January 1992

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Human disturbances of waterfowl can be intentional or unintentional. They may result from overt or directed activities or may be ancillary to activities not initially thought to be of concern to birds. Some of these disturbances are manifested by alertness, fright (obvious or inapparent), flight, swimming, disablement, or death. Therefore, persons responsible for waterfowl management areas should be aware of the problems from human disturbance and should design management and facilities that increase public appreciation of waterfowl.

In the last 20 years, the intensity of water-based recreation increased drastically, especially on inland waters. Waterfowl are wary, seeking refuge from all forms of disturbance, particularly those associated with loud noise and rapid movement. Occasionally, the problem of human disturbance of waterfowl resulted in formal litigation. In Nevada, for example, the Refuge Recreation Act of 1962 was affirmed to permit recreational use only when it did not interfere with the primary purpose for which the Ruby Lake National Wildlife Refuge was established. Compatibility of an activity is based on site-specific effects on the major purposes for which a refuge was established. In a recent survey of harmful and incompatible uses on national wildlife refuges, 42 use categories were determined that could be potential disturbances of waterfowl.

Activities That Cause Disturbances

Given the frequency of human disturbance of waterfowl, information from research about this issue is scant. A review of several thousand journal articles and books revealed that most disturbances are created by water users (chiefly boaters, anglers, hunters) and aircraft (Table). Human activities cause different degrees of disturbance to waterfowl and may be grouped into four main categories. Listed in order of decreasing disturbance these categories are

1. rapid overwater movement and loud noise (power-boating, water skiing, aircraft);
2. overwater movement with little noise (sailing, wind surfing, rowing, canoeing);

3. little overwater movement or noise (wading, swimming); and
4. activities along shorelines (fishing, bird-watching, hiking, and traffic).

Disturbances displaced waterfowl from feeding grounds, increased energetic costs associated with flight, and may have lowered productivity of nesting or brooding waterfowl. Many authors either directly or indirectly implicated themselves as a cause of disturbance during their studies of waterfowl.

Effects on Breeding Waterfowl

Annual increases in waterfowl numbers are determined by several components of reproduction, including the number of breeding pairs, hatching success, and survival of the young. Human disturbance can reduce several of these components, and, in time, result in a declining waterfowl population.

Declining Numbers of Breeding Pairs

Disturbances during critical times of the nesting cycle eventually cause ducks to nest elsewhere or not to nest at all. In Maine, American black ducks and ring-necked ducks did not nest under conditions of excessive human disturbance. Mallards at the Seney National Wildlife Refuge in Michigan failed to nest in areas open to fishing. Some Wisconsin lakes bordered by homes were so heavily used for recreation that breeding ducks did not use otherwise suitable habitat. In Germany, an 85% decrease of the breeding stock of ducks at two small ponds presumably was caused solely by disturbance from an increasing number of anglers during the waterfowl breeding season. Numbers of mallards, green-winged teals, northern shovelers, pochards, and tufted ducks decreased from 26 pairs to 4 pairs during an 8-year period. Human activity on islands can altogether discourage nesting in waterfowl.

Increased Desertion of Nests

Studies of several species of waterfowl identified human disturbances as the cause of desertions or abandonments of nests, especially during early incubation. Disturbance from observers caused a 10% nest abandonment rate by mallards using artificial nest baskets in an Iowa study. Frequent visits to goose nests by biologists

Table. *Human disturbances of waterfowl by source of disturbance, effect, and number of citations in 211 journal articles on the subject.*

Subject	Number of citations
Sources of Disturbance (in alphabetic order)	
Aircraft	
Airplanes	15
Helicopters	10
General	22
Anglers (see fishing)	
Baiting/artificial feeding	7
Barges/shipping	9
Boating (boats, canoes, rowing, airboats, sailing)	66
Cats	2
Development (industrial, pollution, urban, construction)	24
Dogs	6
Farming	19
Fishing	
Commercial	5
Sport (angling)	50
Hazing (scaring)	12
Human activity/disturbance, general	58
Hunting	
Sport	71
Subsistence	2
Military	5
Noise	22
Recreation	
General	18
Aquatic	27
Research/investigator	55
Roads	
General	10
Traffic	11
Trains	1
Trapping	
Furbearer	1
Waterfowl	5
Effects (in alphabetical order)	
Breeding chronology interrupted	2
Brood breakup	14
Brood rearing disrupted	7
Energetic cost (flight) increased	23
Family breakup	6
Feeding interrupted or decreased	52
Molting birds harrassed	9
Nest/nesting	
nest disturbed by researchers	55
nest disturbed by others	27
nesting success reduced	14
Predation on clutches and chicks increased because of research	31
Wariness (alertness, tolerance distance) increased	43

caused nest desertion rates as high as 40%. Canada geese nesting in southeastern Missouri were very sensitive to persons fishing in their nesting areas. Establishing areas closed to fishing during the nesting period decreased nest desertions.

Reduced Hatching Success

Human disturbance has three basic effects on nesting success, that is:

1. exposure of eggs to heat or cold by flushing of hens may kill the embryos;
2. predation of eggs may increase when hens are flushed from nests; and
3. predation of eggs and hens may increase at nests when humans create trails or leave markers by which predators find nests.

When nests of cackling Canada geese were checked several times before hatch, twice the number of eggs were lost to predators. Where human activities disturbed Canada geese or common eiders that were nesting among black-backed gulls, herring gulls, or parasitic jaegers on islands or tundra colonies, the gulls and jaegers often quickly located and consumed eggs in waterfowl nests unoccupied because of human disturbance.

Decreased Duckling Survival

Disturbance by humans during the brood rearing season can break up and scatter broods or frighten parents into running ahead of their ducklings or goslings. Young waterfowl briefly separated from their mother are vulnerable to predators and susceptible to death from severe weather or lack of experience in obtaining food. Disturbances drastically increase kills by gulls of common eider ducklings. For example, the number of eider ducklings killed by gulls in Sweden was 200–300 times greater when broods were disturbed by boats. In northern Maine, American black duck and ring-necked duck broods averaged two fewer ducklings because of mortality from disturbance by motorboats. Human disturbance caused a higher than normal mortality rate of trumpeter swan cygnets in a study area in Alaska. Human disturbance can be quite brutal and direct; water skiers and power boaters have run over white-winged scoter hens and broods, and some boaters have used paddles to kill ducklings.

Effects on Nonbreeding Waterfowl

Migratory and wintering waterfowl generally attempt to minimize time spent in flight and maximize time for feeding. Flight requires considerably more energy than any other activity, except egg laying. Human disturbance compels waterfowl to change food habits, feed only at night, lose weight, or desert the feeding area. Waterfowl respond both to loud noises and rapid movements, such as boats powered by outboard motors, and to visible features, such as sailing boats. Large flocks of waterfowl are more susceptible to disturbances than small flocks.

Not all waterfowl species are equally sensitive to disturbance, and some may habituate to certain disturbances. Pink-footed geese were disturbed at a distance of 500 m when more than 20 cars per day used a road in the fall. Traffic of as few as 10 cars per day also had a depressing effect on habitat use by geese. Thus, the surrounding buffer area must exceed 500 m to render habitat acceptable to flocks of pink-footed geese. Some waterfowl, especially diving ducks (notably canvasbacks and lesser scaups) and geese (notably brants and snow geese) are especially vulnerable to disturbance. Density and pattern of disturbance may influence diving ducks more than dabbling ducks in most areas. Repeated disturbances also can deny birds access to preferred feeding habitats. Use by diving ducks of several good feeding areas along the Upper Mississippi River has been limited primarily by boating disturbances that cause 90 percent of the waterfowl to concentrate on 28 percent of the study area during daytime.

Increased Energy Expenditure and Depleted Fat Reserves

In the absence of disturbance, brants in Great Britain spent an average of 1.1% of their time in flight, but disturbance on weekends caused the time spent in flight to increase as much as sevenfold and prevented brants from feeding for up to 11.7% of the time. Detailed studies are few, but observations suggest that the effects of intensive recreation during the fall and winter could be deleterious to migrating and wintering waterfowl.

Researchers who attempted to quantify the harm from disturbances on migrating and wintering waterfowl indicated that frequency of disturbance, number of affected birds, and changes

in behavior are greater than most suspected. For example, each duck and American coot on Houghton Lake, Michigan, was disturbed on the average of 1.5 times per weekday and more than 2 times during weekend days. On Navigation Pool 7 of the Upper Mississippi River, an average of 17.2 boats passed through the study area each day and resulted in 5.2 disturbances per day and a minimum of over 4 min of additional flight time per disturbance of waterfowl. Birds may have flown up to an additional hour each day because of human disturbances. Over 2500 tundra swans left their most important feeding area on the Upper Mississippi River in response to two small boats.

Changed Migration Patterns

Prolonged and extensive disturbances may cause large numbers of waterfowl to leave disturbed wetlands and migrate elsewhere. These movements can be local in areas of plentiful habitat or more distant and permanent in areas of sparse habitat, causing shifts in flyway migration patterns. Extensive disturbances on migration and wintering areas may limit the use by waterfowl below the carrying capacity of wetlands. Daily disturbance by boaters may have been responsible for eliminating the brant population that once spent November and December on Humboldt Bay, California.

Management Considerations

Fortunately, numbers of breeding waterfowl usually increase in response to reduction or elimination of human disturbances. For the benefit of waterfowl, the harm from human disturbances must be minimized or eliminated. Management alternatives that reduce human disturbances of waterfowl include:

1. increasing the quantity, quality, and distribution of foods to compensate for energetic costs from disturbances;
2. establishing screened buffer zones around important waterfowl roosting and feeding areas;
3. reducing the number of roads and access points to limit accessibility to habitats;
4. creating inviolate sanctuaries; and
5. reducing the sources of loud noises and rapid movements of vehicles and machines.

Disturbances occur chiefly during all critical parts of the annual cycle of waterfowl—nesting, brood rearing, migration, and wintering. Each part of the cycle is crucial to the breeding and survival of waterfowl populations. Common to all parts of the cycle is disturbance while feeding, which may increase flight time and decrease feeding time. Disturbances of nesting birds may cause abandonment of the nest, disruption of the pair bond, reduction in clutch size, increased egg mortality, abandonment of the nesting area, and increased predation of the nest. Disturbances during brood-rearing may cause exhaustion of young and an increase in losses from predation. These disturbances can be lessened or their effects mitigated on refuges or other areas managed for waterfowl. Because disturbances are sometimes caused by professional wildlife managers or researchers and private citizens, creation of sanctuaries is often necessary at critical times and locations. Access to roads and trails can be limited for professionals and for bird-watchers. Activities of other users of wildlife, such as trappers and hunters, may have to be restricted in space and time; boating, angling, camping, and picnicking may be restricted similarly. Human disturbance often is increased by viewing platforms and waterfowl can be viewed at a closer distance if the platform is screened with vegetation and made more like a blind. Proper screens and appropriate control of noise let people really enjoy wildlife close at hand.

Structures such as pumping stations and maintenance buildings on wildlife areas should be screened and placed where necessary human visits cause the least disturbance of waterfowl. Disturbances, particularly at critical times of the year, can be reduced notably by restricting access of pedestrians, autos, and boats; by regulating activities such as farming, grazing, bait collecting, camping, hunting, fishing, and trapping; and by prohibiting the use of nets that can entrap diving ducks. Access by dogs and other pets should not be permitted in critical areas during the nesting and brood-rearing periods. Airboats, aircraft, and all-terrain-vehicles are often useful to managers of waterfowl and wetland, but their use must be carefully planned to minimize harm from sight or sound. Construction of dikes, canals, water control structures, roads, and similar structures and military uses of wetlands or refuge areas should be scheduled for non-critical times in the annual activity cycle of waterfowl.

Disturbance of feeding waterfowl can sometimes be mitigated by acquiring feeding areas

on privately owned land to create a sanctuary or by practicing moist soil management and thus increasing the availability of highly nutritious foods in the refuge or wetland areas. With careful planning, deleterious effects of human disturbance on waterfowl can be mitigated or eliminated by creating sanctuaries in time and space (Figs. 1 and 2).

Managers must aggressively protect waterfowl from any human disturbance that reduces productivity and health of populations. To accomplish this goal, managers must resolve conflicting interests between needs of the public and needs of wildlife and researchers must gather more data to provide a greater range of management options.

Suggested Reading

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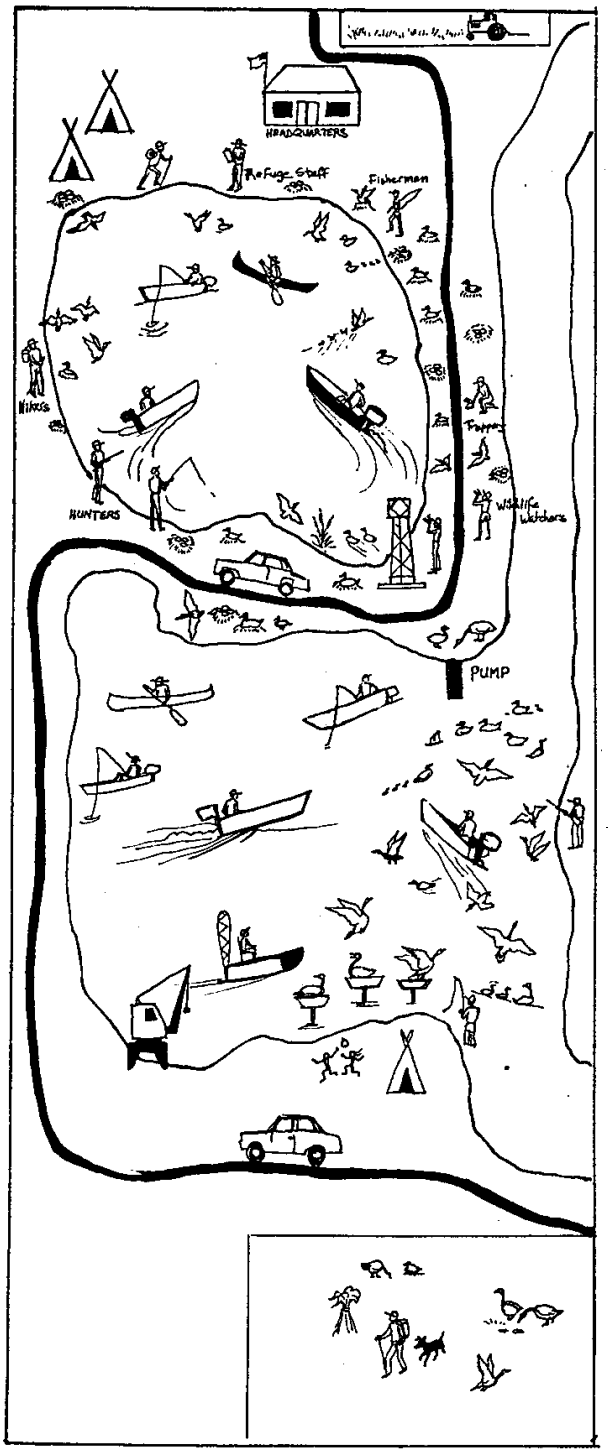


Spring and Summer

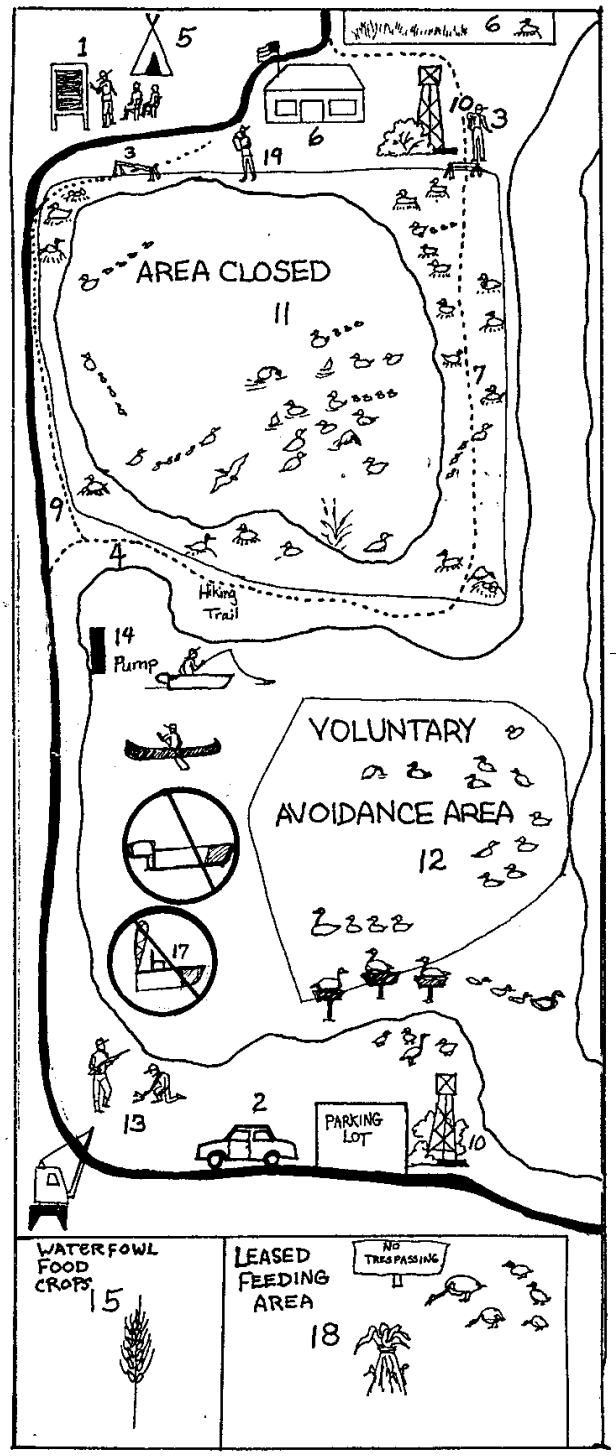
Ducks nest along dikes and in the uplands, and geese nest in tubs on end of lake. Fewer pairs are nesting each year, and many nests are abandoned or destroyed. Predation rates are high, especially in disturbed areas. Disturbance factors seem to be automobiles on tour routes, anglers on shores and in boats on the lake, hikers on trails, and users of the observation tower.

Females hatch large clutches, but survival of young is lower than expected.

Fall and winter

The lake is an important staging area for several species of diving ducks; large numbers of ducks and geese feed in the uplands on and around the refuge. Waterfowl numbers are decreasing despite favorable habitat. The frequency of human disturbance seems to have increased, especially from hunters, late season anglers and boaters, the auto tour, hikers, and wildlife watchers. It is also apparent that refuge staff are spending a lot of time working on minor projects.

Fig. 1. Example of waterfowl refuge with excessive level of human disturbance of waterfowl.



Spring and summer

- Provide educational information so that the public knows the effects of disturbances on the predominant species.
- Seasonally close or restrict use of auto tour. Users of auto tour must stay in vehicles and stop in only designated parking areas.
- Seasonally close or restrict use of hiking and canoe trails.
- Close or restrict the fishing season during peak nesting period.
- Permit camping in only designated areas.
- Delay hay cutting until most clutches have hatched.
- Prioritize and limit special use permits.
- Limit access until most young waterfowl are three weeks old.

Fall and winter

- Provide educational information so that the public knows the migration and wintering requirements of the predominant species.
- Reroute auto tour to areas of secondary importance to waterfowl.
- Move or screen observation towers.
- Close selected areas of the refuge to public access.
- Create voluntary avoidance areas on federal and state waterways.
- Modify regulations to restrict disturbances from hunting and trapping.
- Move water pumping stations away from bird concentration areas.
- Raise high quality waterfowl foods on refuge land.
- Limit size and horsepower of boats on the lake.
- Disallow use of airboats.
- Obtain short term leases and prevent trespass on private lands that contain waste grain.
- Limit the time that refuge staff spend in high waterfowl use areas.
- Delay construction until non peak seasons.

Fig. 2. Examples of management practices that have reduced the level of human disturbance of waterfowl at a refuge.

Appendix. Common and Scientific Names of Birds Named in Text.

Ducks	
Northern shoveler	*Anas clypeata*
Green-winged teal	*Anas crecca*
Mallard	*Anas platyrhynchos*
American black duck	*Anas rubripes*
Lesser scaup	*Aythya affinis*
Ring-necked duck	*Aythya collaris*
Common pochard	*Aythya ferina*
Tufted duck	*Aythya fuligula*
Canvasback	*Aythya valisineria*
White-winged scoter	*Melanitta fusca*
Common eider	*Somateria mollissima*
Geese	
Pink-footed goose	*Anser brachyrhynchus*
Snow goose	*Anser caerulescens*
Brant	*Branta bernicla*
Canada goose	*Branta canadensis*
Cackling Canada goose	*Branta canadensis minima*
Swans	
Trumpeter swan	*Cygnus buccinator*
Tundra swan	*Cygnus columbianus*
Other	
American coot	*Fulica americana*
Herring gull	*Larus argentatus*
Great black-backed gull	*Larus marinus*
Parasitic jaeger	*Stercorarius parasiticus*

Note: Use of trade names does not imply U.S. Government endorsement of commercial products.

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
***Fish and Wildlife Leaflet* 13**
Washington, D.C. • 1992