Gulf Coast Joint Venture

Gulf Coast Joint Venture Priority Science Needs for Landbirds, Shorebirds, & Waterbirds

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Introduction

The Gulf Coast Joint Venture (GCJV) is a regionally-based bird habitat conservation partnership of state, federal, and non-governmental organizations spanning the coastal portions of Alabama, Mississippi, Louisiana, and Texas (Figure 1). The mission of the GCJV is to advance the conservation of important bird habitats within the GCJV region through biological planning, science-based conservation actions, assumption-driven research, and focused monitoring and evaluation of the planning and implementation process (Figure 2). This document presents a contemporary listing of the highest priority science needs for testing critical assumptions, addressing data gaps, evaluating effectiveness of conservation actions, and assessing future challenges to landbird, shorebird, and waterbird habitat conservation in the GCJV region.

Figure 1: The Gulf Coast Joint Venture region and Initiative Areas within which habitat objectives and conservation actions are tailored to address priority bird habitat conservation needs.

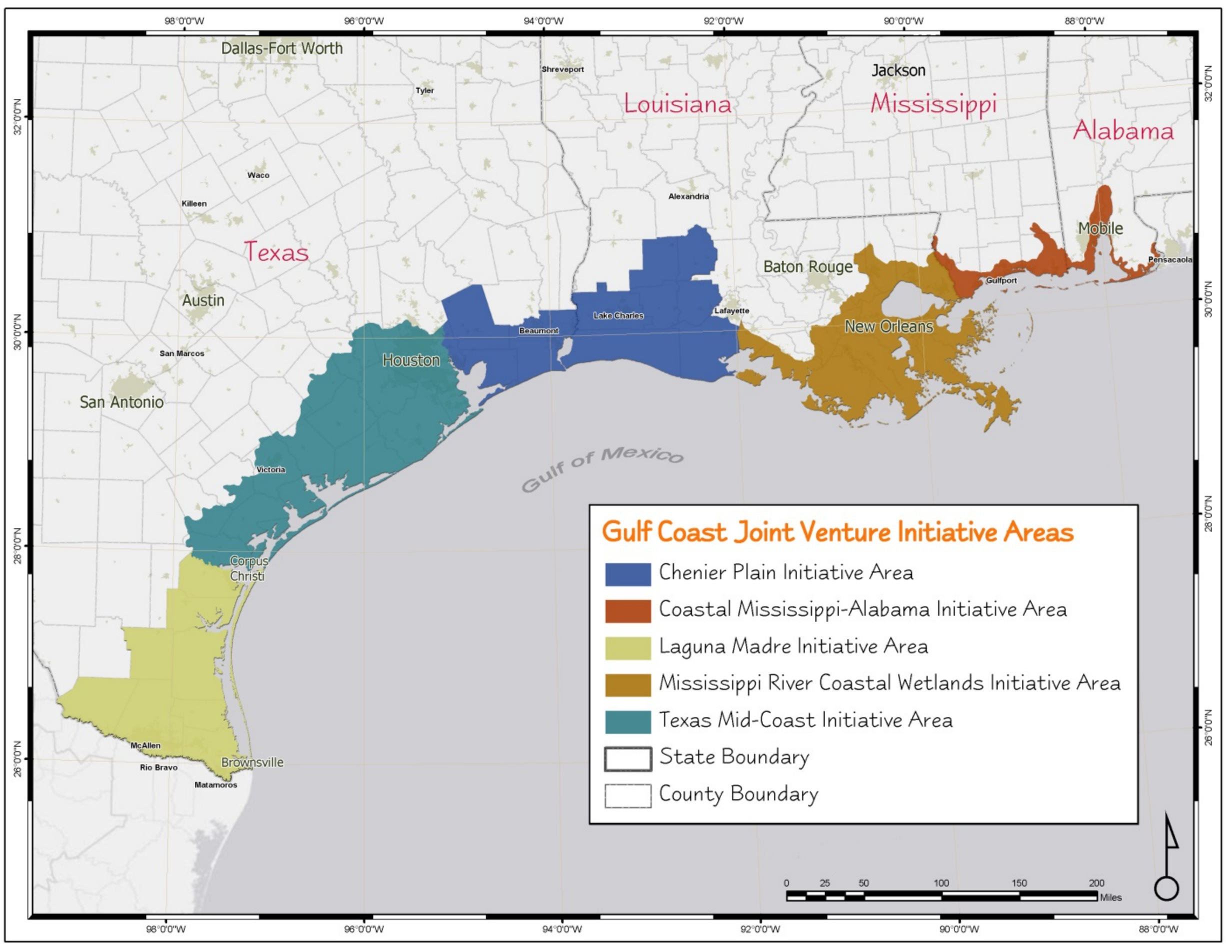
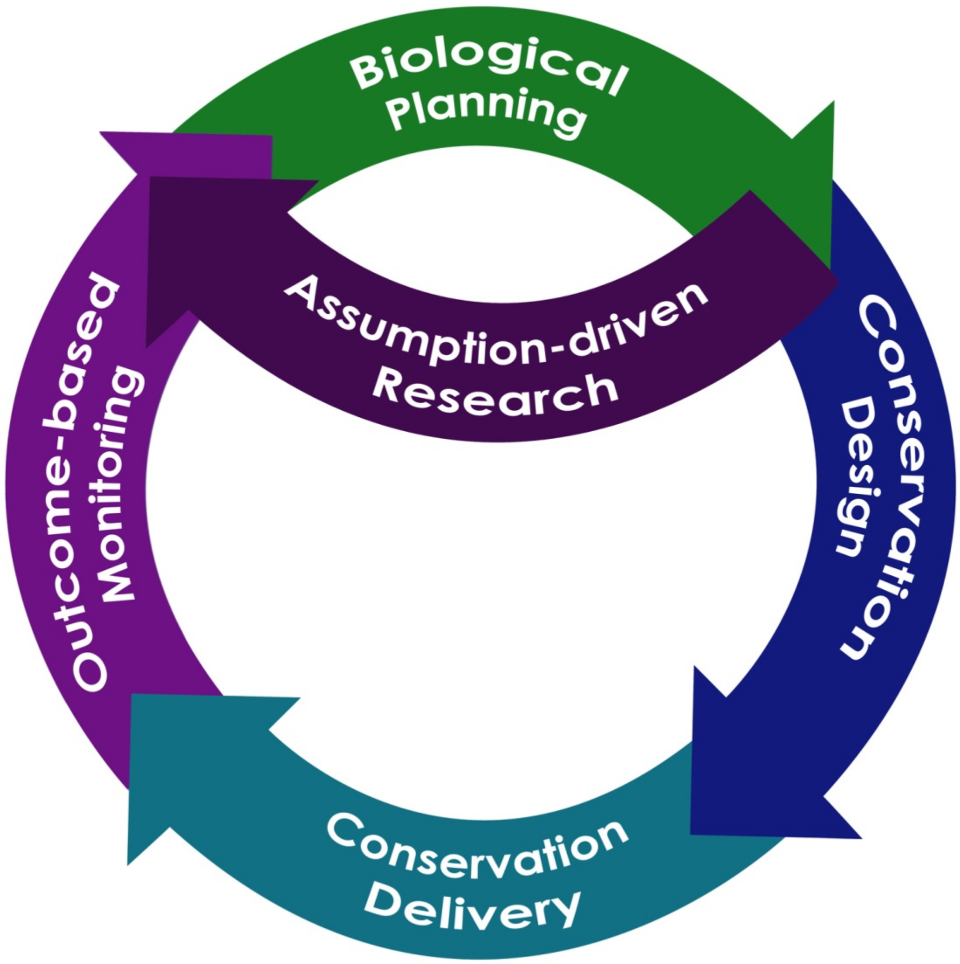


Figure 2. Diagram of the Strategic Habitat Conservation process used by the Gulf Coast Joint Venture to establish, implement, and iteratively refine habitat objectives and conservation actions for priority bird species.



Conservation actions and accomplishments of the GCJV are framed around the needs of priority species identified within each of four bird guilds – waterfowl, landbirds, shorebirds, and waterbirds. For each priority species, the GCJV uses biological models to articulate linkages among population objectives, ecological limiting factors, key habitats, and quantitative habitat objectives. Although developed using the best available science, biological models are often characterized by substantial data uncertainties and untested assumptions. The GCJV promotes targeted research and monitoring to fill critical data gaps, test model assumptions, evaluate impacts of conservation actions on bird populations, and iteratively refine population and habitat objectives for priority species. Four guild-specific technical working groups within the GCJV Monitoring, Evaluation, and Research Team (MERT) are responsible for helping to select priority species, develop and review biological models, and identify priority science needs for refining the biological foundations of population-based habitat objectives and conservation actions.

While some progress has been made in reducing biological uncertainties associated with landbird, shorebird, and waterbird planning in the GCJV region, there remain substantial data gaps, questions about the effectiveness of conservation strategies, and uncertainties about impacts of land-use and environmental changes on important bird habitats in the GCJV region. This document was developed to communicate and describe the list of priority science needs upon which further refinements to landbird, shorebird, and waterbird habitat conservation in the GCJV will depend.

Science needs herein are listed in decreasing order of relative priority, as determined by the GCJV Landbird, Shorebird, and Waterbird Working Groups. Although these science needs are presented as discrete issues, strong linkages and relationships exist among several of them. Thus, opportunities to address multiple needs or objectives through a single research project should be sought and encouraged. Efficiencies in the expenditure of scientific resources to address priority science needs may also be gained through collaborative efforts among multiple scientists or research institutions, and should be encouraged as well.

For each science need, the document provides a description of the problem statement, a discussion of considerations that should be addressed in formulating a study, key study objectives, the geographic scope within the GCJV region to which the issue applies, and a list of minimally expected deliverables. The research consideration section is intended to provide guidance on the development of research plans or study designs, as it highlights studies that have partially addressed a science need, suggests potentially valuable research methodologies, and/or identifies response variables or covariates that should be considered for measurement. However, the information presented for each science need should not be considered exhaustive; individuals interested in addressing any of these needs are strongly encouraged to contact the GCJV Coordinator or Bird Conservation Specialist for additional guidance regarding research needs, objectives, deliverables, and other important considerations.

The overarching purposes of this document are to 1) demonstrate that the GCJV recognizes critical assumptions and data gaps underlying its conservation planning, 2) influence the priorities of researchers and funding entities wishing to address bird-related questions with direct application to GCJV activities; and 3) guide the science investments of the GCJV office and partnership. This document does not present a comprehensive list of science needs for improving the efficiency and effectiveness of landbird, shorebird, and waterbird habitat conservation in the GCJV region. Rather, it is intended to outline the highest priority needs expected to exist over the next 5 years having direct feedback to GCJV activities. Recognizing that scientific research needs exist within a dynamic conservation environment, there is potential for emerging issues to demand a reassessment of GCJV science priorities over shorter time frames. If this occurs, the GCJV will seek guidance from the MERT on whether and how to supplement or reprioritize these science needs.

Prioritized List of Landbird, Shorebird and Waterbird Science Needs

1. Develop and validate a population-habitat model for Black Skimmer in the GCJV region

Problem Statement

Due to their conservation status (Kushlan et al. 2002, Hunter et al. 2006), the importance of the GCJV region to the North American population, and because they are believed to represent other species using similar habitats, Black Skimmer (*Rynchops niger*) are a priority species for the GCJV. Evidence exists that Black Skimmer populations have declined over much of their North American breeding range (Martin and Lester 1990, Gawlik et al. 1998, Michot et al. 2003, Hunter et al. 2006, Foster et al. 2009, Nisbet et al. 2013, Sauer et al. 2014). Primary causes for declines are believed to be related to lack of suitable nesting habitat, and thus hatching and fledging success, due to human disturbance (Schreiber and Schreiber 1978, Erwin 1990, Dinsmore 2008), habitat loss from erosion, subsidence and relative sea level rise (Erwin et al. 2003, 2010), overwash or flooding of nests (Owen and Pierce 2013, Brooks et al. 2014), predation (Erwin et al. 2001, Owen and Pierce 2013, Brooks et al. 2014, Furfey 2014), limited food availability (Erwin 1977, Gordon et al. 2000), and competition with other ground-nesting colonial waterbirds (Owen and Pierce 2013, Furfey 2014).

Using Hunter et al.'s (2006) recommendations as a guideline, the Waterbird Working Group of the GCJV MERT established draft population objectives for the species, but no spatially-explicit habitat objectives exist for the species at this time. The Waterbird Working Group, with modeling assistance from the U.S. Geological Survey (USGS) and in association with the U.S. Fish and Wildlife Service's Gulf Biological Objectives Group, has very recently embarked on an effort to model spatially explicit habitat needs for Black Skimmers using a Bayesian Network model informed by empirical data and expert opinion. The underlying assumption of this effort is that Black Skimmers are limited by suitable nesting habitat, and that suitable nesting habitat can be defined by a set of characteristics derived from available spatial data. Additionally, to halt declines, and potentially increase populations in the GCJV region, it will be necessary to identify the factor or factors above that are most strongly linked to poor nest success, and to identify, if possible, management measures required to mitigate those negative effects.

Research Considerations

The Waterbird Working Group of the GCJV MERT has assisted USGS modelers to develop an influence diagram depicting the most important parameters influencing Black Skimmer nesting in the Gulf of Mexico region, and have also assisted in obtaining colonial waterbird data detailing locations and numbers for Black Skimmer colonies. Some parameters identified by the Waterbird Working Group, such as frequency of island overwash resulting in habitat transition, have proven to be extremely difficult to model and have been eliminated from the modeling process. The modeling team is tasked with providing habitat objectives, by GCJV Initiative Area, in 2018.

Validation of the model could occur in multiple phases, wherein the first phase is expert review, and the second phase incorporates comparison to independent data. Due to the paucity of existing Black Skimmer data, all currently available data is being used to inform model development. New independent data is unlikely to be available during the tenure of this science needs document, so a thorough expert review will be critical. Expert review could involve scrutiny beyond the GCJV Waterbird Working Group to include such reviewers as researchers and habitat managers with experience working the species in the field within the GCJV region. Eventually (i.e., beyond the tenure of this ~5-year document), collection of new, independent data would be necessary to rigorously evaluate the model. Continued refinement of Unmanned Aerial Systems (UAS or drones) and other remote sensing platforms holds promise for generation of independent data necessary to accomplish such an evaluation.

The current model structure does not directly incorporate or predict measures of nest success. The current rationale of the modelling team is that breeding site selection over the long term is a reasonable proxy for parameters like nest success that may be proximate population drivers. Upon completion and validation of the model, the MERT will revisit the need and potential to directly incorporate nest success or other variables not currently in the model.

Key Objectives

a) Complete and validate the spatially explicit Bayesnet Black Skimmer nesting habitat model
b) Use the model to inform potential Black Skimmer habitat objectives for each GCJV Initiative Area
c) Use the model to assess the feasibility of meeting identified population objectives for each GCJV Initiative Area and to inform consideration of new population objectives as necessary

Geographic Scope of Work (GCJV Initiative Areas)

Science needs are relevant to all Initiative Areas. However, priority should be given to work conducted in the Texas Mid-Coast, Mississippi River Coastal Wetlands, and Laguna Madre Initiative Areas as data from the Texas Colonial Waterbird Survey and the Louisiana Natural Heritage Program indicate the species nests most abundantly in these portions of the GCJV region.

Deliverables

a) Spatially explicit quantified habitat objectives (and accompanying spatial data layers suitable for use in a Geographic Information Systems (GIS) environment) for Black Skimmer in each GCJV Initiative Area
b) Comprehensive report describing the spatially-explicit Bayesian Network model inputs, methods, analyses, outputs, and conclusions
c) Synthesis of expert reviewer comments and the degree to which those comments were incorporated in model refinement

Literature Cited

Brooks, G.L., F.J. Sanders, P.D. Gerard, and P.G.R. Jodice. 2014. Daily survival rate for nests of Black Skimmers from a core breeding area of the southeastern USA. The Wilson Journal of Ornithology 126(3):443-450.

Dinsmore, S.J. 2008. Black Skimmer nest survival in Mississippi. Waterbirds 31(1):24-29.

Erwin, R.M. 1977. Black Skimmer breeding ecology and behavior. Auk 94:709-717.

Erwin, R.M., B.R. Truitt, and J.E. Jimenez. 2001. Ground-nesting waterbirds and mammalian carnivores in the Virginia barrier island region: running out of options. Journal of Coastal Research 17:292-296.

Erwin, R.M., D.F. Brinker, B.D. Watts, G.R. Constanzo, and D.D. Morton. 2010. Islands at bay: rising seas, eroding islands, and waterbird habitat loss in Chesapeake Bay (USA). Journal of Coastal Conservation 15:51-60.

Erwin, R.M., D.H. Allen, and D. Jenkins. 2003. Created versus natural coastal islands: Atlantic waterbird population, habitat choices, and management implications. Estuaries 26:949-955.

Foster, C.R., A.F. Amos, and L.A. Fuiman. 2009. Trends in abundance of coastal birds and human activity on a Texas barrier island over three decades. Estuaries and Coasts 32:1079-1089.

Furfey, B.C. 2014. The reproductive and foraging ecology of Black Skimmers (*Rynchops* niger) on a barrier island refuge in coastal Lousiana. Masters Thesis, Arkansas State University. 120 pp.

Gawlik, D.E, R.D. Slack, J.A. Thomas, and D.N. Harpole. 1998. Long-term trends in population and community measures of colonial-nesting waterbirds in Galveston Bay Estuary. Colonial Waterbirds 21:143-151.

Gordon, C.A., D.A. Cristol, and R.A. Beck. 2000. Low reproductive success of Black Skimmers associated with low food availability. Waterbirds 23(3):468-474.

Hunter, W.C., Golder, W., Melvin, S., and J. Wheeler. 2006. Southeast United States regional waterbird conservation plan. Available at: http://www.waterbirdconservation.org/southeast_us.html

Kushlan, J.A., Steinkamp, M.J., Parsons, K.C., Capp, J., Cruz, M.A, Coulter, M., Davidson, I., Dickson, L., Edelson, N., Elliot, R., Erwin, R.M., Hatch, S., Kress, S., Milko, R., Miller, S., Mills, K., Paul, R., Phillips, R., Saliva, J.E., Sydeman, B., Trapp, J., Wheeler, J., and K. Wohl. 2002. Waterbird conservation for the Americas: the North American waterbird conservation plan, version 1. Waterbird Conservation for the Americas, Washington, D.C., 78 pp.

Martin, R.P. and G.D. Lester. 1990. Atlas and census of wading bird and seabird nesting colonies in Louisiana: 1990. Louisiana Department of Wildlife and Fisheries, Louisiana Natural Heritage Program. Special Publication No. 3.

Michot, T.C., C.W. Jeske, J.C. Mazourek, W.G. Vermillion, and R.S. Kemmerer. 2003. Atlas and census of wading bird and seabird nesting colonies in south Louisiana. Barataria-Terrebonne National Estuary Program Report No. 32. Thibodaux, Louisiana.

Nisbet, I.C.T., R.R. Veit, S.A. Auer, and T.P. White. 2013. Marine birds of the eastern United States and the Bay of Fundy. Nuttall Ornithological Monographs. Number 29, Cambridge, Massachusetts, USA.

Owen, T.M. and A.R. Pierce. 2013. Hatching success and nest site characteristics of Black Skimmer (*Rynchops* niger) on the Isles Dernieres Barrier Island Refuge, Louisiana. Waterbirds 36(3):342-347.

Sauer, J.R. J.E. Hines, J.E. Fallon, K.L. Pardiek, D.J. Ziolkowski, Jr., and W.A. Link. 2014. The North American breeding bird survey, results and analysis 1966-2013. Version 01.30.2015. USGS Patuxent Wildlife Research Center, Laurel, Maryland.

Schreiber, R.W. and E.A. Schreiber. 1978. Colonial bird use and plant succession on dredged material islands in Florida. Vol. 1. Sea and wading bird colonies. Tech. Rept. D-78-14. U.S. Army Eng. Exper. Station, Vicksburg, MS.

2. Validate population response of priority colonial nesting waterbirds (e.g., Black Skimmer, Gull-billed Tern, Reddish Egret and Little Blue Heron) to colony site management measures, including erosion control, dredged material placement, vegetation management, disturbance minimization and predator control

Problem Statement

Declines in population of colonial nesting waterbirds in North America and elsewhere have led to the development of numerous publications that recommend management actions to increase numbers of nesting birds, increase nesting or fledging success, or other parameters (Soots and Landin 1978, Hafner 1982, Landin 1986, Erwin 1989, Rodgers and Smith 1995, Rodgers and Smith 1997, Hafner 2000, Kushlan et al. 2002, Erwin et al. 2003, Chaney and Blacklock 2005, Hunter et al. 2006, Golder et al. 2008). Recommended management measures include the use of dredged material to create or augment nesting islands, predator control, vegetation establishment or removal, minimization of human disturbance, and erosion control at vulnerable sites. The GCJV has developed conservation plans for Reddish Egret (*Egretta rufescens*) and Little Blue Heron (*Egretta caerulea*), and will develop similar plans for Black Skimmer and Gull-billed Tern (*Gelochelidon nilotica*). The existing plans provide site-specific management recommendations for colonies, and in some cases a population response has been estimated in terms of either an increase in nesting pairs, or in terms of preventing a predicted decrease under a no-action scenario. There is a need for research that more accurately ties management actions to abundance or vital rate-based population targets. Additionally, it is possible that existing management prescriptions could be refined to produce better responses from colonial nesting bird species through research.

Research Considerations

Soots and Landin (1978), Landin (1986), and Golder et al. (2008) describe colonial waterbird nesting island creation and management measures and provide some predicted responses in terms of use by guild (e.g. bare-ground nesters, herbaceous vegetation nesters, shrub-tree nesters). However, management prescriptions from those documents may not be appropriate for the Gulf of Mexico. Leberg et al. (1995) noted that dredge material island vegetation succession time-span estimates from research in North Carolina (Soots and Parnell 1975) were not applicable to the Atchafalaya Delta, Louisiana. Soots and Parnell (1975) found that North Carolina dredged material island sites were used four to seven years post-creation, while Leberg et al. (1995) found that Atchafalaya Delta created sites were typically only used during the first breeding season post-creation, due to rapid vegetation growth. Additionally, a range of climatic conditions exist in the GCJV region, such that vegetation succession rates on dredged material islands vary across the region (Chaney et al. 1978). Mallach and Leberg (1999) supplemented sand-silt dredged material substrate with shell on created bird nesting islands in the Atchafalaya Delta, Louisiana. Vegetation densities and cover were higher on sand-silt substrates versus areas supplemented with shell after two growing seasons but not after only one growing season. Additionally, the average proportion of eggs hatched on shell substrate was higher than sand-silt substrates, but the proportion of nests that hatched at least one egg was not different between substrates. Also, human observers took longer to locate Black Skimmers and Gull-billed Tern nests on shell substrates versus sand-silt substrates (Mallach and Leberg 1999). Similarly, scientists with the

Barataria-Terrebonne National Estuary Program are planning to experimentally supplement deposited dredged material with limestone near Port Fourchon, Louisiana, and measure abiotic parameters such as substrate temperature, along with the response of nesting Least Terns (*Sternula antillarum*), Common Nighthawks (*Chordeiles minor*), Wilson's Plovers (*Charardrius wilsonia*) and other beach-nesting birds (Emily Clarke, Barataria-Terrebonne National Estuary Program, personal communication).

Coté and Sutherland (1997) analyzed the results of twenty published studies involving predator removal to benefit target bird species. They found that most programs had a positive effect on hatching success and post-breeding, fall population sizes, but that overall increases in target bird species breeding populations were less predictable. Martin et al. (2010) modeled the level of raccoon (*Procyon lotor*) control that would be necessary to recover a population of American Oystercatchers (*Haematopus palliatus*) on the Outer Banks barrier island system in North Carolina while minimizing the number of raccoons removed. Their model indicated that the age of raccoons removed was important due to reproductive potential, as was the rate at which raccoons were removed (e.g., removing more raccoons initially reduced the overall number needed removed in order to reach oystercatcher productivity goals). Their model also indicated that if a minimum number of raccoons were not removed annually, there was the risk of the site functioning as a population sink for oystercatchers.

Carney and Sydeman (1999) published a review of research related to disturbance effects on colonial nesting waterbirds. Much of the research they investigated focused on researcher-generated disturbance, and most studies found negative impacts, but some provided recommendations for minimizing research-oriented disturbance. While human disturbance unassociated with research (e.g., recreation, wildlife viewing, timber harvest, aircraft or boat traffic, etc.) is believed to be a significant problem in some areas, Carney and Sydeman found fewer studies that quantified its effects. However, guidelines for minimizing disturbance to colonial waterbirds, such as recommended colony buffer distances, have been developed to in an effort to mitigate non-research human disturbance (Erwin 1989, Martin and Lester 1990, Rodgers and Smith 1995). Seemingly few studies have attempted to quantify the benefits of reducing human disturbance through management actions. Braby et al. (2001) measured nesting density, hatching success, and vehicular passes at a colony of Damara Terns (*Sterna balaenarum*) before and after erection of informational signage and vehicular barriers, and found that nesting density increased slightly, and hatching success increased from 56% to 80% with disturbance management measures. Similarly, Williams et al. (2004) detected increases in bird abundance, numbers of breeding pairs, and breeding productivity in five colonial waterbird species following a ban on off-road vehicle use on South African beaches.

Key Objectives

a) Estimate GCJV priority colonial nesting waterbird species (e.g. Reddish Egret, Little Blue Heron, Gull-billed Tern and Black Skimmer) response, in terms of reproductive parameters such as nesting, hatching and fledging success, to management actions including dredged material deposition, erosion control measures, vegetation addition or removal, predator control, and human disturbance management

b) Develop management prescriptions for island and mainland waterbird nesting colony sites that are specific to conditions existing in Initiative Areas and that may differ across the GCJV region because of differences in biotic and abiotic conditions

Geographic Scope of Work (GCJV Initiative Areas)

This science need is relevant to all GCJV Initiative Areas. The GCJV Reddish Egret and Little Blue Heron conservation plans (Vermillion and Wilson 2009, Vermillion 2016) identify colonies and recommend management measures to maintain or increase abundance and productivity. The majority of Reddish Egret sites are in the Laguna Madre and Texas Mid-Coast Initiative Areas. The Chenier Plain and Mississippi River Coastal Wetlands Initiative Areas are identified as the most important Initiative Areas for nesting Little Blue Herons based on current monitoring information. The most important Initiative Areas, in terms of nesting abundance, for Black Skimmer and Gull-billed Tern, are the Laguna Madre, Texas Mid-Coast, and Mississippi River Coastal Wetlands.

Deliverables

a) Document describing a recommended suite of management options for colonial waterbird nesting sites, with an estimated response in terms of abundance or reproductive success parameters, specific to each GCJV Initiative Area, which includes, but is not limited to, specific recommendations relevant to:
    1. target island elevations during dredged material deposition
    2. erosion control measures
    3. desired vegetation structure and percent cover
    4. timetables for vegetation set-back as necessary
    5. predator density or damage thresholds which trigger control actions
    6. measures for estimating and controlling human disturbance.

Literature Cited

Braby, R.J., A. Shapira, and R.E. Simmons. 2001. Successful conservation measures and new breeding records for Damara Terns *Sterna baleanarum* in Namibia. Marine Ornithology 28:81-84.

Carney, K.M., and W.J. Sydeman. 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds 22(1):68-79.

Chaney, A. H. and G. W. Blacklock. 2005. Colonial waterbird and rookery island management plan. Coastal Bend Bays and Estuaries Program, Corpus Christi, TX. Available at: http://www.cbbep.org

Chaney, A.H., B.R. Chapman, J.P. Karges, D.A. Nelson, R.R. Schmidt, and L.C. Thebeau. 1978. Use of dredged material islands by colonial seabirds and wading-birds in Texas. Dredged Material Research Program Technical Report D-78-8. U.S. Army Engineers Waterways Experiment Station, Vicksburg MS. 317 pp.

Coté, I.M., and W.J. Sutherland. 1997. The effectiveness of removing predators to protect bird populations. Conservation Biology 11(2):395-405.

Erwin, R.M. 1989. Responses to human intruders by birds nesting in colonies: experimental results and management guidelines. Colonial Waterbirds 12:104-108.

Erwin, R.M., D.H. Allen, and D. Jenkins. 2003. Created versus natural coastal islands: Atlantic waterbird populations, habitat choices, and management implications. Estuaries 26(4A):949-955.

Golder W., D. Allen, S. Cameron, and T. Wilder. 2008. Dredged material as a tool for management of tern and skimmer nesting habitats. DOER Technical Notes Collection (ERDC TN-DOER-E24), Vicksburg, MS: U.S. Army Engineer Research and Development Center. http://el.erdc.usace.army.mil/dots/dorer/doer.html

Hafner, H. 1982. Creation of a breeding site for tree-nesting herons in the Camargue, France. Pages 216-220 *in* Manual of active wetland and waterfowl management (D. Scott, Ed.). IWRB, Slimbridge, UK.

Hafner, H. 2000. Heron nest site conservation. Pages 201-217 *in:* Heron Conservation (J.A. Kushlan and H. Hafner, Eds.). Academic Press, London.

Hunter, W.C., Golder, W., Melvin, S., and J. Wheeler. 2006. Southeast United States regional waterbird conservation plan. Available at: http://www.waterbirdconservation.org/southeast_us.html

Kushlan, J.A., Steinkamp, M.J., Parsons, K.C., Capp, J., Cruz, M.A, Coulter, M., Davidson, I., Dickson, L., Edelson, N., Elliot, R., Erwin, R.M., Hatch, S., Kress, S., Milko, R., Miller, S., Mills, K., Paul, R., Phillips, R., Saliva, J.E., Sydeman, B., Trapp, J., Wheeler, J., and K. Wohl. 2002. Waterbird conservation for the Americas: the North American waterbird conservation plan, version 1. Waterbird Conservation for the Americas, Washington, D.C., 78 pp.

Landin, M.C. 1986. Building, developing and managing dredged material islands for bird habitat. U.S. Army Engineer Waterways Experiment Station, Publication EEDP-07-1.

Leberg, P.L., P. Deshotels, S. Pius, and M. Carloss. 1995. Nest sites of seabirds on dredge islands in coastal Louisiana. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 49:356-366.

Mallach, T.J., and P.L. Leberg. 1999. Use of dredged material by nesting terns and Black Skimmers. Journal of Wildlife Management 63(1):137-146.

Martin, J., A.F. O'Connell, Jr., W.L. Kendall, M.C. Runge, T.R. Simons, A. H. Waldstein, S.A. Shulte, S.J. Converse, G.W. Smith, T. Pinion, M. Rikard, and E.F. Zipkin. 2010. Optimal control of native predators. Biological Conservation 143: 1751-1758.

Martin, R.P. and G.D. Lester. 1990. Atlas and census of wading bird and seabird nesting colonies in Louisiana: 1990. Louisiana Department of Wildlife and Fisheries, Louisiana Natural Heritage Program. Special Publication No. 3. Baton Rouge, LA. 182 pp.

Rodgers, J.A., Jr., and H.T. Smith. 1995. Set-back distances to protect nesting bird colonies from human disturbance in Florida. Conservation Biology 9:89-99.

Rodgers, J.A., Jr., and H.T. Smith. 1997. Buffer zone distances to protect foraging and loafing waterbirds from human disturbance in Florida. Wildlife Society Bulletin 25(1): 139-145.

Soots, R.F., and J.F. Parnell. 1975. Ecological succession of breeding birds in relation to plant succession on dredge islands in North Carolina. National Oceanic and Atmospheric Administration Sea Grant publication UNC-SG-75-27, Raleigh, NC. 142 pp.

Soots, R.F., Jr., and M.C. Landin. 1978. Development and management of avian habitat on dredged islands. Dredged Material Research Program, Technical Report DS-79-18, Office of the Chief of Engineers, Washington, D.C.

Vermillion, W.G. 2016. Gulf Coast Joint Venture Little Blue Heron conservation plan. Gulf Coast Joint Venture, Lafayette, LA. Retrieved from: http://www.gcjv.org/documents.php

Vermillion, W.G., and B.C. Wilson. 2009. Gulf Coast Joint Venture conservation planning for Reddish Egret. Gulf Coast Joint Venture, Lafayette, LA. Retrieved from: http://www.gcjv.org/documents.php

Williams, A.J., V.L. Ward, and L.G. Underhill. 2004. Waders respond quickly and positively to the banning of off-road vehicles from beaches in South Africa. Wader Study Group Bulletin 104:79-81.

3. Determine if Gulf Coast Snowy and Wilson's Plover breeding populations are more limited by adult survival or productivity; if productivity limits population, determine levels of reproductive success needed for population stability

Problem Statement

Gulf Coast Snowy Plover (*Charadrius nivosus*) and Wilson's Plover are classified as species of Greatest Concern in Andres' (2016) *Shorebirds of Conservation Concern – 2016 List*. This designation is due to those species' relatively small population sizes combined with breeding distribution and threats during the breeding and non-breeding season (Andres 2016). Both species are priorities for conservation planning in the GCJV region, however, the most important limiting factors for Gulf populations are not understood. Consequently, neither habitat-population models nor quantified habitat objectives have been developed. To be able to address potential population declines and to achieve population objectives, appropriate management actions need to be determined and implemented. However, this cannot be done without better knowledge of the factor or factors most influencing population growth in the GCJV region, and what vital rates parameters are required to meet population objectives.

Research Considerations

Sandercock (2003) maintained that adult survival had the greatest effect on rates of population change for shorebirds; similarly, Plissner and Haig (2000) found that a Piping Plover (*C. melodus*) population viability model was most sensitive to variation in adult survivorship. However, while a basic prospective elasticity analysis conducted by Sim et al. (2011) for a population of Ring Ouzels (*Turdus torquatus*) indicated the same, an integrated elasticity analysis which accounted for covariance of demographic factors pointed to early brood first-year survival as being the most important influence on rate of population change. However, analyses of this complexity require monitoring of all demographic rates over multiple years (Sim et al. 2011).

Considerable effort has been devoted to investigations of limiting factors for the federally-listed Pacific coast population of Snowy Plover, and to populations breeding in the interior U.S. In a population viability analysis conducted for the species recovery plan, a target of 1.2 to 1.3 young per male, an adult survival rate of 76% and a juvenile survival rate of 50% was calculated necessary to moderately grow the Pacific coast population over 25 years (U.S. Fish and Wildlife Service 2007). The majority of management recommended and undertaken for the Pacific coast population has focused on increasing productivity, through vegetation removal and control of predation and human disturbance, despite the importance of adult survival to population change (U.S. Fish and Wildlife Service 2007, Mullin et al. 2010). This is in part due to the difficulties in altering adult survival through management actions, particularly during the non-breeding season (Mullin et al. 2010, Saalfeld et al. 2013).

A study of breeding Snowy Plovers at Mono Lake, California indicated that predation on clutches and broods was the major limiting factor on the population (Page et al. 1983). The authors stressed the importance of low nesting densities as an anti-predation adaptation. They calculated that a recruitment rate of 0.8 young per female per year was needed for population maintenance. Females in the study population approached that rate through production of second broods. There was no evidence that available nesting or feeding habitat was limiting the Mono Lake birds.

Mullin et al. (2010) studied a population of Snowy Plovers in northern California, and determined that the area was a population sink, dependent on immigration of individuals from other populations. They found that apparent survival of males on their study site was greater than that of females, and that apparent adult survival was greater than juvenile. Growth estimates for the studied population were lower than other coastal California populations, both before and after those other populations had predator control measures implemented. This suggested that management actions to improve low productivity should be implemented on the study site, but the authors cautioned that low adult and juvenile survival could compromise the effects of productivity enhancement measures.

Saalfeld et al. (2011) studied Snowy Plovers in the Texas high plains, comparing data from 1998-1999 with those from 2008-2009. They found mean nest success declined 31% over that time span and attributed the decline to increased predation rates, decreased hydrological integrity, and habitat alterations. In a related study, Saalfeld et al. (2013) found apparent adult survival decreased from 0.77 in 1999-2000 to 0.65 in 2008-2010, and apparent juvenile survival decreased from 0.22 to 0.12 over the same time period. They estimated that it would require a recruitment rate of 5.8 hatchlings per adult to maintain a stable population in absence of immigration. This is likely untenable given the species' clutch size and re-nesting behavior. In the 2013 paper the authors also noted a dramatic decline in adults at one surveyed area between 2007-2008 and opined that the decline may have been due to impacts of four hurricanes that came ashore in the species' wintering area.

Far fewer studies have looked at Wilson's Plover demographic parameters. Hood and Dinsmore (2006) modeled nest survival over the estimated 25-day incubation period and derived a predicted probability of 0.58. In 2003 and 2004, Zdravkovic (2013) recorded hatching success rates ranging from 55-79% in Texas. In Louisiana, during 2007, rates ranged from 50-76% (Zdravkovic 2013). There are a relatively small number of studies providing estimates of Wilson's Plover fledging success. Zdravkovic (2013) compiled estimates of 0.68 young per pair in El Salvador in 2008, 0.88 to 1.0 young per pair in North Carolina in 2008 and 2009, respectively, 1.0 young per pair in Louisiana in 2009, and 1.62 to 1.88 young per pair in Virginia in 2006 and 2007, respectively.

DeRose-Wilson et al. (2013) studied Wilson's Plovers in North Carolina and calculated an apparent adult survival rate of 77% and an apparent 42% survival rate for birds banded as chicks. Breeding pairs produced 0.78 fledglings per pair during the study period. The authors did not determine whether the study populations were decreasing or stable and cited the need to calculate productivity rates needed for population maintenance. They suggested predator removal and protection of sparsely vegetated overwash habitats as key management actions to increase reproductive output.

Key Objectives

a) Determine whether adult survival or productivity is primarily limiting Snowy and Wilson's Plovers in the GCJV region

b) If productivity is the primary factor limiting Snowy and Wilson's Plover's populations in the GCJV region, determine levels of productivity needed for achieving population objectives for the region
c) Determine the most efficacious management tools to increase productivity or adult survival

Geographic Scope of Work (GCJV Initiative Areas)

This work is relevant to the entirety of the GCJV region; however, the highest priority areas are the Laguna Madre Initiative Area, which currently hosts the highest number of breeding Snowy Plovers (Zdravkovic and Hecker 2004, Zdravkovic and Hecker 2006, Thomas et al. 2012) and the second highest number of breeding Wilson's Plover in the region, and the Mississippi River Coastal Wetlands Initiative Area, which currently hosts the highest number of breeding Wilson's Plovers in the region (Zdravkovic 2013).

Deliverables

a) Comprehensive report documenting methods, analyses, results, conclusion, and relevant recommendations, to include:
    1. A determination of whether adult survival or productivity is most limiting population growth in the GCJV region
    2. If productivity is limiting populations, or if adult survival cannot be effectively addressed through management actions, identification of levels of productivity needed to maintain, and increase population to target levels
    3. Identification of appropriate management techniques to increase productivity or adult survival

Literature Cited

Andres, B.A. 2016. Shorebirds of conservation concern - 2016. Available at: http://www.shorebirdplan.org/wp-content/uploads/2016/08/Shorebirds-Conservation-Concern-2016.pdf

DeRose-Wilson, A., J.D. Fraser, S.M. Karpanty, and D.H. Catlin. 2013. Nest-site selection and demography of Wilson's Plovers on a North Carolina barrier island. Journal of Field Ornithology 84(4):329-344.

Hood, S.L. and S.J. Dinsmore. 2006. The influence of habitat on nest survival of Snowy and Wilson's Plovers in the lower Laguna Madre region of Texas. *In* Jones, S.L. and G.R. Guepel, Eds. Studies in Avian Biology 34:124-135.

Mullin, S.M., M.A. Colwell, S.E. McAllister, and S.J. Dinsmore. 2010. Apparent survival and population growth of Snowy Plovers in coastal northern California. Journal of Wildlife Management 74(8):1792-1798.

Page, G.W., L.E. Stenzel, D.W. Winkler, and C.W. Swarth. 1983. Spacing out at Mono Lake: breeding success, nest density, and predation in the Snowy Plover. Auk 100:13-24.

Plissner, J. H., and S. M. Haig. 2000. Viability of piping plover *Charadrius melodus* metapopulations. Biological Conservation 92:163–173.

Saalfeld, S.T., W.C. Conway, D.A. Haukos, and W.P. Johnson. 2011. Nest success of Snowy Plovers (*Charadrius nivosus*) in the southern high plains of Texas. Waterbirds 34(4):389-520.

Saalfeld, S.T., W.C. Conway, D.A. Haukos, and W.P. Johnson. 2013. Recent declines in apparent survival and survey counts of Snowy Plovers breeding in the southern high plains of Texas. The Wilson Journal of Ornithology 125(1):79-87.

Sandercock, B. K. 2003. Estimation of survival rates for wader populations: a review of mark–recapture methods. Wader Study Group Bulletin 100:163–173.

Sim, I.M.W., G.W. Rebecca, S.C. Ludwig, M.C. Grant, and J.M. Reid. 2011. Characterizing demographic variation and contributions to population growth rate in a declining population. Journal of Animal Ecology 80:159-170.

Thomas, S.M., J.E. Lyons, B.A. Andres, E. Elliott-Smith, E. Palacios, J.F. Cavitt, J.A. Royle, S.D. Fellows, K. Maty, W.H. Howe, E. Mellink, S. Melvin, and T. Zimmerman. 2012. Population size of Snowy Plovers breeding in North America. Waterbirds 35(1):1-14.

United States Fish and Wildlife Service [USFWS]. 2007. Western snowy plover (*Charadrius alexandrinus nivosus*) Pacific coast population recovery plan. USFWS, Portland, Oregon, USA.

Zdravkovic, M.G. 2013. Conservation plan for the Wilson's Plover (*Charadrius wilsonia*) Version 1.0. Manomet Center for Conservation Sciences, Manomet, Massachusetts, USA.

Zdravkovic, M., and S. Hecker. 2004. 2004 coastal Texas breeding Snowy and Wilson's Plover census and report. Unpublished report. National Audubon Society Coastal Bird Conservation Program. 41 pp.

Zdravkovic, M., and S. Hecker. 2006. 2005 beach-nesting bird census and report for coastal Mississippi, Louisiana, and Texas. Unpublished report. National Audubon Society Coastal Bird Conservation Program. 45 pp.

4. Improve estimates of carrying capacity/prey density of shorebird habitat in marsh ponds, tidal flats, delta splays, grasslands, beaches, agricultural fields, moist-soil units and other important foraging habitats, and determine how prey base availability is affected by cultivation practices, management, chemical amendments and other human activities

Problem Statement

The GCJV selected a suite of priority shorebirds for conservation planning and habitat implementation. Using the U.S. Shorebird Conservation Plan (USSCP; Brown et al. 2001) population estimates and objectives, and an unpublished document by Hunter (2007) as guidance, the GCJV Shorebird Working Group stepped down USSCP population estimates and objectives to the level of individual GCJV Initiative Areas. Informed by Hunter (2007) the GCJV Shorebird Working Group allocated shorebird objectives by three habitat types: 1) beach-inlet; 2) intertidal, and 3) managed and all inland wetlands, agriculture, and grasslands. The GCJV utilized an energetic model to set habitat objectives for the third habitat category above. The model used a representative prey species, an average prey density, estimated shorebird turnover time, and information regarding the amount of prey needed to sustain shorebird migration to calculate the area of inland/managed shorebird habitat (such as flooded or saturated agricultural fields) to sustain shorebird population objectives. The GCJV plans to develop habitat objectives for other important shorebird habitats in the region, such as beaches, estuarine mudflats, marsh ponds, and grasslands, and is considering using a similar energetic-based approach. Estimates of prey densities in these habitats are limited and mostly obtained from areas outside the Gulf of Mexico. There is a need for a better understanding of prey densities and energy content (e.g. usable calories for shorebirds) in various important shorebird habitats throughout the GCJV region. Additionally, there is a need to refine the prey density and energy content estimates used in the existing inland/managed shorebird habitat model, and to assess how various management actions, both in inland/managed habitats and in other habitats, affect prey densities and availability. These management activities include, but are not limited to, tillage practices, chemical inputs, water level manipulations, prescribed fire, beach grooming, and off-road vehicle use. Also, the existing literature on whether or not shorebirds significantly deplete invertebrate prey resources is not conclusive, and has not been examined in the GCJV region.

Research Considerations

Numerous studies have sampled benthic, water column, and surface-dwelling organisms as part of projects aimed at shorebird habitat assessment (Weber and Haig 1996, Anderson and Smith 2000, Collazo et al. 2002, Placyk and Harrington 2004, Lyons and Collazo 2006, Taft and Haig 2006) with a relatively small subset taking place in the GCJV Region (Thebeau et al. 1981, Rocha and Tunnell 1995, Engelhard and Withers 1997, McLelland 2013). At least two additional projects are underway or have been recently completed in the GCJV region; both are examining the impacts of dredged material placement on shorebird use and shorebird prey (Jessica Peacock, U.S. Geological Survey, personal communication; Abigail Arfman, McNeese State University, personal communication). Ideally, the GCJV would like to be able to assess shorebird prey density and carrying capacity at the level of GCJV Initiative Areas, but it may be necessary to subsample within Initiative Areas to account for differences in sediment type, grain size, wave energy, etc. Studies of shorebird prey densities in estuarine and palustrine marsh habitats appear to be limited.

Some studies have paired assessments of invertebrate densities, abundance, or availability with management activities. Weber and Haig (1996), Brusati et al. (2001), Bolduc (2002) and Fitzsimmons et al. (2009) made general comparisons of invertebrate and waterbird density, abundance and diversity in managed versus unmanaged coastal wetlands, with Bolduc's study taking place in southwestern Louisiana, and Brusati et al.'s and Fitzsimmons' occurring in coastal Texas. Collazo et al. (2002) assessed availability based on water levels in impoundments in the southeastern Atlantic region. Englehard and Withers (1997) examined the impacts of beach raking on benthic and surface dwelling invertebrates. Anderson and Smith (2000) compared invertebrate density and biomass of managed and unmanaged playas, with the primary management driver being length of hydroperiod. Sherfy (1999) compared invertebrate production in disced versus un-disced moist-soil impoundments along the Atlantic coast, and found higher Chironomid larva abundance in disced areas in spring, and higher Amphipod and non-Chironomid Dipteran larva during fall.

Yates et al. (1993) used sediment particle size, based on its effects on invertebrate prey densities, to predict shorebird densities. Wade and Hickey (2008) used satellite imagery, verified with field data, to predict grain size and benthic invertebrate distributions and identify important migratory bird feeding areas on tidal mudflats in Australia.

Investigations into prey depletion by shorebirds have provided somewhat mixed results. Schneider and Harrington (1981) looked at prey depletion by migrant shorebirds on tidal flats near Plymouth, Massachusetts. Using exclosures, they determined that prey densities declined due to shorebird predation. Ashley et al. (2000) conducted exclosure experiments at a created wetland in Nevada, and found that while abundances of American Avocet *(Recurvirostra americana)*, Wilson's Phalarope *(Phalaropus tricolor)*, and Cinnamon Teal *(Anas cyanoptera)* were correlated with Chironomid and Dipteran densities, there was no significant effect on invertebrate densities through avian predation. Similarly, results of an exclosure study conducted by Mitchell and Grubaugh (2005) at five National Wildlife Refuges in the lower Mississippi alluvial valley suggested that shorebirds do not have a significant impact on invertebrate prey densities during southern migration. However, on one of their sampling dates, there was a significant reduction in Chironomid larvae, but that insect was neither the most abundant invertebrate present nor did it comprise the highest biomass.

The contribution of surficial biofilm to estimates of carrying capacity is likely important for GCJV priority species Western Sandpiper (*Caladris mauri*) and certain other shorebird species (Elner et al. 2005, Kuwae et al. 2012).

Common methods to assess invertebrate densities in wetlands include the use of sediment cores for benthic organisms and nets for water column organisms. Cores are often taken to a depth of 10 centimeters (cm), however, Sherfy et al. (2000) argued that a depth of 5 cm was sufficient for use in shorebird food availability studies. Behney et al. (2014) simulated core sampling in a GIS environment with randomly distributed and clumped virtual prey items of varying abundances and determined that taking more small diameter cores was always more time efficient that taking fewer large diameter samples. They presented information for researchers to derive optimal core sample sizes depending on research goals and site conditions.

In addition to determining potential energy content of various shorebird habitats in the GCJV region, additional information is needed to determine availability of invertebrate prey items and how human activities, water depth, predation, patch size and other factors influence availability. Plasma metabolite profiling may be useful in validating shorebird habitat value and availability (Guglielmo et al. 2004).

Key Objectives

a) Determine shorebird carrying capacity/prey density in important GCJV shorebird habitats, in each GCJV Initiative Area, including beaches, marine and estuarine wind- or tidally-exposed flats, palustrine and estuarine marsh ponds, natural and anthropogenic grasslands, sod farms, rice fields, crawfish (*Procambarus sp.*) ponds, other agricultural areas utilized by shorebirds, and moist-soil impoundments
b) Quantify the effects of management actions on shorebird carrying capacity/prey density on the important shorebird habitats referenced above
c) Determine the availability of habitat identified as potentially meeting energy requirements for priority GCJV shorebirds

Geographic Scope of Work (GCJV Initiative Areas)

This work is relevant to all GCJV Initiative Areas, though some habitats are more important to shorebird than others in specific Initiative Areas.

Deliverables

a) Comprehensive report documenting methods, analyses, results, conclusion, and relevant recommendations, to include estimates of potential shorebird energy content per unit area in grams per square meter for important shorebird habitats, by Initiative Area

Literature Cited

Anderson, J.T., and L.M. Smith. 2000. Invertebrate response to moist-soil management of playa wetlands. Ecological Applications 10(2):550-558.

Behney, A.C., R. O'Shaughnessy, M.W. Eicholz, and J.D. Stafford. 2014. Influence of item distribution pattern and abundance on efficiency of benthic core sampling.

Bolduc, Francois. 2002. Effects of structural marsh management and salinity on sediments, hydrology, invertebrates, and waterbirds in marsh ponds during winter on the Gulf coast Chenier Plain. Ph.D. Dissertation. Louisiana State University. 148 pp.

Brown, S., C. Hickey, B. Harrington, and R.Gill, eds. 2001. The U.S. Shorebird Conservation Plan, 2nd ed. Manomet Center for Conservation Sciences, Manomet, MA.

Brusati, E.D., P.J. DuBowy, and T.E. Lacher, Jr. 2001. Comparing ecological functions of natural and created wetlands for shorebirds in Texas. Waterbirds 24(3): 371-380.

Collazo, J.A., D.A. O'Harra, and C.A. Kelly. 2002. Accessible habitat for shorebirds: factors influencing its availability and conservation implications. Waterbirds 25 (Special Publication 2):13-24.

Elner, R.W., P.G. Beninger, D.L. Jackson, and T.M. Potter. 2005. Evidence of a new feeding mode in western sandpiper (*Calidris mauri*) and dunlin (*Caladris alpina*) based on bill and tongue morphology and ultrastructure. Marine Biology 146:1223-1234.

Engelhard, T.K., and K. Withers. 1997. Biological effects of mechanical beach raking in the upper intertidal zone on Padre Island National Seashore, Texas. Texas A&M University-Corpus Christi, Center for Coastal Studies. TAMU-CC-9706-CCS.

Fitzsimmons, O.N., B.M. Ballard, M.T. Merendino, and K.M. Hartke. 2009. The ecological implications of marsh management to wetland birds. Unpublished report. Texas Parks and Wildlife Department. 38 pp.

Guglielmo, C.G., D.J. Cerasale, and C. Eldermire. 2005. A field validation of plasma metabolite profiling to assess refueling performance of migratory birds. Physiological and Biochemical Zoology 78(1):116-125.

Hunter, W.C. 2007. Shorebird estimated populations for planning regions in the southeast U.S. Unpublished document. U.S. Fish and Wildlife Service, Atlanta, GA.

Kuwae, T., E. Miyoshi, S. Hosokawa, K. Ichimi, J. Hosoya, T. Amano, T. Moriya, M. Kondoh, R.C. Ydenberg, and R.W. Elner. 2012. Variable and complex food web structures revealed by exploring missing trophic links between birds and biofilm. Ecology Letters 15:347-356.

Lyons, J.E., and J.A. Collazo. 2006. Verifying assumptions underlying shorebird conservation in the southeastern USA and the Caribbean. Unpublished report. Species at Risk Program, U.S. Geological Survey and U.S. Fish and Wildlife Service. 29 pp.

McLelland, J.A. 2013. Caminada headland beach and dune restoration project (BA-45) – pre-construction benthic organism survey. Unpublished report. Louisiana Universities Marine Consortium, Barataria-Terrebonne National Estuary Program. 17 pp.

Placyk, J.S., Jr., and B.A. Harrington. 2004. Prey abundance and habitat use by migratory shorebirds at coastal stopover sites in Connecticut. Journal of Field Ornithology 75(3):223-231.

Rocha, D.D., and J.W. Tunnell, Jr. 1995. Composition and distribution of the gulf beach benthic invertebrates at Padre Island National Seashore. Texas A&M University-Corpus Christi, Center for Coastal Studies. TAMU-CC-95-03-CCS.

Sherfy, M.H. 1999. Nutritional value and management of waterfowl and shorebird foods in Atlantic coastal moist-soil impoundments. Ph.D. dissertation. Virginia Polytechnic Institute and State University. 309 pp.

Sherfy, M.H., R.L. Kirkpatrick, and K.D. Richkus. 2000. Benthos core sampling and chironomid vertical distribution: implications for assessing shorebird food availability. Wildlife Society Bulletin 28(1):124-130.

Taft, O.W., and S.M.Haig. 2006. Landscape context mediates influence of local food abundance on wetland use by wintering shorebirds in an agricultural valley. Biological Conservation 128:298-307.

Thebeau, L.C., J.W. Tunnell, Jr., Q.R. Dokken, and M.F. Kindinger. 1981. Effects of the IXTOC I oil spill on the intertidal and subtidal infaunal populations along lower Texas coast barrier island beaches. International Oil Spill Conference Proceedings: March 1981, Vol. 1981, No. 1, pp. 467-475.

Wade, S., and R. Hickey. 2008. Mapping migratory wading bird feeding habitats using satellite imagery and field data, Eighty-Mile Beach, Western Australia. Journal of Coastal Research 24(3):759-770.

Weber, L.M., and S.M. Haig. 1996. Shorebird use of South Carolina managed and natural coastal wetlands. Journal of Wildlife Management 60(1):73-82.

Yates, M.G., J.D. Goss-Custard, S. McGrorty, K.H. Lakhani, S.E.A. Le V. Dit Durell, R.T. Clarke, W.E. Rispin, I. Moy, T. Yates, R.A. Plant, and A.J. Frost. 1993. Sediment characteristics, invertebrate densities and shorebird densities on the inner banks of the Wash. Journal of Applied Ecology 30(4):599-614.

5. Estimate seasonal survivorship rates for Seaside Sparrow, and the significance of winter survival and habitat needs in limiting GCJV populations

Problem Statement

Seaside Sparrow (*Ammodramus maritimus*) is a priority species for conservation planning in the GCJV region. The GCJV has developed a population objective and a population-habitat model which assumes that suitable breeding habitat is the main factor limiting population size. The model has been applied in a GIS environment to identify patches of estuarine intertidal marsh with the potential to support source populations (500 breeding pairs), and the GCJV has largely focused on conservation planning and habitat delivery for breeding Seaside Sparrow. In 2010, the GCJV funded a research project through University of Georgia and Mississippi State University (Cooper et al. 2014) that was directed at determining factors related to Seaside Sparrow breeding season densities, nest-site selection and nest success, and to determine factors affecting population persistence in the future. To predict population persistence, Cooper et al. conducted a population viability analysis (PVA) in which they used data collected in the field as part of their study, combined with published data from the Atlantic coast and southern Florida. Sensitivity analyses were performed to determine which demographic factors had the strongest influence on population viability.

Using the initial input values, the PVA predicted a 100% probability of extinction in 15 years, which was considered to be unrealistic. The two demographic parameters in the PVA with the most uncertainty were juvenile survival and adult female survival; both had strong effects on probability of extinction. The relationships between the two parameters were explored in the PVA. As female survivorship decreased, juvenile survival had to be increased to maintain probability of population persistence over a 100-year time span.

Annual survival probabilities derived from the literature and used in the PVA for females and juveniles were 45% and 10% respectively. Given that the population at Cooper et al.'s study site (the Grand Bay National Estuarine Research Reserve) (Grand Bay NERR) is persisting, either one or both of these parameters is incorrect. If female and juvenile survival rates are high enough to ensure persistence, a population is resistant to other parameter fluctuations, such as the number young produced per female, or the number of broods per year.

Overall the PVA proved to be of limited value in providing hard estimates of population persistence or extinction risk, but it did highlight important data gaps:

1. There is a lack of juvenile survival data, especially for the northern Gulf of Mexico
2. Field data collected as part of the study showed adult breeding season survival is high, so winter mortality seems to be a major driver in the studied population; there is no data on winter survival
3. Information is needed on catastrophes that affect adult survival, as adult survival has a much stronger influence on population persistence versus reproductive parameters

The existing GCJV population-habitat model based on breeding territories may not capture essential winter habitat needs. Field observations from the Grand Bay NERR indicate winter movements, but routes and destinations remain unknown. Birds equipped with radio transmitters during the breeding season were not located during the winter, despite searching approximately 90 miles east and west of the Grand Bay NERR, but some individuals returned to the study site (Mark Woodrey, Grand Bay NERR, personal communication). Additional information would allow a more careful assessment of whether winter habitat needs versus breeding habitat needs should form the basis for conservation planning to assess the most limiting factor for Seaside Sparrow in the GCJV region.

Research Considerations

Some methodology utilizing marking and tracking individuals will likely be needed to address questions regarding survivorship, winter habitat needs, and impacts of catastrophic events. Deployment of avian nanotags, monitored by static receiver towers may provide valuable information. This technology is currently being utilized on the Grand Bay NERR and other locations along the Gulf of Mexico. Other methods including deployment of conventional radio-tags and color marking or banding may prove useful as well. It may be necessary to obtain information on marked/tagged individuals as frequently as three times per week. Investigations on Seaside Sparrow genetics may aid in determining populations and distribution, which could guide management decisions as to whether the northern Gulf population should be managed as one or several discrete populations.

Key Objectives

a) Quantify seasonal survivorship rates for adult and juvenile Seaside Sparrow in the GCJV region
b) Incorporate seasonal survival rates into a population model that will elucidate the factor most limiting population growth
c) If winter survival is determined to be the primary factor limiting GCJV Seaside Sparrow populations, determine important locations, characteristics of, and management recommendations for winter Seaside Sparrow habitat that can be incorporated in a GIS modeling framework

Geographic Scope of Work (GCJV Initiative Areas)

Because Seaside Sparrows occur across the GCJV region, science needs are relevant to all Initiative Areas. However, the three Initiative Areas with the most potential Seaside Sparrow habitat (according to Enwright et al. 2015) are the Mississippi River Coastal Wetlands Initiative Area, the Texas Mid-Coast Initiative Area, and the Louisiana portion of the Chenier Plain Initiative Area.

Deliverables

a) Comprehensive report documenting methods, analyses, spatial data layers as appropriate, conclusions, and relevant recommendations

Literature Cited

Cooper, R.J., A.J. Lehmicke, and M.S. Woodrey. 2014. Testing habitat model assumptions for Seaside Sparrow (*Ammodramus maritimus*) in northern Gulf of Mexico tidal marsh: final report. Unpublished report provided to the Gulf Coast Joint Venture Office, Lafayette, LA. 81 pp.

Enwright, N.M., Hartley, S.B., Couvillion, B.R., Brasher, M.G., Visser, J.M., Mitchell, M.K., Ballard, B.M., Parr, M.W., and Wilson, B.C., 2015, Delineation of marsh types from Corpus Christi Bay, Texas, to Perdido Bay, Alabama, in 2010: U.S. Geological Survey Scientific Investigations Map 3336, 1 sheet, scale 1:750,000, http://dx.doi.org/10.3133/sim3336.

6. Assess effectiveness of marsh and beach creation through sediment deposition in providing habitat used by shorebirds with abundant prey

Problem Statement

The GCJV selected a set of priority shorebirds for conservation planning. Two species, Snowy and Wilson's Plover almost exclusively use beach and barrier island habitats. Most of the other GCJV priority shorebird species periodically use beach habitats and also use emergent marsh habitats. Beach nourishment and marsh creation via deposition of dredged material is a common management technique employed on the Gulf of Mexico coast. It is often assumed that restoration or creation of these wetland habitats will confer significant benefits to foraging and nesting shorebirds. However, existing studies of restored and created beach and marsh sites indicate a wide range of variability in benthic fauna recovery or immigration, ecosystem function, and use by shorebirds (Sacco et al. 1994, Simenstad and Thom 1996, Grippo et al. 2007, Wilber et al. 2009). Conservation planning for shorebirds and other wetland dependent birds would benefit from a better understanding of the benefits (e.g., available food energy, suitability as roosting, loafing, or nesting habitat) accrued from creation and restoration of beach and marsh habitats. Perhaps more importantly, wildlife managers and conservation planners would also benefit from identification of best management practices for beach and marsh restoration and creation so that these manipulated habitats more closely resemble natural habitats important to shorebirds over the shortest possible time frame.

Research Considerations

Assessing the effectiveness of marsh and beach creation and restoration from sediment deposition for shorebirds will likely consist of two main efforts: 1) assessing the availability of invertebrate prey items following management, and 2) assessing shorebird use of created habitats. Most existing studies have used sediment sampling to assess densities and community structure of invertebrate prey items (Sacco et al. 1994, Simenstad and Thom 1996, Wilber et al. 2009, Brusati et al. 2001). Methodology for assessing shorebird use has ranged from estimates of abundance (Simenstad and Thom 1996), species abundance and behavior (Brusati et al. 2001), species richness and diversity (Melvin and Webb 1998), and estimates of abundance, species richness, and behavior (Grippo et. al. 2007).

Wilber et al. (2009) compiled existing biological monitoring regarding beach nourishment impacts. In studies Wilber et al. reviewed, benthic recovery time after beach nourishment ranged from two weeks to two years. The authors opined that statistical approaches used to analyze data could affect determinations of benthic invertebrate recovery. They recommended the use of Before-After Control-Impact (BACI) monitoring designs to assess the magnitude and duration of biologically meaningful effects. Grippo et al. (2007) used a BACI design and transect based surveys to assess effects of a beach nourishment project on shorebird and waterbird abundance, species richness, and behavior. Though an independent study at the same site recorded a decrease in biomass and abundance of some invertebrates following beach nourishment, the authors found no significant difference in any bird parameters measured. They hypothesized that decreases in invertebrate biomass and abundance may not have been enough to illicit changed behavior in birds, or that naïve birds arriving on site during migration did not have time to learn whether prey was sufficiently available and therefore foraged at the same rates observed pre-project. Grippo et al. (2007) also noted that potential effects on bird fitness from reduced prey availability were not detectable using the study's methods.

Wilber et al. (2009) also provided best management recommendations to reduce impacts to, and speed recovery of, benthic organisms, such as avoiding placement of material on beaches during seasons of peak benthic organism larval recruitment (spring for the eastern U.S.), and matching deposited sediment as closely as possible to that present on the receiving beaches. Farrell et al. (2016) used Wilber et al. (2009) and other research to develop recommended beach nourishment strategies for American Oystercatchers which are likely applicable to the entire suite of shorebirds using beach habitats in the Gulf of Mexico.

Key Objectives

a) Assess the suitability of created and restored beach and marsh habitats for priority GCJV shorebirds by:
    1. Assessing density of known shorebird prey items in created, restored, and relatively unaltered habitats important to GCJV priority shorebirds
    2. Assessing use of these created and restored habitats by GCJV priority shorebirds and similar species
b) Develop best management practices to:
    1. Optimize the value of created and restored beach and marsh habitats
    2. Minimize negative impacts to invertebrate prey and the birds themselves

Geographic Scope of Work (GCJV Initiative Areas)

This work is relevant to the entire GCJV region.

Deliverables

a) Comprehensive report documenting methods, analyses, results, conclusion, and relevant recommendations, including:
    1. Estimates of shorebird prey densities at created, restored, and relatively unaltered sites known to be important to GCJV priority shorebirds
    2. Recommended best management practices for beach and marsh creation and restoration projects in order to maximize value to foraging, roosting and nesting priority shorebirds, and to minimize impacts to shorebird prey bases and roosting and nesting habitat

Literature Cited

Brusati, E.D., P.J. DuBowy, and T.E. Lacher, Jr. 2001. Comparing ecological functions of natural and created wetlands for shorebirds in Texas. Waterbirds 24(3):371-380.

Farrell, C., M. Korosy, and J. Wraithmell. 2016. The role of coastal engineering in American Oystercatcher conservation. Audubon Florida. 17 pp.

Grippo, M.A., S. Cooper, and A.G. Massey. 2007. Effect of beach replenishment projects on waterbird and shorebird communities. Journal of Coastal Research 23(5):1088-1096.

Melvin, S.L., and J.W. Webb, Jr. 1998. Differences in the avian communities of natural and created *Spartina alterniflora* salt marshes. Weltands 18(1):59-69.

Sacco, J.N., E.D. Seneca, and T.R. Wentworth. 1994. Infaunal community development of artificially estatblished salt marshes in North Carolina. Estuaries 17(2):489-500.

Simenstad, C.A., and R.M. Thom. 1996. Functional equivalency trajectories of the restored Gog-Le-Hi-Te estuarine wetland. Ecological Applications 6(1):38-56.

Wilber, D., D. Clarke, G. Ray, and R. Van Dolah. 2009. Lessons learned from biological monitoring of beach nourishment projects. Presented at the Western Dredging Association Twenty-ninth Annual Technical Conference, Tempe, AZ, pp. 262-274.

7. Survey Black Rail populations in the GCJV region and establish baseline data

Problem Statement

Black Rail (*Laterallus jamaicensis*) is a priority species for conservation planning for the GCJV. It is known to breed along the Texas coast, and migrates through and may overwinter or breed in other parts of the GCJV region. It is a very cryptic species that is more often heard versus seen.

In order to set habitat objectives for Black Rail in the GCJV region, a relatively accurate population estimate is needed. Existing population objectives for the species are largely expert opinion based. The Southeast U.S. Waterbird Regional Conservation Plan (Hunter et al. 2006) estimated that approximately 650 pairs were present in the Gulf Coastal Prairies physiographic region, which comprises the majority of the GCJV region. The Waterbird Working Group of the GCJV Monitoring, Research, and Evaluation Team expressed low confidence in this estimate.

In addition for the need for a more accurate population estimate, there is a need to better understand the spatial and temporal distribution of the species in the GCJV region. Status as an overwintering species is poorly understood, as is period of migration through the region. While a general idea of gross habitat requirements exists, additional information on habitat characteristics, home range, etc., would greatly benefit conservation planning for the species.

Research Considerations

Researchers from Texas State University – San Marcos are currently engaged in a Black Rail project that involves estimation of occupancy and abundance, incorporating detection probabilities, and development of a predictive habitat model using remotely sensed indices of wetness, elevation, etc. (Clay Green, Texas State University – San Marcos, personal communication). It is also hoped the research will establish a survey methodology that can be replicated across the Gulf Coast. For surveys, a combination of point counts employing call-playback (Conway 2011) and autonomous recording units (ARU) are being utilized.

There have been other secretive marsh birds surveys conducted in the GCJV region using call-playback that could provide some information on Black Rail status and distribution but detections have been limited (Mark Woodrey, Grand Bay NERR, personal communication; Michael Seymour, Louisiana Department of Wildlife and Fisheries, personal communication). The Louisiana Department of Wildlife and Fisheries has plans to begin a survey program for Black Rails utilizing ARU (Michael Seymour, Louisiana Department of Wildlife and Fisheries, personal communication).

Key Objectives

a) Derive an accurate Black Rail population estimate for the GCJV region
b) Develop a recommended survey methodology incorporating detection probabilities
c) Identify important habitat characteristics and priority areas for Black Rail conservation during breeding and non-breeding periods

Geographic Scope of Work (GCJV Initiative Areas)

This work is relevant to the entirety of the GCJV region, however, the highest priority areas for this work are the Texas Mid-Coast Initiative Area and the Texas portion of the Chenier Plain Initiative Area, as those areas are known to host breeding Black Rail.

Deliverables

a) Comprehensive report documenting methods, analyses, results, conclusion, and relevant recommendations
b) Table providing Black Rail population estimates by GCJV Initiative Area during both breeding and non-breeding periods
c) Identification of priority sites for Black Rail by GCJV Initiative Areas, including spatial data layers suitable for use in a GIS environment
d) Recommended conservation strategies for the species

Literature Cited

Conway, C.J. 2011. Standardized North American marsh bird monitoring protocol. Waterbirds 34:319-346.

Hunter, W.C., W. Golder, S. Melvin, and J. Wheeler. 2006. Southeast United States regional waterbird conservation plan. Available at: http://www.waterbirdconservation.org/southeast_us.html

8. Develop and quantitatively assess best management practices for breeding Wilson's and Snowy Plovers in the GCJV region, including predator removal or exclusion and disturbance management

Problem Statement

Gulf Coast Snowy Plover and Wilson's Plover are classified as species of Greatest Concern in Andres' (2016) *Shorebirds of Conservation Concern – 2016 List*. This designation is due to those species' relatively small population sizes combined with breeding distribution and threats during the breeding and non-breeding season (Andres 2016). Both species are priorities for conservation planning in the GCJV. To be able to address potential population declines and to achieve population objectives, appropriate management actions need to be determined and implemented. Additionally, the development of habitat targets for management treatment would benefit from an estimation of population response to those treatments.

Research Considerations

Considerable effort has been devoted to management of the federally-listed Pacific coast population of Snowy Plover. The majority of management recommended and undertaken for the Pacific coast population has focused on increasing productivity, through vegetation removal and control of predation and human disturbance (U.S. Fish and Wildlife Service 2007). Appendix C of the recovery plan for the listed population documented current and needed management activities by discrete breeding and wintering sites (U.S. Fish and Wildlife Service 2007). The following management activities were included:

Restrict public access

Restrict boats

Contaminant (oil/tarball) removal

Seek landowner cooperation/cooperative agreement

Prohibit/restrict development

Restrict driftwood collection

Enforce protective rules/regulations

Enhance habitat through creation of ponds/playas for nesting/foraging

Use exclosures

Direct human use by symbolically fencing sensitive areas

Restrict horses

Public information and education

Restrict kites

Restrict livestock

Restrict military uses

Population monitoring during breeding and/or wintering seasons

Restrict off-highway vehicles

Restrict pets

Predator control (other than exclosures)

Use exclusionary signs

Plant and exotic vegetation control

Unknown

Mullin et al. (2010) studied a subset of the Pacific coast population and suggested management actions to increase fecundity, in part because measures aimed at increasing adult survival were more challenging. Neuman et al. (2004) found that hatching rate for Snowy Plovers at Monterey Bay, California, increased from 43% to 68% percent following intensive mammalian predator control and the use of nest exclosures. However, though fledging success initially increased at this site, (from 0.86 pre-treatment to 1.1 fledgling post-treatment per male) it decreased after avian predators learned to take chicks leaving exclosures (Neuman et al. 2004). Fledging success increased again at this site following live trapping and relocation of avian predators (U.S. Fish and Wildlife 2007). Setting up nest exclosures after peak movements of spring migrating raptors is believed to have reduced predation on chick and adults on the Pacific coast (U.S. Fish and Wildlife Service 2007). In other areas, exclosure use has been minimalized or curtailed due to concerns regarding their attractiveness to plover predators (U.S. Fish and Wildlife Service 2007). Appendix F of the Pacific coast Snowy Plover recovery plan lists protocols for the use of nest exclosures (U.S. Fish and Wildlife Service 2007).

Personnel at Point Reyes Bird Observatory were successful in reducing levels of human-induced chick and egg mortality through the use of symbolic fencing, seasonal closure to dog-walking, and active on-site education programs (U.S. Fish and Wildlife Service 2007). Symbolic fencing combined with a docent program is believed to have aided re-establishment of a breeding population of Snowy Plovers at Coal Oil Point Reserve, California (U.S. Fish and Wildlife Service 2007). Seasonal closures to vehicle use on beaches have been employed at multiple sites on the Pacific coast to reduce vehicle-induced mortality to nests and chicks (U.S. Fish and Wildlife Service 2007).

Removal of non-native and native mammalian predators by lethal and non-lethal means has been widely implemented in the Pacific Snowy Plover's range and is believed to have increased survival of clutches and broods (U.S. Fish and Wildlife Service 2007.) Reducing human access to beaches and prompt removal of garbage in areas where humans are allowed access may reduce mammalian predation pressure (U.S. Fish and Wildlife Service 2007). Electric fencing has been used in California to prevent mammalian predators from accessing Least Tern and Snowy Plover nesting sites (U.S. Fish and Wildlife Service 2007).

Control of European and American beachgrass (*Ammophila arenaria* and *A. breviligulata*) and other vegetation, through mechanical and/or chemical treatments, is a management tool used on the Pacific coast to successfully restore Snowy Plover nesting habitat (U.S. Fish and Wildlife Service 2007). Another habitat management tool recommended in the Pacific coast Snowy Plover recovery plan is deposition of dredged material to enhance or create nesting habitat (U.S. Fish and Wildlife Service 2007).

In the Western Hemispheric Shorebird Reserve Network Conservation Plan for the Wilson's Plover (Zdravkovic 2013), the author recommended the following management actions:

- Prohibit stabilization and alteration of coastal shorebird habitat, particularly on important barrier island sites
- Prohibit construction or re-construction of non-essential structures in coastal flood-zone areas
- Maintain overwash areas created by storm-events

- Create, enhance and restore beach-nesting bird habitat through deposition of dredged or mined material
- Prohibit recreational vehicle use on coastal habitat
- Restrict non-recreational vehicle use on coastal habitat e.g., sea-turtle monitoring vehicles, wildlife enforcement patrols, etc.)
- Limit human disturbance in breeding and non-breeding areas through symbolic fencing, pet restrictions, vehicle restrictions, access restriction, prohibition of beach raking, restrictions on beach furniture, etc.
- Use predator exclosures around nests where appropriate
- Actively enforce management and protection measures
- Employ public outreach and education.

DeRose-Wilson et al. (2013) studied Wilson's Plovers in North Carolina. The authors did not determine whether the study populations were decreasing or stable and cited the need to calculate productivity rates needed for population maintenance. They suggested predator removal and protection of sparsely vegetated overwash habitats as key management actions to increase reproductive output.

Key Objectives

a) Determine the most efficacious management tools to increase productivity or adult survival
b) Estimate a population response from application of preferred management options to facilitate development of acre-based treatment targets

Geographic Scope of Work (GCJV Initiative Areas)

This work is relevant to the entirety of the GCJV region; however, the highest priority areas are the Laguna Madre Initiative Area, which currently hosts the highest number of breeding Snowy Plovers (Zdravkovic and Hecker 2004, Zdravkovic and Hecker 2006, Thomas et al. 2012) and the second highest number of breeding Wilson's Plover in the region, and the Mississippi River Coastal Wetlands Initiative Area, which currently hosts the highest number of breeding Wilson's Plovers in the region (Zdravkovic 2013).

Deliverables

a) Comprehensive report documenting methods, analyses, results, conclusion, and relevant recommendations, to include:
    1. Identification of appropriate management techniques to increase productivity or adult survival
    2. Estimation of population response to identified management treatments and derivation of an acre-based target related to chosen treatments

Literature Cited

Andres, B.A. 2016. Shorebirds of conservation concern - 2016. Available at: http://www.shorebirdplan.org/wp-content/uploads/2016/08/Shorebirds-Conservation-Concern-2016.pdf

DeRose-Wilson, A., J.D. Fraser, S.M. Karpanty, and D.H. Catlin. 2013. Nest-site selection and demography of Wilson's Plovers on a North Carolina barrier island. Journal of Field Ornithology 84(4):329-344.

Mullin, S.M., M.A. Colwell, S.E. McAllister, and S.J. Dinsmore. 2010. Apparent survival and population growth of Snowy Plovers in coastal northern California. Journal of Wildlife Management 74(8):1792-1798.

Neuman, K.K., G.W. Page, L.E. Stenzel, J.C. Warriner, and J.S. Warriner. 2004. Effect of mammalian predator management on snowy plover breeding success. Waterbirds 27:257-263.

Thomas, S.M., J.E. Lyons, B.A. Andres, E. Elliott-Smith, E. Palacios, J.F. Cavitt, J.A. Royle, S.D. Fellows, K. Maty, W.H. Howe, E. Mellink, S. Melvin, and T. Zimmerman. 2012. Population size of Snowy Plovers breeding in North America. Waterbirds 35(1):1-14.

U.S. Fish and Wildlife Service [USFWS]. 2007. Western snowy plover (*Charadrius alexandrinus nivosus*) Pacific coast population recovery plan. USFWS, Portland, Oregon, USA.

Zdravkovic, M.G. 2013. Conservation plan for the Wilson's Plover (*Charadrius wilsonia*) Version 1.0. Manomet Center for Conservation Sciences, Manomet, Massachusetts, USA.

Zdravkovic, M., and S. Hecker. 2004. 2004 coastal Texas breeding Snowy and Wilson's Plover census and report. Unpublished report. National Audubon Society Coastal Bird Conservation Program. 41 pp.

Zdravkovic, M., and S. Hecker. 2006. 2005 beach-nesting bird census and report for coastal Mississippi, Louisiana, and Texas. Unpublished report. National Audubon Society Coastal Bird Conservation Program. 45 pp.

9. Simulate Seaside Sparrow population response to predicted habitat changes, such as projected sea level changes

Problem Statement

Seaside Sparrow is a priority species for conservation planning in the GCJV region that is dependent upon tidal saline-brackish marsh. Tidal marsh persistence in the northern Gulf of Mexico may be vulnerable to projected changes in sea level rise, precipitation, temperature, and tropical storm frequency and intensity (Woodrey et al. 2012). Additionally, human development in and adjacent to estuarine marsh may compromise its ecological functions. As a resident species in tidal saline-brackish marsh, the future persistence of Seaside Sparrow is linked to persistence of sufficient quantities of tidal saline-brackish marsh that possesses appropriate characteristics required by Seaside Sparrow (minimum contiguous patch size, vegetation composition, elevation, etc.).

The GCJV developed a habitat-population model for Seaside Sparrow that used an average male territory size of 4 ha (9 ac) (Werner and Woolfenden 1983) and a viable population size of 500 breeding pairs (Twedt et al. 1999). A block of approximately 4,047 ha (10,000 ac) is required to support 500 breeding pairs given this territory size. The GCJV identified potential Seaside Sparrow source population areas by analyzing 2001 National Land Cover Database (NLCD) data and denoting contiguous blocks of estuarine marsh 4,047 ha or greater in size. Within the tenure of this science needs plan, GCJV staff intend to use more recent land cover data and improved parameters for defining habitat contiguity to generate a revised iteration of potential Seaside Sparrow source population areas. To improve Seaside Sparrow conservation planning into the future, it would be valuable to predict future viability of identified habitat blocks, and to identify likely marsh migration patterns to discern where habitat is likely to occur if fresh to intermediate salinity marshes convert to brackish-saline marshes.

Research Considerations

Some predictive modeling of future habitat suitability for Seaside Sparrow in light of predicted changes has taken place in portions of the species' range (Rush et al. 2009, Kern and Shriver 2014). Rush et al. (2009) predicted changes in Seaside Sparrow and other marshbird species occupancy relative to habitat change, and noted that for most species, the directional effect of habitat change was not apparent until modeled changes exceeded 20% of existing conditions. Their results indicated that Seaside Sparrow occupancy could increase as fresh marsh and other habitats converted to brackish and salt marsh, but concurrent increases in human development could cancel out those habitat gains. Cooper et al. (2014) looked at variables influencing density of Seaside Sparrow at the Grand Bay National Estuarine Research Reserve (NERR), and found density was negatively correlated to salinity. The spatial scale of the two studies differed, however. Rush et al. looked at several sites across a range of salinities, while Cooper et al.'s study site was essentially all salt marsh, and birds selected for higher elevation sites which were less saline than other areas on the NERR.

Woodrey et al. (2012) identified priority research topics and general study approaches related to potential impacts of global climate change on Gulf of Mexico birds. Research topics included 1) sea level rise, 2) precipitation patterns, hydrologic regime, and fire, 3) temperature, 4) hurricane frequency and intensity, and 5) model development. One or more priority research need was identified for each research topic, and a general study approach was identified for each priority research need. Empirical field-based studies cited in Woodrey et al. (2012) which may be of value in addressing this GCJV landbird science need include Rush et al. (2010a), Rush et al. (2010b), and Bayard and Elphick (2011).

The Gulf Coast Prairie Landscape Conservation Cooperative (GCP LCC) funded a modeling effort for the entire U.S. Gulf of Mexico coast using Warren Pinnacle Consulting, Incorporated's Sea-Level Affecting Marshes Model (SLAMM) (Clough 2016). Part of the project used SLAMM model results to assess the impact of sea level rise on a set of GCP LCC focal species, including Seaside Sparrow. Trends for key habitat metrics through time and a range of sea level rise scenarios from 0.5 – 2.0 meters (m), were generally negative.

Enwright et al. (2016) modeled the potential for landward migration of tidal saline wetlands along the U.S. Gulf of Mexico coast under three sea level rise scenarios. They found that large areas (from approximately 13,800 square kilometers (km^2) under a 0.5 m rise to about 25,800 km^2 with a 2.0 m rise) were available for landward migration of tidal salt marsh. However, much of that migration was expected to be concentrated along certain coastlines where migration was not expected to be impeded by levees, urbanization, or natural elevation barriers.

Both aforementioned new spatial planning products could be used, in concert with a static depiction of habitat, to depict future habitats capable of sustaining seaside sparrow populations

Key Objectives

a) Assess the viability of potential Seaside Sparrow source population habitat blocks identified by GCJV staff
b) Identify areas likely to support sustainable Seaside Sparrow populations under future predicted climactic conditions and sea levels
c) Identify best management practices needed to maintain Seaside Sparrow habitat values at important marsh sites

Geographic Scope of Work (GCJV Initiative Areas)

Because Seaside Sparrow occur across the GCJV region, science needs are relevant to all Initiative Areas. However, the three Initiative Areas with the most potential Seaside Sparrow habitat (according to Enwright et al. 2015) are the Mississippi River Coastal Wetlands Initiative Area, the Texas Mid-Coast Initiative Area, and the Louisiana portion of the Chenier Plain Initiative Area.

Deliverables

a) Comprehensive report documenting methods, analyses, conclusions, and relevant recommendations for conservation actions or future research
b) Tables, figures, and maps , including spatial data layers suitable for use in a GIS environment, depicting habitat shifts under future alternative scenarios of climate change

c) Summary of best management practices needed to maintain Seaside Sparrow habitat values at important marsh sites

Literature Cited

Clough, J.S. 2016. Evaluation of regional SLAMM results to establish a consistent framework of data and models. Unpublished report prepared for the Gulf Coast Prairie Landscape Conservation Cooperative. Warren Pinnacle Consulting, Inc., Waitsfield, VT. Available at: https://gulfcoastprairielcc.org/science/science-projects/evaluating-sea-level-rise-modeling-for-the-gulf-of-mexico-coast/

Cooper, R.J., A.J. Lehmicke, and M.S. Woodrey. 2014. Testing habitat model assumptions for Seaside Sparrow (*Ammodramus maritimus*) in northern Gulf of Mexico tidal marsh: final report. Unpublished report provided to the Gulf Coast Joint Venture Office, Lafayette, LA. 81 pp.

Enwright, N.M., K.T. Griffith, and M.J. Osland. 2016. Barriers to and opportunities for landward migration of coastal wetlands with sea-level rise. Frontiers in Ecology and the Environment 14(6): 307-316.

Enwright, N.M., S.B Hartley, B.R. Couvillion, M.G. Brasher, J.M. Visser, M.K. Mitchell, B.M. Ballard, , M.W. Parr, and B.C., Wilson, 2015. Delineation of marsh types from Corpus Christi Bay, Texas, to Perdido Bay, Alabama, in 2010: U.S. Geological Survey Scientific Investigations Map 3336, 1 sheet, scale 1:750,000, http://dx.doi.org/10.3133/sim3336.

Kern, R.A. and W.G. Shriver. 2014. Sea level rise and prescribed fire management: implications for seaside sparrow population viability. Biological Conservation 173: 24-31.

Rush, S.A., E.C. Soehren, M.S. Woodrey, C.L. Graydon, and R.J. Cooper. 2009. Occupancy of select marsh birds within the northern Gulf of Mexico tidal range: current estimates and projected change. Wetlands 29: 798-808.

Rush, S.A., R. Mordecai, M.S. Woodrey, and R.J. Cooper. 2010a. Prey and habitat influences the movement of clapper rails in northern Gulf coast estuaries. Waterbirds 33: 389-396.

Rush, S.A., M.S. Woodrey, and R.J. Cooper. 2010b. Variation in nesting habits of clapper rails in tidal marshes of the northern Gulf of Mexico. Condor 112: 356-362.

Twedt, D., D. Pashley, C. Hunter, A. Mueller, C. Brown, and B. Ford. 1999. Partners in Flight conservation plan for the Mississippi alluvial valley. Available at http://www.partnersinflight.org/bcps/plan/MAV_plan.html

Werner, H.W and G.E. Woolfenden. 1983. The Cape Sable sparrow, its habitat, habits, and history. Pp. 55-75 *in* The Seaside Sparrow, its biology and management (T.L. Quay, J.B. Funderburg, Jr., D.S. Lee, E. F. Potter, and C.S. Robbins, eds.). Occas. Pap. North Carolina Biol. Surv., Raleigh, NC.

Woodrey, M.S, S.A. Rush, J.A. Cherry, B.L. Nuse, R.J. Cooper, and A.J. Lehmicke. 2012. Understanding the potential impacts of global climate change on marsh birds in the Gulf of Mexico region. Wetlands 32: 35-49.

10. Identify the habitat components of ideal forest landbird migration stopover habitat

Problem Statement

A significant portion of the populations of eastern U.S. forest-breeding, nearctic-neotropical migratory birds transit through the GCJV region in spring, fall, or both seasons. The region's forested habitats are therefore vital to sustaining or increasing populations of priority forest-breeding migrant birds. The GCJV Landbird Working Group chose a suite of migrant landbirds for conservation planning with the goal of representing critical components of landbird migration habitat. Efforts at qualifying and quantifying migrant landbird stopover habitat have been few. It is unclear to what extent en-route habitat is a limiting factor to nearctic-neotropical migrant populations. Current evidence suggests that the success of an individual migrant is dependent on several factors, primarily the energetic state of the migrant and the abundance and spatial configuration of stopover habitat (Moore and Simons 1992). Moore et al. (1995) concluded that spring migrants on the northern Gulf of Mexico coast preferentially select structurally diverse stopover sites which consist of forested areas with mixed shrub layers, and that maintenance of plant species and structural diversity should be a goal at migratory landbird stopover sites. Much of what is known about migrant use of stopover habitat is summarized below:

- Many migrants are known to be more plastic in their selection of stopover habitat than breeding or wintering habitat (Petit 2000)
- Some migrants select different stopover habitat based on age and sex (Woodrey 2000, Marra and Holmes 2001)
- Birds often use different habitat in spring and fall (Petit 2000)
- Migrants do not always use the same routes each season – there is much variability due to weather, barriers, and timing (Duncan et al. 2002); however, long-term patterns of migrant use along the Gulf of Mexico coast indicate that the vicinity of Longitude 95 degrees West receives consistent, high-use annually (Barrow et al. 2005, Gauthreaux et al. 2006)
- While birds make macro-decisions just prior to landfall (Buler et al. 2007), micro-decisions appear to be made after the bird has arrived at a site, and depend on food availability, competition, and presence of predators (Moore and Simons 1992)
- Species often select different habitat types at different locations along the migration route, but species do not randomly choose habitats (i.e., species are not distributed equitably across major habitat types during migration); migrating birds exhibit selective use of some habitats over others (Petit 2000)
- Habitat selected in migration may or may not be similar to breeding or wintering habitat (Petit 2000
- As intuitively expected, more complex habitats support increased bird species richness in migration (Moore et al. 1990)

- Habitat fragmentation is probably not as great an issue for migrants as it is for breeding birds, though habitat corridors from less suitable woods to rich bottomland hardwoods would be valuable (Petit 2000)

- Importance of mortality during migration to the overall survival rate of a migrant species is unknown (Szep and Moller 2005), though it may be substantial for some species (Sillett and Holmes 2002)

Moore et al. (2005) also provided some general considerations for conservation planning of stopover habitat. A landscape-wide approach should consider the size of suitable habitat patches and the distance between those patches. An important consideration is the orientation of the habitat patch (Barrow et al. 2005). Forest perpendicular to migrant flight paths is preferable because it increases the likelihood of detection by the migrant. Mapping of dispersion areas is important. However, landscape contexts are critical to consider. Concentrations of birds may only indicate that habitat was available, not that the habitat is of high quality.

Available information strongly points to the importance of stratified forest habitat containing a diversity of food-bearing plant species for landbird migrants. Protecting, enhancing, and restoring this habitat along the coast should be a high priority. A conceptual framework for considering stopover habitat was developed at a workshop on Protecting Stopover Sites at Moss Point, Mississippi, in May of 2001 (Duncan et al. 2002). The framework focused on prioritizing stopover habitat based on usage by migrants and generated the simple definitions described below:

- **"Fire Escape**": Like fire escapes in human habitations, these stopover sites are infrequently used, but are utterly vital when they are. Habitat quality may be too low to allow birds to gain significant mass, but at least they will survive, can take shelter, and may be able to get fresh water. Fire escape sites are typically adjacent to significant barriers such as deserts or large bodies of water.

- **"Convenience Store**": Forested patches, such as small parks or woodlots, in a non-forested matrix and located along migratory routes. These sites offer a place where birds can briefly rest and gain some mass easily, perhaps between short flights to higher quality sites, or when migrants' fuel stores are moderate. A given Convenience Store may be better able to serve the needs of some species than others.

- **"Full-service Hotel**": Forested sites in a forested landscape. Full-service Hotels are places where all needed resources (food, water, and shelter) are relatively abundant and available. These places serve many individuals of many species. Bottomland hardwood forests are a good example.

In an effort to quantify the amount and type of migratory landbird stopover habitat available in the GCJV region, parameters were assigned to the categories above to enable spatial analysis of 2001 NLCD land cover data. "Full-service Hotel" habitat was defined as forested habitat patches at least 10,000 acres (ac) in size. This patch size is the size believed to be required to support a viable breeding population of GCJV priority species Swainson's Warbler (*Limnothlypis swainsonii*)(Twedt et al. 1999), and it was opined that this size should provide ample resources for transient landbirds. Based on Buler et al.'s (2007) work with landbird migrants in Mississippi, all forested habitat patches < 10,000 ac in size, within 6 miles (~10 km) of the Gulf of Mexico shore and shorelines of other significant coastal water bodies (e.g., bays, the Laguna Madre, Lake Pontchartrain) was classified as "Fire Escape" habitat. GCJV staff defined "Convenience Store" habitat as being greater than 6 miles from coasts and less than 10,000 ac in size. Testing the validity of, and subsequently refining, this stopover habitat classification is a high priority for the GCJV partnership. Whereas we cannot currently estimate how much of each type of habitat is needed to sustain or increase migrant landbird populations, the relationships and distances between the different types are likely to be important parameters in future planning efforts (Mark Woodrey, Grand Bay NERR, personal communication).

Research Considerations

USGS scientists at the Wetland and Aquatic Research Center are currently working on a landscape-scale approach to the development of migratory landbird forest habitat objectives using empirical data derived from archived radar imagery. Data collected from four radar stations (Lake Charles, Louisiana, Houston, Texas, Corpus Christi, Texas, and Brownsville, Texas) is being analyzed. Each radar area is subdivided into multiple sampling sites, where migrant landbird density and coefficient of variation among sampling sites will be calculated. Landbird migrant density and coefficient of variation will be modeled against parameters of geographic position, degree of human development, and habitat composition. Based on that information, a model will be constructed for each radar area describing those relationships between birds and the environment. Those individual models would lend themselves toward development of a landscape-scale (e.g., the entire GCJV region) model to inform landbird habitat objective setting. This work is among the highest priorities for the GCJV staff and partners. Future model iterations could be used to predict effects of habitat gains or losses on the landscape on distribution and density of migrant landbirds, and thus inform spatial prioritization of habitat conservation actions.

Key Objectives

a) Complete the USGS analysis of weather radar data to determine the most important factors influencing migrant landbird density and variability under radar swept areas studied, and use that data to model important habitats outside of radar zones
b) Evaluate the criteria, such as distance to coast, patch size, and geographic position, used to categorize stopover habitat
c) Determine the ideal amounts and relationships between the three classes of stopover habitat

Geographic Scope of Work (GCJV Initiative Areas)

Science needs are relevant to all Initiative Areas. Based upon the work of Barrow et al. (2005), however, we have identified the Chenier Plain Initiative Area and approximately the northern half of the Texas Mid-Coast Initiative Area as the highest priority area for conservation of forest habitat for migrant landbirds, the Laguna Madre Initiative Area as second highest priority, and the southern half of the Texas Mid-Coast Initiative Area, the Mississippi River Coastal Wetlands Initiative Area, and the Coastal Mississippi-Alabama Initiative Area as the third highest priority (Vermillion et al. 2008).

Deliverables

a) Comprehensive report documenting methods, analyses, conclusions, and relevant recommendations
b) Identification of priority areas for conservation or restoration of existing forested habitat, or creation of new forested habitat by Initiative Area, including spatial data layers suitable for use in a GIS environment

Literature Cited

Barrow, W. C., L. A. Johnson-Randall, M. S. Woodrey, J. Cox, E. Ruelas I., C. M. Riley, R. B. Hamilton, and C. Eberly. 2005. Coastal forests of the Gulf of Mexico: a description and thoughts on their conservation. Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference, C. J. Ralph and T. D. Rich, editors, pp. 450-464.

Buler, J. J., F. R. Moore, and S. Woltmann. 2007. A multi-scale examination of stopover habitat use by birds. Ecology 88(7):1789 – 1802.

Duncan. C., B. Abel, D. Ewert, M. L. Ford, S. Mabey, D. Mehlman, P. Patterson, R. Sutter and M. Woodrey. 2002. Protecting stopover sites for forest-dwelling migratory landbirds. The Nature Conservancy, Arlington, Va. Unpublished report.

Gauthreaux, S.A., Jr., C. G. Belser, and C. M. Welch. 2006. Atmospheric trajectories and spring bird migration across the Gulf of Mexico. Journal of Ornithology, DOI 10.1007/s10336-006-0063-7.

Marra, P. P. and R. T. Holmes. 2001. Consequences of dominance-mediated habitat segregation in American Redstarts during the nonbreeding season. Auk 118(1): 92-104.

Moore, F. R., P. Kerlinger, and T. R. Simons. 1990. Stopover on a Gulf coast barrier island by spring trans-Gulf migrants. Wilson Bulletin 102:487-500.

Moore, F., and T. R. Simons. 1992. Habitat suitability and stopover ecology of neotropical landbird migrants. Pp. 345-355 *In* Ecology and Conservation of Neotropical Migrant Landbirds. Edited by J. M. Hagan and D. Johnston. Smithsonian Institution Press.

Moore, F. R., S. A. Gauthreaux, Jr., P. Kerlinger, and T. R. Simons. 1995. Habitat requirements during migration: important link in conservation. Pp. 121 - 144 *In* Ecology and management of neotropical migratory birds, a synthesis and review of critical issues (T. E. Martin and D. M. Finch, eds). Oxford University Press, New York. 489 pp.

Moore, F. R., M. S. Woodrey, J. J. Buler, S. Woltmann, and T. R. Simons. 2005. Understanding the stopover of migratory birds: a scale dependent approach. Pp. 684-689 *In* Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference, Asilomar, CA. C.J. Ralph and Terry Rich, editors.

Petit, D. R. 2000. Habitat use by landbirds along nearctic-neotropical migration routes: implications for conservation of stopover habitats. Studies in Avian Biology 20:15-33.

Sillett, T.S., and R.T. Holmes. 2002. Variation in survivorship of a migratory songbird throughout its annual cycle. Journal of Animal Ecology 71: 296-308.

Szep, T., and A. P. Moller. 2005. Using remote sensing data to identify migration and wintering areas and to analyze effects of environmental conditions on migratory birds. Pp. 390-400 *In* Birds of Two Worlds, The Ecology and Evolution of Migration. R. Greenberg and P. Marra, editors. Smithsonian Press.

Twedt, D., D. Pashley, C. Hunter, A. Mueller, C. Brown, and B. Ford. 1999. Partners in Flight conservation plan for the Mississippi Alluvial Valley. Available at http://www.blm.gov/wildlife/plan/MAV_plan.html#_1_36

Vermillion, W., J.W. Eley, B. Wilson, S. Heath, and M. Parr. 2008. Partners in Flight landbird conservation plan, BCR 37: Gulf Coastal Prairies, Version 1.3. Available at http://www.gcbo.org/html/CoastalPrairiesFinalCompressed.pdf

Woodrey, M. S. 2000. Age-dependent aspects of stopover biology of passerine migrants. Studies in Avian Biology 20:43-52.

11. Assess status and distribution of Little Blue Heron in the GCJV region, employing a standard repeatable methodology incorporating detection probabilities that can be used across the region by individual states or partners

Problem Statement

Little Blue Heron is a priority colonial-nesting waterbird for the GCJV partnership. Setting population and habitat objectives for colonial waterbirds is considered to be a useful tool for conservation. This process requires an estimate of populations within defined geographic areas so that population and habitat targets can be generated. The GCJV derived a population estimate and set an abundance-based objective for Little Blue Heron. Measuring progress towards the objective will likely require surveys to estimate the number of nesting Little Blue Heron pairs in the GCJV region. Little Blue Herons and other colonial waterbirds in the GCJV region have been surveyed using a variety of methods. The most commonly used methods are surveys of nesting sites from boats, fixed-wing aircraft, helicopters, or by observers on the ground. Each of these approaches has inherent biases, different costs in time and money, and cause varying levels of disturbance to nesting birds. Detection probabilities have not been determined for all methods currently used to survey Little Blue Herons. Frequency of surveys in the GCJV region have also differed across states, and within states, with some areas surveyed annually, and others surveyed on 5-year or greater intervals. Effective colonial waterbird conservation planning across large geographic regions benefits from coordinated and scientifically sound methods that can be replicated spatially and temporally as cost-efficiently as possible, with minimal disturbance to nesting birds.

Research Considerations

Frederick (in Hunter et al. 2006) provided recommendations for monitoring breeding populations of long-legged wading birds. Some of the important considerations he described are presented below:

- Ground counts are advised for dark colored species
- Repeated visits to colonies during the breeding season will provide a more accurate estimate of total nests
- Incubation is the best time during the nesting period for estimating numbers of nests
- The best time of the day for surveys is from approximately one hour after sunrise to mid-day
- Disturbance to colonies is an issue and must be considered during ground counts to avoid colony abandonment or significant nest or chick losses due to predation or exposure
- For monitoring populations over large geographic areas identifying all colonies (100% survey coverage) in the area is highly desirable but may be financially prohibitive
- Concentrate efforts on improving counts at large colonies with repeated visits, photographs, etc.

- Surveys can be more efficient if specific habitats known to be frequently utilized, by waterbirds, such as scrub-shrub swamp inclusions in forested wetlands are identified and targeted.

The large number of waterbird nesting colonies in the GCJV region and their locations (e.g., on private property or in remote areas) may rule out the potential to solely employ ground or boat-based counts. Current colonial nesting waterbird population estimates are derived using a variety of methods, including boat, ground, and aerial surveys. Flight-line surveys have been utilized at some locations, but their accuracy and efficacy deserves additional study. Recently, the utility of UAS (drones) has been explored as a potential method for surveying colonial waterbirds and other species (Vas et al. 2015). In 2015, the GCJV provided funding to Texas State University – San Marcos researchers to explore the utility of UAS for surveying colonial nesting waterbirds in both island and bottomland hardwood settings. Part of the research will include estimation of detection probabilities for priority GCJV waterbird species, and assessment of potential disturbance impacts to nesting birds.

Green et al. (2008) used double observers and a marked-subsample technique in ground counts to derive detection probabilities for shrub- and tree-nesting colonial waterbirds. They found significant differences in probability of detection among species and between observers. Green et al. (2008) also compared helicopter and fixed-wing aircraft surveys to double-observer marked sub-sample ground counts. They found that fixed-wing estimates were approximately 65% higher than ground counts for total nests and for both dark and white-plumaged birds. Counts made from helicopters were similar to ground counts. Based on their findings, Green et al. (2008) recommended the use of double-observer marked-subsample ground counts but acknowledged that this technique was likely infeasible for very large or inaccessible colonies. They also found that while helicopter surveys were more expensive per hour than fixed-wing aircraft surveys, helicopter surveys allowed more rapid assessment such that costs proved similar between platforms.

Key Objectives

a) Describe the most appropriate survey methodology or methodologies for nesting colonies of Little Blue Heron and similar shrub- and tree-nesting colonial waterbirds, taking into account detection bias, potential disturbance issues, the size of the GCJV region, known locations and unknown potential locations of Little Blue Herons, and estimated costs

Geographic Scope of Work (GCJV Initiative Areas)

This work is relevant to all GCJV Initiative Areas; however, the Initiative Areas which have been identified as being most important, in terms of nesting abundance, to Little Blue Herons, are the Chenier Plain and Mississippi River Coastal Wetland Initiative Areas.

Deliverables

a) Comprehensive report(s) documenting methods, results, conclusions, spatial data as appropriate (e.g., survey area and strata), estimated costs, and relevant recommendations for conservation action or future research

Literature Cited

Frederick, P.C. 2006. Recommendations for monitoring breeding populations of long-legged waders (herons, egrets, ibises, storks, spoonbills, order Ciconiiformes). Pages I-1 – I-18 *in* Hunter, W.C., W. Golder, S. Melvin and J. Wheeler. 2006. Southeast United States regional waterbird conservation plan. Retreived from: http://www.waterbirdconservation.org/southeast_us.html

Green, M.C., M.C. Luent, T.C. Michot, C.W. Jeske, and P.L. Leberg. 2008. Comparision and assessment of aerial and ground estimates of waterbird colonies. Journal of Wildlife Management 72(3):697-706.

Vas, E., A. Lescroel, O. Duriez, G. Buguszewski, and D. Gremillet. 2015. Approaching birds with drones: first experiments and ethical guidelines. Biology Letters 11:20140754. Retreived from: http://dx.doi.org/10.1098/rsbl.2014.0754

12. Develop an energetic model that incorporates refueling rates for en-route forest landbird migrants to identify habitat needs

Problem Statement

The GCJV region is critically important to migrant landbirds during spring and fall migration (Lowery 1974, Barrow et al. 2000, Barrow et al. 2005, Gauthreaux et al. 2006, Buler et al. 2007). The Landbird Working Group of the GCJV MERT selected a trio of landbird migrants, Cerulean (*Setophaga cerulea*), Golden-winged (*Vermivora chrysoptera*), and Swainson's Warblers, for conservation planning to represent key components of stopover habitat for forest landbirds. The GCJV has developed a forest habitat prioritization model for landbird migrants based upon level of migrant use, geographic position, patch size, and proximity to coast (Vermillion et al. 2008). However, we lack population and habitat objectives to accompany the spatial prioritization.

Daily ration models have been used to set habitat objectives for waterfowl and shorebirds. The GCJV Landbird Working Group has discussed the possibility of developing an energetic-based model to establish habitat objectives for the three species above. That model would require the following inputs:

- A population objective, based on either an absolute or desired component, with potential competitors for resources (other migrant and resident landbird species) considered
- Energetic requirements of the landbird species during migration
- The length of stay or migration chronology of landbird species in the GCJV region
- The energetic value of various habitats utilized by migrant landbirds
- Identification of habitat management treatments that correspond to quantified migrant landbird foraging value increases

A key model output would be a landscape ranked according to estimates of current energetic value to migrant landbirds. A secondary output would be identification of sites across the landscape where management treatments should be applied to account for emergencies (fall-out episodes) or to address perceived habitat shortfalls.

Research Considerations

It is assumed that food availability (energy) for trans-Gulf of Mexico migrants is most limited during spring migration. To set population and habitat objectives, either an absolute abundance of total migrants with a temporal component (length of stay/residence time), or an absolute abundance at any given point in time with migration chronology (i.e., relative abundance through time) is needed. It is possible that reflectivity data from weather radar combined with mist-netting data could be used to derive an estimate of abundance for a given point in time. Mobile radars may be a potential tool for estimating landbird migrant abundance. Alternately, Partners in Flight (PIF) estimates could be used to set objectives based upon an assumed proportion of migrants moving through the GCJV region.

Numerous energetic-focused studies have been done for birds (Nisbet et al. 1963, Holmes et al. 1979, Tatner and Bryant 1986, Kersten and Piersma 1987, Goldstein 1988, Morrison et al. 1988, Weathers and

Stiles 1989, Kuenzi et al. 1991) but applicability of derived energetic requirement estimates to development of this proposed model is unclear.

Migration chronology data could be derived from mist-netting data collected by Dr. Frank Moore's lab at University of Southern Mississippi or possibly from ebird data. At a 2010 GCJV Landbird Working Group meeting, participants opined that average spring stopover time in Gulf of Mexico coastal habitats was 2 – 3 days.

There has been some published and unpublished work that included estimation of food availability and selection for landbird migrants. Barrow et al. (2000) identified important plants for landbird migrants based on foraging observations at three stopover habitat sites in Texas and Louisiana. Additionally, USGS scientists have determined caloric values for many of the fruits from these important plants, as well as for some important invertebrate prey items (Wylie Barrow and Michael Baldwin, U.S. Geological Survey, personal communication). Several studies have employed branch clipping to estimate arthropod abundance as bird prey items (Johnson 2000, Smith et al. 2007, Dobbs et al. 2009, Cohen et al. 2012). There appear to be fewer avian studies in which ground-dwelling invertebrates were sampled, especially with a focus on transient landbirds. Gautreaux and Moore (2013) estimated leaf litter arthropod biomass in landbird stopover habitat in Mississippi using timed 0.25 m^2 quadrat counts. Wiggers et al. (2014) used a combination of soil sampling and pit fall traps to estimate abundance and biomass of grassland invertebrates. Razeng and Morton (2015) used a combination of pit fall traps, active searches, and sweep netting to sample insects in the ground layer, woody debris, and low foliage of a woodland remnant in New South Wales, Australia, as part of an investigation of nutritional composition of avian prey items.

In 2016, USGS scientists and GCJV staff discussed the possibility of using a spatially-explicit Bayesian Network model to predict the energetic value of wooded habitat within GCJV Initiative Areas, estimate the energetic demand on the habitat based on Next-Generation Radar (NEXRAD) bird reflectivity data, and then determine areas of energetic surplus or deficit. The group identified key ecological processes believed to influence habitat energy content. The model would estimate total realized energy of flowers, fruits, and invertebrates available in a 30 m by 30 m land cover pixel, taking into account a discrete time period in migration, which would both influence energy availability and resource-specific demand based upon species composition at that time period (e.g., more frugivores migrate through at time step X, so fruit demands would be higher than invertebrate or nectar demands). Energy availability would be influenced by the dominant plant species within each pixel; species dominance would be determined through consultation of land cover datasets such as Landfire or from state natural heritage program botanical inventories. The forest migrant bird population objective for this model would be the actual observed number of birds as calculated from NEXRAD reflectivity, and their energy demand would be calculated from the literature, and adjusted to account for the number of days in each discrete migration time period. Though energy availability would be calculated at the 30 m by 30 m pixel level, this information would be scaled up to a 20-hectare (ha) scale, which is a spatial scale relevant to the NEXRAD reflectivity measurements. The model would answer the following question: given that migrants use a given 20-ha area (or the sum of multiple 20-ha areas), at a density determined from NEXRAD reflectivity, is there sufficient food on the landscape to support them? While this prototype model would use current/recent bird use to derive the energetic demand, ultimately the GCJV desires a model that derives its energetic demand from bird numbers that are somehow linked to PIF objectives. Consequently, the ultimate desire is to tweak the prototype described here to reflect a desired landscape condition to support an increased bird population.

Key Objectives

a) Derive a population estimate for spring migrating Cerulean, Golden-winged, and Swainson's Warblers and other bird species with similar foraging strategies for the GCJV region, by Initiative Area, in terms of either total passage migrants or abundance at a single point in time
b) From the population estimate in "a" above, derive a population objective that is linked in some manner to PIF objectives
c) Derive an estimate for migration chronology (if objective is abundance at a single point in time) or turnover time (if objective is abundance of total passage migrants) in the GCJV region and calculate caloric needs to support the population objective during spring migration
d) Develop a method to estimate a caloric content by area (e.g., square meter, acre, hectare, etc.) for various forested habitats encountered by spring migrant landbirds in the GCJV region
e) Spatially depict and quantify habitats needed to support the population objective
f) Determine best management practices to improve caloric output of GCJV forest habitat for spring migrants

Geographic Scope of Work (GCJV Initiative Areas)

Science needs are relevant to all Initiative Areas. Based upon the work of Barrow et al. (2005), however, we have identified the Chenier Plain Initiative Area and approximately the northern half of the Texas Mid-Coast Initiative Area as the highest priority area for conservation of forest habitat for migrant landbirds, the Laguna Madre Initiative Area as second highest priority, and the southern half of the Texas Mid-Coast Initiative Area, the Mississippi River Coastal Wetlands Initiative Area, and the Coastal Mississippi-Alabama Initiative Area as the third highest priority (Vermillion et al. 2008).

Deliverables

a) Comprehensive report documenting methods, analyses, conclusions, and relevant recommendations for conservation actions or future research
b) Spatial and tabular depiction of total current dietary energy (kilocalorie/unit of area) supply for priority landbird migrants and associated species during spring by forest type and Initiative Area
c) Spatial and tabular depiction of dietary energy (kilocalorie/unit of area) deficits, relative to population objective, for priority landbird migrants and associated species during spring by forest type and Initiative Area

Literature Cited

Barrow, W. C., C. Chen, R. B. Hamilton, K. Ouchley, and T. J. Spengler. 2000. Disruption and restoration of en route habitat, a case study: the chenier plain. Studies in Avian Biology 20:71-87.

Barrow, W.C., L.A. Johnson-Randall, M.S. Woodrey, J. Cox, E. Ruelas I., C.M. Riley, R.B. Hamilton, and C. Eberly. 2005. Coastal forests of the Gulf of Mexico: a description and thoughts on their conservation. Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference, C. J. Ralph and T. D. Rich, editors, pp. 450-464.

Buler, J.J., F.R. Moore, and S. Woltmann. 2007. A multi-scale examination of stopover habitat use by birds. Ecology 88(7):1789–1802.

Cohen, E.B., F.R. Moore, and R.A. Fischer. 2012. Experimental evidence for the interplay of exogenous and endogenous factors on the movement ecology of a migrating songbird. PLoS ONE 7(7): e41818. Doi:10.1371/journal.pone.0041818

Dobbs, R.C., W.C. Barrow, Jr., C.W. Jeske, J. DiMiceli, T.C. Michot, and J.W. Beck. 2009. Short-term effects of hurricane disturbance on food availability for migrant songbirds during autumn stopover. Wetlands 29(1): 123-134.

Gauthreaux, S.A., Jr., C. G. Belser, and C. M. Welch. 2006. Atmospheric trajectories and spring bird migration across the Gulf of Mexico. Journal of Ornithology, DOI 10.1007/s10336-006-0063-7.

Gautreaux, J., and F. Moore. 2013. Stopover ecology of Nearctic-neotropical landbird migrants within and urban coastal landscape. Unpublished report submitted to the Gulf Coast Joint Venture, Lafayette, LA. 33 pp.

Goldstein, D.L. 1988. Estimates of daily energy expenditure in birds: the time-energy budget as an integrator of laboratory and field studies. American Zoologist 28: 829-844.

Holmes, R.T., C.P. Black, and T.W. Sherry. 1979. Comparative population bioenergetics of three insectivorous passerines in a deciduous forest. Condor 81: 9-20.

Kersten, M., and T. Piersma. 1987. High levels of energy expenditure in shorebirds: metabolic adaptations to an energetically expensive way of life. Ardea 75: 175-187.

Kuenzi, A.J., F.R. Moore, and T.R. Simons. 1991. Stopover of neotropical landbird migrants on East Ship Island following trans-Gulf migration. Condor 93: 869-883.

Johnson, M.D. 2000. Evaluation of an arthropod sampling technique useful in measuring food availability for forest insectivores. Journal of Field Ornithology 71: 88-109.

Lowery, G. 1974. Louisiana birds. LSU Press, Baton Rouge, LA. 651 pp.

Morrison, M.L., C.J. Ralph, J. Verner, J.R. Jehl, Jr., eds. 1988. Avian foraging theory, methodology, and applications. Studies in Avian Biology No. 13. 515 pp.

Nisbet, I.C.T., W.H. Drury, Jr., and J. Baird. 1963. Weight-loss during migration. Part I: Deposition and consumption of fat by the Blackpoll Warbler *Dendroica striata*. Bird Banding 34(3): 107-138.

Razeng, E. and D.M. Watson. 2015. Nutritional composition of the preferred prey items of insectivorous birds: popularity reflects quality. Journal of Avian Biology 46: 89-96.

Smith, R.J., F.R. Moore, and C.A. May. 2007. Stopover habitat along the shoreline of northern Lake Huron, Michigan: emergent aquatic insects as a food resource for spring migrating landbirds. Auk 124(1): 107-121.

Tatner, P. and D.M. Bryant. 1986. Flight cost of a small passerine measured using doubly labeled water: implications for energetics studies. Auk 103: 169-180.

Vermillion, W., J.W. Eley, B. Wilson, S. Heath, and M. Parr. 2008. Partners in Flight landbird conservation plan, BCR 37: Gulf Coastal Prairies, Version 1.3. Available at http://www.gcbo.org/html/CoastalPrairiesFinalCompressed.pdf

Weathers, W.W. and F.G. Stiles. 1989. Energetics and water balance in free-living tropical hummingbirds. Condor 91: 324-331.

Wiggers, J.M.R. (Hanneke), J. van Ruijven, A.P. Schaffers, F. Berendse, and G.R. de Snoo. 2014. Food availability for meadow bird families in grass field margins. Ardea 103: 17-26.

13. Test and refine assumptions of Le Conte's Sparrow habitat-population model

Problem Statement

Le Conte's Sparrow (*Ammodramus leconteii*) is a GCJV priority species, and the PIF Conservation Plan for Bird Conservation Region 37 (Vermillion et. al. 2008) provides wintering population and habitat objectives for them. Derivation of existing grassland habitat objectives for Le Conte's Sparrow is based on a relatively simple relationship between target winter population size (stepped down from PIF continental objectives) and density during winter (from published estimates). The resulting acreage objective must be met within contiguous grassland blocks of $\geq$ 500 ac and where appropriate conditions (i.e., periodic vegetative disturbance and presence of bunchgrasses) exist.

GCJV partners desire to test critical model assumptions and otherwise improve the habitat-population model for Le Conte's Sparrow, including 1) evaluating the 500 ac block size threshold, 2) evaluating the presumed density of overwintering birds, 3) evaluating "disturbed bunchgrasses" as a suitable proxy for proper vegetative composition and structure, and 4) considering incorporating additional characteristics of landscape context. The existing 500 ac block size assumption derives from general recommendations for breeding grassland birds (USDA 1999), without much documentation in the literature specific to Le Conte's Sparrow. The presumed density of overwintering birds derives from Grzybowski (1982). The basis for existing vegetation and disturbance recommendations are Grzybowski (1982) and Baldwin (2005), which documented Le Conte's Sparrow preferences in coastal Texas for moderately grazed clumped grasses and 3-year burn rotations, respectively. Surrounding landscape characteristics (e.g., developed, open water, or forest) are not currently considered to be relevant determinants of available grassland habitat.

Research Considerations

Quantifying availability of habitats relative to objectives across the landscape is an important consideration, so that habitat deficits or surpluses can be estimated to guide the intensity and regional prioritization of habitat conservation activities. Consequently, habitat characteristics (or their reasonable proxies) must be capable of depiction with land-use/land-cover and/or other derived spatial data at appropriate spatial scales.

One potential approach to address this science need (Wylie Barrow, U.S. Geological Survey, personal communication) is as follows:

1) Select sites from each of the 5 GCJV Initiative Areas that are representative of grasslands there with likely Le Conte's Sparrow presence
2) Sample these sites for Le Conte's Sparrow (and other wintering species) using established methods that include repeat sampling and account for imperfect detection
3) Build hierarchical models of Le Conte's occurrence to estimate their response to key landscape and habitat characteristics

4) Develop models that predict species response (in terms of density) relative to landscape and habitat variables, to inform potential classes of available habitat of varying values

Key Objectives

a) Identify the habitat and landscape-level characteristics and other parameters necessary to refine the GCJV's habitat-population model that quantifies and depicts habitats needed to support target populations of Le Conte's Sparrow, specifically:
    1. Quantify contiguous grassland block size (and possibly configuration) necessary to support the species
    2. Quantify overwintering densities of Le Conte's Sparrows, by GCJV Initiative Area
    3. Characterize habitat and landscape features that define Le Conte's Sparrow habitat within the GCJV
    4. Characterize surrounding landscape characteristics, if any, that are pertinent to defining Le Conte's Sparrow habitat within the GCJV

Geographic Scope of Work (GCJV Initiative Areas)

This work is relevant to all GCJV Initiative Areas, but is highest priority in regions where the majority of Le Conte's Sparrow are estimated to overwinter (i.e., the Texas Mid-Coast then Chenier Plain Initiative Areas, respectively).

Deliverables

a) Comprehensive report(s) documenting the methods, analyses, conclusions, and relevant recommendations for refinement of the GCJV habitat-population model

b) Spatial data, including any classifications or derivatives used in analyses

Literature Cited

Baldwin, H.Q. 2005. Effects of fire on home range size, site fidelity and habitat associations of grassland birds overwintering in southeast Texas. M.S. Thesis, Louisiana State University. 69 pp.

Grzybowski, J.A. 1982. Population structure in grassland bird communities during winter. Condor 84(2):137-152.

U.S. Department of Agriculture. 1999. Grassland birds. Natural Resources Conservation Service, Wildlife Habitat Management Institute. Fish and Wildlife Management Leaflet Number 8. October 1999. 12 pp.

Vermillion, W., J.W. Eley, B. Wilson, S. Heath, and M. Parr. 2008. Partners in flight landbird conservation plan, BCR 37: gulf coastal prairie, Version 1.3. Accessed at: http://www.gcbo.org/wp-content/html/CoastalPrairiesFinalCompressed.pdf

14. Validate King Rail predicted abundance model and accuracy of population estimate in the Mississippi River Coastal Wetlands Initiative Area

Problem Statement

King Rail (*Rallus elegans*) is a priority species for conservation planning in the GCJV region. GCJV staff developed a predicted abundance model for the GCJV geography based on the work of Pickens (2012) and Pickens and King (2014) in the Chenier Plain of Texas and Louisiana. Pickens used remote sensing imagery in combination with point count data to develop species distribution models. He developed maps of King Rail predicted relative abundance for fresh and intermediate marsh in his study area. As part of his analysis, Pickens (2012) looked at the predictive ability of his fresh marsh model in intermediate marsh, and vice versa, and found poor transferability. At Pickens' recommendation, GCJV staff used a modified approach employing three remotely sensed variables to develop King Rail predicted abundance maps for fresh and intermediate marsh, combined, throughout the GCJV region. The remotely sensed variables used were: 1) mean open water at a 180 m scale, 2) mean spring normalized difference vegetation index (NVDI; a measure of vegetation greenness) at a 180 m scale, and 3) the coefficient of variation of spring modified normalized difference water index (MNDWI; a measure of wetness heterogeneity) at a 1 km scale. Pickens also developed King Rail density estimates (birds/ha) for fresh and intermediate marsh in his study area, based upon species home range and point count detections. GCJV staff used eBird data from 2000 – 2017 (eBird 2012) to develop Initiative Area-specific parameter estimates and adjusted those study area densities for marshes throughout the GCJV region to derive an overall population estimate, and subsequently a population objective, namely to increase the existing population by ten percent.

Due to extensive marshes, the GCJV's Mississippi River Coastal Wetlands Initiative Area was estimated to host approximately 33,793 King Rail, making it the second most important Initiative Area, in terms of abundance, for the species. However, because Pickens' work occurred in the Chenier Plain of Texas and Louisiana, the applicability of the GCJV's predicted abundance model to wetlands in the Mississippi River deltaic plain is not known. For example, freshwater wetlands in the bird foot delta of the Mississippi River experience much greater tidal fluctuation than do freshwater marshes in the Chenier Plain. Additionally, Pickens (2012) found poor predictive ability of his fresh and intermediate King Rail relative abundance models across marsh types. Therefore, it is important to assess the performance the GCJV predicted relative abundance model derived for the Mississippi River Coastal Wetlands Initiative Area, and also to assess the accuracy of the derived population estimate for King Rail in this Initiative Area.

Research Considerations

The Conway protocol, which utilizes call-playback and incorporates detection probability is currently the typical method employed to survey secretive marsh birds (Conway 2011). The Conway protocol was used by Pickens and King (2014) for marsh bird surveys in the Texas and Louisiana Chenier Plain, and the results of those surveys were used to validate predicted abundance models derived from remotely sensed variables. Robertson and Olsen (2014) found that density, nest stage and sex influenced response to call-playback in Sora (*Porzana carolina*) and Virginia Rail (*Rallus limicola*), and recommended accounting for those potential detectability biases when estimating marsh bird populations. Researchers at the Grand Bay NERR in Grand Bay, Mississippi have modified the Conway species list to focus on species that are known to utilize Gulf of Mexico marshes, and that species list would likely be applicable to Mississippi River Coastal Wetlands Initiative Area marshes (Mark Woodrey, Grand Bay NERR, personal communication). Subsequent to the Deepwater Horizon explosion and oil spill in 2010, personnel with the Louisiana Department of Wildlife and Fisheries began conducting marsh bird surveys using the Conway protocol and the Grand Bay NERR species list (Michael Seymour, Louisiana Department of Wildlife and Fisheries, personal communication). That data may be useful in validating the King Rail model in the Mississippi River Coastal Wetlands Initiative Area.

The use of ARU for monitoring marsh birds and other cryptic species has generated interest in recent years. Sidie-Slettedahl et al. (2015) compared the results of monitoring three secretive bird species [Yellow Rail (*Coturnicops noveboracensis*), Nelson's Sparrow (*Ammodramus nelsoni*), and Le Conte's Sparrow]) in mid-continent U.S. wetlands using the Conway protocol and also using ARU. They found that ARU recorded fewer birds of all three species, on average, than did human observers using the Conway protocol. The authors hypothesized that human observers were able to detect birds calling at greater distances than ARU, but suggested that ARU could be effective for surveying secretive marsh birds if corrections for detectability were considered. ARUs have been used for Black Rail surveys in Texas (Clay Green, Texas State University – San Marcos, personal communication) and results of those surveys could prove useful for estimations of King Rail abundance.

The maps generated by the GCJV office depict predicted King Rail relative abundance in five unique color quantiles. A stratified random sample design may be desirable to compare predicted low, medium-low, medium, medium-high and high abundance sites.

Key Objectives

a) Assess validity of predicted King Rail relative abundance zones according to GCJV modeling in the Mississippi Coastal Wetlands Initiative Area
b) Determine the accuracy of the Mississippi River Coastal Wetland Initiative Area King Rail population estimate.

Geographic Scope of Work (GCJV Initiative Areas)

The focus of this science need is the GCJV Mississippi River Coastal Wetlands Initiative Area.

Deliverables

a) Comprehensive report documenting methods, analyses, results, conclusion, and relevant recommendations regarding the validity of the GCJV King Rail predicted relative abundance model for the Mississippi River Coastal Wetlands Initiative Area, and the accuracy of the King Rail population estimate for the Mississippi River Coastal Wetlands Initiative Area

Literature Cited

Conway, C.J. 2011. Standardized North American marsh bird monitoring protocol. Waterbirds 34:319-346.

eBird. 2012. eBird: an online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. Available at: http://www.ebird.org.

Pickens, B. A. 2012. Modeling the spatial and temporal dynamics of coastal marsh birds. Ph.D. Dissertation. Louisiana State University. 125 pp.

Pickens, B.A., and S.L. King. 2014. Linking multi-temporal satellite imagery to coastal wetland dynamics and bird distribution. Ecological Modelling 285:1-12.

Robertson, E.P., and B.J. Olsen. 2014. Density, sex, and nest stage affect rail broadcast survey results. The Journal of Wildlife Management; DOI: 10.1002/jwmg.769

Sidie-Slettedahl, A.M., K.C. Jensen, R.R. Johnson, T.W. Arnold, J.E. Austin, and J.D. Stafford. 2015. Evaluation of autonomous recording units for detecting 3 species of secretive marsh birds. Wildlife Society Bulletin 39(3):626-634.

15. Determine primary limiting factors and desired habitat characteristics of Loggerhead Shrikes in the GCJV region

Problem Statement

Loggerhead Shrike (*Lanius ludovicianus*) populations have suffered significant, sizable declines across the continent. According to North American Breeding Bird Survey (BBS) (Sauer et al. 2014) results, the species has experienced an annual decline of >3% survey wide (1966-2012) and has fared worse in some states in the GCJV region: Texas (>4% decline), Louisiana (>2.5% decline), Mississippi (>3% decline), and Alabama (>6% decline). Possible drivers of these declines include reduced prey availability, direct mortality, or reduced productivity from widespread pesticide use and the invasive red imported fire ant (*Solenopsis invicta*) (RIFA), and habitat loss and alteration, particularly the trend towards larger farms with fewer perches, nest trees, and impaling stations. Despite these declines and recognition of possible drivers, the species receives decidedly little attention.

Loggerhead Shrike is a GCJV priority species, for which population and habitat objectives have been endorsed by the GCJV Board (Vermillion et al. 2008). Current habitat objectives are based on the sum of derived habitat needs for 1) adult breeding pairs and their presumed year-round territory size and 2) non-resident over-wintering birds and their (smaller) winter territory size. The grassland habitat needs thus quantified relate to grassland patches of >60 ac with 3-10 trees or large shrubs per ac. The implicit underlying assumption is that within the GCJV geography the species is most limited by availability of suitable habitat during winter, when both residents and overwintering birds are present, and thus populations are at their peak. This critical assumption deserves additional attention, as identification of a different primary limiting factor would lead the partnership toward a different means to quantify habitat objectives. For example, identification of low reproductive success and adult survival due to competition with RIFA as the primary limiting factor for GCJV populations would result in additional qualitative caveats to existing habitat objectives (e.g., grassland patches void of RIFA). If the breeding season is determined to be the period of most substantial population limitation, then GCJV objectives could be refined to specifically address breeding habitat. Identification of pesticides as the primary limiting factor for GCJV populations might move GCJV partners to address policy issues versus (or in addition to) the current habitat delivery-based focus.

A better understanding of key habitat parameters would lead to an improved model that relates target population sizes to quantified habitat needs. The GCJV population-habitat model assumes that a breeding pair defends a territory of approximately 20 ac, nested within a larger patch of suitable habitat at least 60 ac in size, with approximately 3 – 10 small trees or large shrubs per ac available for perching and impaling prey. The target density of trees and shrubs is expert-opinion based. The model assumes resident pairs maintain territories year-round, and that non-resident migratory shrikes occupy smaller (~5 ac) territories. Pairs in Florida and South Carolina maintain territories year-round, but in California, resident pairs separate and defend unique territories (Yosef 1996). Also, no information on territory size exists for the GCJV region, so existing habitat objectives could be improved with region-specific information. Little information exists on whether non-resident birds defend winter territories, or on the area requirements for those over-wintering birds. However, Lymn and Temple (1991) postulated that non-resident birds over-wintering along the Gulf of Mexico coast were habitat limited.

Research Considerations

Historic pesticide use, particularly dichlorodiphenyltrichloroethane (DDT), may have caused declines during the earlier years of the BBS, but such pesticides or their derivatives, though still detectable in shrike eggshells, are present in much lower levels in current eggshells and likely do not explain the continued decline. Herkert (2004) compared dichlorodiphenyldichloroethylene (DDE) and DDT levels in shrike eggshells in Illinois from 1971-1972 to those detected in eggshells from 1995-1996 and found that DDE levels had dropped 79%. Unlike larger predatory birds like Bald Eagles (*Haliaeetus leucocephalus*), Ospreys (*Pandion haliaetus*), and others that experienced population reductions due to DDT and then rebounded, the trend for shrikes has continued a clear downward slope. Still, other studies show a possible link with continued (and even expanded) use of pesticides to shrike declines (Bellar and Maccarone 2002).

The relationship of the RIFA to shrike abundance is also difficult to adequately examine. It may be challenging to disentangle effects of the ants from that of disturbance, which both RIFA and shrikes rely upon for suitable forage. It should also be noted that not all imported fire ant research may be equal; that is, some studies may refer to the monogyne form, whereas others may refer to the polygyne form, a multiqueen form that occurs at tremendously great densities. Interestingly, the polygyne form is more common in pastures and other frequently utilized shrike habitat. Lymn and Temple (1991) noted loss of millions of acres of shrike habitat in the Gulf region and suggested that invasive fire ants may be, in part, responsible for a decrease in habitat suitability for shrikes. However, Yosef and Lohrer (1995) studied the impact of RIFA on nesting Loggerhead Shrikes in Florida and found no significant impact on territory size, prey capture rate, or total time in flight. But nesting, resident shrikes may have an advantage over winter visitors. In the Gulf region, resident birds, which are assumed to maintain a territory throughout the year, may force wintering shrikes into marginal habitats (Brooks 1988). Allen et al. (2001) presented data that suggested RIFA negatively affect insect biomass, insect species richness, and insect diversity and found that wintering Loggerhead Shrikes avoided areas with lower arthropod density, which was attributed to fire ant predation. Interestingly, about a decade since an initial study of RIFA invading a Texas research station (Porter and Savignano 1990) was performed, Morrison (2002) found that most arthropods had rebounded to pre-invasion levels, suggesting an equilibrium may be reached that allows for recolonization of native fauna after several generations (Glancey et al. 1976). Biologists and managers at the Attwater Prairie Chicken National Wildlife Refuge in Eagle Lake, Texas, actively manage to control RIFA on refuge property, and these sites may lend themselves to study of impacts of RIFA on Loggerhead Shrike (Terry Rossignol, U.S. Fish and Wildlife Service, personal communication).

To what extent pesticides or RIFA affect Loggerhead Shrikes directly or indirectly, the greatest threat to populations is likely habitat loss, particularly the loss of native grasslands. But like studies on fire ants and pesticides, results from habitat studies are similarly conflicting. Based on limited studies, breeding habitat does not appear to be limiting, at least in the Midwest where suitable nesting habitat was not occupied by shrikes (Brooks and Temple 1990). Wintering habitat in the northern portions of the wintering range also may not be limiting as suitable habitat was, likewise, not occupied (O'Brien and Ritchison 2011). Wintering habitat in the Gulf South, however, may be limiting (Lymn and Temple 1991). Where little available habitat exists for breeding or non-breeding shrikes, birds may be forced into novel or suboptimal habitats and, perhaps, sinks. During breeding and non-breeding, shrikes may be found in "pastures with fence rows, old orchards, mowed roadsides, cemeteries, golf courses, agricultural fields, riparian areas, and open woodlands" (Yosef 1996), but are also frequently found in suburbs and more urbanized environments. Studies of reproductive success in urban environments are scarce, but, at least one from Tucson, Arizona, showed fledging success similar to other studies in non-urbanized areas and with even greater nest success than those more natural settings (Boal et al. 2003). Craig and Chabot (2012) studied Loggerhead Shrikes in winter along the Texas coast and determined that sites within 0.5 miles from the coast characterized by vacant seasonal homes, mowed lawns, and palm trees were predominantly used by older (after second year) birds, whereas habitats ~ 0.5 – 10 miles inland consisting mainly of rural residential areas, pasture and fallow agricultural fields were used disproportionately by second year birds. Since older birds are typically dominant over younger birds, this suggests that these highly altered coastal habitats are preferred by wintering birds. Additional research on effects of urbanization on breeding and nonbreeding Loggerhead Shrikes is warranted given the projected growth and sprawl of urban areas.

Building on the Craig and Chabot (2012) work, the Gulf Coast Bird Observatory (GCBO) has initiated a study aimed at assessing vital rates and habitat parameters of birds nesting and wintering in urban and non-urban habitats. Craig and Chabot were successful in capturing 150 individuals using walk-in traps baited with live mice, sheltered in a hardware cloth box. The GCBO study will involve trapping and color banding birds to define and map breeding territories and territory attributes. Due to the ability of shrikes to remove single-overlap bands, double- overlap bands will be used. Color banding will also allow identification of migratory shrikes that may arrive during the non-breeding season. Nests will be located in breeding territories, their substrate attributes will be recorded, and productivity parameters will be measured. GCBO staff reference a similar study by Sherry et al. (in press) that can provide further information on the productivity of shrikes nesting in urbanized landscapes. Vital rate information derived from studies such as those referenced above could be utilized in a population model to determine which parameters are most influential on population growth.

Key Objectives

a. Identify the habitat and landscape-level characteristics and other parameters necessary to refine the GCJV's habitat-population model that quantifies and depicts habitats needed to support target populations of Loggerhead Shrike, including:
    1. contiguous habitat block size (and possibly configuration) necessary to support the species
    2. habitat and landscape features that define Loggerhead Shrike habitat within the GCJV
    3. surrounding landscape characteristics, if any, that are pertinent to defining Loggerhead Shrike habitat within the GCJV

b. Quantify key vital rates [e.g., productivity, survival of young, recruitment of young, annual survival of adults, site fidelity, and immigration (DeSante et al. 2005)] for resident Loggerhead Shrikes in various habitats (e.g., agriculture, rangeland, conservation/managed lands, developed areas, and others)
c. Utilize vital rate information to conduct a population analysis to determine the most significant parameters influencing resident population growth
d. Identify important factor(s) leading to reduced winter survival of Loggerhead Shrikes
e. Quantify significance and mechanism(s) of RIFA as limiting factor to breeding and wintering Loggerhead Shrikes

Geographic Scope of Work (GCJV Initiative Areas)

Because breeding and wintering Loggerhead Shrikes occur across the GCJV region, science needs are relevant to all initiative areas. However, priority should be given to work conducted in the Texas Mid-Coast, Chenier Plain, and Laguna Madre Initiative Areas, as data from the Breeding Bird Survey and Christmas Bird Count indicate the species is most abundant in these portions of the GCJV region.

Deliverables

a. Comprehensive report documenting methods, analyses, results, conclusions, and relevant recommendations for refinement of the GCJV population-habitat model
b. Spatial data, including any classifications or derivatives used in analyses
c. Estimates of vital rates of Loggerhead Shrikes in key habitats and recommendations for maximizing productivity
d. A population viability analysis identifying the most important parameters influencing resident shrike population growth
e. Identification of limiting factors and recommendations for mitigation of those factors

Literature Cited

Allen, C.R., R.S. Lutz, T. Lockley, S.A. Phillips, Jr., and S. Demarais. 2001. The non-indigenous ant, *Solenopsis invicta*, reduces Loggerhead Shrike and native insect abundance. Journal of Agricultural and Urban Entomology 18 (4): 249 -250.

Bellar, C.A. and A.D. Maccarone. 2002. The effects of prairie habitat loss and land-use changes on Loggerhead Shrike populations in Kansas. Transactions of the Kansas Academy of Science 105:51–65.

Boal, C.W., T.S. Estabrook, and A.E. Duerr. 2003. Productivity and breeding habitat of loggerhead shrikes in a southwestern urban environment. Southwestern Naturalist 48(4):557-562.

Brooks, B.L. 1988. The breeding distribution, population dynamics and habitat availability and suitability of an upper Midwest loggerhead shrike population. M.S. Thesis. University of Wisconsin, Madison, Wisconsin.

Brooks, B.L. and S.A. Temple. 1990. Dynamics of a Loggerhead Shrike population in Minnesota. Wilson Bulletin 102:441-450.

Craig, S.H., and A. Chabot. 2012. A study of wintering Loggerhead Shrikes in the Texas gulf coastal plain. Colorado Birds 46 (2): 121-126.

DeSante, D.G., P.M. Nott, and D.R. Kaschube. 2005. Monitoring, modeling, and management: why base avian management on vital rates and how should it be done? U.S. Forest Service General Technical Report PSW. 191:795-804.

Glancey, B.M., D.P. Wojcik, C.H. Craig, and J.A. Mitchell. 1976. Ants of Mobile County, AL, as monitored by bait transects. J. Georgia Entomol. Soc. 11: 191-197.

Herkert, J. R. 2004. Organochlorine pesticides are not implicated in the decline of the Loggerhead Shrike. Condor 106:702–705.

Lymn, N. and S. Temple. 1991. Land-use changes in the Gulf Coast region: links to declines in Midwestern Loggerhead Shrike populations. Passenger Pigeon 53:315-325.

Morrison, L.W. 2002. Long-term impacts of an arthropod-community invasion by the imported fire ant, *Solenopsis invicta*. Ecology 83(8): 2337-2345.

O'Brien, E. and G. Ritchison. 2011. Non-breeding ecology of loggerhead shrikes in Kentucky. The Wilson Journal of Ornithology 123(2): 360-366.

Porter, S.D. and D.A. Savignano. 1990. Invasion of polygyne fire ants decimates native ants and disrupts arthropod community. Ecology 71: 2095-2106.

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardiek, D. J. Ziolkowski, Jr., and W. A. Link. 2014. The North American breeding bird survey, results and analysis 1966 – 2013. Version 1.30.2015, USGS Patuxent Wildlife Research Center, Laurel, MD.

Vermillion, W., J.W. Eley, B. Wilson, S. Heath, and M. Parr. 2008. Partners in flight landbird conservation plan, BCR 37: gulf coastal prairie, Version 1.3. Accessed at: http://www.gcbo.org/wp-content/html/CoastalPrairiesFinalCompressed.pdf

Yosef, R. 1996. Loggerhead Shrike (*Lanius ludovicianus*). The birds of North America. (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology. Accessed at: https://birdsna.org/Species-Account/bna/species/logshr

Yosef, R., and F.E. Lohrer. 1995. Loggerhead Shrikes, red fire ants and red herrings? The Condor 97: 1053-1056.