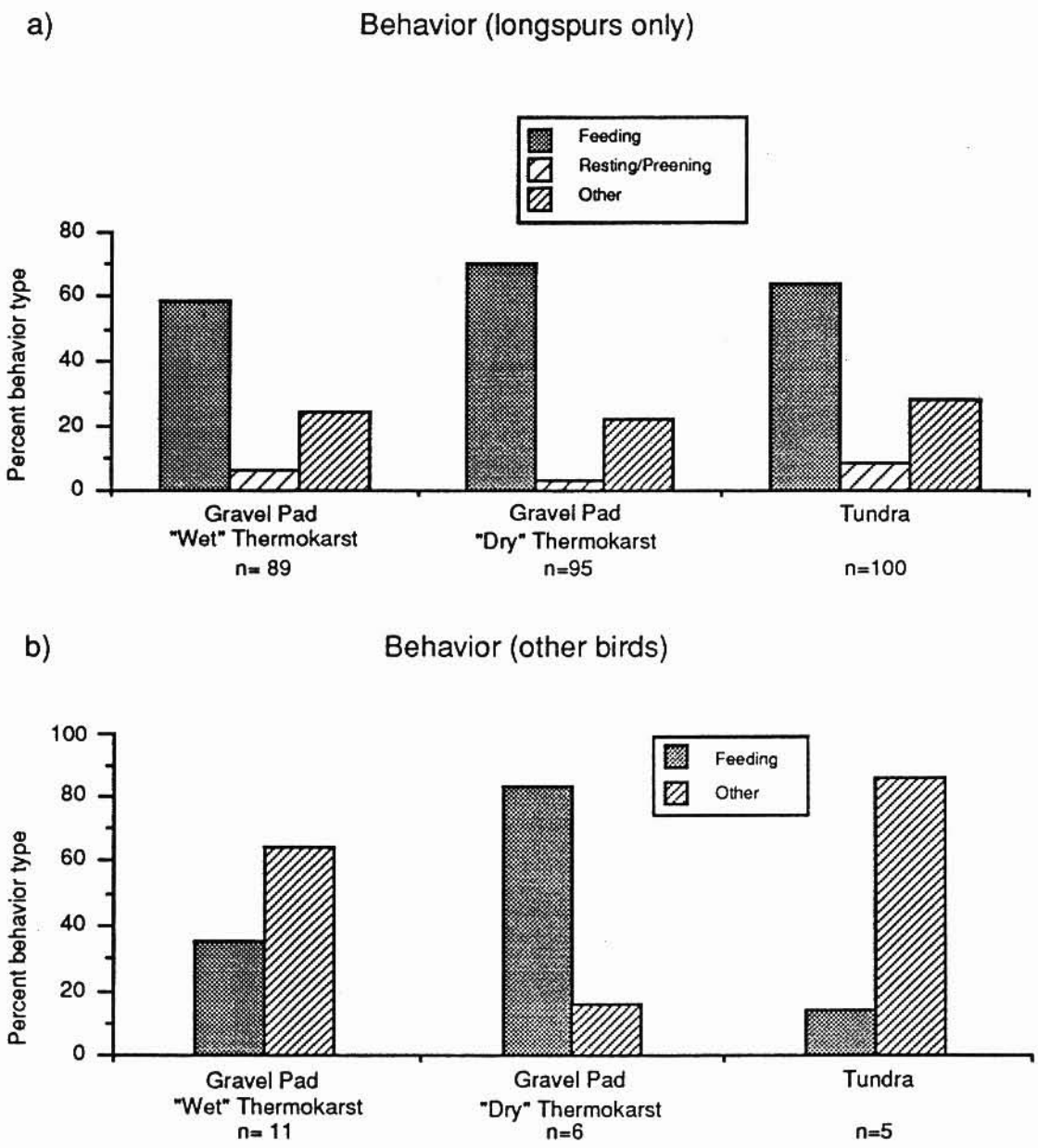


Fig. 5. Proportions of behavior for Lapland Longspurs (a), and for all other bird species (b) on study plots at Storage Pad, Prudhoe Bay, Alaska, 1990. (n is the total number of observations.)

Table 12. Relative abundances of bird species (percent of total) on individual study plots and on all study plots combined at Storage Pad, Prudhoe Bay, Alaska, 1990.

Species	Study Plot			
	"Wet" Thermokarst	"Dry" Thermokarst	Tundra	All Plots
Lapland Longspur	89	95	93	92
Snow Bunting	6	1		2
Common Raven	1	4		2
Semipalmated Sandpiper	2	1		1
Pectoral Sandpiper	1		3	1
Red-necked Phalarope	1		1	1
Parasitic Jaeger	1		2	1
Buff-breasted Sandpiper			1	<1

Delta State 2

The mean numbers of observations and species per 2.5-hr period were highest by far in the reserve pit (Fig. 6a). The tundra plot was slightly higher than the gravel plot with respect to both numbers of observations and species per period. (Because all plots were the same size, no adjustment to level of use was necessary.)

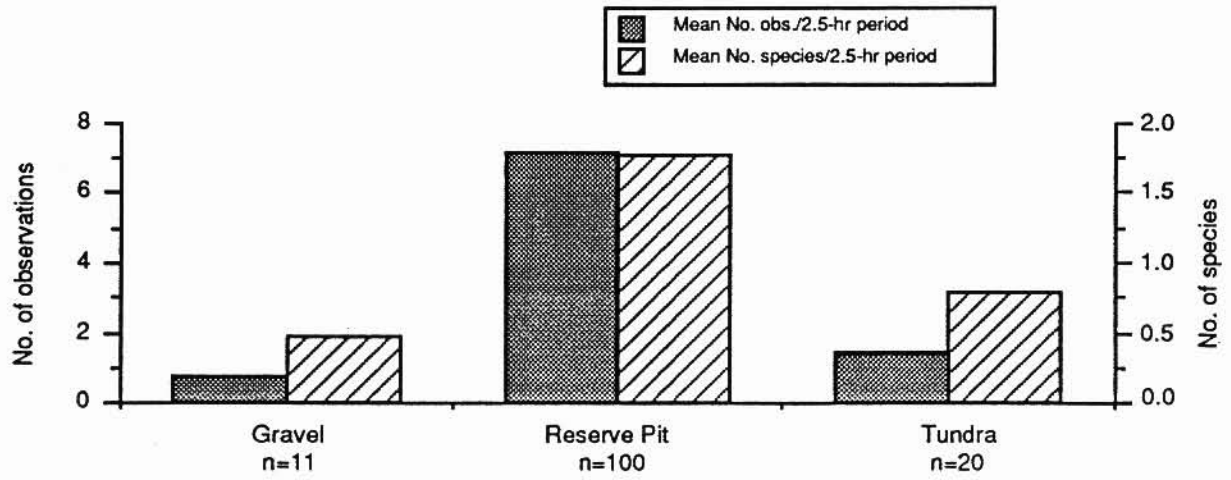
During the entire study period, we recorded 6 species at the reserve pit, 3 on tundra, and 2 on gravel (Fig. 6b). Individuals using the reserve pit were primarily shorebirds (mainly Semipalmated Sandpiper), but longspurs were also observed around the edges of the pit (Table 13). The species diversity index was also greatest in the reserve pit and lowest on the gravel plot.

For Lapland Longspurs, feeding was the most commonly observed behavior on the gravel plot (Fig. 7a). On the reserve pit, longspur behavior was varied; "other" behavior was primarily of birds walking on gravel near the edge of the water. On tundra, the high proportion of "other" behavior resulted when birds known to be present could not be observed well enough to determine behavior. Longspurs represented 34 percent of the total number of observations for all plots combined (Table 13).

For birds other than longspurs, most were observed on the reserve pit where the predominant behavior was feeding (Fig. 7b). Numbers of observations on the gravel and tundra plots were low.

Delta State 2

a) Level of use



b) Species diversity

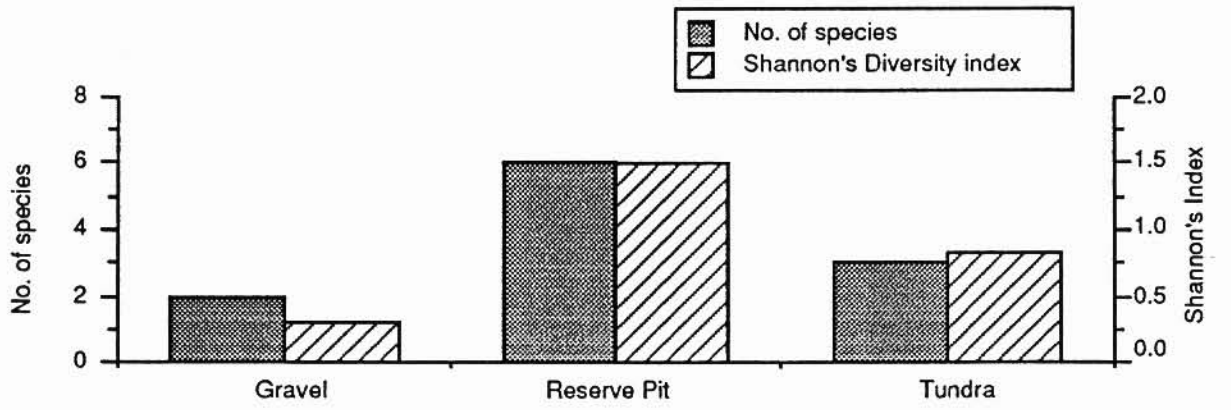
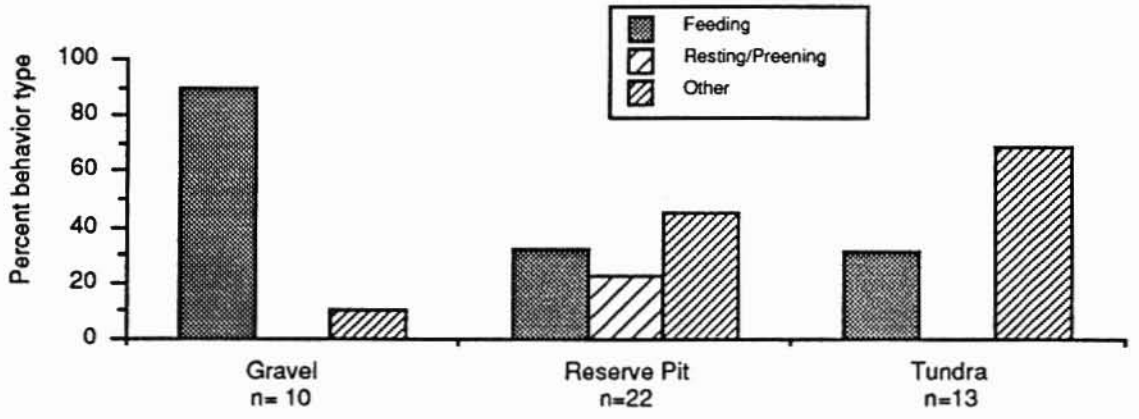


Fig. 6. Level of use (a), and species diversity (b) on study plots at Delta State 2, Prudhoe Bay, Alaska, 1990. (n is the total number of observations.)

Delta State 2

a) Behavior (longspurs only)



b) Behavior (other birds)

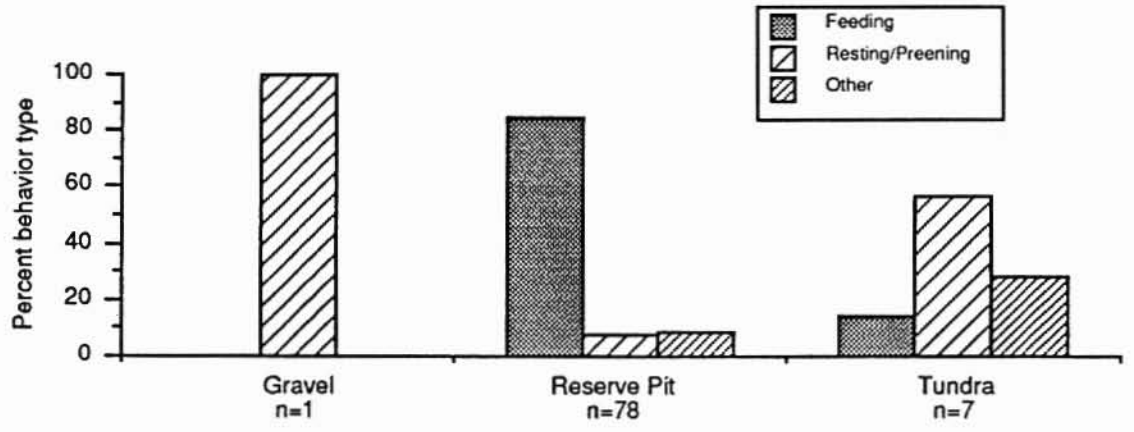


Fig. 7. Proportions of behavior types for Lapland Longspurs (a), and for all other bird species (b) on study plots at Delta State 2, Prudhoe Bay, Alaska, 1990. (n is the total number of observations.)

Table 13. Relative abundances of bird species (percent of total) on individual study plots and on all study plots combined at Delta State 2, Prudhoe Bay, Alaska, 1990.

Species	Study Plot			
	Gravel	Reserve Pit	Tundra	All Plots
Semipalmated Sandpiper		42		35
Lapland Longspur	91	22	65	29
Red-necked Phalarope		17		14
Baird's Sandpiper		11		9
Pectoral Sandpiper		5	25	8
Ruddy Turnstone		3		2
Parasitic Jaeger	9		10	2

Lake State 1 (A)

The mean number of observations per 2.5-hr period was highest on the gravel spray plot and lowest on the tundra plot (Fig. 8a). The unseeded gravel plot and the "road" plot each had fairly high use; the level of use at the seeded gravel plot was about half that of these plots. The mean numbers of species observed per period followed a similar trend—the gravel spray and the tundra had the highest and lowest counts, respectively.

When level of used was adjusted to the size of the smallest plot (the "road", Table 10), the "road" and gravel spray plots had the highest numbers of observations per period (Fig. 8b). The levels of use on the seeded, unseeded, and tundra plots each were reduced by about 65 percent.

Species richness was highest on the gravel spray (11 species) (Fig. 8c). A greater diversity of shorebirds was observed on this plot than on others (Table 14). Richness on other plots ranged from 3 to 5 species. The species diversity index was greatest on the gravel spray and lowest on the seeded and "road" plots. The low diversity index values for the seeded and "road" plots were due to the high proportion of longspurs (Table 14). Diversity on the tundra plot was slightly higher than on the seeded and "road" plots, but it too was quite low because of the disproportionate number of longspurs.

For Lapland Longspurs, feeding was the dominant behavior observed on all plots except tundra (Fig. 9a). The high percentage of "other" behavior on tundra reflects our inability to observe behaviors in dense vegetation. For birds other than longspurs, behavior followed a similar trend (Fig. 9b), although numbers of

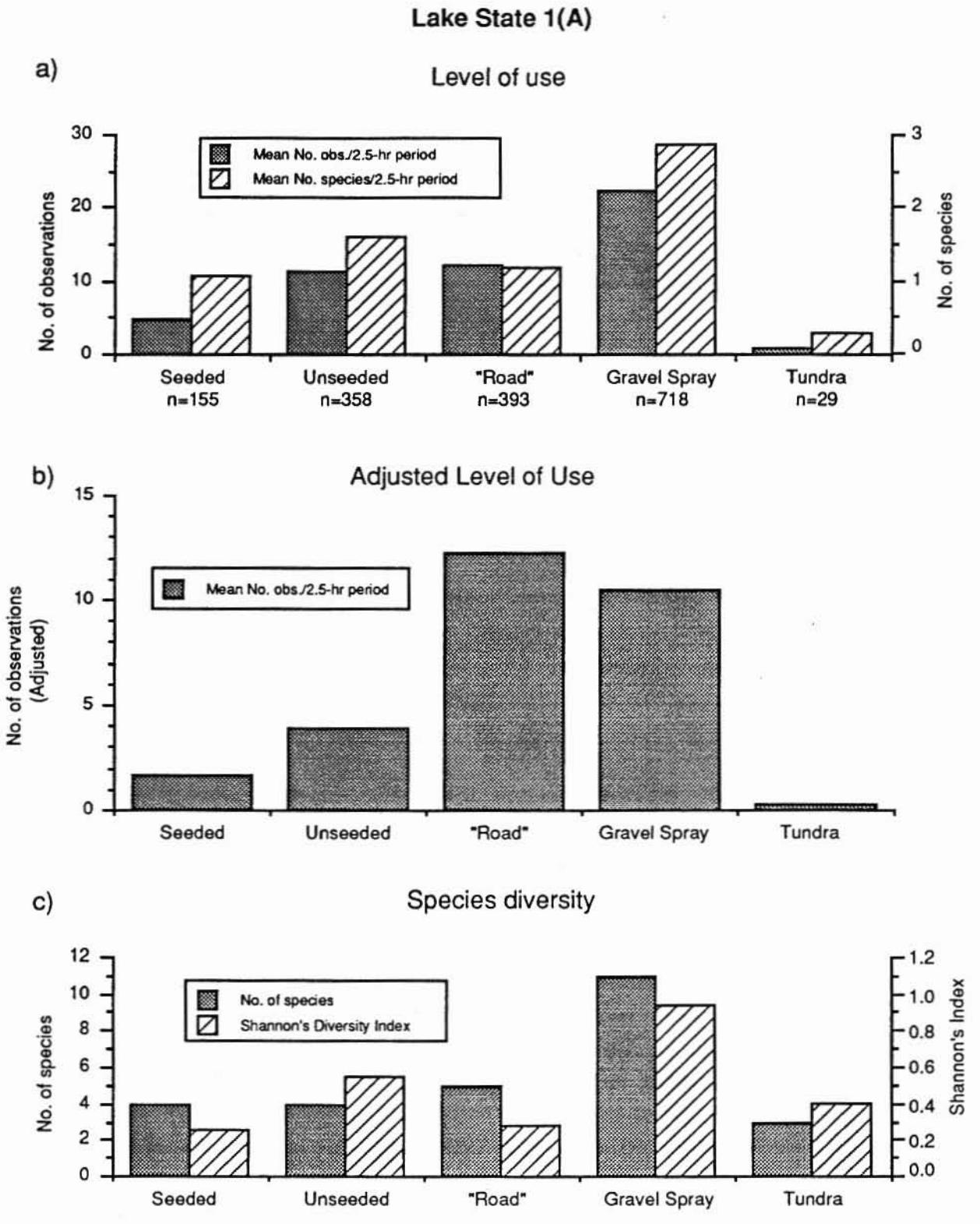


Fig. 8. Levels of bird use (a), levels of use adjusted to standard plot size (b), and species diversity (c) on study plots at Lake State 1(A), Prudhoe Bay Alaska, 1990. In (a), n is the total number of observations. The seeded, unseeded, "road", and gravel spray plots represent disturbed habitats; the tundra plot is undisturbed habitat.

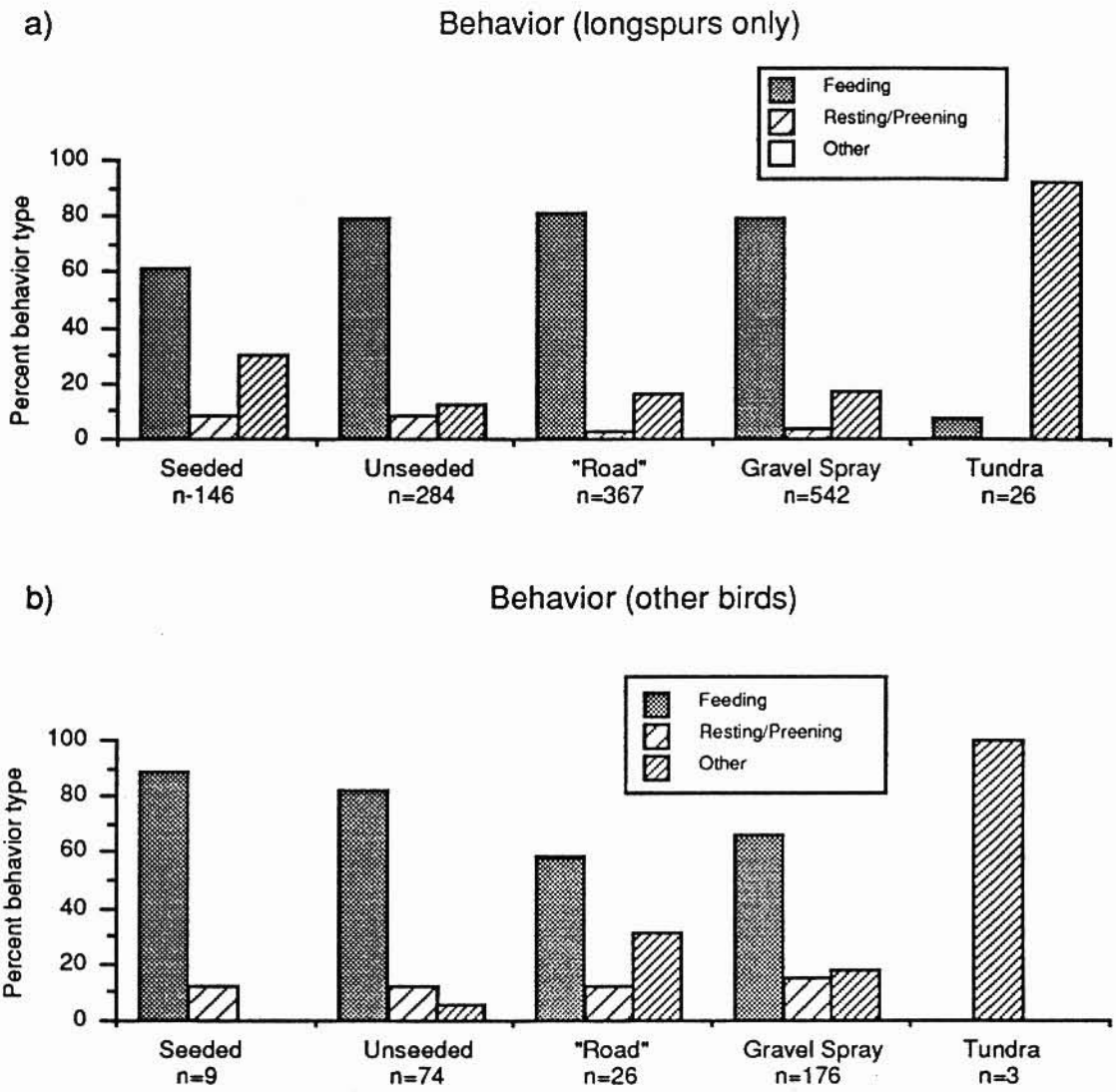


Fig. 9. Proportions of behavior types for Lapland Longspurs (a), and for all other bird species (b) on study plots at Lake State 1 (A), Prudhoe Bay, Alaska, 1990. (n is the total number of observations.) The seeded, unseeded, "road", and gravel spray plots represent disturbed habitats; the tundra plot is undisturbed habitat.