Coastal Protection and Restoration Authority
150 Terrace Avenue, Baton Rouge, LA 70802 | coastal@la.gov | www.coastal.la.gov

2017 Coastal Master Plan

Attachment C3-7:

Green-winged Teal, *Anas crecca,* Habitat Suitability Index Model

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Prepared By: Paul Leberg (University of Louisiana at Lafayette)

Coastal Protection and Restoration Authority

This document was prepared in support of the 2017 Coastal Master Plan being prepared by the Coastal Protection and Restoration Authority (CPRA). CPRA was established by the Louisiana Legislature in response to Hurricanes Katrina and Rita through Act 8 of the First Extraordinary Session of 2005. Act 8 of the First Extraordinary Session of 2005 expanded the membership, duties and responsibilities of CPRA and charged the new authority to develop and implement a comprehensive coastal protection plan, consisting of a master plan (revised every five years) and annual plans. CPRA's mandate is to develop, implement and enforce a comprehensive coastal protection and restoration master plan.

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- The Water Institute of the Gulf - Ehab Meselhe, Alaina Grace, and Denise Reed
- Coastal Protection and Restoration Authority (CPRA) of Louisiana – Mandy Green, Angelina Freeman, and David Lindquist

The following experts were responsible for the preparation of this document:

- Buddy "Ellis" Clairain - Moffatt and Nichol

The following people assisted with access and summaries of data used in this report:

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Executive Summary

The 2012 Coastal Master Plan utilized Habitat Suitability Indices (HSIs) to evaluate potential project effects on wildlife species. Even though HSIs quantify habitat condition, which may not directly correlate to species abundance, they remain a practical and tractable way to assess changes in habitat quality from various restoration actions. As part of the legislatively mandated five year update to the 2012 plan, the wildlife habitat suitability indices were updated and revised using literature and existing field data where available. The outcome of these efforts resulted in improved, or in some cases entirely new suitability indices. This report describes the development of the habitat suitability indices for green-winged teal, *Anas crecca,* for use in the 2017 Coastal Master Plan modeling effort.

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List of Abbreviations

CPRA	Coastal Protection and Restoration Authority
HSI	Habitat Suitability Index
ICM	Integrated Compartment Model
LDWF	Louisiana Department of Wildlife and Fisheries
ppt	parts per thousand
SAV	Submerged Aquatic Vegetation
SI	Suitability Index
USFWS	United States Fish and Wildlife Service
wd	Water depth

1.0 Species Profile

The green-winged teal (*Anas crecca*) is a small duck that is heavily harvested by hunters. It is the most abundant duck recorded in Louisiana Department of Wildlife and Fisheries (LDWF) surveys of wintering waterfowl in coastal habitats.

The species is broadly distributed across the Northern Hemisphere (Johnson, 1995). In North America, the species reproduces in the northern United States and Canada. Breeding habitats include prairie potholes, deciduous parklands, and boreal forests (Johnson, 1995). Green-winged teal reproduce at one year of age. Males and females pair on the wintering grounds, and generally return to the female's natal area to reproduce during the late spring and summer (Figure 1). Males provide no parental care; females incubate eggs and brood the hatchlings (Johnson, 1995). The clutch size varies between six and nine eggs, and incubation takes approximately 21 days.

The green-winged teal spends the winter months in the southern United States, the Atlantic and Pacific coastal states, Mexico, and the Caribbean Islands (Figure 1). While on the wintering grounds, green-winged teal forages in shallow open water areas, in emergent vegetation, and over submerged aquatic vegetation (SAV; White, 1975). Although the species forages over SAV, individuals do not forage over it more frequently than expected based on chance (White, 1975) and SAV does not seem to affect its abundance (Noordhuis et al., 2002). Common diet items consist of seeds, aquatic vegetation, aquatic invertebrates, and rice (Johnson, 1995).

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Nesting and Care of Hatchlings (Northern US and Canada)												
Migration												
Wintering (southern US, including Louisiana)												

Figure 1: Seasonal Activities of the Green-Winged Teal. White cells indicate the life stage/activity is generally not present, light grey cells indicate the life stage is at moderate abundance, dark grey cells indicate times of highest life stage activity.

Trends in winter habitat use by green-winged teal are summarized in Table 1. Bolduc (2002) documented highest use of the species in freshwater marsh in coastal Louisiana, followed closely by brackish and intermediate marsh. Data from the LDWF also suggest heaviest use of freshwater and brackish marsh (Larry Reynolds, unpublished data), with intermediate and saline marsh used to a lesser extent. The species tends to avoid areas of open salt water (Johnson, 1995).

Green-winged teal are also known to use flooded forests for portions of the winter (Fredrickson & Heitmeyer, 1987); however the relative use of this habitat needs additional investigation in

Louisiana. Areas with standing dead trees are used more frequently than those with closed canopies (Baldassarre & Bolen, 1994). This species commonly used scrub-shrub habitat near a reservoir in Texas (Johnson & Swank, 1981), although shrub densities did not appear to be high and were of different species than are being modeled in the master plan.

The green-winged teal prefers intermediate levels of emergent marsh vegetation coverage (25% - 65% of an area) as foraging habitat in Texas wetlands (White, 1975). The species often uses agricultural wetlands such as rice fields (Baldassarre & Bolen, 1994); however, the use of these sites compared to other wetland habitats has not been quantified.

Most foraging occurs in very shallow water (< 25 cm deep) based on work in Louisiana (Bolduc, 2002; Bolduc & Afton, 2004); little foraging occurred in waters deeper than 32 cm. Both Johnson and Rohwer (2000) and Pöysa (1983) documented that most foraging occurred at water depths of ≤5 cm. While this species does not forage on dry land, it frequently utilizes mud flats (Belrose, 1980; Johnson, 1995; Johnson & Rohwer, 2000).

Table 1: Characteristics Associated with Green-Winged Teal Habitat Used in the HSI Model.

Characteristic	Optimum	Suboptimum
Vegetation Type[1]	Freshwater marsh, rice fields, but see note[1]	Intermediate and brackish marsh, followed by forested wetlands
Percent open water[2]	35 – 75%	< 35% or >75%
Water depth[3]	0 – 5 cm	Declining with depth until reaching 32 cm; the slope of this decline appears to increase with depth

[1] Based on Bolduc 2002; however, a different pattern has been observed in LDWF surveys of waterfowl populations.

[2] Based on White. 1975.

[3] Based on Belrose, 1980; Pöysa, 1983; Johnson and Rohwer, 2000; Bolduc, 2002; and Bolduc and Afton, 2004.

2.0 Approach

The 2017 Coastal Master Plan green-winged teal habitat suitability index (HSI) model was modified from the green-winged teal model developed for the 2012 Coastal Master Plan (Nyman et al., 2013). In the original model there were two variables (type of emergent vegetation in a cell and water depth in a cell). The variable related to emergent vegetation was modified from the 2012 model based on new habitat use data and new levels of resolution in inputs from the master plan vegetation model. Likewise, the variable related to water depth is now based on the proportion of a cell with a given water depth rather than the proportion of time a cell has a given average water depth. In addition to these, a variable reflecting the proportion of open water in a cell was added so that the 2017 model now has three variables.

Model variables were selected as a result of a literature review, updated for the current effort, which attempted to identify the important variables associated with habitat used by wintering green-winged teal. In addition, estimates of green-winged teal densities in different marsh types were obtained from LDWF (Larry Reynolds, unpublished data).

Habitat characteristics were assigned values between 0 and 1, with a value of 1 being assigned to the most preferred habitat state (United States Fish and Wildlife Service [USFWS], 1981). Quantitative measures of habitat use for an environmental variable were divided by the value for the variable state that had the highest value. This placed all the values of the variable on a scale from 0 to 1. Additional procedures are discussed for the individual variables. The HSI index values were obtained by taking the geometric means of the suitability indices of the individual variables (USFWS, 1981).

To validate the model, outputs from the 2012 master plan models, generated with the software EverView, were obtained for sites where the author had made field observations suggesting the species was common, uncommon, or absent. Outputs were applied to the habitat suitability model, and the HSI estimates were compared to the authors' field observations. There was strong correspondence between observations of abundance and the HSI estimates. However, this exercise indicated that cells with very high and low values of open water, or with relatively deep water might support more green-winged teal than the initial model had suggested, leading to slight modifications of the model.

3.0 Habitat Suitability Index Model for Green-winged Teal

The HSI for green-winged teal in a model cell is the geometric mean of three suitability index (SI) variables, each scaled from 0–1, where 1 is the most suitable. The resulting HSI will be a value between 0 and 1. Cells with values near 1 should be the most suitable for the species whereas cells with values near 0 are unsuitable.

$HSI = (SI_1 \times SI_2 \times SI_3)^{1/3}$

Where:

SI_1 = Proportion of emergent vegetation (V_1)

SI_2 = Proportion of open water (V_2)

SI_3 = Average water depth during the months of September – March (V_3).

3.1 Applicability of the Model

This model applies to adult green-winged teal wintering in coastal Louisiana.

3.2 Response and Input Variables

V_1 – Proportion of emergent vegetation and associated open water.

V_1 is the proportion of a cell that is wetland and associated open water. This variable should be calculated yearly. When there is no emergent vegetation in a cell, the cell should be assigned to one of following vegetation types based on average annual salinity:

Fresh Attached Marsh if salinity is < 1.5 ppt

Intermediate Marsh if salinity is $\geq$ 1.5 and < 4.5 ppt
Brackish Marsh if salinity is $\geq$ 4.5 and < 9.5 ppt
Saline Marsh if salinity is $\geq$ 9.5 ppt.

These thresholds are taken from Appendix D-4 of the 2012 Coastal Master Plan Report (Visser et al., 2012).

$SI_1 = (1.0 * V_1a) + (1.0 * V_1b) + (0.60 * V_1c) + (0.93 * V_1d) + (0.46 * V_1e) + (0.25 * V_1f) + (0.25 * V_1g) + (0.0 * V_1h)$

When:

V_1a = Proportion Fresh Attached Marsh (Weight = 1.0)

V_1b = Proportion Fresh Floating Marsh (Weight = 1.0)

V_1c = Proportion Intermediate Marsh (Weight = 0.60)

V_1d = Proportion Brackish Marsh (Weight = 0.93)

V_1e = Proportion Saline Marsh (Weight = 0.46)

V_1f = Proportion Swamp Forest (Weight = 0.25)

V_1g = Proportion Bottomland Forest (Weight = 0.25)

V_1h = Proportion non Wetland habitat (Weight = 0.0)

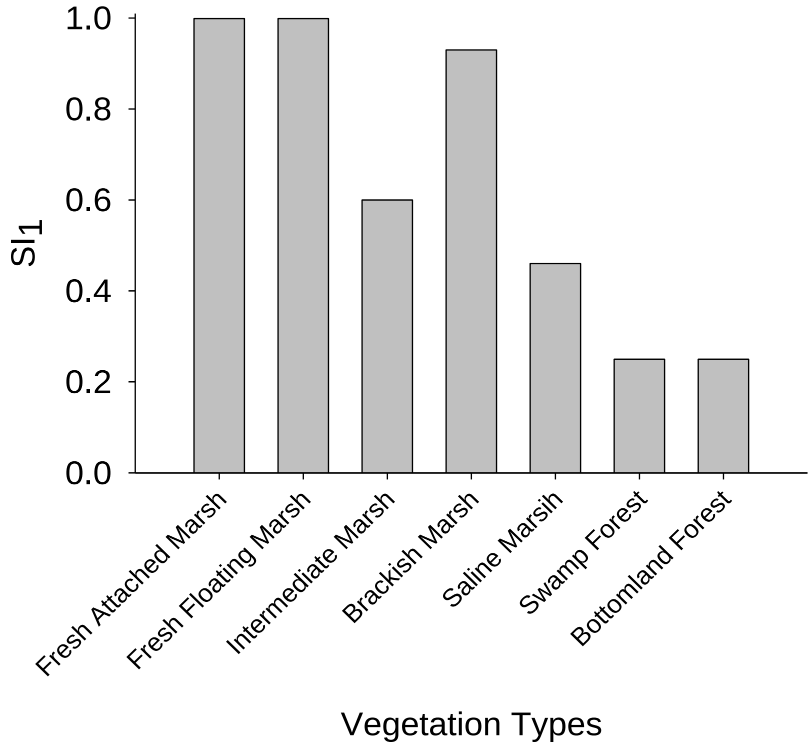

Figure 2: Relative Values (SI_1) of Different Types of Emergent Vegetation Types as Habitat for Green-Winged Teal. Because cells can have varying combinations of different categories, the figure represents SI values for cells comprised entirely of the category represented on the horizontal axis.

Rationale: Green-winged teal abundance has been shown to vary among marsh types in Louisiana (Bolduc, 2002; LDWF aerial surveys of wintering waterfowl). There was not much resolution beyond freshwater marsh, intermediate marsh and brackish marsh in these surveys; LDWF collected data on saline marshes but Bolduc (2002) did not. Bolduc (2002) presented habitat-specific densities; the LDWF data set consisted of counts of birds observed in different marsh types. Because the LDWF survey did not sample the same amount of each habitat type, the number of teal observed in a habitat was adjusted by the amount of habitat surveyed. For each of these data sets, the relative value of a vegetation type as green-winged teal habitat was determined by dividing the measure of use (density, or area-adjusted counts) for that vegetation type by the highest value of use for teal observed in any vegetation type. This process set the value of the habitat type with the most teal use to 1.0 (= optimal habitat), scaling the other use values by the highest value. The scaled values from the two data sets were then averaged for each habitat. These averages were again rescaled, so that the highest averaged value had a value of one. Based on the average of the relative use of marsh habitats obtained from these studies, green-winged teal occur most frequently in freshwater marsh habitats followed closely by brackish marsh, and proportionately less frequently in the other marsh habitat types (intermediate marsh and saline marsh; Figure 2).

Neither Bolduc (2002) nor the LDWF surveys estimated green-winged teal use of flooded bottomland forest or swamp forest. Green-winged teal are known to use flooded forests for portions of the winter (Fredrickson & Heitmeyer, 1987); however, the relative habitat use of this species needs additional investigation. Baker (LDWF, personal communication), suggested a value of 0.25 for forested wetlands which is used above. A value of 0.0 was assigned to cells with no wetland habitat, based on information from Johnson (1995).

V_2: Proportion of cell that is open water (including open water with SAV)

Variable 2 (V_2) is the proportion of the cell that is water (open water combined with open water with SAV). This variable should be calculated yearly.

$SI_2 =$	$(2.5 * V_2) + 0.1$	for $V_2 < 0.35$
	1.0	for $0.35 \leq V_2 \leq 0.75$
	$(-3.6 * V_2) + 3.7$	for $V_2 > 0.75$

Rationale: Green-winged teal habitat use has been shown to vary with the proportion of open water based on research at a site in coastal Texas (White, 1975). White (1975) found that green-winged teal were most commonly observed using sites where the proportion of open water was between 0.35 and 0.75. Cells with proportions of open water in this range were assigned values of 1 = optimal habitat (Figure 3). At both higher and lower proportions of open water, green-winged teal suitability decreases to 0.1. Johnson (1995) also cites researchers reporting green-winged teal avoidance of large areas of open water. Although the species will forage over SAV, individuals do not forage over it more frequently than expected based on chance (White, 1975) and SAV does not seem to affect its abundance on wintering grounds in Europe (Noordhuis et al., 2002). Therefore, open water with SAV is treated the same as open water without SAV.

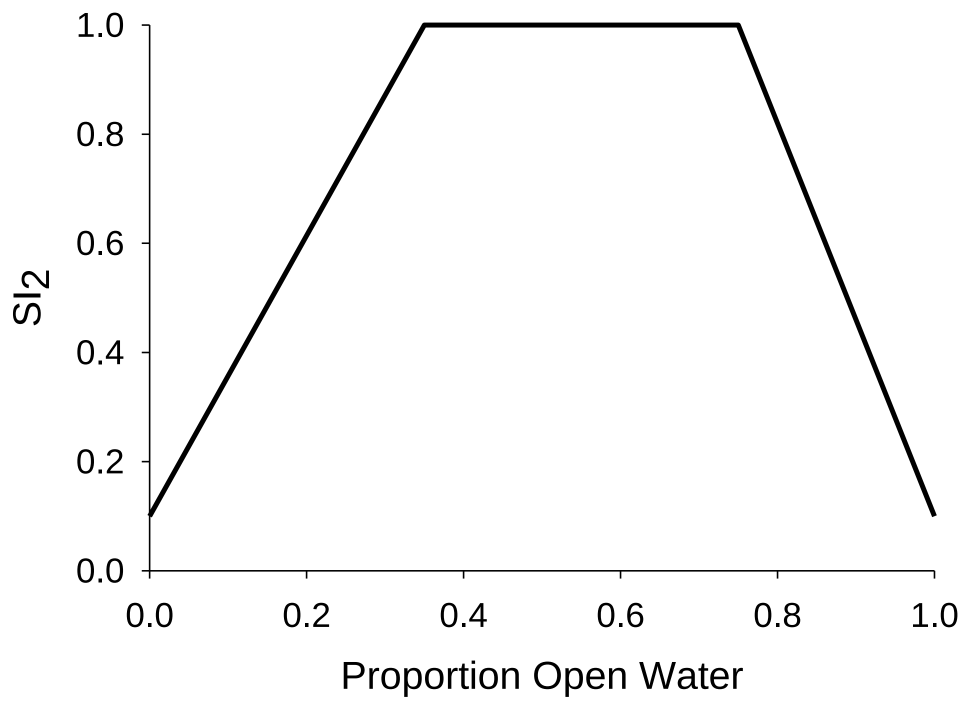

Figure 3: Relative Values (SI_2) of Sites as Habitat for Green-Winged Teal as a Function of the Proportion of Open Water.

V_3: Average water depth

Variable 3 (V_3) is the proportion of pixels in a cell where the average September-March water depth (in cm) provides suitable foraging habitat. This variable should be calculated once per year for the period between September and March.

SI_3= (0.80 * V_3a) + (1.00 * V_3b) + (0.87 * V_3c) + (0.68 * V_3d) + (0.43 * V_3e) + (0.17 * V_3f) + (0.07 * V_3g) + (0.0 * V_3h)

When:

V_3a = the proportion of pixels in a cell where the average water depth (wd) for the period of September-March is $0 \leq wd < 6$ (weight = 0.80)

V_3b = the proportion of pixels in a cell where the wd for the period of September-March is $6 \leq wd < 18$ (weight = 1.00)

V_3c = the proportion of pixels in a cell where the wd for the period of September-March is $18 \leq wd < 22$ (weight = 0.87)

V_3d = the proportion of pixels in a cell where the wd for the period of September-March is $22 \leq wd < 26$ (weight = 0.68)

V_3e = the proportion of pixels in a cell where the wd for the period of September-March is $26 \leq wd < 30$ (weight = 0.43)

V_3f = the proportion of pixels in a cell where the wd for the period of September-March is $30 \leq wd < 34$ (weight = 0.17)

V_3g = the proportion of pixels in a cell where the wd for the period of September-March is $34 \leq wd < 100$ (weight = 0.07)

V_3h = the proportion of pixels in a cell where the wd for the period of September-March is $wd \geq 100$ (weight = 0.0).

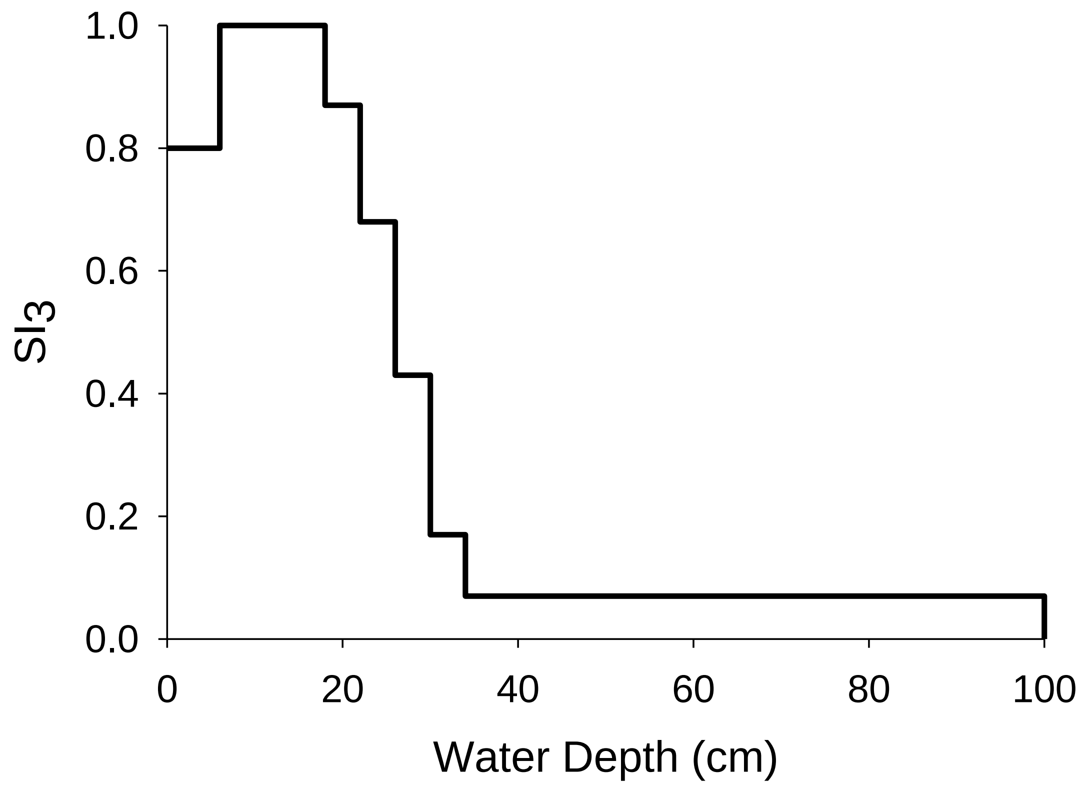

Figure 4: Relative Values (SI_3) of Sites as Habitat for Green-Winged Teal Based on Water Depth. Because cells can have varying combinations of different categories, the figure represents SI values for cells comprised entirely of the category represented on the horizontal axis.

Rationale: Green-winged teal habitat use has been shown to vary by water depth (Bolduc, 2002; Bolduc & Afton, 2004). This index is based on the nonparametric regressions of habitat use developed by Bolduc (2002) and Bolduc and Afton (2004). Those authors divided water depth into classes based on 2-cm incremental increases in depth; some of those depth classes with similar values of habitat use by green-winged teal were combined to simplify this model. The depth class with the highest predicted green-winged teal density was 6 - 18 cm. This depth class was assigned an index of 1.0 = optimal habitat (Figure 4). Depths that were used to a lesser extent received proportionally lower suitability values. The only deviation from this procedure occurred at very shallow water depths (< 4 cm) which received a slightly higher rating than would have been predicted from Bolduc (2002). This modification was based on the observation that this species often forages on mud flats (Belrose, 1980; Johnson, 1995). Bolduc (2002) provided no estimates of habitat use beyond water depths of 81 cm. Because the species typically prefers shallow water habitats (Belrose, 1980; Johnson, 1995), the value of habitats deeper than 100 cm was set to 0. The water depth index was limited to the fall, winter, and spring, when migrating green-winged teal would be most likely to be found in south Louisiana.

4.0 Model Verification and Future Improvements

To help ensure the distributions and patterns of HSI scores across the coast were realistic relative to current knowledge of the distribution of green-winged teal, a verification exercise was conducted. In order to generate HSI scores across the coast, the HSI models were run using calibrated and validated Integrated Compartment Model (ICM) spin-up data to produce a single value per ICM grid cell. Given the nature of a coastwide model, the ICM spin-up data may not reflect 'real-world' conditions in all areas of the coast. For example, some areas known to have wetland vegetation were classified as non-wetland habitat resulting in low HSI scores when high scores would otherwise be expected. In these instances, no improvements could be made to the HSI as these issues reside in other ICM subroutines (i.e., vegetation). As a result, the accuracy of the verification exercise is contingent on these inconsistencies.

In general, and with the exception noted above, cells known to have high concentrations of green-winged teal had the highest HSI values, and cells where few teal are observed had low HSI values. Although there was general agreement between model outputs and known distributions of the species, several improvements are suggested.

More detailed analysis of the species' relative use of different coastal habitats is recommended. There are no solid data on the level of use of forested wetlands by green-winged teal. Similarly, there are no good data on waterfowl use of floating fresh marsh. For our purposes, we assigned this habitat type the same value as emergent fresh marsh; however, the value of floating fresh marsh to waterfowl needs investigation.

Additional data of the effects of water depth and emergent vegetation on green-winged teal abundance would also be helpful. There is a possibility that an interaction exists between water depth and salinity based on Bolduc's (2002) work in impounded and un-impounded wetlands; however, there are insufficient data to assess the effects of water depth in different habitats. Likewise, information on the effects of emergent vegetation and open water comes from one fresh marsh site in coastal Texas. The current model assumes this relationship with open water holds for other marsh types; however, the data are not available to test this assumption.

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