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A DABBLING DUCK MIGRATION MODEL FOR THE UPPER MISSISSIPPI RIVER

General

Seasonal migration habitat is important for waterfowl. Fall migration habitats provide key resources to meet the physiological demands of migration, allowing waterfowl to arrive on wintering grounds in good shape. The Mississippi River is a primary migration corridor. As such, one of the primary management goals for Upper Mississippi River National Wildlife and Fish Refuge is the maintenance and improvement of migration habitat on the Mississippi River.

Numerous habitat models are available for dabbling ducks, but most are geared toward evaluating either breeding or wintering habitat. There are no Fish and Wildlife Service (FWS) HEP models that solely address migration habitat quality for waterfowl. Some models used for other methodologies such as the Missouri's Wildlife Habitat Appraisal Guide (WHAG) address components of migration habitat but involve an overall evaluation of migration/wintering habitat. (Missouri Department of Conservation and U.S.D.A. Soil Conservation Service, 1990). A seasonal migration habitat model for dabblers was developed for evaluating the Pool Slough HREP project (Devendorf, 1998). That model was based primarily on portions of the WHAG model that addressed fall migration habitat components for the mallard. While the model does appear to be a valid tool for evaluating seasonal migration habitat for mallards, it is most applicable for floodplain wetlands and moist soil unit management areas. It is not directly applicable to evaluating fall migration habitat in riverine conditions.

This model was developed to evaluate the general quality of fall migration habitat on the Upper Mississippi River for a wide variety of dabbling duck species including mallard (*Anas platyrhynchosa*) gadwall (*Anas strepera*), pintail (*Anas acuta*), blue-winged teal (*Anas discors*), green-winged teal (*Anas crecca*) wigeon (*Anas americana)*and wood duck (*Aix sponsa*).While there is an abundance of information on the management of pothole habitat and moist soil units to maintain or improve migration habitat, there appears to limited information for quantifying and evaluating migration habitat on large river systems for dabblers. The information for the development of this model is drawn from several sources; the WHAG model, the 1998 Pool Slough model referenced above, and information provided by natural resource personnel over the course of several meetings.

The format adopted for this model follows the procedures developed for the WHAG approach. This approach is somewhat similar to the approach of habitat model development outlined by the U.S. Fish and Wildlife Service (1981) in that a suitability index (SI) 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 Habitat Suitability Index (HSI) is calculated by dividing the sum of the suitability indices by the possible maximum score that could be obtained.

Good migration habitat for dabbling ducks is dependent on water, food and a minimal amount of disturbance (Bookhout et al., 1989, Reid et al, 1989, Ringelman, 1991,). Components of the Pool Slough model that were considered to be applicable to evaluating the quality of migration habitat in riverine conditions were kept. These components addressed habitat composition, fall water conditions, plant species composition and distribution, land use practices, and human disturbance.

Meetings with resource personnel responsible for managing resources on the UMR identified several additional key habitat components that needed to be included in any model to address dabbler migration habitat on the river. The components included: sandbars/mudflats, loafing structures, thermal protection and visual barriers. These components were incorporated into the new model.

Model Description

Model Applicability

Geographic Area. This model was developed to address migratory habitat for dabbling ducks on the Upper Mississippi River (UMR). The model was developed to apply primarily to Pools 1-13 on the UMR, although it may be applicable for lower reaches of the UMR.

Season. This model was developed to primarily evaluate fall migration habitat for dabbling ducks. It may be applicable to spring migration habitat with variations in some variables. Spring nutritional and energetic requirements for waterfowl affect food preferences and behavior, which affect the importance and relationship of the model variables. The model should be modified if it is to be used for evaluating spring migration habitat.

Cover Types. This model was developed to evaluate the potential quality of fall migration habitat for dabbling ducks in large riverine areas and their associated backwaters.

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 dabbling ducks during migration was not found in the literature.

Verification Level. This HSI model provides habitat information useful for impact assessment. This model is a hypothesis of species-habitat relationships and does not reflect proven cause and effect relationships. Jim Nissen and Lara Hills of the U.S. Fish and Wildlife Service, and Tim Fox of the U.S. Geological Survey, and Jeff Janvrin of the Wisconsin Department of Natural Resources reviewed previous drafts of this model. Comments from these reviewers were incorporated into the 2001 version of the model.

In 2011 the model was reviewed by subject matter experts as part of the Corps of Engineers Model Certification process. Reviewers felt that while the technical documentation was weak, the general theory behind the model was sound and the model was potentially useful in characterizing fall migration habitat requirements. Some minor modifications were made to the model documentation to emphasize consideration of woodland size, crop type and timing of crop harvesting when determining variable values. In response to the recommendation to reduce the importance of structure providing thermal protection, since other parameters of the model contribute to meeting this habitat component, the model was modified by reducing the maximum SI for this variable from 10 to 5. There was concern that the model did not take into account the functional relationship between habitat and carrying capacity which could lead to erroneous decisions regarding the value of habitat improvement on dabbling duck populations. . The following Model Constraints section was added to the model documentation to address reviewer concerns that users of the model need to be aware of the model limitations.

Model Constraints: This model is designed to evaluate the potential of an area to provide fall migration habitat for dabbling 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 Parameters

The following section provides a discussion of what variables were used from the 1998 Pool Slough model and what variables were added. The overall model is presented at the end of this discussion.

The specific components from the model, and the reasoning for its inclusion in the new model, are listed below. In some cases the components of the 1998 Pool Slough model came initially from the WHAG model and is so noted in this discussion.

Parameters from the 1998 Pool Slough Model

Distance to Bottomland Hardwoods, Species Composition and Water Availability: This parameter was developed by combining two separate parameters from the WHAG model: Distance to Bottomland Hardwoods-Water Predictability, and Tree Species Composition. Some species of dabbling ducks will feed in wooded areas during migration. Small acorns are a preferred food for mallards and wood ducks for example. The proximity of flooded woodlands can add to the habitat quality of an area during migration. The tree species present determine the habitat quality of the bottomland hardwoods. The presence of mast producing trees (such as oaks) is an indicator of high habitat quality. Wooded areas are not as important a component of migration habitat along the Upper Mississippi River as along the Lower Mississippi River. While these areas can provide sheltered areas during periods of harsh weather, common species composition of woodlands along the UMR (such as elm, walnut, willow, cottonwood, sycamore, maple or ash) provide limited food resources. For this model, the value of riverine woodlands as a habitat component of migration habitat was weighted less than in the WHAG model. This was done by combining the distance to bottomland hardwoods and tree species composition into one parameter, and by changing the range of the suitability index for this parameter from 1-10 to 1-5. Areas less than 1 mile away, with water present and with at least 25% of the tree species composition being pin oak (or species that produce small acorns) are assigned a suitability index of 5 for this variable. Areas greater than a mile away or less than a mile with water rarely present are considered to be of minimal value and are assigned a suitability index of 1. Areas less than a mile away, but with inconsistent water availability or less preferred tree species composition, are assigned intermediate values. While not a specific component of this parameter, the size of the wooded area may be a consideration in determining whether or not it is a functional migration habitat component. If this considered an important consideration in determining the suitability index for any given evaluation, it should be noted in the comments section of the spreadsheet.

Distance to Cropland and Cropland Practices: This component originated with the WHAG model but was modified when it was incorporated into the Pool Slough model Agricultural grains can provide high levels of metabolizable energy during migration. The presence of croplands and the field practices used can be a factor in evaluating the quality of an area as migration habitat. While the distance to cropland parameters listed in the WHAG model are reasonable, it requires that the cropland be unharvested or partially unharvested and flooded to receive a high value. Depending on the type of crop (corn for example), an unharvested field may be of minimal value. The availability of waste grain is a function the amount of crop residues after harvest, which is determined by the efficiency of harvest practices and tillage practices. Dominant crops in the area in any given year and the timing of harvest practices should be a consideration when determining the SI for this parameter. This variable was modified for the Pool Slough model to consider distance to cropland and whether or not crop residues are disturbed. Areas less than 1/4 mile away with residues undisturbed were assumed to be optimum and assigned a suitability index of 10. Areas greater than 1 mile away or less than a mile but with residues disced or plowed were considered to be of minimal value and assigned a value of 1. Fields of intermediate distances and varying amounts of crop residues were assigned intermediate values. Reviewers of previous drafts of this model consistently commented that agricultural crops were of limited value to migrating waterfowl along the UMR. As a result, the value of this variable in determining habitat quality was weighted less than in previous models by changing the range of the suitability index from 1-10 to 1-5.

Water Depths in the Fall: This parameter originated, with no modifications, from the WHAG model. This variable addresses the percent of the area that would offer optimum water depths for foraging (4-18 inches) for dabbling ducks. The suitability index ranges from 10, if greater than 90 percent of the area is at optimum depths, to 1 if less than 10 percent of the area offers optimum water depths. This variable was adapted from the Pool Slough model with some modification. The percent of the area requiring optimum depths underestimates the value that areas of intermediate depth can have in a riverine system. The zones that support rooted floating aquatics and rooted aquatics, while outside the optimum water depths, may still support food plants and invertebrates at optimal foraging depths to migrating waterfowl. This parameter was modified so that optimum conditions were met if greater than 50 percent of the area is at optimum water depths.

Percent Open Water: This parameter originated from the WHAG model. This variable addresses the overall quality of migration habitat as it relates to the interspersion of open water and vegetation. Areas with large unbroken stands of vegetation (such as cattails) are less valuable as migration habitat than areas with an interspersed mix of vegetation and open water. For this model, open water is defined as those water areas with no floating leaved aquatic or emergent vegetation present, or those areas with less than 50% canopy coverage from aquatic vegetation. Optimum areas have a 50/50 mix of open water and vegetation and are assigned a suitability index of 10. Areas with less than 10 percent or more than 90 percent open water are considered to have minimal value and are assigned a value of 1. Varying amounts of open water above and below the optimum 50/50 mix are assigned intermediate values.

Plant Community Diversity: This parameter originated from the WHAG model and was modified for inclusion in this model. This variable addresses the quality of the food plants that are present. High quality habitat provides a diverse assemblage of preferred food plants as opposed to a monotypic stand of one species. Not only does this provide an overall higher quality diet, this ensures that as conditions vary from year to year, some preferred species are likely to be present. The WHAG model evaluated this component based in the number of preferred food plant species present. Bathymetric and flow conditions in a riverine system create the potential for the presence of a wide variety of vegetation communities. Within each of these communities, there may be food/cover plants and invertebrates that are important to dabbling ducks during fall migration. Plant diversity then, is reflected in the variety of vegetation communities present in an area. For this model, the following potential vegetation communities could occur in an island/ riverine complex on the Mississippi River: woody terrestrial, grasses/forbs, emergents, rooted floating aquatics-emergents, rooted floating aquatics, rooted floating aquatics-submergents, emergents-rooted floating aquatics-submergents, and submergents. Conditions are considered optimum if greater than 6 of the vegetation communities are present and is assigned suitability index of 10. Conditions are considered minimal and assigned an index value of 1 if less than 2 communities are present. The presence of a vegetation community should not be the sole criteria in assigning the suitability index for this variable. Consideration should also be given to the extent that the different communities are present. For example, an area that has 4 vegetation communities present, but 3 of the communities comprise 95% of the vegetation beds, may have a lower SI value than area with a more even mix of vegetation communities.

Important Food Plant Coverage: This parameter originated from the WHAG model but was modified when it was incorporated into the Pool Slough model. This variable addresses the percent of the vegetation bed that contain preferred food plants for dabbling ducks. Some important waterfowl food plants identified in the model include bidens, chufa, coontail, cutgrass, duckweeds, pondweeds, foxtail, pigweeds, ragweeds, sedges, smartweeds, spikerushes, bur-reed, arrowhead, wild rice, lotus, wigeon grass, Japanese millet, wild millet, agricultural crops and acorns. If greater than 75 percent of the vegetation beds are comprised of important food species an index value of 10 is assigned. If important food plants cover less than 10 percent of the vegetation beds, conditions are considered minimal and a suitability index of 1 is assigned. Because important food plants, such as some species of pondweeds, may be present outside what is considered optimal water depths, the optimum for percent area comprised of important food species is greater than the percent area at optimum water depths. This variable was adapted from the Pool Slough model with the following modification. The value of the presence of important food species is reduced if the extent of the vegetation beds is limited. If vegetation beds comprise less than 20% of the evaluation area, the Suitability Index for this variable is multiplied by .5.

Disturbance in the Fall: Susceptibility of an area to human disturbance will lower the value of an area as migration habitat. Disturbance in migration areas limit feeding opportunities and force the birds to expend energy in avoidance activity (Reid et al, 1989, Pederson et al, 1989, Kadlec and Smith, 1989). In some cases, the influence of disturbances from bird watchers or researchers may have as great an impact on specific birds as more obvious disturbances such as hunting (Reid et al, 1989). Weather, vegetation cover, water regime and wetland size often lessen the disturbance factor by these types of activities. Hunting can lead to prevention of access to some forage areas, reduction in foraging time and changes in feeding patterns. 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. This variable was adapted from the Pool Slough model with no modifications. Criteria to consider when assigning values to the disturbance variable include whether or not the area is used as a resting area or feeding area, the type of disturbance, the number of types of disturbance, frequency of disturbance, and the time of day of disturbance.

Parameters Developed for this Model

Percent of area with water depths ≤ 10 cm: Sandflats/mudflats are important components of migration habitat. Periodic surveys of heavily used migration areas on the UMR consistently show that dabblers make extensive use of sandflats/mudflats (Nissen, UMRFWR, personal communication). This is one component that resource managers consistently indicated should be to be added to any migration model on the UMR. These areas improve the quality of migration habitat in an area by providing an environment for the development of emergent vegetation characteristic of shallow marsh areas (adding diversity to the food base in the area) and serving as loafing areas. Mudflats/sandflats are often present in conjunction with an island or shoreline habitat, which can also provide protection from the elements. An evaluation of areas known for their concentration of dabblers during migration indicated that sandflats/mudflats make up from 15% to 25% of the area. This mix is considered to be optimum for this model, and areas with greater than 25% or less than 15% are considered to decline in value.

Percent of the Area containing Loafing Structures: Loafing sites/structures offer the opportunity for dabblers to rest and conserve energy. Areas with extensive loafing areas are considered to be of higher quality than areas without. Loafing structures can be present in the form of sandflats/mudflats, tree stumps, low islands, muskrat houses or clumps of vegetation. Conditions are considered optimum if at least 30% of the area contains loafing structures. The area encompassed by sandflats/mudflats or low islands is a direct measurement of the presence of this type of loafing structure. The quantification of the other forms of loafing structure is defined as at least five forms of loafing structure/acre (i.e. – the presence of at least 5 loafing structures (tree stumps, muskrat houses, etc,) within an acre equals one acre of loafing structure).

Availability of Structure to Provide Thermal Protection: Thermal protection is an important component of migration habitat. Protection from prevailing winds during severe weather allows dabblers to conserve energy. Numerous studies on large reservoirs and rivers have shown that waterfowl utilize protected shorelines areas during severe weather. Observations by UMR refuge personnel have noted similar behavior on the river. Cutbank shorelines, protected coves, backwater wetlands, large stands of persistent emergent vegetation or islands can all provide the needed structure to provide thermal protection. In order to be effective, such structure must provide an area of refuge from prevailing winds during periods of severe weather. Due to the intermittent need for sheltered habitat, the presence of this habitat component on at least 5% of an area is more important than the quantity of this particular component when evaluating the migration habitat quality of an area. However, an increase in the area protected, an increase in the number of locations within an area that may provide shelter, or sheltered areas that provide protection from winds originating from all directions may increase the value of this component.

Presence of Visual Barriers: Secure resting areas are important to migrating waterfowl. Even though an area may be closed to hunting, other types of human disturbance, such as fishing, can cause waterfowl to move temporarily from an area. This causes an expenditure of energy and reduces the quality of an area as migration habitat. The effect of these types of human disturbance can be ameliorated to some degree by providing visual barriers within an area. Visual barriers may increase the tolerance level by waterfowl for intrusion by eliminating or reducing visual cues. The presence of visual barriers within an area may also limit the distance waterfowl will move once disturbed, thereby reducing the expenditure of energy. Barriers can be in form of islands or extensive stands of persistent emergent vegetation. The effectiveness of islands as visual barriers may be dependent on height and/or the amount and type of vegetation present. Areas that are vulnerable to disturbance from several sources/locations have the lowest rating for this parameter. Areas that have visual barriers from most sources/locations of disturbance have a moderate value for this parameter. The value of an area may increase to some degree if there are multiple lines of visual barriers present.

Model documentation was prepared by Randall D. Devendorf, Corps of Engineers, St. Paul District

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DABBLING DUCK MIGRATION HABITAT MODEL
UPPER MISSISSIPPI RIVER

VARIABLE		VALUE	COMMENTS
1) Distance to bottomland hardwoods, species composition and water availability			
a) < 1 mile, > 25% pin oaks (or small acorns), water predictable	5		
b) < 1 mile, <25% pin oaks (or small acorns), water predictable	4		
c) <1 mile, >25% pin oaks (or small acorns), water predictable 1 to 3 years	3	ENTER VALUE=	
d) <1 mile, <25% pin oaks (or small acorns), water predictable 1 to 3 years	2		
e) >1 mile, or <1 mile and water unpredictable	1		
2) Distance to Cropland and Cropland Practices			
a) <1mile, with residues undisturbed	5		
b) <1 mile with some residues remaining	3	ENTER VALUE=	
c) >1 mile to any cropland; or <1 mile, with residues disced or plowed.	1		
3) Water Depth 4-18 Inches in fall			
a) >50%	10		
b) 40 - 50%	8	ENTER VALUE=	
c) 30 - 40%	6		
d) 20 - 30%	4		
e) < 20%	1		
4) Water Depths < 4 Inches in fall			
a) 0 - 5%	1		
b) >5% - ≤10%	5		
c) >10% - <15%	7	ENTER VALUE=	
d) 15% - 25%	10		
e)>25% - <35%	7		
f) 35% - <50%	5		
g)≥50%	1		
5) Percent Open Water			
a) < 10%	1		
b) 10 - 25 %	5		
c) 25 - 40%	7	ENTER VALUE=	
d) 40 - 60%	10		
e) 60 -75%	7		
f) 75 - 90%	5		
g) > 90%	1		
6) Plant Community Diversity			
a) >6 vegetation communities present	10	ENTER VALUE=	
b) 4 - 6 vegetation communities present	6		
c) 2-4 vegetation communities present	4		
d) < 2 vegetation communities present	1		
7) Important food plant coverage (% of veg. beds containing important food plants) (multiply value by .5 if vegetation beds cover < 20% of the evaluation area)			
a) >75%	10	ENTER VALUE=	
b) 50 -75%	8		
c) 25 - 50%	6		
d) 10 - 25%	4		
e) <10%	1		

VARIABLE		VALUE	COMMENTS
8) Percent of the Area containing Loafing Structures			
a) <5%	1		
b) 5% - 10%	2	ENTER	
c) >10% - 15%	3	VALUE=	
d) >15% - <30%	4		
e) >30%	5		
9) Structure to Provide Thermal Protection			
a) 0% of the area protected	1		
b) <5% of the area protected	2		
c) at least 5% of the area protected	3	ENTER	
d) >5% of the area protected or at least 5% of area protected & several locations within an area	4	VALUE=	
e) At least 5% of area protected and protection provided from winds originating from all directions	5		
10) Disturbance in the Fall			
a) Closed to hunting and no other human activity occurs	10		
b) Closed to hunting, human activity during migration is minimal or access restricted	8	ENTER VALUE=	
c) Closed to hunting but considerable human activity during migration	5		
d) Open to hunting, access unrestricted	1		
11) Visual Barriers			
a) None present or limited	1		
b) Barriers from most directions/sources of disturbance	3	ENTER VALUE=	
c) Multiple lines of barriers	5		

TOTAL=	0
MAXIMUM POSSIBLE TOTAL =	85
HSI =	0.00