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HABITAT SUITABILITY INDEX MODELS: AMERICAN COOT

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HABITAT SUITABILITY INDEX MODELS: AMERICAN COOT

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PREFACE

This document is part of the Habitat Suitability Index (HSI) Model Series [Biological Report 82(10)] which provides habitat information useful for impact assessment and habitat management. Several types of habitat information are provided. The Habitat Use Information Section is largely constrained to those data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. This information provides the foundation for the HSI model and may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

The HSI Model Section documents the habitat model and includes information pertinent to its application. The model synthesizes the habitat use information into a framework appropriate for field application and is scaled to produce an index value between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). The HSI Model Section includes information about the geographic range and seasonal application of the model, its current verification status, and a list of the model variables with recommended measurement techniques for each variable.

The model is a formalized synthesis of biological and habitat information published in the scientific literature and may include unpublished information reflecting the opinions of identified experts. Habitat information about wildlife species frequently is represented by scattered data sets collected during different seasons and years and from different sites throughout the range of a species. The model presents this broad data base in a formal, logical, and simplified manner. The assumptions necessary for organizing and synthesizing the species-habitat information into the model are discussed. The model should be regarded as a hypothesis of species-habitat relationships and not as a statement of proven cause and effect relationships. The model may have merit in planning wildlife habitat research studies about a species, as well as in providing an estimate of the relative suitability of habitat for that species. User feedback concerning model improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to fish and wildlife planning are encouraged. Please send suggestions to:

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CONTENTS

	Page
PREFACE	iii
ACKNOWLEDGMENTS	vi
HABITAT USE INFORMATION	1
General	1
Food	1
Water	2
Cover	3
Reproduction	5
Interspersion	5
Special Considerations	6
HABITAT SUITABILITY INDEX (HSI) MODEL	6
Model Applicability	6
Model Description	7
Application of the Model	12
SOURCES OF OTHER MODELS	15
REFERENCES	15

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AMERICAN COOT (Fulica americana)

HABITAT USE INFORMATION

General

The American coot (Fulica americana) breeds from south-central Alaska southward to Central America (American Ornithologists' Union 1983). The species is widely distributed in temperate North America with major breeding populations occurring in the prairie marshes of the north-central United States and south-central Canada (Fredrickson et al. 1977). Major winter concentrations of the species occur in fresh and brackish water habitats in California, Florida, Louisiana, and Texas. Concentrations occur on rivers, lakes, ponds, and sewage lagoons during migration where adequate food is available. Large reservoirs that contained shallow water areas with submerged aquatic vegetation were the primary habitat type used by American coots in Oklahoma during fall migration (Eddleman 1983). Many American coots will use an area until food is exhausted or until cold weather forces them to move further south (Fredrickson et al. 1977). The species is gregarious except during the breeding season, when territories are established and defended. The size of the American coot population depends on the availability and quality of breeding habitat (Ryder 1961; McCracken et al. 1981).

Food

The primary food of the American coot is vegetation (Kiel 1955). Vegetation comprised 79% of the foods eaten by juveniles and 89% of the food eaten by adult birds in Washington (Fitzner et al. 1980). The most commonly eaten plants were pondweeds (Potamogeton spp.), watermilfoil (Myriophyllum spp.), and filamentous algae. However, American coots are opportunistic and a variety of plant foods may be used (Sooter 1941 cited by Fredrickson et al. 1977). Fall concentrations of American coots in Wisconsin occurred where surface waters provided submerged aquatic plants (Jahn and Hunt 1964). During winter, American coots often graze in upland habitats and may feed on forage crops (Fredrickson et al. 1977).

Consumption of animal foods by adult birds increases during spring migration, prior to and during the egg laying period (W.R. Eddleman, Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie; letter dated August 12, 1985). Hatchlings are typically fed invertebrates, including adult and larval dragonflies and damselflies (Odonata), flies (Diptera), true bugs (Hemiptera), and beetles (Coleoptera) (Gullion 1954; Fredrickson 1970; Fitzner et al. 1980). Small crayfish (Cambarus spp.) were commonly fed to chicks in Iowa (Fredrickson 1970).

Water

The American coot is a generalist that can use a variety of wetland habitats if adequate water and cover are available (Sugden 1979). However, the highest nest densities in the north-central United States and south-central Canada are associated with inland deep fresh marshes (Type 4 wetlands, as defined by Shaw and Fredine 1956) (Fredrickson et al. 1977). Inland shallow fresh marshes (Type 3) and inland open fresh water (Type 5) were used when suitable vegetation was present. Inland deep fresh marshes and inland open fresh water wetlands were most frequently used by American coots in Alberta (Smith 1961) and Saskatchewan (Sugden 1979). Inland shallow fresh marshes (Type 3) in Alberta received relatively low use by the species (Smith 1961). Inland shallow fresh marshes used by nesting American coots were from 0.1 to 0.2 ha and supported a high interspersion of water and emergent vegetation. Inland shallow fresh marshes used were larger and of better quality than wetlands typically included within this classification. Similarly, seasonal ponds and lakes (Class III wetlands as defined by Stewart and Kantrud 1971) that received the greatest amount of use by American coots in North Dakota were described as representing the upper end of the water permanence gradient within this class and contained suitable nest cover (Kantrud 1985). Based on duration and depth of surface water, seasonal wetlands in North Dakota may provide suitable reproductive habitat up to 50 to 70% of the years (H. A. Kantrud, U.S. Fish and Wildlife Service, Jamestown, ND, letter dated July 22, 1985). Only 5% of the American coot nests located in Saskatchewan were in shallow fresh marshes (Type 3) (Sugden 1979). Seasonally flooded basins (Type 1), were not used by American coots for nesting. Only 1% of the nests located in Saskatchewan were found within wetlands that became dry before young had fledged. Kiel (1955) also reported that American coots did not nest within wetlands that became dry prior to the end of the nesting season.

The most suitable reproductive habitat for American coots in North Dakota was identified as semipermanent ponds and lakes (Class IV as defined by Stewart and Kantrud 1971) (Faanes 1982; Kantrud 1985). Semipermanent ponds and lakes supported 70% of the recorded American coot population but accounted for only 47% of the wetland area surveyed (Kantrud 1985). Seasonal and semipermanent wetlands combined supported 96% of the recorded American coot population. The attractiveness of semipermanent wetlands to breeding American coots was attributed to long-term seasonal water permanence and the typical presence of persistent emergent vegetation within the deep water zone of this wetland class. In addition, the presence of water within this wetland class provides the necessary invertebrate and plant foods required for American coots through the fledgling stage. Breeding American coots were not recorded on ephemeral, alkali, or undifferentiated tillage wetland classes. The absence of the species in these wetland classes was attributed to the short duration of surface water and the absence of suitable nest cover. Ephemeral and undifferentiated tillage wetlands were unsuitable reproductive habitat for the American coot even in years of above normal precipitation due to relatively short, fine-stemmed vegetation associated with these wetland classes. Permanent wetlands accounted for 7% of the wetland area sampled but supported only 4% of the recorded American coot population. Low use of permanent wetlands by breeding American coots was attributed to the typical large size and depth of

wetlands in this class which results in limited availability and distribution of suitable nest cover. The quality of permanent wetlands as reproductive habitat for the American coot is further limited as a result of: minimal shallow feeding areas due to the presence of steep banks and rocky, high-energy, wave-influenced shorelines; a relatively low abundance of invertebrate fauna compared to that present in less permanent wetlands; and competition for the existing invertebrate fauna by fish (Kantrud, unpubl). Permanently flooded marshes associated with lotic waters are probably of higher quality as American coot reproductive habitat than are permanently flooded lentic wetlands because of the continuous inflow of nutrients into the permanently flooded marshes that enhance invertebrate production (Eddleman, unpubl.).

Stable water levels during the breeding season are required for optimum American coot reproductive habitat (Smith 1961). The average water depth at 930 American coot nests in Saskatchewan was 70 cm (Sugden 1979). Less than 1% of the recorded nests were supported by the wetland substrate. Average water depth at nests in Colorado was 49.2 cm (Gorenzel et al. 1982). Kantrud (unpubl.) recorded an average water depth of 58.7 cm at 677 American coot nest sites in North Dakota.

Kantrud (1985) recorded an inverse relationship between water salinity and the abundance of breeding pairs of American coots in North Dakota. Freshwater wetlands accounted for 204 pairs/km^2, slightly brackish wetlands had 129 pairs/km^2, moderately brackish wetlands 79 pairs/km^2, while brackish wetlands supported only 12 pairs/km^2. Subsaline and saline wetlands were not used by breeding American coots. The aversion to saline wetlands was attributed to an absence of suitable vegetative cover, insufficient food, and the American coot's physiological inability to use saline waters for extended periods.

Cover

American coot populations fluctuate in response to water and wetland habitat quality (Fredrickson et al. 1977). Poor cover and shallow water contributed to high nest failure because of greater visibility and accessibility of nests to predators (Gorenzel et al. 1982). The majority of American coot nests in Colorado were in vegetation that concealed the nest from above and from at least three sides. Nests became better concealed by new growth as the breeding season progressed. Preferred nesting cover in Colorado was robust emergent vegetation [i.e., cattail (Typha spp.) and bulrush (Scirpus spp.)]. Vegetation used infrequently or at all as nesting cover included sedges (Carex spp.), spikerush (Eleocharis macrostachya), saltgrass (Distichlis stricta), common reed (Phragmites communis), and American bulrush (S. americanus). Cattail and bulrush were used more heavily than their proportional availability by nesting American coots in Manitoba (Kiel 1955). Hardstem bulrush (S. acutus) was an important vegetative component of cover at 63% (n = 691) and the only vegetation present at 46% of the nests recorded in North Dakota (Stewart 1975).

American coots in Colorado did not appear to prefer any particular plant species as nesting cover (Gorenzel et al. 1982); rather, they responded to location and structure of vegetation. The influence of plant species appears

to be irrelevant as long as the vegetation is in standing water and is sufficiently sturdy to anchor the nest and provide adequate cover (Weller and Spatcher 1965). Cover preference appeared to be related to the vegetation available during the initial nesting period, i.e., residual vegetation from the previous growing season. The majority of American coots in a Wisconsin study area delayed establishment of nests until vegetative growth became suitable for nest construction and concealment (Bett 1983). However, those American coots that did initiate nests early in the reproductive season showed a preference for residual cattail vegetation over stands of residual bulrush. Bulrush became more preferred as vegetative growth progressed and eventually supported the greatest number of American coot nests. The minimum height of residual cattail vegetation used as nesting cover was 40 cm. American coots did not use bulrush as nest cover until it reached a height of 1 m.

Emergent vegetation density influences habitat use by American coots. Extremely dense vegetation impedes locomotion, feeding, and escape (Sooter 1941; Weller and Spatcher 1965). In addition, tall, dense stands of emergent vegetation reduce insolation resulting in reduced production of submerged aquatic vegetation, the coot's primary food (Kantrud, unpubl.). Conversely, sparse vegetative cover affects American coot reproductive success by increased susceptibility of nests to predation and loss due to wind and wave action. American coots in Wisconsin preferred moderate vegetative density in all types of nest cover (Bett 1983). In general, American coots selected against extremely sparse stands of vegetation early in the reproductive season and against excessively dense stands in the latter part of the season. Early season nests were located in residual cover of greater density than were those located in new vegetative growth. Nests were most often recorded within stands of residual cattail where stem densities averaged about 25 stems/0.25 m^2. Stem densities of > 50 stems/0.25 m^2 within stands of residual cattail were avoided. Nest sites within new cattail growth were situated in sites with 15-20 stems/0.25 m^2. Nests within stands of residual bulrush were located in sites with ≥ 40 stems/0.25 m^2 and often ranged over 100 stems/0.25 m^2. Within new bulrush, nests were situated where stem density was approximately 40 stems/0.25 m^2. American coots generally did not establish nests where new bulrush growth exceeded 60 stems/0.25 m^2.

Wetlands with a high degree of interspersion between open water and robust emergent vegetation receive the greatest amount of use by American coots (Smith 1961; Gorenzel et al. 1982). The highest nest densities of American coots in Iowa were recorded when emergent vegetation and open water were highly interspersed and present at a 50:50 ratio (Weller and Fredrickson 1973). As vegetative density increased, resulting in less open water, American coot populations declined. The overall spatial relationship between emergent vegetation and open water was of greater importance in defining reproductive habitat quality for the American coot than were the characteristics of individual stands of emergent vegetation. Although vegetative height and density affected nest site selection, nest location was ultimately determined by the availability and interspersion of open water in relation to vegetative cover. American coots preferred to locate nests at sites that permitted immediate access to open water. Only 11% of the recorded nests were > 2 m from the edge

of emergent vegetation. The preference for situating nests close to the vegetation/water interface was attributed to food availability (submerged vegetation and aquatic insects), enhanced ability for territorial defense, and a preference for approaching the nest by swimming. The majority of American coot nests in a South Dakota study were situated in emergent vegetation < 4.2 m from open water (Vaa et al. 1974). Small patches of plant cover well dispersed throughout a wetland were used as frequently as were the margins of extensive stands of cover (Sugden 1979). However, American coots tended to nest farther from shore in wetlands that provided vegetative cover distributed throughout the wetland basin. Nests in islands of emergent vegetation were more successful than nests placed in bands of emergent vegetation adjacent to wetland shorelines in Colorado (Gorenzel et al. 1982). American coot nests located in bands of emergent vegetation adjacent to shorelines in Wisconsin had lower success than nests surrounded by water due to decreasing water levels as the reproductive season progressed and to predation by mammals, particularly raccoons (Procyon lotor) (Bett 1983).

American coots in Oklahoma selected habitats during fall migration based mainly on the abundance and availability of submergent aquatic vegetation (Eddleman 1983). Open deep-water habitats were used for loafing and escape cover. Over-wintering coots selected sites with abundant submergent vegetation, and sparse emergent vegetation adjacent to expansive, deep, open-water areas.

Reproduction

The American coot's nest is typically a floating platform constructed over water and attached to emergent vegetation (Fredrickson et al. 1977; Gorenzel et al. 1982). Although upland nests, mainly on small islands, have been reported (Miller and Collins 1954). Materials used in nest construction are those that are most readily available (Fredrickson 1970). However, nearby nest material is not essential to selection of the nest site (Sugden 1979). Terrestrial vegetation and debris occasionally may be used for nest construction. Dead material remaining from persistent vegetation was often used as nesting material by American coots during the first weeks of the nesting season in Colorado (Gorenzel et al. 1982). Live plants were increasingly used as nest material and cover as the growing season progressed. Nest construction may be influenced by the availability of potential nest sites (Fredrickson 1970). Structures built by muskrats (Odontra zibethicus) (i.e., lodges, feeding platforms, and latrines) often were used as nest sites by American coots.

Interspersion

The American coot is highly territorial but high densities of the species can occur when local habitat conditions are ideal (Fredrickson et al. 1977). Territories are established prior to nesting and are maintained throughout brood rearing. American coots can reach peak densities of 166.8 pairs/km^2 under ideal cover and water conditions in prairie breeding populations (Stewart and Kantrud 1972). The maximum density of American coots recorded in an Ontario study was 50 territories/km^2 (McCracken et al. 1981). In Manitoba the

density of American coots was 8.6 birds/km² (Kiel et al. 1972). The average nest density recorded in South Dakota was 4.2 nests/ha (Vaa et al. 1974). Sugden (1979) recorded a mean distance between nests of 54 ± 20 m. The mean distance did not differ on wetlands of different size or with the number of nests per wetland. The closest nests were separated by dense vegetative cover that reduced visibility and interpair contact. Approximately one half of the pairs occupied territories that were < 0.3 ha.

Special Considerations

High populations of American coots are not believed to limit breeding populations of ducks (Stollberg 1949; Ryder 1961; Vaa et al. 1974; Fredrickson et al. 1977; Nudds 1981). The presence of American coots did not suppress populations of redhead (Aythya americana), canvasback (A. valisineria), and lesser scaup (A. affinis) in a Saskatchewan study area (Sugden (1979). Programs or actions that acquire or improve waterfowl habitat would benefit American coots (Fredrickson et al. 1977).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This HSI model has been developed for application throughout the breeding range of the American coot within North America (Fig. 1).

Season. This model has been developed to evaluate reproductive habitat quality for the American coot.

Cover types. This model was developed for application in the following cover types (terminology follows that of U.S. Fish and Wildlife Service 1981): Herbaceous Wetland (HW); Lacustrine (L); and Riverine (R).

The American coot is highly dependent on semipermanent and permanent wetlands for its reproductive habitat requirements. Wetlands that maintain surface water for all, or the majority of, the year have been classified by Shaw and Fredine (1956) as inland deep fresh marshes (Type 4) and inland open fresh water (Type 5) wetlands. Stewart and Kantrud (1971) classified wetlands with continuous, or nearby continuous, water presence as permanent (Class V) and semipermanent (Class IV) ponds and lakes respectively. A more contemporary wetland classification system (Cowardin et al. 1979) describes wetlands of these types as permanently flooded and either intermittently exposed or semipermanently flooded. Although any wetland classification system may be used for application of this model, the terminology and description of wetlands in this model follows that described by Cowardin et al. (1979).

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat required before an area will be occupied by a species. Specific information on the minimum habitat area required by the American coot was not located in the literature. Breeding pairs of American

Figure 1. Approximate breeding distribution of the American coot in North America (adapted from Johnsgard 1975).

coots have been recorded on wetlands as small as 0.08 ha in North Dakota (Stewart 1975). Nesting and brood requirements of the American coot are typically best provided by semipermanently flooded, intermittently exposed, and permanently flooded wetlands. This model is based on the assumption that these wetlands, regardless of size, will have the potential to provide the habitat necessary to meet American coots' reproductive requirements.

Verification level. This HSI model provides habitat information useful for impact assessment and habitat management. The model is a hypothesis of species-habitat relationships and does not reflect proven cause and effect relationships. Earlier drafts of this model have been reviewed by Dr. William R. Eddleman, Wyoming Cooperative Fish and Wildlife Research Unit, Laramie, and Dr. Harold A. Kantrud, Northern Prairie Wildlife Research Center, Jamestown, ND. Improvements and modifications suggested by these reviewers have been incorporated into the model.

Model Description

Overview. The American coot depends upon a stable source of surface water and emergent vegetation to provide suitable reproductive habitat. The majority of American coot nests and highest rates of reproductive success have been associated with permanently flooded, intermittently exposed, and semi-permanently flooded wetlands that provide continuous surface water during the

breeding season and that contain extensive stands of emergent vegetation. Permanent wetlands may receive lower use by breeding American coots during years of above normal precipitation. Emergent vegetation that remains standing subsequent to the growing season provides the most suitable nest construction material. Such vegetation can be expected to provide debris for nest construction and cover for the species prior to extensive growth of new vegetation. Emergent vegetation is added to existing nests as it becomes available and is used by later nesting birds. Wetlands that contain a high degree of interspersion between emergent vegetation and open water result in higher nest densities and greater reproductive success than do wetlands where emergent vegetation is present in single, continuous stands or is present in bands immediately adjacent to the shoreline.

The majority of the investigations into the breeding ecology of the American coot have been conducted in the north-central portion of the North American continent where climatic conditions have a substantial influence on vegetation phenology. This model is based on these studies, and emphasizes the importance of persistent, emergent, herbaceous vegetation and the role it plays in habitat quality for the American coot. However, the species also reproduces, although in lower numbers and densities, in southern regions of the continent where emergent, herbaceous vegetation is present and grows throughout the year. In such areas any form of emergent, herbaceous vegetation can be presumed to provide suitable nest cover if it is present in sufficient density.

The following sections provide documentation of the logic and assumptions used to translate habitat information for the American coot to the variables and equation used in the HSI model. Specifically, these sections cover: (1) identification of variables; (2) definition and justification of the suitability levels of each variable; and (3) description of the assumed relationships between variables.

Reproduction component. American coots typically establish nests within herbaceous emergent vegetation associated with permanently flooded, intermittently exposed, and semipermanently flooded wetlands. Seasonally flooded wetlands also are used as reproductive habitat particularly during years of above normal precipitation. Lower use and nest success has been recorded for less permanent wetland types. Therefore, this model is based on an evaluation of the abundance of emergent vegetation, the interspersion of emergent vegetation and open water, and water permanence within a wetland.

The reproductive life requisite value for the American coot is assumed to be a function of the percent of the wetland basin dominated by persistent herbaceous vegetation, edge index value between emergent vegetation and open water and water regime. The assumed relationships between values for these habitat variables and suitability index values for American coot reproductive habitat quality are provided in Figure 2.

Fig. 2a

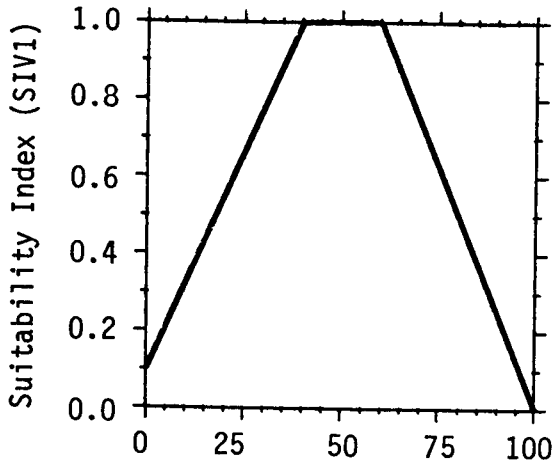


Fig. 2b

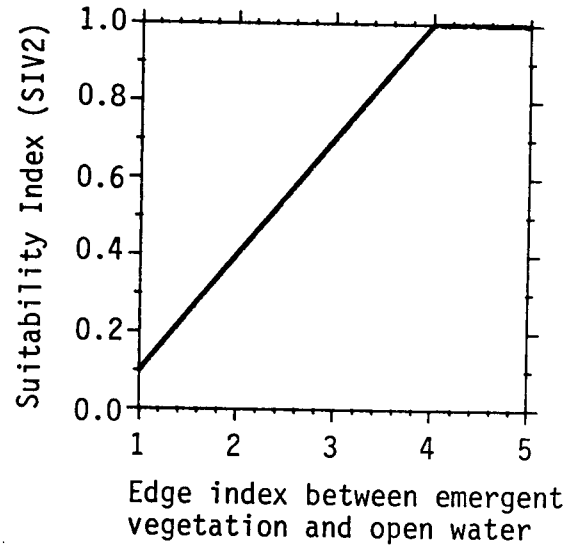
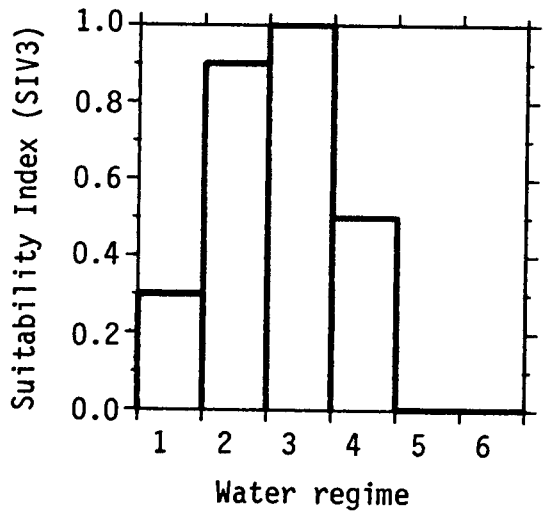


Fig. 2c



1. Permanently flooded
2. Intermittently exposed
3. Semipermanently flooded
4. Seasonally flooded
5. Temporarily flooded
6. Intermittently flooded

Figure 2. The relationships between values for habitat variables used to evaluate American coot reproductive habitat and suitability indices (SI) for the variables.

American coots nest over water in emergent vegetation. Any type of emergent vegetation apparently will provide suitable nest material and cover during the growing season. However, persistent emergent herbaceous vegetation such as cattails and bulrushes, provides ideal nest cover and construction material because of its robust nature. In addition, the debris remaining from previous years' growth provides important nest construction material for early nesting American coots. The assumed relationship between the abundance of persistent emergent herbaceous vegetation and an index of reproductive habitat quality (SIV1) for the American coot is provided in Figure 2a. Wetlands lacking persistent emergent herbaceous vegetation are assumed to have minimum reproductive habitat potential for the American coot because of the absence of suitable nest cover. A minimum value has been assigned to such situations to allow for the possibility of nesting in vegetative cover present at the edge of wetland basins. However, American coots rarely nest in extremely shallow water and nest success under these conditions can be expected to be extremely low. Optimum conditions are assumed to be present when 40 to 60% of a wetland basin is dominated by persistent emergent herbaceous vegetation. Extensive coverage of persistent emergent vegetation will provide nest construction material, nest cover and escape cover for pairs and broods. Habitat quality for the American coot is assumed to decrease as the coverage of persistent herbaceous vegetation increases above 60% due to the absence of open water, which results in less area available for territorial display, movement, and reduced availability of submerged vegetation a primary food source for the species. Wetland basins completely dominated by persistent herbaceous vegetation are assumed to be unsuitable reproductive habitat for the American coot.

The spatial relationship between open water and emergent vegetation can have a major influence on reproductive habitat quality for the American coot. Even though an abundance of persistent emergent herbaceous vegetation may reflect optimum conditions, its distribution within the wetland can have a significant effect on reproductive habitat quality. Forty percent of the wetland basin dominated by vegetation in one single stand will have less reproductive habitat potential for the American coot than would an equal amount of vegetation distributed throughout the wetland in small stands. Cover completely surrounded by water provides preferred nest sites and results in higher nest success than nest sites adjacent to wetland shorelines. The relationship between the amount of emergent vegetation edge and open water present within a wetland and an index of habitat quality (SIV2) for the American coot is provided in Figure 2b. The index value is based on the area of the wetland, the amount of wetland-upland edge, and the amount of vegetative edge within the wetland. The wetland's area is compared to a circle of the same size. Wetlands that are close to circular in shape and contain no emergent vegetation, or emergent vegetation in an extremely narrow band adjacent to the shore, will receive an edge index value of 1.0, which is assumed to reflect minimal reproductive habitat potential for the species. In contrast, a wetland of equal area containing many small stands of emergent vegetation or a highly asymmetrical shoreline will receive a high edge index. Wetlands containing stands of emergent vegetation surrounded by water will receive a higher index value than will wetlands where such vegetation is only present adjacent to the shoreline. The exact edge index value that represents ideal interspersion between open water and emergent vegetation is unknown. However, for the purposes of this model, a wetland that supports emergent

vegetation in sufficient quantity and distribution to yield an index value of 4 (i.e., four times the amount of edge is present due to emergent vegetation than would be present for the same wetland basin without emergent vegetation) is assumed to reflect optimum habitat conditions.

The presence of surface water within a wetland has a major influence on reproductive habitat quality for the American coot. Wetlands that do not maintain surface water throughout the breeding season are unsuitable reproductive habitat. The relationship between the persistence of surface water within a wetland and an index of habitat quality (SIV3) for the American coot is provided in Figure 2c. Intermittently flooded and temporarily flooded wetlands typically have surface water present for only a short period during the breeding season and are assumed to represent unsuitable reproductive habitat for the American coot. Depending on the abundance of vegetation and duration of surface water present, seasonally flooded wetlands may have some reproductive habitat potential for the American coot. However, the value assigned to seasonally flooded wetlands is relatively low due to the typically limited presence of surface water in all years. Semipermanently flooded wetlands contain surface water throughout the growing season in most years and are assumed to have optimum reproductive potential for the American coot. The relatively consistent presence of surface water within these wetlands provides the nesting, security cover, and feeding habitat required by the species. Intermittently exposed wetlands are assumed to represent slightly less than optimum reproductive habitat based on the absence of surface water within these wetlands during low precipitation years. Because of excessive depth and typical large size, permanently flooded wetlands have limited emergent and submergent vegetative cover, low nutrient content, and low invertebrate availability, resulting in relatively low potential as reproductive habitat for the American coot.

HSI determination. The calculation of an HSI for the American coot considers only the life requisite value calculated for reproductive habitat. Therefore, the HSI for the American coot is equal to the reproduction component value, determined with Equation 1.

The percent of the wetland basin dominated by persistent herbaceous vegetation and the interspersion of such vegetation, evaluated by the edge index between emergent vegetation and open water, are assumed to have equal value in determining the reproductive habitat index value (RSI). Moderate density of persistent emergent herbaceous vegetation well interspersed throughout the wetland will represent optimum habitat conditions. A low density of persistent emergent herbaceous vegetation will be partially compensated for if it is well interspersed throughout the wetland. Wetlands dominated (> 60% cover) by persistent emergent herbaceous vegetation will receive lower value because the amount of edge between open water and vegetative cover is reduced. Water regime is assumed to have the greatest influence on the determination of a reproductive habitat index value for the American coot. Temporarily flooded and intermittently flooded wetlands have no value as American coot reproductive habitat regardless of the presence and interspersion of persistent emergent herbaceous vegetation within these wetlands. Semipermanently flooded wetlands provide optimum water conditions. Intermittently exposed and permanently

flooded wetlands will have less than optimum values as reproductive habitat for the American coot regardless of the density and interspersion of emergent vegetation. The assumed relationships described above are expressed in Equation 1.

$$HSI = RSI = (SIV1 \times SIV2)^{1/2} \times SIV3 \quad (1)$$

Application of the Model

Summary of model variables. Three habitat variables are used in this model to evaluate reproductive habitat quality for the American coot. The relationship between habitat variables, cover types, life requisite value and HSI are summarized in Figure 3. Definitions and suggested measurement techniques (Hays et al. 1981) for the variables used in the American coot HSI model are provided in Figure 4.

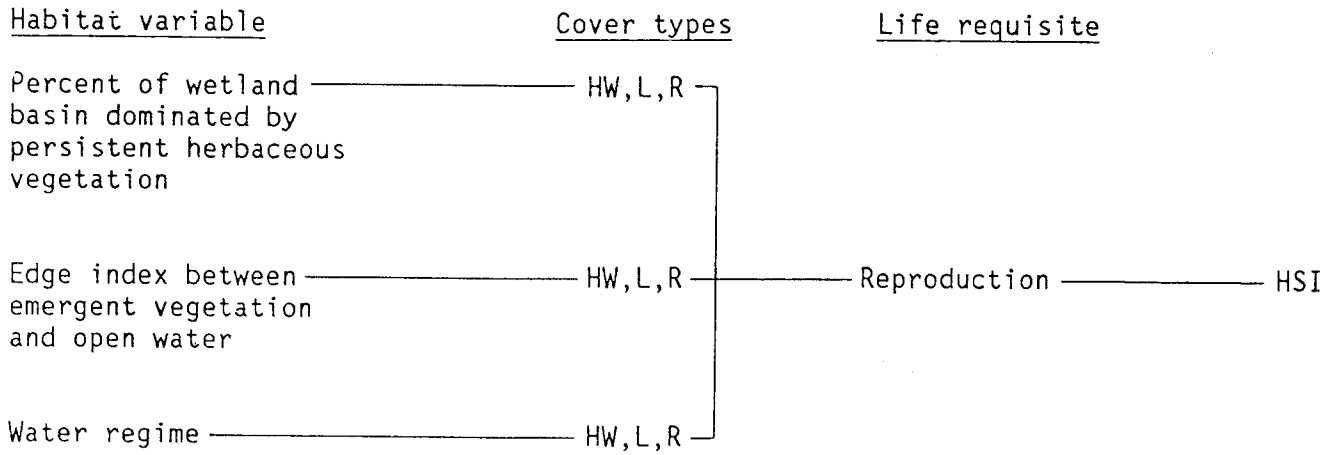


Figure 3. Relationships of habitat variables, cover types, and life requisites in the American coot HSI model.

Variable (definition)	Cover types	Suggested technique
Percent of wetland basin dominated by persistent emergent herbaceous vegetation [the proportion of a wetland that supports emergent herbaceous vegetation that normally remains standing after the growing season (e.g., cattails and/or bulrushes)].	HW,L,R	Remote sensing, on-site inspection
Edge index between emergent vegetation and open water (a ratio to determine the amount of edge between emergent vegetation and open water. Computed by: Edge Index = $\frac{\ell}{2\sqrt{A\pi}}$ where: ℓ = length of edge of wetland boundary and emergent vegetation A = area of wetland cover type An edge index of 1.0 is equivalent to a circle, the greater the deviation from a circular shape, the greater will be the edge index value)	HW,L,R	Remote sensing, on-site inspection
Water regime [the permanence of surface water in a wetland (as defined by Cowardin et al. 1979) as follows: Permanently flooded: water covers the land surface throughout the year in all years.	HW,L,R	Remote sensing, on-site inspection, National Wetland Inventory maps

Figure 4. Definitions of variables and suggested measurement techniques.

Variable (definition)	Cover types	Suggested technique
Intermittently exposed: Surface water is present throughout the year, except in years of extreme drought.		
Semipermanently flooded: Surface water persists throughout the growing season in most years.		
Seasonally flooded: Surface water is present for extended periods, especially early in the growing season, but is absent by the end of the season in most years.		
Temporarily flooded: Surface water is present for brief periods during the growing season, but the water table usually lies well below the soil surface for most of the season.		
Intermittently flooded: The substrate is usually exposed, but surface water is present for variable periods without detectable seasonal periodicity].		

Figure 4. (concluded).

Model assumptions. The American coot HSI model is based on the following key assumptions.

1. Excluding vegetative characteristics, semipermanently flooded wetlands provide optimum reproductive habitat for the species. Less permanent wetlands may be used during years with above normal precipitation. However, when considered on a long-term average basis, less permanent wetlands have minimum to no value as American coot reproductive habitat. Permanently flooded and intermittently exposed wetlands are assumed to be indicative of less than optimum habitat quality because of lower cover and food availability.

2. Wetlands that do not support emergent vegetation have minimum value as American coot reproductive habitat. Persistent emergent herbaceous vegetation is assumed to provide optimum conditions for nest establishment due to its robust nature and presence during the early nesting period.

3. Wetlands that contain highly dispersed stands of emergent vegetation and open water are assumed to provide higher quality reproductive habitat than do wetlands with emergent vegetation present in a single stand or in narrow bands along the shoreline.

SOURCES OF OTHER MODELS

No other habitat models for the American coot were located in the literature.

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16. Abstract (Limit: 200 words)

A review and synthesis of existing information were used to develop a Habitat Suitability Index (HSI) model for the American coot (Fulica americana). The model consolidates habitat use information into a framework appropriate for field application, and is scaled to produce an index between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). HSI models are designed to be used with Habitat Evaluation Procedures previously developed by the U.S. Fish and Wildlife Service.

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