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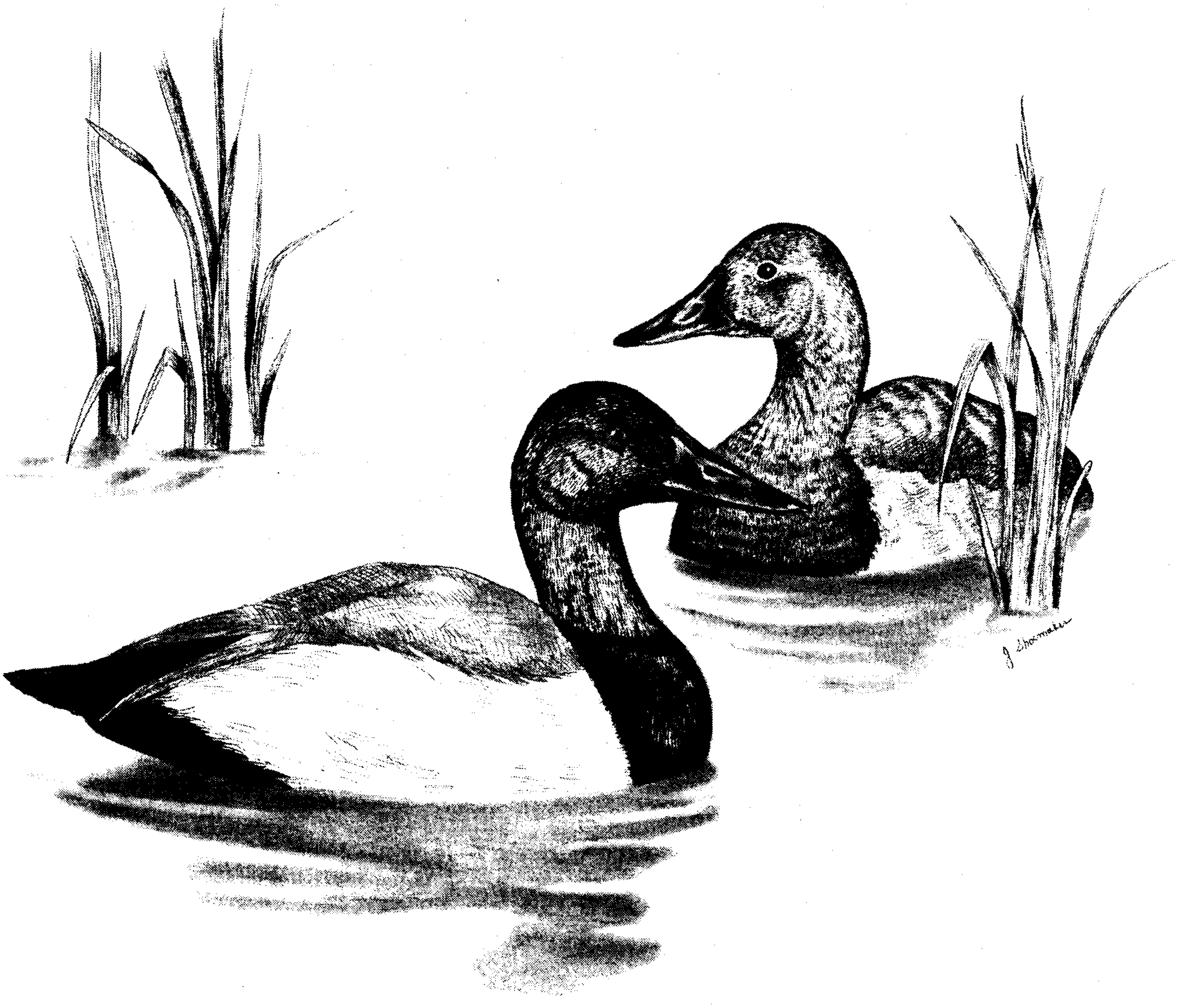
HABITAT SUITABILITY INDEX MODELS: CANVASBACK (BREEDING HABITAT)



and Wildlife Service

Department of the Interior

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September 1984

HABITAT SUITABILITY INDEX MODELS: CANVASBACK (BREEDING HABITAT)

by

Richard L. Schroeder
Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
Drake Creekside Building One
2627 Redwing Road
Fort Collins, CO 80526-2899

Western Energy and Land Use Team
Division of Biological Services
Research and Development
Fish and Wildlife Service
U.S. Department of the Interior
Washington, DC 20240

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PREFACE

This document is part of the Habitat Suitability Index (HSI) Model Series (FWS/OBS-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. The habitat use information provides the foundation for HSI models that follow. In addition, this same information may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

The HSI Model Section documents a habitat model and 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 application information includes descriptions of the geographic ranges and seasonal application of the model, its current verification status, and a listing of model variables with recommended measurement techniques for each variable.

In essence, the model presented herein is a hypothesis of species-habitat relationships and not a statement of proven cause and effect relationships. Results of model performance tests, when available, are referenced. However, models that have demonstrated reliability in specific situations may prove unreliable in others. For this reason, feedback is encouraged from users of this model concerning improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to fish and wildlife planning. Please send suggestions to:

Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
2627 Redwing Road
Ft. Collins, CO 80526-2899

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CANVASBACK (*Aythya valisineria*)

HABITAT USE INFORMATION

General

Canvasbacks (*Aythya valisineria*) breed from Alaska south to Montana and the Dakotas, with the highest breeding densities found in the parklands of Southcentral Canada (Bellrose 1976). Canvasbacks nest over water in a variety of wetland habitats, including large marshes, ponds, sloughs, and potholes. Their preferred breeding habitat is shallow prairie marshes, bordered by cattail (*Typha* spp.), bulrush (*Scirpus* spp.), and similar emergent vegetation (Johnsgard 1975).

Food

The spring and summer food of adult females and juveniles in Manitoba was primarily aquatic invertebrates (Bartoneck and Hickey 1969). The diet of adult males during the spring and summer was predominantly plant material and consisted of 95% pondweed tubers (*Potamogeton* spp.) by volume. The fall diet for juveniles and adults of both sexes was 78% plant material (primarily pondweed) and 22% aquatic invertebrates. Canvasback females feed heavily on sago pondweed tubers (*P. pectinatus*) and chironomid larvae during the breeding season (Serie, pers. comm.).

Water

Information on dietary water requirements was not found in the literature. Habitat requirements related to water are discussed in the Reproduction section.

Cover

Cover needs of the canvasback during the breeding season are assumed to be the same as reproductive habitat requirements and are discussed in the following section.

Reproduction

Information in the literature on the reproductive habitat needs of canvasbacks is generally presented in terms of breeding pair use, nesting requirements, and brood use. Canvasback pairs utilize large, deep, open, permanent ponds for feeding, resting, and courtship activities (Olson 1964; Trauger and Stoudt 1974). Breeding pairs of canvasbacks prefer the more permanent wetland types; pair densities in these wetlands were more than double the densities in seasonal and ephemeral wetlands (Sugden 1978; Stoudt 1982). Breeding pair densities were lowest in ponds smaller than 0.2 ha (0.5 acres) (Stoudt 1971, 1982; Sugden 1978). Densities of canvasback pairs were higher in wetlands surrounded by pasture or woodland than in wetlands bordered by hayland or cropland (Stoudt 1982). Breeding pair densities were highest when the emergent vegetation present was bulrush or cattail and lowest when the emergent cover was willow (*Salix* spp.).

Canvasbacks generally nest solitarily on ponds (Sugden 1978) with the nest placed in emergent vegetation over water that is 15 to 61 cm (6 to 24 inches) deep (Bellrose 1976). Nests are usually 0.9 to 18 m (1 to 20 yds) from the edge of open water (Hochbaum 1944). Of 177 ponds containing canvasback nests in Saskatchewan, 160 ponds had one nest each, 13 ponds had two nests each, 3 ponds had three nests each, and 1 pond had five nests (Sugden 1978). Cover is a major factor affecting pond selection by nesting females. However, canvasbacks show considerable adaptability to changing habitat conditions. Cattails provide an important nest site for canvasbacks (Keith 1961; Stoudt 1971), although their presence is not critical (Sugden 1978). Nest sites generally reflect available emergent cover, which is related to water levels (Sugden 1978). High water tends to eliminate much of the herbaceous cover, and nest sites during times of high water are provided by flooded willows and shrubs at pond margins (Stoudt 1971; Sugden 1978). During years of normal water levels, canvasbacks make greater use of cattail, whitetop (*Scolochloa festucacea*), and sedge (*Carex* spp.) for nesting and less use of flooded willows and associated shrubs.

Canvasbacks use smaller, shallower, semipermanent ponds for nesting (Trauger and Stoudt 1974). A typical pond used for nesting is less than 0.4 ha (1.0 acre) in size and contains emergent vegetation for the overwater nest (Olson 1964; Trauger and Stoudt 1974). Nest densities in two Canadian study areas were highest on small wetlands and declined as wetland size increased (Sugden 1978; Stoudt 1982). Nest densities in Manitoba varied from 0.62 nests/ha (0.25/acre) on wetlands of 0.1 to 0.5 ha (0.25 to 1.25 acres) to no nests on wetlands greater than 10 ha (25 acres) (Stoudt 1982). Nest densities in Saskatchewan declined from 0.43 nests/ha (0.17 nests/acre) in wetlands less than 0.21 ha (0.53 acres) to 0.08 nests/ha (0.03 nests/acre) in wetlands greater than 1.62 ha (4.0 acres) (Sugden 1978). Seasonal and semipermanent wetlands received high use by nesting canvasbacks.

Land use adjacent to wetlands apparently affected canvasback nest density (Stoudt 1982). Wetlands bordered by ungrazed woodland had the highest nest density [2.32 nests/ha (0.93 nests/acre)], whereas wetlands bordered by cultivated land had 0.17 nests/ha (0.07 nests/acre).

Habitat preferences of canvasback broods are similar to those of breeding pairs (Stoudt 1971, 1982; Trauger and Stoudt 1974; Sugden 1978). Brood use is highest in larger, more permanent wetlands and lowest in smaller, seasonal wetlands (Evans et al. 1952; Stoudt 1971, 1982; Sugden 1978). Brood use in

Manitoba tripled as the range of pond sizes increased from 0.1 to 0.5 ha (0.25 to 1.25 acres) to 0.6 to 1.0 ha (1.5 to 2.5 acres) (Stoudt 1982). However, brood use increased much more slowly as pond size increased from 1.0 ha (2.5 acres) to greater than 4 ha (10 acres). Broods are reared mostly on open water, which is used for escape (Hochbaum 1944). Broods prefer wetlands with one-third or less of the water covered by emergent vegetation (Stoudt 1982). Based on a comparison of percent use versus percent availability, Duebbert and Frank's (1984) data show that broods prefer semipermanent and permanent wetlands and make very little use of seasonal wetlands.

Several studies have compared the density of canvasback pairs, nest densities, and brood use with the type of wetland. Results of these studies are summarized in Table 1.

Nesting success of canvasbacks is affected by a wide range of factors, including nest parasitism by redheads (Aythya americana), weather, and predation (Sugden 1978). The breeding range and habitat preferences of the redhead are similar to those of the canvasback, and canvasback nests are often parasitized by redheads (Weller 1959). Redhead parasitism in Saskatchewan resulted in a reduction of approximately 2.7 eggs per canvasback nest (Sugden 1980). Canvasback renesting attempts in Manitoba were parasitized more heavily by redheads than were first nests (Stoudt 1982).

Forty-three percent of the canvasback nests in a Saskatchewan study area hatched, 35% were destroyed by predators, 11.5% were deserted, 3.5% were lost to hail and floods, and 6.5% were lost to unknown causes (Sugden 1978). Predation accounted for 86% of all nest losses in a Manitoba study, with raccoons (Procyon lotor) accounting for 69% of the predation losses (Stoudt 1982). The encroachment of raccoons into canvasback breeding grounds is a recent occurrence and has resulted in considerable nest destruction (Bellrose 1976) and a loss of productivity (Stoudt 1982).

Interspersion and Movements

The home range of a breeding pair of canvasbacks included many potholes, but only a few potholes were used frequently (Dzubin 1955). The male canvasback had an estimated home range of 520 ha (1,300 acres).

Canvasback broods frequently move from one pothole to another (Evans et al. 1952). One brood moved 0.91 km (0.58 miles) during 29 days of observation; no broods used any pothole for more than 23 consecutive days. Serie (pers. comm.) has recorded brood movements exceeding 2.4 km (1.5 miles).

The highest recorded density of canvasbacks in Canada was 8 pairs/km^2 (20.7 pairs/mi^2); most areas contained fewer than 4 pairs/km^2 (10.4 pairs/mi^2) (Sugden 1978).

Special Considerations

Canvasback populations declined from 1958 to 1963 due to drought conditions on the breeding grounds, resulting in low production (Geis and Crissey

Table 1. Canvasback breeding pair, brood, and nest densities in different wetland types.

	Wetland type	Density	Reference
Breeding pairs	Class III[a]	1.6 pairs/km² (4.1/mi²)	Kantrud and Stewart (1977)
	Class IV	8.1 pairs/km² (21.0/mi²)	
	Class V	2.2 pairs/km² (5.7/mi²)	
	Type 3[b]	0.06 pair/ha (0.024/acre)	Sugden (1978)
	Type 4	0.19 pair/ha (0.077/acre)	
	Type 5	0.22 pair/ha (0.089/acre)	
	Type 3[c]	0.1 pair/ha (0.04/acre)	Stoudt (1982)
	Type 4	0.2 pair/ha (0.08/acre)	
	Type 5	0.3 pair/ha (0.12/acre)	
	Type 3[d]	0.05 pair/ha (0.02/acre)	Stoudt (1971)
	Type 4	0.22 pair/ha (0.09/acre)	
	Type 5	0.30 pair/ha (0.12/acre)	
	Type 6	0.024 pair/ha (0.01/acre)	
	Type 7	0.49 pair/ha (0.20/acre)	
Brood use	Type 3[c]	0.01 brood/ha (0.004/acre)	Stoudt (1982)
	Type 4	0.10 brood/ha (0.04/acre)	
	Type 5	0.12 brood/ha (0.049/acre)	
	Type 3[d]	0.0 brood/ha (0.0/acre)	Stoudt (1971)
	Type 4	0.10 brood/ha (0.04/acre)	
	Type 5	0.25 brood/ha (0.10/acre)	
	Type 6	0.32 brood/ha (0.13/acre)	
	Type 7	1.01 broods/ha (0.41/acre)	
Nesting	Type 3[b]	0.25 nest/ha (0.10/acre)	Sugden (1978)
	Type 4	0.19 nest/ha (0.077/acre)	
	Type 5	0.12 nest/ha (0.049/acre)	
	Type 3[c]	0.12 nest/ha (0.049/acre)	Stoudt (1982)
	Type 4	0.64 nest/ha (0.26/acre)	
	Type 5	0.12 nest/ha (0.049/acre)	

Wetland types - (a) Stewart and Kantrud (1971)
(b) Martin et al. (1953)
(c) Shaw and Fredine (1956)
(d) Shaw and Fredine (1956), modified to include man-made water areas. Type 6 is a stock-watering pond, and Type 7 is a dugout.

1969). Restrictive hunting regulations, including closed seasons, were subsequently enforced. Implementation of these regulations has been related to a sharp reduction in canvasback mortality rates. Habitat deterioration due to intensified agricultural production poses a serious threat to the welfare of the canvasback (Trauger and Stoudt 1974). The canvasback was on the Audubon Society's Blue List from 1975 to 1981 (Tate 1981) and on its list of Species of Special Concern in 1982 (Tate and Tate 1982). The canvasback also is on the list of national species of special emphasis (U.S. Fish and Wildlife Service 1982).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model was developed for the entire breeding range of the canvasback (Fig. 1 shows the area of applicability within the contiguous United States).

Season. This model was developed to evaluate the breeding season habitat of the canvasback.

Cover types. This model was developed to evaluate habitat in Lacustrine (L), Deciduous Scrub/Shrub Wetland (DSW), and Herbaceous Wetland (HW) habitats (terminology follows that of U.S. Fish and Wildlife Service 1981).

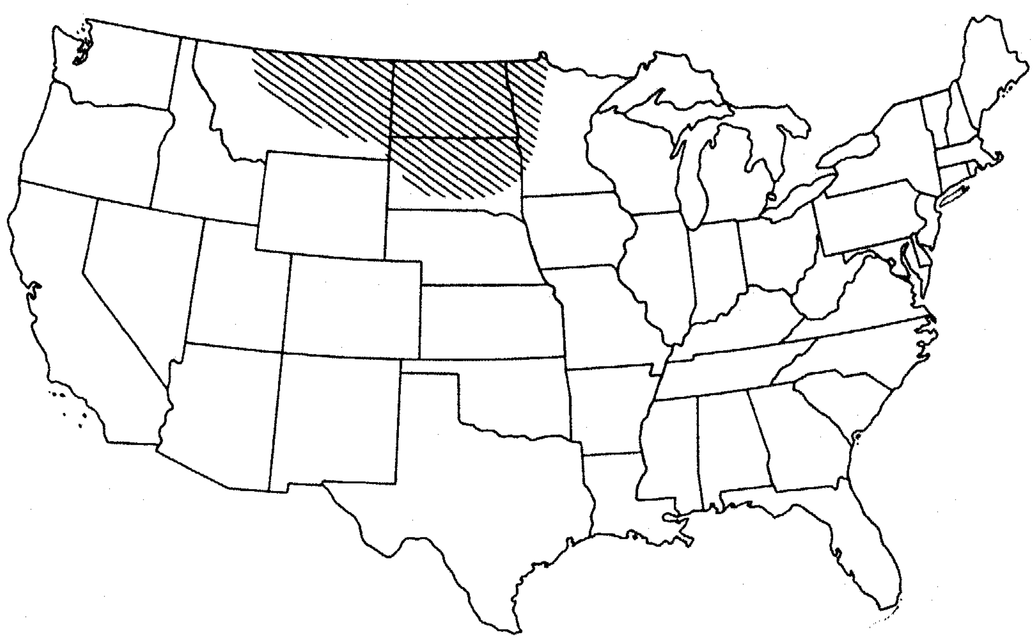


Figure 1. Geographic applicability of the canvasback HSI model within the contiguous United States (modified from Bellrose 1976).

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before a species will live and reproduce in an area. Specific information on the minimum area for canvasbacks was not found in the literature.

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. Previous drafts of this model were reviewed by Jerome Serie, Northern Prairie Wildlife Research Center, U.S. Fish and Wildlife Service, Jamestown, ND, and Lawson Sugden, Prairie Migratory Bird Research Center, Canadian Wildlife Service, Saskatoon, Saskatchewan. Comments from these reviewers have been incorporated into this model.

Model Description

Overview. The ability of an area to meet the reproductive needs of the canvasback is assumed to be an indication of overall habitat suitability. Cover and water needs during the breeding season are assumed to be met by reproductive habitat requirements of the species. The influence of food availability has not been sufficiently studied (Serie, pers. comm.), and therefore, food is not included as a model component. This model assumes that optimal habitat conditions for the canvasback occur when a variety of wetlands exist to meet both pair/brood needs and nesting needs. Pairs and broods tend to prefer larger, more permanent, open wetlands, whereas nesting requirements are met in smaller, semipermanent wetlands with abundant emergent vegetation.

The following sections provide documentation of the logic and assumptions used to interpret the habitat information for the canvasback and to explain and justify the variables and equations that are used in the HSI model. Specifically, these sections cover the following: (1) identification of variables that are used in the model; (2) definition and justification of the suitability levels of each variable; and (3) description of the assumed relationship between variables.

Pair/brood component. The habitat requirements of canvasback pairs and broods are very similar, and are, therefore, treated as one component in this model. Pairs and broods prefer wetlands with large amounts of open water and relatively small amounts of emergent vegetation. It is assumed that ideal conditions are provided in wetlands with 10 to 33% of their area in the summer containing emergents with the balance in open water. Suitability is assumed to decrease to zero as the ratio of emergent vegetation to open water approaches 100%. Wetlands with no emergent vegetation will have only moderate suitability due to the total lack of cover which may be used as escape cover by females with young broods (Sugden, pers. comm.). The relationship between the ratio of emergents to open water and a suitability index (SIV1) for canvasback pairs and broods is presented in Figure 2a.

Fig. 2a

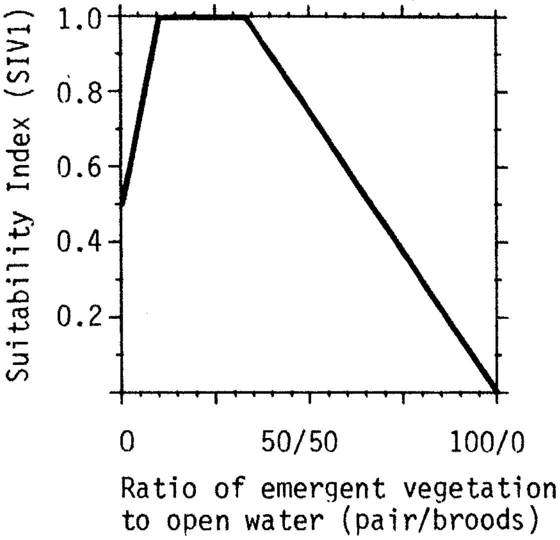


Fig. 2b

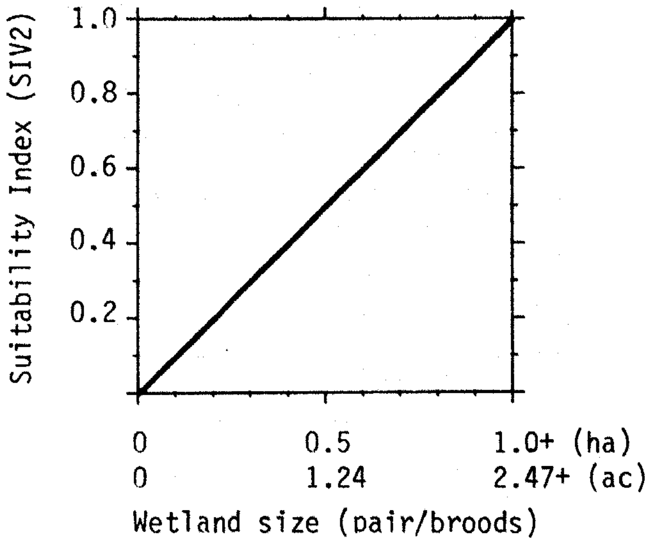
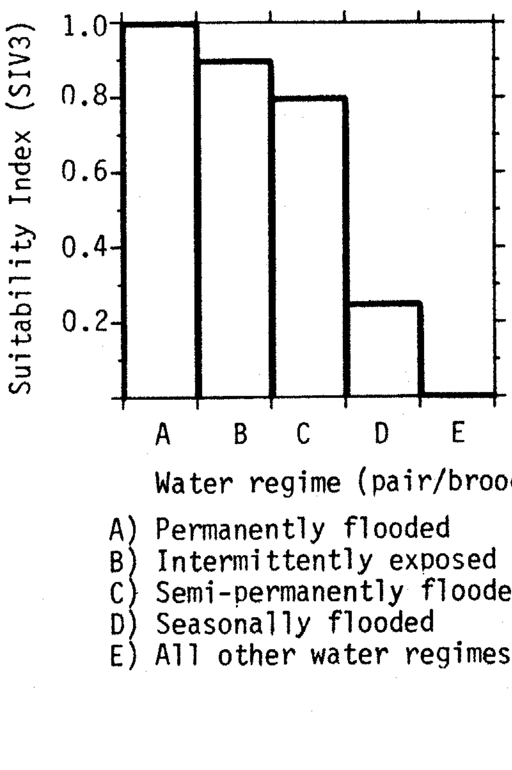


Fig. 2c



A) Permanently flooded
B) Intermittently exposed
C) Semi-permanently flooded
D) Seasonally flooded
E) All other water regimes

Figure 2. The relationships between variables used to evaluate canvasback pair/brood habitat and the suitability indices for the variables.

Pair and brood densities are consistently higher in wetlands exceeding 1 ha (2.47 acres) in size (Sugden 1978; Stoudt 1982) and it is assumed that wetlands of this size or larger provide optimal conditions. Suitability for pairs and broods is assumed to decrease to zero as wetland sizes approach 0 ha. The relationship between wetland size and a suitability index (SIV2) for pairs and broods is presented in Figure 2b.

Pair and brood densities also vary with the permanence of the wetland. The highest pair and brood densities are consistently found in the more permanent wetlands, whereas densities in seasonal wetlands are much lower. The data showing pair and brood densities in various wetland types (see Table 1 on page 4) reflect three somewhat different wetland classification systems, and are not totally compatible. This model uses the water regime modifiers described by Cowardin et al. (1979) to describe wetland permanence categories. Suitability indices for each water regime were derived by assessing the relative value of different wetland types for both pairs and broods. The relationship between water regime and a suitability index (SIV3) for pairs and broods is presented in Figure 2c.

The overall suitability of the pair/brood component is related to the ratio of emergent vegetation to open water, wetland size, and water regime. Each of these variables exerts a major influence on the suitability of the pair/brood component. It is assumed that low values for any one of these variables may be partially compensated for by higher values of the remaining variables. However, habitats with low values for two or more of these variables will have low suitability. This relationship can be expressed mathematically by the following equation:

$$\text{pair/brood component} = (\text{SIV1} \times \text{SIV2} \times \text{SIV3})^{1/2}$$

This specific equation was selected with the use of graphic computer displays of many sample data sets. The outputs of these analyses indicated that the above equation most closely matched the perceived importance and interactions of these three variables as they affect the pair/brood component of canvasback habitat.

<u>Nesting component</u>. Nesting females prefer smaller wetlands with more emergent growth than do pairs and broods. Nesting canvasbacks also tend to utilize wetlands that are in slightly lower permanence categories. Specific information on the ratio of emergent vegetation to open water that is preferred by nesting canvasbacks was not found in the literature. It is assumed in this model that optimal conditions occur when this ratio is between 30 to 60% emergent and 70 to 40% open water. Suitability is assumed to decrease to zero as the percent emergents approaches zero, while low suitabilities are assumed to exist in areas of solid emergent cover, due to the low nesting potential provided in these situations. The relationship between the ratio of emergents to open water and a suitability index (SIV4) for nesting canvasbacks is presented in Figure 3a.

Fig. 3a

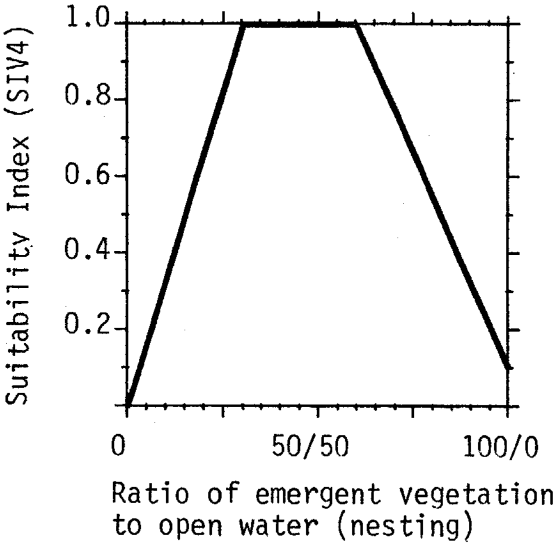


Fig. 3b

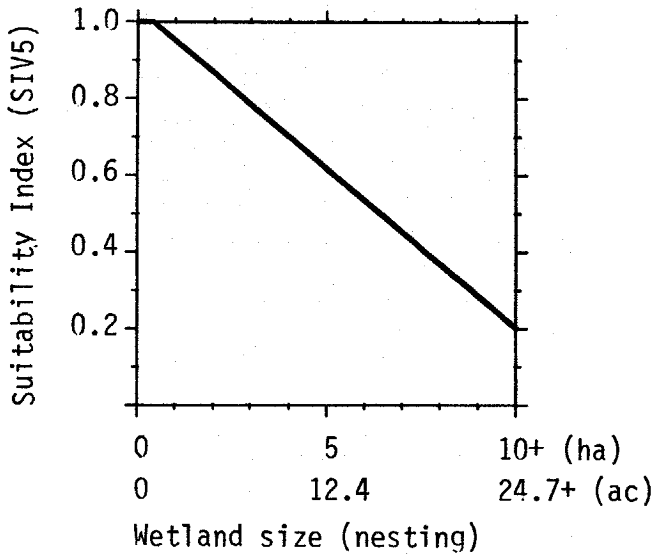
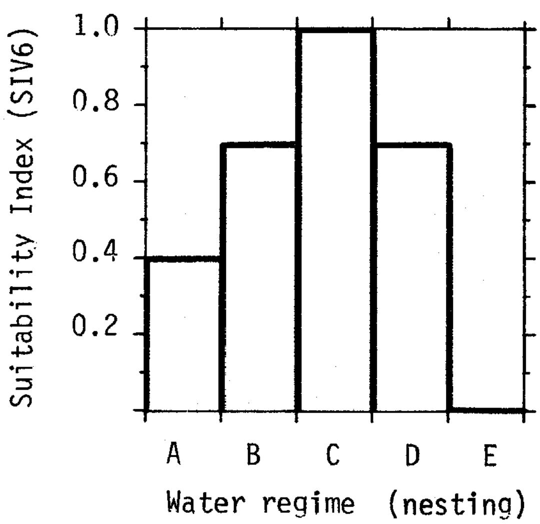


Fig. 3c



A) Permanently flooded
B) Intermittently exposed
C) Semi-permanently flooded
D) Seasonally flooded
E) All other water regimes

Figure 3. The relationships between variables used to evaluate canvasback nesting habitat and the suitability indices for the variables.

Nest densities of canvasbacks are consistently higher in smaller wetlands and decrease as wetland size increases (Sugden 1978; Stoudt 1982). It is assumed that optimal conditions for nesting occur in wetlands 0.5 ha (1.2 acres) or smaller in size, and that nesting suitability will decrease to a low level as wetland size increases to 10.0 ha (24.7 acres). Wetlands exceeding 10.0 ha (24.7 acres) are assumed to have a constant low value as nesting habitat. The relationship between wetland size and a suitability index (SIV5) for nesting canvasbacks is presented in Figure 3b.

Nest densities have been shown to vary with the permanence of the wetland. Semipermanent wetlands provide optimal conditions, whereas seasonal wetlands are moderately high in value, and permanent wetlands are moderately low for nesting canvasbacks. As with the data for pairs and broods, nest density data were collected using somewhat different wetland classification systems. This model uses the water regime modifiers of Cowardin et al. (1979) to describe wetland permanence categories. Suitability indices for each water regime were developed by assessing the relative value of different wetland types for nesting canvasbacks. The relationship between water regime and a suitability index (SIV6) for nesting canvasbacks is presented in Figure 3c.

The overall suitability of the nesting component is a function of the ratio of emergent vegetation to open water, wetland size, and water regime. Each of these variables exerts a major influence on the suitability of the nesting component. It is assumed that low values for any one of these variables may be partially offset by higher values of the remaining variables. However, habitats with low values for two or more of these variables will have low suitability. This relationship can be expressed mathematically by the following equation:

$$\text{nesting component} = (\text{SIV4} \times \text{SIV5} \times \text{SIV6})^{1/2}$$

This specific equation was selected with the use of graphic computer displays of many sample data sets. The outputs of these analyses indicated that the above equation most closely matched the perceived importance and interactions of these three variables as they affect the nesting component of canvasback habitat.

<u>Interspersion component</u>. The habitat needs of pairs/broods and nesting canvasbacks may be provided by different wetlands; therefore, this model considers the proper mix and interspersion of wetlands that are required to provide optimal conditions.

It is suggested that users analyze units of habitat 2.59 km^2 (1.0 mi^2) in size when assessing wetland quality for canvasbacks. It is assumed that, if both pair/brood needs and nesting needs are in the proper mix, broods would be able to move from nesting cover to brood ponds within an area of this size.

The proper mix of wetlands providing nesting needs versus pair/brood needs can be determined by a comparison of the amount of wetland area needed to hatch one canvasback versus the amount needed to support a single canvasback of brood age. It is assumed in this analysis that brood habitat use data will accurately represent the habitat needs of canvasback pairs.

Nest density data for various wetlands from Stoudt (1982) show maximum nest densities to be 2.32 nests per ha (0.94 per acre) with a corresponding nest success of 53%. The maximum reported number of young hatched per successful nest was 7.2. This is equivalent to the production of 8.85 young per ha (3.58 per acre), or a need for 0.113 ha (0.28 acre) of wetlands in nesting habitat to produce one canvasback duckling.

Maximum brood densities reported for canvasbacks were 1.01 per ha (0.41 per acre) (Stoudt 1971), and the maximum mean brood size in a given year was reported as 5.9 (Stoudt 1982). This is equivalent to 5.96 brood age ducks per ha (2.41 per acre), or a need for 0.168 ha (0.42 acre) of wetlands in brood habitat to support one canvasback.

A comparison of the amount of area needed in nesting habitat versus brood habitat per canvasback young will produce a ratio of 40% in nesting to 60% in brood habitat. It is assumed that this represents the optimal mix of wetlands providing these specific needs and that as either value approaches zero, the value for that component will also approach zero. The relationships between the amount of area providing nesting and pair/brood habitat to suitability indices are presented in Figures 4a and 4b, respectively.

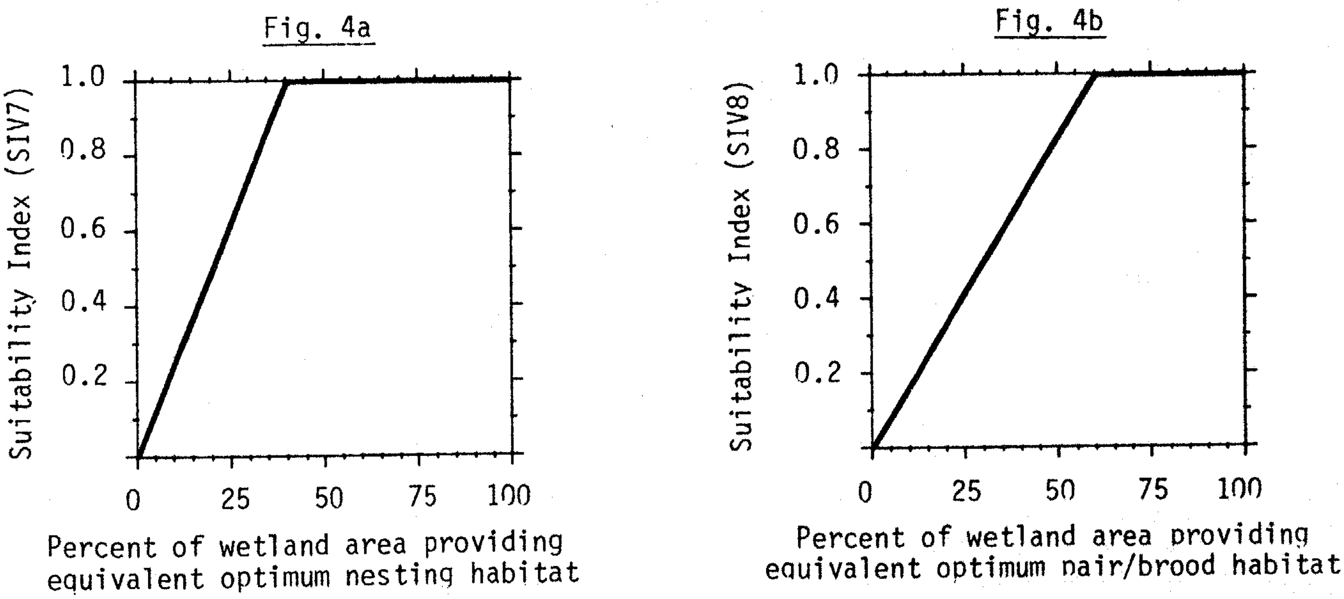


Figure 4. The relationships between the percent of the wetland area providing nesting and pair/brood habitat and the suitability indices for these variables.

Model Relationships

HSI determination. The overall HSI for the canvasback is a function of the quality, composition, and interspersion of areas providing pair/brood and nesting habitat. Pair/brood and nesting values must be determined for each individual wetland. Several steps are required to determine the overall HSI value, as follows:

1. Subdivide the study area into units 2.59 km^2 (1.0 mi^2) in size and perform the following calculations on each area.

2. Determine SI values for each variable in each individual wetland by entering the field data into the appropriate SI graph. Note that the same field data is used in the variables for pairs/broods as for nesting, but the SI graphs may have different suitability levels for the same field score.

3. Calculate pair/brood and nesting habitat values for each individual wetland by using the SI values from each individual wetland in the appropriate equation.

4. Multiply the pair/brood and nesting values for each wetland by the area of the wetland and sum these products separately for pairs/broods and nesting. These sums are the amount of area in the equivalent of optimum pair/brood and nesting habitat, respectively.

5. Determine the percent of the area providing the equivalent of optimum pair/brood and nesting habitat as follows:

$$\text{Percent of area in equivalent optimum pair/brood habitat} = 100 \times \frac{\text{Area in equivalent optimum pair/brood habitat}}{\text{Total area of wetlands in the 2.59 km}^2\text{ unit}}$$

$$\text{Percent of area in equivalent optimum nesting habitat} = 100 \times \frac{\text{Area in equivalent optimum nesting habitat}}{\text{Total area of wetlands in the 2.59 km}^2\text{ unit}}$$

6. Enter the percentage determined in Step 5 for each component (pair/brood and nesting) into the appropriate SI graph (Fig. 4a or 4b) and determine an index value for the pair/brood and nesting components.

7. The HSI for wetlands contained within each 2.59 km^2 (1.0 mi^2) unit is the lower of the pair/brood or nesting component values.

8. The HSI for wetlands in the entire project area must consider both the amount of wetlands in each 2.59 km^2 (1.0 mi^2) unit and the HSI for these wetlands to account for the relative value of each unit. Therefore, the HSI for wetlands in the entire project area is equal to the weighted average (based on wetland acreage) of the HSI's determined for wetlands on each 2.59 km^2 (1.0 mi^2) unit.

Summary of model variables. Six habitat variables are used in this model to determine pair/brood and nesting values for the canvasback. The relationship between habitat variables, life requisites, cover types, and the HSI for the canvasback is illustrated in Figure 5.

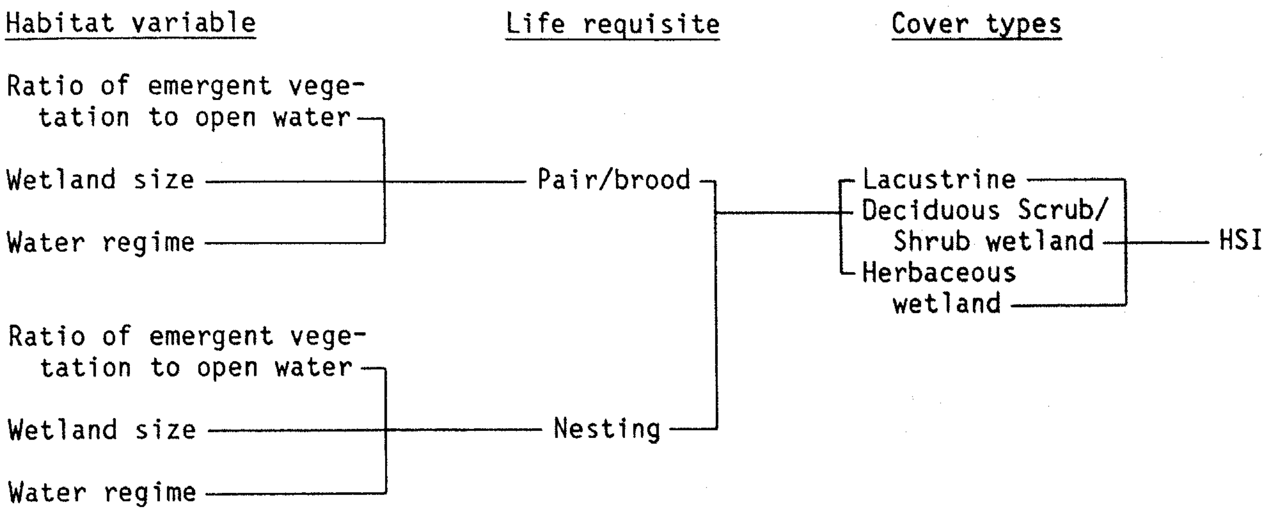


Figure 5. Relationships between habitat variables, life requisites, cover types, and the HSI for the canvasback.

Application of the Model

Definitions of variables and suggested field measurement techniques (Hays et al. 1981) are provided in Figure 6.

SOURCES OF OTHER MODELS

No other habitat model for the canvasback was located in the literature.

Habitat variable (definition)		Cover types	Suggested technique
V1,V4	Ratio of emergent vegetation to open water (the area of the wetland dominated by emergent vegetation as compared to the area of the wetland comprised of open water.	L,DSW,HW	Remote sensing
V2,V5	Wetland size (the size of the combined area of wetland vegetation and open water of individual wetlands).	L,DSW,HW	Remote sensing
V3,V6	Water regime (the permanence of water in a wetland, defined by Cowardin et al. 1979, as follows: A) Permanently Flooded. Water covers the land surface throughout the year in all years. Vegetation is composed of obligate hydrophytes. B) Intermittently Exposed. Surface water is present throughout the year except in years of extreme drought. C) Semipermanently Flooded. Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface. D) 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. When surface water is absent, the water table is often near the land surface. E) All other water regimes.)	L,DSW,HW	Remote sensing, or on-site inspection

Figure 6. Definitions of habitat variables and suggested measurement techniques.

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This model is part of the Habitat Suitability Index Model series (HSI), which Provides habitat information useful for impact assessment and habitat management. This model was developed, based on a synthesis of existing information, for the entire breeding range of the canvasback (Aythya valisineria). Suitability indices ranging from 1.0(optimum habitat) and 0.0 (unsuitable habitat) are developed for habitat variables important to the breeding needs of the canvasback.

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