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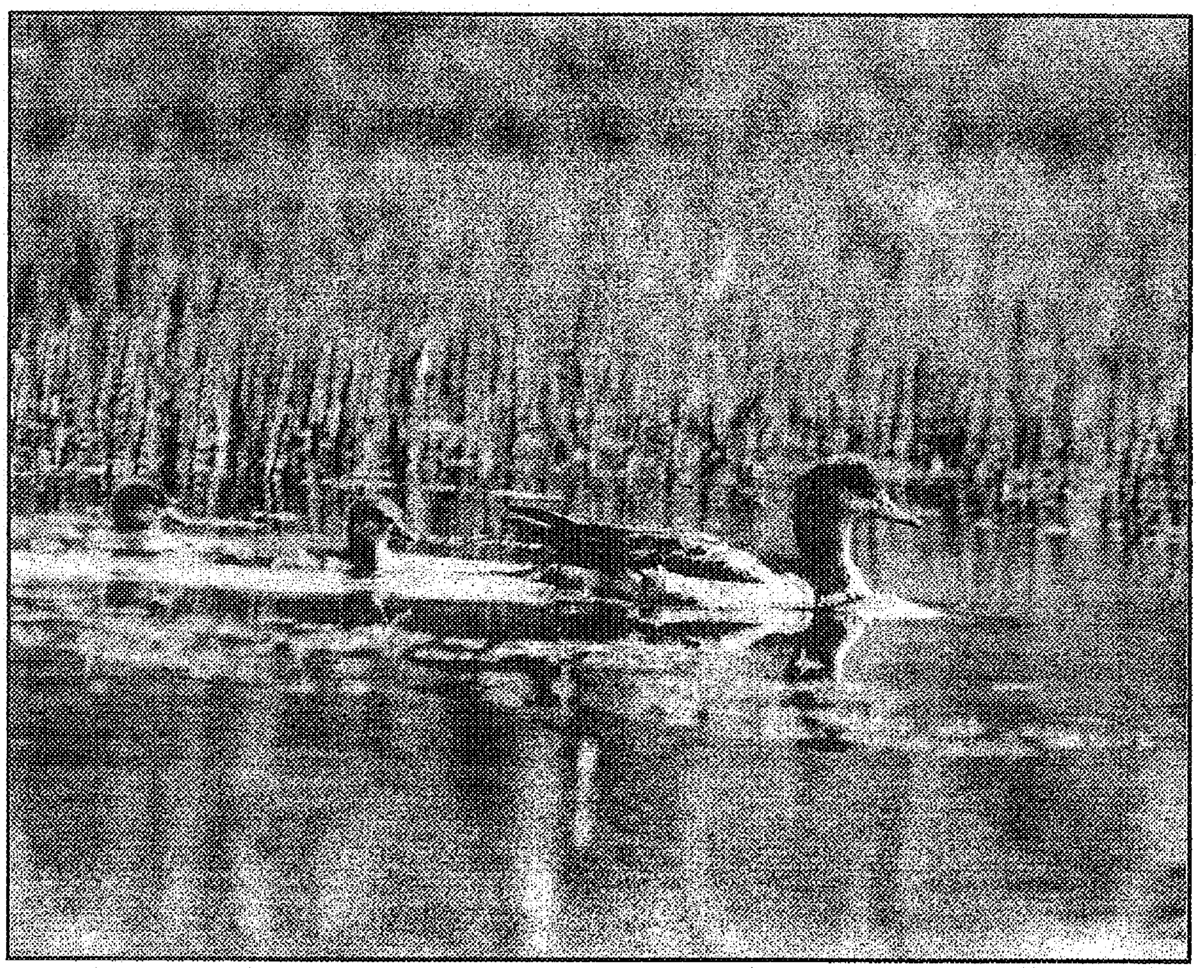
Waterfowl Production and Initial Effects of Fire on Wetlands in the Pah River Flats: Final Report

INVESTIGATORS: R.R. Jandt and M.L. Fisk



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Abstract

Waterfowl brood surveys were conducted in the Pah River Flats, Alaska during July of 1995. Duck production was not significantly different between plots burned in a 1992 wildfire and unburned plots for the third year following the burn. Fire did not produce any statistically detectable positive or negative effects on waterfowl production or habitat in the first three years following the fire. Fewer diver broods were found in burned ponds during all three years following the fire. Dabbler broods were more numerous on moderately burned ponds and less numerous on severely burned ponds, especially in the first two years. The four-year average for waterfowl produced from this wetlands complex was 1,147±180 young ducks annually, or 16.4 young ducks/km^2. American wigeon (*Anas americana*), greater scaup (*Aythya marila*) and green-winged teal (*Anas crecca*) were the predominant species.

INTRODUCTION

Ground brood counts based on the number and size of broods counted during the peak of breeding season in July have been used in several places in Alaska to estimate waterfowl production (Brubaker and Witmer 1989, Doyle 1989, USFWS 1991). Information on waterfowl habitat quantity, quality, relative productivity and utilization is essential to establish informed management policy relating to wetlands on public land.

The Bureau of Land Management (BLM) conducted brood surveys in the Pah River Flats in 1989, when production was estimated at 610±138 young ducks (Anderson and Robinson 1991). This figure was thought to be lower than usual in this region due to extensive spring flooding. From 1990 to 1992, the U.S. Fish and Wildlife Service (USFWS) included the Pah River Flats in the larger refuge survey for the Koyukuk-Nowitna National Wildlife Refuge. As a result, sampling intensity declined, and little specific pond production information is available for the Pah River Flats during that period.

In July 1992 a lightning-caused wildfire burned over 2000 ha of the Pah River Flats (Fig. 1). Two of the 10 plots surveyed in 1989 were entirely within the fire perimeter, and parts of several others were affected. The fire 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.

Surveys to record post-fire waterfowl production began in 1993 and continued through 1995 (Jandt and Morkill 1994, this report). The goal of this study was to obtain information on waterfowl production, habitats and effects of fire on wetlands ecosystems. This information will be useful when managers make land use decisions and choose fire management options.

We would like to express our gratitude to the USFWS, Koyukuk/Nowitna Refuge staff for helping with fuel logistics and the loan of a cabin. H. Brownell, M. Fisk, R. Jandt, A. Koscis and A. Morkill participated in the collection of the data. C.R. Meyers provided botanical expertise and A. Batten, at the University of Alaska Fairbanks Herbarium, helped document the range extensions. Invertebrate identifications were provided by M. Vinson and staff at the BLM Aquatic Ecosystem Lab, Utah State University. We thank pilot A. Greenblatt of Wright's Air for sharing our camp and providing safe and efficient transportation. Thanks also to the folks at Alaska Fire Service-Galena Zone and pilot J. Patrick of Trans Alaska Helicopters for logistics and helicopter support.

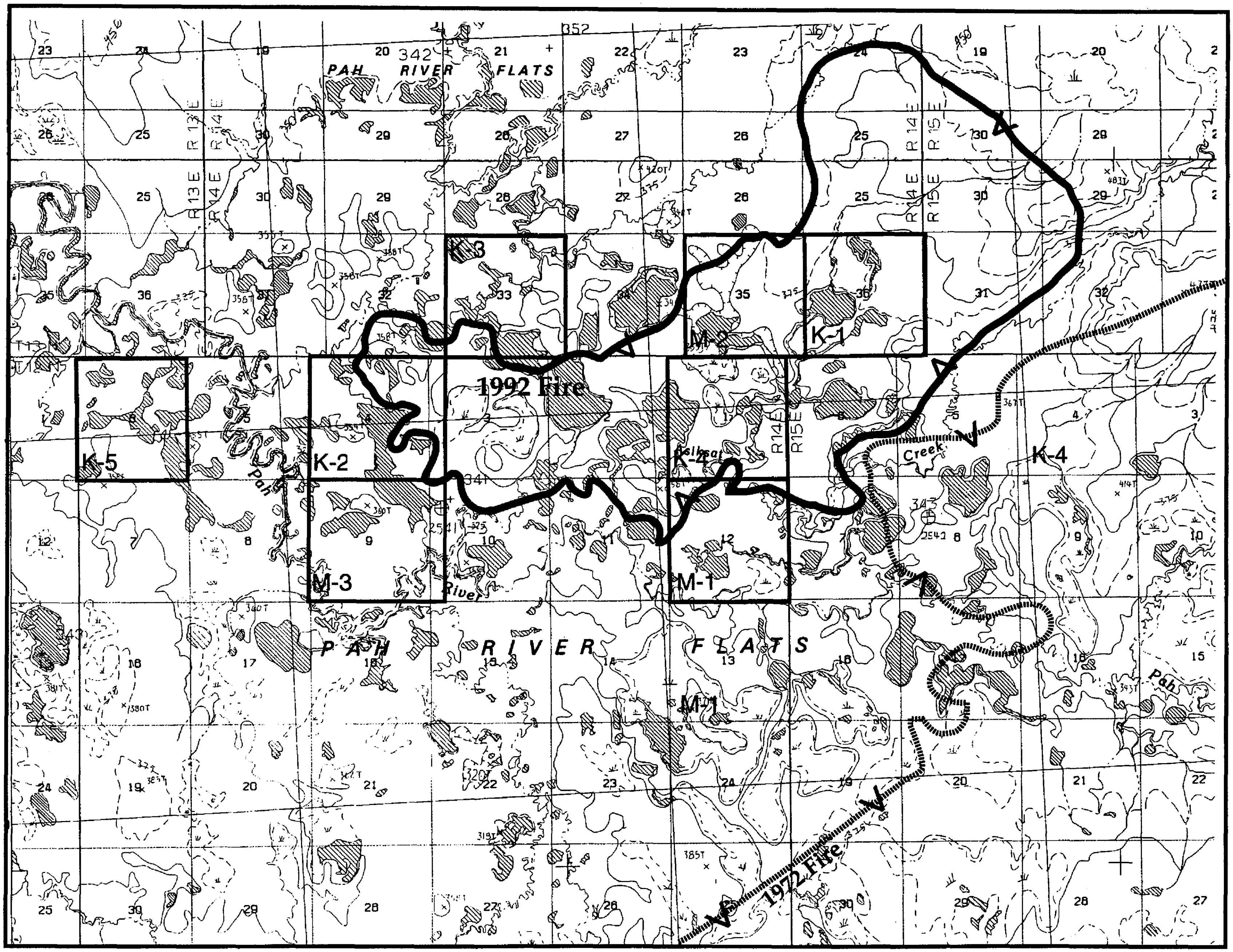

Figure 1. Pah River Flats plot locations and fire perimeters.

STUDY AREA

The Pah River Flats, located just below the Arctic Circle in northcentral Alaska, is a basin between the Kobuk and Koyukuk rivers that covers about 728 km^2 (Fig. 1).

The climate in this region is cold and continental with temperature extremes ranging from 90° F to -68° F and an average yearly precipitation of 32 cm (data from Hughes).

The Pah River flows from the northeast corner of the study area to the south, continuing to the northwest corner in a wide arc. North of the study area, the river makes its way through the Lockwood Hills and eventually empties into the Kobuk River.

Upland vegetation is a typical taiga mosaic of sedge meadow, spruce forest, deciduous shrub and treeless tundra. More than 500 ponds and lakes, in addition to the stream and river riparian habitat, form a wetland complex that is underlain by continuous permafrost. Many of the 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. The development of littoral zones varies greatly between ponds, but most support a border of emergent vegetation cover with an average 22% floating aquatic plants. Common aquatic plants include bur reed (*Sparganium* sp.), pondweeds (*Potamogeton* spp.), bladderwort (*Utricularia* spp.), and pond lily (*Nuphar polysepalum*). Plant nomenclature follows Hultén (1968).

METHODS

The Pah River Flats basin 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 originally 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 used to select sample plots in 1989 (Anderson and Robinson 1991a). The same ponds were sampled in 1993, 1994 and 1995, except the least productive of the three strata was dropped. This "low production" stratum represented about 21,000 ha, but required access by helicopter. In addition, two sample plots surveyed in 1989 had no observed broods. Therefore, we decided to concentrate observations on the most productive wetlands.

During post-fire surveys from 1993 through 1995, eight plots were sampled: five in the "key" and three in the "moderate" stratum (Fig. 1). The "key" and "moderate" strata totaled 7,000 ha and provided the estimates for total production. Disregarding the potential broods on the remaining 21,000 ha of "poor" habitat means that production estimates should be regarded as minimums.

A Cessna 185 floatplane or Bell 206L helicopter provided access to individual plots. Sampling for 1995 was conducted July 20-24. Observers walked or canoed around the margins of all ponds in sample plots using binoculars and spotting scopes to identify waterfowl. Spring water levels were moderate due to an early breakup in 1995. The water level in most ponds was average to low during the July survey.

RESULTS

A total of 113 broods and 442 young ducks were observed in 1995. The expanded estimate of duck broods in the Pah River Flats was 266 ± 85 broods, a coefficient of variation (CV) of 0.32. When corrected for sampling fraction after Cochran (1977:p. 92), the CV is reduced by half, bringing it within the target range of about 15%.

The most variation occurred in the three "moderate" plots, which ranged from one to 12 broods and accounted for 79% of the variance in the production estimate.

The 1995 production of young ducks was 1,258 ± 445. The species composition of broods was similar to previous years. American wigeons were most numerous, accounting for 33% of the total broods observed (Fig. 2). Green-winged teals and greater scaup each represented 17% of the total broods observed (Fig. 2).

The average brood size in 1995 across age classes (considering only observed broods of known size) for the most frequently observed dabblers was 4.1 young for wigeon (n=38), 6.0 for green-winged teal (n=19), and 4.4 for northern pintail (*Anas acuta*) (n=12) (Table 1). The average brood size for greater scaup, the only diver observed with broods, was 4.9 (n=30). This brood size for scaup was down somewhat from its previous estimate of 6.5 (n=17) in 1994, and less than the historical average for Alaska of 6.22, compiled by the USFWS from 1984 to 1989 (Hodges and Witmer 1990). The decrease was not explained by brood age as scaup broods from both years were young: 70% Class I broods in 1994 and 80% in 1995. Otherwise, the four-year average brood size for the major species represented is comparable to Alaska averages (Table 1).

Observers recorded a total of 459 adult ducks in 1995. Scaup was the most common diver and adult duck, accounting for 33% of total adults (Fig. 3). All positively identified scaup were greater scaup, but due to their similarity, some lesser scaup (*Aythya affinis*) could have been in the flocks as well. Surf scoters (*Melanitta perspicillata*), black scoters (*M. nigra*), and bufflehead (*B. albeola*) were the other divers observed. Wigeon was the most common dabbler duck, accounting for 30% of the total adults (Fig. 3). Green-winged teal, mallard (*Anas platyrhynchos*), northern pintail, and northern shoveler (*A. clypeata*), made up the balance of dabbling ducks. A total of 19 geese were observed, including the greater white-fronted goose (*Anser albifrons*) and Canada goose (*Branta canadensis*). Also reported were three sandhill cranes (*Grus canadensis*), 36 red-necked grebes (*Podiceps grisegena*) and a pair of Pacific loons (*Gavia pacifica*).

Comparing production on sample plots affected by the burn to unburned plots did not demonstrate any significant effects on waterfowl broods, possibly due to the large variability among plots and among different years (Figs. 4A and 4B). Of the eight plots studied, four had little or no burn, two were at least half-burned and two were completely within the burn perimeter (Fig. 4A).

The two plots with the highest duck production in 1995 (and 1994) were an unburned plot, K-5 (n=40 broods), and a burned plot, K-4 (n=26). It was difficult to classify plot areas with a mixture of burn effects as burned or unburned, so data was analyzed by pond as well.

Four classes of fire severity were determined for 57 ponds: unburned, partially burned, burned and severely burned. Partially burned ponds were

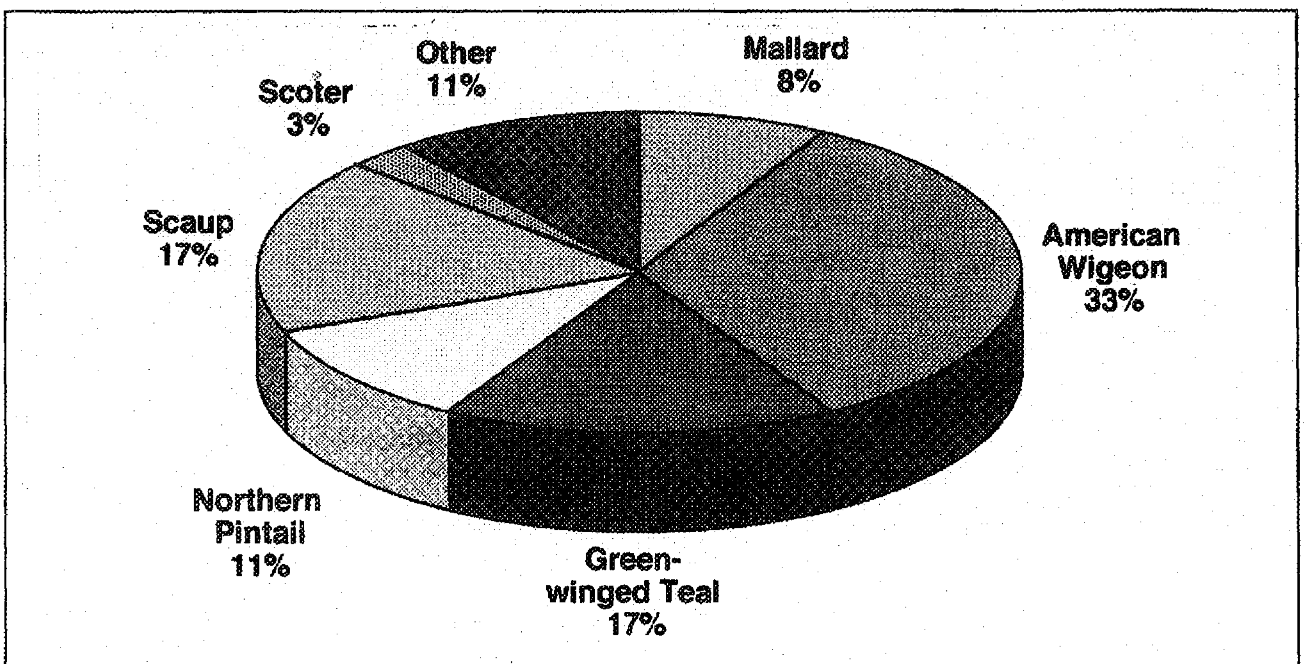

Figure 2. Species composition by percentage of observed duck broods in the Pah River Flats, Alaska, July 1995.

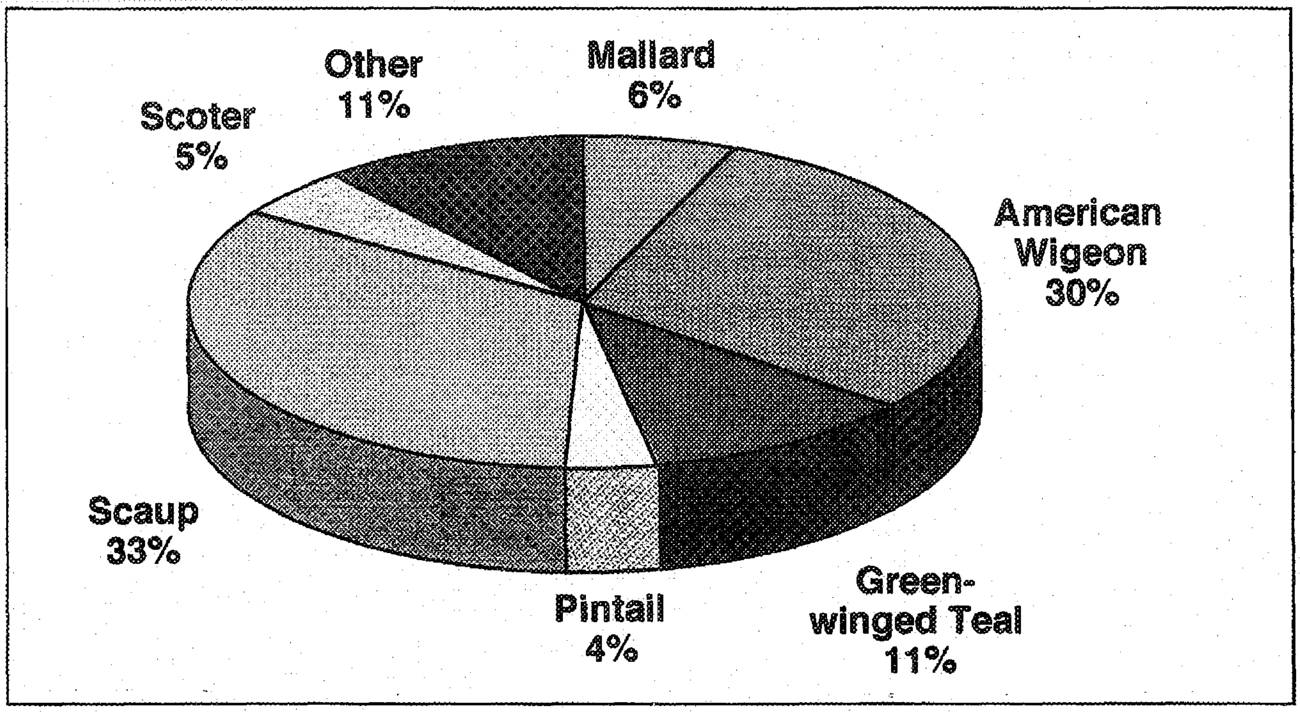

Figure 3. Species composition by percentage of adult ducks in the Pah River Flats, Alaska, July 1995.

excluded from analysis in these results except where specifically mentioned. 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 were burned down to the pond margin over a substantial portion of the perimeter.

Burned ponds (n=32) (including severely burned) had slightly lower production, measured in duck broods, in 1993. By 1994, production of burned ponds was equal to unburned ponds (n=22), and by 1995 the production of burned ponds had surpassed production of unburned ponds (Fig. 5). However, the variances associated

Brood Size

Species	1989	1993	1994	1995	4-Year Average	n=	State Average
American wigeon	3.8	5.5	5.2	4.1	4.7	109	4.9
Greater scaup	5.4	7.1	6.5	4.9	6.0	57	6.2
Green-winged teal	4.6	4.6	3.5	6.0	4.7	56	4.7
Mallard	1.3	2.8	4.0	3.8	3.0	29	4.5
Northern pintail	4.3	4.4	5.0	4.4	4.5	34	4.3

Table 1. Average brood size for most commonly observed species by year and compared to the USFWS Alaska historic average from 1984-1989 (Hodges and Witmer 1990).

Source	d.f.	SS	MS	F	P
Burn treatment	3	11.16	3.72	0.22	0.883
Year	2	31.22	15.61	5.00	0.008*
Interaction	6	32.60	5.43	1.74	0.119
Error (residual)	104	324.48	3.12		
Total	115	3206.20	27.88		

Table 2. Analysis of variance (ANOVA) table for n=59 ponds over 3 years (1993-1995) in each of 4 burn categories (unburned, partially burned, burned, severely burned). Significance indicated by *.

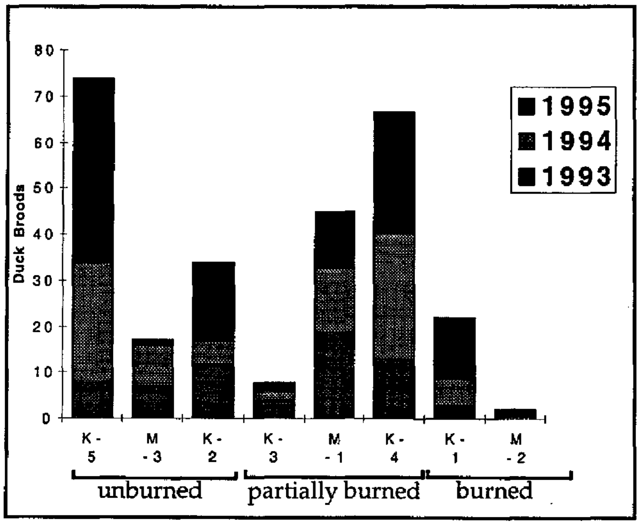

Figure 4A. Number of duck broods by plot for each of three years after the 1992 fire.

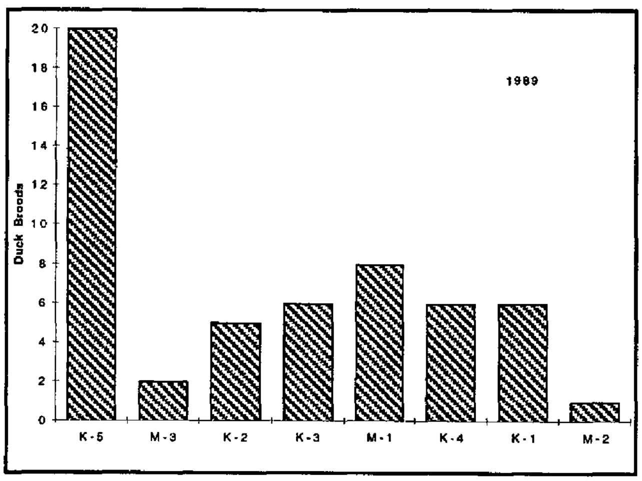

Figure 4B. Number of duck broods by plot in1989 (preburn) in the Pah River Flats survey area.

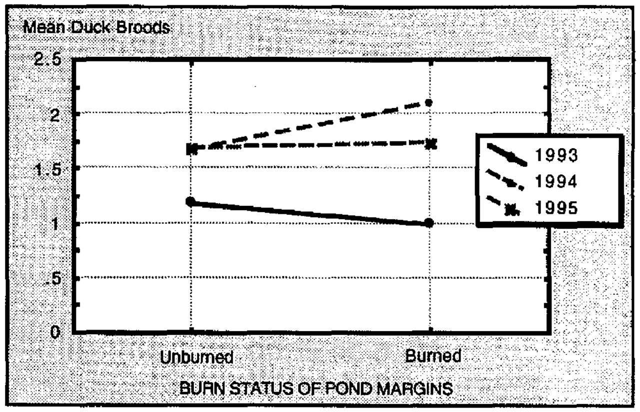

Figure 5. Graph comparing mean duck brood production on ponds with (n=32) or without (n=22) burn effect over the three years following a wildfire.

with mean production estimates are high enough that these differences are not statistically significant, as illustrated for the three burn classes in (Fig. 6.)

There were statistically fewer diver broods on burned ponds in a t-test on three years of pooled post-fire data ($p < 0.05$) (Fig 7.) Dabbler broods, in contrast, tended to be more numerous on burned ponds ($p = 0.07$), but less numerous on the severely burned ponds (not significant). When three years of post-burn production data on ponds were compared in an ANOVA (type I, repeated measures), only the year effect was significant ($F=3.43$, $p<0.05$), and the burn effect was not (Table 2).

Specimens of important aquatic and emergent plants were collected opportunistically in 1993 and 1994, since little or no previous botanical collecting had been done in this remote area. A list of plants collected during the surveys is located in Appendix A. These collections extend or expand the known ranges of four species that are found mostly in pond or stream riparian areas. *Calla palustris* is commonly known as wild calla. Plants are 20-45 cm tall and leaf blades are 6-15 cm long and 4-12 cm wide, with red berries (Welsh 1974). *Nymphaea tetragona* is commonly known as the dwarf water lily. The leaves float and are shaped much like an arrowhead, but are 2.5-8 cm wide with a leathery look (Welsh 1974). *Potamogeton epihydrus* var. *ramosus*, also known as nuttall pondweed, has submersed leaves 20 cm long and 3-10 mm wide and floating leaves that are more oblong than the submersed leaves (Welsh 1974). *Lysimachia thyrsiflora* or tufted loosestrife is 0.2-0.8 m tall with leaves that are scale-like and

	Order	Common Name	Unburned (#)	Burned (#)
Annelids:	*Tubificida*	tubifex worm	6	3
Arthropods:	*Hydracarina*	water mite	0	3
(crustaceans)	*Amphipoda*	scud	7	9
	Cladocera	water flea	1	53
	Copepoda	copepod	35	17
	Ostracoda	seed shrimp	0	1
(insects)	*Coleoptera*	water beetle	17	10
	Diptera	midge & cranefly larvae	4	11
	Odonata	dragon, damsel, & caddisfly larvae	7	16
	Hemiptera	water boatmen & water striders	6	12
Gastropods & pelecypods:	*Limnophila*	snails	9	11
	Veneroidea	mussels	3	4
Flatworms:	*Tricladida*	planarians	3	1
Other:	*Nematophora*	horsehair worms	0	5

Table 3. Families and number of aquatic invertebrate organisms collected from lakes with burned *vs.* unburned margins in the Pah River Flats, 1994. Most were not identified beyond the level of order.

enlarged at the top of the plant and smaller at the base, (Welsh 1974). *Drosera anglica,* the long-leaved sundew, is a carnivorous plant that generally grows south of the Yukon River. Hulten (1968) noted a disjunct population in the locality of our study area.

Aquatic invertebrates were collected from three ponds (one unburned pond and two ponds with burned margins) in 1994. A total of 248 organisms from 32 taxa were identified and classified from the samples (Table 3). In general, the biotic indices seemed to indicate a water quality rating of excellent in tests designed to detect organic pollution. More species were islolated from the burn sample (n=25) than from the unburned (n=18), but species richness, based on EPT richness (the number of different taxa in three pollution-sensitive insect orders) and dominant family contribution, was slightly higher in the unburned sample. Voltinism, a measure of life-cycle length, differed between the two samples, with long-lived species more prevalent in the sample from the unburned lake (17.2% vs. 7.5%). Due to the limited sampling effort, no attempt was made to attach statistical significance to any of the observed differences.

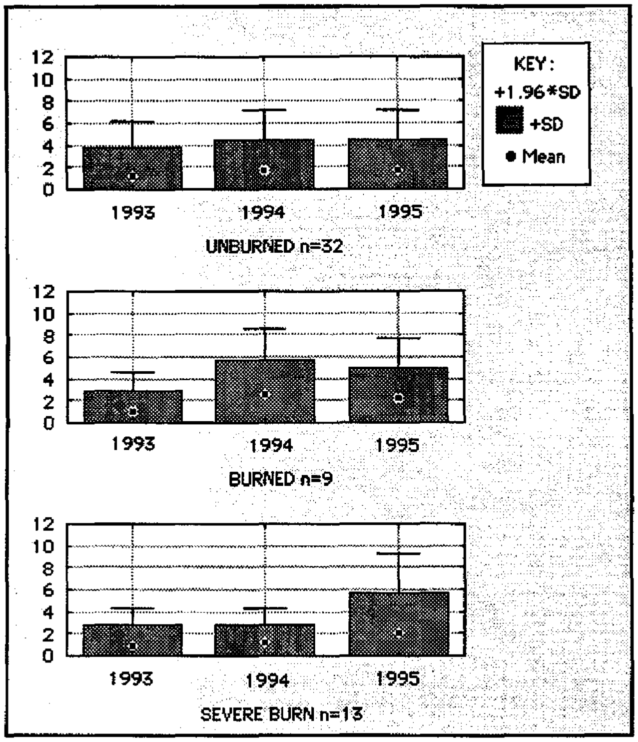

Figure 6. Average duck brood production over three years, showing mean and standard deviation, for ponds with three levels of burn effect.

DISCUSSION

Waterfowl Production in the Pah Flats

Interestingly, expanded brood production in 1995 and 1994 was almost identical: 266 and 260, respectively. The mean production of young ducks in 1995 (17.9/km^2) was slightly lower than the 20.3/km^2 recorded in 1994, but the difference was not significant. The estimate of total duck broods produced increased each survey year from 1989 to 1995 (Table 4). Dabbler broods, geese broods and total broods were more numerous in 1995

	Dabblers		Divers		Total Broods		Total Young	
Year:	Broods	S. D.	Broods	S.D.	Broods	S.D.	Young	S.D.
1989	118	±41	22	±16	142	±47	616	±185
1993	178	±81	31	±16	231	±103	1295	±575
1994	192	±60	45	±27	260	±84	1419	±483
1995	176	±49	61	±35	266	±85	1258	±445

Table 4. Estimated duck production annually in the Pah River Flats, including dabbler broods, diver broods, total broods, and total young over four survey years.

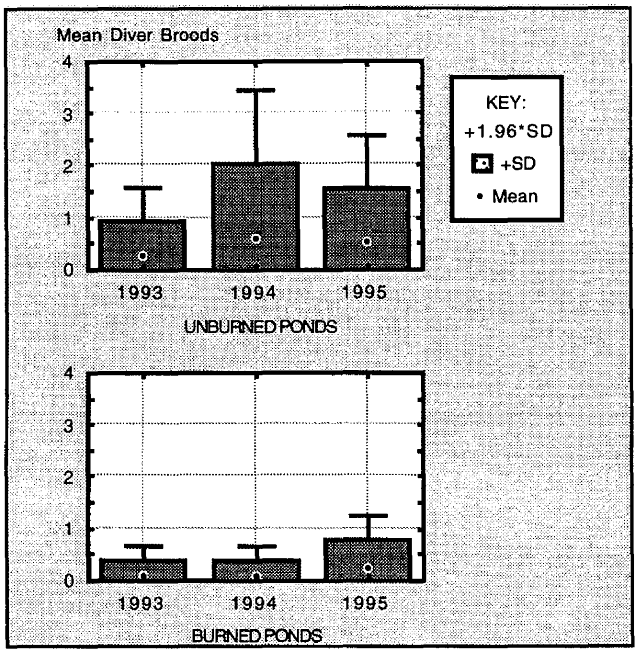

Figure 7. Comparison of diving duck broods (mainly scaup) on ponds with (n=32) or without (n=22) burn effect in the first three years following a wildfire.

than in 1994, while diver broods remained about the same. Species composition changed little from 1994 to 1995: northern pintail and scoters, including surf scoters and black scoters, both decreased by 6%.

No plot was uniformly highest in duck production over all four years, but plot K-5, an unburned plot, was consistently a good producer and had the highest average production of 110 ± 59 young ducks, while K-4, a burned plot, was second. The continuous high production in plot K-5 could be a result of high levels of nutrient exchange with the nearby Pah River through a combination of seasonal flooding and numerous small channels that connect the water bodies within the plot.

The four-year average production for the whole survey area is 1,147 ±264 young ducks annually or 16.4 young ducks/km^2, compared to 11.0/km^2 in 1990 (Hodges and Conant 1990) for the Koyukuk/Nowitna National Wildlife Refuge just south of the Pah River Flats. However, the figure for the Koyukuk/Nowitna Wildlife Refuge is based on a management area that is much larger than the Pah River flats and a substantial portion is less suitable waterfowl habitat than the core area used for the Pah survey.

The average brood sizes for the Pah River Flats were close to the historical brood sizes for Alaska from 1984 to 1989 (Table 1). These results indicate that the quality of waterfowl breeding habitat on the Pah River Flats is similar to that on designated refuges in other areas of Interior Alaska.

Burned Areas/ Ecosystem Effects

Vegetation recovered in the burn along familiar patterns for Interior Alaska taiga. Very little regrowth was observed in heavily charred areas the following season, but by two years severely burned areas were dotted with vigorous young individual plants of Labrador tea (*Ledum palustre*), tussock cottongrass (*Eriophorum vaginatum*), salmonberry (*Rubus chamaemorus*), and blueberry (*Vaccinium uliginosum*). Revegetation in the moderately burned areas was more rapid, with heavy growth of wild rhubarb (*Polygonum alaskanum*), Laborador tea, fireweed (*Epilobium angustifolium*), resin birch (*Betula glandulosa*), and sprouting paper birch (*B. papyrifera*).

By the third year, horsetail (*Equisetum arvense*), beauverd spirea (*Spiraea beauverdiana*), bearberry (*Arctostaphylos uva-ursi*), dwarf birch (*Betula nana*), and willows, especially diamond leaf willow (*Salix planifolia* ssp *pulchra*), were notable in burned spruce stands. Paper birch seedlings were about 0.5 m and numerous in these stands. Other burned areas near pond margins were revegetating as tall grass (*Calamagrostis canadensis*) stands up to 1 m in 1994 and approximately 1.5 m in 1995.

Dominant species for floating aquatic and emergent vegetation for 1993 and 1994 consisted of sedges such as *Carex aquatilis*, wild calla, buckbean (*Menyanthes trifoliata*), marsh five finger (*Potentilla palustris*), marestail (*Hippuris vulgaris*), and grasses. In 1993, severely burned ponds had significantly less ($p < 0.05$) floating aquatic plant cover than burned ponds and burned ponds had slightly more than undisturbed ponds. By the second year of the survey, however, both classes of burned ponds had slightly more floating cover than unburned ponds, and none of the means were statistically different (Jandt and Morkill 1994). If pond nutrients were enhanced by runoff from burned areas, one would expect the effect to be transient, lasting only a year or so following the burn, as was demonstrated for forest floor nutrients following the Rosey Creek fire near Fairbanks (MacCracken and Viereck 1990).

Emergent cover appears to have regrown well on burned ponds; within two years it was similar in abundance to that on undisturbed ponds. In 1993, emergent cover averaged 64% on unburned lakes and 39% on all types of burned lakes (Jandt and Morkill 1994), while in 1994 they were close to the same, at 22% and 15% respectively (R. Jandt, unpublished data). Emergent cover typing was of a very general nature, but differences in species composition did not appear to be great. Sedges dominated both burned and unburned emergent cover, but lush growths of *Calamagrostis* and fireweed were observed on the banks of some burned ponds. It seemed that diversity of the emergent vegetation was a favorable factor, as the average number of broods was higher on ponds having grass or plants other than sedges as the dominant emergent growth (Jandt and Morkill 1994). In 1993-1994, ducks did not show any other pattern of preference for particular floating or emergent vegetation types that was statistically significant. Dabbler brood density increased slightly with an increasing percentage of floating and aquatic vegetation cover (Jandt and Morkill 1994). This finding might be expected for shallow ponds, since aquatic vegetation can be used as an index of aquatic invertebrate numbers that have been shown to correlate with duck densities (Joyner 1980). The qualitative invertebrate samples obtained in 1994 provided our first direct look at the trophic level that may underlie duck production.

Although more aquatic invertebrate organisms, and more species, were contained in a sample from two burned ponds than in a sample from an unburned pond, the burned pond's biotic community was dominated by a few families and by organisms with short life cycles. Voltinism differed between the two samples, with long-lived species more prevalent in the sample from the unburned lake. One short-lived species—*Daphnia*, the common water flea—was the most numerous organism in the burned sample, but did not even occur in the unburned sample. Taxa requiring more than one year to complete their life cycle (semivoltine) are more dependent on stable conditions, so their absence may indicate instability or a recent disturbance.

Other concurrent invertebrate sampling by BLM fisheries biologists in Interior Alaska seems to indicate that total taxa richness, EPT richness, and dominant family percent contribution are indices that can be correlated with a decline in water quality in mined areas (C. Kretsinger, pers. comm.). Our qualitative results indicate that it may be possible to detect differences in the invertebrate fauna of ponds after they are subject to disturbance by fire, and the subject warrants further investigation. Earlier studies, such as one on stream invertebrates following the Chicken fire of 1966, found little change in the invertebrate fauna (Lotspeich et al. 1970).

Songbird activity recorded in burned areas for 1994 and 1995 included common redpoll (*Carduelis flammea*), white-crowned sparrow (*Zonotrichia leucophrys*), boreal chickadee (*Parus hudsonicus*), black-backed woodpecker (*Picoides arcticus*), ruby-crowned kinglet (*Regulus satrapa*), alder flycatcher (*Empidonax alnorum*), rusty blackbird (*Euphagus carolinus*), savannah sparrow (*Passerculus sandwichensis*), and fox sparrow (*Passerella iliaca*).

Other species noted within the whole study area were American tree sparrow (*Spizella arborea*), yellow warbler (*Dendroica petechia*), orange-crowned warbler (*Vermivora celata*), American pipit (*Anthus rubescens*), gray-cheeked thrush (*Catharus minimus*), American robin (*Turdus migratorius*), northern shrike, (*Lanius excubitor*) pine grosbeak (*Pinicola enucleator*), white-winged crossbill (*Loxia leucoptera*), belted kingfisher (*Ceryle alcyon*), semipalmated plover (*Charadrius semipalmatus*); and olive-sided flycatcher (*Contopus borealis*), a candidate for the endangered species list.

Burned Areas/Production

No significant direct effects on waterfowl brood production were demonstrated on sample plots affected by the burn compared to unburned plots. This may be due to the large inherent variability among plots and years and the small number (8) of plots. Also, the plots did not burn uniformly or completely, but generally contained a mixture of burn types. It would also be difficult to differentiate the effects of other environmental variables, such as spring flooding, which affect certain plots more than others. Another difficulty was that the pre-fire data from 1989 seemed to represent an unusually low production year, so it was of limited use in comparison with post-fire data.

When data was analyzed by ponds to avoid the mix of burn effect on plots, another assumption was violated: namely, that ponds that are close to each other (on the same plot) may not be strictly independent samples. Still, using this approach, it appears that burned ponds (n=32) had slightly lower production in 1993, but were equal to unburned ponds (n=22) in production by 1994, and surpassed them in 1995 (Fig. 5).

Although these overall differences were not statistically significant, they nevertheless agree with anecdotal observations that production seemed displaced from severely burned areas for a year or two toward the edge of the burn. Some aspects of this trend were statistically detectable, such as fewer diver broods on the burned ponds (Fig. 7).

The increase in dabbler broods on moderately burned ponds approached significance (p=0.07). If this somewhat subtle effect was really due to the fire and was not an artifact of some pre-existing difference in the ponds in burned *vs.* unburned areas, it appeared to be transient, with very little difference between the groups by the third year following the fire (Fig 6). We were able to document that no major positive or negative impacts on waterfowl production were associated with the first few post-fire breeding seasons. This information will be useful background for fire management planning in this area and other waterfowl production areas in taiga ecosystems.

CONCLUSIONS

This study illustrates the difficulty of determining the effects of ecosystem change on organisms at higher trophic levels. There are many possible effects on water nutrients, 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 spring flooding, temperature changes, and natural abundance and distribution cycles of competitors or predators.

None of these factors were controlled in this study, and the extent of their influence is unknown. It does seem safe to conclude that wildfire did not produce any major detrimental effects on waterfowl production or habitat in the three seasons following the fire.

APPENDIX A: Marsh plants collected in the Pah River Flats, 1993-1995

Plant	Common Name	Range ext	Notes
Calla palustris	wild calla	+	slight extension
Caltha natans	floating marsh marigold		range connection
Carex aquatilis	water sedge		
Carex canescens	silvery sedge		
Carex limosa	shore sedge		
Chamaedaphne calyculata	cassandra		
Cicuta mackenzieana	mackenzie water hemlock		
Drosera anglica	long-leaved sundew		disjunct population
Epilobium palustre	swamp willow-herb		
Equisetum fluviatile	swamp horsetail		
Hippuris vulgaris	common marestail		
Lemna trisulca	ivy-leaved duckweed		
Lysimachia thyrsiflora	tufted loosetrife	+	
Nymphaea tetragona	dwarf water lily	+	
Potamogeton epihydris var. ramosus	nuttall pondweed	+	
Potamogeton filiformus	filiform pondweed		
Potamogeton perfoliatus	clasping long-leaf pondweed		
Rorippa islandica	marsh yellowcress		
Sium suave	water parsnip		
Sparganium angustifolium	narrow-leaved bur reed		
Sparganium sp.			sterile specimen*
Utricularia intermedia	flat leaf bladderwort		

*probably *S. hyperboreum* or *S. minimum*

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