WATERBIRD PREDATION AT FOUR NORTHERN MINNESOTA AQUACULTURE SITES

By

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Gurnee K. Bridgman

Aquaculturists perceive some waterbird species to be a major economic threat to their livelihood, because rearing ponds offer a concentrated and convenient food source. We determined presence of waterbird species and seasonal and diumal time-activity budgets for the more common waterbirds at four northern Minnesota aquaculture facilities from 27 May to 4 November 1996. Thirteen waterbird species used the facilities; however, only Doublecrested Cormorants (Phalacrocorax auritis), Red-necked Grebes (Podiceps grisegena) and Common Loons (Gavia immer) were considered common. Seasonal time-activity budgets indicated that all species spent much of their time resting (36.0% - 82.5%). No seasonal differences in feeding were noted for cormorants and grebes, whereas loons fed more in the early season. Diumal time-activity budgets indicated that cormorants fed more during the early morning, whereas loons fed more during the late morning, but only in the late season. Feeding activity by grebes did not differ by time of day. The low densities of cormorants at our study sites may suggest that they are more of a perceived threat for aquaculturists, though selective tree removal next to aquaculture sites may reduce any potential problems. Grebes, with low densities and little time allocated to feeding, are probably an unimportant waterbird predator. More loon research is needed to determine the extent of their damage at aquaculture facilities.

Key Words - Aquaculture, Common Loons, Double-crested Cormorants, Gavia immer, Phalacrocorax auritis, *Podiceps* grisegena, Red-necked Grebes, waterbird predators

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The author also wishes to express particular thanks for the support and guidance of Dr. Elizabeth H. Rave, in effecting this research designed to benefit the aquaculturists in the State of Minnesota.

TABLE OF CONTENTS

LIST OF TABLE AND FIGURES

TABLE

FIGURES

Introduction

Waterbird predation at aquaculture facilities has been studied extensively in the southern United States (Molt and Boyd 1995; Glahn et al. 1995; Brugger 1995). Predation, especially by Double-crested Cormorants (Phalacrocorax aurids), can cause major economic loss, as aquaculture facilities offer a convenient and concentrated food source. For example, Stickley et al. (1992) calculated that a flock of 100 cormorants in the Mississippi Delta could eat up to $400 worth of catfish (Ictallurus punctatus) in just nine hours. Glahn and Brugger (1995) estimated an annual loss of 20 million catfish fingerlings at a replacement cost of $1.8 million in the Mississippi Delta region. Additionally, an unchecked cormorant population over the damage season can reduce pond populations of catfish by 50%, at a cost of approximately $18,000 per pond (Stickley et al. 1992). Obviously, predatory waterbirds can have a devastating impact on aquaculture fish in the South.

Conversely, relatively little is known about waterbird predation in the northern United States. In northern Minnesota, anecdotal comments by aquaculturists suggest that predation can be severe, but concrete data are sparse (Haws 1985; Windels 1994). In these areas, aquaculturists rely not on catfish for human consumption, but on baitfish (Finescale Dace [Phoxinus neogaeus], Fathead Minnow [Pimephales promelas], White Sucker *(Catostomus*

commersorn], and Golden Shiner *[Nofemigonus chrysoleucas])* and gamefish (Walleye *[Stizostedion vitreum]* and Muskelunge [Esox lucius]) for the fishing industry (Hamre, B.; Wertish, J.; Englund, T., pets. comet.). Fingerlings are stocked in the ponds, which are natural bodies of water found in forests or prairies, as early in the season as practical, and are harvested when they reach marketable size. Aquaculturists then sell the baiifish to dealers and the gamefish to private industry for restocking area lakes (Hamre, B., pets. comet.).

Aquaculturists perceive the most common and damaging waterbird predators in northern Minnesota to be Double-crested Cormorants and American White Pelicans *(Pelecanus erthrorhynchos)* (Windels 1994). Rednecked Grebes (*Podiceps grisegena)* and Common Loons *(Gavia immer)* may also cause some damage, though aquaculturists do not consider them as threatening as cormorants and pelicans (Hamre, B.; Englund, T., pets. comet.). Windels (1994) investigated cormorant and pelican depredation on selected Minnesota ponds. He found that the number of fish consumed per cormorant hour ranged from 6.2 to 9.3 on Walleye ponds, 15.0 to 68.1 on White Sucker ponds, and 15.0 to 51.8 on Fathead Minnow ponds. For pelicans, consumption rates were higher: 147.1 fish per pelican-hour on Walleye ponds, 171.6 on White Sucker ponds, and 15.2 on Fathead Minnow ponds. Not only can waterbirds consume many fish, but their populations, particularly those of cormorants, are increasing. Haws (1985) noted an annual population growth rate of 40% for cormorants in Minnesota from 1970 to 1985, whereas Weseloh et al. (1995) found an average increase of 28.8% per year in Great Lakes breeding populations of cormorants from 1970 to 1991.

Population growth since the 1970's reflects reduced pesticide use (Hobson et al. 1989; Weseloh et al. 1995). Continued growth is anticipated presuming continued reduction in use of pesticides. Thus, the predation problems for aquaculturists will likely intensify. Indeed, in 1995 the United States Fish and Wildlife Service issued 2,680 cormorant depredation permits in Minnesota to commercial bait dealers in an attempt to reduce cormorant predation at aquaculture facilities (Wetzel, A.J., pers. comm.).

Although cormorants, pelicans, and other waterbirds are known to frequent Minnesota aquaculture ponds (Windels 1994; Matlhare 1992), little is known as to what proportion of time birds spend feeding relative to other activities. Additionally, little is known about the time of year when most damage occurs. Increased nutritional needs during and prior to migration and during brood rearing are factors that may influence predation levels. We initiated this study to determine whether population increases in some waterbird populations may be causing an economic loss to aquaculturists in northern Minnesota.

Our objectives were to determine (1) which species of waterbirds were found at aquaculture sites in northern Minnesota and (2) time-activity budgets for the most common waterbirds while present at aquaculture sites.

Methods

We selected four aquaculture facilities in northern Minnesota known to have previous waterbird predation. The sites were Sullivan's Pond (20 hectares), located 1.6km east of Bemidji, MN (Section 12, Town 146N, Range 33W), Lake 16

(60 hectares), located 5.1 km south of Emmaville, MN (Section 16, Town 141 N, Range 34W), Lake Cameron (130 hectares), located on the west edge of Erskine, MN (Section 5, Town 148N, Range 42W), and Lake 61 (20 hectares), located 3.2km west of McIntosh, MN (Section 7, Town 148N, Range 41 W) (Fig. 1).

We visited each site one time per week from 27 May through 4 November 1996, ending after the fall migration and pond freezeup. We partitioned observation time into periods based on migration patterns: early (spring migration: 27 May- 6 June 1996), middle (nesting and brood rearing: 7 June- 30 September 1996) and late (fall migration: 1 October- 4 November 1996). Diurnal observation periods were set based on local sunrise and sunset times, which were partitioned into four equal sections: (1) dawn to midmorning, (2) mid-morning to mid-afternoon, (3) mid-afternoon to early evening, and (4) early evening until dusk. A block observation schedule was used, rotating site and time of day to achieve equivalent observation weight at each of the four sites over the entire study.

We observed birds from locations adjacent to the ponds. After arriving at the pond, we waited 10 minutes before beginning observations to avoid behaviors caused by our arrival. Viewing was by unaided eye, with 10 x 50 binoculars, or with a 20 x 45 variable spotting scope, depending on the distance to the bird.

To determine which waterbirds frequented the aquaculture facilities, we scanned the entire area every 15 minutes during each observation period and recorded the number of individuals for each species present. All individuals on the water, in nearby trees, or in the air were counted. We also conducted time-activity budgets of the three most common predatory waterbirds using the ponds--

cormorants, Red-necked Grebes, and loons-- to determine if damage differed by season or time of day. Species observations were based on the proportion of birds present. For example, if 70% of the birds were cormorants and 30% were grebes, we selected seven cormorants for every three grebes. Birds were randomly selected and observed for five minutes, during which time its instantaneous behavior was recorded every 15 seconds (Weins et al. 1970). If only one bird was present on the pond, it was observed again during the next five-minute observation period. However, whenever possible, different birds were selected to reduce sampling bias. Activities were categorized as feeding (diving or preparing to dive under the surface), resting (motionless or nearly so on the water or, for cormorants, roosting in a tree at the water's edge), locomoting (swimming or flying), comfort (behaviors associated with body maintenance), agonistic (fighting, wing-beating, or other aggressive behaviors between two or more individuals), courting (courtship displays, mating, or nest building), alert (raising the head in response to some outside activity or disturbance), and other (behaviors not included in the above categories).

Our findings were analyzed using the SPSS statistical package (Norusis 1995). All percentages were arcsine transformed to satisfy normality assumptions (Steel and Torrie 1980). We used an analysis of variance to determine the effects of season on individual activities. Since aquaculturists are primarily concerned with how frequently waterbird predators feed at their ponds, we used an analysis of variance to determine the effects of time of day on feeding activity. We compared

differences among seasonal means for each behavior category and among time of day means for feeding with a Duncan's Multiple Range Test (Norusis 1995).

Results

Presence of predatory waterbirds at the four aquaculture sites was based on 1,224 total scans. During these scans we observed thirteen species of predatory waterbirds (Table 1). Most had minor presence, but three species were regarded as common: Double-crested Cormorants, Rednecked Grebes, and Common Loons. Although Black Terns *(Chlidonias niger)* and Ring-billed *Gulls (Larus delawarensis)* were relatively common, they were present at the sites only for a few weeks. Terns were seen briefly in May, but disappeared thereafter. Most Ring-billed Gulls were seen in Erskine at the end of the mid-season period when they were rafting prior to fall migration.

We conducted approximately 306 hours of time-activity observations on cormorants, Red-necked Grebes, and loons. Seasonal data showed that cormorants spent the majority of their time resting; they rested more in the late season (82.5%) than in either mid (50.9%) or early (49.7%) season , P=0.0380 (Fig. 2). They also had more comfort activity in the early season (33.6%) than in the late season (0.0%), P=0.0421. No other activities differed seasonally (Fig. 2). Grebes also spent the majority of their time resting (52.2% - 58.8%), though this did not differ seasonally, P=0.8018 (Fig. 3). Grebes did not differ seasonally in any activity except other, where the early season (6.7%) was higher than the late season (0.4%), P=0.0482 (Fig. 3). Loons allocated much of their time to resting (36.0% -

46.5%), P=0.0577 and to feeding (Fig. 4). Loons fed more in the early (32.4%) and mid (41.6%) season than in the late (13.8%) season, P=0.0001. They locomoted more in the early season (12.9%) than in the mid (5.9%) or late (7.9%) season, P=0.0172, and allocated more time to comfort activity in the late season (31.8%) compared to the early (6.1 %) or mid (11.5%) seasons, P=0.0000 (Fig. 4).

Because feeding behavior of cormorants and grebes did not differ seasonally, we combined feeding data for each species when comparing time of day observation periods. Cormorants fed more during the early morning period (25.4%) than during the late morning (10.2%), early afternoon (9.2%), and late afternoon (1.0%) periods, P=0.0349 (Fig. 5). In contrast, grebes did not feed differently throughout the day (11.6 -17.2%), P=0.5871 (Fig. 6). During the late season, loons fed more in the late morning (59.0%) than in other time of day periods (0% -12.5%), P=0.0003 (Fig. 7), but feeding did not diffier by time of day during the early, P=0.2145, and mid, P=0.0540, seasons (Fig. 7).

Discussion

Thirteen waterbird species were observed on our study sites, though densities of most of these species were low. Only Double-crested Cormorants, Black Terns, and Ring-billed Gulls had a mean group size of more than three birds when observed during a scan. Black Terns and Ringbilled Gulls, however, seemed not to be a persistent problem for aquaculturists, as they were present only for brief periods during the early and late seasons, respectively. Common Loons and Red-necked Grebes were seen in a high proportion of scans (24.3% and 22.5%, respectively), but since they occurred in groups of less than two individuals, aquaculturists do not

perceive them as a potential threat but rather are tolerant of them (Englund, T., pers. comm.). Thus, at our study sites, cormorants seemed to be the only waterbird viewed as a potential threat by aquaculturists. Indeed, cormorants are frequently cited as being a major threat at other facilities throughout Minnesota (Matihare 1992; Windels 1994). However, because the mean flock size fiar cormorants at our study sites was not large (3.3 birds), perhaps cormorants are more of a perceived problem. Further research is needed to confirm this. Additionally, two of our four sites were located in the prairie and two in forests. Cormorants were never seen at the forest sites. This suggests that if cormorants are a problem for aquaculturists, perhaps the more costly game species, such as Walleye (Minn. Aquaculture Report 1993), should be raised in forest ponds to minimize potential economic loss.

Pelicans, mentioned by aquaculturists whom we contacted as a major predatory waterbird, were never observed during our study, though they passed through one prairie site before our observations began. Four pelican colonies were active in Minnesota as of 1994, one in Lake of the Woods County, two in Big Stone County, and one in Lake Faribault County (Fall 1994). Many breeding colonies are also found in the Canadian provinces of Manitoba and Saskatchewan (Windels 1994). Thus, pelicans could be a potential problem for aquaculturists in northern Minnesota during their annual migrations. During these times, selective scare techniques such as pyrotechnics or effigy devices (scarecrows that utilize sound and motion; Andelt et al. 1997; Mott and Boyd 1995) may be effective deterrents. However, habituation to some of these devices can occur (Stickley et al. 1992), suggesting the need for further investigation as to their relative effectiveness. Additionally, because pelicans are primarily surface feeders that take prey usually no deeper than one meter (Findholt

and Anderson 1995), aquaculturists who perceive them as a problem may reduce damage by using deeper ponds or raising fish species that prefer deeper water.

Seasonal time-activity budgets of the three most common species at our study sites, Double-crested Cormorants, Red-necked Grebes, and Common Loons, revealed that all birds allocated much of their time to resting, with only loons allocating a high proportion of time to feeding. However, although time spent feeding by cormorants and grebes may be relatively short, the total number of fish taken, especially by cormorants, can be up to 504g per bird per day, about 22% of their body mass (Glahn and Brugger 1995). Thus, a flock of cormorants can cause much damage in a short period of time. Indeed, the US Fish and Wildlife Service (1995) stated that cormorant predation is particularly high where fish are concentrated in artificially high densities, such as in stocked ponds. However, at our study sites, cormorant densities were lower than those reported in other studies. For example, Windels (1994) reported cormorant flock sizes of up to 50 birds in western Minnesota. Further, research is needed to determine if the few birds at our study sites take enough fish to warrant their control. Since grebes are territorial rather than colonial, and occurred at lower densities than cormorants, the relatively short amount of time they spent feeding during our study suggests that they may be unimportant predatory waterbirds. For loons, which spend up to 41.6°/a of their seasonal time feeding, more data, particularly number of grams of fish taken per bird per day, are needed to verify their economic impact.

Although feeding by cormorants did not differ seasonally, it differed by time of day, with birds feeding more during early morning. Therefore, if cormorants are perceived as a problem, deterrent efforts would be most effective during this period. Many

preventative methods exist to reduce cormorant predation. The simplest and most effective consists of using a wire or cloth mesh over a pond to prevent the birds' access to fish (US Fish & Wildlife Service 1981). However, this is impractical for northern Minnesota aquaculturists, since the ponds they use are natural, and typically large, bodies of water. Other methods used on man-made aquaculture ponds include pyrotechnics and effigy devices, but birds quickly become accustomed to them (Andelt et al. 1997). Additionally, these can be impractical for many northern Minnesota aquaculture sites, given that many homeowners and recreationists live on and use these natural ponds. A potential control method may be as simple as removing trees in which cormorants roost. We observed at our study sites that cormorants frequently spent time in trees adjacent to ponds during their breaks from feeding. We should note, however, that since cormorant numbers were not excessive at our study sites, aquaculturists should think carefully about using any control technique. The most cost-effective approach may be to do nothing and absorb, or pass on to the consumer, the relatively low cost of fish loss.

Diets of cormorants vary greatly throughout the year (Glahn et al. 1995). Because we did not investigate their diets, further research is necessary to quantify which fish species are depredated when and to what degree.

Determining pre- and post-stocking predation might suggest better timing to minimize potential losses. Glahn et al. (1995) suggest delaying stocking in the south until the birds have migrated north. Perhaps delaying stocking in the north until birds have set their initial feeding patterns, or have moved through into Canada, might be effective for some Minnesota aquaculturists. Although these methods may not eliminate predation, they may provide an economic benefit at particular sites.

With the anticipated continued growth in cormorant populations, further research on their damage at aquaculture sites is desirable. Efforts should be targeted at sites located nearer to roosting sites, and the effects of tree removal need quantifying. However, it is important to realize that predation by any waterbird species is a localized problem. Therefore, each site should be assessed as to the cost effectiveness and feasibility of dispersing (or removing) the birds versus doing nothing. Only then can aquaculturists maximize their profits.

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Table 1. Summary of waterbird species observed at northern Minnesota aquaculture sites, 27 May - 4 Nov. 1996.
Total Scans = 1,224.

Species	# Scans Seen[a]	% Total Scans[b]	Total # Seen[c]	ean # per Scan[d]
Bald Eagle	6	0.5%	7	1 .2
Belted Kingfisher	3	0.2%	3	1.0
Black Tern	64	5.2%	199	3.1
Common Loon	297	24.3%	387	1.3
Common Tern	8	0.7%	18	2.3
Double-crested Cormorant	78	6.4%	254	3.3
Great Blue Heron	25	2.0%	25	1.0
Green-backed Heron	5	0.4%	5	1.0
Osprey	4	0.3%	4	1.0
Pied-billed Grebe	50	4.1%	83	1.7
Red-necked Grebe	275	22.5%	667	2.4
Ring-billed Gull	85	6.9%	2,192	25.8
Western Grebe	11	0.9%	11	1.0

a) # Scans Seen = # of scans in which the species were seen.
b) % Total Scans = percentage of total scans in which the species were seen.
c) Total # Seen = total number of individuals seen throughout the study.
d) Mean # per Scan = mean number of birds observed per scan.

Figure 1. Minnesota aquaculture site locations: 1)Erskine: Lake Cameron {Section 5, Township 148N, Range 42W}; 2) McIntosh: Lake 61 {Section 7, Township 148N, Range 41W}; 3) Bemidji: Sullivan's Pond: {Section 12, Township 146N, Range 33W}; 4) Emmaville: Lake 16 {Section 16, Township 141N, Range 34W}.

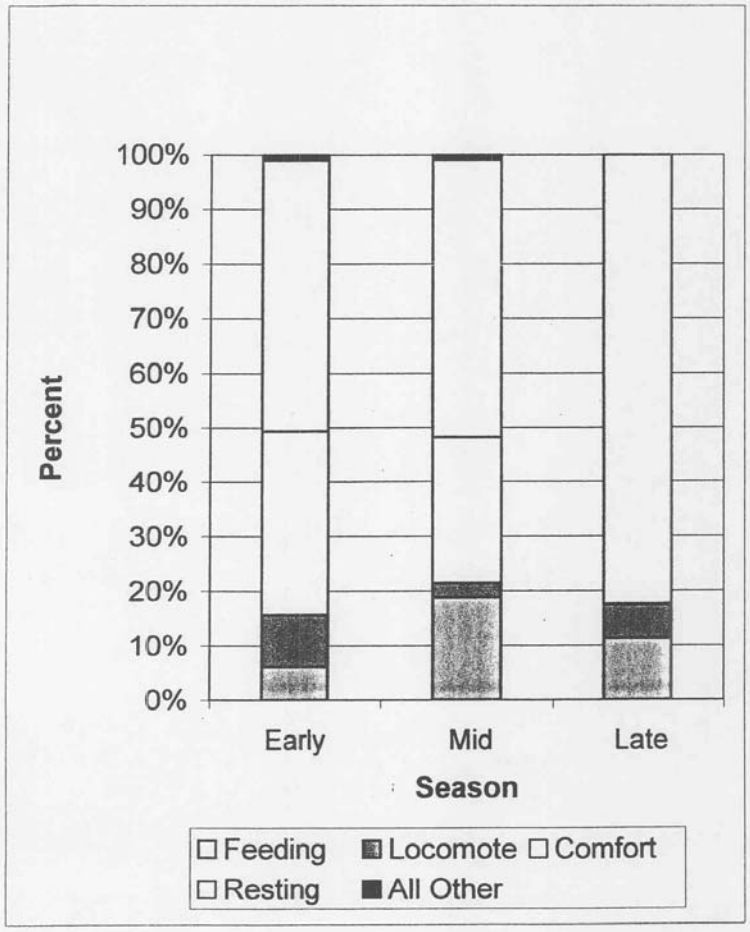

Figure 2. Seasonal time-activity budgets of Double-crested Cormorants at northern Minnesota aquaculture sites. Early season 27 May - 6 June 1996; mid season 7 June - 30 Sept. 1996; late season 1 Oct. - 4 Nov. 1996.

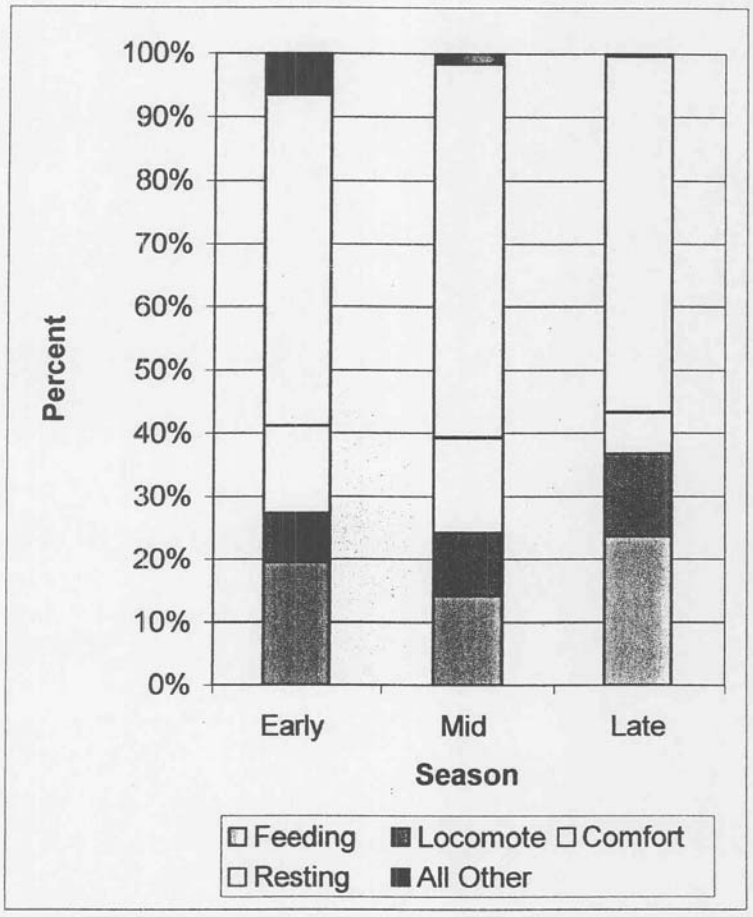

Figure 3. Seasonal time-activity budgets of Red-necked Grebes at northern Minnesota aquaculture sites. Early season 27 May - 6 June 1996; mid season 7 June - 30 Sept. 1996; late season 1 Oct. - 4 Nov. 1996.

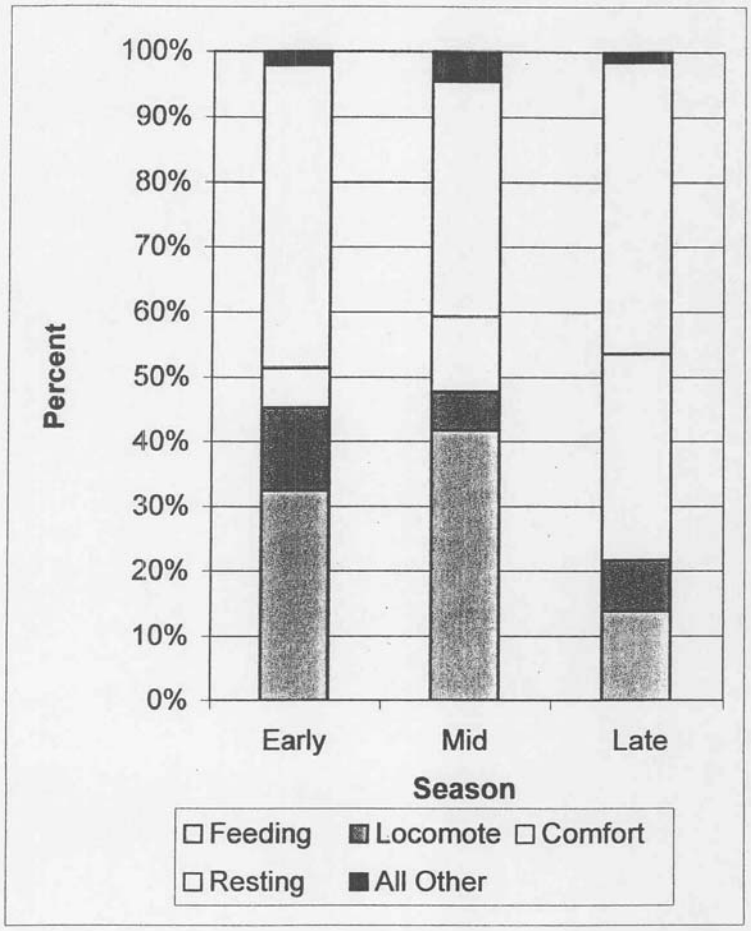

Figure 4. Seasonal time-activity budgets of Common Loons at northern Minnesota aquaculture sites. Early season 27 May - 6 June 1996; mid season 7 June - 30 Sept. 1996; late season 1 Oct. - 4 Nov. 1996.

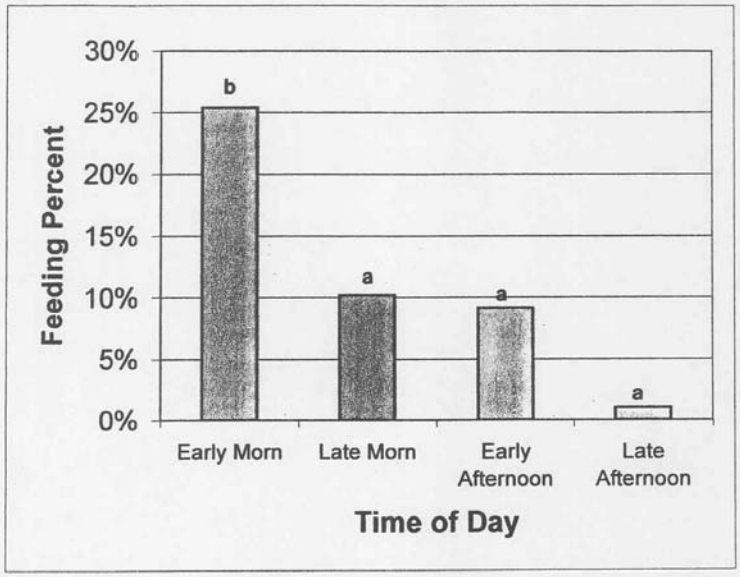

Figure 5. Percent of time Double-crested Cormorants spent feeding during four diurnal time periods at northern Minnesota aquacultural sites, 27 May - 4 Nov. 1996. Bars sharing the same letter are not significantly different (P>0.05).

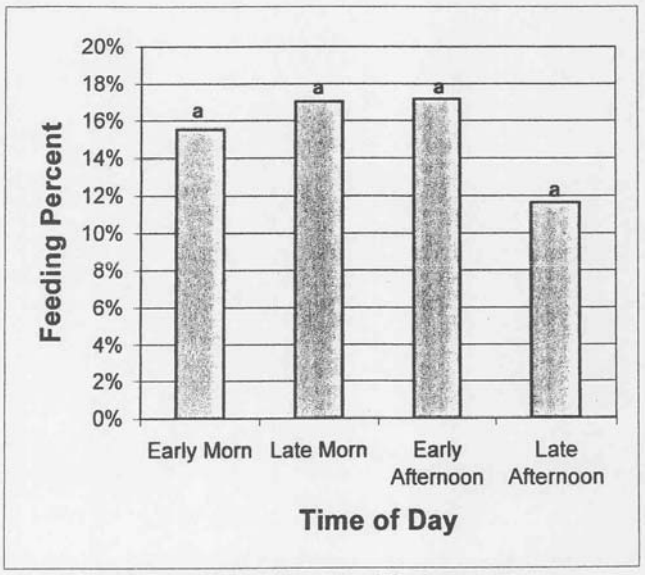

Figure 6. Percent of time Red-necked Grebes spent feeding during four diurnal time periods at northern Minnesota aquacultural sites, 27 May - 4 Nov. 1996. Bars sharing the same letter are not significantly different (P>0.05).

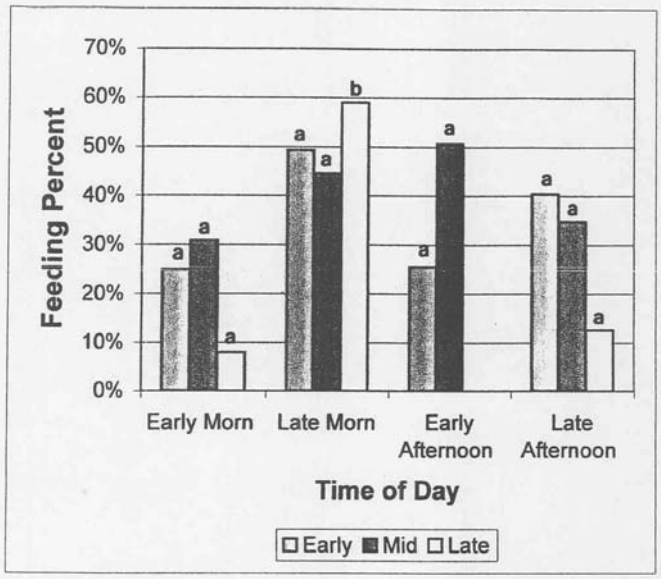

Figure 7. Percent of time Common Loons spent feeding during four diurnal time periods at northern Minnesota aquacultural sites. Early season 27 May - 6 June 1996; mid season 7 June - 30 Sept. 1996; late season 1 Oct. - 4 Nov. 1996. Bars within the same season sharing the same letter are not significantly different (P>0.05).