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NESTING ACTIVITY OF YELLOW-BILLED LOONS ON THE COLVILLE RIVER DELTA, ALASKA, AFTER THE *EXXON VALDEZ* OIL SPILL

REBECCA FIELD,[1] MICHAEL R. NORTH,[2] AND JUDITH WELLS[3]

ABSTRACT.—During the summer after the *Exxon Valdez* oil spill in Prince William Sound in March 1989, we surveyed Yellow-billed Loons (*Gavia adamsii*) on lakes in the Colville River delta in northern Alaska. A study in 1983–1984 documenting nesting activity in the same area provided a baseline for comparisons of possible effects of the spill on nesting activity. Density of adult loons in 1989 was similar to densities in 1983–1984. We located 26 pairs of Yellow-billed Loons in 29 nesting territories. However, only 42% of the loon pairs nested in 1989, compared to 76% nesting pairs in 1983 and 79% in 1984. *Received 2 June 1992, accepted 5 Nov. 1992.*

The Yellow-billed Loon (*Gavia adamsii*) is the rarest of the four loon species that breed in Alaska (Derksen et al. 1981, Armstrong 1983, Scott 1983). The population estimate for Alaska is about 5000 Yellow-billed Loons (King 1979) and the estimate of the worldwide population is less than 10,000 (Alaska Dept. Environ. Conservation 1990). Nest sites of the loon, distributed in patches throughout the Arctic (Armstrong 1983, Scott 1983), are concentrated in the Colville River delta (Fig. 1; Pitelka 1974, Derksen et al. 1981, Sage 1971, North and Ryan 1988, Gerhardt et al. 1988). Although single or scattered Yellow-billed Loon nests have been observed throughout northern and western Alaska, the Alaktak area (80 km southeast of Point Barrow) is the only other location in Alaska with known concentrations of Yellow-billed Loons (Sjolander and Agren 1976).

In March 1989, the *Exxon Valdez* ran aground in Prince William Sound on the southern coast of Alaska, spilling approximately 11 million gallons of oil (Trustee Council 1990). Oil drifted over more than 30,000 km^2 of coastal and offshore areas in the northern Gulf of Alaska (Piatt et al. 1990). After the spill, proportionately more (8.7%) loons in the sound were killed by the oil than were represented in prespill surveys (1.4%) (Piatt et al. 1990). During the month after the spill, density of loons declined around heavily oiled islands but increased in unaffected inlets and bays (Piatt et al. 1990). By September 1989, 87 Yellow-billed Loon carcasses had been retrieved from the spill area, representing 26.6% of identified loon species (Table 1, J. Piatt pers. comm.). Assuming retrieved

[1] U.S. Fish and Wildlife Service, Massachusetts Cooperative Fish and Wildlife Research Unit, Univ. of Massachusetts, Amherst, Massachusetts 01003.
[2] U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Anchorage, Alaska 99501.
[3] Dept. of Forestry and Wildlife Management, Univ. of Massachusetts, Amherst, Massachusetts 01003.

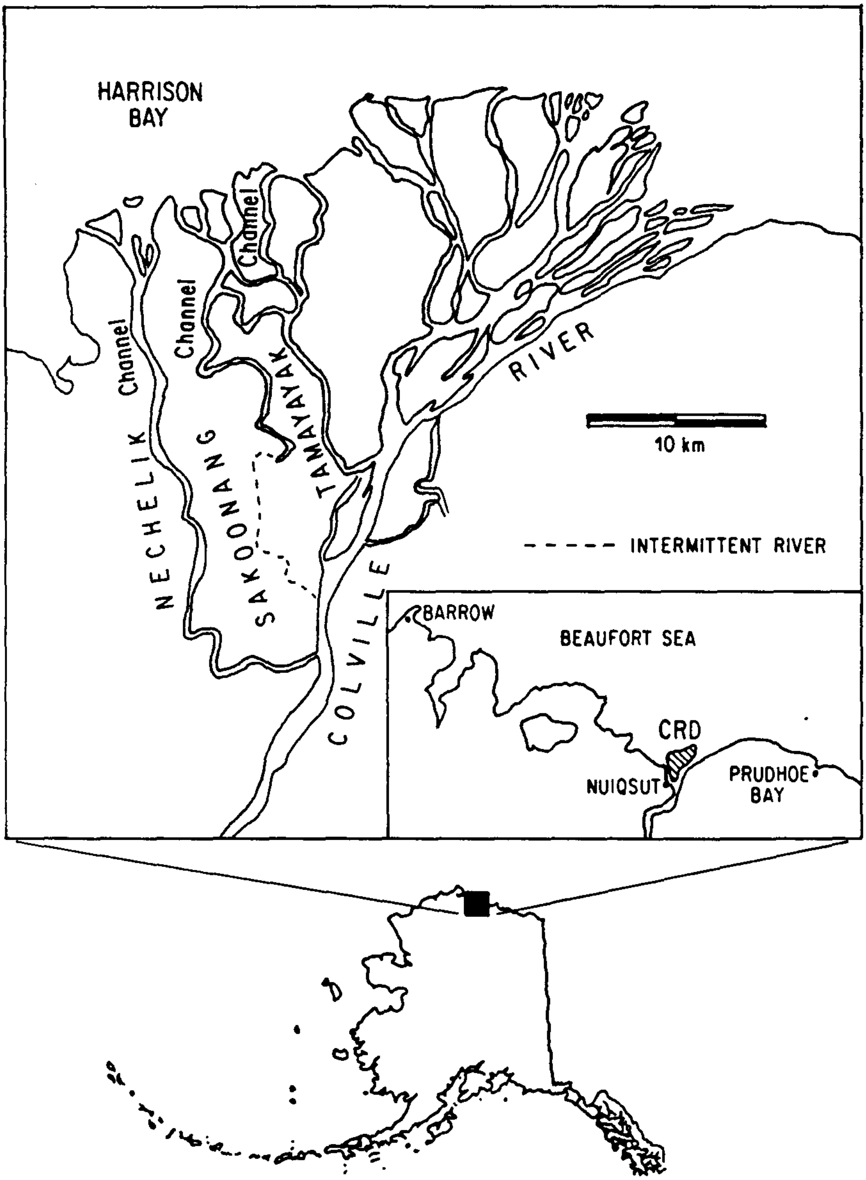

FIG. 1. Map of the Colville River delta (CRD) with inserts showing location in the central, northern coast of Alaska.

TABLE 1
NUMBERS OF LOONS KILLED BY THE *EXXON VALDEZ* OIL SPILL, MARCH 1989[a]

	Number recovered	Percent[b]
Common Loon	216	66.2
Yellow-billed Loon	87	26.6
Pacific Loon	18	5.5
Red-throated Loon	5	1.5
Unidentified	69	—
Total loons	395	

[a] U.S. Fish and Wildlife Service, unpublished data, compiled by J. Piatt, Sept. 1989.
[b] Unidentified loons excluded from computations.

birds represented 10–30% of the kill (Piatt et al. 1990), mortality of oiled Yellow-billed Loons may have been 300–900 birds. Yellow-billed Loons in Prince William Sound were listed as a non-alcid species that may have suffered high mortality (Piatt et al. 1990).

In the summer of 1989, we studied nesting Yellow-billed Loons in the same sites on the Colville River delta as those investigated by researchers of the U.S. Fish and Wildlife Service and North Dakota State Univ. in 1983 and 1984 (North 1986, North and Ryan 1988). As in their studies, number of nesting pairs and chicks were determined, and nest sites were mapped. Our objectives were to determine if adult Yellow-billed Loons were present in these sites in the first nesting season after the oil spill, to record nesting activity in previously used territories, and to compare the number of adults and the nesting activities with results from the 1983–1984 study.

STUDY AREA AND METHODS

The Colville River is the major river system of the Alaska North Slope, draining an area of 60,000 km^2 between the Brooks Range and the Beaufort Sea (Walker 1983). The 600-km^2 delta, located 260 km southeast of Point Barrow, Alaska, at 70°19′N, 150°30′W (Walker 1983, Fig. 1), is on continuous permafrost (Walker 1983). Wetlands are extensive on the delta because of low underground drainage, overland runoff, and low evaporation (Sater 1969). Lakes larger than 5 ha cover 16% of the delta surface (Walker 1978). We designed our study after North and Ryan (1988). Twenty-six nest sites in this study were the same as those surveyed in the 1983–1984 survey. We also checked three additional Yellow-billed Loon nest sites located after the earlier study. We conducted the fieldwork 9–16 July 1989. Although we were able to check each territory only once, the timing of the visits was at the end of incubation when loons are most attentive to nest sites and eggs. In 1983, eggs were first sighted on 15 June and, in 1984, on 16 June (North and Ryan 1988). In Yellow-billed Loons, incubation takes 27–29 days (Sjolander and Agren 1976, North and Ryan 1988), so we estimated that the second week in July was the third week of incubation for most breeding pairs. Because Yellow-billed Loons are wary during nesting (Sage 1971, Sjolander and Agren

1976), we observed them from a minimum distance of 25 m before we approached them on foot or by boat for better observation. We recorded the territory as not active if a nest was not sighted within about 100 m of a previous nesting site and adults were either not present or, based on behavior, seemed not to be nesting. When we were unable to locate nests, we distinguished nesting from non-nesting birds by behavioral differences. When approached, a nesting pair either lies low in the water near the nests or dives and surfaces at a distance (Sage 1971, Sjolander and Agren 1976, Titus and VanDruff 1981, North 1986). Nonbreeding pairs, however, remain undisturbed and continue swimming together. We observed that pairs that lost their young usually swim independently of each other with little interaction.

We used the z-test statistic to test significance in nesting effort (E) in 1983–1984 vs 1989, H_o: $E_{83-84} = E_{89}$ vs H_o: $E_{83-84} > E_{89}$ (Brownie et al. 1978). We did not include the covariance term in the formula from Brownie et al. (1978) because we were not able to measure the covariance in the nesting effort between 1983 and 1984. If there had been any, it would probably have been positive (loons successful in 1983 would more likely be successful in 1984) which would have increased the value of z. To reject the null hypothesis at the 5% level, z must be greater than 1.645 (Brownie et al. 1978). This statistic was also used to compare proportions of nesting adults in 1983 and 1984, using the formula modified for a two-year comparison (Brownie et al. 1978).

RESULTS

Twenty-six of 29 known territories were occupied by pairs of Yellow-billed Loons (Table 2). Three vacant nesting territories had been occupied during the earlier study (North and Ryan 1988). One of the vacant territories was occupied by two pairs of Pacific Loons (*G. pacifica*). Only 11 (42%) of 26 pairs of Yellow-billed Loons nested in 1989 (Table 2), compared to 76% in 1983 and 79% in 1984. We concluded that clutches from two of the active nests had been destroyed because we saw fresh eggshell fragments at the nest. Our assumptions were supported by the behavior of the adults which were swimming independently of one another on an adjacent lake. Inaccessibility of nests or proximity of potential predators precluded counting eggs of three other active nests. The six checked nests had a total of 11 eggs. Proportions of nesting adult loons did not differ significantly between 1983 and 1984 ($z = 0.26$). However, the proportion in 1989 was significantly less than in 1983–1984 combined ($z = 3.20$).

DISCUSSION

Densities of adult Yellow-billed Loons during our study in the Colville River delta were similar to densities in 1983–1984 (North and Ryan 1988). In three vacant territories, the adults may have been away during our survey in two cases, although this was unlikely given the stage of the nesting cycle. We conclude that the third territory was not occupied because of Pacific Loons in the area. Yellow-billed Loons do not tolerate Pacific Loons in their territories and act aggressively towards them (Sage 1971, North 1986). The loons that we observed may have included some

TABLE 2
NESTING STATUS OF YELLOW-BILLED LOON PAIRS OBSERVED ON THE COLVILLE RIVER DELTA, ALASKA, IN 1983, 1984, AND 1989

	1983	1984	1989
Checked territories	25	28	29
Located pairs	25	28	26
Nesting pairs	19	22	11
Non-nesting pairs	6	6	15
Nesting pairs	76%	79%	42%

of the individuals observed in the 1983–1984 study (North and Ryan 1988). Loon pair bonds can last for years (Sjolander 1978), and loons appear to return to their previous nesting territories (McIntyre 1974). Strong and colleagues (Strong and Lutz 1986, Strong et al. 1987) reported reuse of specific nest bowls by Common Loons (*G. immer*), and speculated that most pairs probably return to the same territory each year. However, for Arctic (*G. arctica*) and Red-throated (*G. stellata*) loons in the Northwest Territories, Davis (1972) reported little fidelity to nest ponds, much less specific nest sites.

Although we observed adult Yellow-billed Loons in most breeding territories in the Colville River delta in 1989, fewer pairs nested than in 1983–1984. There was a difference of 34–37% in proportion of nesting pairs between 1989 and the two previous years (Table 2). Some variation in nesting effort would be expected from annual fluctuations. While little is known about annual variation in Yellow-billed Loon nesting activities, Dickson (1992) reported a range of 52–89% of Red-throated Loon pairs nesting over five years at five locations in the Mackenzie River delta, Canada. He concluded that only large changes in productivity (31–43% for a 95% certainty) would be indicative of human impacts because of other breeding variables. The percent of nesting Yellow-billed Loons on the Colville River delta in 1989 (42%) is below the annual variability for Red-throated Loons, and the difference in nesting effort between the 1989 season and the earlier years (1983–1984) is within Dickson's (1992) range of large changes, suggesting a major impact on the nesting population.

There are several likely factors that would cause results showing occupied nest territories but low productivity. The most conspicuous factor is possible impacts of the *Exxon Valdez* oil spill. If loons on the Colville River delta had overwintered in Prince William Sound or migrated through that area, the oil spill may have affected nesting success. Loons are considered a species with high susceptibility to oil toxicosis (Gullett 1987).

King and Sanger (1979) assigned Yellow-billed Loons an oil vulnerability index of 65, the highest among loon species and higher than the average of 51 for 128 bird species in the Northeast Pacific Region.

Direct mortality from the oil spill may have altered the age structure of the nesting population. If adults had not survived into the breeding season, vacant nesting territories may have been quickly filled with newly paired loons. Croskery (1988) reported that Common Loon territories in northwestern Ontario were filled within a few days after removal of the original pair. Available birds would have been present on the Colville River delta if the habitat was saturated with nesting loons, a conclusion drawn from North's study (1986). The oil spill may also have had sublethal effects on reproductive success. Adult loons that contacted the oil but survived to the nesting grounds may have ingested small amounts of oil or transferred oil residues to eggs. Hoffman and Albers (1984) found that Prudhoe Bay crude applied to Mallard (*Anas platyrhynchos*) eggs was less toxic than other crude oils but still caused embryotoxicity.

There are several other possible but less likely explanations for lower breeding effort in 1989. Some pairs may have lost their first clutch and repeated nesting later in the season after our fieldwork. However, despite occasional renesting attempts (Sjolander and Agren 1976), Yellow-billed Loons commonly have single broods; a replacement brood is improbable in northern Alaska because of the short Arctic breeding season (Sage 1971, Harrison 1978, North 1986). Some pairs may have elected not to breed in 1989. Small percentages of Common Loons in southern Alaska maintain territories but nest only every fourth or fifth year (N. Tankersley, pers. comm.). However, the large number of non-nesting Yellow-billed Loons on the Colville River delta in 1989 suggests that causal factors were affecting the population, not just individual pairs. Weather conditions can influence breeding activities of the loons on the delta. In a late spring, Red-throated Loons delayed nest initiation and fewer pairs (71% vs 88–92%) laid eggs (Dickson 1992). The decrease in proportion of nesting loons between our study and the earlier study on the Colville River delta was greater than that reported by Dickson (1992), and the weather conditions in the summer of 1989 were relatively mild and storm-free (D. Gibson, pers. comm.).

Without marked birds from the Colville River delta, we cannot be sure that these Yellow-billed Loons overwintered in or migrated through Prince William Sound, causing us to be cautious about conclusions on the impact of the oil spill. However, the Yellow-billed Loon population will continue to be threatened by oil spills because of its small size, low reproductive rate, and use of coastal habitat during winter and migration.

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LITERATURE CITED

ALASKA DEPT. ENVIRON. CONSERVATION. 1990. Loon species hard hit by oil spill. Oil Spill Chronicle 2(17):3.

ARMSTRONG, R. H. 1983. Guide to the birds of Alaska. Alaska Northwest Publishing Co., Anchorage, Alaska.

BROWNIE, C., D. R. ANDERSON, K. P. BURNHAM, AND D. S. ROBSON. 1978. Statistical inference from band recovery data—a handbook. Resource Pub. 131. U.S. Fish and Wildl. Serv., Washington, D.C.

CROSKERY, P. R. 1988. Reoccupation of Common Loon, *Gavia immer,* territories following removal of the resident pair. Can. Field-Nat. 102:264–265.

DAVIS, R. A. 1972. A comparative study of the use of habitat by Arctic Loons and Red-throated Loons. Ph.D. diss., Univ. Western Ontario, London, Canada.

DERKSEN, D. V., T. C. ROTHE, AND W. D. ELDRIDGE. 1981. Use of wetland habitats by birds in the National Petroleum Reserve-Alaska. Resource Pub. 141. U.S. Fish and Wildl. Serv., Anchorage, Alaska.

DICKSON, D. L. 1992. The Red-throated Loon as an indicator of environmental quality. Occasional Paper no. 73. Canadian Wildl. Serv., Ottawa, Ontario.

GERHARDT, F., R. FIELD, AND J. PARKER. 1988. Bird-habitat associations on the North Slope, Alaska: chronological species summaries, 1987. U.S. Fish and Wildl. Serv., Anchorage, Alaska.

GULLETT, P. A. 1987. Oil toxicosis. Pp. 191–196 *in* Field guide to wildlife diseases: Vol. 1. General field procedures and diseases of migratory birds. (M. Friend, ed.). Resource Pub. 167. U.S. Fish and Wildl. Serv., Washington, D.C.

HARRISON, C. 1978. A field guide to the nests, eggs, and nestlings of North American birds. Stephen Greene Press, Brattleboro, Vermont.

HOFFMAN, D. J. AND P. H. ALBERS. 1984. Evaluation of potential embryotoxicity and teratogenicity of 42 herbicides, insecticides, and petroleum contaminants to Mallard eggs. Arch. Environ. Contam. Toxicol. 13:15–27.

KING, J. G. AND G. A. SANGER. 1979. Oil vulnerability index for marine oriented birds. Pp. 227–239 *in* Conservation of marine birds of northern North America. (J. C. Bartonek and D. N. Nettleship, eds.). U.S. Fish and Wildl. Serv. Wildl. Res. Rep. 11, Washington, D.C.

KING, R. 1979. Results of serial surveys of migratory birds on National Petroleum Reserve-Alaska, in 1977 and 1978. Pp. 187–226 *in* Studies of selected wildlife and fish and their habitats on and adjacent to the National Petroleum Reserve in Alaska 1977–1978. Vol. 1. Field Study 3. U.S. Dept. Interior. Nat. Petroleum Reserve in Alaska, 105(c) Land Use Study, Anchorage, Alaska.

MCINTYRE, J. W. 1974. Territorial affinity of a Common Loon. Bird Banding 45:178.

NORTH, M. R. 1986. Breeding biology of Yellow-billed Loons on the Colville River delta, arctic Alaska. M.S. thesis, North Dakota State Univ., Fargo, North Dakota.

——— AND M. R. RYAN. 1988. Yellow-billed Loon, *Gavia adamsii,* breeding chronology and reproductive success in arctic Alaska. Can. Field- Nat. 102:485–490.

PIATT, J. F., C. J. LENSINK, W. BUTLER, M. KENDZIOREK, AND D. R. NYSEWANDER. 1990. Immediate impact of the 'Exxon Valdez' oil spill on marine birds. Auk 107:387–397.

PITELKA, F. A. 1974. An avifaunal review for the Barrow region and North Slope of arctic Alaska. Arct. Alpine Res. 6:161–184.

SAGE, B. L. 1971. A study of White-billed Divers in Alaska. Brit. Birds 64:519–528.

SATER, J. E. (coordinator). 1969. The Arctic basin, revised edition. The Arctic Institute of North America, Washington, D.C.

SCOTT, S. L. (ed.). 1983. Field guide to the birds of North America. Nat. Geogr. Soc., Washington, D.C.

SJOLANDER, S. 1978. Reproductive behavior of the Black-throated Diver, *Gavia arctica.* Ornis Scand. 9:51–65.

——— AND G. AGREN. 1976. Reproductive behavior of the Yellow-billed Loon, *Gavia adamsii.* Condor 78:454–463.

STRONG, P. I. V. AND B. W. LUTZ. 1986. Strong affinity to an old nest and hatching of an abandoned egg by Common Loons. Passenger Pigeon 48:74–75.

———, J. A. BISSONETTE, AND J. S. FAIR. 1987. Reuse of nesting and nursery areas by Common Loons. J. Wildl. Manage. 51:123–127.

TITUS, J. R. AND L. W. VANDRUFF. 1981. Response of the Common Loon to recreational pressure in the Boundary Waters Canoe Area, northeastern Minnesota. Wildl. Monogr. 79.

TRUSTEE COUNCIL. 1990. The 1990 state/federal natural resource damage assessment and restoration plan for the *Exxon Valdez* oil spill. Juneau, Alaska.

WALKER, H. J. 1978. Lake tapping in the Colville River delta, Alaska. Pp. 233–238 *in* Proc. Third Int. Conf. on Permafrost, Edmonton, Alberta, Vol. 1. Nat. Res. Council, Ottawa, Ontario, Canada.

———. 1983. Guidebook to permafrost and related features of the Colville River delta, Alaska. Guidebook 2. Fourth Int. Conf. on Permafrost, Fairbanks, Alaska. Alaska Div. Geol. Geophy. Surveys, Juneau, Alaska.