3 Setting Goals for Regional Wetland Protection and Restoration

LIZA RIDDLE

Process and Methodology for Establishing Acreage Goals

The Implementation Strategy is derived from the San Francisco Bay Area Wetlands Ecosystem Goals Project (Goals Project.) Many of the individuals who worked on the *Habitat Goals* also served on the San Francisco Bay Joint Venture Implementation Strategy Committee to shape the SFBJV's acreage methodology and goals. Beginning in mid-1998 members of the Implementation Strategy Committee began working with scientists from the San Francisco Estuary Institute (SFEI) to adapt the Goals Project to the needs of the SFBJV's habitat goals. The idea was to use its carefully derived projections of regional wetlands objectives as a framework for the wetlands classifications and goals of the SFBJV. This required three adaptations of the Goals Project: 1) reduction of its implicit longer-term time frame to a more practical horizon; 2) revision of the geographic scope to accommodate the Joint Venture's geographic boundaries (which exclude the Suisun Marsh and include San Mateo coastal areas); and 3) a simplification of the Goals Project's 14-category classification into the Joint Venture's three habitat categories.

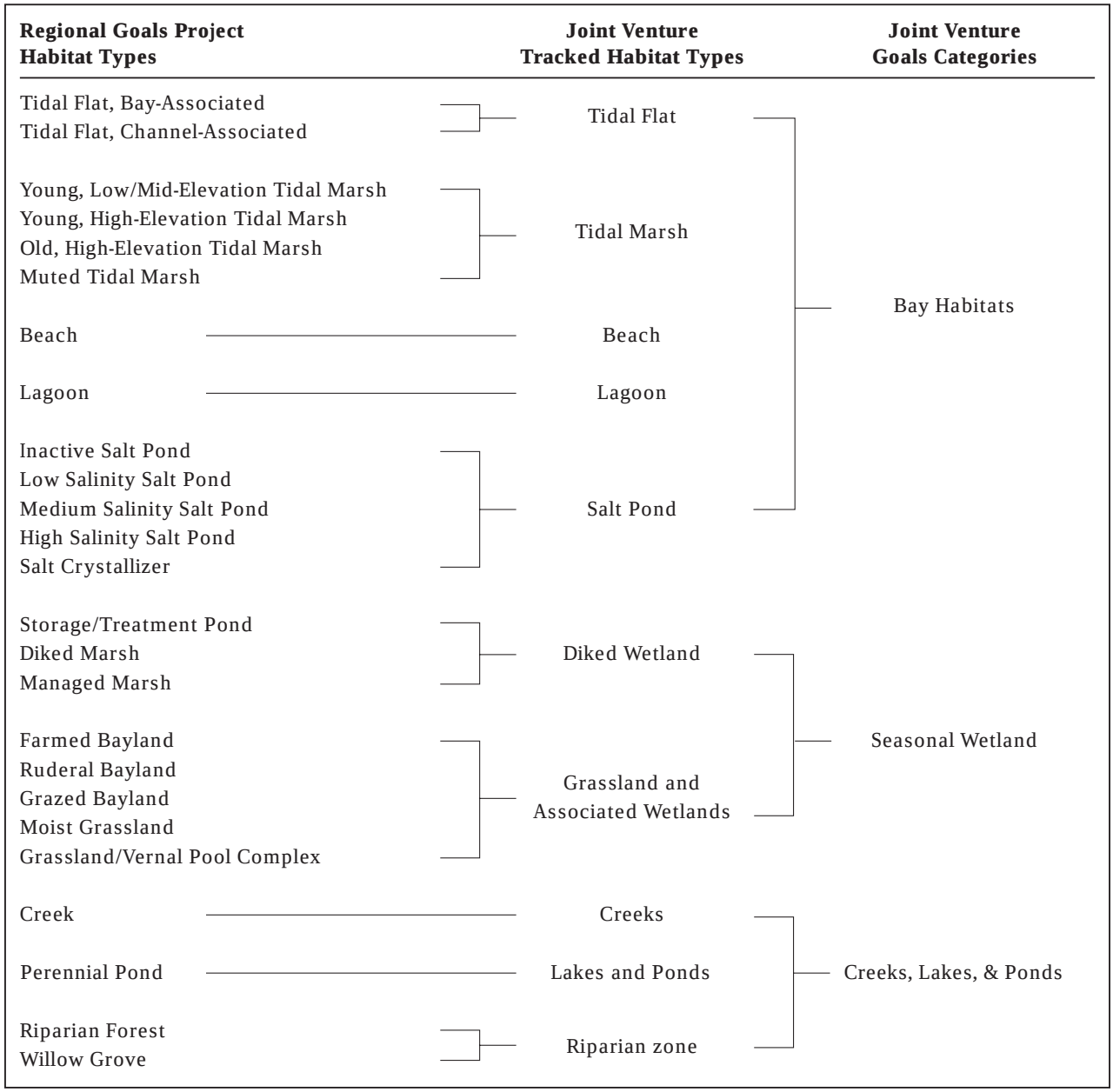
This last adaptation required a two-step process: translating the Goals Project's habitat categories into the Joint Venture's "tracked habitats" and, in turn, combining these to create three habitat goal categories for this Implementation Strategy. The three consist of 1) Bay Habitats, 2) Seasonal Wetlands, and 3) Creeks and Lakes. These categories will serve as the primary measures of SFBJV in meeting its objectives for wetland acquisition, restoration, and enhancement. **Figure 3-1** summarizes this classification process, showing how the Goals Project categories map onto the three Joint Venture habitat goals.

The methodology and process behind the Joint Venture's goals for wetlands acquisition, restoration and enhancement are summarized in the "Goals Setting Worksheets," **Appendix E**.

Habitat Goals for the San Francisco Bay Joint Venture

The long-term vision for wetlands of the San Francisco Bay Estuary presented in *Habitat Goals* has served as an excellent template for defining the Joint Venture's habitat goals, which can also be regarded as milestones of the Goals Project. The Geographic Information System–based mapping and analysis of the historic extent of wetlands in *Habitat Goals* provided a reliable foundation for developing the Joint Venture's habitat goals. SFEI researchers who

Figure 3-1
San Francisco Bay Joint Venture Habitat Classification



Source: SFBJV (1999)

prepared the *Habitat Goals* first identified acreage estimates for historic and current coverage of wetlands. These acreages, displayed in **Table 3-1,** were adapted to determine the "Past" (historic) and "Present" (current) areas of the wetland habitats within the geographic scope of the SFBJV.

The acreages presented in this table are reasonably accurate for the Baylands and within a radius of three miles of the Bay. Beyond this zone, the SFBJV used acreage estimates derived from reviews of topographic and soils maps, so these figures are far less precise. The goals for creek and riparian zones are based on perennial stream lengths, with acreage estimates derived from averaging the widths of riparian forest habitat from eight existing riparian corridors in the North, Central, and South Bays. The average riparian zone was determined to extend approximately 20 meters from each bank. Creek and riparian zone acreage was thus calculated by multiplying a creek's length by 40 meters.

Table 3-1
San Francisco Bay Joint Venture Tracked Habitats Summary

SFBJV Habitat Goals Categories	SFBJV Tracked Habitat Categories	Past (acres)	Present (acres)	Total Present (acres)
Bay Habitats	Tidal Flat	49,000	28,000	
	Tidal Marsh	125,000	32,000	
	Lagoon	80	4,000	**98,070**
	Beach	200	70	
	Salt Pond	1,500	34,000	
Seasonal Wetlands	Diked Wetland	0	18,000	
	Grassland and Associated Wetland	84,000	53,000	**71,000**
Creeks, Lakes and Ponds	Lake	NA	12,000	**14,500**
	Creek & Riparian Zone	69,000	2,500	

Source: SFEI, *Habitat Goals*, (July, 1999)

Table 3-2 presents the habitat goals by the three broad categories of habitats discussed above. These goals were reviewed and revised by the SFBJV's Implementation Strategy Committee, and serve to encompass the tracked habitats and significantly simplify the tasks of monitoring progress toward the goals without misrepresenting the wetland values or functions underlying them. As previously noted, these goals assume a 20-year timeline for accomplishment.

In order to elucidate the SFBJV's habitat goals, it is important to make a clear distinction between *restoration,* defined as the conversion of one habitat type to another (e.g., diked baylands to tidal wetlands), and *enhancement,* which is the improvement in the functioning and biological diversity of an existing habitat.

Table 3-3 displays the future projections for each of the habitat types in the Baylands and nearby areas by subregion, again using the Goals Project as an analytic framework.

The Goals Project uses the past acreage figures displayed in Table 3-1 as target goals for acquisition, restoration, and enhancement within a 50- to 100-year timeframe. To accommodate the SFBJV's 20-year framework, the Implementation Strategy Committee determined that, as a rule for acquisition and restoration categories, the SFBJV would seek to accomplish 75 percent of the long-term goals of the Goals Project. The Committee set goals for enhancement at 50 percent of total habitat goals for the long term. Specific acreage goals were not set for uplands associated with wetlands. However, the Joint Venture recognizes the importance of adjacent upland habitat to provide nesting cover, foraging areas, refuge from predators, and a buffer from incompatible uses. The general rule states that adjacent upland habitat will be protected in the form of buffer zones wherever possible.

Within the SFBJV's 20-year horizon for accomplishing its goals, The Joint Venture will review and revise its Implementation Strategy at approximately five-year intervals.

How Waterfowl Will Benefit from the Implementation Strategy

Introduction. The San Francisco Estuary is an important migration and wintering refuge for waterfowl in the Pacific Flyway. It supports a diverse assortment of waterfowl, including over 20 duck species. More ducks winter in the San Francisco Estuary than in the much larger Chesapeake Bay (Harvey et al. 1992). The North American Waterfowl Management Plan (NAWMP) identified San Francisco Bay as one of 34 "Waterfowl Habitat Areas of Major Concern." According to the *NAWMP Concept Plan for Waterfowl Habitat Protection, San Francisco Bay, California,* ducks in San Francisco Bay comprised five to 13 percent of California's total duck population during midwinter inventories from 1984 to 1989. San Francisco Bay's open waters are of primary importance to diving and sea ducks; almost one-half of California's diving ducks are found in San Francisco Bay (Accurso 1992). Midwinter percentages of Pacific Flyway waterfowl populations using San

Table 3-2
Habitat Goals for the San Francisco Bay Joint Venture

SFBJV Habitats		SFBJV Tracked Habitat Goals (acres)			SFBJV Habitat Goal Categories (acres)[1]		
Habitat Goal Categories	**Tracked Habitats**	**Aquire[2]**	**Restore[2]**	**Enhance**	**Acquire[3]**	**Restore**	**Enhance**
Bay Habitats	Tidal Marshes	43,000	32,000	20,000			
	Tidal Flats	12,000	4,000	6,000			
	Lagoons	1,500	50	1,500	**63,000**	**37,000**	**35,000**
	Beaches	113	60	35			
	Salt Ponds	6,000	1,000	7,500			
Seasonal Wetlands	Diked Wetlands	16,000	6,000	12,000			
	Grasslands and Assoc. Wetlands	21,000	1,000	11,500	**37,000**	**7,000**	**23,000**
Creeks and Lakes	Lakes	3,000	1,000	6,000			
	Creeks and Riparian Zones	4,000	4,000	16,000	**7,000**	**5,000**	**22,000**

Notes: 1. Numbers are to the nearest thousand. **2.** Numbers are double-counted in instances where restoration takes place on acquired land. **3.** SFBJV is a nonregulatory entity, and thus acquisition goals reflect working cooperatively with a willing seller.

Sources and Significance

Tidal Marsh: Based on San Francisco Bay Area Wetlands Ecosystem Goals Project (Goals Project) Historical and Modern Tidal Marsh coverage, Goals Project regional ecological goals, estimate of currently protected lands, and estimate of potential 20-year accomplishments.

Tidal Flat: Based on Goals Project Historical and Modern Tidal Flat coverages, estimate of currently protected lands, assessment of required shorebird support, and estimate of potential 20-year accomplishments.

Lagoon: Based on Goals Project Historical and Modern Lagoon coverages, Goals Project regional ecological goals, estimate of currently protected lands, and estimate of potential 20-year accomplishments. Goal for restoration refers to natural lagoon-beach complexes.

Beach: Based on Goals Project Historical and Modern Beach coverages, estimate of currently protected lands, narrative recommendations of Goals Project, and estimate of potential 20-year accomplishments.

Salt Pond: Based on Goals Project Historical and Modern Salt Pond coverages, Goals Project regional ecological goals, estimate of currently protected lands, and estimate of potential 20-year accomplishments.

Diked Wetlands: Based on Goals Project Historical and Modern Diked Wetland and Storage/Treatment Pond coverages, Goals Project regional ecological goals, estimate of currently protected lands, and estimate of potential 20-year accomplishments.

Grasslands and Associated Wetlands: Based on Goals Project Historical and Modern Moist Grassland and Grassland/Vernal Pool Complex coverages, Goals Project regional ecological goals for Agricultural Baylands, goal of no net loss of existing moist grasslands and grassland/vernal pool complexes, estimate of currently protected lands, and estimate of potential 20-year accomplishments.

Lakes: Based on Goals Project Historical Perennial Pond coverages, modern mapping by National Wetland Inventory, estimate of currently protected lands, and estimate of potential 20-year accomplishments.

Creek and Riparian Zones: Based on estimates of historical amount of natural creek channel using the Goals Project Historical Rivers and Creeks coverage. Estimated from existing channels using USGS 100,000 Digital Line Graph Hydrology Files; estimate of existing natural creek channel using Goals Project Modern Riparian Forest coverage, analysis of average riparian width (of about 20 meters to a side), and estimate of potential 20-year accomplishments. Goal of 4,000 acres represents 25 percent of the approximately 16,000 acres of existing channel on the flatlands, of which 800 acres are estimated to be natural, based upon the amount of existing Riparian Forest (770 acres or 16 acres per mile).

Table 3-3
San Francisco Bay Joint Venture Wetland Habitat Goals by Subregion
Summary goals for the Bay Area as presented in Table 3-2, divided among the acreage objectives for each of the five subregions of the San Francisco Bay Joint Venture.

Subregions by Goals Categories	Bay Habitats (acres)	Seasonal Wetlands (acres)	Creeks and Lakes (acres)	Total by Subregion (acres)
Suisun Subregion				
Acquire	3,000	11,00	250	15,000
Restore	2,000	1,000	1,000	4,000
Enhance	2,000	6,000	4,000	12,000
North Bay Subregion				
Acquire	23,000	18,000	250	42,000
Restore	15,000	4,000	1,000	20,000
Enhance	13,000	12,000	4,000	29,000
Central Bay Subregion				
Acquire	9,000	1,000	250	11,000
Restore	4,000	0	1,000	5,000
Enhance	4,000	1,000	3,000	8,000
South Bay Subregion				
Acquire	28,000[1]	7,000	500	38,000
Restore	16,000	1,000	2,000	19,000
Enhance	42,000[1]	4,000	11,000	57,000
San Francisco/San Mateo Coast[2]				
Acquire	TBD	TBD	TBD	TBD
Restore	TBD	TBD	3,000	3,000
Enhance	TBD	TBD	5,000	5,000
Total Acreage by type	**161,000**	**66,000**	**33,000**	**260,000[3]**

Source: SFEI, Regional Habitat Goals, (July 1999)

Notes: 1. 25,000 acres of salt ponds are included in both acquisition and enhancement; as with other acquisitions, this assumes a willing seller. **2.** The San Francisco/San Mateo wetland acreages appear as TBD or "To Be Determined," since they have not been estimated. This subregion was not part of the Goals Project. **3.** San Mateo/San Francisco Coast acreages for Riparian Restoration and Enhancement are not part of the acreage totals, as they represent very rough estimates that will need to be refined and peer reviewed.

Francisco Bay (mean of 1955–1999 surveys) include 24 percent of surf scoter, 44 percent of canvasback, and 46 percent of scaup. The Bay's coastal wetlands are used to a lesser extent by dabbling ducks, geese, and swans.

This plan reflects a broad restoration and conservation effort developed in part from the *Baylands Ecosystem Habitat Goals (1999)*, but is also intended to be a framework to improve habitat for waterfowl and other waterbirds. According to *Expanding the Vision: 1998 Update, North American Waterfowl Management Plan*, the continental populations of most waterfowl species have increased in recent years, in some cases to record highs. However, three species, northern pintail and two species of scaup, have markedly declined during the same period. All of these species are found in substantial numbers in San Francisco Bay. The Bay is particularly important to scaup, as almost one-half of Pacific Flyway scaup winter in San Francisco Bay (**Table F-1,** in Appendix).

Although San Francisco Bay scaup populations have not declined in recent years, midwinter aerial waterfowl surveys (conducted since the 1950s on open bays and salt ponds) reveal substantial declines in abundance for some species, including canvasback and pintails **(Table F-2)**. Canvasback declines occurred in the early 1960s and mid-1970s. Pintail declines occurred in the mid-1960s, late 1980s, and early 1990s.

The purpose of this section of the Implementation Strategy is to:

- select a set of indicator species to represent the Bay's diverse waterfowl community
- review the significance of San Francisco Bay to the Pacific Flyway and NAWMP
- establish habitat-related waterfowl population goals
- establish priorities for waterfowl habitat management and conservation for the SFBJV
- make habitat management recommendations which help achieve those goals.

Waterfowl Indicator Species

The San Francisco Bay Joint Venture has selected a set of seven key waterfowl indicator species, which collectively represent the 32 native waterfowl species of San Francisco Bay. Within broad categories, such as the diving ducks, there are important differences between species in habitat usage, migratory patterns, and breeding habitat. These subtle differences can be reflected in differences in the population dynamics of the respective species (e.g., **Figures F-1** to **F-3**). Key indicator species identified are mallard, northern pintail, northern shoveler, canvasback, scaup (both greater and lesser), surf scoter, and ruddy duck. The list of indicator species is similar to that found in *Baylands Ecosystem Habitat Goals (Habitat Goals)*. Species were selected to represent the range of habitats used by waterfowl in the Bay. Consideration was also given to whether populations are of Pacific Flyway, and/or local significance.

Geese and Swans

Geese and swans are uncommon in San Francisco Bay. Tule geese were included on the *Habitat Goals* list, but have not been included in the San Francisco Bay Joint Venture indicator list. This is because in the San Francisco Bay Area they utilize only the Suisun Marsh; the Suisun Marsh was part of the focus area for the Goals Project but is not included within the SFBJV because it is part of the Central Valley Habitat Joint Venture. Canada geese comprise the only notable population of geese within the territory of the San Francisco Bay Joint Venture. The resident population includes, but is not limited to, approximately 100 pairs that nest in the Napa-Sonoma Marshes Wildlife Area (Larry Wyckoff, CDFG, personal communication). The wintering population includes a small flock of Aleutian Canada geese which uses a reservoir near Pinole.

Dabbling Ducks

Dabbling ducks comprise almost one-half of the waterfowl in San Francisco Bay in early fall. This includes the resident birds and early migrants such as pintail. After the wintering diving ducks arrive, dabbling ducks account for only 8–30 percent of Bay waterfowl (Accurso 1992). Mallards use diked baylands and managed mashes extensively, and are the most abundant locally nesting ducks. Mallards are also the species most prized by hunters. Mallard populations are representative of other locally breeding dabbling ducks, such as gadwall and cinnamon teal. Northern shoveler and northern pintail do not nest locally in significant numbers, but are two of the most abundant wintering dabbling duck species **(Table 3-4).** They are representative of other com-

Male pintail duck US FISH AND WILDLIFE SERVICE

Table 3-4
Peak Fall–Winter Aerial Survey Counts for Waterfowl Species in San Francisco Bay[1]

Species[2]	1987–88	1988–89	1989–90
Geese			
Canada goose	64	76	183
Dabbling Ducks			
Gadwall	3,413	2782	1,526
American widgeon	7,320	6096	3,701
Mallard	506	695	702
Blue-winged teal	0	0	2
Cinnamon teal	333	317	174
Northern shoveler	26,746	38,711	48,079
Northern pintail	12,415	5,242	8,771
Green-winged teal	1,989	313	430
Diving Ducks			
Canvasback	20,235	24,153	29,818
Redhead	1	3	3
Ring-necked duck	0	0	1
Scaup	89,599	131,448	139,214
Scoter	53,763	43,263	61,248
Bufflehead	2,780	7,094	5,373
Goldeneye	97	920	909
Merganser	102	140	107
Ruddy duck	19,163	23,686	24,073
Total Waterfowl	**201,846**	**260,858**	**284,439**

Source: Accurso 1992[3]

Notes:
1. Survey area does not include Suisun Marsh and Sacramento Delta.
2. Species in italic type are key indicator species.
3. This study was the most comprehensive waterfowl survey ever performed in San Francisco Bay, and comprised biweekly aerial surveys.

mon wintering species, such as American widgeon and green-winged teal. In San Francisco Bay, northern shovelers are salt and sewage pond specialists. They are extremely abundant during December and January, outnumbering all other dabbling ducks combined (Accurso 1992). Northern pintails use a broad range of habitats within the Bay, including diked wetland, open bay, salt ponds, and seasonal wetlands.

Diving and Sea Ducks

Diving ducks are the most numerous type of waterfowl in San Francisco Bay, and are what the Bay is renowned for among waterfowl enthusiasts. Canvasback and scaup represent the large diving ducks that winter on the Bay. Scaup are the most abundant ducks on San Francisco Bay **(Table 3-4);** through the course of the winter, they total 36–68 percent of the total Bay waterfowl population (Accurso 1992). The two species of scaup (greater and lesser) are lumped together because of their similar appearance as it is difficult to identify scaup to the species level during aerial surveys. Although similar in size, canvasback and scaup have different habitat requirements. Most canvasbacks are found in salt ponds, particularly those in the North Bay, while scaup more commonly utilize shallow open bay habitats (Accurso 1992). Ecologically similar larger diving ducks include common goldeneye, redhead, and ring-necked ducks. The ruddy duck represents the small diving ducks that use managed marshes and salt ponds. The bufflehead is also in this group. The surf scoter is by far the most abundant species of sea duck in the Bay, and the second most abundant waterfowl species overall (Accurso 1992). Ecologically similar species include white-winged and

Goldeneye, a diving duck relatively common to salt ponds. SAVE THE BAY

black scoters, as well as red-breasted mergansers, smaller populations of which occur in the Bay.

San Francisco Bay Waterfowl and the NAWMP

The North American Waterfowl Management Plan (NAWMP), written in 1986, set an ambitious goal of returning North American waterfowl populations to the levels of the 1970s. The goal was based on breeding populations during average environmental conditions. Wintering populations were not explicitly considered. This presents challenges for establishing goals in San Francisco Bay, which is overwhelmingly a waterfowl wintering rather than breeding area. The implementation strategy of the SFBJV will not significantly impact geese or swans, since usage of the Bay by these birds is very limited. The ducks of San Francisco Bay, however, are significant at the Flyway scale and thus important to the NAWMP.

Continental scaup populations are substantially lower than the NAWMP goals; even more disturbing is the fact that scaup are the only duck whose continent-wide population trend from 1986–1998 was decreasing *(Expanding the Vision: 1998 Update, North American Waterfowl Management Plan)*. Almost one-half of all scaup in the Pacific Flyway use San Francisco Bay, so the importance of this habitat cannot be overstated. Even as scaup decline continentally, they appear to be increasing in San Francisco Bay **(Figure F-1)**. The 1990s had the highest decade average since mid-winter counts were initiated in 1955 **(Table F-2)**. The migratory habits of scaup are not well documented. We do not know where most of the Bay's scaup are breeding (John Takekawa, USGS-BRD, personal communication), nor do we know much about their habitat usage patterns during migration. Thus, wintering is the only phase of their life cycle where habitat usage is well documented. It is critical that we maintain and enhance that wintering habitat.

Pintails are locally abundant in San Francisco Bay **(Table 3-4)**, especially in salt ponds. There is a history of pintail use in the South Bay. They are one of the earliest arriving migrant species, so their use of the Bay is longer than most. There appears to be little interchange of South Bay pintails with the much larger Central Valley population; thus the South Bay pintails may represent a distinct subpopulation (Miller in *Habitat Goals*). It is important to conserve such within-species metapopulation diversity. However, the total contribution of San Francisco Bay to the Pacific Flyway pintail populations is minor.

Populations of several other diving duck species are of regional importance and concern. Though continentally canvasbacks are increasing *(Expanding the Vision: 1998 Update, North American Waterfowl Management Plan)*, the Pacific Flyway population has been decreasing since the mid-1970s **(Figure F-2)**. The decline of the San Francisco Bay population has been even more pronounced, suggesting a decline in habitat quality relative to other wintering areas. The decline in habitat associated with the closing of Leslie Salt's North Bay salt ponds is one possible explanation. A shift in the Bay's benthic fauna to exotic species, especially the Asian clam *Potamocorbula amurensis*, may also have contributed. More exotic species have been introduced to San Francisco Bay than any other body of water on the West Coast.

San Francisco Bay is also an important wintering area for surf scoters. They are the second most

abundant wintering waterfowl species **(Table 3-4)**. Recent midwinter Bay indices have approached historic highs **(Figure F-3, Table F-2)**, but this may simply reflect improved survey technique following a restructuring of the methods in 1988 (John Takekawa, USGS-BRD, personal communication). Like scaup, scoters present problems with identification, especially during aerial surveys. However, ground surveys have revealed that surf scoter represent 99 percent of scoter in the Bay (Accurso 1992; John Takekawa, USGS-BRD, personal communication); thus misidentification is not a significant problem. It is clear that an increasing portion of Pacific Flyway scoters is wintering in San Francisco Bay. Sea duck populations are also of concern. According to the Sea Duck Joint Venture, continental sea duck populations are substantially lower than they should be, and may be suffering from contaminants in Bay sediments. High concentrations of selenium and other metals have been found in scoters from San Francisco Bay (Ohlendorf et al. 1986), and these may negatively impact survival and/or reproduction. Water quality improvement and pollution reduction initiatives could benefit sea ducks and other benthivorous species. Restoration of riparian and coastal wetlands should reduce the bioavailability of the Bay's contaminant load by sequestering contaminants in accreted wetland sediments.

Setting Waterfowl Population and Habitat Restoration Goals

Diving ducks in San Francisco Bay represent 25–50 percent of Pacific Flyway populations, thus the Bay is absolutely essential to the continued health of these populations. The habitat needs of these species will not be met elsewhere in the Pacific Flyway. The activities of the Central Valley Habitat Joint Venture primarily benefit geese and dabbling ducks. The Pacific Coast Joint Venture is working in diving duck wintering areas such as Puget Sound and Humboldt Bay, but these areas are much less significant than San Francisco Bay. San Francisco Bay is the single most important estuary on the Pacific Coast for waterfowl and many other taxa (Fritz Reid, Ducks Unlimited, personal communication).

The activities of the SFBJV will effect a modest increase in the quantity of overall wetland habitat **(Table 3-5),** but significant changes in the quantity of specific habitat types. The major benefits to waterfowl will not accrue from the modest increase in habitat area, but rather the improvement of existing habitat via restoration, better management, and improved water quality. Wetland habitat shifts will be from the categories of "Salt Pond" and "Grassland and Associated Wetland" to "Tidal Wetland." Salt

Table 3-5

Anticipated Changes in San Francisco Bay Habitat Quantity Resulting from SFBJV Activities. (Goals partially derived from *Habitat Goals*)

Habitat Type	Present Habitat Area (acres)	Projected Change in Habitat (acres)	Percentage Change in Habitat Area
Tidal Flat	28,000	4,000	+14
Tidal Marsh	32,000	32,000	+100
Lagoon	4,000	-750	-19
Beach	70	60	+86
Salt Pond	34,000	-14,250	-42
Diked Wetland	17,000	6,000	+35
Grasslands and Associated Wetland[1]	53,000	-24,000	-45
Lake	12,000	1,000	+8
Creek and Riparian Zone	2,500	4,000	+160
TOTAL	**182,570**	**+8,060**	**+4**

Source: *Habitat Goals*, 1999

1. Category includes 30,000 acres of "Agricultural Baylands" (farmed lands), which have lower and unpredictable habitat value.

pond acreage "lost" to restoration will be primarily high salinity ponds, including crystallizers and bittern ponds (Carl Wilcox, CDFG, personal communication). These ponds do not support significant waterfowl use. Ponds retained will generally be more preferred by waterfowl, and in some cases will be managed expressly as diving duck habitat (Carl Wilcox, CDFG, personal communication). Grasslands and associated wetlands are diked and drained wetlands used for agriculture, and they are managed expressly to minimize ponding. The ponding which does occur on such land is generally only from January–March, and it does not provide reliable, high-quality habitat. Diked wetlands managed specifically for waterfowl provide much better habitat.

To achieve the habitat restoration objectives of the Joint Venture, salt pond acreage may be reduced by as much as 40 percent **(Table 3-5)**. This could have a significant deleterious effect on waterfowl in general and diving ducks in particular as salt ponds have become critical habitat for a number of species over the past century. The importance to waterfowl of salt ponds, both active and inactive, is demonstrated in **Table 3-6**.

The change in salt pond acreage should be a guideline for the SFBJV, rather than an absolute goal. Therefore, all projects conducted through the partners of the SFBJV shall consider potential impacts on waterfowl, as well as on other biota in the Bay. Given the magnitude of this habitat change, populations of these species merit careful observation and monitoring before, during, and after the restoration. An adaptive management approach to wetland restoration and management will be necessary to maintain waterfowl habitat in the long term. Losses of salt pond habitat will be offset by enhancement of remaining salt ponds, and increases in other habitat types used by diving ducks, such as tidal flat, diked wetland (managed seasonal marsh), muted tidal marsh, and deepwater (see **Table 3-5**). As noted previously, much of the salt pond acreage lost will be in high salinity ponds of low waterfowl habitat value. Also, large open ponds will be incorporated into large-scale tidal marsh restorations. Ponds about a meter in depth were a common, natural feature in the Suisun Marsh of the late 1800s, and supported large numbers of canvasback (where dabbling ducks now dominate). Loss of salt pond habitat can be partially offset by creating more seasonal wetlands, and by including muted tidal habitat in tidal marsh restorations. The muted tidal marsh at Tolay Creek, San Pablo NWR, supports large numbers of pintails during the fall (J. Jasper Lament, personal observation). Tidal marshes are an important resource for waterfowl, because, unlike many seasonal wetlands, they persist even during drought years *(NAWMP Concept Plan for Waterfowl Habitat Protection, San Francisco Bay, California)*.

One of the key attributes of the salt pond habitat is the lack of disturbance. There is little to no boat traffic on the salt ponds, thus they provide a refuge from human disturbance for rafting waterfowl. The ever-increasing boat traffic on the Bay may exact an energetic toll on wintering birds. There is probably little that can be done by the SFBJV to reduce traffic on the open Bay, but efforts can be made to provide secure, alternative roosting and feeding sites in peripheral waters.

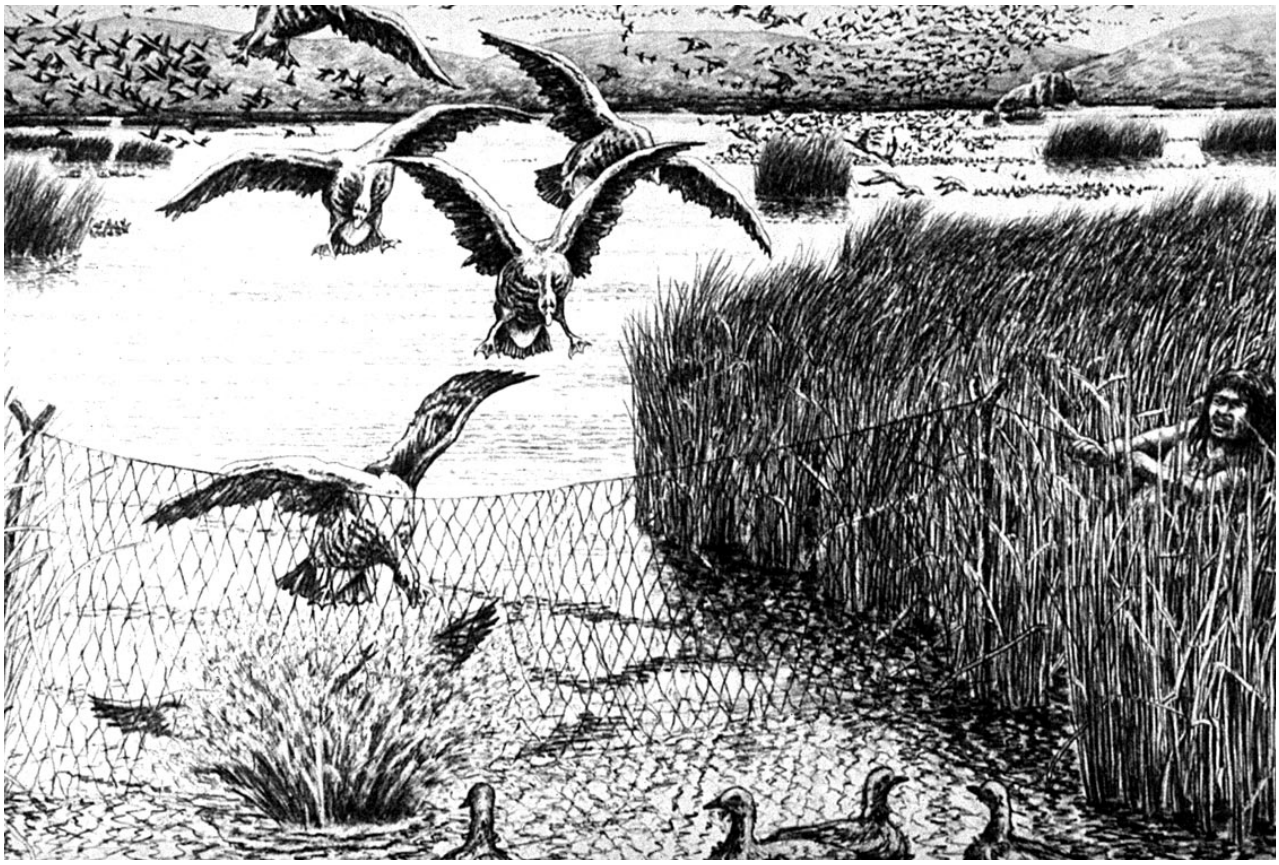
Certain diving duck species use salt ponds extensively (Accurso 1992), thus it has been suggested that maintaining recent diving duck populations **(Table 3-4)** could be a challenge if salt ponds are converted to tidal marshes. The North Bay salt

Table 3-6

Wintering Waterfowl Usage of Salt Pond Regions as a Percent of San Francisco Bay Regional Wintering Population

Species	North Bay Salt Ponds 1988–89	North Bay Salt Ponds 1989–90	South Bay Salt Ponds 1988–89	South Bay Salt Ponds 1989–90	Mean Total Salt Ponds Usage
Northern shoveler	8	10	91	88	98.5
Northern pintail	19	13.6	66	67	82.8
Canvasback	59	38	17	17	65.5
Scaup	11	2.4	2.6	1	8.5
Scoter	<0.2	<0.2	<1.2	<1.2	<1.4
Bufflehead	30	38	50	46	82
Ruddy duck	25	30	67	55	88.5

Source: Accurso, 1992



The Bay Area's original inhabitants, the Ohlone, hunted ducks with nets. FROM *THE OHLONE WAY*

ponds accounted for 15 percent of the Bay's total diving duck population in 1988–89 and eight percent in 1989–90, while the South Bay salt ponds held 11 percent and eight percent respectively (Accurso 1992). Salt pond usage by scaup, the Bay's most abundant diving duck, and scoter is quite low. Usage is much higher for canvasback, bufflehead, and ruddy duck **(Table 3-6)**. However, during winter storms, more than 50 percent of all scaup and canvasback may be found on North Bay salt pond habitats. This demonstrates the subtle differences in habitat requirements of the various diving duck species, and the need to intensively manage the salt ponds that will be maintained in their current condition.

Certain waterfowl populations will benefit from an increase in diked (managed) wetland acreage **(Table 3-5)**. The 35 percent increase in diked wetlands will benefit dabbling ducks, such as mallard, widgeon, and pintail, but also diving ducks. For example, a 90-acre diked wetland at Viansa Winery (Sonoma County) supports 30,000+ canvasbacks and pintail at a time (John Nagel and Fritz Reid, Ducks Unlimited, personal communication). Canvasback usage is especially common during periods of rough weather on the Bay, and they probably feed heavily on the submerged aquatic vegetation. This particular wetland also provides excellent dabbling duck wintering habitat.

The limited usage of the Bay by dabbling ducks, geese, and swans could be significantly expanded by restoration of tidal and freshwater marshes, riparian systems, lakes, ponds, and associated uplands. Restoration of these critical habitats would also benefit shorebirds, passerines, wading birds, and other types of wetland-dependent wildlife, including several special status species.

Shovelers and pintails both use salt ponds extensively **(Table 3-6)**. For these species, creation of new managed freshwater wetlands (6,000 acres) will help offset the reduction in salt pond acreage. Managed freshwater wetlands would be particularly sensible at sites where tidal marsh restoration is not feasible due to human activities. Management of vegetation and water levels is key to maintaining habitat diversity, and helps avoid cattail monocultures. Large stands of cattail that lack open water provide poor habitat for waterfowl and shorebirds. Seasonal wetland habitat should also be incorporated into tidal marsh restorations by designing an elevational salinity gradient. Some dabbling ducks, such as pintail and green-winged teal, will benefit from the

planned restoration of tidal flats (4,000 acres), while others, such as wood ducks and mallards, will benefit from the restoration and enhancement of riparian zones (20,000 acres). An increase in local mallards is foreseeable if a significant amount of breeding habitat is created. Local mallard production could be further enhanced through improved management of natural grasslands. Nesting structures and predator control would help reduce the impact of predation by introduced red foxes. Finally, shovelers would benefit from any new sewage lagoons, which though not part of the SFBJV Implementation Strategy, are a likely byproduct of continued human population growth in the Bay Area.

Waterfowl Population Goals

A primary waterfowl goal of the SFBJV is to provide enough high quality wetland habitat to consistently support wintering populations of key Bay waterfowl species at recent peak population levels. Key Bay waterfowl species are canvasback, scaup (greater and lesser), and scoters. More specifically, the goal for these species is to sustain populations in every year at the peak levels recorded in 1989–90 **(Table 3-4)**. Levels for 1989–90 were the highest recorded during three years of intensive surveying by Accurso (1992). This was the most comprehensive waterfowl survey conducted for San Francisco Bay waterfowl.

A secondary goal of the SFBJV is to provide enough habitat to consistently support wintering populations of other Bay indicator waterfowl species at recent peak population levels. Other Bay indicators are: mallard, northern pintail, northern shoveler, and ruddy duck. More specifically, the goal for these species is to sustain populations in every year at the peak levels recorded in 1987–90 **(Table 3-4)**. However, achieving this goal would not be an acceptable substitute to attaining the primary diving duck goals.

Other Habitat Issues

Transitional Habitat

Tidal marsh restoration is an extended process, which creates transitional habitat (in the form of large, brackish ponds) favored by diving ducks. The Tolay Creek Project in San Pablo Bay NWR is an example of a tidal marsh restoration that created diving duck habitat. The restoration of tidal action in the creek created a 53-acre brackish pond from diked, farmed baylands. This pond received immediate usage by rafts of both dabbling and diving ducks. This pond will persist for years, before bay sediments accumulate sufficiently for the area to return to tidal marsh. These projects demonstrate that better management can enhance diked baylands for the benefit of both dabbling and diving ducks. These transitional habitats, while valuable in the short term, cannot be counted on for long-term waterfowl habitat contributions.

Clean Water and Aquatic Vegetation

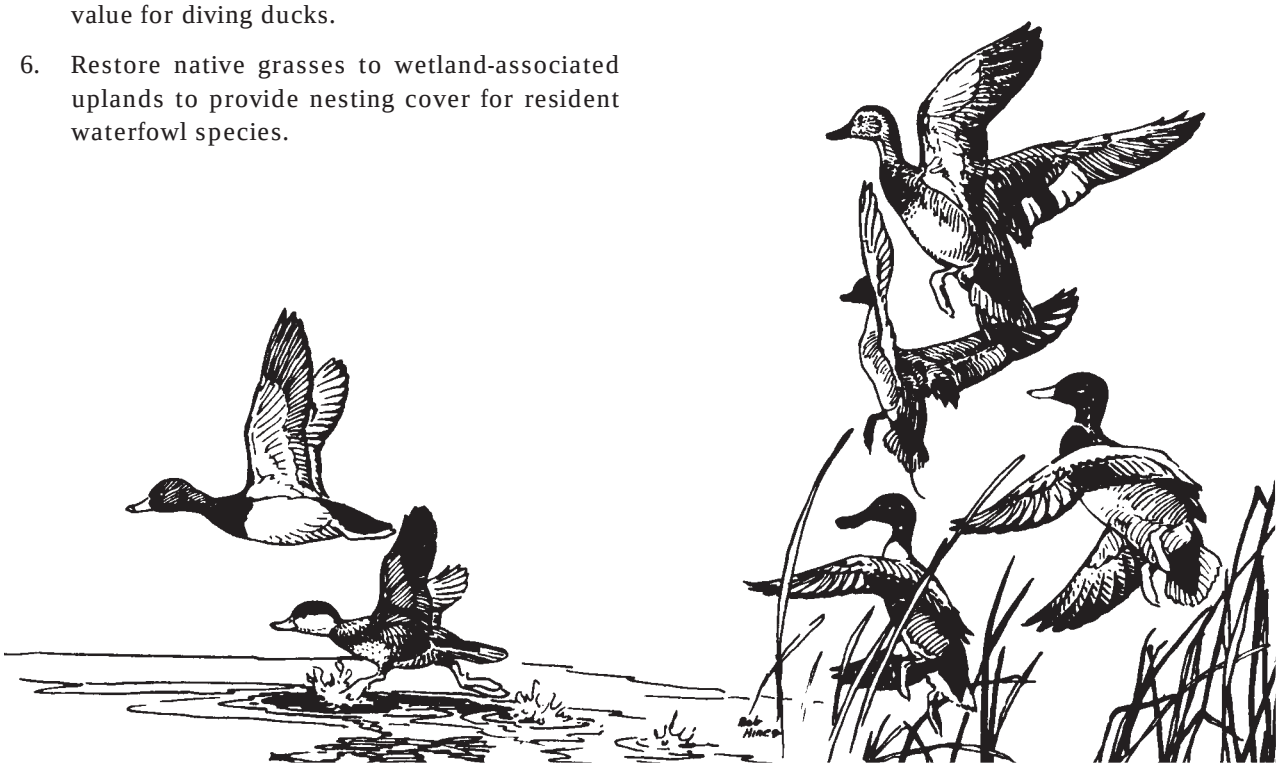
Habitat values in the open shallow bay should also improve due to better water quality. Riparian and tidal marsh restoration will reduce contaminants and sediment in runoff. Tidal marshes will filter sediments resuspended by wind and wave action on mudflats (Carl Wilcox, CDFG, personal communication). This will lead to cleaner water in the Bay. Cleaner Bay water should produce more submerged aquatic vegetation. Aquatic vegetation provides nutritional value to diving ducks superior to the mollusks that are currently available (Jorde et al. 1995). It is a particularly important dietary item for canvasbacks (Yocom and Keller 1961; Bellrose 1980). Though historic records are scarce, it seems likely that aquatic vegetation was more abundant historically, when water clarity was better. Diving and sea ducks will benefit significantly from this change, as has been observed in Chesapeake Bay. Reduced salinity due to excessive discharge of freshwater treated sewage is causing localized problems for aquatic vegetation, especially near San Jose in the South Bay. This problem should be addressed to restore ambient Bay salinity.

Exotic Aquatic Species

As the benthic invertebrate fauna of the Bay gradually shift to exotic species, it is unknown what the effect will be on molluskivorous species like scaup, scoter, and canvasback. Little is known of the nutritive value of the native or the exotic invertebrate species. For example, in the Great Lakes, it appears that diving ducks are exploiting the abundant exotic zebra mussel, but it is unknown what the effect of this dietary shift has been on survival or contaminant bioaccumulation.

Actions to Benefit Waterfowl

1. Protect, enhance, and restore diving duck wintering habitat, especially shallow open water, and ensure the maintenance of at least the peak population levels of diving duck populations recorded in 1989–90. Top priority species are canvasback, scaup, and scoter.
2. Ensure provision of sufficient habitat to consistently support at least the peak levels of resident and wintering populations of the other indicator waterfowl species recorded in 1987–90.
3. Preserve historic composition of waterfowl community relative to dabbling, diving, and sea ducks.
4. Improve management of existing habitat (especially water circulation) in active and inactive salt ponds to increase production of invertebrates and submerged aquatic vegetation (especially widgeon grass, *Ruppia maritima*).
5. Develop seasonal and riparian wetland restoration and enhancement projects that will restore filtration functions and contribute to improved water quality throughout San Francisco Bay. Improved water quality will lead to healthier aquatic vegetation, and provide higher habitat value for diving ducks.
6. Restore native grasses to wetland-associated uplands to provide nesting cover for resident waterfowl species.
7. Encourage minimal disturbance zones in shallow bay habitats favored by diving and sea ducks.
8. Encourage conservation and enhancement of shallow bay habitats favored by diving and sea ducks.
9. Where appropriate, preferentially restore higher salinity salt ponds (>70 ppt) and crystallizer ponds to tidal marsh or dry playa, rather than low and moderate salinity ponds (which have higher waterfowl habitat value).
10. Where consistent with other goals, reserve or develop large (200 to 550 ha) salt ponds of moderate salinity (20 to 30 ppt) for large diving ducks, and manage those ponds for production of widgeon grass, *Ruppia maritima*. Retain the same relative acreage of moderate salinity salt ponds within both North and South Bay.
11. Where consistent with other goals, reserve or develop medium (50 to 175 ha) salt ponds of variable salinity (<70 ppt) for small diving ducks and dabbling ducks (especially northern shoveler).
12. If industrial salt production ceases in South Bay, explore possibility of maintaining some



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high salinity ponds through alternative water management strategy, in order to maintain production of brine shrimp and brine flies (important food resources for some waterfowl species).

13. Restore riparian habitat to expand habitat for dabbling ducks. Plant native hardwood trees (especially oaks) and develop nest box programs in creek and riparian restoration projects where wood duck habitat potential exists.

14. Incorporate side channels and floodplain enhancement into creek and riparian restoration projects.

15. Where consistent with other goals, manage some diked seasonal wetlands for diving ducks by keeping large expanses of open water and minimizing emergent vegetation.

16. Expand waterfowl monitoring program at both Bay-wide and project-specific scales, to support enactment of adaptive management programs.

The Role of Research, Monitoring, and Evaluation

Waterfowl monitoring at the scale of the entire Bay is currently inadequate. A single midwinter survey provides only a snapshot of waterfowl use: it does not provide enough information to measure the effects of this Implementation Strategy. The addition of early and late season surveys to the existing midwinter survey would represent a great improvement. Ideally, the protocol of Accurso (1992) would be adopted, i.e., aerial surveys every two weeks from October through April. This would provide a much more complete picture of waterfowl usage in the Bay.

A substantial waterfowl-monitoring program is already being conducted by the staff of the US Geological Survey Biological Research Division, San Francisco Estuary Field Station. Monthly waterfowl ground surveys are conducted on the former North Bay salt ponds, which are now part of the California Department of Fish and Game Napa-Sonoma Marshes Wildlife Area. As habitat restoration progresses on this site, the impact on waterfowl will be tracked, facilitating the development of an adaptive management program. Over a period of one year, new management practices could be tested, the impact on waterfowl usage tracked, and feedback derived for the following year's management program. This type of program has been extremely successful in breeding habitat areas such as the Prairie Habitat Joint Venture.

We do not yet understand the mechanisms that limit wintering populations of waterfowl. This makes it very difficult to link habitat restoration goals with the population-based goals of NAWMP. Energetics-based models are a promising new approach to estimating wintering habitat requirements. However, data on food production in tidal habitats is insufficient to support such an approach in the Bay. Feeding ecology is much more complex in the Bay than in the rice country of the Central Valley. Dietary items are more diverse and dispersed, and they change in availability seasonally, and even daily. All we know at present is that food availability in the Bay is correlated with shallow bay acreage. But data on prey availability and nutritional value is insufficient to establish a direct link to the birds. More research is needed on consumption, density, and production of prey, as well as changes in diet between and within years. Until habitat needs can be determined, it is best to take a conservative approach and maximize habitat quantity and quality.

Therefore, it is an objective of this Implementation Strategy to monitor and evaluate the effects on waterfowl of the implementation of the habitat goals and make recommendations to ensure viable waterfowl populations. This objective is included with the Monitoring Objectives of Chapter 5. In light of the factors discussed above, waterfowl monitoring as part of wetland restoration should be conducted using an adaptive management approach.