SEASONAL HABITAT USE BY RIVER OTTERS AND EVERGLADES MINK IN FLORIDA

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Abstract: Seasonal habitat use by river otters (*Lutra canadensis*) and Everglades mink (*Mustela vison evergladensis*) was documented in the Big Cypress Swamp, Florida, using line transects of chalk-dusted trackboards and anal scent attractant. Response to scent was species-specific in late wet season, indicating that mating occurs in autumn, when water levels are high in marshes and swamps. Mustelids retreated from marshland as it dried, and most had moved to permanent ponds in the late dry season. This period of concentrated aquatic food coincides with lactation in mink. Use of line transects with olfactory attractants may enable monitoring of otter and mink population levels and trends on a regional or statewide scale, but rigorous testing of the technique is needed.

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The river otter is included in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (U.S. Fish and Wildlife Service 1977). Treaty obligations require determination that otter harvest for export is not detrimental to the species before export permits are issued (Endangered Species Sci. Auth. 1978). The Everglades mink is listed as threatened by the Florida Game and Fresh Water Fish Commission (1980).

Protected status has increased interest in these mustelids, but little is known of their biology in Florida. Information from reports by otter trappers was presented by McDaniel (1963). The scattered information available on Everglades mink has been reported by Layne (1974) and Brown (1978), and new data were presented by Smith (1980). Both species occur in the Big Cypress Swamp in southwestern Florida. The objective of our study was to use a measure of relative abundance, adapted from the scent station technique reported by Linhart and Knowlton (1975) and Linhart et al. (1977), to document seasonal habitat use by otters and mink within a large wetland in South Florida.

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STUDY AREA

Most of the western Big Cypress Swamp is drained by the Fakahatchee Strand, a 25,000-ha swamp forest fringed by seasonally wet marshland. Despite low topographic relief, the drainage is covered by a diversity of habitats dictated by physical gradients of hydroperiod, fire, and salinity, all modified by recent manipulations. Hydroperiod is shortest in the marshes flanking the strand, and consequently fires are most frequent there, preventing development of swamp forest. Minor surface features including sloughs, ridges, and areas of slightly lower or higher bedrock cause local variation in the intensity of flooding and fire and result in a mosaic of marsh and wet savanna habitats. Because fires and flooding historically were linked by their common origin in summer thunderstorms, a relatively stable line occurs beyond which fires rarely reach and hence swamp forest persists. In the center of the strand, in low spots where deep water and permanent inundation prevent tree growth, a series of small ponds marks the deepest part of the drainage. Downstream, a coastal salinity gradient that shifts inland in the dry season and seaward in the rainy season works in concert with flooding, fire, and frost to maintain a broad area of saltmarsh and mangrove. The interplay of all these factors in South Florida ecosystems is examined in depth by Wade et al. (1980).

Human modifications of the swamp forest include drainage, logging, road construction, and introduction of fire into the forest. Construction of the north-to-south Barron River and Faka Union canals has speeded drying of the marshland, reduced the lateral flow of water into the strand, and decreased the watershed by one-half by diverting the upstream Okaloacoochee Slough to the sea. A herringbone pattern of tram roads and borrow ditches built by loggers removing the mature cypress in the 1940's and 1950's has diversified the topography and restricted water flow in the swamp. The combination of postlogging litter, reduced flooding, and increased topographic relief has enabled fire and exotic vegetation to invade the swamp. Fires, caused by hunters and lightning, have created a mosaic of successional stages in the regenerating swamp forest.

Nine habitats were selected for sampling, to represent the different biological communities formed by flooding, fire, salinity, and historical manipulations. (1) Freshwater marsh with baldcypress (*Taxodium distichum*) is a wet savanna with fairly frequent, low-intensity fires and shallow soil over limestone. (2) Freshwater marsh with slash pine (*Pinus elliottii* var. *densa*) is another fire climax community occurring on slightly higher ground and tolerating frequent fires (about every 3–10 years); common associates are waxmyrtle (*Myrica cerifera*), saw palmetto (*Serenoa repens*), and cabbage palmetto (*Sabal palmetto*). (3) Freshwater marsh with sawgrass (*Cladium jamaicensis*) and muhly (*Muhlenbergia* spp.) is also a fire climax, tolerating flooding and drought, and requiring frequent fire (about every 1–3 years). Small islands of encroaching waxmyrtle occur in this habitat. (4) Freshwater marsh with spikerush (*Eleocharis* spp.) is lower, having a long hydroperiod with little or no annual dry period and with fires usually restricted to drought years. During this study, all the freshwater marsh habitats were flooded in the rainy season and dry in the dry season. (5) Salt marsh and mangrove is a mosaic of red mangrove (*Rhizophora mangle*) along tidal channels, salt marsh dominated by needle rush (*Juncus roemerianus*) and saltgrass (*Distichlis spicata*), and freshwater marsh with *Eleocharis*, cordgrass (*Spartina spartinae*), and cattail (*Typha* spp.). During the rainy season the salt marsh was flooded to 0.3 m, but only tidal channels and mangrove areas were flooded during the dry season. (6) Recently burned swamp forest was dominated by cypress, cabbage palmetto, foxtail grass (*Setaria corrugata*), lovevine (*Cassytha filiformis*), and some sawgrass. Repeated burning of this habitat was indicated by exposed bedrock and palm roots. The habitat was near a canal and became completely dry in the dry season, although flooded to 1 m in the rainy season. (7) Willow swamp had cut and burned cypress stumps and was dominated by large willows (*Salix caroliniana*), young red maples (*Acer rubrum*), and a few cypress saplings. The hydroperiod here was longer than in the recent burn; in the dry season, the soil remained moist and some borrow ditches contained water. (8) Regenerating cypress swamp was dominated by cypress, red maple, and cabbage palmetto. Fire scars on cypress stumps were old. Soil remained moist during the dry season. (9) Virgin cypress swamp was dominated by large cypress and laurel oaks (*Quercus laurifolia*), with thick undergrowth in areas where old trees had been lost to hurricanes. This habitat contained a permanent pond, but the rest of the swamp habitats had only moist soil in the dry season. The 4 habitats in swamp forest were considered seral stages following human disturbance, whereas the 4 plant associations in freshwater marsh were taken to reflect distinctive regimes of flooding and fire on relatively high ground.

METHODS

Relative frequencies of otters and Everglades mink were seasonally estimated on 3 replicate transects in each habitat. Animals were attracted by mustelid anal scent lures (otter lure and #1 mink lure, S. S. Hawbaker and Sons, Fort Loudon, Pa.) and visits were recorded from tracks in chalk dust on a 0.4 m^2 masonite board. Dust applied to this smooth surface controlled the otherwise problematic variable of track legibility (Melquist and Hornocker 1979). Lure was applied to the tip of a 9-cm dowl rod that stood in a hole at the center of each board. Published information on the home range size and daily movements of mink (Gerell 1970) was used to guide our choice of trackboard spacing. Gerell showed that mink in Sweden used portions of their home ranges (in units not exceeding 300 m) for a period of several days and then moved to another portion. This guidance was of limited value, because no average length was given for these subsets of the home range, and home ranges in South Florida habitats presumably would be 2-dimensional, in contrast to the nearly linear mink habitat (streams, lake edges) studied by Gerell. We chose short intervals between scent stations to avoid missing an occupied segment of a home range with 2 adjacent stations; each transect consisted of a line of 10 trackboards placed at 60-m intervals. Otter and mink lure were alternated, so attractant for each species was on 5 trackboards at 120-m intervals. Where possible the 3 transects in each habitat were placed in a single line with a distance of 180 m between transects. In areas too small to allow a linear configuration, transects were placed in a 3-sided array with a distance of 240 m between each. Trackboards were checked each morning for 2 consecutive days during 3 periods—late wet season (Sep–Nov), early dry season (Dec–Feb), and late dry season (Mar–May)—spanning the annual extremes of flooding and drought.

Statistical analysis was done on arcsine-transformed data using the Statistical Analysis System, version 79.3 (Helwig and Council 1979). Effects of species, scent, season, and habitat were tested with analysis of variance (ANOVA) for balanced data.

RESULTS

To determine whether otter and mink relative frequency should be computed on a scent-specific basis, visits to trackboards were tested for a scent effect. Rather than responding generally to mustelid scent, the species visited their own species' scent more often ($P < 0.001$) (Fig. 1A). Season affected this response (Fig. 1B), with the strongest species-specific response occurring in autumn (late wet season) and the weakest in spring (late

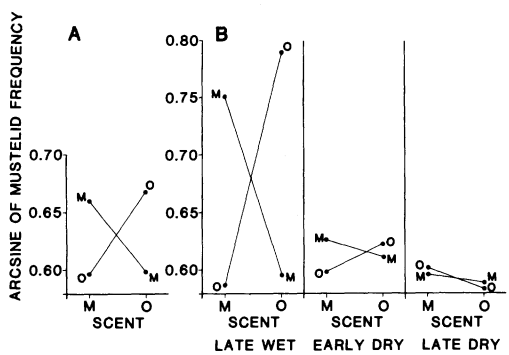

Fig. 1. Relative frequency of mink (M) and otter (O) visits per board day to mink and otter scent. For this and subsequent figures, the origin of the *Y*-axis is the transformed value of $Y = 0$. A. The species-scent interaction is highly significant ($P < 0.001$). B. The season-species-scent interaction is highly significant ($P < 0.001$).

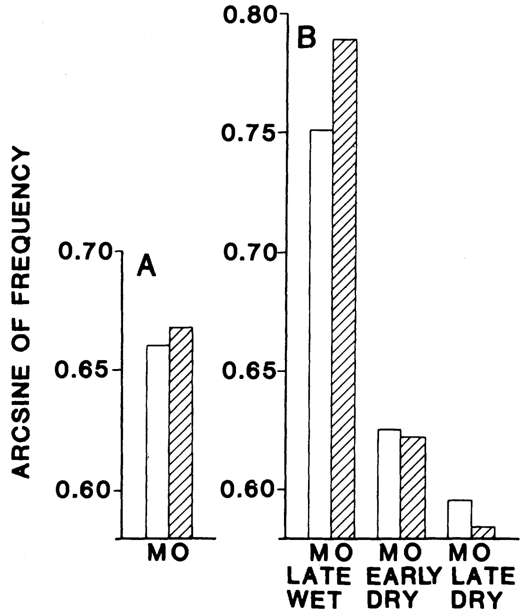

Fig. 2. Relative frequency of mink (M) and otter (O) visits to their own scent per board day. A. Overall difference in mink and otter frequency is not significant ($P > 0.54$). B. Seasonal effects on mink and otter frequencies are highly significant ($P < 0.001$). Differences in mink and otter frequency within seasons are not significant ($P > 0.19$–0.85).

dry season). Therefore, subsequent analysis of relative frequencies of otters and mink was based on visits to their own species' scent, with visits to other scent deleted.

The apparent abundance of otters and mink relative to each other over the total area sampled was not different ($P > 0.05$) over the period of study (Fig. 2A) or within seasons (Fig. 2B). However, the seasonal effect on otter and mink frequency was striking (Fig. 2B). The latter result can be explained by a reduced response to olfactory cues in the dry season or a seasonal movement following the diminishing aquatic habitat to areas that were weakly sampled, or both.

The effect of habitat on frequency of otter and mink visits was strong (Fig. 3). Trackboard visits indicated that otter and mink abundance was lowest in freshwater marsh habitats, intermediate in salt marsh, and highest in swamp forest. Alternatively, it is possible that the apparent habitat effect was an artifact of seasonal movement. However, operation of both habitat and season effects was confirmed by further ANOVA (Fig. 4).

The higher frequency of track station visits in swamp than in marsh prevailed in the late wet season. As first lateral marshes and then the downslope salt marsh dried in the dry season, mustelid visits to trackboards became restricted to swamp forest habitats. In the late dry season, most mustelid visits occurred in the virgin cypress swamp, where aquatic habitat persisted.

DISCUSSION

The strength of the scent effect reflects the importance of olfactory communication to otters and mink. The species-specificity of responses to anal scent lures and the resulting ability to demonstrate season and habitat effects shows that the line transect using olfactory attractants is a valuable research tool for these mustelids. Our results provide some insights into the biology of the species, suggest new hypotheses to test, and show poten-

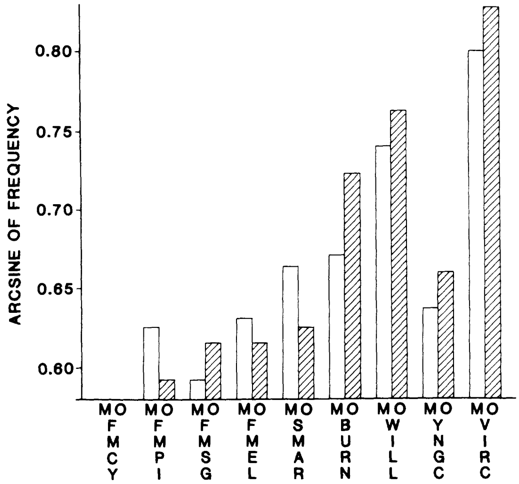

Fig. 3. Relative frequency of mink (M) and otter (O) visits to their own scent per board day. Habitats are freshwater marsh with dwarf cypress (FMCY), pine (FMPI), sawgrass (FMSG), and *Eleocharis* (FMEL); salt marsh (SMAR); and the swamp forest sere from recent burn (BURN), willow (WILL), young cypress (YNGC), to virgin cypress with lakes (VIRC). Habitat effects on frequency of each species are highly significant ($P < 0.001$). Differences between species frequencies in each habitat are not significant ($P > 0.28$–0.77).

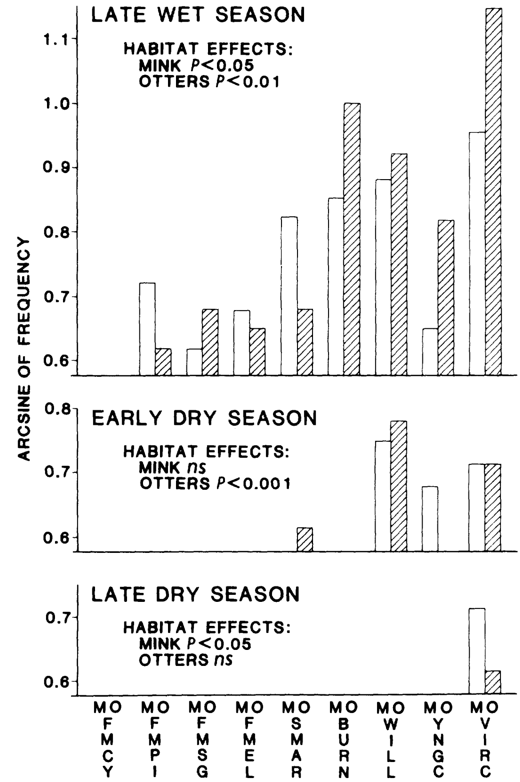

Fig. 4. Relative frequency of mink (M) and otter (O) visits to their own scent per board day. Habitats are as in Fig. 3. Mink and otter differences are not different ($P > 0.05$) within seasons or within habitat-season combinations. Habitat effects on combined frequency of mustelids are highly significant ($P < 0.001$) in each season. Significance levels of habitat effects on each species by season are shown. Significant season effects by habitat and species are for mink in BURN ($P < 0.001$) and for otter in the 4 seral stages: $P < 0.05$ in BURN, YNGC, and VIRC, and $P < 0.01$ in WILL.

tial for developing an abundance index on the scale needed for management.

Although no difference between species abundance of mink and otter was detected, the inference that otters and mink had equal population sizes is not warranted because the 2 species may differ in their home range sizes or levels of response to olfactory cues. Visual observations indicate that both species are common in the Fakahatchee Strand, and our results are consistent with this conclusion. However, until details of scent response are understood, interpretation of multiple-species data like ours must be restricted to within-species analysis. Hence for the present, a sampling design using several species' scent should be used only as a convenient way of gathering data simultaneously on several individual species.

The seasonal pattern of response to scent suggests that both otter and mink in South Florida mate in the late wet season (autumn), unlike winter-spring breeding of both species farther north (McDaniel 1963, Gerell 1970, Lauhachinda 1978, Hamilton and Whitaker 1979). This interpretation assumes that these mustelids are highly responsive to sexual information that is included in olfactory communication during the breeding season. If we are correct that Everglades mink mate in autumn, the relation of their reproductive cycle to photoperiod (Hammond 1951, Enders 1952) must differ from that of subspecies in temperate zones.

Other patterns in the biology of South Florida otters and mink may be deduced from the significant season and habitat effects. Although the seasonally declining mustelid abundance could have resulted from either a weakening olfactory response or changing habitat use, concurrence of significant scent and habitat effects showed both factors to be involved. Changes in habitat use indicate movement to follow changes in the distribution of aquatic habitat—with use of marshes restricted to wet season and movement within the swamp to central ponds in the late dry season. At this time, mink appeared to use drier sites not used by otters, probably because of mink's ability to hunt in terrestrial habitat. Although not adequately demonstrated by our sampling, field observations of otter sign suggested that otters may have occupied all of the permanent water bodies remaining in the late dry season. Trackboard sampling designed to document use of ponds in the center of the Strand at this time probably would have provided insight into mustelid biology at the period of most limited habitat.

Several authors have documented the role of South Florida hydroperiod in changing distribution and abundance of aquatic organisms used as food by larger predators (Kahl 1964, Environmental Protection Agency 1973, Kushlan 1976). When the marshes flood in the rainy season, fish disperse widely and occur in low density. Ensuing reproduction increases density to higher levels by late wet season. As marshes and then swamps dry in the dry season, fish travel toward ponds and concentrate in increasingly high density. Maximum density occurs just before the edges of permanent ponds become dry. The aggregations of predators then cause densities to decline. It is doubtful whether the territorial behavior of mink (Gerell 1970) and (perhaps) otters (see Melquist and Hornocker 1979) permits them to aggregate at dry season food concentrations, as do colonial wading birds. Evidence that Everglades mink lactate in March and April (Hamilton 1948, Smith 1980) indicates that this energetically most costly phase of reproduction occurs while aquatic food is most concentrated. The extensive movements by male otters (Melquist and Hornocker 1979) and mink (Gerell 1970) during the mating period, suggested by our data to occur in late wet season, would be facilitated by the widespread distribution of aquatic food organisms with increasing densities due to reproduction in the floodwaters. No doubt this movement pattern is important to maintain outbreeding of the mustelid populations.

Before the scent station technique can be applied to monitor population levels and trends on a regional or statewide basis, further testing will be necessary. Different arrays may need to be tested for sampling on a larger scale. Different chemicals and concentrations should be compared (Turkowski et al. 1979). The relative frequencies recorded need to be equated with actual abundance, by use of the scent station method concurrently with studies of radio-tagged animals. The technique needs to be tested along rivers and lakes and their associated swamps and marshes. Because of the highly species-specific response in the late wet season, autumn is the appropriate time for sampling South Florida. We hypothesize that breeding in northern Florida is in late winter and spring as in Alabama and Georgia, because of their similar warm temperate climates, and suggest this season for scent station sampling. The proper season for sampling also will need to be tested in the transitional climate (Dohrenwend and Harris 1975) of central Florida.

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