Evaluation Plan
Gulf Coast Joint Venture

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Introduction

The Gulf Coast Joint Venture (GCJV) Evaluation Plan complements existing GCJV implementation plans by addressing the most critical assumptions underlying implementation planning and the most prominent information needs that are currently limiting efficient planning. This document provides the rationale behind each of these evaluation issues, and their enumeration coincides with their priority relative to GCJV conservation planning. Where work is in progress, this document also outlines the contributions of GCJV partners toward each issue.

A series of linked assumptions of increasingly narrow focus forms the basis for most GCJV biological planning. At the broadest continental scale is the basic assumption that there is a cross-seasonal effect of winter habitats on waterfowl breeding populations. This has been one of the basic principles underlying the North American Waterfowl Management Plan and associated delineation of priority habitat ranges that span breeding and non-breeding regions. A slightly more focused assumption is that these cross-seasonal effects are manifest through enhanced survival during the nonbreeding season and/or subsequent recruitment during the breeding season. Narrower still is the explicit assumption of GCJV plans that availability of foraging habitat is the most limiting aspect of winter waterfowl habitats. An important component of evaluating this assumption is quantifying foraging habitat. At the finest scale are evaluation issues regarding the success of regional, local, or site-specific management actions on achieving intended management goals (e.g. increasing foraging values).

Issues at each of these various scales are important in assessing the effectiveness of the GCJV and the NAWMP. It is inappropriate to focus all evaluation resources on the effectiveness of site-specific management actions intended to increase foraging values, without any assessment of whether foraging value is indeed the habitat parameter of most significance to populations. Likewise, it is difficult to draw conclusions about cross-seasonal effects at the continental scale without a firm understanding of how to best quantify winter habitat value at local and regional scales.

We address this realm of assumptions with several issues related to our ability to quantify foraging habitat, as well as some tests of the assumption that foraging habitat is limiting, and an issue related to the effectiveness of a common management strategy.

Other evaluation issues pose broader questions regarding certain species or issues. In some cases we lack sufficient information to incorporate biological needs into conservation planning. For snow geese, mottled ducks, and offshore scaup, we pose issues that affect whether these birds should be considered a conservation priority for the GCJV, and if so, at what level of urgency.

This plan intends to strike an appropriate balance among evaluation issues of different scales and types. The intent is to facilitate critical assessments of the most important assumptions underlying activities of the GCJV, and provide guidance and feedback to improve future planning and implementation.

This document is not intended to be a complete list of all important research questions related to waterfowl in the region, but rather outlines the highest priority needs with direct feedback into GCJV activities. The purposes of this document are to 1) demonstrate that the GCJV recognizes the critical assumptions behind its conservation planning, 2) influence the priorities of researchers and funding entities wishing to address waterfowl questions with direct application to GCJV activities, and 3) guide the evaluation/research activities of the GCJV office.

1. Seasonal Water on Rice Prairies and Coastal Sand Plains

Issue: Quantifying surface water on cultivated rice, idle fields, and moist soil habitats during dry years will provide a baseline on which agricultural enhancement management objectives will be based.

The Gulf Coast Joint Venture (GCJV) encompasses coastal marsh from Alabama to south Texas, and includes a significant band of coastal prairie to the north of Chenier Plain and Texas Mid-coast marshes, and coastal sand plains inland from the Texas Laguna Madre. The GCJV is geographically subdivided into 7 "initiative areas", which serve as planning units with separate population and habitat objectives – Mobile Bay, Coastal Mississippi Wetlands, Mississippi River Coastal Wetlands of Louisiana, Chenier Plain (Louisiana and Texas), Texas Mid-Coast, and Laguna Madre.

The importance of the GCJV to continental waterfowl populations is mainly as a wintering site, so the primary basis for habitat planning in the GCJV is providing foraging habitat for wintering waterfowl. These activities generally take the form of maintaining existing marsh, restoring degraded marsh, and enhancing agricultural habitats of the coastal prairie and coastal sand plain. Habitat needs in these regions are modeled based on energetic requirements of waterfowl and foraging values of four habitat types.

Initiative areas provide a spatial framework for prioritizing and implementing habitat projects. Although initiative areas provide only a broad spatial scale for planning, it is an appropriate scale for migratory and highly mobile waterfowl and wetland birds on the Gulf Coast. Within initiative areas, separate objectives for coastal prairie and coastal sand plain habitat types further refine the priority and delivery of projects.

The Texas Mid-coast, Texas Chenier Plain, and Louisiana Chenier Plain Initiative Areas include a southern band of estuarine emergent marsh, bordered on the north by extensive coastal prairies. These 3 regions account for 56% and 93% of the GCJV's midwinter duck and goose objectives. Gulf Coastal prairies are highly altered landscapes that now support extensive rice culture, yet continue to support large numbers of migratory and resident birds and other wetland wildlife. Cultivated rice and idle fields in rice rotations are important waterfowl habitats, expected to meet a significant portion of the foraging needs of waterfowl (roughly half the ducks and almost all geese) in these three initiative areas.

The dominant feature of the Laguna Madre Initiative Area is the hypersaline lagoon system on the eastern fringe, but inland portions are similarly dominated by agricultural lands of the coastal sand plain. Wetlands on these agricultural lands, particularly seasonal wetlands, are expected to support a significant portion of the Laguna Madre Initiative Area's midwinter duck and goose objectives.

GCJV habitat plans are based on bi-weekly waterfowl population objectives for each planning region. Flooded habitat acreages necessary to energetically sustain the duck population objectives for each of the 3 rice prairie regions and the coastal sand plain have been determined based on estimates of seed densities by habitat type (Davis et al. 1960, Harmon et al. 1960), true metabolizable energy (TME) of seeds (Petrie 1994), seed spoilage rates (Neely 1956), a seed density threshold below which we assume foraging is no longer energetically advantageous (Reinecke 1989), and the competing energetic demand of geese in these flooded agricultural habitats.

Rice farmers on the Gulf Coast typically utilize a 2- or 3-year rotation, in which only ½ to 1/3 of fields in a given year are planted to rice, with a portion of the remainder left idle. Some fields that are planted to rice are fertilized and reflooded after an initial harvest in July or August to encourage a second crop of rice growth from the same stubble. The second harvest occurs in late October or early November, with some second-growth rice fields left unharvested for various reasons. This results in 4 distinct agricultural habitats with waterfowl foraging value – rice harvested only once, rice harvested twice, unharvested second-growth rice, and idle habitats. For the coastal sand plain of the Laguna Madre Initiative Area, seasonal moist soil wetlands are considered to be the only wetland habitat with waterfowl foraging value.

Because waste rice and other seeds in harvested rice fields are subject to deterioration, depredation, and sprouting, their highest foraging value to waterfowl is soon after harvest. Therefore waterfowl energetic demands and associated flooding objectives are separated into two periods. Once-harvested rice fields, along with idle habitats, are targeted for flooding during an early period (August through October). Second-growth rice fields (harvested and unharvested) and idle habitats are targeted for flooding during the late (November through March) period. For each flooding period, objectives are apportioned into habitats by subjective estimates of relative availability (i.e., potential) of each habitat type during each period. Objectives for seasonal moist soil wetlands of the Laguna Madre Initiative Area are similarly apportioned into early and late periods.

Though this model yields total prairie and coastal sand plain habitat needs for waterfowl, knowledge of minimal or baseline habitat already existing is necessary to formulate meaningful management objectives. The primary objective of this work is to determine the proportion of the modeled habitat need, for each of the agricultural habitat types, that is minimally provided by normal agricultural practices and rainfall in the Texas Mid-Coast, the Chenier Plain of Texas and Louisiana, and the Laguna Madre area of Texas. The difference between what is "minimally provided" during dry years and the modeled habitat need will serve as regional and habitat-specific managed flooding objectives for GCJV partners. Similar information from average and wet years will provide insight into expected variation in habitat provision. Additionally, we will test some of the subjective estimates of habitat availability (potential) by actually delineating the proportion of rice-rotation fields that fall into each of the 4 habitat categories.

<u>Methods</u>

NOAA climatological data station records will be collected for the Laguna Madre, Texas Mid-Coast, and Chenier Plain Initiative Areas from 1982 to the present. This information will be compiled into monthly precipitation averages by year for each satellite scene of the respective initiative areas. Using this precipitation data, scenes will be selected for 3 dates of imagery from each of 3 years - relatively dry, average, and wet years - with priority given to years with typical rainfall patterns. Landsat Thematic Mapper (TM) scenes with minimal cloud cover will be reviewed. The objective is to summarize habitat conditions for October, December, and February of 3 years for each scene representing dry, average, and wet variation since the early 1980's. Digital Orthophoto Quarter Quadrangles will also be acquired to assist with the delineation of field boundaries as needed.

Landsat TM image analysis will yield water availability acreage estimates on fields for each month of the migration and wintering period. Water availability will be determined separately for each of the 4 habitat types of interest, which have different foraging values and may have different typical water regimes.

Separating fields into the various habitat types will be accomplished with images from early in the growing season and adjacent to each harvest period. For instance, multi-date summer imagery will be used to delineate the four forage habitat types of interest. Specific rice fields will be identified from March or April imagery, when newly sprouted rice is expected to be readily discernable from other crops, permanent crawfish ponds, and idle fields. Comparison of these labeled fields to signatures obtained from late June or early July (pre-harvest) imagery will yield a "mature rice field" signature that can be used to identify rice fields in other years. Field verification of the imagery will be accomplished with crop records from county Farm Service Agency offices. Mid- to late October (pre-second harvest) imagery will be used to identify fields that were cultivated for, or volunteered, a second crop. Mid- to late November imagery will allow identification of second-growth fields that were not harvested. GIS analysis will be employed to generate maps and corresponding acreage statistics by habitat type.

Desired Products:

- Table(s) depicting surface water acreage by habitat type, initiative area, and study year

- Graph(s) depicting the seasonal (August thru March & September through March) precipitation totals relative to other years for years of selected scenes that were used to derive values for the above table.
- Graph(s) depicting monthly precipitation totals within a season, relative to the long term average monthly totals, for years of selected scenes that were used to derive values for the above table.

2. Foraging Values of Coastal Marsh Habitats

Issue: Lack of information on waterfowl food densities in coastal marsh habitats currently precludes energetic modeling of coastal habitat needs for waterfowl.

Issue: The food limitation assumption that underlies GCJV plans to provide foraging habitat will be tested by examining food depletion rates across broad geographic scales.

Quantitative habitat objectives for the GCJV have been modeled only for the agricultural portion of the GCJV. Those objectives are based on estimates of seed densities (Davis et. al. 1960, Harmon et. al. 1960), true metabolizable energy of those seeds (Petrie 1994), a threshold seed density below which foraging is not energetically advantageous (Reinecke 1989), seed spoilage rates (Neely 1956), and an assumed proportion of duck foraging need that we should provide in those habitats (as opposed to coastal marsh). Currently a lack of information on food densities within coastal marsh habitats precludes similar energetic modeling of the foraging capacity of this portion of the joint venture area. Because the foraging capacity of coastal marsh is unknown, we must subjectively assume a proportion of foraging need that is supplied by the agricultural areas.

Acreage estimates of coastal marsh are available from the National Wetlands Inventory (NWI), and rough acreage estimates of ponds and lakes are also available within those broad habitat categories for Louisiana (Chabreck 1971). With food density data from coastal marsh ponds, we will be able to 1) set habitat objectives for coastal marsh that are meaningful relative to population objectives, 2) initially address the assumption that foraging habitat is limited, 3) avoid subjective assumptions about the relative provision of food in agricultural versus coastal marsh settings, and 4) make foraging habitat supply predictions based on predicted loss and degradation of coastal marsh (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority [LCWCRTF and WCRA] 1998).

Seed biomass of waterfowl foods in coastal marsh likely vary by marsh type. Food density data should be collected so that it reflects these potential differences, while also being applicable to the habitat acreage database to which it will be applied - NWI. At the broadest level, NWI marsh types can be subdivided into fresh, intermediate, brackish, and saline for coastal Louisiana; and fresh and estuarine for coastal Alabama, Mississippi, and Texas.

Seeds and submerged aquatic vegetation are the primary food energy sources for waterfowl in coastal marsh, though invertebrates are an important dietary component for protein acquisition. Because GCJV habitat objectives are based on energetic needs, food plants are the highest priority of this work. Sampling design should be such that results are applicable, within a given habitat type, across the GCJV.

Initial sampling should coincide as nearly as possible with the end of the vegetative growing season and the onset of major waterfowl migrations in the early fall. All standing and fallen seeds and above- and below-ground plant parts of known waterfowl foods should be sampled to a substrate depth of at least 10cm (Jemison and Chabreck 1962) and included in the estimate of available forage.

If/when foraging habitat is limiting, we would expect food sources to be largely depleted across broad spatial scales, at least to a density below which foraging is not energetically advantageous. To test this assumption, a second series of sampling should occur at the same sites to determine food depletion rates. This second sample period should occur at the end of the major waterfowl wintering period, but prior to any new vegetative growth in the spring.

Desired Products:

- Table(s) depicting average biomass per unit area of potential waterfowl foods by marsh type, study year, sample period (September/October or February/March), food type (seeds, below-ground vegetation, SAV), and genus.

- Graph(s) depicting September/October versus February/March biomass per unit area of each waterfowl food type by site and study year.
- Map depicting all study sites relative to the GCJV boundary.

3. Availability of Duck Habitat within NWI Classifications

Issue: Delineation of ponds within broader National Wetland Inventory habitat classifications will allow application of waterfowl food density data from coastal marshes (issue #2) to an appropriate acreage of available habitat.

Coastal marsh waterfowl habitat of the GCJV is mapped only to the extent of National Wetland Inventory classifications (with water chemistry modifiers in Louisiana to differentiate brackish, intermediate, and saline estuarine wetlands). These habitat classifications are useful for mapping broad habitat categories, but to be useful for modeling energetic supply to waterfowl, we must be able to differentiate actual duck habitat (ponds) within these broad NWI habitat classifications. Data exist regarding numbers and area of ponds distributed among the major marsh types of Louisiana (Chabreck 1971). However, extensive marsh deterioration has occurred since that study, and the size, shape, and distribution of marsh ponds may have been drastically altered. More current information applicable to the entire GCJV would improve estimates of available waterfowl foods in coastal marsh habitats.

An appropriate method to obtain this information is to digitize "ponds" from recent aerial infrared photography. A 5-10% randomly distributed subsample, stratified by habitat classification and GCJV initiative area, would be sufficient. At the broadest scale, habitat should be stratified into 4 categories for Louisiana (fresh, intermediate, brackish, and saline marsh); and 2 categories for coastal Alabama, Mississippi, and Texas (fresh and estuarine marsh). Acreage of all open water should be quantified and categorized such that large lakes, major bayous, and navigation channels unsuitable for foraging waterfowl can be excluded. Care should be taken to account for documented biases associated with estimating wetland numbers of different sizes when sample area boundaries intersect wetland boundaries (Johnson and Higgins 1998).

Desired Products:

- Table(s) depicting total acreage and number of ponds per unit area for each pond size class and marsh type.
- Map depicting the sampled area(s) relative to the entire GCJV.
- Metadata describing the dates and type(s) of imagery used to delineate ponds.

4. Foraging Values of Agricultural Habitats

Issue: Waterfowl food density data from Gulf Coast ricefields and moist soil habitats is not contemporary, and estimates that better reflect current conditions would improve the reliability of modeled habitat objectives.

Issue: The food limitation assumption that underlies GCJV plans to provide foraging habitat will be tested by examining food depletion rates across broad geographic scales.

Agricultural flooding objectives for the GCJV are based on the amount of seed energy necessary to energetically sustain a portion of the population objective. Agricultural flooding objectives are apportioned into one of five habitat categories - 1) early idle/moist soil, 2) early single harvest rice, 3) late idle/moist soil, 4) late harvested ratoon rice, 5) late unharvested ratoon rice. "Early" flooding is defined as mid-August through October, while "late" flooding is November through March.

Foraging values of GCJV agricultural habitats are currently based on seed density data from 4 decades ago (Davis et al. 1960, Harmon et al. 1960). Changes in agricultural practices such as increased harvest efficiency and herbicide use have probably changed the amount of waste rice and weed seeds available to ducks from harvested and idle fields, so a contemporary estimate is desirable.

Initial seed sampling in single harvest rice and idle fields should occur in mid to late August, after rice harvest and before the arrival of significant numbers of early migrant waterfowl. Because seed density data will be used to estimate potential foraging value, seed sampling should include any mature seeds still attached to standing plants.

Initial seed sampling in harvested ratoon rice, and a second sampling from idle fields, should occur in late October or early November. This sampling should follow the ratoon harvest, and coincide with the beginning of the GCJV "late" flooding period as nearly as possible. If unharvested ratoon fields are available, they should be sampled at this time, also. However, unharvested fields may be rare in some years and some regions, and yield of unharvested fields can be reasonably estimated from statewide agricultural summaries or other harvest-related sources.

If foraging habitat is limiting, we would expect food sources to be largely depleted across broad spatial scales, at least to a density below which foraging is not energetically advantageous. To test this assumption, a second series of sampling should occur at the same sites to determine food depletion rates. This second sample period should occur at the end of the major waterfowl wintering period, but prior to any new vegetative growth in the spring.

Desired Products:

- Table(s) depicting biomass per unit area of all seeds by field type (1-crop harvested, 2-crop harvested, 2-crop unharvested, or idle), sample period (August/September, October/November, or February/March), study year, and genus.
- Graph(s) depicting within-season changes in biomass per unit area for waterfowl food plant seeds by site and study year.
- Map depicting all study sites relative to the GCJV boundary.

5. Food Limitation and Depletion Related to Disturbance

Issue: Waterfowl food depletion as a strong test of the food limitation assumption should incorporate factors that account for regional winter population size. Factors that account for site-specific relationships to sanctuary may also prove informative in defining the appropriate role and distribution of refuges.

GCJV habitat objectives are based on the assumption that availability of fall and winter foraging habitat imposes constraints on survival or recruitment of waterfowl. Such constraints may not exist when wintering waterfowl populations are low and/or when abundant timely rainfall provides a plethora of natural habitat. Fall population size, weather-induced migration, weather-related winter habitat availability, and habitat conditions in other migration and wintering areas may interact to produce varying degrees of habitat limitation on the Gulf Coast.

If/when foraging habitat is limiting, we would expect food sources to be largely depleted across broad spatial scales, at least to a density below which foraging is not energetically advantageous. One potentially confounding variable in studying food depletion is disturbance. Even if foraging habitat is limited, food depletion may not occur at a given site if the frequency, duration, and/or magnitude of disturbance are sufficient to prohibit waterfowl access to food resources. There are several forms of human disturbance common to waterfowl habitats of the Gulf Coast, with potential to preclude waterfowl access to food. These include regular airboat activity (e.g. 3-d seismic operations), excessive hunting, frequent crawfish harvesting, recreational fishing boat activity, or excessive visitation.

Evening round-trip flights of southwest Louisiana pintails from sanctuary to nocturnal foraging sites are known to become longer as winter progresses (Cox and Afton 1998a), consistent with the concept of preferential food depletion nearest to sanctuary. It is reasonable to believe that other species may exhibit similar patterns of foraging and refuging behavior, perhaps to varying degrees. A waterfowl food depletion study that a priori incorporates disturbance or sanctuary would be a stronger test of this refuging theory, and could be particularly informative about the role and appropriate distribution of sanctuary within a landscape of habitat.

One suggested study design would test for waterfowl food depletion differences among numerous paired study sites across the entire GCJV, with pairs allocated to each initiative area (i.e., strata) in sufficient numbers to elucidate any regional differences among initiative areas. Each pair would consist of a hunted and non-hunted section of otherwise similar habitat in proximity to each other, and sampling at each site would occur both with and without waterfowl exclosures. Sampling of the habitat for waterfowl foods should occur, at a minimum, before most waterfowl arrive and again at the end of the waterfowl wintering period as described for Issues #s 2 and 4. Care would have to be taken to assure similar habitat type and quality within each pair, and a standard definition of "hunted" should be applied (e.g., at least one hunt per week). Such a study should encompass 2 years at a minimum, to accommodate different winter population sizes and distributions of waterfowl.

Other appropriate study designs include experimental manipulation of disturbance so that treatments could be randomly applied, experimental placement of known quantities of waterfowl foods, rigorous quantification of different degrees of disturbance, or a design in which 3 or more levels of disturbance are incorporated a priori. Behavioral observations to test for differences in time spent feeding, etc., may also be a useful component of a study of this type. Such a study could conceivably be combined with other food sampling and depletion studies (e.g. Issues #s 2 and4) to reduce overall food sampling effort.

Desired Products:

-Probability values from statistical procedures that test for overall and regional differences in waterfowl food depletion among disturbance treatments.

-Map depicting study sites relative to the entire GCJV.

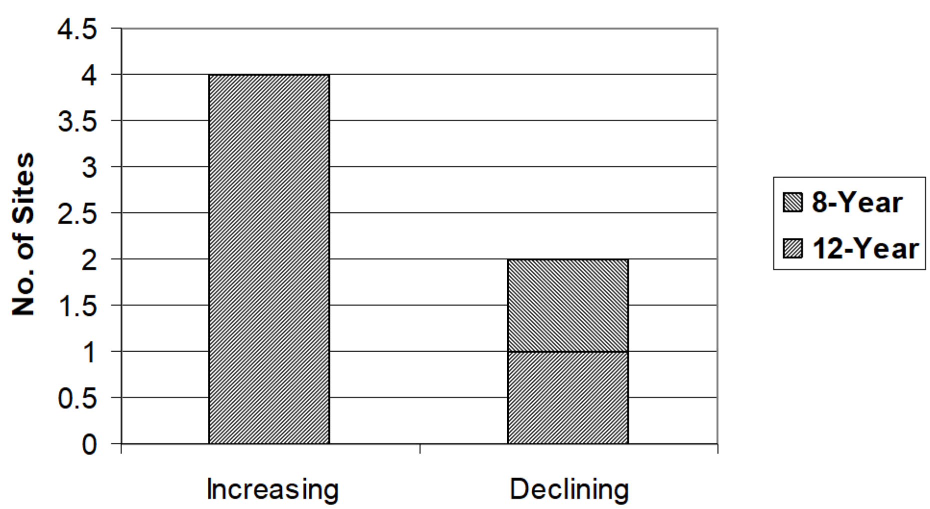
6. Mottled Duck Population Status and Trends

Issue: Ambiguous information regarding trends in mottled duck populations confounds GCJV efforts to appropriately prioritize conservation actions that impact this species.

The GCJV is home to approximately 90% of the worldwide population of mottled ducks. Because mottled ducks are non-migratory, GCJV habitats are entirely responsible for meeting virtually all life cycle requirements for this western gulf coast population. Because conditions within the GCJV are crucial to the well-being of the species, it is imperative that we discern population trends that might dictate conservation actions.

Unfortunately, uncertainty and ambiguity best describe the population trend information that is available. For example, Anderson & Haukos (1998) analyzed short-term (1991-98) and long-term (1986-98) trends in mottled ducks counted on 8 national wildlife refuges and management units of the Mid-Coast and Chenier Plain of Texas. Most long-term trends suggested population increases, while most short-term trends suggested population declines, with varying degrees of statistical significance (Fig. 1).

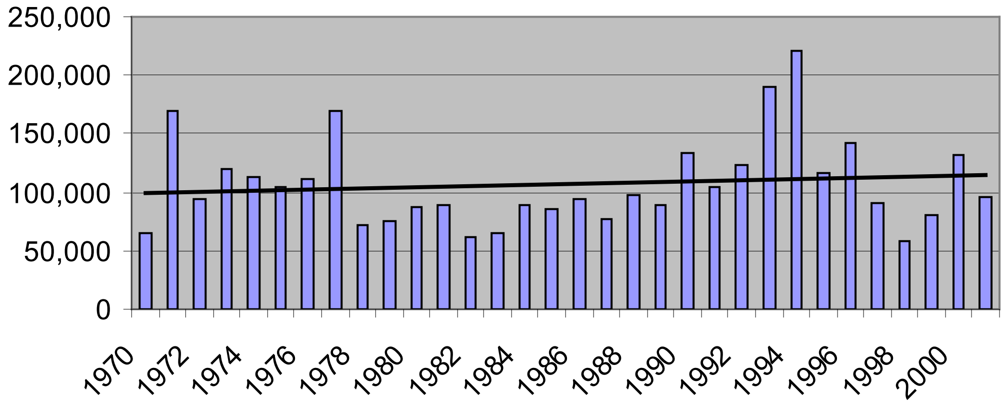
Fig. 1. Coastal Texas Refuge Mottled Duck Trends (P<0.05) 1986-1998.



Source: Anderson & Haukos 1998.

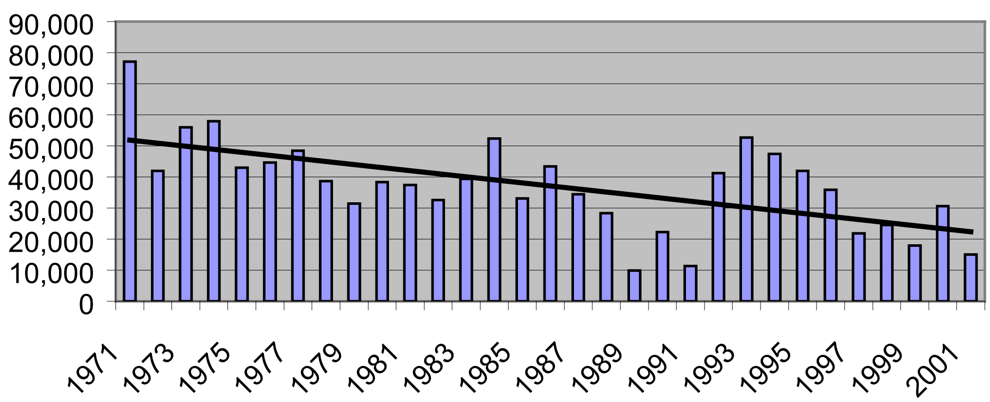
Though it is an imperfect enumeration of population size, the coordinated midwinter waterfowl survey may be the best existing dataset for long-term trends of mottled ducks across the entirety of their western gulf coast range. These data indicate a stable population (Fig. 2), although Texas trends indicate a regional decline (Fig. 3). Unpublished data from breeding population surveys of select coastal refuges in Texas since 1985 show a decline similar to that of the midwinter survey over the same time period (J.Neaville, unpublished data).

Fig 2. Mottled Duck Midwinter Indices in the Western Gulf Coast[1], 1970-2001.



[1] TX, LA, MS, and AL combined; R^2=0.013, F=0.409, P=0.527.

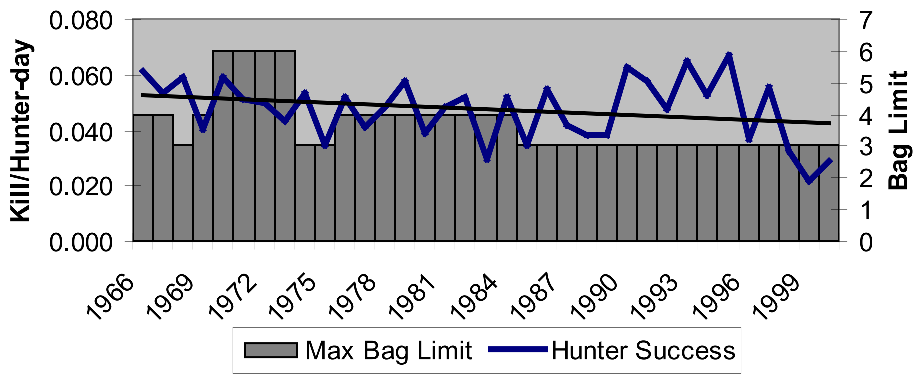
Fig. 3. Mottled Duck Midwinter Indices in Texas, 1971-2001[1].



1 R^2=0.375, F=17.428, P=0.0002.

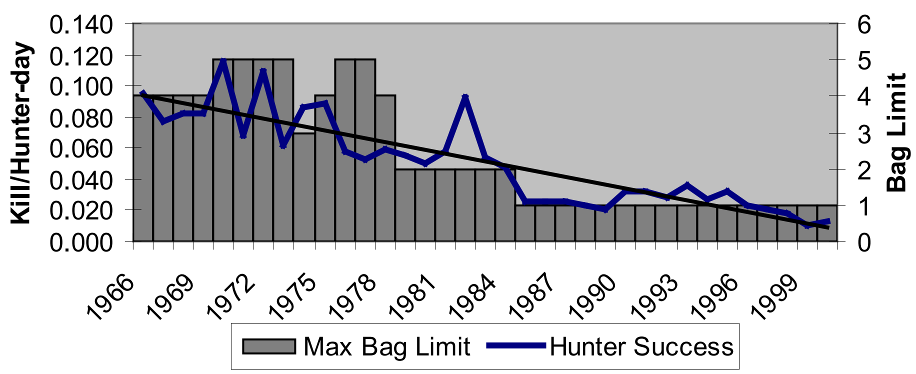
Another index of population trend (Rusch et. al. 1989) is annual hunter success for the species, corrected for the number of hunter-days. Louisiana mottled duck hunter success trends are stable (Fig. 4). Texas mottled duck hunter success has declined significantly, but interpretation is confounded by substantial changes in daily bag limits (Fig. 5).

Fig. 4. Louisiana Mottled Duck Hunter Success Trends, 1966-2000[1].



[1] R^2=0.070, F=2.500, P=0.123.

Fig. 5. Texas Mottled Duck Hunter Success Trends, 1966-2000[1].



[1] R^2=0.765, F=107.625, P<0.00001.

Recent estimates of mottled duck population abundance (Ballard et. al. 2001, B.C. Wilson, unpublished data) suggest a larger population than previously thought (Stutzenbaker 1988). This does not diminish the possibility, however, of declining population trends for the species. A reliable population index is needed across the range of western Gulf Coast mottled duck habitats. Ballard et. al. (2001) or Neaville (unpublished data) provide reasonable models for breeding population survey techniques that could be applied across the range of the species.

Desired Products:

- A statistically valid operational survey across the species' western Gulf range.

7. Habitat Use of Inshore/Offshore Scaup

Issue: A lack of understanding about how (or if) offshore scaup populations use coastal marsh habitats currently limits conservation planning on their behalf.

Continental population levels of scaup are well below the North American Waterfowl Management Plan objective, and their status is a concern to waterfowl managers. Reasons for the decline are poorly understood, but several non-exclusive and potentially cross-seasonal factors have been suggested, including problems with contaminants, female survival, and recruitment (Austin et. al. 2000). Louisiana and Texas are 2 of the most important states for wintering scaup (Afton & Anderson 2001), and scaup lead GCJV waterfowl population objectives over all other species, despite the fact that these objectives exclude offshore populations.

Current GCJV habitat objectives do not account for needs of offshore scaup. This is due to 1) a lack of understanding about the degree of interchange between offshore & inshore scaup, 2) a lack of survey information to provide reliable numbers of offshore scaup, 3) a lack of information about the effects of inland habitat management on offshore scaup, and 4) a paucity of information regarding direct management activities that might benefit offshore scaup and their habitats.

Our current assumption, albeit weak, is that there is little interchange between inshore and offshore scaup populations, and that their respective habitat needs should therefore be met in their respective separate habitats. This assumption can be tested, and any inshore/offshore interchange quantified, with a study that would mark individual birds and track their habitat use through a wintering season.

Habitat use analyses should incorporate relationships to current and past hypoxic zones of the Gulf of Mexico. Because scaup feed largely on sessile benthic fauna such as clams (Bowman 1973), their food source may be particularly vulnerable to changes in the size and distribution of the zone of deoxygenated water.

Desired Products:

- Tables, graphs, maps, and/or statistical test results that depict the likelihood of individual scaup using both inshore and offshore habitats, and the factors affecting such potential habitat transition(s).
- Tables, graphs, maps, and/or statistical test results that depict the occurrence of scaup relative to suspected important habitat features (e.g., clam beds, hypoxic zone, etc.)

8. Habitat use of redheads relative to dietary freshwater

Issue: A better understanding of redhead movements between feeding and drinking sites, as well as effects of freshwater wetland conservation on the distribution of foraging redheads and shoalgrass depletion, would facilitate conservation of inland freshwater wetlands in a manner most beneficial to the species.

Seagrass meadows associated with barrier islands of the GCJV are home to 75% of the U.S. population of wintering redheads (Michot 2000). Wintering redheads feed almost exclusively on a single prey species – shoalgrass (*Halodule* sp.) – within only a handful of sites continentally. This creates a risky situation for wintering redheads. The situation is particularly disconcerting because long-term changes have occurred in species composition of Laguna Madre seagrasses which do not bode well for feeding redheads (Onuf 1995). Additionally, the seagrass meadows of Chandeleur Sound, Louisiana, are jeopardized by coastal erosion acting on the relatively fragile Chandeleur Island Chain.

There is only limited evidence (Michot 1997) to suggest that current populations of redheads are food-limited in winter, even with populations well above NAWMP goals. But their limited winter distribution and associated vulnerability to regional or local habitat degradation warrant a closer risk-assessment for this species, and a more risk-averse habitat provision strategy.

Mainland freshwater wetlands adjacent to hypersaline seagrass meadows are important sources of dietary freshwater to feeding redheads (Adair et. al. 1996). Availability of seagrass meadows as redhead foraging habitat may be influenced by the distribution of these dietary freshwater sources. Conservation of appropriately distributed freshwater wetlands to provide dietary freshwater to redheads is a recommendation of the Laguna Madre and Texas Mid-Coast Initiative plans, with specific recommendations for wetland distribution relative to seagrass meadows based on Haukos et. al. (2000). Estimates of appropriate distances between foraging and drinking sites are largely anecdotal, though.

One explicit assumption of such freshwater conservation is that we can influence the distribution of foraging redheads. If freshwater availability is limiting the availability of foraging habitat, we should also see subsequent changes to the distribution of seagrass depletion. Therefore, an evaluation of radio-marked redheads that incorporates seagrass meadow distribution, shoalgrass depletion, and proximity to freshwater wetlands is warranted to validate the underlying assumptions of freshwater wetland conservation for the sake of redheads.

Desired Products:

- Tables, graphs, maps, and/or statistical test results that depict winter shoalgrass tuber depletion with respect to proximity to suitable freshwater wetlands.
- Tables, graphs, maps, and/or statistical test results that depict changes in the distribution of wintering redheads within the Laguna Madre with respect to changes in availability of freshwater wetlands (i.e., through conservation actions and/or natural temporal variability).
- Tables, graphs, maps, and/or statistical test results that depict the distances of redhead movements between foraging and drinking sites of the Laguna Madre.

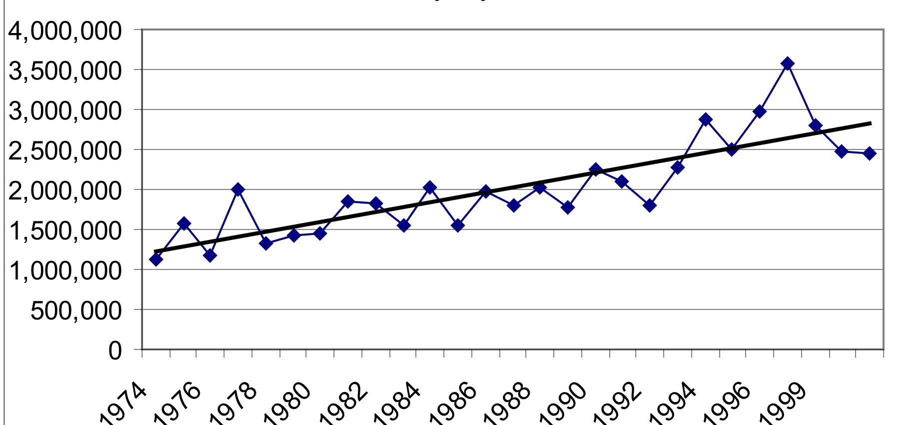
9. Breeding Grounds Affiliation of Snow Geese

Issue: If the origins of snow geese using GCJV coastal marshes differ from snow geese using agricultural habitats, current population reduction efforts should attempt to maintain geese in their historic marsh range where they are an integral part of that ecosystem.

GCJV population objectives for snow geese are based on historical populations and are well below current estimates for the region. Also, the GCJV Management Board has explicitly supported harvest regulation changes to decrease survival and population size of mid-continent white geese (snow and Ross' geese). So GCJV waterfowl conservation actions are intended to be neutral or detrimental to snow goose overwinter survival.

Mid-continent snow goose populations have dramatically increased in the past 3 decades (Fig. 1), causing severe detrimental impacts to breeding areas and prompting efforts to reduce continental populations (Batt 1997).

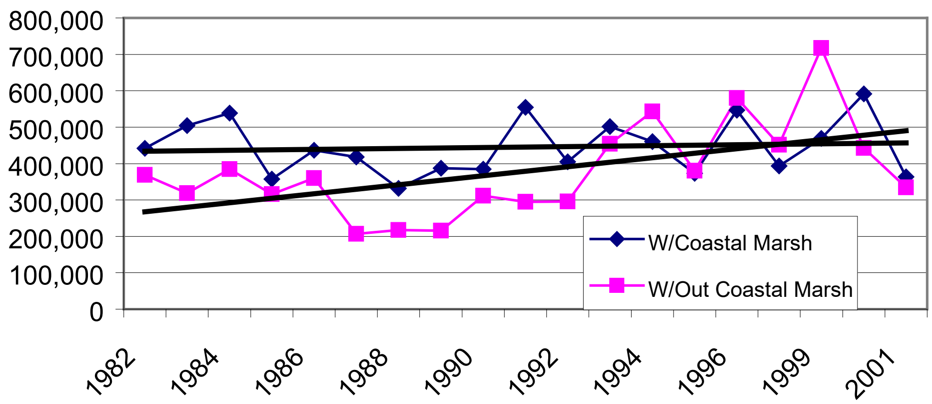
Fig. 1. Winter indices of snow/Ross' geese for the Mississippi and Central Flyways, 1974-2000.



Linear regression trend R^2=0.689, F=55.454, P<0.00001.

However, indications are that numbers of snow geese are either declining or remaining stable in their traditional coastal marsh range, while the increases are occurring in the agricultural regions of the Gulf Coast and elsewhere. Midwinter indices from Texas indicate that since 1981 when data are available by zone, the population is stable in all zones that include coastal marsh, while the population has increased in the remainder of the state (Fig 2). Similarly, data from Louisiana indicate that populations are stable for the southern portion of the state, while numbers have increased dramatically in other areas (Fig. 3). In both cases, the apparently stable southern zones include significant portions of rice and agriculture, along with coastal marsh. Thus, a potential decline in populations using coastal marshes may be masked by heterogeneity of habitats within southern survey zones.

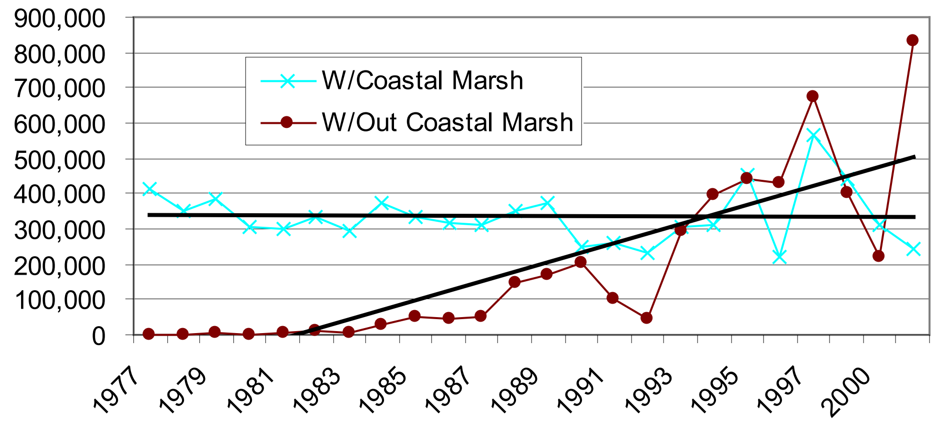
Fig. 2. Winter indices and linear regression trends of snow/Ross' geese in Texas survey zones with[1] and without[2] coastal marsh, 1982-01.



[1]Survey zones with coastal marsh are 1, 3, and 4; R^2=0.010, F=0.178, P=0.678.

[2]Survey zones without coastal marsh are 2, NE, NW, and S; R^2=0.288, F=6.869, P=0.018.

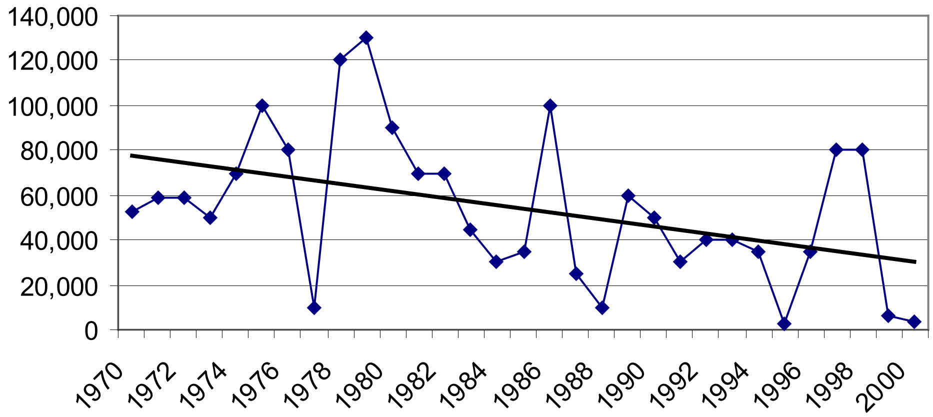
Fig. 3. Winter indices and linear regression trends of snow/Ross' geese in Louisiana survey zones with[1] and without[2] coastal marsh, 1977-01.



[1] Zones with coastal marsh are III (SW) and IV (SE); R^2=0.018, F=0.459, P=0.505.
[2] Non-coastal zones are I (NW) and II (NE); R2=0.653, F=46.963, P<0.00001.

Data from specific sites of coastal marsh suggest that this is the case. Anderson and Haukos (1998) examined white goose trends at 7 National Wildlife Refuges (NWRs) that are predominantly Texas coastal marsh. They looked at 7-year and 12-year trends on 7 sites. Of these 14 trend analyses, only 2 showed any evidence of an increasing white goose population, 1 of which was statistically significant. Downward white goose trends were evident for the other 12 analyses, 7 of which were statistically significant. Similarly, peak snow goose counts at Lacassine NWR in Louisiana show declining trends since 1970 (Fig 4). Long-term white goose indices from coastal marsh areas are scarce, but anecdotal accounts indicate that goose trends at these marsh sites are representative of marsh goose trends region-wide.

Fig. 4. Peak counts of white geese on Lacassine NWR, 1970-00.



Linear regression trend R^2=0.185, F=6.574, P=0.016.

Morphological differences have been documented between snow geese that utilize traditional coastal marsh and those from coastal rice prairies (Alisauskas 1998). One of several explanations is that the breeding origin of coastal "marsh geese" differs from the origin of other geese. If this is the case, "marsh geese" may be inappropriately targeted for population reductions. Geese are an important component of coastal marsh ecosystems, in some cases opening homogenous stands of emergent vegetation into habitats that are more attractive to shorebirds and ducks.

Currently, mid-continent snow goose management strategies assume that overwinter survival is too high for all wintering populations, and do not recognize a potential risk of contributing to the decline of subpopulations that may not be contributing to arctic breeding habitat degradation. This should be addressed so that regional conservation planning appropriately complements continental objectives.

Appropriate research approaches include 1) using satellite transmitters to track coastal marsh white geese northward to their breeding grounds, 2) retrospectively analyzing band recovery data to determine origins of geese harvested in coastal marsh, 3) retrospectively analyzing coastal marsh resightings of geese that were neck-collared on the breeding grounds, and 4) studying geese marked and resighted in various winter habitats.

Desired Products:

- Tables, graphs, maps, and/or statistical test results that depict the probability of GCJV "marsh geese" breeding in colonies with known habitat destruction problems and compare that probability to white geese from non-marsh portions of the GCJV and other mid-continent wintering areas.
- Tables, graphs, maps, and/or statistical test results that depict the probability of interchange among GCJV "marsh geese" and white geese wintering in other GCJV habitats.

10. Improve Offshore Scaup Estimates

Issue: Unreliable or non-existent abundance estimates of offshore Gulf Coast scaup populations restricts our ability to appropriately account for the needs of those birds in conservation plans.

Continental population levels of scaup are well below the North American Waterfowl Management Plan objective, and their status is a concern to waterfowl managers. Reasons for the decline are poorly understood, but several non-exclusive and potentially cross-seasonal factors have been suggested, including problems with contaminants, female survival, and recruitment (Austin et. al. 2000). Louisiana and Texas are 2 of the most important states for wintering scaup (Afton & Anderson 2001), and scaup lead GCJV waterfowl population objectives over all other species, despite the fact that these objectives exclude offshore populations.

Current GCJV habitat objectives do not account for needs of offshore scaup. This is due to 1) a lack of understanding about the degree of interchange between offshore & inshore scaup, 2) a lack of survey information to provide reliable numbers of offshore scaup, 3) a lack of information about the effects of inland habitat management on offshore scaup, and 4) a paucity of information regarding direct management activities that might benefit offshore scaup and their habitats.

After quantifying the degree of interchange between inshore and offshore scaup (Evaluation Issue #6), estimating total scaup populations is the logical next step toward accounting for scaup needs in GCJV habitat plans. To the extent that population numbers lead to quantifying habitat conservation objectives through energetic models or other means, population estimates are a necessary link to establishing objectives for this species.

A pilot survey of scaup in offshore waters of Louisiana was designed and implemented in 2000 and 2001. The survey was designed to include those portions of bays and offshore waters up to 5 miles offshore that are not covered by the coordinated midwinter survey, so that scaup numbers from the 2 surveys are roughly additive. Approximately 2000 miles of random aerial survey lines, stratified by 16 units, results in a 5.4% sampling intensity. Results of this pilot survey clearly document large numbers of scaup in these previously unsurveyed areas of Louisiana, with offshore estimates ranging from 469,730 to 808,222. Very large flocks of scaup in offshore waters of Mississippi were observed by some of the survey participants, but not included in this survey. Lesser numbers were observed in offshore waters of the Texas Chenier Plain during an informal survey timed to coincide with the effort in Louisiana. Expansion of a well-designed and coordinated survey to the offshore waters and bays of Texas, Mississippi, and Alabama is necessary to enumerate scaup populations of the GCJV. Responsibility for analyzing, summarizing, and archiving data, as well as distributing associated reports, needs to be clarified.

Desired Products:

- Statistically valid estimates of scaup abundance for at least 3 consecutive years in offshore portions of Texas, Louisiana, Mississippi, and Alabama.
- Archives of data summaries, analyses, methodologies, and maps associated with such estimates.

11. Nocturnal, diurnal, and seasonal habitat use of ducks

Issue: Winter habitat use by dabbling ducks is poorly understood, except for southwest Louisiana pintails, and data on nocturnal habitat use is especially meager.

Other than pintails in southwestern Louisiana, little is known about nocturnal habitat use of any Gulf Coast dabbling ducks. Nocturnal habitat use of southwestern Louisiana pintails differs markedly from diurnal locations, presumably shifting from diurnal roost sites to nocturnal feeding sites (Cox & Afton 1997, 1998). Others have documented diurnal concentrations of ducks at sanctuaries, and subsequent nocturnal dispersal to unknown sites (Tamisier 1976). If other species exhibit similar patterns, the relative importance of diurnal concentration sites is probably overestimated, and the importance of nocturnal feeding sites could easily be underestimated. In light of current knowledge about pintails, habitat use studies that incorporate sanctuary and nocturnal components could be particularly helpful in delineating critical habitats and defining the appropriate role and distribution of refuges.

Systematic aerial surveys are commonly used to assess the importance of waterfowl habitats (e.g., Palmisano 1973). Nocturnal habitat use information is necessary to interpret survey data, which are exclusively diurnal snapshots. Diurnal habitat use can be determined from well-designed aerial surveys that collect simultaneous habitat information. But without radio-marked birds, or another method to assess nocturnal habitat use, determining important habitats from aerial survey information is suspect.

Energetic models used to determine habitat objectives in GCJV implementation plans make numerous assumptions, including estimates of how various waterfowl species use agricultural versus coastal marsh habitats for foraging requirements. Those estimates are subjective, and are almost exclusively based on daytime observations (whether anecdotal or systematic data). A more objective assessment of habitat use by species, including any seasonal differences, would improve the accuracy of modeled habitat objectives.

Radio-marked birds are probably the best source of habitat use information that is not limited to daytime, and not biased by search patterns or visibility (at least within regions that can be covered by aerial signal receiving).

Desired Products:

- Tables, graphs, maps, and/or statistical test results that depict duck habitat use within the GCJV, by species or species-groups, both diurnally and nocturnally.
- Tables, graphs, maps, and/or statistical test results that depict duck habitat use within the GCJV relative to areas of known sanctuary.

12. Effects of Coastal Marsh Restoration on Long-term Habitat Sustainability

Issue: The sustainability of some coastal marsh restoration methods is ambiguous, but this information is critical to attaining long term landscape designs.

A variety of marsh restoration activities are identified in GCJV initiative area plans. GCJV coastal marshes are extremely dynamic and complicated systems in their natural state, but currently are highly altered and degraded due to a variety of man-induced factors. This creates a difficult scenario for managers that wish to restore a degraded system, especially when degradation factors range from site-specific (e.g., dredge and fill), to continental (e.g., Mississippi River hydrology), to global (e.g., sea level rise).

The long-term sustainability of some marsh restoration techniques has been questioned (Cahoon 1994, Nyman & Chabreck 1995, Reed & Foote 1997), primarily because of concerns about the low probability under some management scenarios of marsh elevation keeping pace with subsidence and/or sea level rise (i.e., relative sea level rise). Conversely, documented accretion rates of some managed marshes appear to be at sustainable levels (Foret 1997). Because of conflicting information and the importance of this issue to entities such as the GCJV that are interested in designing long term landscapes, sustainability of restoration techniques deserves closer scrutiny. Of particular interest are factors that explain the differences between the above conflicting findings in structurally managed marshes. These differences could elucidate management regimes that are most appropriate for long-term conservation.

Desired Products:

- Tables, graphs, maps, and/or statistical test results that compare parameters of long-term marsh health (vegetation, elevation, nutrients, etc.) among different management scenarios.

- Map(s) of study sites, documentation of management objectives, specific management practices actually attempted, and success of such attempts over the course of the study.
- Determination of whether any failures were a failure to properly implement the management strategy, or a failure of the strategy itself.

13. Intraspecific Interactions Between Ducks and Geese Sharing GCJV Habitats

Issue: The degree that ducks and geese compete for resources is unknown, but assumed to be significant. This assumption has significant ramifications to GCJV energetic models that yield habitat objectives.

Energetic models that form the basis for GCJV habitat objectives assume that geese and ducks compete for similar food resources, at least in agricultural areas. This assumption is based on knowledge that ducks and geese both use flooded agricultural fields, and have at least one common food source in waste rice (Dillon 1957, Hobaugh 1985). What is not known is the degree to which they compete for other food sources, the similarity of their food density thresholds for foraging, or potential physical interactions that might play a role in resource competition.

In addition to waste rice, agricultural fields contain seeds from many plant species that are preferred by ducks (Davis et. al. 1960, Harmon et. al. 1960). Other than waste rice, ducks and geese may be seeking separate food sources from the same habitat. The degree to which coexisting ducks and geese forage in separate niches of agricultural habitats is largely unknown.

Large numbers and large body sizes of geese translate into a substantial energetic demand that exerts significant influence on GCJV modeled habitat objectives for agricultural enhancement. Different assumptions about the degree to which geese deplete waterfowl foods would have marked implications to habitat objectives that are primarily intended to bolster duck populations.

The current assumption behind GCJV energetic models is that geese foraging on dry fields deplete the foraging potential of that field for ducks, if the field becomes flooded later. This is only true to the extent that geese are foraging for the same food items, and that they deplete food resources to similar levels as ducks before ceasing to feed there.

Geese demonstrate a dietary transition from waste rice in the fall to sprouting green vegetation in late winter (Hobaugh 1984, 1985). This transition may be due to changing physiological needs, depletion of waste rice that coincides with the availability of green vegetation (Hobaugh 1984), or both. A better understanding of this transition, including the seed threshold at which geese cease to forage for them, and the remaining value to foraging ducks, has important ramifications to GCJV habitat objectives. If geese are only effectively competing for seeds with ducks until January, for instance, then such a seasonal component to competition needs to be accounted for in energetic models. Similarly, if geese are only effectively competing for seeds with ducks above a certain seed density threshold (and that threshold is higher than the threshold for ducks), then an appropriate adjustment should be made in energetic models.

Aside from direct competition for food resources, there may be other factors that render habitats less valuable for ducks if geese are present. The degree to which agonistic interactions with geese negatively affect ducks is unknown. Perhaps there are other limitations that the presence of geese imposes on important duck social interactions. Alternatively, geese may improve food resources for ducks by opening dense stands of vegetation through grubbing.

An investigation of this issue would necessarily involve behavioral observations, waterfowl food sampling, and bird collections for esophageal analyses from sites where ducks and geese coexist, as well as sites where each occurs exclusively. Such a study would also necessarily include a temporal component to capture any changes in interactions through the fall and winter periods.

Desired Products:

- Tables, graphs, maps, and/or statistical test results that

14. Winter Site Fidelity and Breeding Grounds Affiliation of GCJV Duck Species

Issue: Information regarding winter site fidelity has implications to the likelihood of winter waterfowl management influencing attainment of winter population objectives. Similarly, breeding origins of ducks are necessary to interpret any changes in winter population distributions, which are linked to GCJV population objectives.

GCJV population objectives are based on the assumption that 1970s winter duck distributions are appropriate and attainable. Relative distributions (i.e., percentages) of birds counted in midwinter surveys were used to apportion continental objectives into flyways, and further into initiative areas. Depending on the degree(s) of winter site fidelity, the status of particular habitat regions (i.e., breeding or wintering) may be especially important determinants of GCJV wintering populations for some species. Similarly, potential correlations between overwinter habitat quality and regional breeding propensity or production should be explored.

Winter habitat management or other factors that affect winter survival may influence local/regional populations. Hestbeck (1993) examined winter bandings and subsequent recovery distributions of pintails and found that birds from coastal areas, including the Gulf Coast, exhibited higher winter fidelity than pintails in other regions. If this were to hold true for other species, then winter management could be particularly important to attaining GCJV population objectives.

If there are sub-populations of some duck species that have historically shown high winter site fidelity to the GCJV, perhaps we should look in a more regionally focused manner (on both breeding and wintering areas) for factors that could negatively impact these GCJV winter populations. Winter site fidelity could be assessed from winter bandings and recoveries, both within and outside the GCJV. Such analyses should be species-specific.

If winter site fidelity to the GCJV has been high, then historical breeding origins of GCJV winter duck populations, and any subsequent changes in more recent years, could be informative regarding changing distributions of wintering ducks. An assessment of past origins of GCJV wintering birds, as well as any shifts through time, should be explored.

Decade-specific harvest derivation analyses would elucidate any changes to breeding origins of GCJV winter populations. If data permits analyses by GCJV initiative area, that would have ramifications to initiative area-specific population objectives. For instance, perhaps specific breeding survey strata that are more related to GCJV winter populations than continental populations as a whole can be identified. Such knowledge could have important implications for assessments of cross-seasonal survival, condition, or recruitment of ducks using GCJV winter habitats.

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