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Overwater Nesting by Ducks: A Review and Management Implications

Stephen H. Bouffard
US Fish & Wildlife Service, Pocatello, Idaho

David E. Sharp
US Fish & Wildlife Service, Laurel, Maryland

Carol C. Evans
Western Range Service, Elko, Nevada

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Stephen H. Bouffard[2]
David E. Sharp[3]
Carol C. Evans[4]

Abstract.--Nest success of overwater duck nests is generally higher than nests in upland sites. A review of the literature indicated that the major factors limiting success of overwater nests were fluctuating water levels, nest parasitism, predation, and human disturbance. Regional patterns of the occurrence of these factors could not be discerned. General management guidelines for improved recruitment and reduced nesting female mortality are suggested.

INTRODUCTION

Waterfowl that nest over water, including most species of diving ducks, will be the focus of this review. Man-made nesting structures placed overwater have improved nest success and production of several species of dabbling ducks, but are not within the scope of this review. Therefore, our objectives were to review representative nesting studies and compile information regarding limiting factors that have been suggested for overwater nesting ducks. Based on these factors, general management guidelines to improve recruitment and reduce nesting female mortality of overwater nesting waterfowl are presented.

LIMITING FACTORS

On a comparative basis, fluctuating water levels during the nesting season can be more disruptive to overwater nesters than to upland nesters. Nest success of overwater nests is often high (>50%), but have been reduced to 10% or less by fluctuating water levels (C. C. Evans and D. E. Sharp, unpubl. data). While some upland nests in low-lying areas may be susceptible to flooding, nearly all overwater nests are affected by water level fluctuations. Water level changes, as little as 10-15 cm over a few days, may be sufficient to cause adverse effects. Low levels reduce the water barrier and allow easier access by mammalian predators into the marsh, and thus increase the susceptibility of eggs, nesting females, and broods to predation (Stoudt 1971). Female diving ducks may be more susceptible to predation than dabbling ducks when low levels isolate nests, because they have more difficulty getting airborne from dry surfaces than water. Low water levels can also result in increased egg parasitism or nonbreeding (Olson 1964). High water can inundate nest cover (Joyner 1975) and (Mendall 1958). If residual cover is flooded early in the nesting season, females may be forced to nest in lower quality sites or forego breeding entirely. Nests in flooded residual cover are more susceptible to avian predators (Joyner 1975). Record high water levels at Ruby Lake National Wildlife Refuge (NWR), Nevada, flooded nesting cover in 1984-85. During this period, canvasbacks (*Aythya valisineria*) and redheads (*A. americana*) were found to have a reduced breeding effort, lower nest success, and an increase in the incidence of egg parasitism by redheads (C. C. Evans, unpubl. data).

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[2]Stephen H. Bouffard, Biologist, U.S. Fish and Wildlife Service, Pocatello, Idaho.
[3]David E. Sharp, Waterfowl Specialist, U.S. Fish and Wildlife Service, Laurel, Maryland.
[4]Carol C. Evans, Range Management Consultant, Western Range Service, Elko, Nevada.

The incidence of parasitic egg laying is generally confined to overwater nests and upland nests that are close to water (Joyner 1975). Although several species of ducks are known to lay eggs in the nests of other ducks, this type of parasitic behavior is most commonly reported for redheads and ruddy ducks (Oxyura jamaicensis). In some areas, the incidence of parasitic egg laying on overwater nests can be very high, as Weller (1959) trapped 13 different redheads at a single canvasback nest. Host clutch sizes are usually reduced by egg displacement that can occur when parasitic females attempt to lay eggs in a nest with the host female present. Olson (1964) reported an average of 15.4 redhead eggs in canvasback nests, while host eggs averaged 3.9. A large number of parasitic eggs may also reduce host clutch size by suppressing ovulation, or may cause the host to abandon the nest (Weller 1959).

Predation can limit productivity of overwater nesting waterfowl (Table 1). Nesting overwater restricts access by most mammals especially canids and skunks (Mephitis mephitis) which are major predators of upland nests and nesting females. Sargeant et al. (1984) found that diving ducks were taken by red foxes (Vulpes vulpes) less frequently during the nesting period than dabbling ducks. In North Dakota nest success of mallards (Anas platyrhynchos) nesting overwater was higher than those nesting in upland sites (Krapu et al. 1979). Mink (Mustela vison) and raccoons (Procyon lotor), which are less hampered by water, are major predators of overwater nests and nesting females (Eberhardt and Sargeant 1977, Sayler 1985,). Predation by gulls and corvids is not similarly affected by a water barrier, but seems to be more affected by visual obstruction of vegetation than mammalian predators. Most avian predation occurs when nesting females are not attending the nest (Dwernychuk and Boag 1972a, Bourget 1973). Waterfowl nesting near larid colonies can have both positive and negative effects on nest success. Nesting near colonies of terns and small gulls can increase nest success as larids keep corvids out of the colony, thus reducing loss of waterfowl eggs. However, this benefit can be offset by gull predation on ducklings (Dwernychuk and Boag 1972b), as large gulls can prey on both eggs and ducklings.

Quality and quantity of the vegetation used for nesting can affect the vulnerability of nests to predation. Nesting cover conceals nests from visual-oriented predators, such as birds. Dwernychuk and Boag (1972a) found an inverse relationship between amount of cover and number of eggs lost from simulated nests. Where cover was thinned by flooding, 67% of the overwater nests were destroyed by gulls, while in an adjacent marsh not similarly affected by flooding, only 4% of the overwater nests were lost to gulls (Joyner 1975). Conversely, for scent-oriented predators, cover functions as a physical barrier that reduces search speed and efficiency. Bowman and Harris (1980) found no difference in proportion of partially and totally concealed nests found by raccoons in laboratory tests. However, the raccoons found fewer nests when the cover was spatially complex. Where predator populations are low, nest success can be high even with low quality cover (Steel et al. 1956). Where predator populations are high, dense, good quality cover will not provide sufficient protection from predation (Stoudt 1982, Krasowski and Nudds 1986). Much of this problem is the result of the concentration of both predators and prey into smaller and smaller islands of habitat. Agricultural activities and changes in the natural predator community, including a reduction or elimination of wolves (Canis lupus) and coyotes (C. latrans), have allowed red foxes and raccoons to increase their ranges and densities (Stoudt 1982).

High density overwater nesting cover functions to provide protection from predation, egg parasitism, human disturbance and effects of wind or waves. Preferences by overwater nesters for species composition and density of nesting cover has been found to vary among areas. High density nesting by canvasbacks and redheads at Ruby Lake NWR were found hardstem bulrush (Scirpus acutus) with densities of 300-430 stems of residual cover per m^2 (S. H. Bouffard, unpubl. data).

Distribution of nest cover is also important. Female diving ducks usually nest near patches of open water. Steel et al. (1956) found 97% of all diving duck nests were within 14m of open water. At Ruby Lake NWR the mean distance from diving duck nests to open water was 7.5m (S. H. Bouffard, unpubl. data). High interspersion of nesting cover with open water increases the area available to nesting ducks. Weller and Spatcher (1965) recommended a 50:50 ratio of open water:emergent vegetation. At Ruby Lake NWR prime nesting areas were composed of 53% emergent vegetation, 31% open water, and 16% upland. Canvasback nest densities at Ruby Lake NWR are generally high, often exceeding those of the Prairie Pothole Region of southern Prairie Canada. Olson (1964) speculated that selection of small ponds or open water areas within areas of prime nesting cover by nesting canvasbacks reduced parasitism; searching the peripheral cover of small ponds and openings by parasitic redheads was not cost effective in terms of time and energy expenditures.

Human disturbance can have adverse impacts on recruitment of overwater nesting waterfowl. Detrimental effects of human activity on nesting have been reported by Jahn and Hunt (1964) and Keith (1961) and on broods by Beard (1953). Mendall (1958) documented increased waterfowl

Table 1. Comparison of nest success of overwater nests among several studies from various locations in North America.

Species	Location[1]	Date	Percent Nest Success[2]		Limiting[3] Factors	Source
Ruddy duck	IA	1939+	A	73	1,2	Low 1941a
Redhead			A	56-73	1	Low 1941b
Mallard	ND	1974-77	M	54	2	Krapu et al. 1979
Canvasback	MB(potholes)	1959-61	A	21	1,2,4,5	Olson 1964
	(large marsh)		A	29		
Canvasback		1977-80	A	67	2,4	Sayler 1985
Redhead			A	50	2,4	
Canvasback		1961-72	A	45	1,2,4,7	Stoudt 1982
Canvasback	AB	1952-65	A	36	1,4,5	Smith 1971
Redhead			A	52		
Ruddy duck			A	64		
Canvasback	SK	1952-65	A	65	2,4,5	Stoudt 1971
Redhead			A	52		
Ruddy duck			A	60		
Canvasback		1971-75	A	44	5	Sugden 1978
Ring-necked duck	ME(1st nests)	1943-55	A	70	2,3	Mendall 1958
	(renests)		A	61		
Redhead	PQ	1969-72	M	93	None	Alliston 1979
Canvasback	OR	1942,46-47	A	43	2,6	Erickson 1948
Redhead	ID	1949-51	A	85		Steel et al. 1956
Ruddy duck			A	56	1,3	
Canvasback			A	67		
Redhead	MT	1960-61	A	15	6,7	Lokemoen 1966
Redhead and ruddy duck	UT	1967	A	100	None	McKnight 1974
		1968	A	74	6	
Ruddy duck	CA	1952	A	32	2	Rienecker and Anderson 1960
Redhead			A	45		
Ruddy duck		1957	A	69		
Redhead			A	88		
Canvasback	NV(Ruby Lake NWR)	1972,77-83	M	69	2,6,7,8	S. H. Bouffard, C. C. Evans, and D. E. Sharp, Unpubl. data
		1984-85	M	13,10		
Redhead		1972,77-83	M	68		
		1984-85	M	5,20		

[1]State/Province abbreviations: IA = Iowa; ND = North Dakota; MB = Manitoba; AB = Alberta; SK = Saskatchewan: ME = Maine; PQ = Quebec; OR = Oregon; ID = Idaho; MT = Montana; UT = Utah; CA = California; NV = Nevada.

[2]Nest success calculations: A = apparent nest success; M = Mayfield nest success.

[3]Limiting factors (not in order of importance): 1=nest desertion; 2=water level fluctuation; 3=predation; 4=mammalian predation; 5=avian predation; 6=parasitism; 7=human disturbance; 8=inclement weather.

production following a closure of boating on Moosehorn NWR. Studies in the early 1970's at Ruby Lake NWR prompted a closure of boating during peak nesting of canvasbacks and redheads (USFWS 1976). Flushing females off nests by humans can increase vulnerability of the eggs to avian predators.

It has been shown that fish can have negative impacts on waterfowl recruitment. Fish, nesting female ducks, and ducklings function as predators of macroinvertebrates. Macroinvertebrates are necessary for egg production in ducks and growth of ducklings. Reduction of invertebrate numbers by fish and its negative impact on waterfowl production and distribution has been reported (Eriksson 1979, Eadie and Keast 1982, Pehrsson 1984). Carmichael (1983) documented dietary overlap of introduced game fish and diving ducks at Ruby Lake NWR. Canvasback clutch size at Ruby Lake NWR is lower than other marshes (Bouffard 1983) and canvasback duckling growth rates are slower than reported elsewhere (80-90 days to fledging: S. H. Bouffard, unpubl. data). This suggests that impacts of competition by fish may be occurring.

Review of several studies revealed that water fluctuation, predation and disturbance were important limiting factors in the west, in the pothole area and in the northeast (Table 1). Nest parasitism was a common limiting factor in the pothole area and in the west where redheads and ruddy ducks were common (Table 1). Overall, we concluded that differences in factors affecting nest success were site specific, and that no regional patterns existed.

Management Implications

When water control is possible, the maintenance of relatively stable marsh levels during the nesting season (April-June) is the single most important management practice for increasing recruitment. During the nesting season water levels should not fluctuate more than 10-15 cm. Slowly dropping levels are preferable to rising levels. After nests have hatched, water levels can be allowed to fluctuate with the natural regime, or with desired management objectives.

Vegetation management should be directed at maintaining dense, but highly interspersed cover, with 30-50% open water to 50-70% emergent nesting cover ratio. The assimilation of local information on nest success and cover utilization is fundamental in developing sound vegetation management practices, because the density and species of emergent vegetation used for nesting varies among areas. Manipulation of vegetation by water level control may involve trade-offs related to the incompatability of maintaining stable levels during the nesting season.

Various management practices can be used to manipulate cover: water interspersion. Of these, fire should be used cautiously. At Ruby Lake NWR, 2 years were necessary for the residual nest cover to return to its preburn density; no overwater nests were found in burned areas during the 2 years (S. H. Bouffard, unpubl. data). Bray (1984) found similar recovery rates for residual nest cover in Utah. Therefore, we suggest that burning can be used as a management tool, but should be used sparingly and in small blocks.

Fishing, boating, and other recreational activities should be curtailed on nesting marshes from April through August. Nesting females have been shown to be extremely sensitive to human disturbance during nesting. Although limited information exists on the impact of disturbance on duckling survival, preliminary information suggests that important brood areas should also be protected from high levels of human intrusion (D. E. Sharp, unpubl. data). Overwater nesters are particularly vulnerable to these types of disturbances because of their dependence on aquatic habitats for nesting, feeding, and brood rearing.

Fish have been shown to compete with waterfowl for food and have negatively affected waterfowl populations. The presence of fish increases the demand for fishing and introduction of bait fish-farming which increase human disturbance. Fish should not be introduced into marshes that are primarily managed for waterfowl.

Predator control has been shown to be cost effective and has increased recruitment of upland nesting waterfowl (Balser et al. 1968, Deubbert and Lokemoen 1980, Lokemoen 1984). Predator control increased egg hatch rates and improved chick survival of whooping cranes (Grus americana) at Grays Lake NWR (Drewien et al. 1985). Practices that exclude predators from ground nesting birds, such as electric fences (Lokemoen et al. 1982) have not been tested for diving ducks. Where predation has been shown to limit diving duck production, we recommend that carefully designed studies that evaluate predator exclusion or removal be initiated before extensive predator control programs are implemented.

Management guidelines that we propose are general concepts designed to improve production and reduce the effects of factors limiting recruitment of overwater nesting ducks. These practices may not complement efforts to improve production of upland nesting waterfowl, other wildlife species, or for management of wintering or migration areas. Wetland managers will have to tailor these concepts to specific areas using local information and integrate management practices for overwater nesting waterfowl with other wildlife objectives. Finally, we strongly recommend that managers carefully design and execute a biologically sound monitoring program to evaluate management practices that are implemented.

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