PROJECT TITLE: Montana Prairie Pothole Region Breeding Shorebird and Breeding Waterfowl Monitoring Project

FY Requested	FY Funded
2014	2014

Project Proposal

NWR: BOWDOIN WETLAND MANAGEMENT DISTRICT

RFP ID: 61585-194-2013

Project Type:	Focus:	Scale:
Monitor	Migratory Birds	Multi-station

☑ Staff Biologist?

☑ This proposal has station support?

☑ FWS protocols were followed regarding data managment?

☑ This proposal supports a priority in a CCP/ HMP or other refuge plan

Benton Lake Wetland Management District CCP Objective; Preserving Intact Landscapes Objective 1:Over the next 15 years, protect 170,000 acres of wildlife habitat (grassland, wetland, riparian areas, sagebrush-steppe, and forest) that support intact, functional landscapes, protect high priority habitat and linkage zones for Service trust species, increase resiliency for climate change and other stressors and support working landscapes within refuge complex conservation areas (pg 121 of CCP).Bowdoin Lake Wetland Management District CCP Objective; Habitat Protection and Acquisition Objective 1: Over the next 15 years, protect at least 900 acres of depressional wetlands and 16,000 acres of grasslands on private land within the refuge complex through the purchase of perpetual conservation easements or fee title from willing sellers (pg156 of CCP).

☐ This proposal supports a "Top Region 6 Priority"

PROJECT DESCRIPTION

The purpose of this project is to develop landscape-scale habitat models that identify priority conservation areas for both breeding shorebirds and breeding waterfowl in the Bowdoin and Benton Lake Wetland Management Districts (WMDs). These models and their application in a Geographic Information System (GIS) will provide decision support tools to target easement and fee-title acquisition within the WMDs. Populations of several shorebird species in the Prairie Pothole Region (PPR) appear to be declining, largely because of loss of grasslands and wetlands. Marbled godwit (Limosa fedoa), long-billed curlew (Numenius americanus), willet (Tringa semipalmata), Wilson's phalarope (Phalaropus tricolor), upland sandpiper (Bartramia longicauda), American avocet (Recurvirostra americana) and Wilson's snipe (Gallinago delicata) are listed as priority species by Partners in Flight (Casey 2000) or the U.S. Shorebird Plan (Brown et al. 2001). Millions of dollars are spent annually in the PPR for conservation of breeding waterfowl (Neimuth et al. 2009). However, little money has been dedicated to protecting habitat for shorebirds breeding in the PPR. By identifying and conserving areas where high-priority breeding shorebird habitat overlaps with high-priority habitat for breeding waterfowl we can begin to integrate conservation of non-game wetland dependent species with waterfowl conservation. This is a long-term adaptive process that includes updating models with annually collected survey data to update and improve model performance. Reductions in the 2013 budget resulted in fewer technician hires and the surveys could not be completed according to protocol. These missing data can result in models with lower precision and accuracy compared to fully informed models with complete survey data. We are requesting the assistance of a GS-5 biological technician for the 2014 field season to help complete all surveys.

OBJECTIVES

This monitoring project will be used to develop breeding shorebird models, improve upon existing, species specific, breeding waterfowl models and to estimate the density and distribution of breeding shorebirds and breeding waterfowl across the area. Results will be applied in a GIS to produce maps which will identify priority areas for conservation treatments in the Bowdoin and Benton Lake WMDs of north-central Montana.

DESIGN AND METHODS

The study area encompasses the Benton Lake and Bowdoin Wetland Management Districts in north-central Montana. The WMDs include approximately 18.6 million acres (see attached map) of interspersed cropland, mixed grassland, and shrubland with a gradient of wetland communities ranging from dense to sparse with rivers and streams distributed throughout the landscape. Breeding Shorebird Survey DesignShorebird survey routes were selected using a random stratified sampling method (Lohr 1999). In an attempt to capture the environmental gradient of the study area, approximately 50 potential routes were identified where 25 mile road segments crossed more than one ecoregion (Woods et al. 2002), as we expected these routes would have a greater variability in habitat resources. Potential routes were then buffered by the detection distance for a stop (400 meters) and wetland basins within the buffered area summed. The summed wetland areas were then divided into four equal quantile strata. A Neyman optimal allocation (Neyman 1934) was used to estimate the number of routes to run in each stratum. We estimated that we could run about 14 routes and used the optimal allocation anticipating that it would reduce the variability in our response (shorebirds detected). Once the estimated number of routes per stratum was identified, a simple random sample within each stratum identified the specific routes to run. Stops were then placed at ½ mile (0.8 km) intervals along the length of the route, except in a few cases where road layout interfered with systematic stop placement. Stops are typically ¼ mile from intersections and section lines. However, not all legal sections are 1 mile square so some stops are slightly more or less than ½ mile apart. Breeding Shorebird Data CollectionPrior to the start of shorebird surveys we will ensure all observers are able to identify the seven target shorebird species by sight and sound and are familiar with the survey protocol (see attached). Breeding shorebird surveys will be conducted using a modified version of the Breeding Bird Survey (BBS) protocol (Bystrak 1981) following the methods of Neimuth et al. 2009.Each shorebird route will be surveyed twice to encompass the breeding phenologies of the different shorebird species in the study area. Field observers will visit each shorebird route once during the period May 1 – May 15 and again during the period June 1 – June 15. Routes will be assigned to field observers and all 50 stops within a given 25 mile route will be surveyed in a single day when conditions allow. Routes will be consistently surveyed from east to west. If the survey of particular route cannot be completed in one

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day due to weather or accessibility issues the route will be re-surveyed the following day starting at the beginning of the route. If a survey is terminated due to high winds (> 20 mph), the observer will record the average wind speed (mph) and the maximum wind gust (mph) during a 15 second time period, using a Kestrel wind/temperature meter. Surveys will begin at sunrise and should be completed in approximately four hours. Observers will use hand-held GPS receivers, vehicle odometers and aerial photos to aid in locating stops. At the first and last stop of a given route, observers will record time, average wind speed (mph) over 15 seconds, and temperature (F) using a Kestrel wind/temperature meter. Only one observer will count birds, and focus only on species listed on the data form. Counting will be done during a three minute period measured using a stopwatch, from outside the vehicle, at a stationary point. Observers will scan uplands as well as wetlands, as several of these species make extensive use of uplands. Every bird seen and heard within 1/4 mile (400 m) will be counted during the three minutes at each stop. Observers will note the direction and likely destination of birds leaving the current stop to reduce the possibility of recounting birds. Any bird detected before or after the three minute survey period will be recorded in the comments section of the datasheet along with the stop number. Surveys will be discontinued in the case of unsatisfactory weather including steady drizzle or prolonged rain, fog, or excessive wind (> 20 mph). If a survey is interrupted by inclement weather, observers will wait up to half an hour and resume the survey, if possible. If inclement weather lasts longer, a note will be made in the comments that the survey was terminated. If observers encounter excessive noise at a stop and the disturbance lasts < 45 seconds they will ignore it. Otherwise, they will temporarily suspend the count until the offending noise has ceased or moved on. Counting may be extended by 1 minute at stops with excessive, prolonged noise.Breeding Waterfowl Survey DesignBreeding duck surveys will be conducted on a sample of wetland basins. A two-stage stratified random sampling design (Cochran 1977) was used to determine which wetland basins would be sampled. This was done to account for the variation in basin densities across the landscape and the variation in the composition of the 6 basin classes. The study area was divided into 4-mi2 primary sampling units (hereafter plots) using aggregated 1-mi2 public land survey sections. Plot size was chosen to approximate the home range size of a breeding mallard hen (Cowardin et al. 1988). Individual wetland basins within a plot served as secondary sampling units in the two-stage sampling design. Clustering sample wetland basins within survey plots will increase the number of sampled basins by reducing travel time for a limited number of field observers. The survey plots were divided into four strata to minimize the variance in the breeding duck counts. Ideally, each survey plot would have been assigned to a stratum based on the expected number of breeding duck pairs occupying the plot. Since these data were not available, the plots were categorized based on the best surrogate of breeding duck pairs from previous modeling efforts in the U.S. PPR. Reynolds et al (2006) found the square root of wetland basin surface area to be the most significant predictor of breeding pairs. The square root of wetland basin surface area was calculated for each basin within a survey plot and then summed for all basins within a plot to estimate the potential number of breeding ducks within each survey plot. Plots with no basins were removed from the study.Sample size is based on budgetary constraints rather than trying to achieve a specific statistical power.
It was estimated that the available field observers would be able to survey approximately 700 basins dispersed among 61 plots based on previous breeding waterfowl survey efforts in the U.S. PPR. The 61 plots were allocated among strata using Neyman optimum allocation methods (Neyman 1934). Sample basins were stratified on basin class then randomly selected from all available basins within the sample plots. The optimal allocation of wetland basin class strata avoided oversampling classes with smaller variances, such as temporary basins, that are more numerous and may be dry more frequently than other classes (Reynolds et al. 2006). Approximately 750 wetlands were included in the sample in anticipation of access to some basins being denied. Breeding Waterfowl Data CollectionPrior to beginning breeding waterfowl surveys all observers will be trained on identification of

waterfowl and survey protocol (see attached). Breeding waterfowl surveys will follow the methods described by Cowardin et al. (1995). Each sample basin will be surveyed twice to encompass the breeding phenologies of the different waterfowl species in the study area. Field observers will visit each sample wetland once during the period May 1 – May 15 and again during the period May 20 – June 4. Survey plots will be assigned to field observers and all sample basins within a given 4 mi2 plot will be surveyed in a single day when conditions allow. Permission, weather, accessibility, wetness, numbers of birds, numbers of sample basins, and size of wetlands will affect the rate at which plots can be surveyed. If the survey of basins within a plot cannot be completed in one day, the remaining basins will be surveyed the following day. Surveys will begin mid-morning and continue until mid-late afternoon and will be discontinued during steady rainfall or winds exceeding 20 miles per hour. Hardcopy, plot-based maps will be provided to crew members depicting the perimeter and unique numerical identifier of the sample basins. Color aerial photography (National Agricultural Imagery Program [NAIP] 2005) is overlaid on the maps to assist observer orientation and navigation to survey wetlands. Field observers will be provided with hand-held GPS receivers for navigation purposes. Landowner contact information will be included on the hardcopy maps. We will use the methods described by Dzubin (1969) and Hammond (1969) to record duck population data. Sample basins will be accessed on foot or at a distance by all-terrain vehicles (ATV) to reduce disturbance. The entire wetland basin will be scanned instantaneously and unique duck social groups of all species separately tallied. Social groups will be determined by behavior and spatial arrangements of different waterfowl species. A social group is defined as > 1 duck of the same species associating with each other in close proximity and not exhibiting territorial or aggressive behavior towards one another. Social groups will be recorded on data cards using fractional notation with the number of males / number of females for each social group present (e.g., 1 male gadwall and 1 female gadwall = 1/1) (Dzubin 1969). Data will be recorded for all wetland basins that contain surface water regardless of whether birds are present. Observers will disturb dense vegetation in sample basins to count all ducks present. Only waterfowl that settle on the water during observation will be counted. If observer disturbance causes ducks to leave the sample basin, the birds will be counted and the direction and likely destination of birds leaving the wetland will be noted to reduce the possibility of recounting birds on sample basins that have not yet been surveyed. Field observers will collect information on basin characteristics once the waterfowl survey is completed. The extent of the wetland area of the sample basin will be estimated as percent full by comparing the current surface water with the NWI wetland basin polygon on the field map. A basin with no surface water will be recorded as dry and will not be surveyed for waterfowl. Additionally, the vegetative cover class will be determined by patterns of vegetation and open water interspersion (Stewart and Kantrud 1971).

DATA ANALYSIS/MODELS

Breeding Shorebird Data AnalysesWe will examine various landcover and climatic variables at several spatial scales using ESRI's ArcMap Ver. 10.2 software (available from: http://www.esri.com). Model analyses will be completed using R (R Development Core Team 2011). Before developing a list of competing candidate models, all habitat covariates will be evaluated for collinearity, at multiple spatial scales, through inspection of pairwise plots and corresponding correlation coefficients. Any combination of covariates with correlations > |0.6| will be considered highly collinear and will not be included together in models. The total number of breeding shorebirds observed at each stop will be modeled using generalized linear mixed models, a Poisson distribution, and log-link function. The Poisson distribution is commonly used when analyzing discrete count data when large counts are rare events (Neter

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et al. 1996, Agresti 2007). Lack of independence in the repeated measures will be accounted for using a compound symmetrical correlation structure. Models will be ranked using ΔAICc and model weight to determine the models best suited for making predictions (Burnham and Anderson 2002). Currently, goodness-of-fit methods for generalized linear mixed models are not well defined (Pan and Lin 2005). Repeated (n=10) 10-fold cross validation (Rodrigues et al. 2010) will be used as a form of goodness-of-fit to 1) assess the predictive ability of the best fitting models and 2) calculate a squared correlation coefficient value that summarizes the discrepancy between observed values and predicted values (R2). Although the root mean square error (RMSE) is a frequently-used measure of the differences between values predicted by a model and the values actually observed, mean absolute error (MAE) is a measure that is more robust to outliers in the data that can result in large RMSE estimates (Willmott and Matsuura 2005). Both RMSE and MAE will be calculated and reported in the cross validation results. We will explore additional methods of analyses including N-mixture models (Royle 2004) and hierarchical models (Royle and Dorazio 2008).Application of Model ResultsThe ArcGIS Spatial Analyst software extension will be used to apply regression coefficients from the top models for each species to the covariates for the study area to create density and distribution maps. These maps will provide a decision support tool for field staff to target conservation actions.AssumptionsSeveral assumptions will be made throughout this study. We assume field observers will correctly locate each stop and instantaneously scan, correctly identify, and count all breeding shorbirds of the target species.The competing model analysis will also incorporate several assumptions. Repeated measures GLMM assume 1) within-subject (i.e. sample basin) variation lower than among subjects 2) adjacent observations are likely to be more correlated than more distant observations 3) heterogeneous variances 4) normally distributed random effects 5) fixed X. These assumptions and their potential violation will be addressed in discussion of analyses results.InferenceIt is difficult to make causal inferences when unknown confounding covariates are present in the observed processes. Although the associations identified from this study will provide insight to land managers on local- and landscape-scale habitat characteristics important to breeding shorebirds in the study area, sound inference can only be achieved through long-term data encompassing the variation in landscape resources over time.Breeding Waterfowl Data AnaylsesSee breeding shorebird analyses methods above.

REVIEWERS:

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PARTNERS

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SOURCES OF SUPPORT:

Years Funding Requested: 1

Request From I&M Program:	$24,500.00	Salary & Benefits:	$23,000.00
Contributed By Station:	$0.00	Equipment:	$0.00
Contributed By Partners:	$19,000.00	Contracts:	$0.00
Allocation Grand Total:	$43,500.00	Travel:	$1,500.00
		Other:	$0.00

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		Year 1		Year 2		Year 3
Personnel 1:	Biological Technician	$23,000.00				
Personnel2:						
Personnel3:						
Salary and Benefits Sum:		$23,000.00				
Equipment:		$0.00				
Contracts:		$0.00				
Travel:		$1,500.00				
Other:		$0.00				
Project Cost IM:		$24,500.00		$0.00		$0.00
Station Contribution:		$0.00				
Partner Contribution:	Prairie Pothole Joint Venture (PPJV) is providing 1 term GS-7 biological technician.USFWS Habitat and Population Team (HAPET) is providing vehicle, field equipment (Spotting scope, binoculars, Kestrel wind/temp meter, stopwatch, field vehicle, gps unit) and desktop computer.	$19,000.00				

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Project Cost Totals:	$24,500.00	$0.00	$0.00
Allocation Totals	$43,500.00		$0.00

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	Year 4		Year 5	
Personnel 1:				
Personnel2:				
Personnel3:				
Salary and Benefits Sum:				
Equipment:				
Contracts:				
Travel:				
Other:				
Project Cost IM:		$0.00		$0.00
Station Contribution:				
Partner Contribution:				
Project Cost Totals:		$0.00		$0.00
Allocation Totals		$0.00		$0.00

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DATA MANAGEMENT:

Description of data entry, verification, editing and software.

Field observers will be trained on data collection methods described in project protocols and data forms will be provided. Upon return from the field data will be entered into the shorebird MS Access database and the Four Square Mile MS Access database. Metadata will be created for newly collected or produced biological and spatial data according to Executive Order 12906. All data including MS Access databases, protocols, field maps, photographs, reports and prioritization maps will be stored in hardcopy in biologist files and electronically on a Windows 2008 Server with a backup tape library for full and incremental backups to tape. Backup tapes and hard copies will be stored in fireproof file cabinets at Benton Lake NWR.

Please describe metadata including the who, what, where, and when of the data.

Please describe data security and archiving. Provide the schedule and location for regularly backing up files.

STATUS AND RESULTS

ADDITIONAL INFORMATION:

LITERATURE CITED:

Agresti, A. 2007. An Introduction to Categorical Data Analysis, Second edition. John Wiley & Sons, Inc., Hoboken, New Jersey.Akaike, H. 1973. Information theory and an extension of the maximum likelihood principle. Pages 267-281 in International symposium on information theory, Akademiai Kiado, Budapest, Hungary.Bolker, B. 2008. Generalized linear mixed models: a practical guide for ecology and evolution. Trends in Ecology and Evolution 24:127-135. Breslow, N.E., and D.G. Clayton. 1993. Approximate inference in generalized linear mixed models. Journal American Statistical Association 88:9-25.Brown, S., C. Hickey, B. Harrington, and R. Gill, eds. 2001. U. S. Shorebird Conservation Plan, 2nd ed. Manomet Center for Conservation Sciences, Manomet, MA. 60 p.Burnham, K.P., and D.R. Anderson. 2002. Model selection and multimodel inference: a practical information-theoretic approach. Springer-Verlag, New York, New York, USA.Bystrak, D. 1981. The North American Breeding Bird Survey. Studies in Avian Biology 6:34–41. Casey, D. 2000. Partners in Flight Bird Conservation Plan Montana Version 1.1. Montana Partners in Flight, Montana Department of Fish, Wildlife and Parks, Kalispell.Cliff, A.D., and J.K. Ord. 1981. Spatial processes: models and applications. Taylor & Francis.Cochran, W.G. 1977. Sampling Techniques, 3rd ed. John Wiley and Sons, Inc. New York, New York.Cowardin, L.M., D.H. Johnson, T.L. Shaffer, and D.W. Sparling. 1988. Applications of a simulation model to decisions in mallard management. U.S. Fish

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and Wildlife Service Technical Report 17. 28 p.Cowardin, L.M., T.L. Shaffer, and P.M. Arnold. 1995. Evaluations of duck habitat and estimation of duck population sizes with a remote-sensing-based system. National Biological Service Biological Science Report 2., Wasington, D.C.Dzubin, A. 1969. Assessing breeding populations of ducks by ground counts. Pages 178–230 in Saskatoon Wetlands Seminar. Canadian Wildlife Service Report Series 6, Ottowa, Ontario, Canada.Environmental Sciences Research Institute. 2006. ArcGIS Version 10.2. Redlands, California, USA.Hammond, M.C. 1969. Notes on conducting waterfowl breeding population surveys. Pages 238–258 in. Saskatoon Wetlands Seminar. Canadian Wildlife Service Report Series 6, Ottowa, Ontario, Canada.Hurvich, C.M., and C.L. Tsai. 1989. Regression and time-series model selection in small samples. Biometrika 76:297-307.Legendre, P. 1993. Spatial autocorrelation: Trouble or new paradigm? Ecology 74:1659-1673.Lohr, S.L. 1999. Sampling: Design and Analysis. Brooks/Cole Publishing Company. Pacific Grove, California. Niemuth, N.D. , R.E. Reynolds , D.A. Granfors , R.R. Johnson , B. Wangler , and M.E. Estey. 2009. Landscape-level planning for conservation of wetland birds in the U.S. Prairie Pothole Region. Pages 533–56 in Millspaugh, J.J. and F.R. Thompson. eds. Models for Planning Wildlife Conservation in Large Landscapes. Elsevier Academic Press, New York, New York.Neyman, J. 1934. On the two different aspects of the representative method: The method of stratified sampling and the method of purposive selection. Journal of the Royal Statistical Society 97:558-606.Neter, J., M. H. Kutner, C. J. Nachtsheim, and W. Wasserman. 1996. Applied Linear Statistical Models. McGraw-Hill, Boston, Massachusetts.Pan, Z., and D.Y. Lin. 2005. Goodness-of-fit methods for generalized linear mixed models. Biometrics 61:1000-1009.R Development Core Team. 2011. A language and environment for statistical computing. R. Foundation for Statistical Computing, Vienna, Austria. ISBN 3- 900051-07-0. Retrieved from http://www.R-project.orgReynolds, R.E., T.L. Shaffer, C.R. Loesch, and R.R. Cox. 2006. The Farm Bill and duck production in the Prairie Pothole Region: Increasing the benefits. Wildlife Society Bulletin 34:963-974.Rodríguez, J.D. ,A. Pérez, J.A. Lozano. 2010 Sensitivity analysis of k-fold cross validation in prediction error estimation. IEEE Transactions on Pattern Analysis and Machine Intelligence 32:569-575.Rosenberg, M.S. 2001. PASSAGE. Pattern analysis, spatial statistics, and geographic exegesis. Version 1.0. Department of Biology, Arizona State University, Tempe, Arizona.Royle, J.A. 2004. N-mixture models for estimating population size from spatiallyreplicated counts. Biometrics 60:108–115.Royle, J.A. and R.M. Dorazio. 2008. Hierarchical Modeling and Inference in Ecology: The Analysis of Data from Populations, Metapopulations, and Communities. Academic Press, San Diego, California. Stewart, R.E., and H.A. Kantrud. 1971. Classification of Natural Ponds and Lakes in the Glaciated Prairie Region. Resource Publication 92. Washington, DC: US Fish and Wildlife Service.U.S. Fish and Wildlife Service. 2012. Comprehensive conservation plan, Benton Lake National Wildlife Refuge Complex, Montana. Lakewood, Colorado: U.S. Department of the Interior, U.S. Fish and Wildlife Service. 305 p.U.S. Fish and Wildlife Service. 2011. Comprehensive conservation plan: Bowdoin National Wildlife Refuge Complex. Lakewood, Colorado: U.S. Department of the Interior, U.S. Fish and Wildlife Service. 276 p.Williams, B.K., M.D. Koneff, and D.A. Smith. 1999. Evaluation of waterfowl conservation under the North American Waterfowl Management Plan. Journal of Wildlife Management 63:417-440.Woods, A.J., J. Omernik, M. Nesser, J.A. Shelden, J.A. Comstock, and S. H. Azevedo. 2002. Ecoregions of Montana, 2nd edition (color poster with map, descriptive text, summary tables, and photographs). Map scale 1:1,500,000.Zuur, A.F., E.N. Ieno, N.J. Walker, A.A. Saveliev, and G. Smith. 2009. Mixed Effects Models and Extensions in Ecology with R. Springer, New York, New York.