Condor 84:66–70

NESTING ECOLOGY AND PRODUCTION OF WESTERN GREBES AT BEAR RIVER MIGRATORY BIRD REFUGE, UTAH

MARK L. LINDVALL

AND

JESSOP B. LOW

ABSTRACT.—The nesting ecology of Western Grebes (*Aechmophorus occidentalis*) was studied at Bear River Migratory Bird Refuge, Utah, in 1973 and 1974. Western Grebes nested on dry land, emergent vegetation, and in open-water areas in colonies and single nests. They selected sites near open water (approximately 30 cm in depth). At least one young hatched in 21% of the nests. Avian predation and abandonment of nests caused the largest losses. Mated pairs produced an average of 1.7 young.

Western Grebe nesting habits have been described by several authors. Bent (1919) characterized nests in North Dakota, California, and Saskatchewan, as floating in emergent vegetation. In Oregon, Finley (1907) found three or four eggs to be the usual clutch size. Palmer (1962) summarized available information on the courtship behavior, range, plumage characteristics, nesting habits, and food habits. Herman et al. (1969) and Rudd and Herman (1972) described the effects of DDT contamination on Western Grebes, and Lindvall and Low (1979, 1980) reported on organochlorine pesticide and PCB residues in these grebes.

Because the breeding biology of Western Grebes has received little comprehensive study and may be affected by pesticides, we wished to further investigate reproductive success. In 1973 and 1974 we examined nests and nesting habitat and investigated causes of nest loss at Bear River Migratory Bird Refuge.

STUDY AREA AND METHODS

Bear River Migratory Bird Refuge is 25 km west of Brigham City, Utah, on the northern edge of the Great Salt Lake. Water from the Bear and Malad rivers is held in five large impoundments at the refuge by a system of dikes and canals. The refuge contains 9,268 ha of open water, and 5,811 ha of marsh. The marsh most nearly fits the class IV (semipermanent ponds or lakes), D (brackish), cover type 4 (open water or bare soil on 95% of the wetland area) according to the classification of Stewart and Kantrud (1971). Narrowleaf cattail (*Typha augustifolia*), hardstem bulrush (*Scirpus acutus*), alkali bulrushes (*Scirpus americanus* and *S. paludosus*), saltgrass (*Distichlis stricta*), and pondweed (*Potamogeton* spp.) are the predominant plants. Water depth in the five refuge units ranges from a few centimeters at the heads of the units, to approximately 50 cm in the center of each unit, and to over 2 m along the dikes and canals. Hot dry summers are usual with an average annual precipitation of 34 cm. The average minimum summer temperature is 19°C, and the average maximum temperature is 37°C.

We located Western Grebe nests by driving along the dikes or by rowing a small boat along marshy edges. Most nests were built along the edge of the deeper water and were easily found. Nests were marked with a nest number on a stake in nearby vegetation, and were visited at three- or four-day intervals to collect data on nesting habitat and nest success. Fate of eggs was determined by examination for egg membrane caps and the presence or absence of yolk in the nest. Nests in colonies were observed mostly from a blind; adult attentiveness and activities and nest predation were noted.

Broods and adults were censused weekly throughout the summer by counting all birds seen from dike roads. In 1974 regular stops were made on the outside unit boundaries to scan the far sides of the refuge impoundments. Using this method, most of the water area of the refuge was covered.

We classified grebes as: adults, class 1 young (on parent's back), class 2 young (free-swimming downy young), or class 3 young (showing black on the head and neck). Because class 1 young were often concealed under a parent's wings and back feathers, they were often difficult to count at a distance. Adult birds were often known to have young on their backs but estimating numbers was difficult. Class 3 birds, especially at later stages of development, resemble adults and thus were difficult to classify. Class 2 birds were the most conspicuous and thus presented the best estimate as to trends in breeding numbers and success of nesting.

Young remained in class 2 for approximately two weeks. By adding the actual counts from every other survey week minus a correction factor (for those birds that may have been counted twice), we obtained an estimate of class 2 production. The correction factor for a weekly survey was one-seventh of the class 2 total from the survey that preceded by two weeks the survey being corrected. One-seventh was used because if a class 2 young were to be counted twice, it would have to become a class 2 on the day of the first week's survey. We assumed that one-seventh of the young on each survey were just entering class 2. A weekly count thus equaled the actual count minus one-seventh the actual count of the survey made two weeks previously.

Western Grebes occur in two color phases (Storer 1965). We conducted two surveys in 1973 to determine the percent of the population in each phase and whether birds bred only with those of the same phase. Birds were classified as "dark phase" if the black of the crown extended below the eye and as "light phase" if the black of the crown ended at a level above the eye. Light-phase birds usually have a paler, more dappled color on the back than dark-phase birds. Birds were considered paired if swimming close together with no other birds nearby. All single birds and birds in flocks where pairing was not evident were counted as unpaired.

RESULTS AND DISCUSSION

ADULT POPULATIONS

Western Grebes arrived at Bear River Refuge in late March and numbers steadily increased throughout the spring and summer. Survey data collected in 1974 indicated an adult population between 11 June and 30 July of about 690 birds. In August and September, numbers rose with the inclusion of young in the adult class and the arrival of migrants from other areas (Fig. 1). Many birds remained on the Refuge until mid-October, after which most of them departed. By the end of November, a few stragglers remained and occasionally a few remained through the winter.

Twelve percent of the birds (103 of 717 birds) were light phase and the remainder dark phase. Of 161 pairs seen on two days, only one consisted of a light and a dark phase bird. If the birds were mating irrespective of color phase, 35 of the 161 pairs observed would be expected to be dark-light pairs. These results agree with Storer's (1965) finding that the grebes tend strongly to select mates of their own phase.

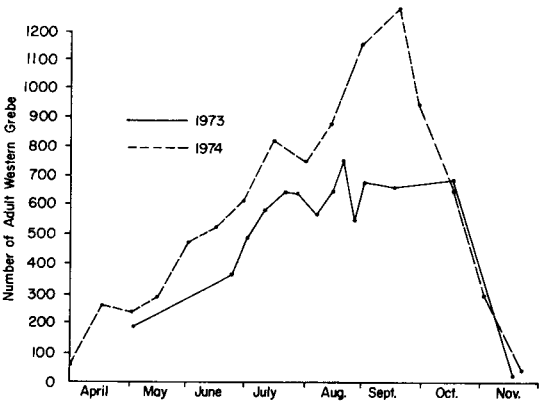

FIGURE 1. Numbers of adult Western Grebes at Bear River Migratory Bird Refuge in 1973 and 1974.

NEST SITE SELECTION

Western Grebes at Bear River Refuge built nests in emergent vegetation, in open water, and on dry land. Nests in emergent vegetation are typical of Western Grebes (Palmer 1962, Herman et al. 1969). Dry-land nesting has been reported by Nero (1959) and Nero et al. (1958), who believed it to be the result of the loss of emergent vegetation. However, Bear River Refuge did not lose emergent vegetation during the study period.

Fifty-four percent of 386 nests were in emergent vegetation (details given in Table 1). Nests were always constructed of materials in

TABLE 1. Nesting materials and surrounding vegetation at Western Grebe nests, Bear River Migratory Bird Refuge, 1973–1974.

	Non-colony nests	Colony nests
Nesting materials		
Hardstem bulrush	16	92
Cattail	4	27
Hardstem bulrush-cattail	5	6
Saltgrass	3	7
Hardstem bulrush-saltgrass	2	1
Alkali bulrush	2	61
Cattail-saltgrass	0	2
Sago pondweed	0	158
Total	32	354
Surrounding vegetation		
Hardstem bulrush	17	92
Cattail	6	30
Hardstem bulrush-cattail	3	2
Saltgrass	3	7
Sago pondweed	0	158
None	0	5
Hardstem bulrush-saltgrass	2	0
Alkali bulrush	0	60
Cattail-saltgrass	1	0
Total	32	354

TABLE 2. Nest characteristics of Western Grebes at Bear River Migratory Bird Refuge, 1973–1974.

Characteristic	Colony nests	Non-colony nests
Mean distance to open water (m)	0.3	0.1
Mean distance to nearest nest (m)[a]	10	—
Mean distance to land (m)	205	2
Mean depth nearest open water (m)	0.3	0.4
Mean nest diameter (m)	0.4	0.5
Adjacent moving water (no.)	87	9
Adjacent stagnant water (no.)	296	23
Floating nests (no.)	119	4
Non-floating nests (no.)	83	3

[a] Non-colony not included for this variable.

the surrounding vegetation. They were located near open water (average distance 0.4 m) and built on a snag, or resting on the bottom in shallow water (76%), or were floating (24%). The average distance from land of nests built in emergent vegetation was 55 m (Table 2). Most nests were conspicuous and easily observed.

Nests in open water accounted for 41% of the total; they were found in 1973 and 1974 in the same location. These floating raft-like nests were constructed exclusively of pondweed (*Potamogeton* spp.) in stagnant water with no emergent vegetation. The nests were about 70 cm across and extended 30 cm below the water's surface. The nest platforms were approximately 10 cm above water level at the edges and 5 cm in the center. In 1973, Western Grebes nested in dense pondweed beds about 0.8 km from shore in 56 cm of water. Nests were held in place by the dense mat of pondweed surrounding them. In 1974, pondweed was not so dense as in 1973 and the colony was located only 200 m from shore in 29 cm of water. Nests in 1974 were smaller (average diameter 24 cm) and were held in place by contact with the bottom, not anchored in or surrounded by pondweed. This type of nesting has not previously been reported for Western Grebes.

Dry-land nests made up 5% of the total and were made of materials from the surrounding vegetation. Most dry-land nests were located near flowing water (89%) and close to open water (average distance to open water was 4 cm). The average depth of the nearest open water was 21 cm.

Western Grebes selected nest sites near water more than 20 cm deep. They commonly nested in places where emergent vegetation was sparse or lacking. Of 202 nests found in 1974, only three had overhead cover. This was the only trait consistently shared by all three nest types. Bent (1919), Wetmore (1924), Yocum et al. (1958), Davis (1961), and Sturling (1964) also suggested that Western Grebes prefer to nest near or on open water. Nearness to open water could allow for early detection of and rapid escape from predators.

Western Grebes at the Refuge nested singly or in colonies. Colony nests were more easily found and thus single nests (5%) may be underrepresented. Single nests and their placement did not significantly differ from colony nests in terms of water depth, vegetation from which they were constructed, or surrounding vegetation. McCartan and Simmons (1956) reported both colonial and non-colonial nesting for the Great Crested Grebe (*Podiceps cristatus*).

Most (95%) nests were in colonies numbering from 5 to 88 nests. The colonies lined channels into the marshes or the edge of dikes with emergent vegetation, channels without emergent vegetation, edges of large open-water areas, and open-water areas devoid of emergents.

In colonies with 10 or fewer nests, nests were spaced an average of 30 m apart, while colonies larger than 10 nests averaged 15 m or less. Burger (1974) described a similar situation for the White-tufted (*Rollandia rolland*) and Silvery grebes (*Podiceps occipitalis*).

Egg laying, begun in late May, peaked the first half of July (Fig. 2). Clutches started in the peak period 1 to 15 July were a combination of first nestings and renestings. We found evidence of renesting at Bear River Refuge as clutches destroyed by avian predation were replaced. Nero (*in* Palmer 1962) stated that replacement clutches are common in Western Grebes.

Both male and female grebes shared incubation duties as the members of pairs were often seen to replace each other on the nest. The incubation period was 21 to 28 days, averaging 24 days for 14 clutches for which the day of first laying and hatching were known. Bent (1919) reported incubation to be "about 23 days." The average clutch size for 70 complete clutches was 2.6 and ranged from one to four. Herman et al. (1969) found a modal clutch size of three while Nero (*in* Palmer 1962) stated clutches usually numbered three to four. Davis (1961) found many four-, five-, and six-egg clutches. Clutches larger than four eggs were not incubated and we considered them dump nests; however, only three of these dump nests were found. Bent (1919) and Finley (1907) also reported dump nests for Western Grebes.

NESTING SUCCESS

Although we did not monitor open-water nests for success, the fate of 221 colonial and non-

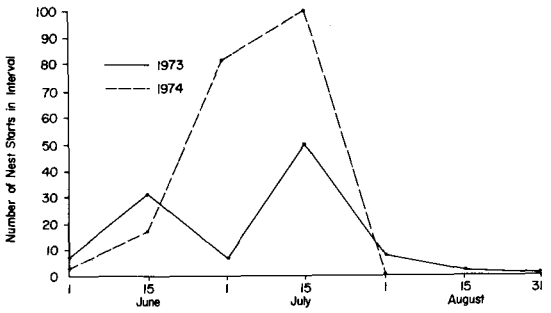

FIGURE 2. Nesting activity of Western Grebes at Bear River Migratory Bird Refuge in 1973 and 1974.

TABLE 3. Fate of Western Grebe nests at Bear River Migratory Bird Refuge, 1973–1974.

Fate	Non-colony nests	Colony nests
Successful nests (some or all eggs hatched)	14	33
Avian predation	14	75
Abandoned	1	9
Flooded and destroyed by wave action	1	10
Lost but cause unknown	1	10
Drop in water level and abandoned	0	56
Unknown fate	1	162
Total	32	355

colonial nests located in vegetation showed that 21% of the clutches hatched at least one young. When disturbed, the grebes did not cover their eggs, thus making an already conspicuous nest even more visible to predators; however, the eggs were generally covered when undisturbed birds left their nests.

Avian predation accounted for 40% of the nest loss (Table 3). American Coots (*Fulica americana*) and California Gulls (*Larus californicus*) were the main nest predators. Egg predation was observed three times, two of which involved human disturbance. Coots were common in the grebe nesting areas and often swam among the grebe nests. In one instance, a coot jumped on an untended nest and ate a portion of one of the eggs. Upon returning to its nest, the grebe picked up the broken egg and deposited it in the water 2 m from the nest. The grebe then left the area and a coot attempted to break the remaining egg. Upon returning an hour later the grebe resumed incubating the remaining egg. In another case, a California Gull made several aerial passes at a grebe nest before removing an egg, which it then dropped on the ground a few meters from the nest.

Yocum et al. (1958) found evidence of egg predation on Western Grebe nests by Ring-billed Gulls (*Larus delawarensis*). McCartan and Simmons (1956) observed predation of Great Crested Grebe nests by European Coots (*Fulica atra*). We believe that some form of disturbance allows predation as we saw Western Grebes defend their nests against both coots and gulls. Disturbance from human activity such as cars, planes, or helicopters sometimes caused birds in the Refuge to leave their nests and swim about the colony. Birds also left their nests for short periods to chase other Western Grebes from the nesting area and to add vegetation to their nests. On rare occasions, they left their nests for several hours.

The (uncontrolled) water level at one large colony dropped 38 cm in less than three weeks, exposing mudflats. Twenty-five percent of the grebes subsequently abandoned their nests. Burger (1974) reported nest losses from flooding in the White-tufted and Silvery grebes. Flooding caused few losses at the Refuge due to the relatively stable water levels. Only 5% of the nests were lost to wave action and flooding.

Abandonment accounted for a loss of 4% of the nests monitored. This figure may be low because abandoned nests may have been destroyed by predators before they were checked, thus being counted as lost owing to predation rather than abandonment.

Nests in open water were not monitored for success because of their vulnerability to predation associated with the resulting disturbance. A California Gull nesting colony and loafing area were located near an open-water grebe colony in 1973; gulls were responsible for some of the grebe egg losses.

BROOD PRODUCTION

Broods were reared in large open-water areas and ditches. The young were fed until they were almost adult size (four to five weeks). After 7 to 10 days of age, young began to spend more time off the backs of parents. However, young remained near the parent birds and climbed on the back of a parent when alarmed.

Young Western Grebes can be classified as to color phase. Dark-phase young began showing black on the head, neck, and back at 12 days of age. Light-phase young did not show black on the head, neck or back until after five or more weeks. At 25 to 35 days of age, the young resembled the adults in size, plumage, and color phase.

The first young were seen on 1 June 1973 and on 28 May 1974, indicating that some birds began pairing and breeding during May, before most of the birds arrived on the nesting grounds. Brood rearing reached a peak in late July (Fig. 3). The peak counts for class 2 young were in August. The last class 1 young were

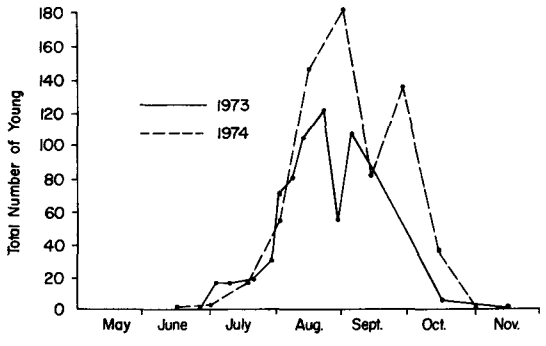

FIGURE 3. Western Grebe young at Bear River Migratory Bird Refuge in 1973 and 1974.

seen in late September. The fate of young hatched this late was unknown. Occasionally a few Western Grebes were icebound in late fall.

In 1973, 158 class 2 young were produced and in 1974, 269. Several indices to reproductive success were computed. One was the number of young per adult. Total class 2 young produced and the number of adults present at breeding time gave an index of 0.35 young per adult. Another indicator of success was the average class 2 brood size per mated pair: this was 1.7. Rudd and Herman (1972) found 1.7 young per mated pair in what they considered a normally reproducing population. In the population at Clear Lake, California, where Rudd and Herman (1972) believed DDD to be affecting reproduction, 1.0 young per mated pair was found.

In most respects the nesting habits of Western Grebes at Bear River Refuge are similar to those of populations studied elsewhere. Nesting in areas with no emergent vegetation and non-colony nests have not been previously reported. Western Grebes at Bear River Refuge have fairly high pesticide and PCB levels (Lindvall and Low 1979, 1980) but appear to be reproducing normally as compared to those studied by Rudd and Herman (1972). Avian predation caused the greatest losses but renesting may have lessened its impact.

ACKNOWLEDGMENTS

This project was funded primarily by the U.S. Fish and Wildlife Service through the Utah Cooperative Wildlife Research Unit. Funding was also provided by The Wildlife Society and the Ecology Center, Utah State University. Special thanks for field supervision and manuscript review are given to John Kadlec, David Capen, Lloyd Gunther, Wayne I. Jensen, and Robert R. Selander.

LITERATURE CITED

BENT, A. C. 1919. Life histories of North American diving birds. U.S. Natl. Mus. Bull. 107.

BURGER, J. 1974. Determinants of colony and nest-site selection in the Silver Grebe (*Podiceps occipitalis*) and Rolland's Grebe (*Rollandia rolland*). Condor 76:301–306.

DAVIS, D. G. 1961. Western Grebe colonies in northern Colorado. Condor 63:265–266.

FINLEY, W. L. 1907. The grebes of southern Oregon. Condor 9:97–101.

HERMAN, S. G., R. L. GARRETT, AND R. L. RUDD. 1969. Pesticides and the Western Grebe, p. 24–55. *In* M. W. Miller and G. G. Berg [eds.], Chemical fallout. Charles C Thomas, Springfield, IL.

LINDVALL, M. L., AND J. B. LOW. 1979. Organochlorine and PCB residues in Western Grebes from Bear River Migratory Bird Refuge, Utah. Bull. Environ. Contam. Toxicol. 22:754–760.

LINDVALL, M. L., AND J. B. LOW. 1980. Effects of DDE, TDE, and PCB's on shell thickness of Western Grebe eggs, Bear River Migratory Bird Refuge, Utah 1973–1974. Pestic. Monit. J. 14:108–111.

MCCARTAN, L., AND K. E. L. SIMMONS. 1956. Territory in the Great Crested Grebe *Podiceps cristatus* re-examined. Ibis 98:370–378.

NERO, R. W. 1959. Western Grebe colony. Nat. Hist. 68:291–295.

NERO, R. W., F. W. LAHRMAN, AND F. G. BARD. 1958. Dry land nest site of a Western Grebe colony. Auk 75:347–349.

PALMER, R. S. [ED.] 1962. Handbook of North American birds. Vol. 1. Yale Univ. Press, New Haven, CT.

RUDD, R. L., AND S. G. HERMAN. 1972. Ecosystem transferal of pesticide residues in an aquatic environment, p. 471–485. *In* F. Matsumura, G. Bonsh, and T. Misato [eds.], Toxic effect of pesticide residues on wildlife. Environmental toxicology of pesticides. Academic Press, New York.

STEWART, R. E., AND H. A. KANTRUD. 1971. Classification of natural ponds and lakes in the glaciated prairie region. U.S. Bur. Sport Fish. Wildl. Resour. Publ. 95.

STORER, R. W. 1965. The color phases of the Western Grebe. Living Bird 4:59–63.

STURLING, D. 1964. Western Grebe colony on Shurway Lake revisited. Murrelet 45:8–9.

WETMORE, A. 1924. Food and economic relations of North American grebes. U.S. Dep. Agric. Bull. 1196.

YOCUM, C. F., S. W. HARRIS, AND H. A. HANSEN. 1958. Status of grebes of eastern Washington. Auk 75:36–47.

U.S. Fish and Wildlife Service, Target Rock National Wildlife Refuge, Box 533, Huntington, New York 11743. Address of second author: Utah Cooperative Wildlife Research Unit, College of Natural Resources, Utah State University, Logan, Utah 84322. Accepted for publication 8 March 1980.