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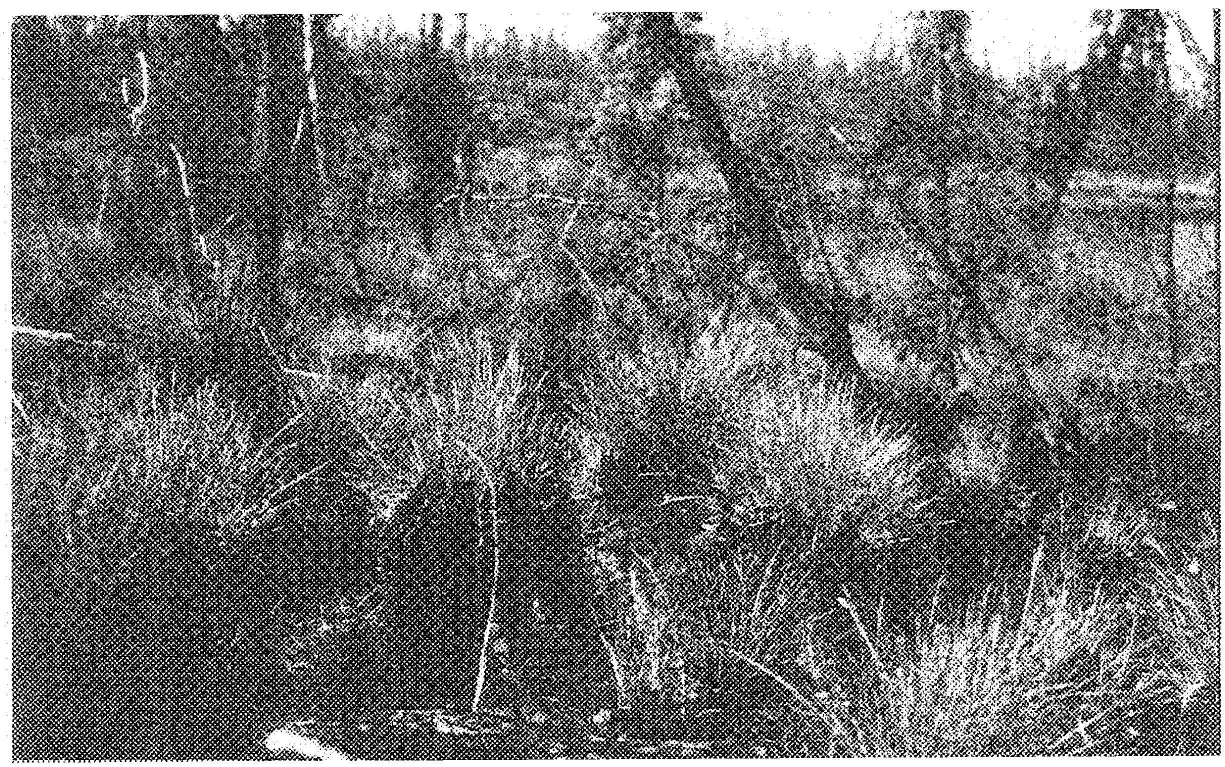
Waterfowl Production and Effects of Fire on Wetlands in the Pah River Flats

R.R. Jandt and A.E. Morkill



Authors

A. E. Morkill is a wildlife biologist with the Kobuk District, Fairbanks, Alaska.

R. R. Jandt is a wildlife biologist with the Kobuk District, Fairbanks, Alaska.

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INVESTIGATORS: R.R. Jandt and A.E. Morkill

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Abstract

Abstract : Waterfowl brood surveys were conducted in the Pah River Flats, Alaska, during July 1993. Although spring flooding was extensive, duck production was greater than previous estimates from 1989. A large portion of the study area had burned in a lightning-caused wildfire in the summer of 1992. Some features of waterfowl production and aquatic vegetation in burned and unburned ponds were compared. A brief review of some effects of fire on waterfowl proposed in the literature is included.

INTRODUCTION

Alaska's public wetlands are becoming an increasingly valuable resource as continental waterfowl breeding habitat diminishes because of development and drought conditions. Of the original 350,000 km^2 of wetland habitat in the conterminous United States, less than half remains (Tiner 1984). During drought years in the prairie states and provinces, more than half all northern pintails *(Anas acuta)* and one third of all wigeons *(Anas americana)* breed in Alaska (Lensink and Derksen 1990). Inventories in 1989-1992 have helped to identify important wetlands on Bureau of Land Management (BLM) lands in the Kobuk District and to gain an understanding of species composition, habitat selection, and habitat quality. Such baseline data is essential to determine the impacts of development and various land management options (such as fire suppression) on breeding waterfowl (BLM 1986). Although fire plays a large role in interior Alaska ecosystems, very little has been published on the effects of fire on wetlands and waterfowl in Alaska. The short- and long-term effects of wildfires on taiga wetlands are largely unknown.

Ground brood counts have been used in several places in Alaska to estimate waterfowl production based upon the number and size of broods counted during the peak of breeding season in July (Brubaker and Witmer 1989, Doyle 1989, USF&WS 1991). The Kobuk District BLM conducted brood surveys in the Pah River Flats in 1989 and on the Seward Peninsula in 1989-1993 (Anderson and Robinson 1991a, 1991b, Brown and Jandt 1992, Brown et al. 1993). In 1989, the Pah River Flats produced an estimated 610±138 young ducks (Anderson and Robinson 1991a). Ten 2.6-km^2 plots, containing 54 waterbodies, were surveyed to obtain the estimate. Production for 1989 was thought to be lower than usual in this region due to extensive spring flooding. In 1990-1992, the Pah River Flats was included in the larger refuge survey for the Koyukuk-Nowitna National Wildlife Refuge, and sampling intensity declined, so that little specific pond production information is available for the Pah River Flats during that period.

In July, 1992 a lightning-caused wildfire burned over 2,000 ha of the Pah River Flats. Two of the 10 plots surveyed in 1989 were entirely within the fire perimeter, and parts of several others were affected. The fire has provided a window of opportunity to study the effects of fire on waterfowl and the taiga wetlands ecosystem, with the advantage of having pre-fire production data. The goal of this study was to obtain information on waterfowl production, habitats, and effects of fire on wetlands ecosystems to use in making land use decisions and choosing fire management options.

We would like to express our gratitude to M. Spindler and the USF&WS, Koyukuk/Nowitna Refuge staff for helping with the logistics of this survey. Biotechnician R. Brown played an integral role in helping collect and compile the data. Invertebrate samples were collected and identified by R. Brown with assistance from B. Piorkowski, University of Alaska, Fairbanks (UAF). We thank pilot Buck Woods of K-2 Aviation for sharing our primitive camp and providing safe and efficient transportation. Also, we are grateful to our supervisor, H. Brownell, M. Stevenson at Interagency Fire Coordination Center and staff at Alaska Fire Service, Galena, for bearing with us through numerous contingency plans.

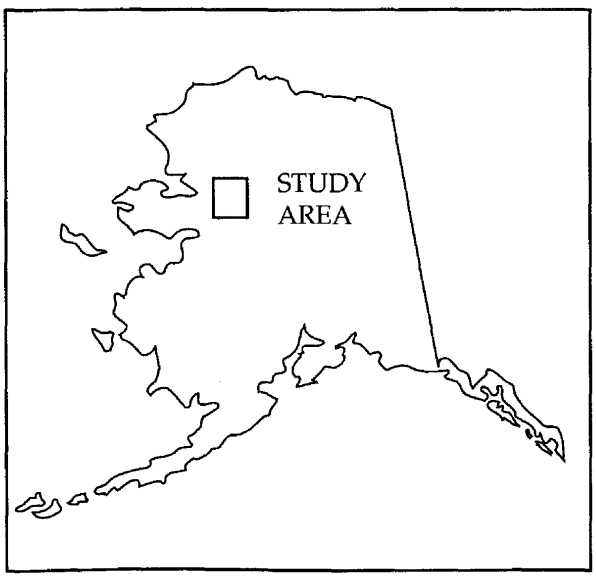


Figure 1. Study area location.

STUDY AREA

The Pah River Flats, located just below the Arctic Circle in northcentral Alaska, is a basin covering about 728 km^2, which lies between the Kobuk and the Koyukuk rivers (Fig. 1). The climate in this region is cold and continental with extremes in temperature ranging from 90° F to -68° F and average yearly precipitation of 32 cm (data from Hughes). The Pah River flows from the northeast corner of the study area to the south and then to the northwest corner in a wide arc. North of the study area, the Pah River makes its way through the Lockwood Hills and eventually empties into the Kobuk River. Upland vegetation is a typical taiga mosaic of sedge meadows, spruce forests, deciduous shrubs, and treeless tundra. Over 500 ponds and lakes, in addition to the stream and river riparian habitat, form a wetland complex which is underlain by continuous permafrost. Many of the

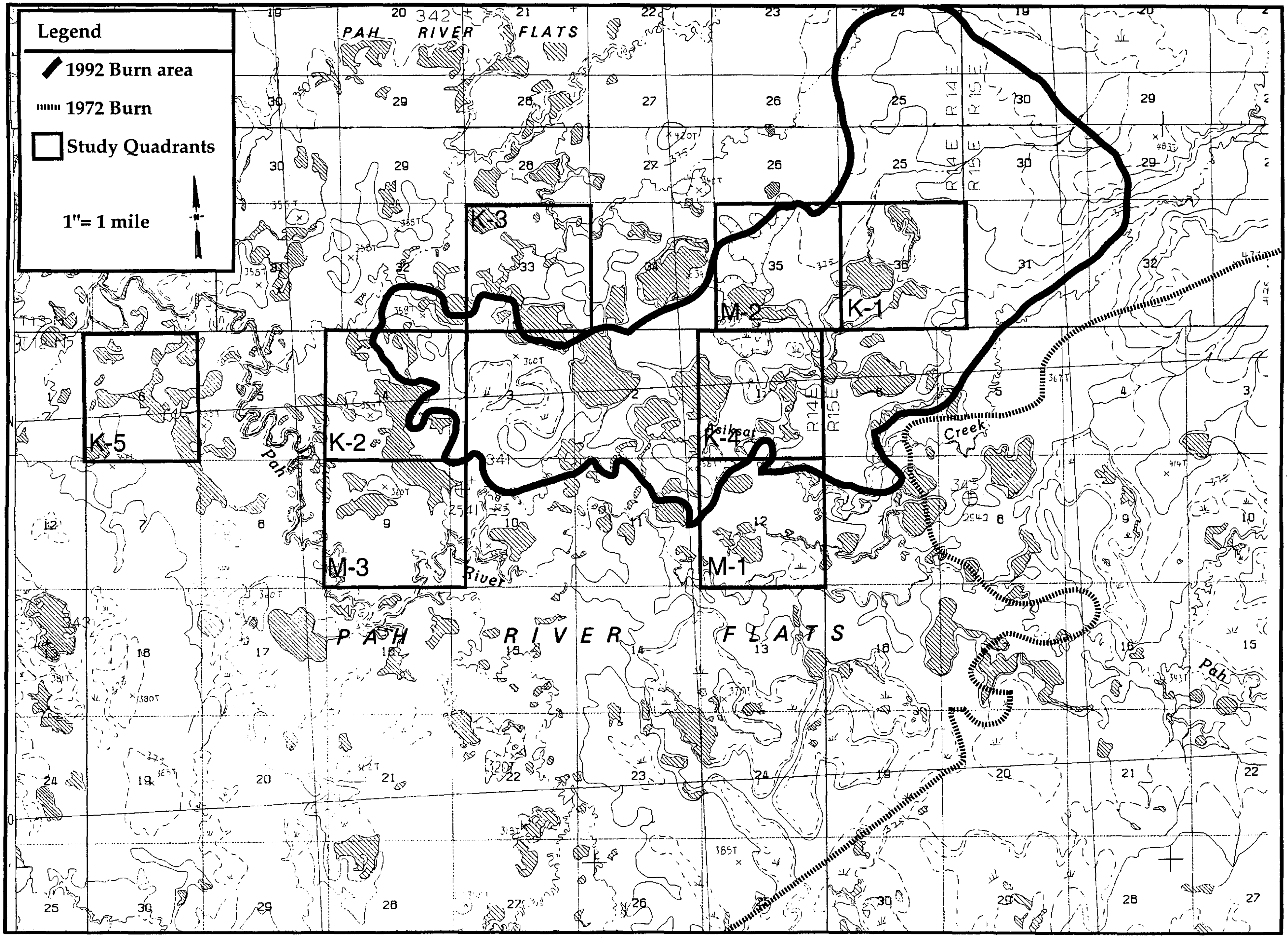


Figure 2. Map of study plots. Area within the solid line was burned in 1992. Area east of the shaded line was burned in 1972.

ponds are cryogenic ("cave-in") ponds formed by local thawing of perennially frozen ground. Other types of ponds include oxbows, river-flooded lowlands, and bog lakes. Although the development of littoral zones varies greatly between ponds, most support a border of emergent vegetation and average 22% cover of floating aquatic plants. Common aquatic plants include bur reed (*Sparganium* sp.), pondweeds (*Potamogeton* spp.), bladderwort (*Utricularia* spp.), and pond lily (*Nuphar polysepalum*).

METHODS

The Pah River Flats contains approximately 289 km^2 of lowland/wetlands complex containing numerous small ponds and lakes up to 80 ha in size. The survey area was divided into 2.6-km^2 plots defined by section lines on U.S. Geological Survey (USGS) 1:63,360 scale topographic maps. Each plot was stratified as "key," "moderate" or "poor" habitat based on water surface area, number of ponds and the presence of streams that appeared on the maps. A stratified random sampling scheme was originally used to select sample plots (Anderson and Robinson 1991a) and the same ponds were sampled in 1993, except that the least productive of the three strata was dropped. This low production stratum represented about 21,000 ha, but requires access by helicopter, and two sample plots surveyed in 1989 had no observed broods. Therefore, we decided to concentrate observations on the most productive wetlands. The "key" and "moderate" strata totaled 7,000 ha and provided the estimates for total production in both years. Eight plots were sampled: five in the "key" and three in the "moderate" stratum (Fig. 1).

A floatplane provided access to individual plots. Observers walked or canoed around the margins of all ponds in sample plots using binoculars and spotting scopes to identify waterfowl. Priority was given to identifying, quantifying and aging broods, but all observed waterfowl were recorded. Qualitative information about the water level, water clarity, bottom substrate, and associated vegetation for ponds was recorded on a survey form. Observers also estimated the percent of pond area covered by floating or submerged aquatic vegetation and the percent of the margin with emergent plant cover. Plant specimens were gathered opportunistically and submitted to the UAF Herbarium, in order to document range extensions occurring in this relatively unknown and unstudied remote basin.

Samples of macroinvertebrates were obtained opportunistically and preserved in alcohol jars for identification by UAF specialists. This yielded some information on species occurrence previously unreported for this area.

Statistical comparisions of data by plot and by pond for 1989 and 1993 were done using Student's t-tests. Pairwise comparisons among different treatment groups for fire severity were done using t-tests for independent samples.

RESULTS

Brood surveys

Observers recorded 382 adult ducks and 298 young in 57 broods, and 67 geese with 25 young. One trumpeter swan (*Cygnus buccinator*) was recorded. American wigeons (*Anas americana*) were the most common ducks, accounting for over half of the adult ducks and 35% of the broods (Fig. 2 and Fig. 3). Green-winged teals (*A. crecca*), mallards (*A. platyrhynchos*), northern shovelers (*A. clypeata*), and northern pintails (*A. acuta*) made up the balance of dabbling ducks. Divers included greater scaups (*Aythya marila*), Barrow's goldeneye (*Bucephala islandica*), oldsquaws (*Clangula hyemalis*), and black scoters (*Melanitta nigra*). One observer also reported seeing three adult ruddy ducks (*Oxyura jamaicensis*), which are rarely seen so far west in Alaska. Scaup accounted for 83% of the 180 adult divers seen and most of the diver broods (Fig. 2 and Fig. 3). The average brood size across age classes (considering only observed broods of known size) for northern pintails was 4.4 (n=8), and for American wigeons was 5.5 (n=24). These figures are similar to USF&WS data from 1984 to 1989 in Alaska, where northern pintail broods averaged 4.34 young and American wigeon broods averaged 4.87 young (Hodges and Witmer 1990).

The expanded estimate of duck broods in the Pah River Flats was 231 ± 92 broods, a CV of 0.40. This is equivalent to an average of 3.29 broods/km^2. The estimated production of young ducks was 1,295 ± 518. The high variance of the estimate is due primarily to extreme variation among the three "medium" plots, which ranged from 0 to 19 broods. This stratum contributed 98% of the overall variance, with the main factor being plot M-1. The number of broods on this unburned plot increased from 8 broods in 1989 to 19 in 1993.

Vegetation/Physical Characteristics of Waterbodies

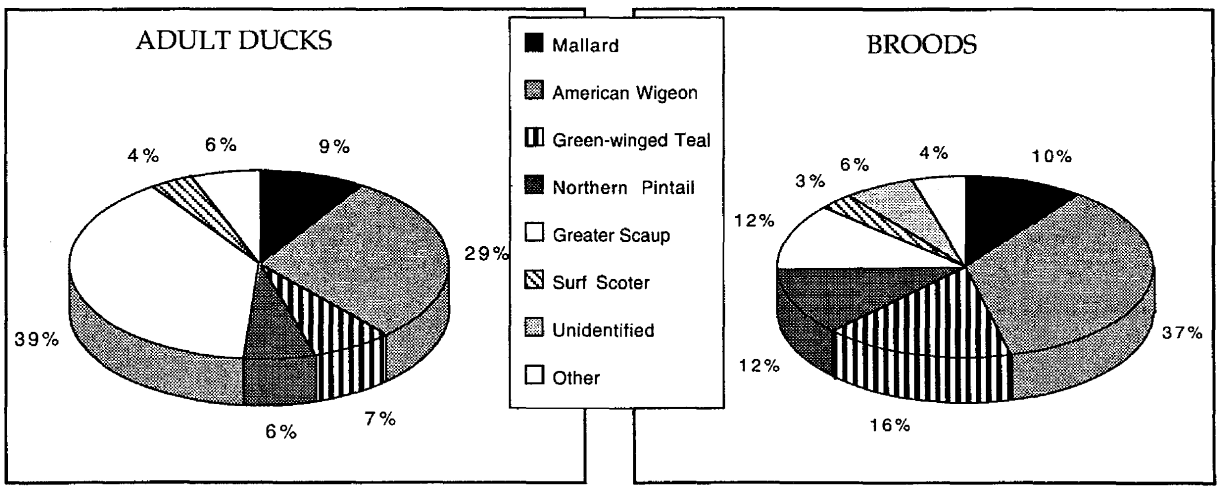
Water levels were extremely high in early spring, probably higher than any time in the past 20 years, according to a long-time local resident. The water level in most ponds had returned to near average by the July survey, however (Fig. 4). This was expected as 80% of ponds had some kind of stream or channel connection for drainage. Nearly all ponds had clear water with moderate staining (86%) as opposed to muddy or murky water and generally had less than a quarter of their surface area covered with floating and submergent aquatic vegetation (Fig. 5). Floating vegetation on stagnant ponds (n = 7) was dominated by water lilies (*Nuphar polsepalum* and *Nymphaea tetragona*) and bur reed (*Sparganium* sp.). Ponds with open hydrologic regimes (n = 30) had much larger components of pondweeds (*Potamogeton* sp.), water milfoil (*Myriophyllum* sp.), and other species.

Sedges, especially *Carex aquatilis* were the primary emergent plants providing cover on pond margins (Fig. 6). Other important plants were Calla lily (*Calla palustris*), buckbean (*Menyanthes trifoliata*), marsh fivefinger (*Potentilla palustris*), marestail (*Hippuris vulgaris*), and grasses. Percent emergent cover followed a bimodal distribution, in that ponds tended to have scant emergent cover or be completely surrounded by it. Although sample sizes were small, higher numbers of broods were associated with the ponds having grasses as the primary emergent cover (Table 1).

Slightly higher numbers of broods were observed on open *vs.* closed hydrologic systems, but this difference was not statistically significant. Broods were also more concentrated on ponds having high values for percent floating and emergent cover (Table 2).

Burned Areas

Comparing plots affected by the burn to their pre-burn production values did not demonstrate any significant effects on waterfowl broods, which may be due to the large variability between production in different years (Fig. 7). This high variablility is characteristic of most brood surveys, and is observed in both burned and unburned plots (Fig. 7). Of the eight plots studied, four had little or no burn, two were at least half burned and two were almost completely burned. Half of the unburned plots increased and half decreased in production compared to 1989. The partly burned plots had increased production, and the mostly burned plots decreased slightly. It was difficult to classify plot areas with a mixture of burn effects as burned or unburned, so data was analyzed by



Figures 2&3. Species composition by percentage of ducks and duck broods in the Pah River Flats, Alaska, July 1993.

	CAREX	CALLA	MENYANTHES	GRASS	HIPPURIS	POTENTILLA
Dabbler	1.1	1.2	1.1	2.3	0.6	0.1
Diver	0.2	0.2	0	0.5	0.4	0
Total	1.4	1.5	1.1	2.8	1.0	0.1
Ponds:	n = 32	n = 16	n = 11	n = 6	n = 5	n = 10

Table 1. Average number of duck broods/pond among ponds differing in primary emergent cover.

	Floating			Emergent		
	0-19%	20-59%	60-100%	0-19%	20-59%	60-100%
Broods	1.1	1.2	1.8	0.8	0.3	1.5
Ponds:	n = 26	n = 12	n = 6	n = 13	n = 6	n = 24

Table 2. Average number of duck broods/pond among ponds differing in percent floating and emergent cover.

pond as well. Three classes of fire severity were determined for ponds: not burned, burned, or severely burned. Partially burned, or questionable ponds were excluded from analysis. "Burned" ponds had most of the upland perimeter burned, but often a band of riparian vegetation remained between the burn and the water's edge. "Severely burned" ponds had most of their surrounding vegetation completely burned (although new plant growth was occurring) and some areas charred to mineral soil.

There was a slight increase in floating and emergent vegetative cover on burned ponds compared to unburned ponds. On severely burned ponds, however, the trend was reversed and they had the least floating and emergent cover (Table 3). Differences in waterfowl production on burned and unburned ponds were less clear but appeared to follow the same general pattern (Table 3).

Invertebrates were collected from near camp and plot K-4, ponds 4 and 9 and consisted of insects, mollusks, and leeches. Only macroscopic animals were collected, using forceps to remove them from the substrate. Most of the insects collected were life stages of caddis flies, from the families Limnephilidae and Ryacophilidae. Some adults were classified to the genus Nemotaulius. There were also predatory diving beetles, larval and adult, of the order Coleoptera (family Dystiscidae). Mollusks consisted of clams, mostly small (<1cm in length), but others were 10 cm or more in length. The small ones represented the family Shpaeriidae. Perhaps the most interesting invertebrates were the viviparous leeches, *Alboglossiphonia heteroclita*. Many individuals were carrying several hundred young on their ventral surface. They are parasitic, feeding on the blood of their hosts, which they await by attaching themselves in back to submerged sticks or plants and waving the front end around in search of a host.

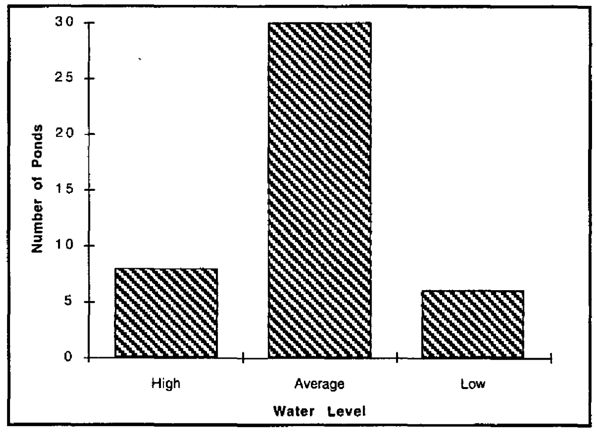


Figure 4. Water level in ponds as judged by exposed mud bank and inundated vegetation, Pah River Flats, July 1993.

	Unburned	Burned	Severe	Sample (n)
% Floating	21	39*	14*	24, 8, 11
% Emergents	67	79*	38*	23, 7, 10
Broods/pond	1.15	1.22	0.92	33, 9, 13
Adults/pond	5.27	6.33	3.62	33, 9, 13
Geese/pond	2.24	0	1.38	33, 9, 13

*Difference significant at $p < 0.05$.

Table 3. Comparison of percent floating/emergent vegetative cover, and average duck densities by burn category.

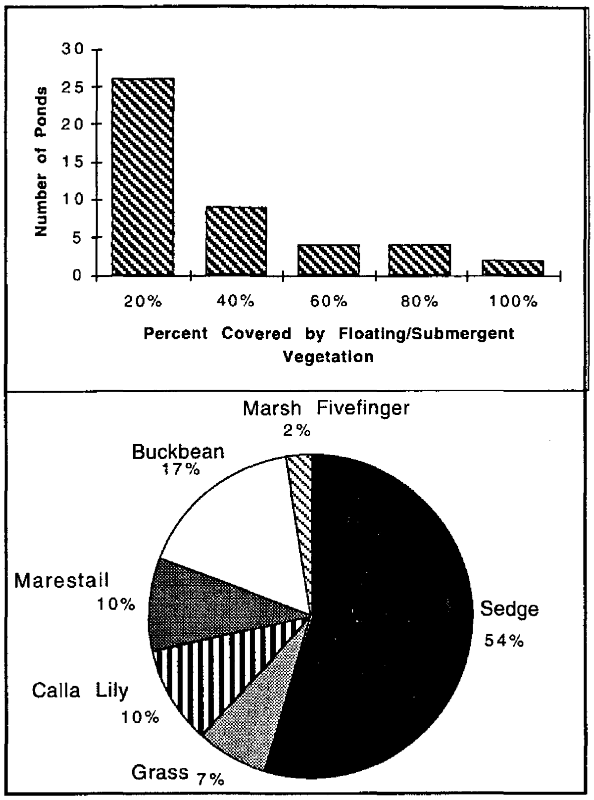


Figure 5. Percent coverage and types of aquatic and floating vegetation in ponds, Pah River Flats, Alaska.

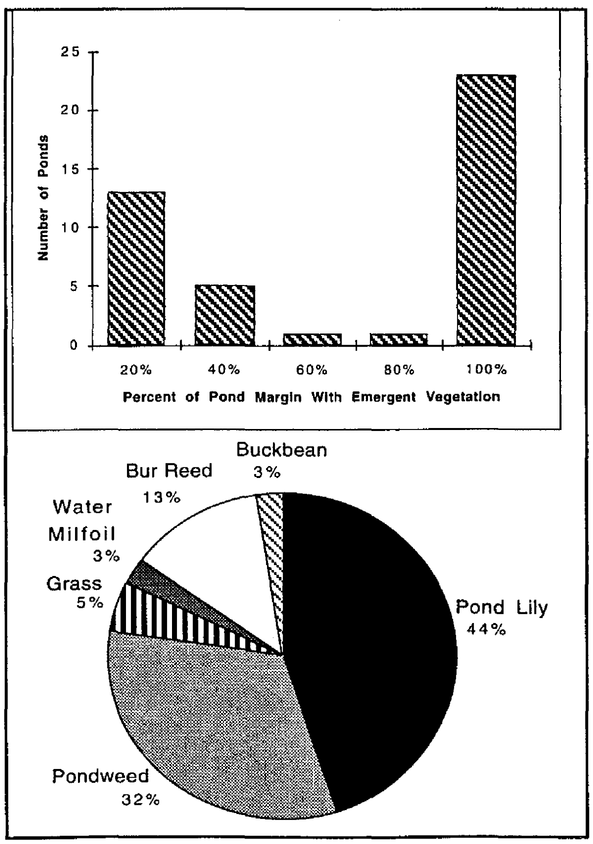


Figure 6. Percent coverage and types of emergent vegetation in ponds, Pah River Flats, Alaska.

DISCUSSION

Comparison of 1989 and 1993 data

The mean production of young ducks in 1993 (18.4/km^2) was significantly higher than the 8.7/km^2 recorded on the same two strata in 1989 ($t = 3.61$, $P < 0.01$). The observed increase in broods came in the dabbler component, with little change in diver or goose brood production (Fig. 8). The estimate of total production changed significantly because the increases came in the "moderate" stratum, which represented two thirds of the land area. Species composition was similar to 1989, but less than half as many red-necked grebes (*Podiceps grisegena*) were seen in 1993: 22 adults with 6 young compared to 48 with one young in 1989. Both survey years were noted for severe spring flooding, which is generally expected to lower production by flooding nest sites and submerging mud flats used for feeding. In 1989, the nearby Koyukuk NWR had less than half its usual duck production (Bertram 1990), and the estimate for the Pah River was hypothesized to be below aver-

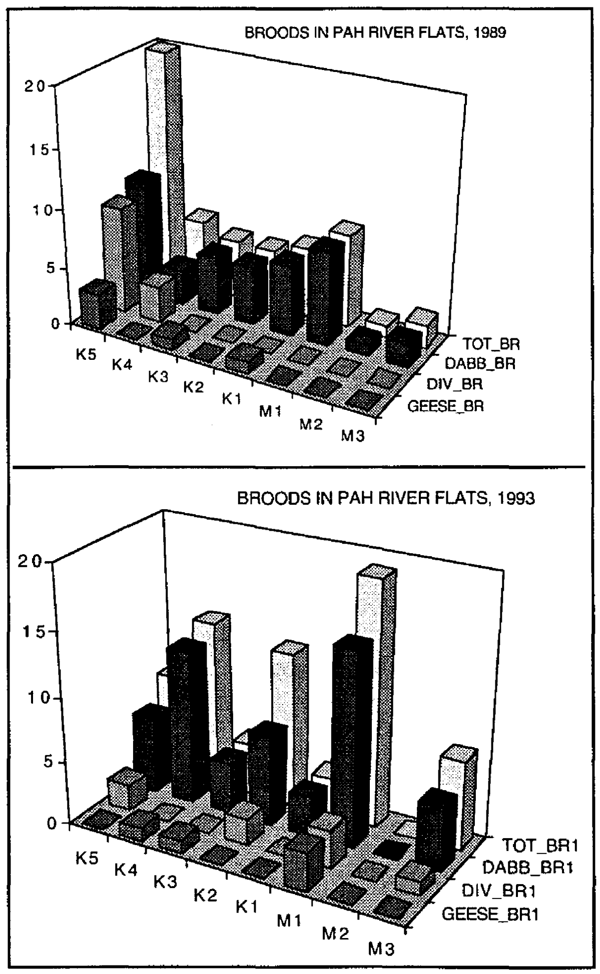


Figure 7. Comparison of waterfowl brood production by plot on two survey years in the Pah River Flats, Alaska.

age as well (Anderson and Robinson 1991a). The signs of spring flooding appeared even more marked in 1993, as debris was observed hanging 6-8 feet over July pond levels in some survey plots. An aerial reconnaissance and photography taken May 26 showed pond levels to be flooded into the surrounding trees, especially notable on the west side of the Flats, near the river (plots K-2, M-3, K-5 and K-3) (Fig. 1, Fig. 9). The least flooded plots on May 26 were K-1 and K-4, in the center of the burned area. Standing water in meadows which are usually dry probably provided additional transient shallow water habitats in spring 1993. One factor which may have helped to ameliorate negative impacts of flooding in 1993 was warm weather early in the spring, in contrast to 1989, which had unusually cool weather and a late thaw.

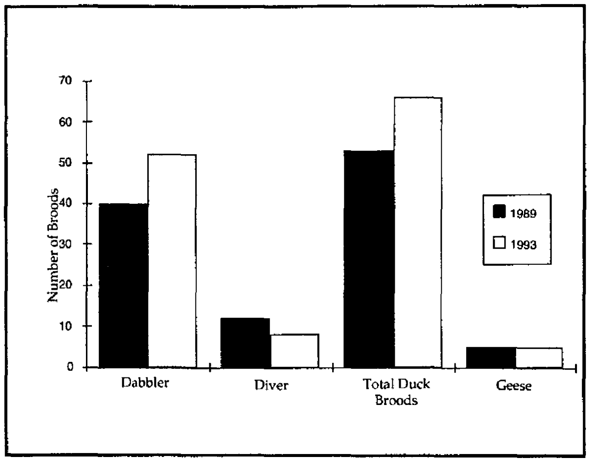


Figure 8. Comparison of waterfowl brood production in 1989 and 1993, Pah River Flats, Alaska.

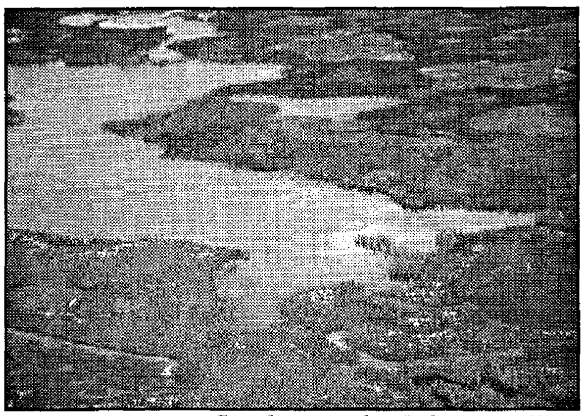


Figure 9. Spring flooding in the Pah River Flats (north end of plot M-3), May 26, 1993.

Vegetation

Duck use did not show any pattern of preference for particular floating or emergent vegetation types, except for grass emergent cover (Table 1). The data indicates that hens with broods may prefer ponds with emergent grasses as opposed to other types of emergent cover, and this would be an interesting hypothesis for further research. Derksen et al (1981) found ducks in the National Petroleum Reserve of Alaska preferred ponds with margins dominated by pendent grass (*Arctophila fulva*), and believed this was due to higher numbers of aquatic invertebrates using the emergent plant substrate and dense escape cover. Alternatively, there may have been other characteristics associated with the ponds having grass-type emergent vegetation which were attractive to brood hens.

Brood density increased with increasing percent cover of floating and aquatic vegetation, and to a lesser extent with percent cover of emergent vegetation (Table 2). This finding was not surprising as, for shallow ponds, aquatic vegetation can be used as an index of aquatic invertebrate numbers, and this has been shown to correlate with duck densities (Joyner 1980). Aquatic invertebrates are a prime source of highly digestible protein, which is very important for breeding females and young (Krapu and Swanson 1977). Hydrological connections of ponds seemed to influence the type of submergent vegetation that dominated ponds, in that closed stagnant ponds tended to have more pond lilies and those connected to a stream system tended to have more pondweed (*Potamogeton* sp.) and greater species richness. Greater species richness in hydrologically connected ponds has been previously reported for eastern interior Alaska (Murphy et al. 1984). Ponds are connected to a stream system have been shown to have higher levels of nutrients, such as nitrite and phosphate, and more duck use than isolated ponds (Murphy et al. 1984). These plants may provide an indication of the nutrient status of ponds.

Fire Effects

Percent floating and emergent vegetative cover was greater on ponds which were lightly burned than unburned ponds, but lower on severely burned ponds. Emergent cover typing was of a very general nature, but differences in species composition did not appear to be great. Caution is needed in interpreting this data, however, as we did not compare the aquatic vegeatation on the burned and unburned ponds before the fire, and it is possible the differences are purely coincidental. If upland vegetation plots could have been sampled as originally planned, the effects of the burn would have been more quantifiable, as many burned areas clearly had their vegetative patterns altered as a result of the fire.

Studies from temperate wetlands in North America indicate that reductions in height and density of tall, emergent hydrophytes by fire benefit breeding waterfowl by increasing interspersion of cover and open water and enhancing nutrient levels (Kantrud 1988). However, nest success has sometimes been observed to decline in the first season after burning due to reduced availability and quality of nesting cover (Martz 1967, Messinger 1974, Hochbaum 1985). This effect is most important where availability of suitable nesting cover and predation are important limiting factors. Long day length in summer, presence of permafrost, low biological productivity, and other factors cause the role of fire in the far north to differ from that in more temperate systems (Wein and MacLean 1983). There are few definitive studies published on the effect of fire in taiga wetlands, but some mechanisms have been proposed. Lowering of the permafrost layer may cause the water table to drop and result in drainage of some wetlands, as was observed on the Yukon Flats (Buckley 1958). We found it interesting that much of the region immediately east of our Pah study area affected by a fire in 1972 has drained or dried up between 1956 when the topographic maps were made and the present (see map). Conversely, if ground ice content is high, fire may form new wetlands by removing insulating tundra vegetation and Sphagnum moss, leading to melting and subsidence (Bliss and Wien 1972). It has also been suggested that early growth of plants in newly burned areas, due to increased depth of the active layer early in the spring, may permit earlier nesting (Buckley 1958, Bliss and Wein 1972). Early vegetative growth did not appear to be the rule for severely burned plots in our study area, where many charred areas were just beginning to sprout vegetation in July. However, we did not attempt to document plant phenology and it would be interesting to try to detect a difference in subsequent growing seasons. Bliss and Wein (1972) reported that plant tissues from a burned site in Alaska had higher nutrient levels one year after a fire. This might make the early revegetation on burned sites attractive to geese, but we did not observe a preference for burned ponds in our study (Table 3).

Differences in duck production between burned/unburned plots were greater than the between-year effects, although neither was statistically significant. Anecdotal observation suggested that severely burned areas where most of the cover was removed were occupied by fewer duck broods. These differences could not be quantified, however, perhaps due to the overriding effect of between-pond variability. Still, the similar pattern documented for vegetative cover, combined with a tendency for duck broods to favor ponds with increased levels of cover suggest that this difference may be a real effect. Certainly it provides one hypothesis for testing in future experimental work.

This study illustrates the difficulty of determining the effects of ecosystem change on organisms at higher trophic levels. There are many possible effects: effects on plant food, cover, aquatic invertebrates as food, predators, etc. Effects may differ on different life stages, such as nesting and brood-rearing. Also, it is very difficult to isolate natural systems from other factors, such as the spring flooding, effect of temperature, and natural cycles in abundance and distribution of competitors or predators. None of these factors were controlled in this study, and the extent of their influence is unknown. As it would be difficult to draw many valid conclusions from one year's data, we plan to continue the collection of data from this area, and to present our conclusions in a subsequent report.

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