LOON PRODUCTIVITY, HUMAN DISTURBANCE, AND PESTICIDE RESIDUES IN NORTHERN MINNESOTA

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Olson (Olson and Marshall 1952) studied the Common Loon (*Gavia immer*) in the Knife Lake area of the Superior National Forest of Minnesota during 1950. Magnus and Karns (unpublished cooperative survey, Superior National Forest and the Minnesota Department of Conservation, Division of Game and Fish) later found decreased loon reproduction in the same area. I participated in the latter survey in 1966 and 1967. During 4 months of work and travel by canoe through the Boundary Waters Canoe Area (BWCA) from 1 July until 1 November 1966, I did not observe young loons. Massive loon die-offs in Lake Michigan during the falls of 1963, 1964, and 1965 gave additional cause for concern for the loon populations, although those loons as well as many gulls apparently died of poisoning from *Clostridium botulinum* Type E (Fay 1966).

I initiated the present study in order to further document the status of the Common Loon population in the Superior National Forest and to evaluate the possibilities that decline in the population might be related to pesticide contamination and/or increased human activity in the area.

METHODS

Observations were made on as many pairs of loons in the Superior National Forest as possible. Travel in the BWCA was coordinated with the ecological survey team of the North Central Forest Experiment Station (NCFES). This team was working on a 10-days-on and 4-days-off schedule, making 8-day canoe trips into the BWCA. During the 4 "off" days, territories of loons which were accessible by road or less than 1 day's canoe paddle were visited. In this manner, 2 readily accessible loon territories were kept under surveillance throughout the summer. Methods and distances made systematic observations on all known loon territories impossible. However, most pairs were observed for several days and at more than one time during the summer. Supplementary observations were contributed by members of the ecological survey team of the NCFES who were traveling separately from me.

Five fish, 5 loon eggs, and tissues from 3 loons I collected in the BWCA were analyzed by the Wisconsin Alumni Research Foundation for pesticide residues. One smallmouth bass (*Micropterus dolomieui*), 3 northern pike (*Esox lucius*), and a walleye pike (*Stizostedion vitreum*) from 5 different lakes with loon populations were analyzed. Four of the loon eggs obtained for analysis were being incubated and apparently viable. The fifth (abandoned) had a slight crack and was putrid at the time of collection. Two immature loons were shot and appeared to have been healthy. Each came from a nest in which 2 young had been produced. A mature bird was found dead and tangled in aquatic vegetation at Burntside Lake. It had buckshot embedded in its neck and I presumed that this was the cause of death. This loon had been killed

TABLE 1

LOON PRODUCTIVITY IN THE KNIFE LAKE CHAIN

Year	No. territories checked	No. young loons
1950*	42	21
1964**	45	19
1965	31	10
1966	21	1 (plus 4 unhatched eggs)
1967	49	5 (plus 1 pipped egg)

* Olson and Marshall 1950.
** Magnus and Karns, unpublished data, 1964–1967.

very recently and showed no signs of decomposition. Samples of fat, liver, brain, and breast muscle were analyzed for each of the loons.

RESULTS

We observed 85 loon territories in the Superior National Forest between 1 May and 15 October, 1967. The majority of these were on lakes in the BWCA and inaccessible by road. Many territories were observed too early in the summer to ascertain reproductive success. Thirty-six pairs of loons were known to have attempted nesting and, of these, 11 pairs successfully hatched 18 young. Two of the 18 young were collected for pesticide residue analyses. The figure of 18 young for 36 pairs of loons is a biased record since assisting teams on several occasions reported territories where young loons were present, but did not report all of the territories they observed which were occupied by adults only. I checked several territories where young had been observed by other parties. Omitting this bias, 6 young were produced by 31 pairs of loons. Renesting was observed in both pairs which were under observation throughout the summer, however neither pair brought off young.

Forty-nine of the 85 loon territories observed in 1967 were in the Knife Lake chain. Table 1 presents loon productivity data for this area from 1950 through 1967.

The number of paddling canoeists using the BWCA increased 54% from 1961 to 1966. Motoring canoeists increased 44% during the same period (Lucas 1967). On some major canoe routes, over 14,000 people travel through in a summer. On some lakes, nearly every suitable site is used for camping. When fishing season opens the last of May, nearly every campsite is occupied on lakes which are known to have good fishing and are accessible by motor. All of the loon nests we found were on islands

TABLE 2

RESIDUE ANALYSES PPM LIPID WEIGHT

		DDE	DDD	PP'DDT	Dieldrin
Loon #5444	Muscle	4.13	1.01	1.11	<.52
	Liver	4.71	2.25	1.12	<.72
	Brain	1.72	<.37	.49	<.37
	Fat	4.07	.65	1.48	<.02
Loon #5445	Muscle	3.23	.88	.91	<.59
	Liver	2.68	<.72	<.72	<.72
	Brain	4.83	1.48	2.76	<.49
	Fat	3.22	1.59	.68	<.03
Loon #5446	Muscle	1030.88	797.06	69.49	18.27
	Liver	1214.49	1023.83	25.36	23.83
	Brain	552.2	265.56	530.00	6.56
	Fat	1624.43	685.52	1469.01	5.44
Loon eggs	1	176.29	5.96	16.26	4.97
	2	323.88	.64	1.80	16.19
	3	240.51	16.95	40.89	8.26
	4	223.83	12.89	32.55	4.56
	5	173.31	19.23	25.04	5.97
Fish	1	11.66	3.50	2.94	13.92
	2	12.53	6.98	6.77	<1.39
	3	14.21	2.79	4.83	<1.24
	4	6.85	<3.70	<3.89	<3.70
	5	6.05	1.09	9.07	<.34

or sedge mats. Nine of the 18 nests we located were on campsite islands or on islands that had been used for lunch stops as indicated by fireplaces. Six of these nests were unsuccessful. Hatching results were not known for the remaining 3, but the chances of successfully hatching eggs seemed very slim for 2 of these. The third was on a large island on the far side from the campsite and may have been successful.

On an island campsite in Agnes Lake, fishermen were seen throwing fish entrails into an alder thicket 0.3 m from a loon nest. Subsequently, ravens (*Corvus corax*) arrived and began to eat the fish remains. I collected the egg for pesticide residue analysis. Loons do not actively defend their nests. They may either sneak off the nest at the approach of intruders or display, racing on the water surface and treading water and calling, attempting to draw the intruders away. They return to disturbed nests only after a considerable period of time, leaving the eggs subject to predation by crows

(*Corvus brachyrhynchos*), ravens, otter (*Lutra canadensis*), muskrat (*Ondatra zibethica*), etc. We found several nests with pieces of eggshell in them and no young loons surviving. In one territory 2 eggs had holes pecked in them, apparently by crows or ravens. The eggs had been pushed off the nest into the surrounding sweet gale (*Myrica gale*). In another instance, eggshell was found in the water in front of the nest, suggesting an otter may have been responsible. One abandoned nest contained an egg which was cracked, perhaps by an adult loon leaving the nest hastily.

The Boundary Waters Canoe Area has not been sprayed since 1963. Lakes peripheral to the BWCA, where resorts and summer homes are located, are sprayed regularly throughout the summer. Personal communication with property owners and personal observation on Burntside Lake in 1967 indicated that mosquitoes and black flies were no problem around this lake in spite of the fact that the habitat was excellent and in 1967 these insect populations were high. Apparently spraying occurred several times during the summer on this lake and probably many others. Some of these pesticides arrive in the BWCA either directly or through drainage patterns and animal movement.

The results of the pesticide residue analyses on a lipid weight basis are presented in Table 2.

DISCUSSION

Water clarity and physiographic features of lakes in the study area have remained constant and therefore do not explain the decline in reproduction. Changes in fish abundance and species composition in these lakes are not known. Two factors affecting loons have changed significantly. One is the increased number of human visitors at a critical time of year and the other is the spraying of pesticides.

The opening of fishing season coincides with the beginning of the loon nesting season. Loons are more inclined to desert their nests when disturbed early in the nesting season than after incubation has progressed (Olson and Marshall 1952). So, at the time when loons are most susceptible to disturbance, many lakes have every campsite occupied and new ones being made by fishermen.

Canoeists favor island campsites and loons prefer to nest on islands of 1 ha or less. Of 54 nests located by Olson, 50 were on islands. The use of nesting islands for campsites may be a key factor limiting loon reproduction in the BWCA. In most cases, campers do not destroy eggs or even locate nests, but they do, by their mere presence, keep the loons away from their nests. Loon nesting sites are established a week or 2 before the

arrival of the first campers. Fortunately islands which are used for nesting by loons on some lakes are too small and/or marshy to attract people.

The loon eggs and fish analyzed for pesticide residues gave fairly constant results in spite of the fact that they were collected from widely separated lakes. The immature loons collected on Tofte Lake (#5444) and Hub Lake (#5445) gave similar, comparatively low results. The adult female (#5446), found dead on Burntside Lake, was highly contaminated (Table 2).

Since the young birds were not yet able to fly, the pesticides they contained came either from their parents or from the lake on which they were taken. Hub Lake is fairly inaccessible; Tofte can be reached by road and has a cabin on it. The mature bird from Burntside Lake could have been contaminated from many sources: on the wintering grounds, during migration, and from any lakes on which she fed during the summer.

The DDT residue levels in loons 5444 and 5445 are similar to those given by Locke and Bagley (1965) for loons killed by botulism. Loon 5446 certainly contained residue levels that would be considered fatal on the basis of studies of other species of birds (Stickel et al. 1966). The loon eggs contained residues of DDE within the range of other aquatic bird eggs recorded by Faber and Hickey (1973).

Loons in the BWCA are to some degree affected by high levels of pesticide residues, but the main factor limiting reproduction appears to be the disturbance of nesting sites by canoeists.

SUMMARY

In recent years there has been a decline in loon reproduction in the Superior National Forest. The biota of certain lakes in the Superior National Forest on which resorts are located contain high concentrations of pesticides and these may affect reproductive success of loons, but, the most important factor seems to be the increasing number of canoeists in the area. Virtually every island in some of the lakes is occupied several times a week by campers during the critical early nesting period. Campers usually do not destroy loon eggs directly, but do frighten loons off of their nests, leaving them susceptible to predators.

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Dr. Harry M. Ohlendorf is now a life member of the Wilson Ornithological Society. Dr. Ohlendorf is presently a wildlife research biologist and assistant director of the Patuxent Wildlife Research Center. His principal interests in ornithology are the effects of environmental contaminants on fish-eating birds. He has published several of his studies, including 2 papers on flycatchers that have appeared in recent issues of the Wilson Bulletin. In addition to his ornithological interests, Dr. Ohlendorf enjoys gardening, canoeing, and woodworking.