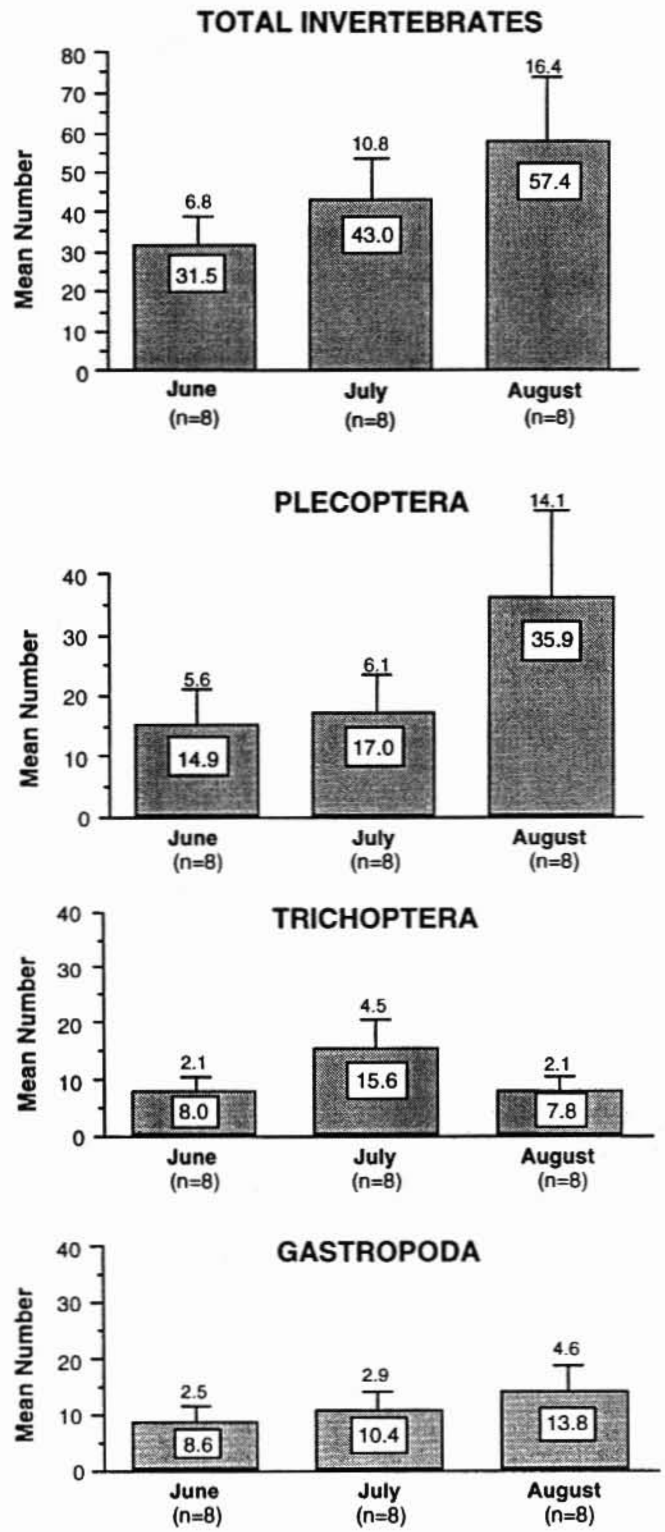

Figure 2. Mean numbers of invertebrates (by taxa and for all taxa combined) in ponds and impoundments during June, July, and August 1992, Prudhoe Bay, Alaska. Sample sizes (n) are based on the number of water bodies. Error bars denote SE (Standard error)

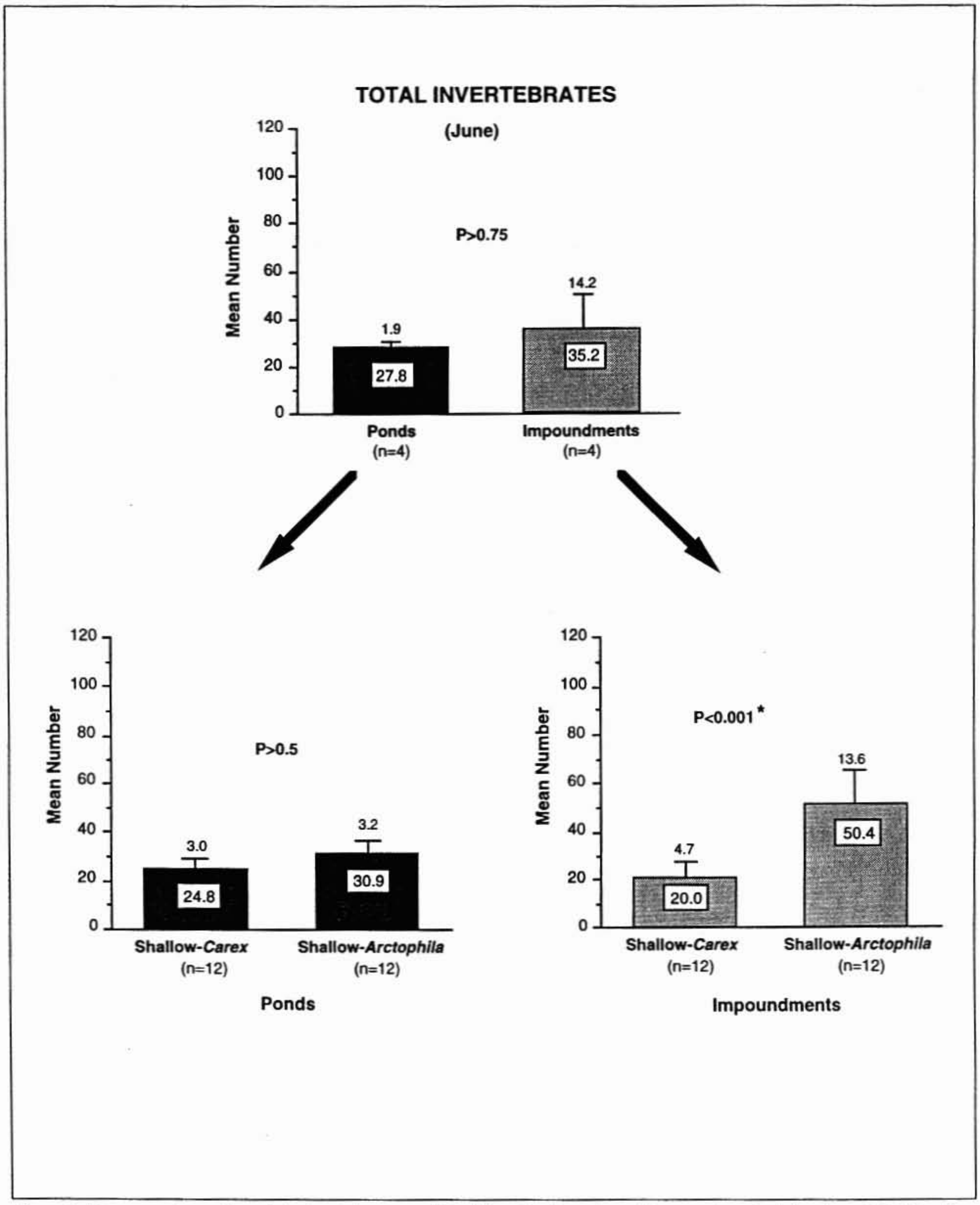

*Figure 3. Mean numbers of invertebrates (all taxa combined) in natural ponds and impoundments during June 1992, Prudhoe Bay, Alaska. Probabilities with an asterisk indicate that values are significantly different ($P<0.05$). Values for ponds and impoundments (top histogram) are for Shallow-*Carex* and Shallow-*Arctophila* water bodies combined. Sample sizes (n) for the top histogram are based on the number of ponds and impoundments sampled (treatment effects). Sample sizes for the bottom histograms are based on six sweeps within each water body for both ponds and impoundments. Error bars denote SE (Standard error).*

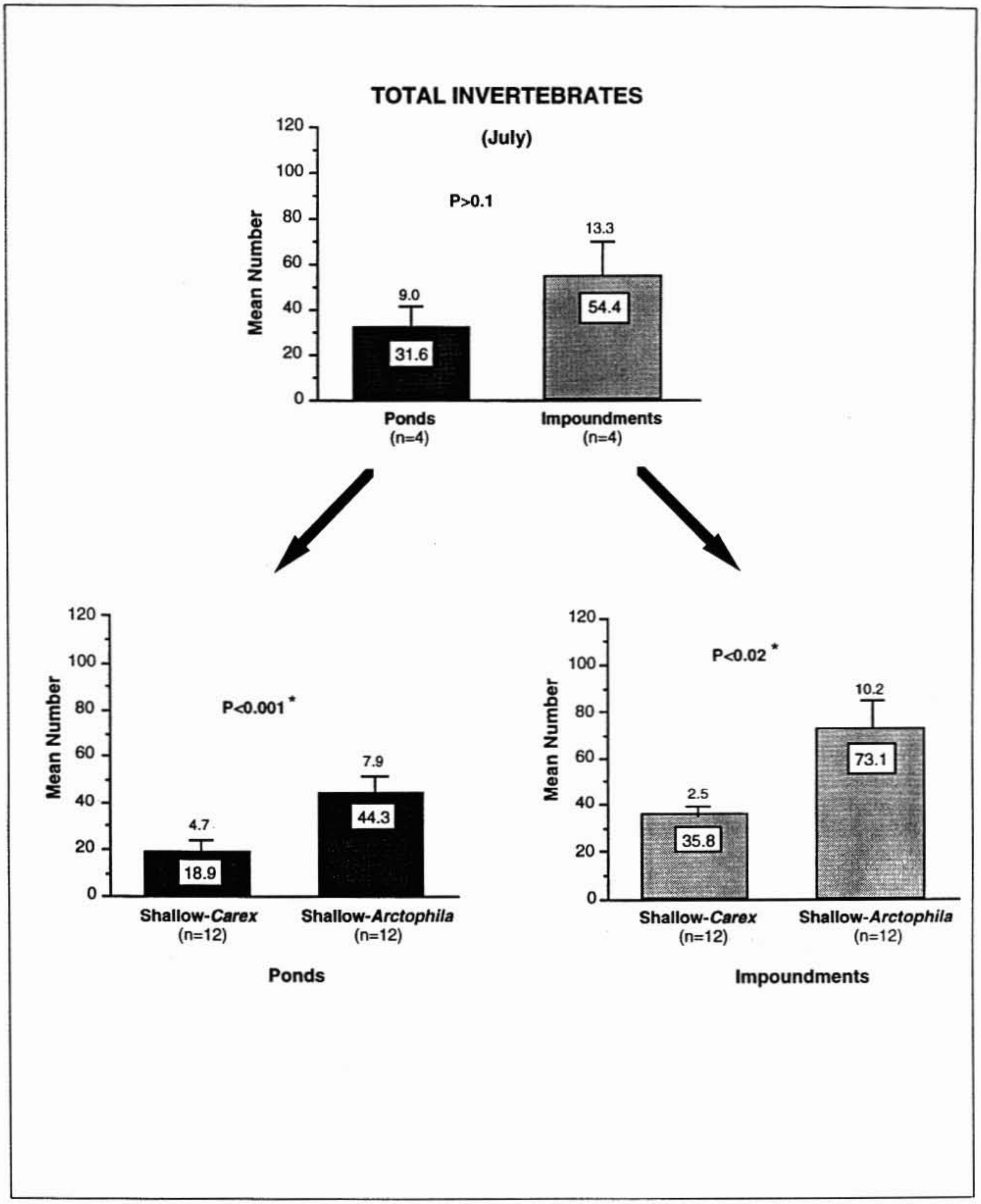

Figure 4. Mean numbers of invertebrates (all taxa combined) in natural ponds and impoundments during July 1992, Prudhoe Bay, Alaska. Probabilities with an asterisk indicate that values are significantly different (P<0.05). Values for ponds and impoundments (top histogram) are for Shallow-Carex and Shallow-Arctophila water bodies combined. Sample sizes (n) for the top histogram are based on the number of ponds and impoundments sampled (treatment effects). Sample sizes for the bottom histograms are based on six sweeps within each water body for both ponds and impoundments. Error bars denote SE (Standard error).

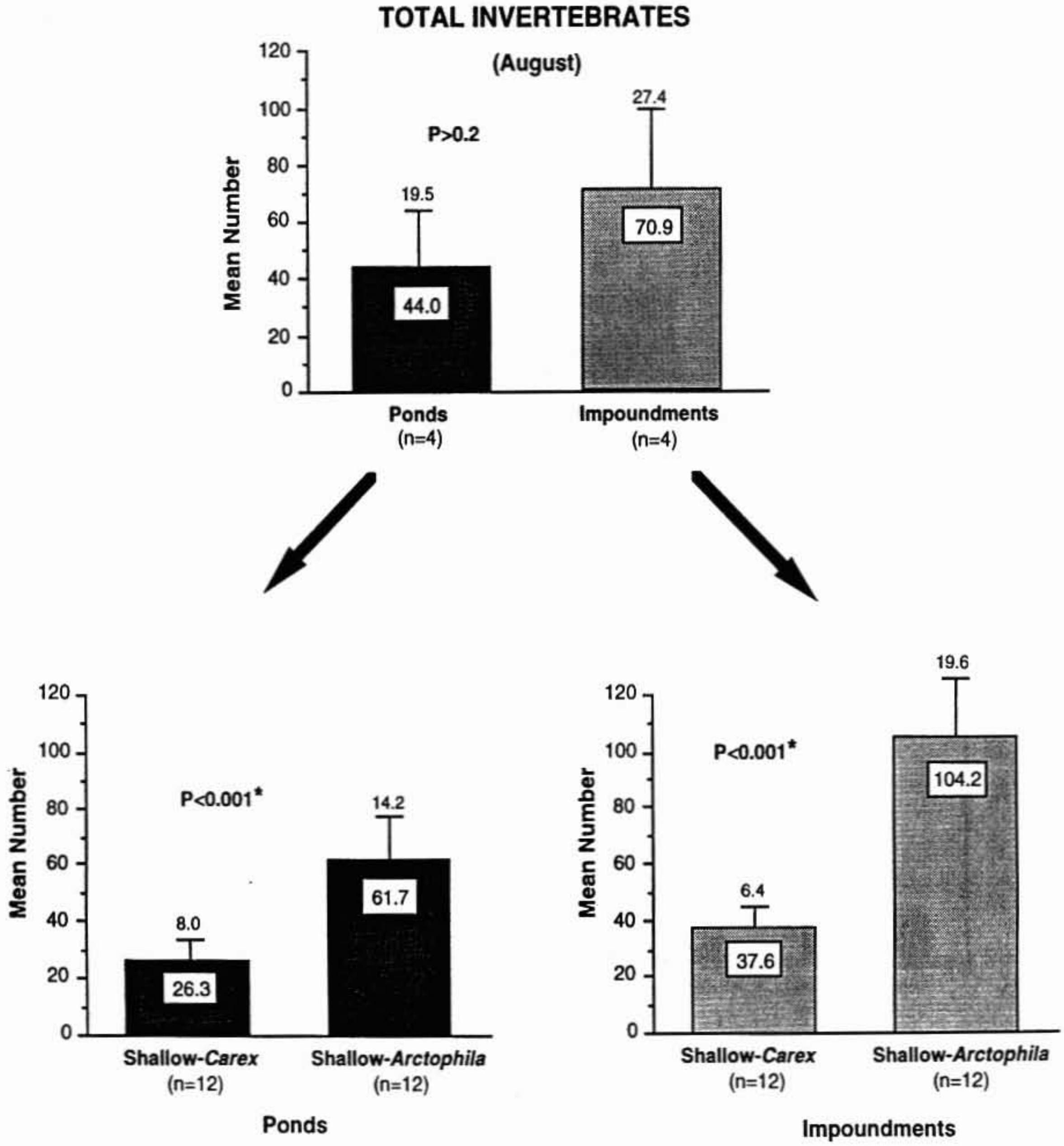

*Figure 5. Mean numbers of invertebrates (all taxa combined) in natural ponds and impoundments during August 1992, Prudhoe Bay, Alaska. Probabilities with an asterisk indicate that values are significantly different ($P<0.05$). Values for ponds and impoundments (top histogram) are for Shallow-*Carex *and Shallow-*Arctophila *water bodies combined. Sample sizes (n) for the top histogram are based on the number of ponds and impoundments sampled (treatment effects). Sample sizes for the bottom histograms are based on six sweeps within each water body for both ponds and impoundments. Error bars denote SE (Standard error).*

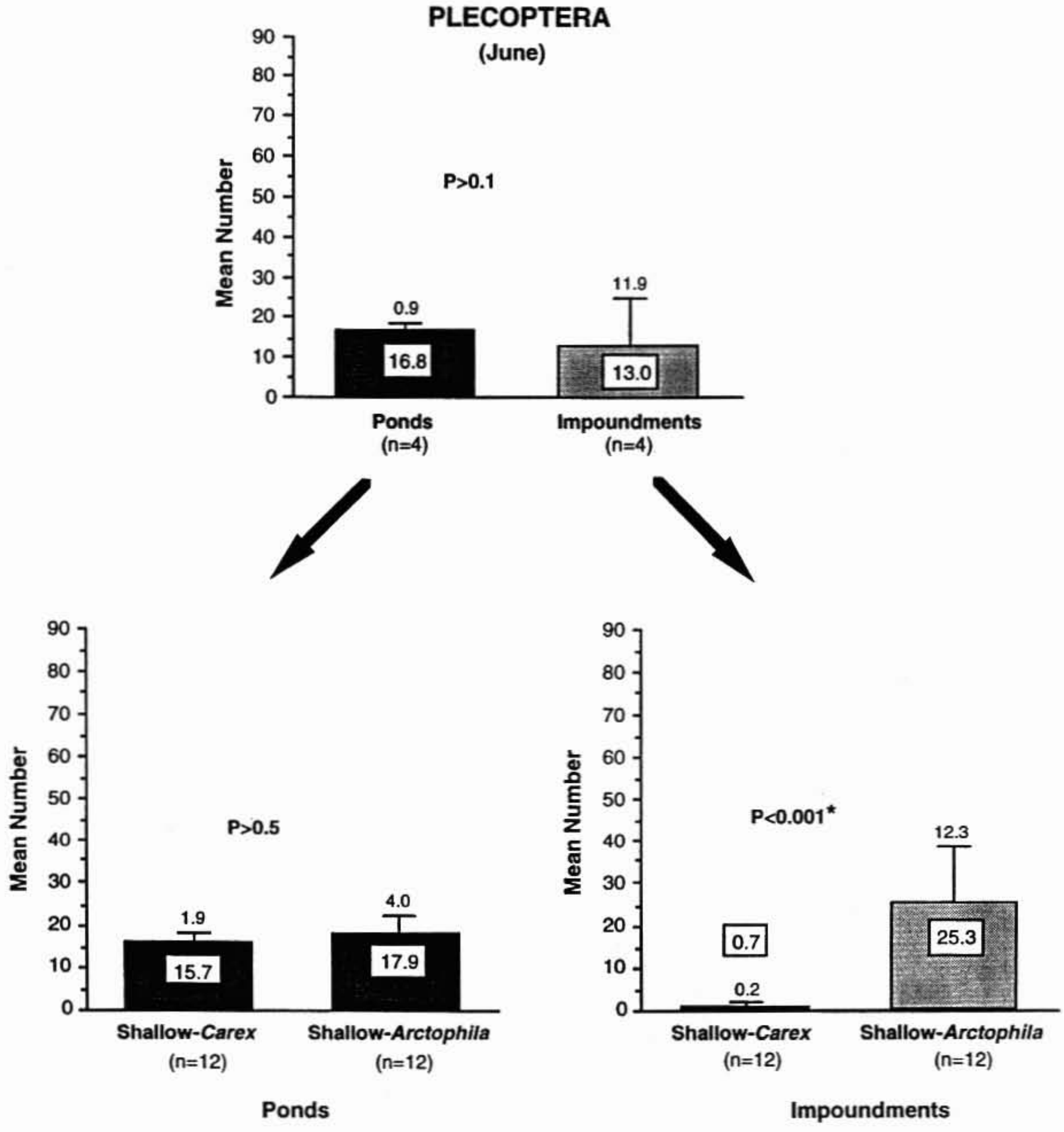

*Figure 6. Mean numbers of plecopterans in natural ponds and impoundments during June 1992, Prudhoe Bay, Alaska. Probabilities with an asterisk indicate that values are significantly different ($P<0.05$). Values for ponds and impoundments (top histogram) are for Shallow-*Carex *and Shallow-*Arctophila *water bodies combined. Sample sizes (n) for the top histogram are based on the number of ponds and impoundments sampled (treatment effects). Sample sizes for the bottom histograms are based on six sweeps within each water body for both ponds and impoundments. Error bars denote SE (Standard error).*

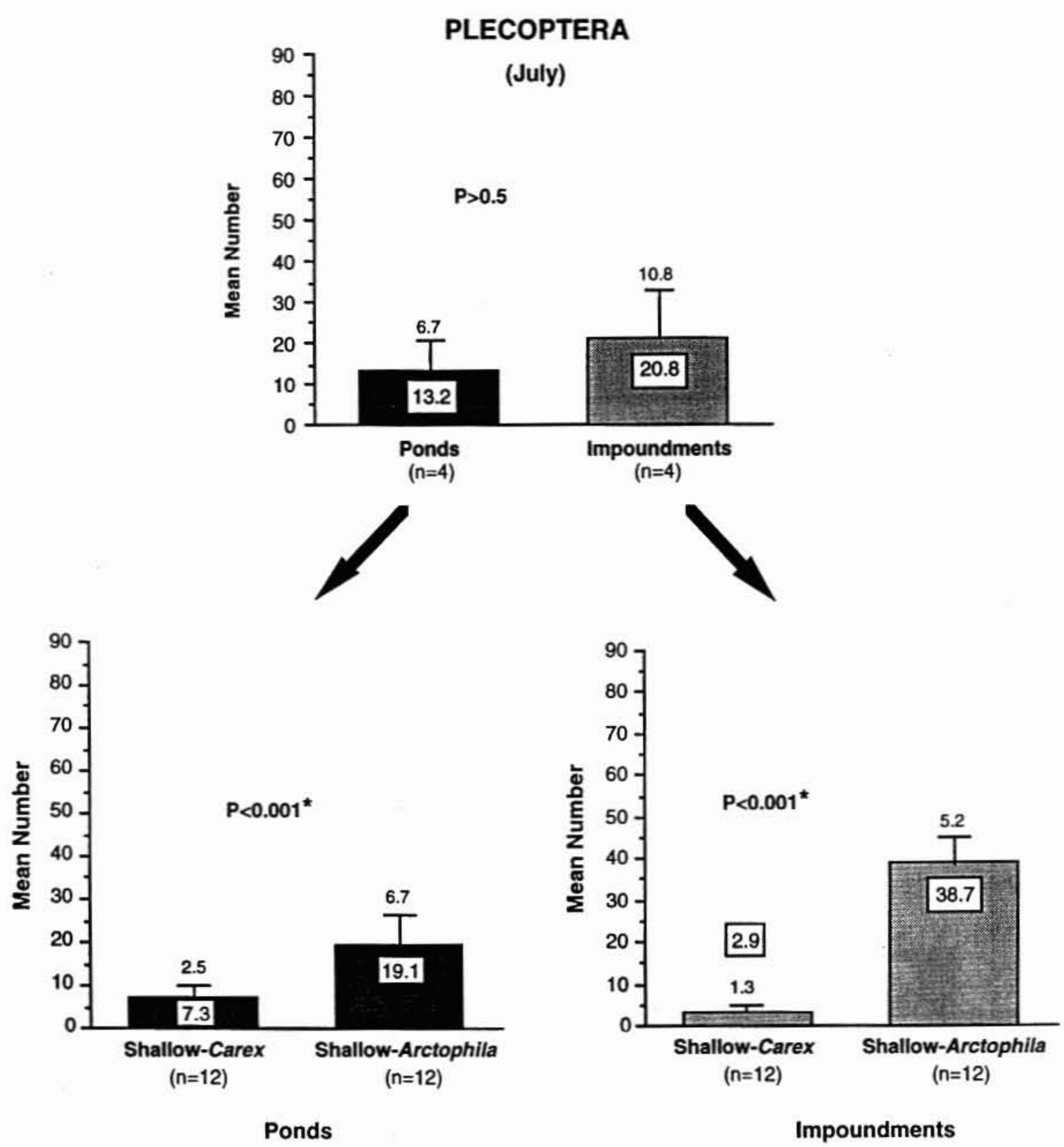

*Figure 7. Mean numbers of plecopterans in natural ponds and impoundments during July 1992, Prudhoe Bay, Alaska. Probabilities with an asterisk indicate that values are significantly different ($P<0.05$). Values for ponds and impoundments (top histogram) are for Shallow-*Carex *and Shallow-*Arctophila *water bodies combined. Sample sizes (n) for the top histogram are based on the number of ponds and impoundments sampled (treatment effects). Sample sizes for the bottom histograms are based on six sweeps within each water body for both ponds and impoundments. Error bars denote SE (Standard error).*

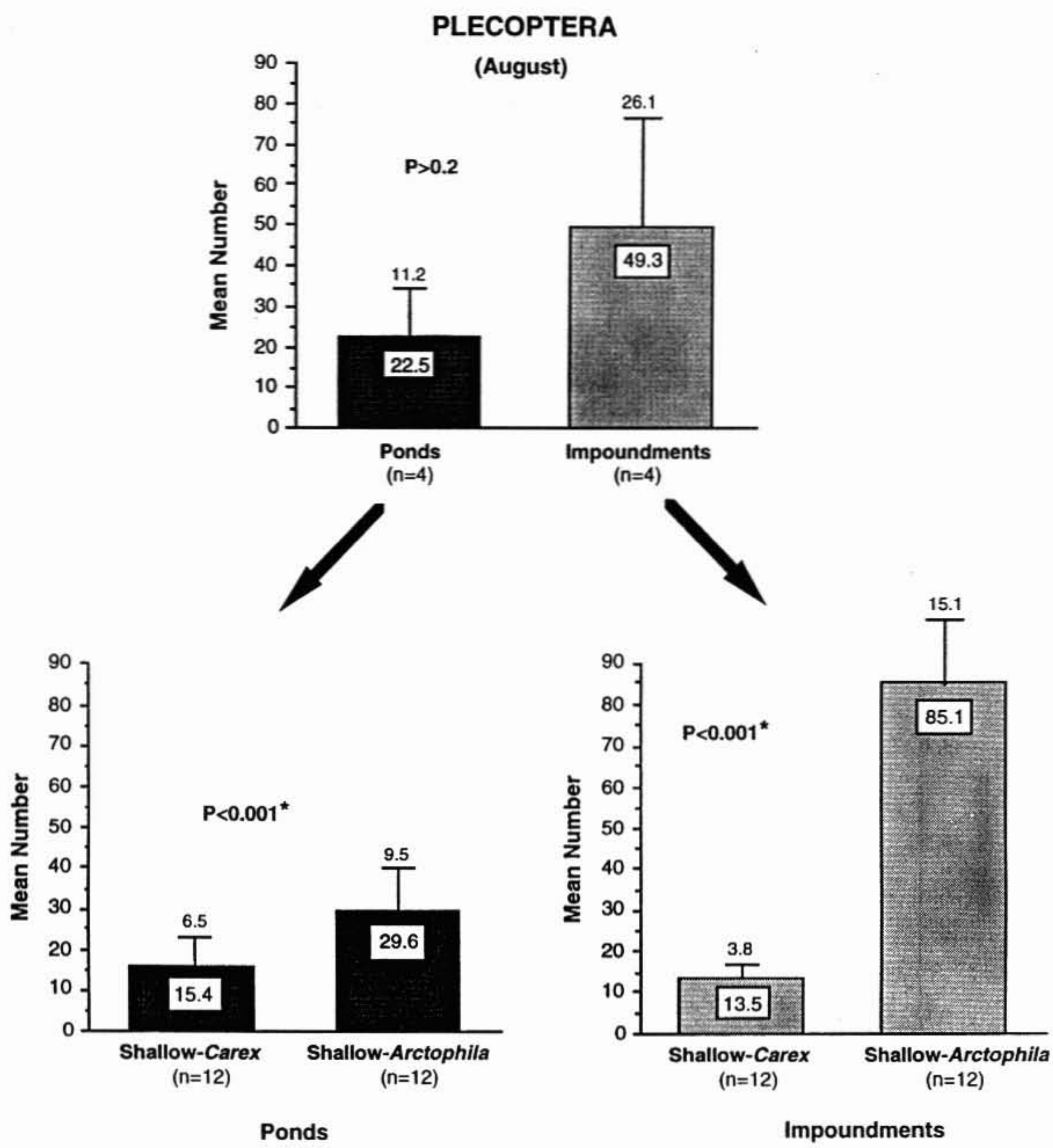

Figure 8. Mean numbers of plecopterans in natural ponds and impoundments during August 1992, Prudhoe Bay, Alaska. Probabilities with an asterisk indicate that values are significantly different ($P<0.05$). Values for ponds and impoundments (top histogram) are for Shallow-Carex and Shallow-Arctophila water bodies combined. Sample sizes (n) for the top histogram are based on the number of ponds and impoundments sampled (treatment effects). Sample sizes for the bottom histograms are based on six sweeps within each water body for both ponds and impoundments. Error bars denote SE (Standard error).

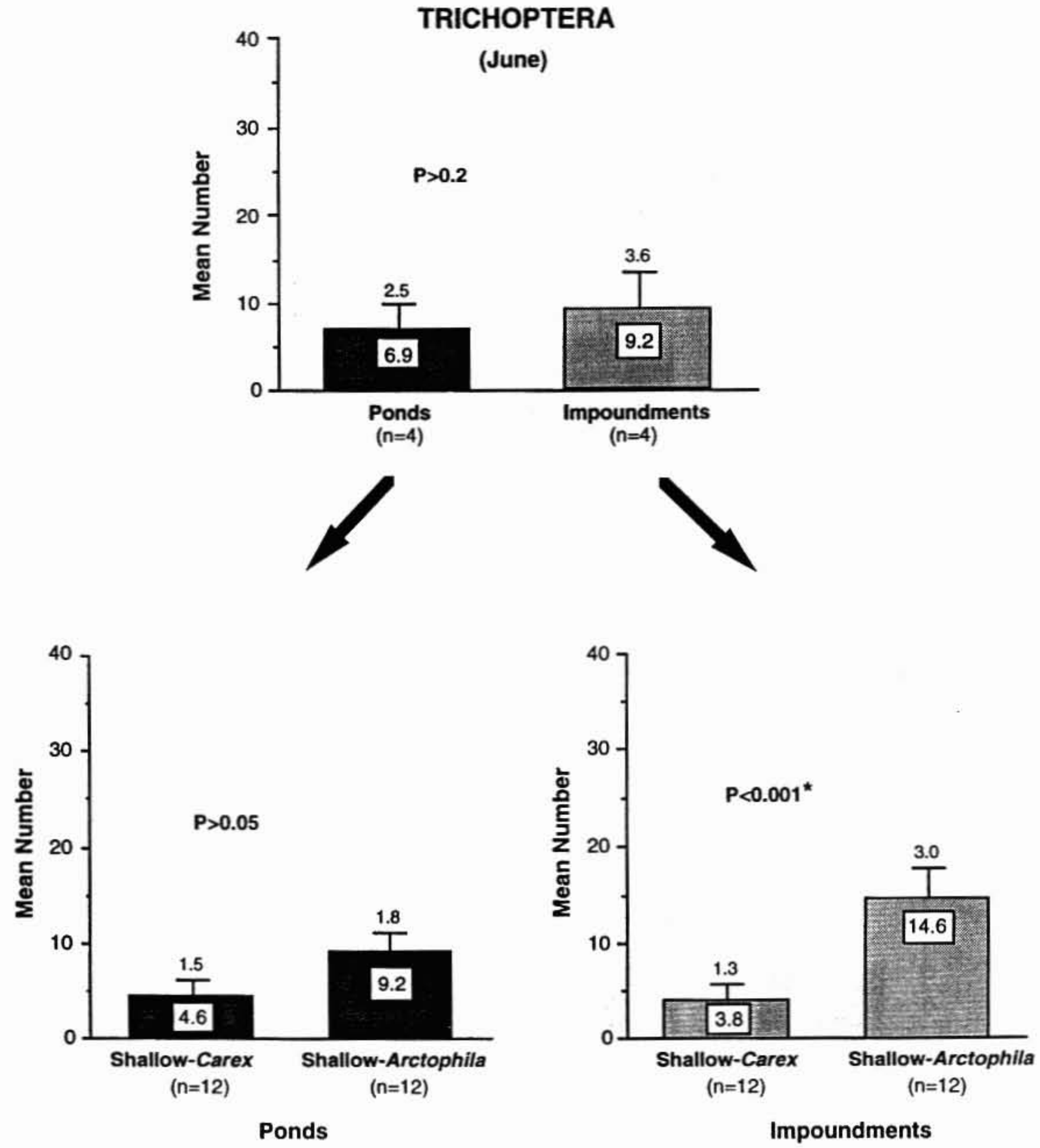

Figure 9. Mean numbers of trichopterans in natural ponds and impoundments during June 1992, Prudhoe Bay, Alaska. Probabilities with an asterisk indicate that values are significantly different (P<0.05). Values for ponds and impoundments (top histogram) are for Shallow-Carex and Shallow-Arctophila water bodies combined. Sample sizes (n) for the top histogram are based on the number of ponds and impoundments sampled (treatment effects). Sample sizes for the bottom histograms are based on six sweeps within each water body for both ponds and impoundments. Error bars denote SE (Standard error).

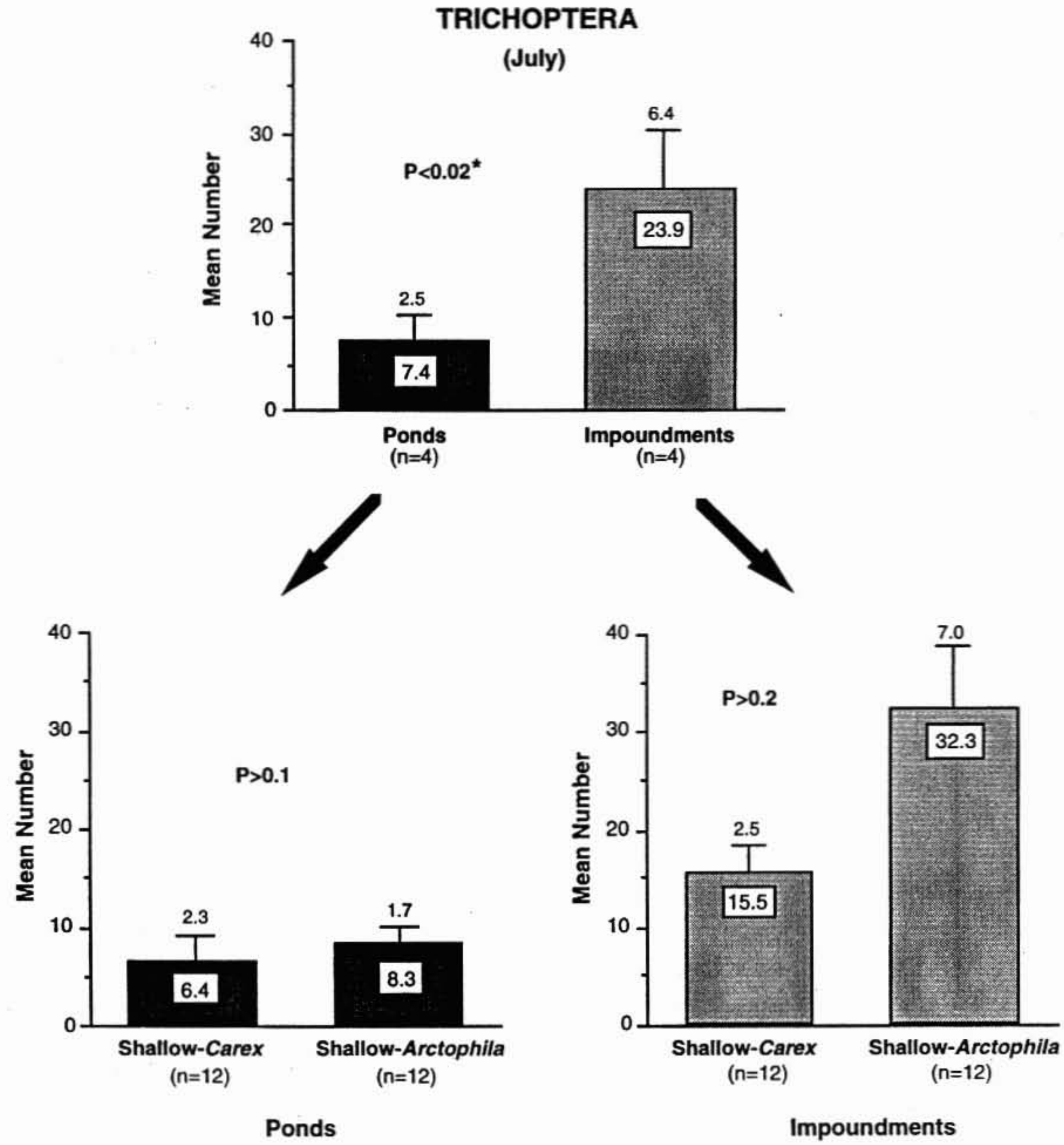

*Figure 10. Mean numbers of trichopterans in natural ponds and impoundments during July 1992, Prudhoe Bay, Alaska. Probabilities with an asterisk indicate that values are significantly different (P<0.05). Values for ponds and impoundments (top histogram) are for Shallow-*Carex *and Shallow-*Arctophila *water bodies combined. Sample sizes (n) for the top histogram are based on the number of ponds and impoundments sampled (treatment effects). Sample sizes for the bottom histograms are based on six sweeps within each water body for both ponds and impoundments. Error bars denote SE (Standard error).*

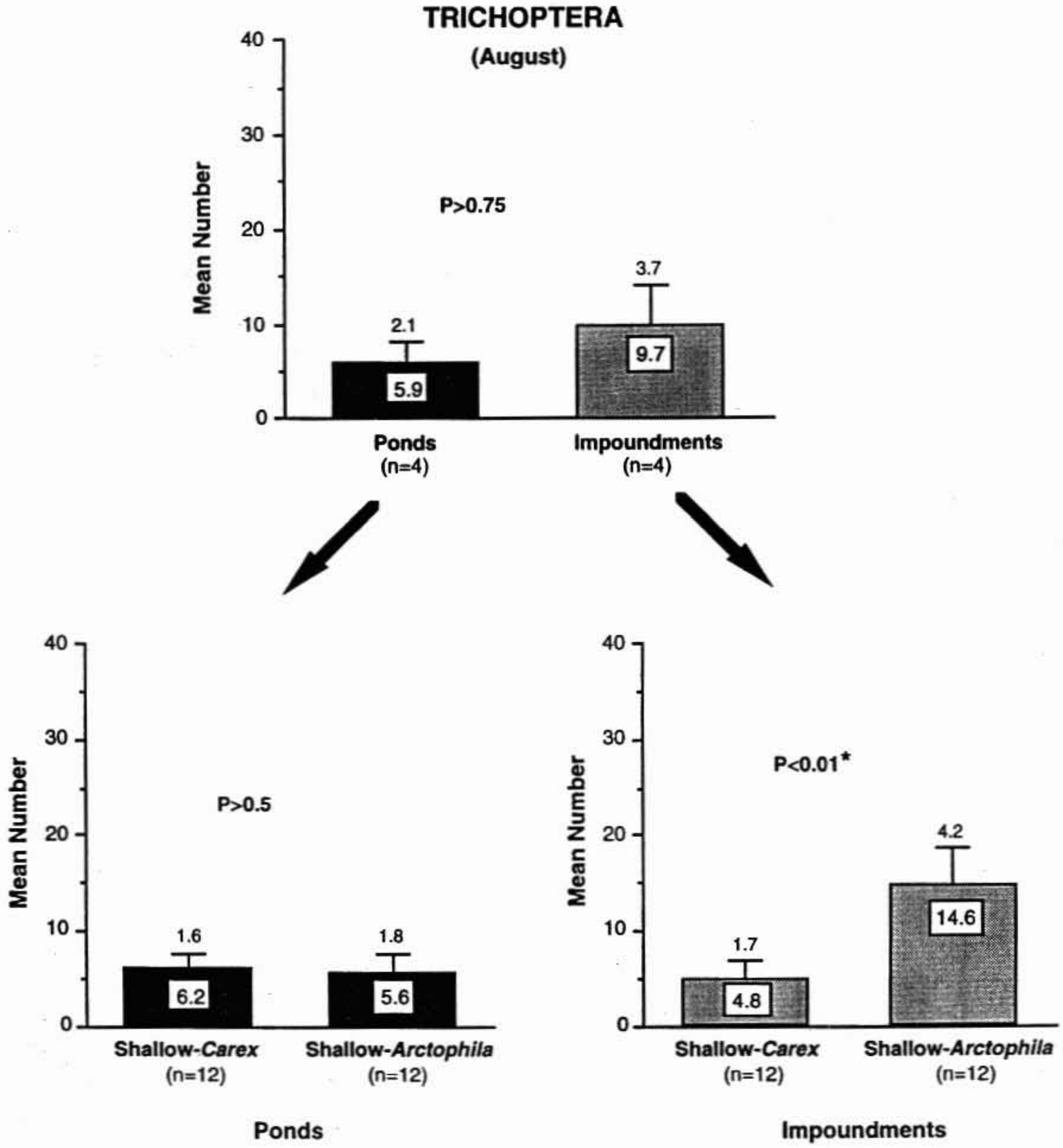

*Figure 11. Mean numbers of trichopterans in natural ponds and impoundments during August 1992, Prudhoe Bay, Alaska. Probabilities with an asterisk indicate that values are significantly different (P<0.05). Values for ponds and impoundments (top histogram) are for Shallow-*Carex* and Shallow-*Arctophila* water bodies combined. Sample sizes (n) for the top histogram are based on the number of ponds and impoundments sampled (treatment effects). Sample sizes for the bottom histograms are based on six sweeps within each water body for both ponds and impoundments. Error bars denote SE (Standard error).*

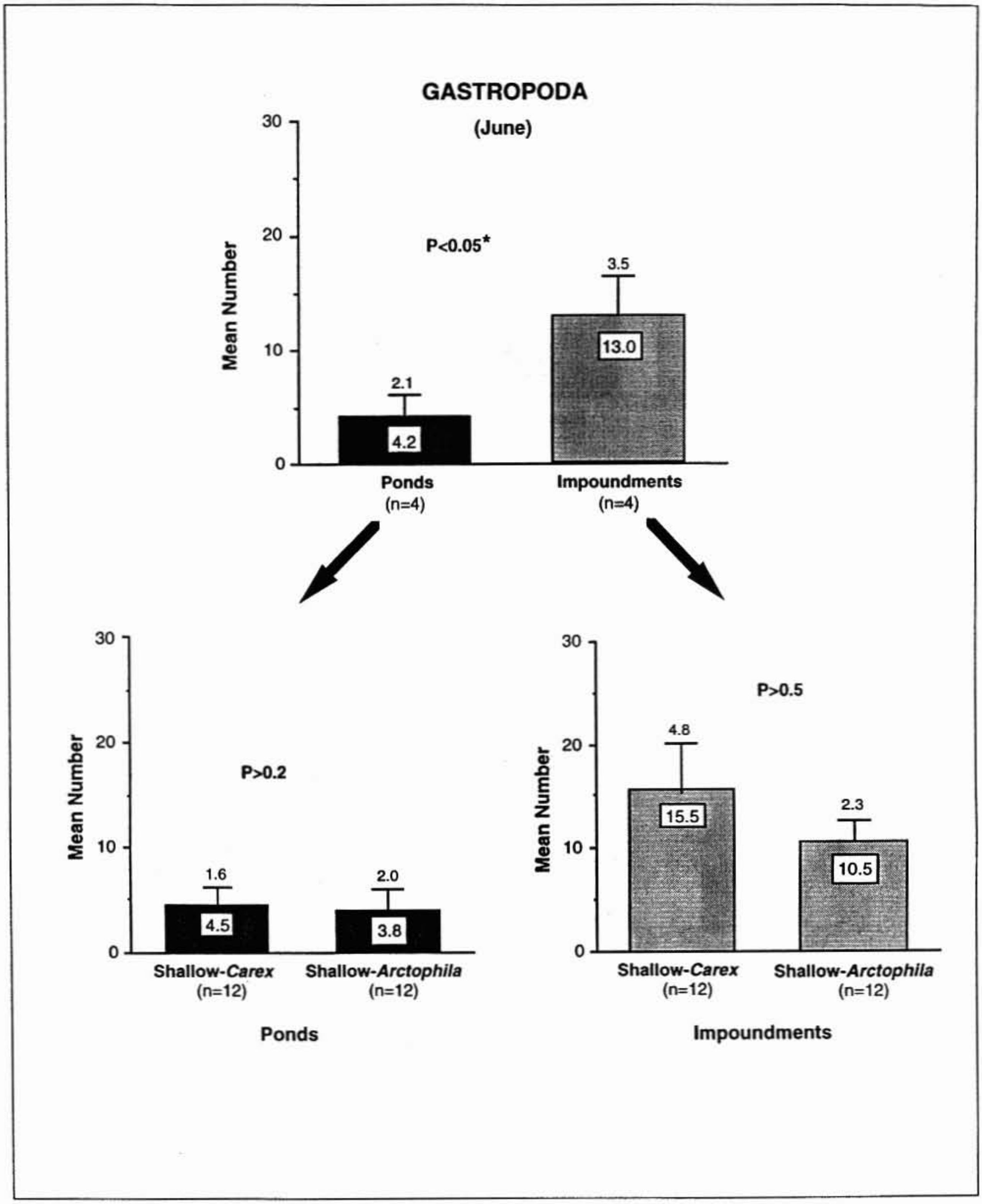

Figure 12. Mean numbers of gastropods in natural ponds and impoundments during June 1992, Prudhoe Bay, Alaska. Probabilities with an asterisk indicate that values are significantly different ($P<0.05$). Values for ponds and impoundments (top histogram) are for Shallow-Carex and Shallow-Arctophila water bodies combined. Sample sizes (n) for the top histogram are based on the number of ponds and impoundments sampled (treatment effects). Sample sizes for the bottom histograms are based on six sweeps within each water body for both ponds and impoundments. Error bars denote SE (Standard error).

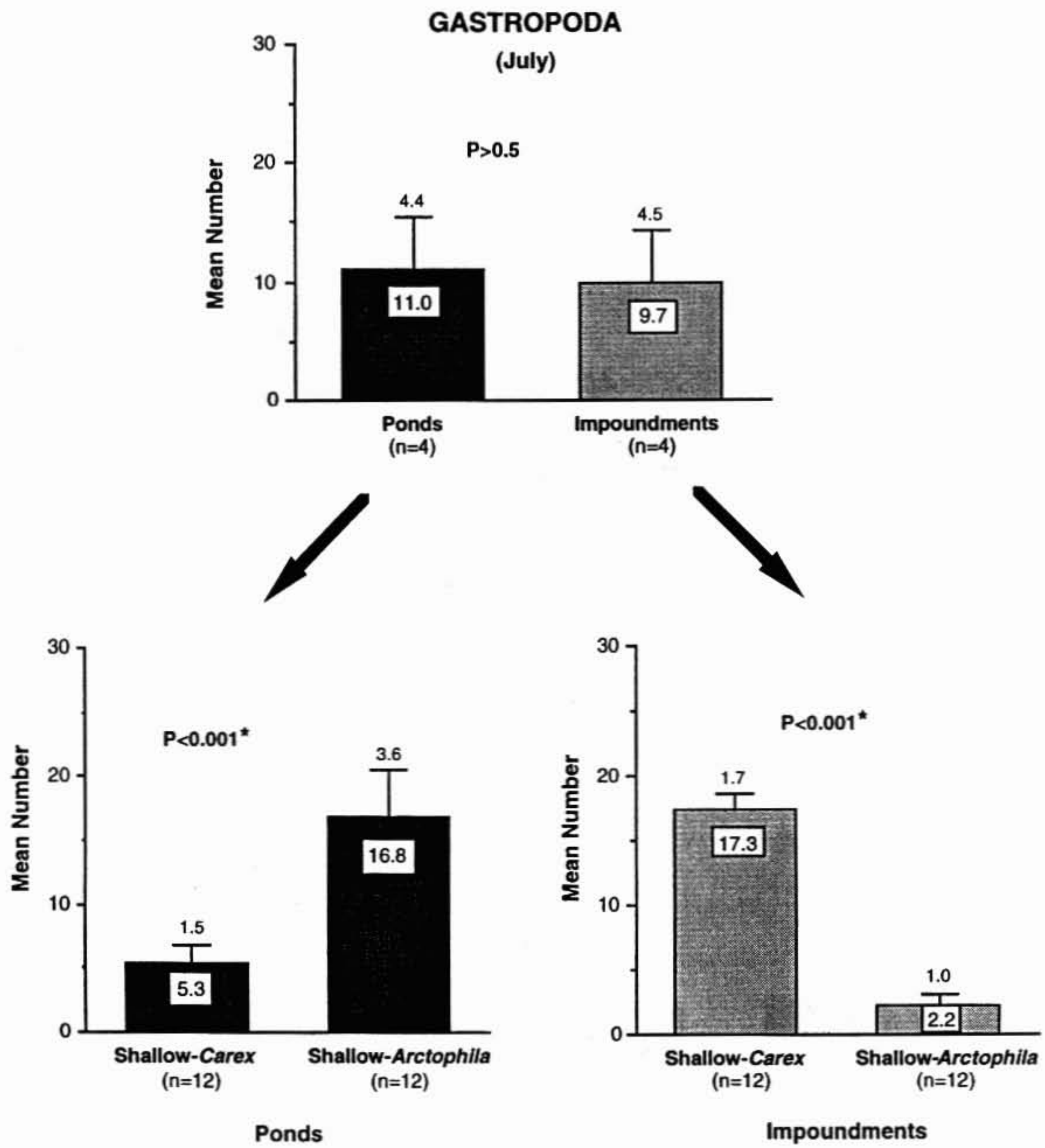

Figure 13. Mean numbers of gastropods in natural ponds and impoundments during July 1992, Prudhoe Bay, Alaska. Probabilities with an asterisk indicate that values are significantly different (P<0.05). Values for ponds and impoundments (top histogram) are for Shallow-Carex and Shallow-Arctophila water bodies combined. Sample sizes (n) for the top histogram are based on the number of ponds and impoundments sampled (treatment effects). Sample sizes for the bottom histograms are based on six sweeps within each water body for both ponds and impoundments. Error bars denote SE (Standard error).

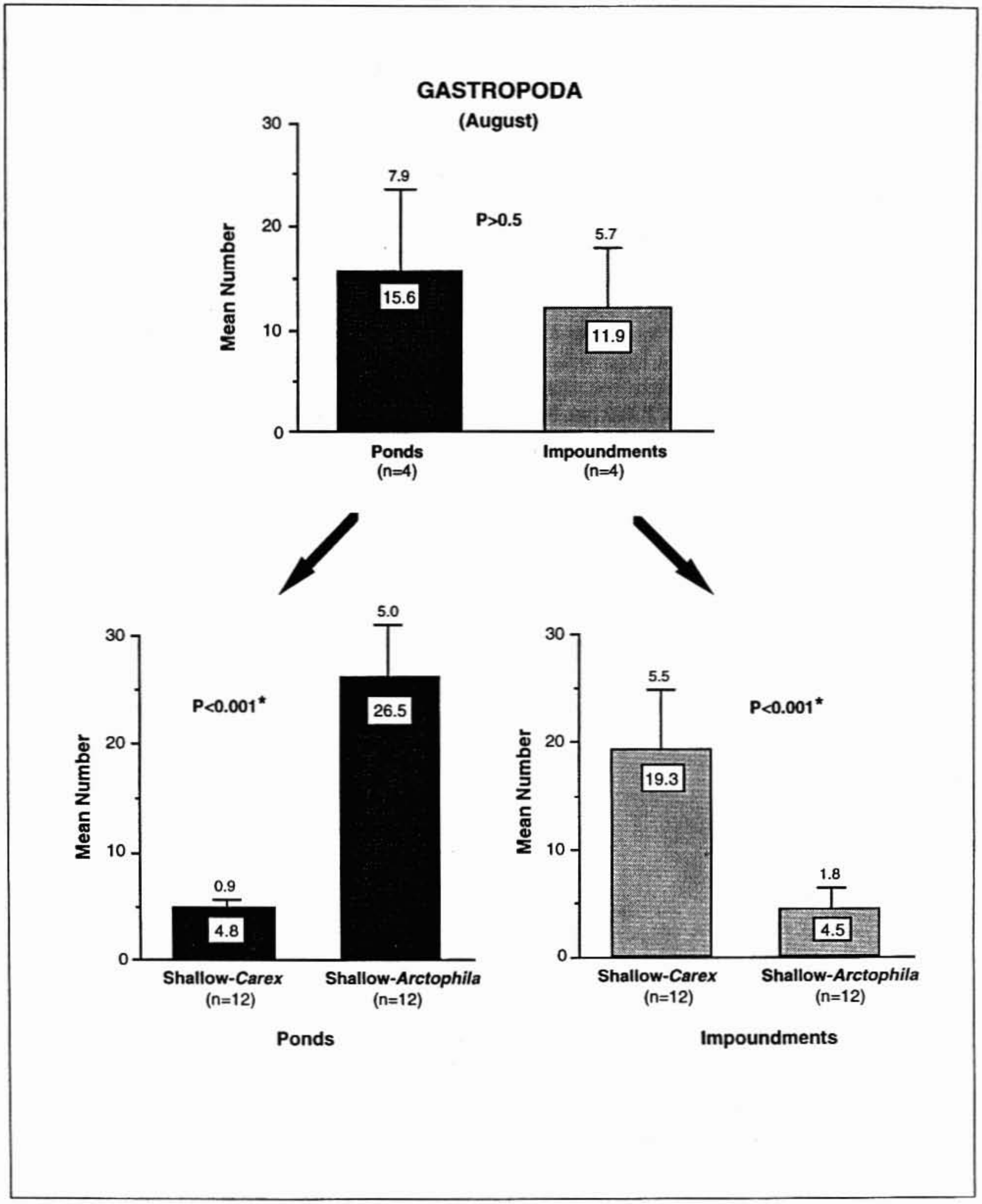

Figure 14. Mean numbers of gastropods in natural ponds and impoundments during August 1992, Prudhoe Bay, Alaska. Probabilities with an asterisk indicate that values are significantly different (P<0.05). Values for ponds and impoundments (top histogram) are for Shallow-Carex and Shallow-Arctophila water bodies combined. Sample sizes (n) for the top histogram are based on the number of ponds and impoundments sampled (treatment effects). Sample sizes for the bottom histograms are based on six sweeps within each water body for both ponds and impoundments. Error bars denote SE (Standard error).

Waterbird Abundance

Water Body Characteristics

Although impoundments in June averaged larger in surface area than ponds (Table 3), size differences were less apparent (and often reversed) as the season progressed and water levels declined more rapidly in impoundments than ponds. Water levels at 9 of 15 (60%) impoundments declined approximately 0.5 m. Declines in water level were due to drainage after culvert thaw and removal by water trucks. At the majority of sites (67%) with declining water levels, drawdown occurred during a 2-week period from 12 to 25 June. Drawdowns usually resulted in a large reduction in overall surface area of impoundments. For example, at the Frontier (no. 1), E-Pad (no. 3), P-Pad (no. 21), and CC2 (no. 29) impoundments (Appendices C, D, and F), surface area was reduced by 50% to 70%. No similar reductions in surface area of natural ponds occurred. At the E-Pad and P-Pad impoundments, water levels declined to reveal a series of discrete water bodies with shape, orientation, and bank gradient characteristics of nearby natural ponds, supporting the observation that impoundments form in drained lake basins or other low-lying areas (Walker et al. 1986, Walker et al. 1987), often with pre-existing natural wetlands.

Impoundments were ice-free and available to waterbirds earlier than ponds (Table 4). Early melting of impoundments may result from shallower water than ponds and from heat provided by spring runoff, which accumulates to a greater extent on impoundment than pond surfaces prior to melt. When observations began on 5 June, impoundments averaged 75% open water compared to <10% for ponds. The average date when impoundments were 100% ice-free was 9 June, six days earlier than natural ponds.

Between Sampling Periods

Bird densities were low and birds were patchily distributed in the oil fields in 1992. On 905 of 1440 (62.8%) visits to the 30 ponds and impoundments, no birds were observed (Fig. 15).

Ducks (all species combined) declined in abundance during the breeding season at both ponds and

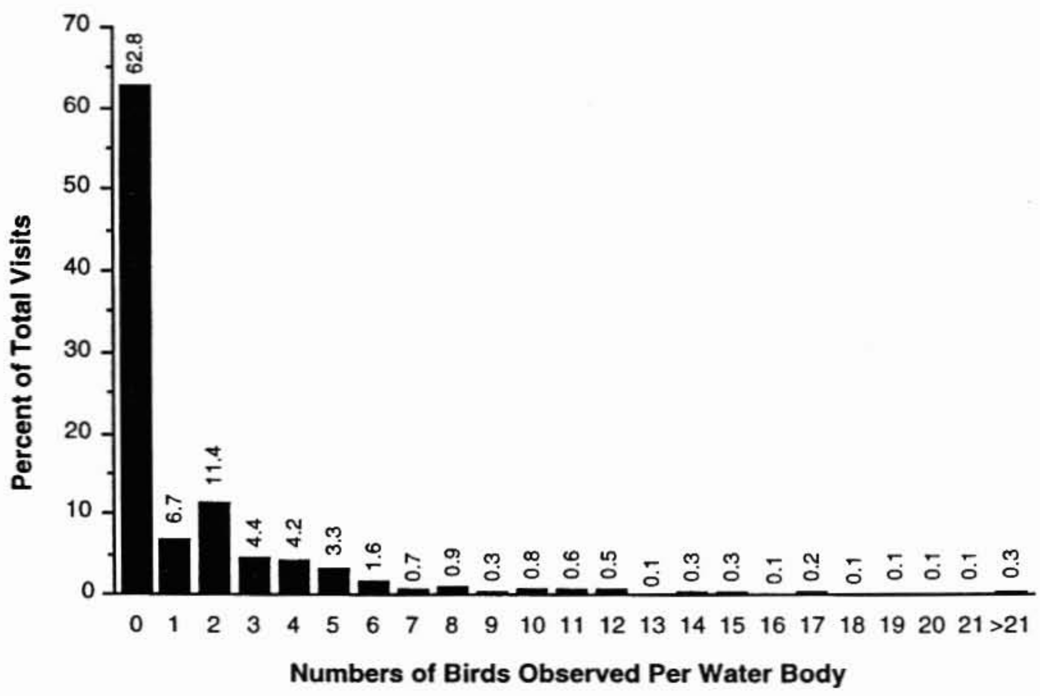

Figure 15. Numbers of birds observed per water body during 1440 visits to ponds and impoundments between 5 June and 27 July 1992, Prudhoe Bay, Alaska.

impoundments (Fig. 16), likely as a result of dispersal to tundra nesting areas and to feeding areas on large lakes and on the Beaufort Sea. In addition to eiders, Northern Pintail, and Oldsquaw, the following species were included in counts of total ducks: Mallard (*Anas platyrhynchos*), Northern Shoveler (*Anas clypeata*), Greater Scaup (*Aythya marila*), Green-winged Teal (*Anas crecca*), American Wigeon (*Anas americana*), and Gadwall (*Anas strepera*). However, because these latter species were low in numbers, they were not analyzed individually. Among the more abundant duck species (eiders, Northern Pintail, and Oldsquaw), only Northern Pintails, the majority of which do not nest in the oil field, increased in abundance during mid-summer.

Within Sampling Periods

Ducks (all species combined) were more abundant on impoundments than ponds during early (2.59 ± 0.42/impoundment versus 2.25 ± 0.79/pond), middle (1.78 ± 0.34/impoundment versus 1.31 ± 0.52/pond), and late summer (0.86 ± 0.22/impoundment versus 0.40 ± 0.21/pond) (Fig. 16). However, differences were not significant. Pollard et al. (1990) also found that waterfowl (ducks, geese, and swans) were more abundant on impoundments than ponds.

Northern Pintails were consistently more abundant on impoundments than ponds in early (1.15 ± 0.25/impoundment versus 0.36 ± 0.13/pond), middle (1.40 ± 0.30/impoundment versus 0.63 ± 0.25/pond), and late summer (0.63 ± 0.16/impoundment versus 0.25 ± 0.19/pond) (Fig. 16). Again, differences were not significant. Oldsquaws were more abundant on ponds than impoundments during early (1.02 ± 0.40/pond versus 0.74 ± 0.26/impoundment), middle (0.31 ± 0.12/pond versus 0.11 ± 0.04/impoundment), and late summer (0.04 ± 0.02/pond versus 0.03 ± 0.01/impoundment), but not significantly so (Fig. 17). Eiders were also more abundant on ponds than impoundments in early (0.70 ± 0.30/pond versus 0.43 ± 0.15/impoundment) and mid-summer (0.34 ± 0.21/pond versus 0.19 ± 0.19/impoundment) (Fig. 17). In late summer, after ducklings had hatched, eiders were slightly more abundant on impoundments (0.15 ± 0.10/impoundment) than ponds (0.10 ± 0.07/pond).

Eider Nests and Brood Observations

Four King Eider nests were located, all on impoundments (one at West Beach State, one at P-Pad, and two at West Dock). All four nests failed. Two nests were found in late June after they were abandoned and/or preyed upon. Two nests found active on 19 and 20 June were predated on 21 June and 5 July, respectively. Sources of predation were unknown; but at one nest, a Parasitic Jaeger (*Stercorarius parasiticus*) landed nearby while the female eider was 10 m away. Arctic fox (*Alopex lagopus*) predation was thought to be the main cause of poor Common Eider (*Somateria mollissima v-nigra*) nest success on the Endicott Causeway in 1991 and 1992 (Johnson et al. 1992), and foxes also may have been responsible for failure of eider nests in this study.

King and Spectacled eider broods were the only waterfowl broods observed. One King Eider brood with two Class 1b young was found on the Gasline Pond on 23 July, and one brood with four Class 1a young was observed on the DS7a Impoundment on 13 and 17 July. A single Spectacled Eider brood with two Class 1c young was observed on the E-Pad Impoundment on 21 July. Based on age spans for young of other duck species (Gollop and Marshall 1954), Class 1a, 1b, and 1c eider young may range in age from approximately 1–7, 8–14, and 15–20 days, respectively.

Waterbird Activity Budgets

Pacific Loons

Pacific Loon pairs (Fig. 18) and individuals (Fig. 19) foraged more on impoundments (56.1 ± 3.9% and 63.6 ± 5.4%, respectively) than natural ponds (51.5 ± 4.2% and 59.1 ± 6.1%, respectively). Pairs on impoundments spent a greater percentage of total foraging time subsurface foraging (65.1%) than diving (34.9%), while the reverse was true for pairs on ponds (51.9% diving versus 48.1% subsurface foraging). On both ponds and impoundments, individual loons foraged more by diving (56.3% and 59.4%, respectively) than by subsurface feeding (43.7% and 40.6%, respectively). The foraging ecology of Pacific Loons is discussed in more detail in a later section of this report. Mean dive duration of Pacific Loons was greater on ponds (33.7 ± 2.4 seconds, n = 10 ponds) than impoundments (31.2 ± 1.3 seconds, n = 10 impoundments). Average dive lengths were determined only for those water bodies where we observed a minimum of three diving bouts, each consisting of at least five dives. Mean dive lengths for each bout were then combined to determine average dive length for birds at that water body.

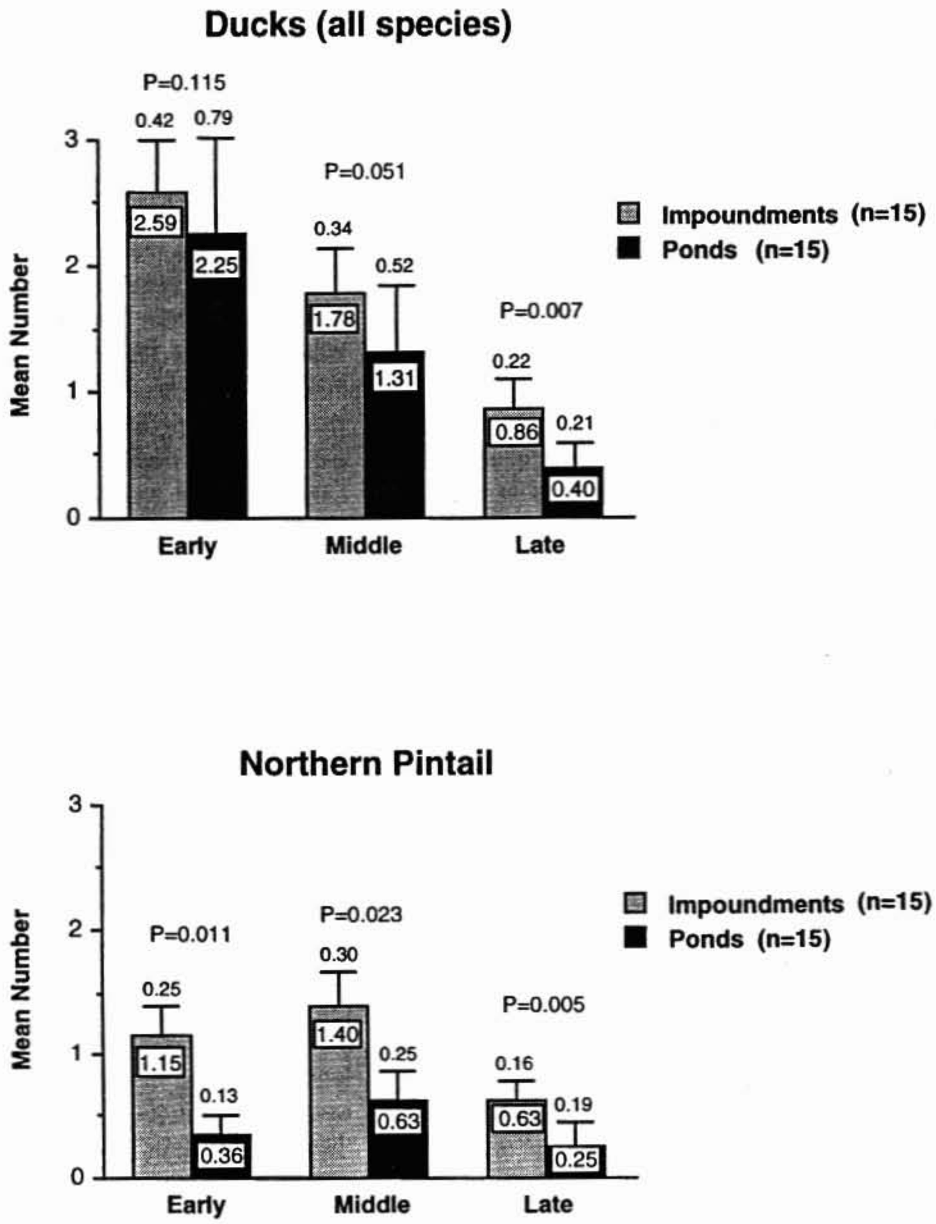

Figure 16. Mean numbers of birds (total ducks and pintails) observed in impoundments and natural ponds during three time periods in 1992, Prudhoe Bay, Alaska. Although means are presented in the histograms, the Mann-Whitney U test compares rank sums to determine significant differences. Differences were considered significant at $P<0.0042$ (for the 12 comparisons, a family error rate of 0.05 requires a per comparison error rate of 0.05/12=0.0042). Early, Middle, and Late refer to the following periods: 5-20 June, 21 June-7 July, and 8-27 July, respectively. Error bars denote SE (Standard error).

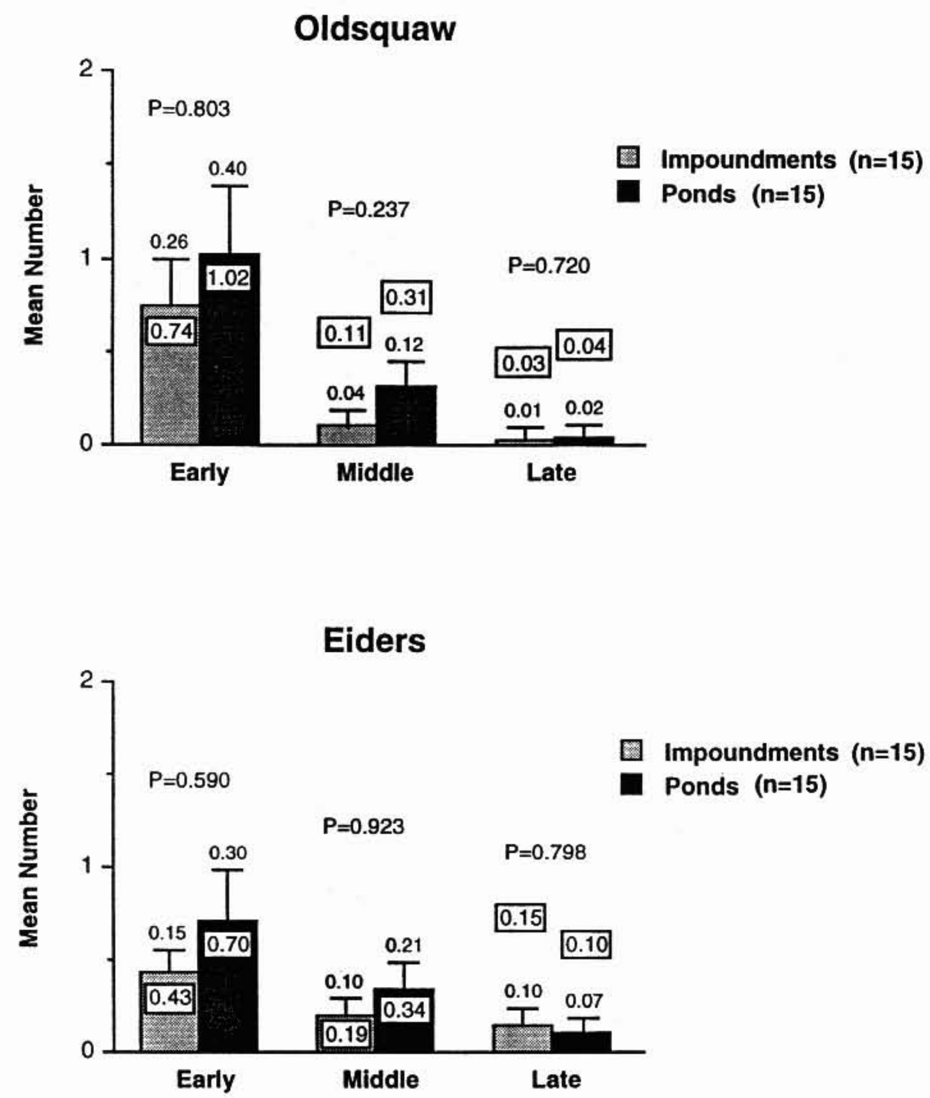

Figure 17. Mean numbers of birds (Oldsquaws and eiders) observed in impoundments and natural ponds during three time periods in 1992, Prudhoe Bay, Alaska. Although means are presented in the histograms, the Mann-Whitney U test compares rank sums to determine significant differences. Differences were considered significant at P<0.0042 (for the 12 comparisons, a family error rate of 0.05 requires a per comparison error rate of 0.05/12=0.0042). Early, Middle, and Late refer to the following periods: 5-20 June, 21 June-7 July, and 8-27 July, respectively. Error bars denote SE (Standard error).

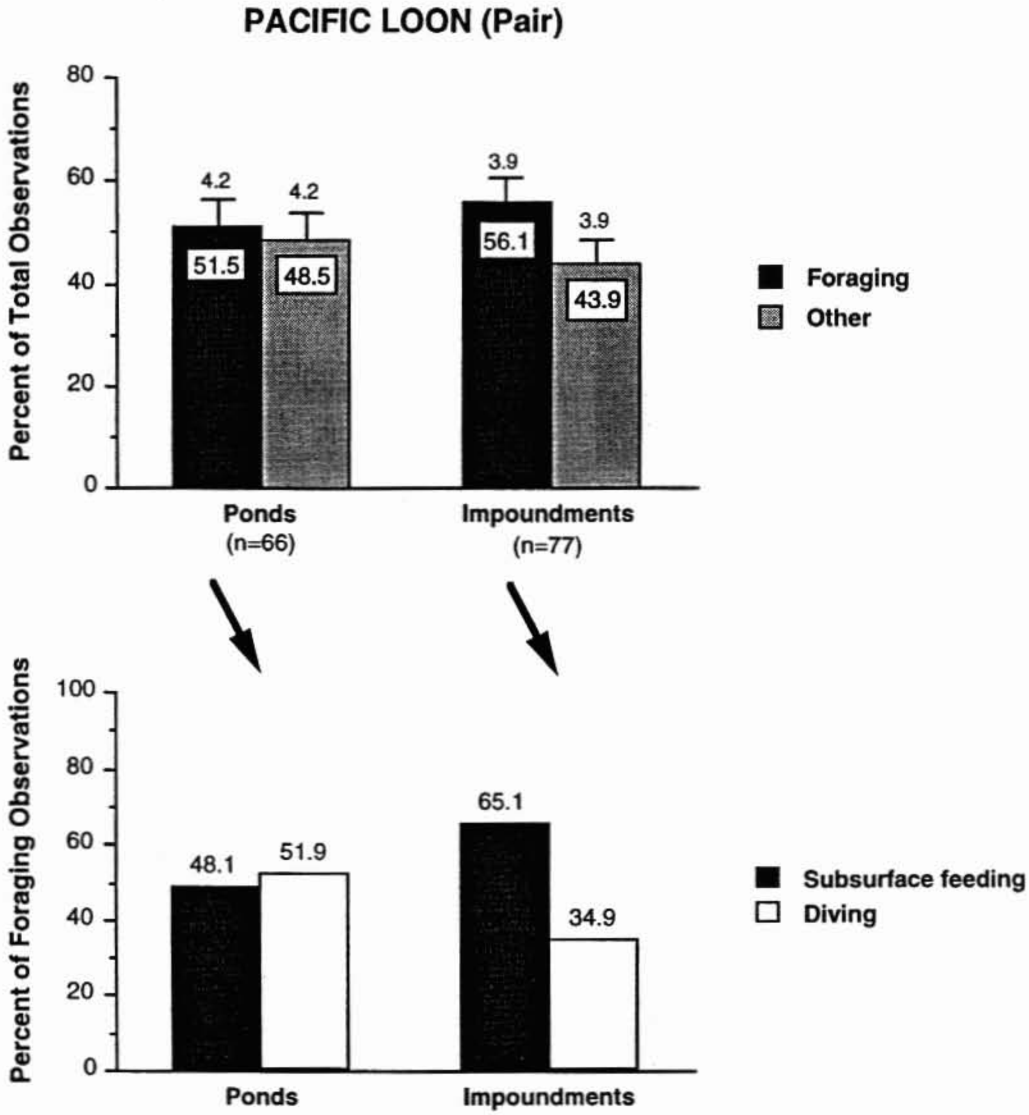

Figure 18. Comparative behavior of Pacific Loon pairs (non-incubating) on ponds and impoundments in 1992, Prudhoe Bay, Alaska. Because of large differences between ponds and impoundments in the number of observations per water body, sample sizes (n) represent the total number of pairs observed on ponds and impoundments rather than the number of ponds and impoundments at which behaviors were recorded. The bottom graph refers to the percent contribution of different foraging methods to total foraging time. Error bars denote SE (Standard error). Differences were not tested statistically.

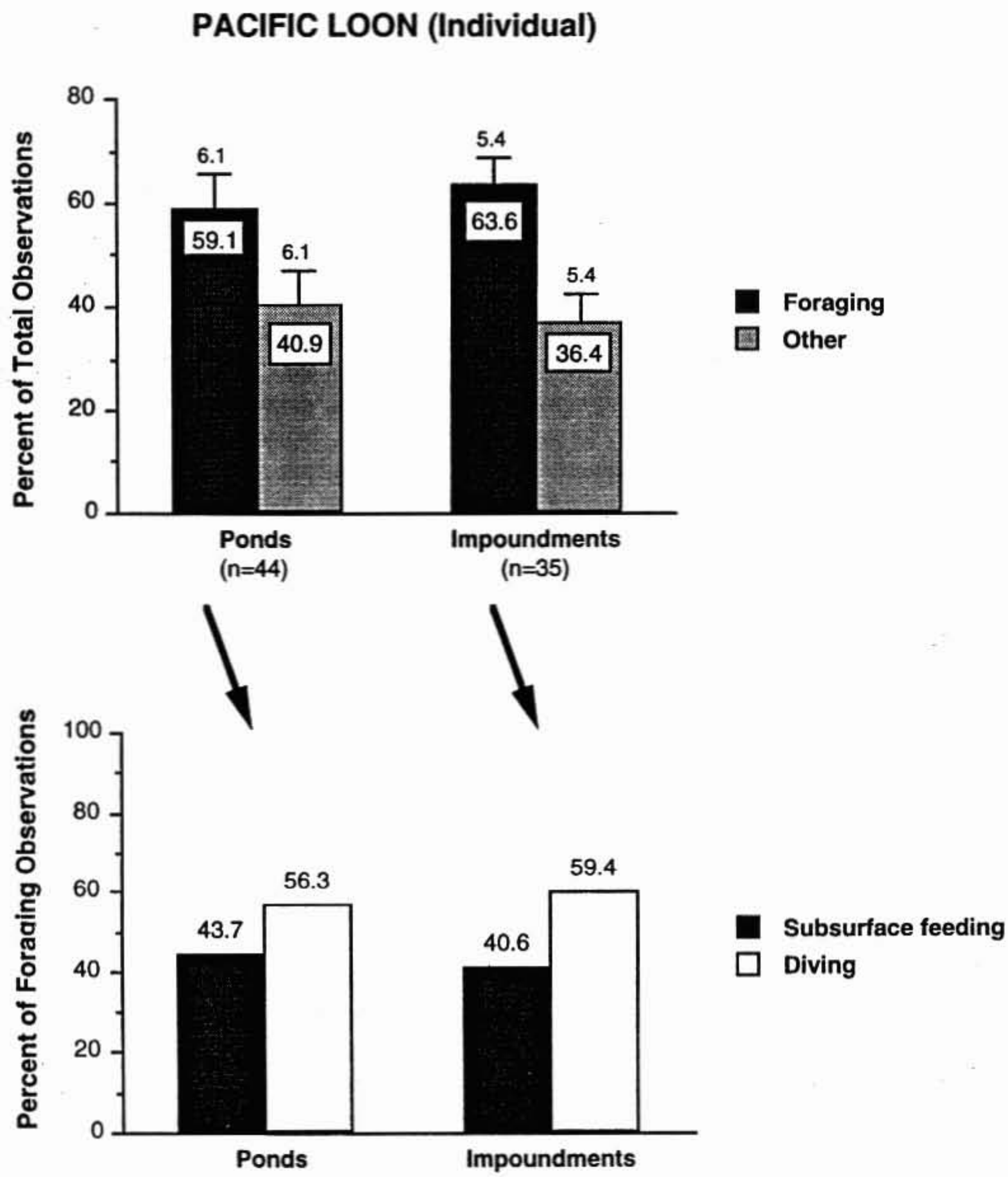

Figure 19. Comparative behavior of Pacific Loon individuals on ponds and impoundments in 1992, Prudhoe Bay, Alaska. Because of large differences between ponds and impoundments in the number of observations per water body, sample sizes (n) represent the total number of individuals observed on ponds and impoundments rather than the number of ponds and impoundments at which behaviors were recorded. The bottom graph refers to the percent contribution of different foraging methods to total foraging time. Error bars denote SE (Standard error). Differences were not tested statistically.