Evaluation of factors affecting food abundance and time-activity budgets of whooping cranes at Aransas National Wildlife Refuge

R. Douglas Slack, William E. Grant, Todd M. Swannack, and Jeffery R. Wozniak

Department of Wildlife and Fisheries Sciences
Texas A&M University
College Station, TX 77843-2258

Preliminary Proposal

Background

The recently completed SAGES study of whooping crane ecology at Aransas National Wildlife Refuge (ANWR) led to many comments, questions and criticisms about the relationships between freshwater inflows and crane energetics. It is important that these critical questions not go unanswered so that the proper management decisions can be made to protect the endangered crane population. The studies we propose are exactly what those who criticized our prior work said is most urgently needed.

Food chain and energy budget. Whooping crane diets consist of many different food items, however, blue crabs (*Callinectes sapidus*) have been documented as the major food source (Hunt and Slack, 1989; Chavez-Ramirez, 1996; Pugesek et al., 2008; Slack et al., 2009). As with any animal population, blue crab abundance fluctuates through time because of intrinsic (i.e., intra-population interactions) and extrinsic (i.e., environmental) factors (Turchin, 2003). Results from our recent study have shown that during years of low blue crab abundance whooping cranes utilize other food resources such as clams, snails, and insects (Slack et al., 2009). These other food items have been identified as less nutritious for whooping cranes (Nelson, 1996) and it has been suggested that a diet lacking blue crabs is detrimental to whooping crane vitality. In fact, Pugesek et al. (2008) correlated low blue crab abundance with whooping crane mortality on the wintering grounds and hypothesized that low blue crab abundance was the causal factor for higher whooping crane mortality.

However, a part of ecological theory (optimal foraging theory) states that top predators, like whooping cranes, will maximize the net rate of energy gain while foraging (Stephens and Krebs, 1986). Thus, as a preferred food resource becomes scarce, and increased searching costs reduce the net rate of energy gain, predators will “switch” to alternative, perhaps less nutritious but more abundant, prey that yield a higher net rate of energy gain. The concept of predators “switching” to alternative prey also is a central concept in both population and community ecology (Murdoch and Oaten, 1975). It follows that whooping crane diets low in blue crabs may not necessarily be detrimental to their vitality. Currently, an energetic budget has not been prepared using the energetic values of all of the available food items for cranes. In addition, the energetic expenses and gains for crane movements across the refuge to forage in uplands, visit freshwater sources, and to visit supplemental feeding sites have not been determined. A comprehensive evaluation of factors that affect the energy budget of whooping cranes, including the effect of supplemental feeding, is necessary to determine whether or not the cranes are energy limited in the ANWR marshes.

Hydrologic connectivity. The salt marsh at the ANWR within the Guadalupe estuary is a heterogeneous landscape of tidal creeks, inland bays, and intermittently connected ponds. Hydrological connectivity within the marsh is important ecologically because it affects salinity regimes, nutrient exchange, and the distribution and abundance of plant and animal species. For example, prolonged inundation allows aquatic organisms to migrate into the marsh, whereas periods of disconnection trap these organisms in ponds and also increase nutrient and mineral concentrations as surface water evaporates, which can impact marsh macrophytes (Mitsch and Gosselink, 2007; Miller et al., 2009). Recent studies at ANWR found correlations between salinity and productivity of the halophytic Carolina Wolfberry (*Lycium caroliniaum*) (Butzler and Davis, 2006), and between three abiotic factors (water level, salinity and wind speed) and the distribution and abundance of blue crabs (Slack et al., 2009). However, it is currently unclear how the inundation regime affects the abundance of these two species, both of which are important food items for whooping cranes (Hunt and Slack, 1989; Chavez-Ramirez, 1996; Slack et al., 2009). Flooding events that affect hydrological connectivity within the marsh, which are strongly influenced by a combination of tides, wind, and storm surges can be quite irregular. Given the importance of aquatic food items in the diet of the whooping cranes, and the potential impact the flooding regime has on these species, it is paramount to develop a clearer understanding of how hydrological connectivity affects marsh dynamics.

Supplemental feeding. During the 2008-2009 winter, food resources for whooping cranes at ANWR were scarce due to sub-optimal environmental conditions. In order to ensure birds received enough nutrition for their spring migration, ANWR personnel provided supplemental feed to the cranes. Given that supplemental feed has been provided to the birds, it is paramount to understand the energetic contribution this food source makes to the crane's overall energy budget and health.

Objectives of study

1) Determine and use the whooping crane time activity budget to develop an energetic model for whooping cranes wintering at ANWR.

2) Determine importance of marsh connectivity to the distribution and abundance of principle food items of cranes.

3) Evaluate the use and contribution of supplemental food sources.

Methods of study

Food chain and energy budget including supplemental feeding. For those whooping crane food items for which energetic values are unknown, samples will be collected at ANWR and processed at Texas A&M University following Nelson et al. (1996) to determine gross energetic values. In addition, all major known food items will be routinely sampled in the field and at upland sites following techniques of Pugesek et al (2008), Butzler and Davis (2006), and Hunt and Slack (1989). Time-activity budgets of cranes will be determined following methods of Chavez-Ramirez (1996). Behavioral observations of whooping cranes will be made from permanent and mobile blinds in marsh habitats (following Lafever, 2006), upland use sites including freshwater sites and at supplemental feeders. An effort will be made to observe birds at two sites (one with a feeder and one without a feeder) an equal number of times. Energetic budgets will be modeled in relation to marsh connectivity regimes and various other abiotic factors. These energy budgets, along with literature information, will be used to develop a daily energy balance model, formulated as a compartment model based on difference equations. Personnel from ANWR will work with the SAGES team both in development of specific methodologies and in management of supplemental feeding stations.

Hydrologic connectivity. We propose to study the inundation regime of the salt marshes of ANWR using both field methodologies and state-of-the-art computer modeling techniques. Field methodologies will follow that of Butzler and Davis (2006) and Miller et al., (2009). Briefly, we will use pressure water level data loggers (Infinities USA) to monitor water levels and salinities in a tidal creek and multiple intermittently-connected ponds within representative whooping crane territories. These recorders will provide real-time data that we can use to determine inundation regimes and salinity dynamics of the marsh. Computer modeling techniques will include developing a spatially-explicit, dynamic model that simulates marsh inundation and records the water level at which each area first becomes inundated. Simulated areas will not be inundated based exclusively on their elevation, but rather based on their sea-level connection, which we define as the water level at which water can first find its way into the area. Thus, as simulated water levels rise, some areas of lower elevation will flood later than some areas of higher elevation if water must breach a dike to reach the lower area. The model will simulate water loss via evapotranspiration in unconnected ponds using Hargreaves equation (Hargreaves *et al.*, 1985). The model will be evaluated by comparing simulated daily water-level changes in the tidal creeks and representative intermittently-connected ponds associated with each territory to patterns in water levels observed in the field during the periods represented by these time series. Once the model has been calibrated, it will allow us to test, via simulation, various hypotheses regarding cause-effect relationships between hydrological connectivity and the distribution and abundance whooping crane food items within the marsh.

Budget

Item	Year Jan. 2010-Dec. 2010	Jan. 2011-Aug. 2011
Salaries*	$126,840.00	$131,508.00
Equipment and supplies**	$94,150.00	$30,000.00
Total Direct	$220,990.00	$161,508.00
Indirect (15%)	$33,148.50	$24,226.20
Total Cost	$254,138.50	$185,734.20
Grand Total	$439,872.70	

Schedule

If authorization to proceed is timely received, field work will begin January 2010. Draft of the final report will be delivered 31 August 2011. In addition to the final draft, we will provide quarterly reports to the sponsors and the staff of ANWR.

Literature Cited

Butzler, R.E. and S.E. Davis. 2006. Growth patterns of Carolina Wolfberry (*Lycium carolinianum L.)* in the salt marshes of Aransas National Wildlife Refuge, Texas USA. Wetlands. 26:845-853.

Chavez-Ramirez, F., 1996. Food availability, foraging ecology, and energetics of whooping cranes wintering in Texas. Ph.D. Dissertation, Texas A & M University, College Station, Texas.

Hargreaves, G.L., Hargreaves, G.H. and Riley, E.P., 1985. Agricultural benefits for Senegal River Basin. Journal of Irrigation and Drainage Engineering, 111:113-124.

Hunt, H.E. and R.D. Slack. 1989. Winter diets of whooping and sandhill cranes in South Texas. Journal of Wildlife Management 53:1150-1154.

LaFever, K. E. 2006. Spatial and temporal winter territory use and behavioral responses of whooping cranes to human activities. Masters Thesis, Texas A&M University, College Station, Texas, USA.

Miller, C. J., S. E. Davis III, D. L. Roelke, H. P. Li, M. J. Driffill. 2006. Factors influencing algal biomass in intermittently connected, subtropical coastal ponds. Wetlands. 29:759-771.

Mitsch W. J. and J. G. Gosselink. 2007. Wetlands. John Wiley and Sons, Inc. Hoboken, New Jersey.

Murdoch, W. W., and A. Oaten. 1975. Predation and population stability. Advances in Ecological Research 9:1-131.

Nelson, J.T., R.D. Slack and G.F. Gee. 1996. Nutritional value of winter foods for whooping cranes. Wilson Bulletin 108:728-739.

Pugesek, B.H., M. J. Baldwin and T. V. Stehn. 2008. A low intensity sampling method for assessing blue crab abundance at Aransas National Wildlife Refuge and preliminary results on the relationship of blue crab abundance to whooping crane winter mortality. Proceedings of the tenth North American Crane Workshop. Pp. 13-24.

Slack, R. D., W. E. Grant, S. E. Davis, T. M. Swannack, J. Wozniak, D. Greer and A. Snelgrove. 2009. Linking freshwater inflows and marsh community dynamics in San Antonio Bay to Whooping Cranes. Submitted to Guadalupe-Blanco River Authority and San Antonio River Authority. 188 pp.

Stephens D.W. and J. R. Krebs. 1986. Foraging Ecology. Princeton University Press. Princeton, New Jersey.

Turchin, P. Complex Population Dynamics. 2003. Princeton University Press. Princeton, New Jersey.