Differential Habitat Use of Patagial-tagged Female Mallards.—Patagial tags are commonly used in avian studies to document movements and behavior of individual birds. Most researchers have considered their use a qualified success, but some have reported skin and feather abrasions (Kochert et al. 1983, Mudge and Ferns 1978, Southern 1971), behavioral effects (Southern and Southern 1985), and possible increases in mortality (Bolen and Derden 1980, Howe 1980). In this paper we describe high mortality rates resulting from differential habitat use of female Mallards (*Anas platyrhynchos*) marked with patagial tags.

Study area and methods.—Salt plains bait traps (Szymczak and Corey 1976) and cannon nets (Dill 1969) were used to capture Mallards at Bonny Reservoir, a 4400-ha waterfowl wintering area 225 km east of Denver. Birds were trapped along the north shoreline of the reservoir. Bright orange or yellow patagial tags measuring 4.5 × 9 cm were attached to both wings of female Mallards using monel poultry wing clips (National Band and Tag Co., Newport, Kentucky). The streamer portion of the tag, constructed from nylon-coated vinyl material, weighed 1.8 g. Brass-coated metal eyelets were used to reinforce the attachment hole prior to crimping the clip through the patagium. Birds were also marked with standard U.S. Fish and Wildlife Service leg bands.

Bonny Reservoir has the largest concentration of wintering Mallards in Colorado (10-yr mean = 44,900). During fall and winter, ducks use the reservoir (water-ice complex) as their primary roost. In December and January, roost sites are normally restricted to small open water areas in the middle of the reservoir. During inclement weather, such as occurred in late December 1982, small groups of ducks periodically leave the main flock to seek alternate roosting areas. The preferred alternate roosts are the drain and spillway streams within 1 km downstream from the dam. These shallow, slow-moving streams remain ice-free during winter. Hybrid cattail (*Typha glauca*) is present as shoreline or mid-stream vegetation in both areas.

Hunting in the alternate roost area downstream from the dam was controlled by the Colorado Division of Wildlife and restricted to 10 blinds hunted 3 d/wk (Saturday, Sunday, Wednesday). Hunters were required to check in and out through a station where harvest and hunter activity were recorded.

Results.—Patagial tags were affixed to 100 adult and 100 yearling female Mallards on 2–7 December 1982. During the final segment of the hunting season (11 December–16 January) at least 28 marked birds were shot from the 10 controlled hunting blinds. Age-related mortality was not apparent ($P > 0.10$), with 13 adult and 15 yearling females taken. Most mortality occurred within 10 d after marking, although 8 patagial-tagged Mallards were killed during the last 2 wk of the season (Table 1). Most (75%) marked birds were shot on days that were preceded by two days of hunting closure (Saturday and Wednesday).

A strong correlation existed between the number of hunter-hours and the number of marked birds recovered ($r = 0.934$, $P < 0.005$), but not between hunter-hours and total Mallards killed ($r = 0.262$, $P > 0.10$). As the total number of Mallards shot per hunter-hour increased, there was a decrease in the percent of total hens (Spearman rho = -0.702, $P < 0.005$) and marked hens (rho = -0.811, $P < 0.001$) in the harvest.

Aerial counts in 1982–1983 revealed 39,500 (12/1), 46,000 (12/15) and 12,500 (1/4) Mallards on Bonny Reservoir (Colorado Div. Wildlife, unpubl. data). Females comprise about 40% of a wintering Mallard population in Colorado (Hopper 1973). Using the lowest count (January) during the harvest period as the base population, 5000 hens were potentially available for harvest from the controlled hunting blinds. Hunters shot 48 unmarked female Mallards during the final season segment, for a population harvest rate of 0.0096. In contrast, marked hens were harvested at a rate of 0.1400 (28 ÷ 200). Had unmarked mallard females been killed at a rate comparable to marked birds, 700 hens would have been harvested. Conversely, less than 2 marked birds should have been shot if their hunting mortality rate was equivalent to that of unmarked birds.

Discussion.—Patagial-tagged Mallards experienced a mortality rate at least 15 times that of unmarked ducks. Increased hunting vulnerability was actually much greater since rates of harvest are calculated using a conservative base population. Hunters have been known to selectively shoot marked animals, suggesting a possible cause for the proportionately large kill of marked ducks. However, the point system used in Colorado to determine

TABLE 1. Mallard harvest and hunter effort on a controlled shooting area at Bonny Reservoir during the final segment of the 1982–1983 hunting season.

Period	No. harvested				
	Females				
	Marked	Unmarked	Males	Total	Hunter-hours
December 11–17	10	13	29	52	359.0
18–24	8	10	29	47	298.5
25–31	2	8	67	77	84.0
January 01–07	0	6	42	48	117.0
08–14	5	11	114	130	271.0
15–16	3	0	12	15	155.5
Total	28	48	293	369	1285.0

bag limits provides a strong selective bias against the harvest of hen Mallards, since females in 1982–1983 had a point value 3.5 times that of males. Hunters in the controlled area shot more hens when hunting success was poor. In doing so, hunters were probably trying to fill their bags by shooting ducks at every opportunity. For this reason, and because marked birds represented conservatively only 1 in 25 hens in the population, we conclude that hunter selectivity for marked birds could not have accounted for the extreme differences in harvest rates between marked and unmarked hens.

Patagial-tagged birds have been suspected of undergoing behavioral changes, including interference with migration (Howe 1980, Southern and Southern 1985) and higher rates of nest desertion (Anderson 1963). Changes in other behavior, such as habitat selection, are difficult to quantify due to observer bias. This bias would be particularly pronounced if behavioral changes caused birds to isolate themselves from large flocks or to occupy more densely vegetated habitats, behavior that has been detected among newly-instrumented, radio-marked ducks (Kirby 1976, J. K. Ringelman, unpubl. data).

Following ice formation, ducks at Bonny Reservoir have only a few open water sites available that afford both isolation from the main flock and aquatic emergents in which to hide. The nearest and largest of these wetlands is the controlled hunting area below the dam, the site where 28 marked ducks were killed. We believe that the high mortality rate of patagial-tagged birds was attributable to behavioral changes that caused marked ducks to occupy the same wetland that was heavily used by hunters. This aberrant behavior continued for at least 6 wk after marking. High harvest of marked hens on days preceded by 2 d of hunting closure suggests that marked birds were habitually using the controlled hunting area, were quick to adapt to the lack of harassment, and were therefore highly vulnerable to hunters once hunting resumed. Differential mortality rates between marked and unmarked birds may not have occurred in the absence of hunting in this area. Nevertheless, changes in the habitat used by marked birds would have still been evident. Investigators contemplating the use of patagial-tagged ducks in habitat selection studies should be aware of potential behavioral changes among marked cohorts.

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A Technique to Mark Incubating Birds.—In a study of the movement patterns of Cattle Egrets (*Bubulcus ibis*), we desired a marking technique that would minimize disturbance to the nesting colony and at the same time mark a large number of incubating adult egrets. The primary focus of our study was monitoring egret movements over an adjacent airport runway, where the birds posed a serious air-strike hazard. Seigfried (Trans. Roy. Soc. S. Afr. 39:420, 1971) placed "rain spray" sprinklers at the tops of roost trees and sprayed egrets with printers' ink using a motor-driven pump system. Although effective, this technique was too costly and labor intensive for our study.

We first attempted marking adult egrets by sprinkling Rhodamine B dye powder (E. I. duPont de Nemours & Co., Wilmington, Delaware) directly on egret eggs, a technique similar to one reported by Mossman (J. Wildl. Manage. 24:104, 1960). (Reference to trade names does not imply endorsement of commercial products by the federal government.) This method was unsuccessful in marking the adults, and only stained the outer surface of the eggs and nest. We then added the Rhodamine B powder to an oil-based silica gel (Vaseline would act as a similar medium). The dye to gel ratio we used was 1 cc of powdered dye dispersed in 10 cc of gel. We then placed 1 cc of the gel-dye mixture in the center of the upper surface of each egg in 16 clutches at the egret roost tree. Adults were off their nests for approximately 20 minutes as we applied the mixture to the clutches. Birds left the roost when we were within 20 m of the roost and returned to their nests 5 min after our departure. As the incubating birds preened their feathers to remove the sticky gel, the dye mixture spread over the ventral feather tract. The humidity in the air reacted with the dye mixture and stained the adult egrets' plumage. Birds marked with this technique retained purple feathers for 2–6 mo. With a spotting scope, stained birds were visible 200 m away.

This technique would probably be most effective with birds that have white or light colored plumage (e.g., larids, egrets). The primary advantage of this technique is that it allows researchers to mark large numbers of birds in a relatively short period of time without having to capture any birds. Although we did not autopsy egrets for traces of the dye, Rhodamine B is a systemic dye. Avian and mammalian consumption of food treated with the dye results in internal florescent marking of soft tissues (Evans and Griffith. J. Wildl. Manage. 37:73–81, 1973).

We made no attempt not to block the eggshell pores while using this technique, as another aspect of the study was investigating potential population control measures to minimize the air-stike hazard at the adjacent airport. None of the 16 clutches we applied