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A MIGRATORY HABITAT MODEL FOR DIVING DUCKS USING THE UPPER MISSISSIPPI RIVER

by

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General

Large lakes and riverine impoundments are major habitat types used by diving ducks during spring and fall migration through the midwestern region of the United States. The Upper Mississippi River (UMR) is a major staging area for diving ducks in the Mississippi and Atlantic Flyways. The most numerous diving ducks using these areas are lesser scaup (Aythya affinis), redhead (Aythya americana), canvasback (Aythya valisineria) and ring-necked duck (Aythya collaris). The UMR's navigation pools 5,7,8,9 and 19 are considered to be the most important areas as far as providing migratory habitat on the river (Korschgen 1989).

The major component of migration habitat differs from breeding habitat in that the requirement for cover is of minor importance. It is assumed the following habitat components need to be considered in developing a model to evaluate the quality of migratory habitat for diving ducks; size of water body, water depth, types and abundance of aquatic vegetation, and susceptibility of the area to human disturbance.

Size of Waterbody

Korschgen (1989) indicated that wetlands greater than 100 acres in size was important to diving ducks, because they provided protection from predators and minimized human disturbance. Stoudt (1970) conducted a survey to delineate canvasback migration and wintering habitat. In 1968 all known concentration areas of canvasbacks were surveyed for use. During that study 35% of the concentration areas surveyed were between 1,000 and 4,000 acres in size, 10% of the areas were less than 200 acres in size and 7% were greater than 50,000 acres in size. The remaining 48% of the areas surveyed were between 200 to 1000 acres in size or between 4,000 and 50,000 acres in size.

Water Depth

Water depth is a parameter affecting the type and amount of aquatic vegetation present. Emergent vegetation is not critically important to diving duck migratory habitat. In addition, feeding habits of diving ducks are adapted more to deeper water depths. Redheads and ring-necked ducks will feed as dabblers in shallower water (1-2 feet in depth) while scaup and canvasback generally feed more by diving (Bellrose 1978). An area that would be suitable for all species of diving duck would have a range of water depths from 18 inches to 6 feet. Lake Christina, in west-central Minnesota, was at one time a key resting and feeding area for canvasbacks until water quality degradation resulted in the loss of extensive aquatic vegetation beds. The average depth of in Lake Christina is about 5 feet. A diving duck model (unpublished) developed in the Rock Island District for the Lake Chautauqua Habitat Rehabilitation and Enhancement Project suggests a depth of 18 inches to 3 feet as optimum.

Aquatic Vegetation

With the exception of the scaup, the species addressed in this model are primarily herbivorous during migration. Generally, diving ducks feed on the subterranean parts of the plants such as tubers, rootstalks, winter buds and green vegetative parts rather than the seeds. Korschgen (1989) provided a summary of important fall foods for migrating diving ducks in the Mississippi Flyway. The most important submergent vegetation species are sago pondweed (Potamogeton pectinatus), pondweeds (Potamogeton spp.), wildcelery (Vallisneria americana) and coontail (Ceratophyllum demersum). Sedges (Scirpus spp.), arrowhead (Sagittaria spp.), wild rice (Zizania aquatica), yellow water lily (Nuphar spp.), and smartweeds (Polygonum spp.) are some emergent vegetation species of importance. In a study of food habitats of canvasbacks at Lake Onalaska in pool 7 from 1978-1979, (Korschgen et. al 1988) this species fed primarily on winter buds of wildcelery and the tubers of stiff arrowhead. Korschgen (1989) noted that studies of food habits and movements of diving ducks in the Keokuk pool indicate that ducks using Keokuk pool incorporate a greater proportion of invertebrates in their diet than in the Lake Onalaska area. Korschgen (1989) also presented a composite list of fall foods making up the bulk of the diet of migrating diving ducks in the Mississippi Flyway. Benthic invertebrates of that were listed as utilized by three or more of the target species (canvasback, redhead, lesser scaup and ring-necked duck) were: fingernail clams (Sphaeriidae), snails (Gastropoda), mayflies (Hexagenia spp.) and midges (Chironomidae). Krapu and Reinecke (1992) noted that Brazen and Korschgen (cited as personal communication) also found that canvasbacks feed on pondweed and wildcelery during spring stopovers on pools of the Upper Mississippi River, while macro-invertebrates made up about a quarter of their diet.

Disturbance

Staging areas for migratory waterfowl on the UMR are important in that they allow the migrating birds to put on necessary fat reserves to complete their migration. Korschgen (1989) noted that diving ducks feed predominantly on large bodies of water, obtaining their food beneath the surface of the water and away from shore. Korschgens' summary of data indicates that canvasbacks spend about 20 to 25 percent of the time feeding with the remainder of the time spent in energy-conserving behaviors such resting or sleeping. Having areas free of disturbance is important to ensuring the maximum weight gain can be achieved during the staging period. Stoudt (1970) reported that 65% of the canvasback concentration areas were used mainly for feeding and 26 % were used mainly for refuge. Many areas of refuge, however, also had good food resources. Only 6% of the areas surveyed appeared to be used for refuge purposes only. Thornburg (1973) reported that diving duck movements within the Keokuk Pool were related to hunting activity and food distribution. During the day, flocks tended to congregate in the less disturbed lower portions of the pool to rest, and fed in the upper portions of the pool at night. Korschgen pointed out that other types of human disturbance such as boating, fishing and sightseeing may be just as significant as disturbance factors as hunting.

HABITAT SUITABILITY INDEX MODEL

The format adopted for the development of this model follows the procedures developed for the Wildlife Habitat Appraisal Guide (WHAG) (Missouri Department of Conservation 1990). The WHAG approach is somewhat similar to the approach of habitat model development outlined by the U. S. Fish and Wildlife Service (1981) in that suitability index relationship for each of the parameters must first be developed. It differs from the FWS approach in that the relationships for each parameter are presented on a discrete scale and the SI ranges from 0 to 10. Some parameters may be identified as having greater importance by identifying them as critical factors or by weighting. The final HSI is calculated by dividing the sum of the suitability indices by the possible maximum score that could be obtained. The Rock Island District used this approach to develop a diving duck model for the Lake Chautauqua Habitat Rehabilitation and Enhancement Project.

Model Applicability

Geographic area. This model was developed to address migratory habitat for diving ducks on the Upper Mississippi River. Subject matter experts commented during model certification review that the model would be applicable to other diving duck fall staging areas and that consideration should be given to widening the geographic range of applicability. There is general consensus that the model is applicable to the Upper Mississippi River system and other large river ecosystems in the Midwest.

Season. This model was developed to primarily evaluate fall migratory season habitat for diving ducks. It may be applicable to spring migration habitat with variations in some variables. Most studies with respect to migration habitat characteristics have focused on fall migration requirements. Spring nutritional and energetic requirements for waterfowl may affect food preferences and behavior. As a result the importance and relationship of the variables with respect to spring migration habitat quality may differ. For example, waterbody size and disturbance may not be as critical of migration component variables as they appear to be for fall migration habitat. Consideration should be given to modifying the model if it is to be used for evaluating spring migration habitat.

Cover types. This model was developed to evaluate habitat in Lacustrine, Riverine and Herbaceous Wetland habitats.

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat required before a species will use the area during migration. Specific information on the minimum area required before it will be used by diving ducks as migration habitat was not found in the literature.

Verification level. This HSI model provides habitat information useful for impact assessment. 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 Kathy Cheap, Rick Frietsche, Carl Korschgen and Eric Nelson of the U. S. Fish and Wildlife Service, Jeff Janvrin and John Wetzel of the Wisconsin Department of Natural Resources, and Pete Fasbender of the Corps of Engineers. Comments from these reviewers were incorporated into the 1995 version of the model.

In 2011 the model was reviewed by subject matter experts as part of the Corps of Engineers Model Certification process. Overall the model was found to be fundamentally sound with recommendations for minor changes to improve model accuracy. Suggestions to slightly modify the Water Depth, Invertebrate Populations Present and Disturbance variables were incorporated into the updated model.

Model Constraints. This model is designed to evaluate the potential of an area to provide fall migration habitat for diving ducks and is not necessarily meant to be used to predict carrying capacity or duck use days. While considered to be fundamentally sound for planning purposes, consideration should be given to field verification based on retrospective analysis of data from constructed projects to strengthen the validity of the variables and relationships.

The model structure relies on the evaluator to document the reasoning and source for arriving at the SI values. Evaluators are encouraged to identify how the categorical variables of abundance and disturbance are defined within the context of a given study to ensure consistent definitions are applied within a project over time. This approach will assist in providing meaningful interpretation of monitoring results and project accomplishments.

The model assumes that overall habitat quality is not limited by water quality, but rather reflected in the values of certain variables such as vegetation diversity/abundance and invertebrate abundance/diversity. Weighting or modifying the overall HSI may be appropriate in instances where WQ may be a critical factor in determining overall habitat quality and value to migrating waterfowl, such as areas near highly eutrophic or polluted waters near sewage outfalls.

Model Description

Overview. The primary concern in providing suitable migratory habitat is food and a minimum of disturbance. Studies of energetics of canvasbacks on the UMR have shown that during the stopover period individuals accumulate an average of 10-15% gain in body weight before departing for the wintering areas (Takekawa 1987). Krapu and Reinecke (1992) noted that mallards, ring-necked ducks, canvasbacks and lesser scaup breeding in the midcontinent region of North America imported most of the fat required for the production of their initial clutches. Large fat reserves were developed on the wintering grounds or on spring staging areas. The key components considered in evaluating migration habitat for diving ducks for this model are: the size and characteristics of the waterbody, its susceptibility to human disturbance, and type and amount of aquatic vegetation that is present.

The following sections provide the logic and assumptions used to interpret the migratory habitat information for diving ducks. The overall model is presented at the end of this discussion.

Size of Water Body. Larger wetland areas appear to be preferred as they minimize the possibility of disturbance. Wetlands smaller than 100 acres were cited as being less valuable than larger areas and is therefore assigned a suitability index of 1. Areas greater than 100 acres in size are assumed to provide average migration habitat and are assigned a suitability index of 5. Stoudt's (1970) survey indicated a high percentage of the known migration concentration areas ranged in size from 200 - 1000 acres and that over 42% of the concentration areas were over 1,000 acres in size. . Based on this information it is assumed that areas greater than 200 acres but less than 1,000 acres have the potential to provide fairly high quality migration habitat and are assigned a suitability index of 7. Wetlands greater than 1,000 acres in size appear to provide optimum feeding or resting areas and are assigned an optimum value of 10.

Water Depth. Water depth is a factor in determining the type and extent of aquatic vegetation present. Suitable water depths for all species of diving ducks would range from 18 inches to 6 feet. Some reviewers felt that the optimum range for water depths should have an upper limit of 4 feet while others felt that an upper limit of 6 feet was appropriate. Prior to its decline in water quality and vegetation composition, Lake Christina, in Minnesota, was one of the Mississippi Flyways most heavily used resting and feeding areas. This 4,000 acre lake had an average depth of about 5 feet. Based on the above information, this model assumes that the optimum depth range for diving ducks is between 18 inches and 6 feet. Suitability of the area is based on the amount of the habitat that would meet the depth criteria. It is assumed that an area with less than 10 % meeting the depth criteria would have minimal migration habitat value because the depths would not be suitable for feeding and would most likely not be conducive to the development of the preferred types or amount of aquatic vegetation. Therefore, areas with less than 10% meeting the depth criteria are assigned a suitability index of 1. The areas suitability increases fairly proportionately as the percent area meeting the depth criteria increases. An area with at least 70% meeting the depth criteria is assumed to be optimal with a corresponding suitability index of 10.

Percent submergent vegetation cover. Limited specific information on aquatic vegetation densities for migration habitat was found in the literature. Areas identified as important migration habitat, are described as having dense stands of aquatic vegetation. Korschgen (1988) noted that when Weaver Bottoms, in pool 5, provided good habitat when marsh vegetation was present in about 75% of the 1,100 acre area. The diving duck model developed for the Lake Chautauqua project suggests that greater than 70% coverage in the area should be considered optimal. Reviewers indicated that percent submergent vegetation coverage of 50% should be considered optimal. For this model 50% percent submergent vegetation coverage is considered optimal and is assigned a suitability index of 10. If less than 10% of the area has submergent aquatic vegetation the area is assigned a suitability index of 1.

Percent emergent vegetation cover. Korschgen (1988) indicated that wildcelery was more important than arrowhead to canvasbacks staging in pool 7. Arrowhead was not extensively exploited until later in the migration season when the plants had withered and areas were more characteristic of open water. It appears that emergent vegetation can be an important component of diving duck migration habitat but not if it is too extensive in coverage. As with submergent vegetation, an area with less than 10 percent emergent vegetation coverage is assumed to provide minimal value and is assigned a suitability index 1. In addition if an area is predominately emergent vegetation (50% or greater), the area is assumed to have minimal value for diving duck migration habitat and is assigned a suitability index of 1. An area with 25% coverage of emergent vegetation is considered to be optimal and is assigned a suitability index of 10.

Species composition of aquatic vegetation present. The value of an area as migration habitat is directly related to the presence of key species in the submergent/emergent aquatic beds. The suitability criteria of the aquatic beds are the same for both submergent and emergent species. If none of the key species are present, or less than 10% of the aquatic bed is comprised of identified key species, the area is assumed to have minimal value and is assigned a suitability index of 1. The value of the aquatic beds is assumed to increase proportionately with an increase in % composition by at least one key species. If more than 1 key species is present in the aquatic beds, the corresponding suitability index is increased by 1. An area with greater than 60% of the aquatic bed comprised of key food species is considered to be optimum.

Invertebrate populations present. Benthic invertebrates can be a key food source during migration. While studies indicate that aquatic vegetation appears to be the preferred foods for diving ducks during migration, there are some key migration concentration areas where the primary food source being utilized are invertebrates. In areas where there is good aquatic vegetation and conditions promote the development of good invertebrate populations, animal foods can comprise a substantial proportion of the diet. Taxonomic groups that appear to be the most important are fingernail clams (Sphaeriidae), snails (gastropoda), mayflies (Hexagenia spp.), amphipods (Amphipoda) and midges (Chironomidae). The suitability index is based on the presence and abundance of these key taxonomic groups. If none of the key groups are present or if they are present but not at levels that are considered to be abundant, the area is assigned a minimal value of 1. Areas where at least 1 key taxonomic group is present at levels that are considered very abundant are considered optimum and assigned a suitability index of 10. Assigning values to this variable is subjective and relies heavily on professional judgment as to abundance. Conditions that may indicate abundance may include vegetation presence, current, water quality, substrates or survey data.

Disturbance. Susceptibility of an area to human disturbance will lower that value of an area as migration habitat. Disturbance in migration areas limit feeding opportunities and force the birds to expend energy in avoidance activity. It is assumed that an area with uncontrolled access will provide minimal value or provide only short term migration habitat and is assigned a suitability index of 1. Areas closed to all human activity or entry is considered optimum and is assigned a value of 10. Areas closed to hunting but subject to other forms of human disturbance are assigned intermediate values.

DIVING DUCK MIGRATION HABITAT MODEL
UPPER MISSISSIPPI RIVER

1) Size of Water Body

a. Less than 100 acres	1
b. 100 to 200 acres	5
c. 200 to 1,000 acres	7
d. Greater than 1000 acres	10

2) Water Depth - Percent of Area 18" to 5'

a. Less than 10 percent	1
b. 10 to 40 percent	3
c. 40 to 70 percent	5
d. Greater than 70 percent	10

3) Percent Submergent Vegetation Cover

a. Less than 10 percent	1
b. 10 to 30 percent	3
c. 30 to 50 percent	6
d. Greater than 50 percent	10

4) Species of Submergent Vegetation Present
(Key species: wild celery, sago pondweed, and other pondweeds)

a. None of key species present or less than 10 percent of aquatic bed	1
b. At least one key species covers 10 to 30 percent of aquatic bed (add one point if more than one key species present)	3
c. At least one key species covers 30 to 60 percent of aquatic bed (add one point if more than one key species present)	6
d. Greater than 60 percent of aquatic bed is comprised of key food species	10

5) Percent Emergent Vegetation Cover

a. Less than 10 percent or greater than 50 percent	1
b. 10 to 20 percent or 30 to 50 percent	5
c. 20 to 30 percent	10

6) Species of Emergent Vegetation Present
(Key species: arrowhead (S. rigida), soft-stem bulrush, wild rice)

a. None of key species present or less than 10 percent of aquatic bed	1
b. At least one key species covers 10 to 30 percent of aquatic bed (add one point if more than one key species present)	3
c. At least one key species covers 30 to 60 percent of aquatic bed (add one point if more than one key species present)	6
d. Greater than 60 percent of aquatic bed is comprised of key food species	10

7) Invertebrate populations present
(Key taxonomic groups: Sphaeriidae, Gastropoda, Hexagenia spp., Amphidoa, Chironomidae)

a. None of the key taxonomic groups present or present but not abundant	1
b. At least 1 key taxonomic group present and is moderately abundant	5
c. At least 1 key taxonomic group present and is very abundant	10

8) Disturbance

a. Access uncontrolled - Considerable human activity during migration	1
b. No hunting activity occurs or closed to hunting only but considerable human activity occurs during migration (such as fishing/boating)	6
c. No hunting activity occurs or closed to hunting only and human activity during migration is minimal	8
d. No human activity occurs or closed to human entry	10

TOTAL	___
MAXIMUM POSSIBLE TOTAL	80
HSI	___

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