A Validity Test of a Habitat Suitability Index Model for Clapper Rail

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Abstract: A method of habitat assessment known as Habitat Evaluation Procedures has been developed by the U.S. Department of Interior Fish and Wildlife Service. A linear relationship is assumed to exist between an area's Habitat Suitability Index (HSI) and carrying capacity. The objective of this study was to determine whether an HSI model for clapper rail (*Rallus longirostris*) is valid for predicting habitat suitability for this species in Georgia. Call-count surveys were conducted for clapper rail on 12 40-ha areas of tidal salt marsh during the winter and the spring of 1982–1983. Call counts and HSI values were not strongly related during wintering or nesting seasons based on correlation analyses. Several possible interpretations of study results are discussed.

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Coastal regions of the United States provide essential habitat for fish and wildlife resources. Loss or modification of estuarine and marine areas (Cowardin et al. 1979), due to proposed and ongoing water resource development projects, must be quantitatively estimated if project alternatives are to be correctly evaluated for environmental costs and benefits. The U.S. Fish and Wildlife Service has developed and implemented a habitat-based assessment method known as Habitat Evaluation Procedures (Habitat Evaluation Procedures Group 1980). This method is based on measurement of the suitability of a given habitat to support selected species and on the area of habitat. When applying Habitat Evaluation Procedures, the suitability of an area is evaluated in terms of an HSI. HSI values can range from 0 (unsuitable habi-

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tat) to 1 (optimum habitat); a direct relationship between the HSI value and carrying capacity is assumed.

An HSI model has been recently developed for clapper rail (Lewis and Garrison 1983). The objective of this study was to test the model by determining the relationship between HSI and the number of clapper rails present. We assumed that rail population density reflected carrying capacity and we compared the HSI's to wintering and breeding populations of rails on the Georgia coast. A second objective was to evaluate habitat variables not in the model in order to determine which ones might have potential for strengthening the model.

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The Clapper Rail Model

The clapper rail model was developed from a review and synthesis of the literature that described habitat requirements of the species. Thus, it is a hypothesis of year-round habitat relationships, not a statement of proven cause and effect relationships. Throughout its development, the model was reviewed and critiqued by biologists with special expertise on clapper rail and by staff of the U.S. Fish and Wildlife Service's National Coastal Ecosystem Team. The model was developed for estuarine tidal salt and brackish wetlands along the Atlantic, Gulf of Mexico, and Pacific coasts that are inhabited by 7 subspecies of clapper rail (Mangold 1977).

Three specific habitat variables are considered from which Suitability Indices (SI) will be calculated. Fig. 1 shows how the HSI is related to food and cover life requisites and to the 3 habitat variables.

Clapper rails feed on fiddler crabs (*Uca* spp.), other small crabs (*Eurytium* spp., *Panopeus* spp., *Sesarma reticulatum, Callinectes sapidus*), mollusks, clam worms (*Nereis* spp.), snails (*Littorina irrorata, Melampus* sp., *Nassarius obsoleta, Polygrya* sp.), parasitic worms (Ascaridae), insects, spiders, and fish (Howell 1932, Moffitt 1941, Oney 1951, 1954, Bateman 1965, Wilbur and Tomlinson 1976). The primary feeding habitat requirements described in the literature are (1) mud flats and gently sloping banks of creeks, ditches, bayous, or shorelines at low tide and (2) the saltwater emergent or scrub-shrub mangrove wetland. During low tides, mud flats and

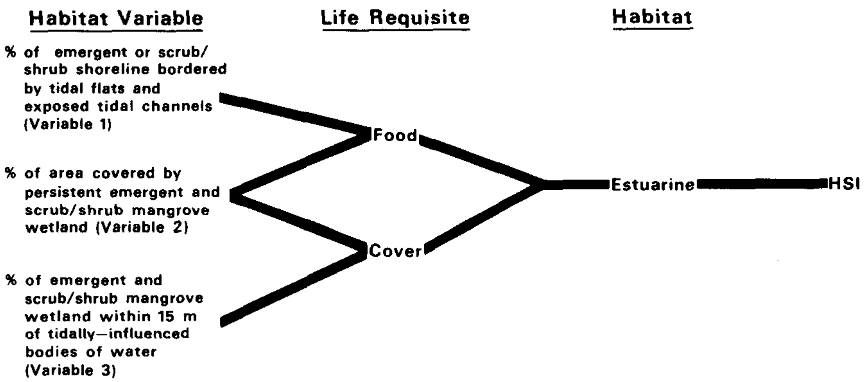

Figure 1. Relationship of habitat variables and life requisites to the HSI for clapper rail.

exposed channels provide feeding habitat (Mangold 1977, National Fish and Wildlife Laboratory 1980). Variable 1 is the percentage of the area in this habitat. The literature does not specify the optimum amount of these tidal mud flats but Lewis and Garrison (1983) interpreted habitat as optimum when at least 50% of the shoreline was bordered by tidal flats and exposed channels.

Mangrove and emergent wetland habitats (Variable 2) meet the second feeding habitat requirement. Emergent wetland is an estuarine intertidal area characterized by erect, rooted, herbaceous hydrophytes, mainly perennials (Cowardin et al. 1979). These marshes usually include species of *Spartina, Juncus, Salicornia,* and *Grindelia.* Shrubby mangrove wetland, the scrub-shrub of Cowardin et al. (1979), characterized by mangrove (*Rhizophora mangle* and *Avicennia germinans*) not exceeding 6 m in height, is used occasionally by clapper rails. For any coastal unit being evaluated, the highest SI is assumed attained when 100% of the land area is emergent or scrub/shrub mangrove wetland (Lewis and Garrison 1983).

The cover habitat requirements of clapper rails can be categorized into nesting and non-nesting needs. For example, cover needs from late summer through winter, when rails are more widely dispersed than during the nesting season, are met by the emergent and scrub-shrub mangrove wetlands, the same habitats important in Variable 2. Cover requirements during the nesting season are more restricted.

The literature stresses that important nesting habitat is emergent or scrub-shrub wetlands bordering ditches and tidal creeks (Kozicky and Schmidt 1949, Stewart 1951, Oney 1954, Stone 1965, Wilbur and Tomlinson 1976). Important nesting habitat is composed of *Spartina, Salicornia, Grindelia,* and, occasionally, mangroves. These genera usually make up the vegetation bordering tidally-influenced bodies of water. Most nests on the Atlantic Coast are located within 5 m of water (Kozicky and Schmidt 1949, Stewart 1951), but rails along the Gulf coast nest at slightly greater distances from water (Sharpe 1976, Holliman 1978). The vegetated wetland bordering tidally-influenced water (streams, rivers, ditches, sloughs, bayous, embayments) is preferred nesting habitat; the optimum width of this fringe apparently varies with the subspecies or geographic location. The model uses a 15-m fringe bordering a tidally-influenced body of water as the area most suitable for nesting cover (Variable 3). Coastal areas with a large water to vegetative interface (i.e., containing uneven shorelines and with many embayments, streams, rivers, and ditches) are assumed to provide the best nesting habitat. Ideal habitat is that which contains at least 25% of the total wetland area in this 15-m fringe (Lewis and Garrison 1983).

Each variable is given an SI from 0 to 1 depending on the extent to which optimum habitat conditions exist. These SI's are then entered into the following geometric mean function:

$$HSI = (SI_{V_1} \times SI_{V_2} \times SI_{V_3})^{1/3}$$

Methods

In an effort to include good and poor rail habitat in our sample scheme, we asked Georgia Department of Natural Resources and United States Fish and Wildlife Service employees to identify areas of low, medium, and high rail populations that they were familiar with on the Georgia coast. From their rankings we chose 6 areas of "poor" habitat and 6 areas of "good" habitat. The 12 40-ha study units were located in estuarine areas between barrier islands and the mainland. Most of the area is salt marsh and the primary vegetation is smooth cordgrass (*Spartina alterniflora*) (Johnson et al. 1974).

Typical rail habitat in Georgia consists of 79% smooth cordgrass, 20% black rush (*Juncus roemerianus*), and 1% salt flats or salt meadows (Hon et al. 1977). Average temperatures range from about 10° C in January to 30° C in July and August. Average annual rainfall is about 127 cm (Johnson et al. 1974).

Call counts have been used as population indices for clapper rail (Tomlinson and Todd 1973, Holliman 1978, Gill 1979), Virginia rail (*Rallus limicola*) (Glahn 1974, Griese et al. 1980), sora rail (*Porzana carolina*) (Glahn 1974, Griese et al. 1980), and black rail (*Laterallus jamaicensis*) (Repking and Ohmart 1977).

To evaluate the model for use on winter habitat, we conducted call-count surveys on each of the study units between mid-December and mid-

February. Call counts were conducted again during May to see if the HSI model was suitable for evaluating nesting habitat. A recording of a clapper rail call was broadcast from the center of each of the 4 quadrants within a study unit. The number of clapper rail calls heard and also the number of birds producing these calls were counted within a 5-minute interval following the broadcast. Call counts were not conducted during rain or when winds exceeded Beaufort Scale 4 (29 km/hour).

Data on species of vegetation, vegetation density, and on numbers of fiddler crabs and periwinkle snails (the major food items of clapper rails in Georgia, Oney 1954) were also recorded at each study site. These data were thought to be potentially useful for improving the clapper rail HSI model. Sampling was conducted on 36 0.2-m^2 plots at each study site.

HSI's were calculated for each study area. All 3 habitat variables were measured on panchromatic aerial photographs (scale 1:3960) with a planimeter. A correlation analysis was performed to measure the closeness of linear relationship between the number of rails found within a study unit and the HSI value for that unit.

Results

Clapper rails responded to taped calls in 11 of 12 study areas during the winter census (Table 1). Of these 11 areas, the number of rails heard calling ranged from 1 to 55 with a mean of 18.6. Numbers of calls ranged from 1 to 108 with a mean of 28.6. During the spring sampling period, clapper rails responded to the taped call on only 4 of the study areas. Of these 4 areas, numbers of rails ranged from 1 to 20 and the number of calls ranged from 1 to 50 with means of 10.0 and 20.3, respectively.

The mean number of rails heard within each study area was not significantly correlated with the HSI values calculated for that respective area during winter ($r = 0.21$) or spring ($r = 0.26$).

In spring, the abundance of emergent or mangrove wetlands (V_2) was the variable most influential ($r = 0.41$) in determining habitat suitability. We suggest future testing of alternative functions that weigh Variable 2 when nesting habitat is being evaluated. For winter habitat, alternative HSI functions that add numbers of fiddler crab burrows and numbers of periwinkle snails as variables should also be tested in the future. The abundance of fiddler crabs appeared to be the most important variable influencing rail distribution in winter.

Discussion

Because of the wide tidal fluctuation (2.7 m or more) and the gently sloping terrain, many shorelines bordered tidal flats or exposed channels.

Table 1. Numbers of clapper rails heard on the 12 study areas during winter and spring and corresponding habitat suitability indices.

Study area	*N* of rails heard during winter	*N* of calls heard during winter	*N* of rails heard during spring	*N* of calls heard during spring	Major plant species[a]	Habitat suitability index
1	1	1	0	0	S	0.99
2	25	29	0	0	S	0.99
3	8	9	0	0	S	0.99
4	18	20	0	0	S	0.92
5	0	0	0	0	S	0.65
6	26	44	12	21	J	1.00
7	2	3	7	9	J	1.00
8	55	108	0	0	S	0.94
9	30	40	0	0	S	0.98
10	16	24	20	50	S	1.00
11	16	24	0	0	S	0.99
12	8	13	1	1	S	1.00
Mean	17.1	26.2	3.3	6.7		0.95

[a] S = *Spartina alterniflora* and J = *Juncus roemerianus*.

Consequently, the percentage of wetland shoreline that bordered favored feeding habitat (Variable 1) exceeded 50% on all study sites. This may not be a problem when the model is used at some West Coast or north Atlantic Coast sites that have rocky shorelines, steeper shoreline gradients, or less tidal fluctuation. For Georgia conditions, Variable 1 is either an insignificant habitat factor or an SI of 1 should require a higher percentage of the shoreline bordered by tidal flats and exposed channels. Variables 2 and 3 also had fairly high SI's, indicating that present model scaling is not sensitive enough to do a good job of ranking Georgia rail habitat.

A problem faced in developing HSI models is that the literature does not always provide sufficiently detailed descriptions of optimum habitat. In order to develop the SI graphs, it is then necessary for the model developer to make a judgement about what variable value will characterize optimum habitat. If this judgement is inaccurate, then either model scaling is poor or the model is totally inadequate. Variable 1 of the rail HSI model appears to be an example of poor scaling.

Validity testing of wetland HSI models is in its infancy and many problems exist in developing and interpreting such tests. The following comments apply to trying to validate the rail HSI model and any similar model.

As noted, the HSI values are assumed to be a measure of carrying capacity. There are many reasons why a given population may not be at carrying capacity in a given year (i.e., disease, weather conditions, hunting pressure, behavior patterns). These factors are often independent of habitat. A validity test will reach an invalid conclusion if enough study area populations do not reflect carrying capacity of the habitat.

Another problem is the uncertainty of accuracy of many wildlife population indices. A model might be validated or invalidated by questionable population data. The rail HSI model was to be tested in a 1-year contract interval. Certainly the prospect for population data representative of carrying capacity would improve if the rails had been censused several years in sequence.

Conclusions

Weak but positive correlations existed between the HSI values and rail relative densities during winter and during the nesting season on the 12 study sites. Although an attempt was made to select sites with both good and poor rail habitat, ranges in HSI's were relative narrow (0.65 to 1.0).

During winter, the area with the lowest HSI (0.65) was the only area on which rails did not respond to the recording. During spring, only the 4 areas with HSI ratings of 1.0 produced calling responses by clapper rails. The model seemed to classify rail habitat suitability for these 5 areas. The problem with the model may be one of scaling and sensitivity. A revised scaling for the SI's would result in a lower ranking for the poorest habitats and ratings of 1.0 for only the excellent habitat.

This model was developed for use on all clapper rail habitat in North America. Scaling might have been appropriate if representative habitats all along the Atlantic, Gulf, and Pacific coastal regions had been tested. When habitat along the Georgia coast is compared to rail habitat nationwide, most Georgia areas may actually rank as good to excellent habitat.

Literature Cited

Bateman, H. A. Jr. 1965. Clapper rail (*Rallus longirostris*) on Grand Terre Island, Jefferson Parish, Louisiana. M.S. Thesis, Louisiana State Univ., Baton Rouge. 144pp.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Off. Biol. Serv. U.S. Dep. Int. Fish and Wildl. Serv., Washington, D.C.

Gill, R. Jr. 1979. Status and distribution of the California clapper rail (*Rallus longirostris obsoletus*). Calif. Fish and Game 65:36–49.

Glahn, J. F. 1974. Study of breeding rails with recorded calls in north-central Colorado. Wilson Bul. 86:206–214.

Griese, H. J., R. A. Ryder, and C. E. Braun. 1980. Spatial and temporal distribution of rails in Colorado. Wilson Bul. 92:96–102.

Habitat Evaluation Procedures Group. 1980. Habitat Evaluation Procedures (HEP). ESM 102. U.S. Dep. Int. Fish and Wildl. Serv., Div. Ecol. Serv.

Holliman, D. C. 1978. Clapper rail (*Rallus longirostris*) studies in Alabama. Northeast Gulf Sci. 2:24–34.

Hon, T., R. R. Odum, and D. P. Belcher. 1977. Results of Georgia's clapper rail banding program. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 31:72–76.

Howell, A. H. 1932. Florida bird life. Fla. Dep. Game and Fresh Water Fish Comm. and Bur. Biol. Surv., U.S. Dep. Agric., Coward-McCann Inc., N.Y. 579pp.

Johnson, A. S., H. O. Hillestad, S. F. Shanholtzer, and G. F. Shanholtzer. 1974. An ecological survey of the coastal region of Georgia. Natl. Park Serv. Monogr. Ser. 3. 233pp.

Kozicky, E. L. and F. V. Schmidt. 1949. Nesting habits of the clapper rail in New Jersey. Auk 66:355–364.

Lewis, J. C. and R. L. Garrison. 1983. Habitat suitability index models: clapper rail. U.S. Dep. Int. Fish and Wildl. Serv. FWS/OBS–83/10. 15pp.

Mangold, R. E. 1977. Clapper rail (*Rallus longirostris*). Pages 84–93 *in* Sanderson, G. C., ed. Management of migratory shore and upland game birds in North America. Internat. Assoc. Fish and Wildl. Agencies. 358pp.

Moffitt, J. 1941. Notes on the food of the California clapper rail. The Condor 43:270–273.

National Fish and Wildlife Laboratory. 1980. Selected vertebrate endangered species of the seacoast of the United States: California clapper rail. U.S. Dep. Int. Fish and Wildl. Serv. Biol. Serv. Prog. FWS/OBS–80/01.27. 6pp.

Oney, J. 1951. Fall food habits of the clapper rail in Georgia. J. Wildl. Manage. 15:106–107.

Oney, J. 1954. Final report, clapper rail survey and investigations study. Ga. Game and Fish Comm. Atlanta. 50pp.

Repking, C. F. and R. D. Ohmart. 1977. Distribution and density of black rail populations along the lower Colorado River. The Condor 79:486–489.

Sharpe, T. L. 1976. Productivity and distribution of the clapper rail in a Louisiana saltmarsh. M.S. Thesis, Louisiana State Univ. and A&M College, Baton Rouge. 91pp.

Stewart, R. E. 1951. Clapper rail populations of the middle Atlantic States. Trans. North Am. Wildl. Conf. 16:421–430.

Stone, W. 1965. Bird studies at old Cape May. Vol. 1, Dover Publ. Inc., New York, N.Y. 484pp.

Tomlinson, R. E. and R. L. Todd. 1973. Distribution of two western clapper rail races as determined by responses to taped calls. The Condor 75:177–183.

Wilbur, S. R. and R. E. Tomlinson. 1976. The literature of the western clapper rails. U.S. Dep. Int. Fish and Wildl. Serv., Spec. Sci. Rep.-Wildl. 194, Washington, D.C. 31pp.