of the harrier's presence. On the fifth pass the harrier seized the young crane and held it on the ground for 5–6 sec. An adult crane approached within 3 m and the harrier flew off without the victim. Neither of the adults displayed any of the typical defensive postures described for cranes by Layne (Fla. Field Nat. 9:51–75, 1981). Both adults called periodically and all three cranes stayed near the victim until 12:00 when I approached the site. The attacked crane was dead, with several deep punctures at the base of the neck. The dead bird measured 67.5 cm from bill tip to base of feet and, based on size, was estimated to be 5 weeks old.

Food habits of the Northern Harrier are well documented (Errington and Breckenridge, Amer. Midl. Natur. 17:831–848, 1936; Bent, U.S. Natl. Mus. Bull. 167, 1937; Randall, Wilson Bull. 52:165–172, 1940; Schipper et al., Ardea 63:1–29, 1975). Accounts of avian predation on Sandhill Cranes have not been documented, although a recent study has identified the Great Horned Owl (*Bubo virginianus*) as a source of crane chick mortality (C. D. Littlefield, pers. comm.).

Judging from the adult cranes' behavior prior to the attack, the Northern Harrier may not be regarded as a predator. However, this observation may represent atypical parental behavior, and the paucity of records of such events recorded may be due to the difficulty of observing cranes in the tall vegetation that characterizes their nesting habitat. Hence, harrier attacks, such as the one reported here, may be more frequent than the literature suggests.—DAVID L. GENTER, *Dept. Zoology, Univ. Montana, Missoula, Montana 59812.* *Accepted 26 Nov. 1984.*

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Water-crossing behavior of raptors during migration.—Migration pathways of many birds are known to be influenced by large bodies of water (Ralph, Bird-Banding 49:237–247, 1978). The best example of lakes and oceans acting as barriers to migration is the aggregations of Falconiformes along coastlines and at the end of peninsulas (Allen and Peterson, Auk 53:393–404, 1936; Haugh and Cade, Wilson Bull. 78:88–110, 1966; Evans and Lathbury, Ibis 115:572–585, 1973; and summarized by Newton, Population Ecology of Raptors, Buteo Books, Vermillion, South Dakota, 1979). While some species are reluctant to cross water, others make long distance flights (>100 km) over water (Williamson, Br. Birds 47:434–441, 1954; Brown and Amadon, Eagles, Hawks and Falcons of the World, McGraw-Hill, New York, New York, 1968; Moreau, The Palearctic-African Bird Migration Systems, Academic Press, New York, New York, 1972; Beamon and Galea, Ibis 116:419–431, 1974; Walter, Eleonora's Falcon, Univ. Chicago Press, Chicago, Illinois, 1979; Kerlinger et al., Auk 100: 488–490, 1983). Few studies have been conducted to determine what species undertake water crossings and under what conditions birds cross (Kerlinger, Anim. Behav. 32:1029–1034, 1984). In this paper I report on the water crossing tendencies of 10 Falconiform species during migration at two locations in North America. In addition, I test the hypothesis that long, narrow-winged species undertake water crossings more readily than species with low aspect ratio.

Methods.—Study sites were located at Whitefish Point, Chippewa Co., Michigan (46°40'N, 84°57'W) for spring migration (27 April–6 May 1981) and at Cape May Point, Cape May Co., New Jersey (38°56'N, 74°58'W) for autumn migration (3 September–13 October 1980). Upon reaching the ends of these peninsulas, migrants must either cross >18 km of water or fly hundreds of km around Lake Superior or Delaware Bay in directions that are inappropriate for migration. The crossings are similar in distance (18.2 km at Cape May and

17.7–26.7 km at Whitefish depending upon flight direction) and the destinations are visible except during periods of rain, fog, or haze. At Cape May strong NW–W winds could potentially blow a migrant out over the Atlantic Ocean, while E–SE winds might push birds over Delaware Bay. With strong SE–E winds at Whitefish, birds could be blown out over the main body of Lake Superior. For a more complete description of the crossings see Kerlinger (1984).

Observations were conducted from 07:00–16:00 EST. Migrant raptors were observed with the naked eye as they approached the end of the peninsulas and with 7× binoculars as they moved offshore. When birds approached within approximately 200 m of the shoreline (marked by houses at Cape May and a treeline at Whitefish) they were considered subjects for the study. Once a migrant or flock of migrants passed this line their behavior was observed and recorded. As birds left the shoreline I made a visual assessment of flight altitude as follows: <5 m above the water, 5–30 m, 30–100 m, >100 m yet easy to see without binoculars, and difficult to see without binoculars.

To test the hypothesis that the tendency of a species to make water crossings is related to the species' flight morphology I regressed aspect ratio (of each species) on the proportion (arcsine transformed) of each species that crossed Delaware Bay and Lake Superior. The rationale for using aspect ratio (span^2/wing area) is that it is a relative measure of wing length and width. Birds such as gulls (Larinae), terns (Sterninae), and tubenoses (Procellariiformes), that spend a large proportion of their lives flying over water, are usually long winged with high aspect ratios, while landbirds generally tend to have shorter wings of lower aspect ratio (Savile, Evolution 11:212–224, 1957; Warham, New Zealand J. Zool. 4:78–83, 1977). Thus, a positive relationship (regression coefficient) is predicted if longer winged species cross water more often than shorter winged species. Wing spans were obtained from labels on specimens in the Vertebrate Museum of the University of California at Berkeley, and from recently acquired specimens that I obtained in New York and South Carolina. Wing areas were from Poole (Auk 55:511–517, 1938) and from fresh specimens from New York and South Carolina. Because male and female raptors differ in size, I computed the mean span and wing area of all male and female specimens of each species ([mean of males + mean of females]/2) to compute aspect ratio.

Results and discussion.—All species made water crossings on some occasions (Table 1). The tendency to cross Lake Superior or Delaware Bay varied greatly among species with some crossing infrequently (Turkey Vultures, Red-tailed and Broad-winged hawks), others crossing more often (Merlins, American Kestrels, Sharp-shinned and Rough-legged hawks), and others that usually made crossings (Peregrine Falcons, Northern Harriers, Ospreys). The tendency of a given species to cross was a positive function of aspect ratio (Fig. 1), a result that is consistent with the hypothesis that birds with relatively long wings (similar to seabird morphology) are more likely to cross water barriers than species with relatively short wings.

When encountering the shoreline, Northern Harriers, Peregrine Falcons, Ospreys, and Merlins rarely hesitated to fly out over water, while Turkey Vultures, American Kestrels, Broad-winged and Sharp-shinned hawks usually hesitated before venturing out over water, or turning back inland. An attempt was made to quantify the behavior of migrants at the shoreline, but behavior was so variable that this was not possible. Behavior included soaring in one place over the ground, flight back and forth along the shore, gaining altitude while flapping into the wind, soaring to great altitudes, descending to eye level, perching on driftwood or other objects, and hunting along the treeline or dunes. Hunting near the shoreline was obvious among Northern Harriers, Merlins, American Kestrels, and Sharp-shinned Hawks.

When individual migrants did fly out over water some returned after flying varying distances from shore. Some individuals, especially Broad-winged Hawks and Turkey Vul-

TABLE 1
SUMMARY OF WATER CROSSING BEHAVIOR OF MIGRATING HAWKS AT CAPE MAY AND WHITEFISH POINTS

Species	N	% cross	% not leave shore	% out over water and back
Turkey Vulture (*Cathartes aura*)	31	10	64	26
Osprey (*Pandion haliaetus*)	83	93	5	2
Northern Harrier (*Circus cyaneus*)	112	93	4	3
Sharp-shinned Hawk (*Accipiter striatus*)	7648	71	17	12
Broad-winged Hawk (*Buteo platypterus*)	2123	26	33	41
Red-tailed Hawk (*B. jamaicensis*)	55	11	47	42
Rough-legged Hawk (*B. lagopus*)	125	69	17	14
American Kestrel (*Falco sparverius*)	764	66	25	9
Merlin (*F. columbarius*)	46	76	15	9
Peregrine Falcon (*F. peregrinus*)	14	100	0	0

tures, disappeared toward the opposite shore before returning (Table 1). Flocks of these two species returned to shore approximately 10 min after leaving on at least three occasions.

Regardless of whether the migrant returned or crossed, all species employed continuous flapping or intermittent flap-and-glide flight over water. When leaving the shore, Turkey Vultures usually employed gliding flight, but when returning to shore their flight incorporated intermittent bouts of flapping. A most unusual mode of flight was employed by at least three Peregrine Falcons as they disappeared out over the Atlantic Ocean at Cape May. The downwind soaring flight of Peregrine Falcons was very different from soaring flight over land in that the circles (more accurately called trochoids) were along a vertical axis of 20–40° to the water that took them to within 2 m of the waves at the lowest point and about 10 m at the highest. Some flapping was noted during that phase of the circle that altitude was gained, at which time birds faced into the wind. This mode of soaring was suggestive of dynamic soaring (Pennycuick, pp. 1–73 *in* Avian Biology, Vol. 5, D. S. Farner and J. R. King, eds., Academic Press, New York, New York, 1975) with some powered flight involved. It is also possible that lift was gained by static soaring in updrafts created by wind deflected off the waves. Both static and dynamic soaring are less energetically expensive than powered flight, but dynamic soaring would only be possible when the wind was blowing toward the appropriate direction for migration. No other species were seen soaring when over water, except Ospreys that appeared to be foraging, so it is not likely that many raptors found thermals over the water.

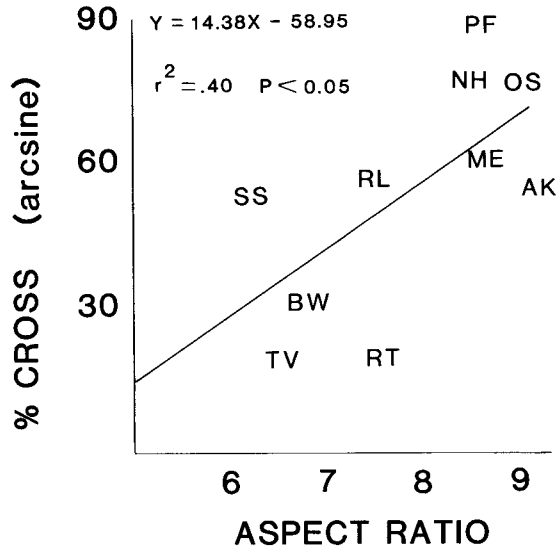

FIG. 1. Relationship between the percentage of each species that made crossings and that species' aspect ratio. (PF = Peregrine Falcon, NH = Northern Harrier, OS = Osprey, ME = Merlin, RL = Rough-legged Hawk, AK = American Kestrel, SS = Sharp-shinned Hawk, BW = Broad-winged Hawk, RT = Red-tailed Hawk, TV = Turkey Vulture.)

Because so little soaring occurred over water, the altitude of flight at the initiation of crossings was the same as over land or lower and varied considerably. No Turkey Vultures, Rough-legged, Red-tailed or Broad-winged hawks flew within 5 m of the waves, but varying percentages of the other species did so: Peregine Falcon, 23%; Osprey, 9%; Northern Harrier, 22%; Merlin, 34%; Sharp-shinned Hawk, 5%; American Kestrel, 19%. The positive correlation between the proportion of each species that crossed and the proportion seen below 5 m (both arcsine transformed) was significant ($r = 0.74$, N = 10, $P < 0.01$), an indication that those species that crossed most often were more likely to fly at very low altitudes. Flight at <5 m above the water made raptors difficult to detect at times. Flight at high altitudes also made raptors difficult to detect and undoubtedly biased observations to lower flying birds. On a few occasions Broad-winged Hawks (including one flock of >500) at Whitefish and Sharp-shinned Hawks (once >300 within 1 h) at Cape May were noted initiating crossings at such heights that they were nearly undetectable with the unaided eye, even when directly overhead. Kerlinger (1984) noted that a significantly larger proportion of Sharp-shinned Hawks tended to cross Lake Superior and Delaware Bay when they approached the shoreline at high altitudes as opposed to low altitudes. Thus, it is possible that a much larger number of birds crossed Lake Superior and Delaware Bay than was estimated in this study.

In addition to variability in altitude of flight, there were at least four other factors that potentially influenced the accuracy of assessing the numbers and proportions of raptor species that made crossings at Whitefish and Cape May Point: (1) Birds flying inland after encountering Lake Superior or Delaware Bay may have been counted several times before crossing (Kerlinger and Gauthreaux, Anim. Behav. 32:1021–1028, 1984). (2) Individuals of species

that forage over water may have been counted incorrectly as migrants returning to shore. I witnessed successful hunting forays by a Peregrine Falcon (capturing a warbler-sized bird) and an American Kestrel (carrying a Tree Swallow [*Tachycineta bicolor*]) over water, as well as several unsuccessful attempts at avian prey by Merlins. (3) Birds migrating in rain or fog were more difficult to detect than when visibility was better. Of the seven Merlins and one Peregrine Falcon I saw flying over water during steady rainfall, all were difficult to observe and some would not have been detected at distances >300 m. (4) Finally, individuals of some species (particularly Peregrine Falcons) may have initiated crossings at Whitefish and Cape May before arriving at the ends of the peninsulas and were never observed (P. Dunne, pers. comm.).

The results of the present study strongly suggest that the tendency of a species to undertake water crossings is related to its morphology. Longer-winged species, often with pointed wings, have high aspect ratios that decrease induced drag and therefore the energetic cost of powered flight (Pennycuick 1975). Reduced cost of flight and low drag coefficients may permit long-winged species to soar in weak updrafts, and thus promote longer distance flight over water. The finding that falcons and Ospreys regularly undertake water crossings is in agreement with findings by Kerlinger et al. (1983), although the Northern Harrier was conspicuously absent from their species list from the North Atlantic Ocean. A list of raptor migrants from the island of Malta also shows that the long, narrow-winged falcons, Ospreys and kites are more likely to cross the Mediterranean Sea than are the wider-winged buteos, accipiters, eagles, and vultures (Beaman and Galea 1974). Whether this relationship is a general one can only be determined by tests at crossings of varying distances in which many species are examined. Future studies should test this relationship and investigate why water crossings are effective barriers to migration and dispersal.

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Sex ratios in broods of Cooper's Hawks.—Adult female Cooper's Hawks (*Accipiter cooperii*) are about 1.5 times as heavy as males (Brown and Amadon, Eagles, Hawks and Falcons of the World, McGraw-Hill, New York, New York, 1968) and in the nest the females are noticeably larger at one week of age. Meng (Ph.D. diss., Cornell Univ., Ithaca, New York, 1951) reported a virtually even sex ratio (35 males, 36 females) in 20 broods of Cooper's Hawks in New York, but he did not determine if this ratio resulted from differential mortality at either the egg or nestling stage. Lack (The Natural Regulation of Animal Numbers, Oxford Univ. Press, London, England, 1954) suggested that male raptors might have lower survival rates in the nest because larger females would be more successful in competition for food. If so, the sex ratio at conception might be biased toward males (Newton, Population Ecology of Raptors, Buteo Books, Vermillion, South Dakota, 1979). Newton and Marquiss (Am. Nat. 113:309–315, 1979) failed to find such a bias in eggs of European Sparrowhawks