Human disturbance of diving ducks on Long Point Bay, Lake Erie

Richard W. Knapton, Scott A. Petrie, and Garth Herring

Abstract Excessive human disturbance can have detrimental effects on waterfowl foraging efficiency and body fat acquisition and can ultimately reduce the carrying capacity of migrational staging areas. We monitored the influence of human activities on staging waterfowl on the Inner Bay at Long Point, Lake Erie during spring (92 hours) and fall (108 hours) of 1993. Mixed-species flocks of diving ducks (*Aythya* spp.) were the most frequently disturbed waterfowl group. Disturbance rates were greater in spring than fall, but number of birds disturbed was considerably greater in fall ($P<0.05$). This was because birds tended to be concentrated in a few locations during fall, such as the middle of the bay (a no-hunting sanctuary in fall), and disturbances often elicited a response from entire flocks. Although results were insignificant, diving ducks tended to fly farther and spend more time in flight following fall disturbances. Birds disturbed in spring followed a response A model; they flew away from the disturbance but promptly resumed feeding once the disturbance (primarily commercial fishing boats) had passed. Some birds disturbed in fall followed a response B model; they flew away from the foraging area and probably discontinued feeding, although daily rates of disturbance were low (primarily by hunting boats). Providing refuges in portions of the Inner Bay that restricted or banned boat traffic during peak migration would probably increase the suitability of Long Point as a staging area for diving ducks. Reductions in disturbance would be particularly beneficial in spring, because females must acquire body fat for reproduction and migration at a time when ice cover and winter senescence often limit availability of food resources.

Key words body fat, disturbance, diving ducks, fishing, foraging, hunting, Lake Erie, Long Point, migration, refuge, staging

Lower Great Lakes coastal wetlands provide critically important staging habitat for migrating waterfowl, particularly diving ducks (*Ayathya* spp., Dennis and Chandler 1974, Crowder and Bristow 1988, Prince et al. 1992). Unlike dabbling ducks, geese, and swans, which attain much of their nutrition through terrestrial feeding, diving ducks are dependent solely on aquatic foods. Consequently, diving ducks consume large quantities of aquatic plants and invertebrates during migration to obtain energy and nutrients necessary for sustained flight, future reproduction, and survival (Takekawa 1987, Serie and Sharp 1989, Knapton and Petrie 1999, Petrie and Knapton 1999). The Great Lakes coastal wetlands, upon which diving ducks have been dependent historically for feeding and resting, have been affected severely by drainage and development (Crowder and Bristow 1988, Smith et al. 1991, Herdendorf 1992, Prince et al. 1992); less than 5% of western Lake Erie's coastal wetlands remain (Herdendorf 1987). This wetland loss has increased the dependence of several species of waterfowl on the few remaining wetlands, and it also has concentrated increasing numbers of humans who partake in water-based recreational and commercial activities.

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Long Point wetlands have been preserved from development and drainage by a strong hunting tradition and consequently receive the greatest waterfowl use of all staging areas in Ontario south of James Bay (Dennis and Chandler 1974, Dennis et al. 1984). However, the spectacular migrations of birds and excellent fishing and boating opportunities attract increasing numbers of people to Long Point every year to partake in numerous recreational and commercial activities (Wilcox 1993). This increase in human activity has the potential to adversely affect the suitability of Long Point Bay for staging waterfowl. Excessive disturbance by humans is detrimental to waterfowl on staging, wintering, and breeding areas (Balat 1969, Korschgen et al. 1985, Havera et al. 1992) and may be as harmful as habitat destruction (Dahlgren and Korschgen 1992). Disturbance increases flight time and decreases feeding time; it also can force birds to forage in less preferred habitats (Hohman and Rave 1990, Havera et al. 1992). Consequently, disturbances could influence the ability of birds to acquire the fat necessary for migration as well as for egg laying following spring migration and for overwinter survival following fall migration (e.g., Ankney and MacInnes 1978, Krapu 1981, Haramis et al. 1986). Excessive human disturbance also can cause premature departure from staging areas and shifts in distribution of some duck species, especially diving ducks (Bell and Austin 1985, Edwards and Bell 1985, Dennis and Chandler 1974, Havera et al. 1992).

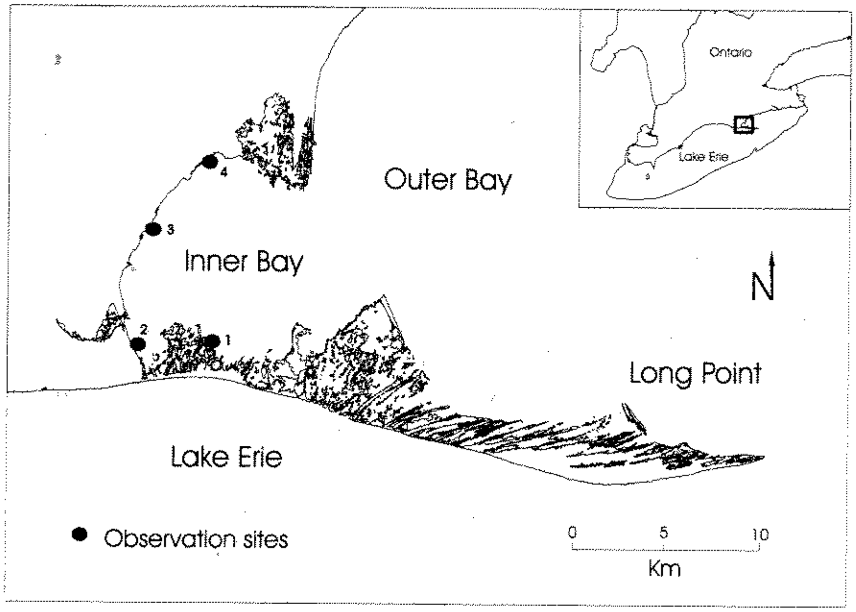


Figure 1. Geographic location of Long Point Bay, Lake Erie, and location of observation sites used to monitor human disturbance of waterfowl, 1993.

Diving ducks (primarily canvasbacks [*Aythya valisineria*], redheads [*A. americana*], lesser scaup [*A. affinis*], and greater scaup [*A. marila*], hereafter scaup) have altered their daily activity patterns at Long Point during the latter part of this century (Petrie 1998). Whereas 16% of the diving ducks surveyed (diurnal surveys) during fall in the 1970s were located off the south shore of the peninsula in Lake Erie (Figure 1), that proportion increased to 31% in the 1980s and further to 80% in the 1990s (Petrie 1998). Although increased numbers of birds have been gathering on Lake Erie during the day, large flocks make regular flights into the Inner Bay at dusk to forage at night (Petrie 1998). This increased diurnal use of the lake probably reduces the quality or quantity of food available to ducks and may expose birds to more inclement micro-climatic conditions. In contrast, considerably fewer birds (7%) use the lake during spring and the proportion of diving ducks using the Inner Bay during spring has increased since the 1970s (Petrie 1998). However, it is not known whether there are greater rates of disturbance at Long Point during fall or whether birds are simply more likely to change their distribution patterns in response to anthropogenic activities then. For instance, waterfowl acquire nutrients for migration and reproduction while on spring staging areas, the temporal constraints of which may preclude them from relocating to less preferred feeding sites during the day.

Although boat traffic has not been monitored formally on the Inner Bay, the increased number of marinas and boat slips shows that boat traffic has increased throughout the last half century (Wilcox 1993). Given the popularity of Long Point and the projected increase in the human population of the lower Great Lakes region, we can expect that boat traffic will continue to increase.

Our objectives were to determine types, locations, and frequencies of waterfowl disturbances on the Inner Bay of Long Point and to determine whether there are seasonal differences in rate of these disturbances. We also identify and propose management actions that could be implemented to reduce waterfowl disturbance on Long Point Bay.

Study area

Long Point is a 35-km sandspit extending into the eastern basin of Lake Erie (80°30E, 42°35N to 80°03E, 42°33N; Figure 1). This spit partially encompassed and protected a large shallow-water area from the wave action of Lake Erie. This facilitated the formation of 24,000 ha of marsh that is important for waterfowl migrating between Atlantic and Gulf coast wintering areas and prairie, boreal, and arctic breeding areas (Petrie 1998). Wetlands of Long Point were a mixture of palustrine and lacustrine types, supporting diverse stands of submergent and emergent macrophytes in deltaic and riverine wetlands and a 280,000-ha embayment, the Inner Bay. The Inner Bay was shallow, with an average depth of 2 m, and over 90% of the bottom was covered by submerged aquatic vegetation (Wilcox 1994, Knapton and Petrie 1999). The dominant macrophytes, *Chara vulgaris*, *Valisneria americana*, *Najas* spp, and *Myriophyllum spicatum*, and associated macroinvertebrates are important foods for migrating waterfowl (Wilcox 1994, Knapton and Petrie 1999, Petrie and Knapton 1999).

The Inner Bay supports a commercial fishery (17 active licences), operating during spring and fall, and an increasing number of sport fishermen (Wilcox 1993). All of the commercial hoop-nets and draw seines are located on the perimeter of the bay, extending into the bay no more than 1,000 m. Long Point attracts thousands of duck hunters during fall migration. Hunting is not permitted beyond 200 m from the shoreline of the bay, leaving a substantial nonhunted area.

Methods

We chose 4 observation sites around the perimeter of the Inner Bay, each located at a suitable position to view waterfowl and human disturbances (Figure 1). Sites also were chosen based on accessibility by road, proximity to aquatic macrophyte beds, and known use by waterfowl.

We monitored each of the 4 sites for 60 minutes during 23 spring survey days conducted between 5 and 29 April (92 hours) and during 27 fall survey days conducted between 16 September and 8 December (108 hours). We selected observation sites randomly (without replacement) such that each of the 4 sites was monitored during each survey day. Timing of observation sessions alternated such that observations were conducted throughout the morning one day (starting at dawn) and afternoon the next (starting between 1300 and 1400). All flocks within sight were monitored individually and continuously throughout the observation period.

Observations were made using 8 × 50 binoculars and a 22X wide-angle spotting scope. We recorded 1) number of waterfowl present on the water before a disturbance, 2) number of birds disturbed as compared to the number of waterfowl present in the area, 3) distance birds flushed from the disturbance (estimated in meters), 4) time birds spent flying after a disturbance (in seconds), 5) distance birds flew after being disturbed (estimated in meters), 6) identity of waterfowl disturbed and their activities before disturbance (e.g., foraging, loafing), 7) type of disturbance, and 8) number of disturbances per observation period.

When birds disappeared from sight (because of marsh vegetation or the need to observe another disturbed flock), distance flown and disturbance time were classified as unknown. Disturbances were classified as 1) commercial fishing boats, 2) hunting boats, or 3) other boats, including recreational and sport fishing vessels, or self (because of researcher presence). The 1993 waterfowl hunting season at Long Point began on 25 September and ended on 31 December. Aerial waterfowl surveys were conducted throughout the spring ($n=4$) and fall ($n=5$) study periods to determine population sizes, document where flocks concentrated, and calculate waterfowl-use days in the area. Waterfowl-use days were calculated by averaging number of waterfowl from each successive pair of surveys, multiplying by number of days separating the 2, and summing over the season. Seasonal differences in the distance waterfowl flushed from disturbances, duration of flight time, and distance flown after being disturbed were compared using Mann-Whitney U tests. Seasonal differences in hourly disturbance rates were compared using a 2-tailed t-test (Sokal and Rohlf 1981).

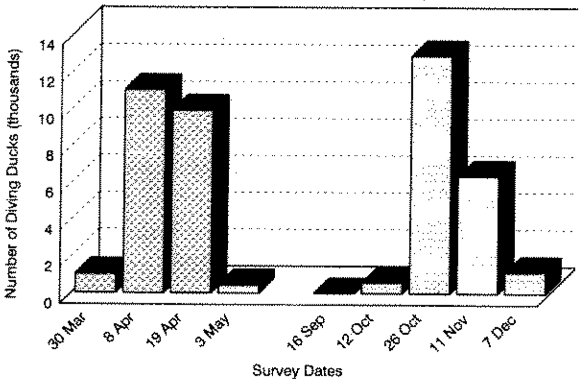


Figure 2. Number of diving ducks counted (aerial survey) on the Inner Bay of Long Point, 1993.

Results

Peak daily spring (n=11,008 ducks) and fall (n=12,863 ducks) Inner Bay waterfowl counts were similar during 1993 (Figure 2). However, as the fall migration was more protracted, total fall waterfowl days on the Inner Bay (552,051 days) exceeded that of the spring (413,346 days). Diving ducks (*Aythya* spp., *Bucephala* spp., *Mergus* spp., *Melanitta* spp., and *Oxyura jamaicensis*) were the most predominant waterfowl group on the Inner Bay during spring (99.7%) and fall (99.0%). Diving duck use off the south shore of the peninsula in Lake Erie was substantially less during the spring (peak count=63, waterfowl days=1,445) than during the fall (peak count=95,291, waterfowl days=4,443,878).

The most frequently disturbed species on the Inner Bay were *Aythya* spp. (74% of observed disturbances, n of flocks=268); flocks primarily consisted of mixed-species flocks of scaup and canvasbacks. In spring, mixed-species flocks of *Aythya* spp. comprised 86% (n=251) of disturbed flocks. In fall, percentage disturbances of mixed-species flocks of *Aythya* spp. and pure flocks of canvasbacks and scaup were similar, at 22% to 24% each.

Table 1. Number of boating disturbances, waterfowl disturbance rates, distance flown ($\bar{x} \pm$ SD), and flight times ($\bar{x} \pm$ SD) for waterfowl responding to boating disturbance on the Inner Bay, Long Point, 1993.

	Number of disturbances	Disturbances/ hour[a]	Distance flown (m)	Flight time (sec)
Spring	291	3.2	746 ± 498	33 ± 16
Fall	71	0.7	939 ± 1,173	51 ± 59

[a] Calculated from 92 hours of observation in spring and 108 hours of observation in fall.

Table 2. Temporal distribution of daily waterfowl disturbances in the Inner Bay, Long Point, 1993.

	0600–0800	0800–1000	1000–1200	1200–1400	1400–1600	>1600
Spring	185	38	55	0	13	0
Fall	18	40	13	0	0	0

The disturbance rate (number of disturbances/observation hour) was greater in spring (3.2/hour) than in fall (0.7/h, Table 1, P<0.05), but of 62,736 waterfowl that were disturbed, only 19% were disturbed during spring; 81% were disturbed in fall. This difference resulted from birds being in smaller flocks in spring; mean number of birds disturbed was 41±119 (SD) in spring and 717±1,648 in fall (P<0.05). Birds flushed at similar distances from disturbances during spring (189.1±116.1 m) and fall (174.4±110.1 m, Mann-Whitney U=0.88, P>0.05). While results were insignificant, birds tended to fly farther (Mann-Whitney U=0.71, P>0.05) and spend more time in flight in fall (Mann-Whitney U=0.45, P>0.05) than they did during spring (Table 1).

Waterfowl were disturbed most often between 0600 and 0800 in spring (63.5% of spring disturbances) and between 0800 and 1000 in fall (56.3%, Table 2). Number of waterfowl disturbances was substantially less during afternoon in both seasons. This is probably the result of fewer commercial fishermen and hunters using the Inner Bay in the afternoon. Commercial fishing boats were the most common cause of waterfowl disturbance during spring (85.2% of disturbances and 81.2% of waterfowl disturbed); hunting boats were the most common cause of disturbance in fall (50.7% of disturbances and 66.6% of waterfowl disturbed, Table 3). Disturbances related to commercial fishing were considerably less during fall, accounting for 26.7% of disturbances and 31.7% of all waterfowl disturbed.

Table 3. Comparison of different types of disturbance in spring and fall in the Inner Bay, Long Point, 1993.

	Commercial fishing	Hunting boats[a]	Other disturbances[b]
Spring	248	0	43
Fall	19	36	16

[a] No hunting in spring.

[b] Includes disturbances from recreational boats, sport fishing and researchers

Discussion

Diving ducks rely upon quality wetlands during migration because they depend entirely on aquatic food. However, excessive human disturbance can cause changes in diving duck distribution, abundance, and feeding site selection (Thornburg 1973, Korschgen et al. 1985, Hohman and Rave 1990, Kahl 1991) and can force birds to depart prematurely from key staging areas (Hume 1976, Bell and Austin 1985, Edwards and Bell 1985). Consequently, anthropogenic disturbance decreases the effective carrying capacity of important staging areas and also can compromise ability of ducks to acquire the body fat necessary for migration, egg laying, and overwinter survival (see Haramis et al. 1986, Serie and Sharp 1989, Barzen and Serie 1990, Kahl 1991).

Two major responses to disturbances are shown by birds (Bélanger and Bédard 1990): response A is to fly away but promptly return to the foraging site and resume feeding; response B is to depart the foraging site for a roost site or choose an alternative, possibly less profitable feeding site. Our spring data fit a response A model as disturbances were frequent, often involving few birds that did not fly far before resuming feeding. The greater rate of disturbances in spring (3.2/hour) resulted from a more regular routine of boat traffic than in fall (0.7/hour) and the fact that birds were distributed more evenly throughout the Inner Bay in spring. Commercial fishermen checked seine and hoop-nets on a regular, often daily basis during spring. When fishermen did disturb small rafts of waterfowl, the birds often returned to essentially the same area and resumed feeding.

Ducks were more concentrated during fall (often in the middle of the bay in the no-hunting sanctuary), which, combined with a substantial reduction in commercial fishing, resulted in fewer anthropogenic disturbances than during spring. However, this flocking behavior was related to a greater tendency for birds to fly farther, spend more time in flight, and leave the area following a disturbance, i.e., a response B. Waterfowl hunting boats were the most frequent cause of fall disturbances (Table 3). However, unlike commercial fishing boats, hunting boats were less likely to venture into areas where large rafts of waterfowl occurred, which generally were inside the no-hunting sanctuary. Regardless, hunting boats did venture periodically among staging flocks, apparently in an attempt to increase shooting opportunities.

Since the 1970s (and probably earlier), the proportion of diving ducks using the Inner Bay at Long Point (relative to the rest of Long Point and the adjoining lakeshore area) has increased during spring and declined during fall (Petrie 1998). Apparently, even though disturbance rates were much less, canvasbacks, redheads, and scaup have altered their daily patterns of habitat use during fall. Diving ducks tend to leave the Inner Bay (a preferred feeding area) during the day and concentrate on less productive or sub-optimal areas along the southern shore of Long Point, on the open waters of Lake Erie; birds are observed regularly flying into the Inner Bay in the evening and returning to the lake in the early morning. This is not exceptional, as several studies have reported that waterfowl respond to daylight disturbance by feeding at night (Thornburg 1973, Pedroli 1982, Takekawa 1987). As fall migrating waterfowl are not constrained by the need to acquire reserves for reproduction and their life history strategies do not necessitate prompt arrival on wintering areas, spending the day on the

Disturbance increases flight time and decreases feeding time; it can also cause changes in diving duck distribution, abundance, and feeding-site selection.

Long Point Bay, Lake Erie, is one of the most important staging areas for diving ducks in eastern North America.

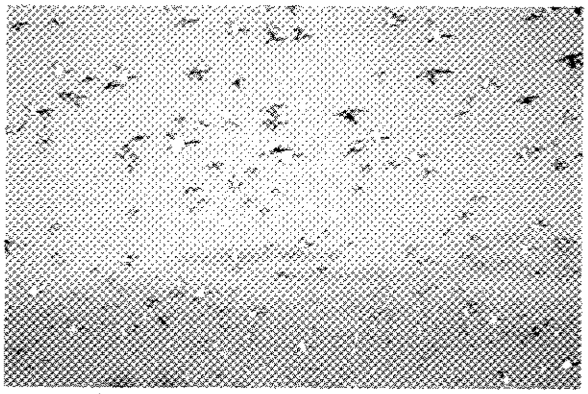
lake and limiting quality feeding opportunities to nocturnal foraging bouts on the Inner Bay is probably a suitable nutritional tactic in fall.

Although fewer birds were generally disturbed during spring, rates of spring disturbance were substantially greater than during the fall and also were much greater than reported for waterfowl staging in other regions (Korschgen et al. 1985, Bélanger and Bédard 1989, Kahl 1991, Havera et al. 1992). This may be problematic as spring disturbances may have greater impact on migratory waterfowl populations than autumn disturbances (Kahl 1991). Spring migration is generally temporally shorter than fall and migrating waterfowl incur the additional cost of acquiring reserves for reproduction over and above the fat they must accumulate for migration. Consequently, birds must acquire more body fat during spring migration, although they have less time and often less space (due to ice cover) to do it.

We suggest that the nutritional and temporal constraints of acquiring the reserves necessary for migration and reproduction may constrain waterfowl from relocating to the lake in spring, despite greater rates of human disturbance. That is, greater present and future nutritional costs probably obligate birds to forage intensively during the day and night (Petrie and Petrie 1998). Adverse spring weather conditions (creating more inclement microhabitat conditions on the lake) and the fact that Lake Erie is sometimes partially to entirely ice-covered during spring migration also probably prevent waterfowl from making regular daily movements to the lake. Consequently, when rates of human disturbance surpass some critical threshold during fall, birds are capable of relocating to the lake during the day and returning to the Inner Bay at night to feed. In contrast, we suggest that when the spring critical threshold is exceeded (which would probably be greater than the fall threshold), nutritional, temporal, spatial, and meteorological constraints discourage birds from relocating to the lake. At this critical point, birds probably vacate the Inner Bay for other staging areas with less human interference. The premature departure of waterfowl in response to human disturbance is documented on wintering as well as staging areas (Hume 1976, Bell and Austin 1985, Edwards and Bell 1985). Food resources in spring may be less abundant (Korschgen et al. 1988) and of lower nutritional quality (Takekawa 1987) than in fall, also suggesting that repeated and constant disturbances may have a significant impact on nutrient reserves in spring staging waterfowl, despite the fact that birds are showing a type A response.

Research and management recommendations

Long Point is internationally recognized as a staging area for waterfowl. Yet, except for the designation of no-hunting zones and signs posted to inform boaters about the adverse effects of human interference, waterfowl are not well protected from disturbance while using Long Point Bay. Therefore, because of the adverse effects of disturbance and the fact that the demand for water-based recreation will continue to increase at Long Point, further spatial and temporal restrictions on human activities may need to be imposed. This is probably most critical during spring because birds are often spatially constrained by ice cover at a time when they also are temporally constrained by the need to acquire reserves for migration and reproduction. Available management options include: inviolate refuges,



Human disturbance is probably most deleterious in spring because females must acquire body fat for reproduction and migration at a time when ice cover and winter senescence often limit availability of food resources.

voluntary compliance refuges, no-wake or no-motorized-boat zones, and fishing or hunting restrictions (Kahl 1991). It has been suggested that inviolate refuges are the most effective and most enforceable option, but also are often the most controversial. It also has been suggested that refuges should be at least 2.25 to 4 km^2 and should encompass as much of a feeding area as feasible (Kahl 1991). Given the large size of the Inner Long Point Bay (72 km^2), establishing either one large or several smaller refuges that exclude all forms of boat traffic during spring and fall migration may be desirable. This management strategy would be preferable to regulations that restrict boating to a specified distance from rafting waterfowl, as this is more difficult to enforce.

It is relatively easy to assess the proximate effects of human disturbance on waterfowl. It is these effects that can ultimately compromise the carrying capacity of key staging areas, as well as the ability of birds to meet the energy requirements of migration, breeding, and survival. Obtaining information pertaining to these ultimate effects of disturbance, however, is much more difficult. Human disturbance is most likely to increase on all lower Great Lakes wetlands, so an indication of the ultimate effects of disturbance on waterfowl (e.g., their ability to acquire body fat and the length of stay) is essential.

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