Science and Research Needs Related to Waterfowl Management on National Wildlife Refuges in the Southeast Region

Action Item 2.5 (Science Team): Identify key research assumptions, knowledge gaps, and questions underpinning waterfowl management practices on National Wildlife Refuges.

	Research Need	Priority Tier	Existing Research / Notes	Suggested Study / Approach
Habitat Management	Determine if waterfowl abundances are reliable indicators of habitat quality or a reliable guide for habitat management	I	*See Hagy et al. (2017) for a relevant discussion. Related to Lower Mississippi Valley Joint Venture Science Need. Limited and inconsistent information relating waterfowl abundance to food density. Evaluate assumption that food abundance on National Wildlife Refuges (NWR) in the SE is a factor affecting continental or local waterfowl populations.*	Monitoring waterfowl habitat and abundance (diurnal and nocturnal) at multiple refuges, in multiple (replicated) habitats, and over multiple (5 or more) years in a coordinated fashion (possible use of IWMM) could be used to answer these questions. Also see Mallard Migration Model developed by Lonsdorf et al. (2016). Current work with thermal imaging technology may provide new opportunities to address this research need.
	Evaluate need for wood duck boxes	I	*Many refuges still maintain wood duck boxes, although wood duck populations may have rebounded to the point where boxes are no longer needed (See Denton et al. 2012).*	Experimental study opening and closing wood duck boxes and monitoring survival, recruitment, and dispersal. Are box programs more important for education than population management?
	Conduct cost-benefit analysis to find minimum cost to provide Duck Energy Days (DED) and/or tradeoffs with other management actions or refuge needs	II	*Existing data is likely available for this analysis. Data sources could include select refuges participating in Integrated Waterbird Management and Monitoring with cropping and non-cropping habitat management.*	Also, an elaborate sensitivity analysis of parameters within daily ration models for estimating energy supply would help focus and prioritize research (See Livolsi et al. 2015 and Ringelman et al. 2017).
	Identify factors influencing habitat selection of waterfowl and other wetland birds	II	*Track waterbird habitat use relating to habitat structure and wetland productivity of managed wetland and flooded agricultural lands for targeted species including mallard, northern pintail, king rail, black rail, least bittern, purple gallinule, and all shorebirds. See work by McClanahan (2015) and Osborn (2015) at Tennessee NWR for dabbling ducks.*	Many studies have evaluated aspects of habitat selection for waterfowl and other wetland-associated birds. A meta-analysis for the Southeast would be an excellent starting point.
	Evaluate restoration of SAV and coastal marsh vegetation communities	III	*Brasher (2015) reviewed marsh terracing in the Gulf Coast and noted mixed results of this practice in restoring SAV communities and encouraging marsh outside of terrace edges. Water turbidity and nutrient input issues may be primary causes of SAV loss in coastal areas (compounded by storm damage, channeling, subsidence, etc.; ACOE 2011)*	A review of published studies region-wide similar to Brasher (2015) would be an excellent starting point.
	Methods of weed control in wetlands	TR	*Many sources of information available. Strickland et al. (2009) is an excellent source of information on use of herbicides for waterfowl management. Osborn (2015) and Allen et al. (2007) evaluated control strategies for alligatorweed on NWRs. Strader and Stinson (2005) published an excellent moist-soil management guide targeting NWRs in the SE.*	No additional research is recommended at this time. Training may be needed. Local agricultural extension agents may be helpful in recommending chemicals for use. Distributing existing manuals or creating new technical guides may be needed.
	Wetland plant identification	TR	*A number of valuable wetland plant identification guides are available, including Schummer et al. (2012), Bryson and Defelice (2010), and Miller and Miller (2005). In the future, a more comprehensive wetland plant field guide, which includes wildlife uses, may be beneficial.*	No additional research is recommended at this time. Training or development of an additional comprehensive field guide may be needed which combines aspects from Schummer, Bryson, and Miller's books.

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Sanctuary	Value of sanctuary and optimal design	I	*See sanctuary prospectus developed by the USFWS Region 4 Wetland Working Group Science Team and sanctuary compendium developed by Mike Brasher and Brian Davis for the Gulf Coast Joint Venture. Legal and biological components of sanctuary should be separated and defined. Biological benefits of sanctuary for waterfowl populations or hunter support should be identified through new research projects.*	Studies are needed to: 1) demonstrate effects of sanctuary on hunter harvest, 2) demonstrate effects of sanctuary on survival, 3) demonstrate effects of sanctuary on movements and migration chronology, 4) quantify sanctuary on the landscape.
	Role of food availability within waterfowl sanctuaries	I	*None known to be available.*	Experimental manipulations of food density or current habitat and bird monitoring over many years with varying conditions (e.g., through Integrated Waterbird Management and Monitoring [IWMM]) may be needed to better understand if food density within sanctuaries affects waterfowl abundance and condition.
	Effects of non-waterfowl hunting disturbances within waterfowl sanctuaries	II	*None known to be available. See Osborn et al. (2017) for note on waterfowl disturbance within sanctuaries from non-hunting sources.*	Experimental disturbances could be used to address this research need. Also, large-scale analysis of IWMM data may be useful.
	Assess benefits of temporal sanctuaries	II	*See St. James et al. (2013) and Hagy et al. (2017) for example studies. Often, disturbances from human access (e.g., hunting) are restricted to a few days per week and/or only portions of the day.*	Assess whether or not this provides actual sanctuary conditions and how it affects waterfowl harvest.
Food	Evaluate the effect of genetically engineered crops and neonicotinoid pesticide use on waterfowl, including how these affect the ability of NWRs to meet objectives	I	*No current data may be available. Data sources could include select refuges participating in IWMM with cropping and non-cropping habitat management.*	Multiple NWRs could track yields of crops and compare with utilization by ducks (October and March yield surveys) to identify DEDs used by ducks and those available. Comparisons could be made with state or private wildlife management areas with different policy restrictions.
	Food use and selection of ducks by primary foraging habitats	I	*Diet studies in primary foraging habitats and for focal species for management, such as gadwall and wood ducks in aquatic bed; mallards, green-winged teal, and northern pintail in moist-soil; black duck, wood ducks, and mallards in forested; and northern pintail and red head in coastal emergent marshes. Diet studies are also needed to better understand the role of invertebrates as important food sources for different species during winter and spring migration.*	Following suggestions of Callicutt et al. (2011), additional diet studies could be conducted to determine if foods are consumed by ducks (e.g., iva, sesbania, milo, etc.). Unbiased methodologies recommended by Callicutt et al. (2011) should be used to update diet literature.
	Energy value of agricultural grains	II	*Increase the number of species of waterfowl and of plants with known TME values. Although agricultural crops have been included in the most TME studies, waterfowl species-specific information is limited (e.g., How much variation exists between species of ducks for a single moist-soil seed?; regional TME variation) and should be examined. Priority plant species may include corn, milo, Japanese millet, browntop millet, soybean, and rice.*	Redo work of Loesch and Kaminski (1989) using soybeans, conventional and GMO corn, milo, moist-soil seeds, invertebrates on Mallards and one or more other species of dabbling and diving ducks.

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Food	Value of invertebrates in diets of waterfowl	II	*Metabolizable energy of aquatic invertebrates is low compared to agricultural seeds. They are likely an insignificant source of energy during winter for most duck species, although they may provide an important source of protein and other nutrients. McClanahan (2015) included a table listing all available true metabolizable energy (TME) values, including invertebrates, and McClain (2017) listed an average TME value of 0.9 kcal/gram based on available information. However, very limited information is available on energy value or other functions of aquatic invertebrates in the diets of ducks during fall, winter, and spring migration. Priority taxa may include chironomids, amphipods, oligocheates, planorbid snails, and other taxa identified through new diet studies, especially those conducted in spring.*	Following suggestions of Callicutt et al. (2011), additional diet studies could be conducted to help understand the amount of aquatic invertebrate use in SE, especially in late winter and early spring migration. More research may be needed to demonstrate the importance of invertebrates in providing protein and other nutrients.
	Energy value of natural wetland foods, such as moist-soil seeds and submersed aquatic vegetation	II	*Metabolizable energy of submersed aquatic vegetation is probably low compared to agricultural and moist-soil seeds. McClain (2017) listed an average TME value of 0.9 kcal/gram and included a table listing all available SAV TME values. However, very limited information is available on energy value or other functions of SAV in the diets of ducks during fall, winter, and spring migration. Priority plant species may include widgeongrass, hydrilla, chara, and Eurasian watermilfoil. Although natural seeds have been included in the most TME studies, waterfowl species-specific information is limited (e.g., How much variation exists between species of ducks for a single moist-soil seed?; regional TME variation) and should be examined. Priority plant species may include sesbania, ragweed, Walter's millet, red-root flatsedge, and others.*	Current research is ongoing (e.g., McClain 2017, Gross 2018) which will identify additional TME values of SAV. Additional TME information is needed to better understand energetic importance wetlands with aquatic bed vegetation.
	Development of a body condition index to quickly and efficiently evaluate waterfowl within various wetland types or regions	III	*See metabolite indices (e.g., Anteau et al. 2008, 2011) and body condition indices (Devries et al. 2008, Arsnoe et al. 2011)*	Blood metabolite indices could be tested on other species.
	Acorn availability	III	*Straub (2012) published estimates of acorn density in the Lower Mississippi Valley and Gray et al. (2013) included a table indicating acorn density at varying composition level of oaks.*	No additional research is recommended at this time.

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Food	Index method for estimating energy value of moist-soil wetlands	III/TR	*There are a number of acceptable indexes for predicting seed yield of moist-soil plants. Laubaun and Fredrickson (1992) and Gray et al. (1999a,b) provided regression equations using plant measurements to predict seed yield. Although accurate, these methods were time consuming and worked for a limited number of common moist-soil species. Gray et al. (2009) provided a new method for predicting seed yield of moist-soil plants using a dot grid or scanner and this method was recently adjusted to include benthic seeds and verified as robust to temporal and spatial variation by Osborn et al. (2017). Dr. Matt Gray currently has a seed head scanning service at the University of Tennessee and will develop DED estimates for a fee. The Waterfowl Management Handbook also provides a simplified method developed by Laubhan and was recommended by Strader and Stinson (2005). Naylor et al. (2005) developed a much simplified visual seed production index in California which was verified by Stafford et al. (2011) in Illinois and is included in the IWMM protocol. The Naylor seed production index is the most easily implemented and likely of sufficient quality for use in most applications on NWRs in the SE.*	Large scale verification of the Naylor index might be useful, but use of the Naylor index is probably reasonable in the meantime as suggested by IWMM protocol. This may be primarily a training need.
Other	Research evaluating importance of habitat in the Southeast to waterfowl	I	*Mallard migration model (Lonsdorf et al. 2016) and previous sensitivity analyses (Hoekman et al. 2002) are working examples. The USFWS Region 4 Waterfowl Working Group Communication Team has developed a background document summarizing current state of science on this topic.*	Conduct sensitivity analysis or develop individual-based models to understand how habitat conditions in the SE affect to waterfowl populations.
	Develop methods for establishing waterfowl forage and human dimensions objectives for National Wildlife Refuges	I	*Several Joint Ventures in the Southeast have done extensive work stepping down continental waterfowl objectives to the state and BCR level (e.g., GCJV, LMVJV, and ACJV geographies).*	Research may be needed to identify a biologically-based strategy for allocating energy objectives using a top-down approach rather than a "current operational capacity" approach. An SDM approach or workshop may be beneficial
	Wood duck banding programs	II	*Demonstrate necessity of wood duck banding data in the monitoring of continental waterfowl populations, especially the contribution of data from the southern portions of the Mississippi and Atlantic Flyways. Demonstrate how band return data can be useful in the SE Region.*	See white paper by Pam Garrettson, USFWS. Also see new research comparing BBS data to band return data - Zimmerman et al. (2017).
	Survival rates and Lincoln estimates from post season (fall/winter/spring) waterfowl banding programs	II	*Demonstrate usefulness of winter banding programs for SE Refuges and for larger-scale science needs (e.g., lesser scaup, black ducks, mallards). Pat Devers (USFWS) is currently evaluating usefulness of post-season banding program for black ducks and Arnold et al. (2016) demonstrated the value for lesser scaup.*	An analysis of existing winter banding data to estimate survival rates would be an excellent starting point.
	Canada goose molt banding	III	*Demonstrate usefulness of summer molt banding programs for NWRs in the SE or larger-scale science needs. See previous research from South Dakota and Ohio to estimate survival rates, yearly fidelity, pre-season movements, and dispersal.*	Demonstrate post-breeding season dispersal off NWRs and molt migrations to identify role of NWRs in supporting temperate-breeding Canada goose populations and harvest.

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Monitoring Methods	Optimal survey frequency	I	*Illustrate effects of weekly, biweekly, and monthly waterfowl survey spacing on annual use days, peak abundances, and other metrics*	There may be existing survey data available for this analysis from IWMM or research projects.
	Compare nocturnal vs. diurnal use of primary habitats	I	*Examine nocturnal vs. diurnal use of several different primary foraging habitats (e.g., corn, rice, moist-soil, forested, etc.) and quantify effects on densities, abundances, use days, and behavior using different survey timing. See Anderson & Smith (1999).*	Possibility may be to use a UAV with a thermal sensor to fly transects over area at night and during the day for comparison.
	Plant seed production estimates	II	*Develop biomass production (pound/ac or kg/ha) estimates for common moist-soil plant species for use in energetic carrying capacity estimation per the % composition method (e.g., Laubhan 1992).*	Use existing core sample data to develop means and ranges of seed density data.
	Develop SAV food production index	II	*Develop SAV assessment similar to Naylor et al. (2005).*	Gross (2018) developed an index for the Midwest, USA.
	Efficacy of cruise-style waterfowl surveys	III	*Compare results of typical refuge "cruise" surveys used as total counts to IWMM-style counts extrapolated up to the same area by habitat and overall.*	Conduct IWMM simultaneously as cruise-style surveys.
	Seed production index (SPI) species vs. all duck foods in moist-soil wetlands	III	*Compare biomass (kg/ha) from core samples from only species included in the SPI, all species considered duck food, and all duck food overall to see if SPI really reflects overall energy value of moist-soil wetlands. In other words, how conservative is the SPI?*	Existing core sample data can possibly be used for this analysis.