



Inventory and Monitoring Plan

Two Rivers National Wildlife Refuge



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Signature Page¹

<i>Action</i>	<i>Signature /Printed Name</i>	<i>Date</i>
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Introduction

This inventory and monitoring plan (IMP) documents the inventory and monitoring surveys that will be conducted at Two Rivers National Wildlife Refuge from 2014 through 2029, or until the refuge's Comprehensive Conservation Plan (CCP) and Habitat Management Plan (HMP) are revised.

The majority of surveys considered in this plan address resource management objectives identified in the HMP (2012) for this refuge. Other surveys are a continuation of past monitoring conducted for the purpose of understanding long-term trends in specific resources or are part of regional and national survey efforts. This IMP was developed according to the Inventory and Monitoring (I&M) policy (701 FW 2) for the National Wildlife Refuge System.

Two Rivers NWR was established in 1958 as part of the Mark Twain NWR complex. Two Rivers NWR is headquartered near the small town of Brussels, Illinois, in Calhoun County, only 20 air miles from St. Louis, Missouri. This location is near the confluence of the Mississippi and Illinois Rivers. The Refuge includes six divisions - Calhoun, Gilbert Lake, Batchtown, Portage Island, Apple Creek, and Clarksville Island totaling 9,360 acres. Spanning 60 miles of the Mississippi River, and 9 miles of the Illinois River, the Refuge functions as an important link for migratory birds that rest, feed, and winter along the Mississippi Flyway.

Methods

Station staff generated a list of extant and anticipated surveys by generating a list of all observational efforts to gather information on refuge resources. This extensive list was later refined to exclude general observations (reconnaissance) of refuge resources that do not require protocols or data management. The remaining surveys were then assigned a priority score using 17 pre-defined criteria (Appendix A). Priority scores were used to assign the survey to one of three groups that ranked the surveys (Appendix B).

Prioritizing and Selecting Surveys

The priority ranking of surveys was determined during a one-day meeting at Two Rivers NWR on March 6th, 2013. Refuge Manager John Mabery and Refuge Wildlife Biologist Ken Dalrymple, met with Region 3 Zone Biologist Brian Loges to prioritize the surveys. Background information for each survey was summarized in advance by the Wildlife Refuge Biologist and briefly discussed prior to prioritizing the surveys. The 17 criteria, assignment rules, weighting and score calculation process followed the Criteria for Prioritizing Surveys Entered into the

PRIMR Database ²(Appendix A). The Two Rivers Refuge staff made all decisions required to produce the survey priority scores (Appendix B).

Estimating Capacity

A cost-benefit analysis (Appendix C) was performed to maximize the value of the selected surveys, given staffing and budget constraints. Selecting only surveys that can be conducted with anticipated resources should lead to high quality surveys, e.g., commitment to all components of conducting a survey (planning, administration, implementation, data analysis and archiving, reporting and feedback to management). Following the completion of the cost-benefit analysis, two cost-efficient inventories were added to the set of selected surveys (forest inventory & bathymetry).

In the cost-benefit analysis, the value of a selected survey was estimated from the priority score from the SMART ranking process, adjusted for frequency over the life of the IMP. The adjustment helps to identify low frequency surveys with high cost efficiencies (for example, one-time inventories). To determine a budget constraint, the staffs responsible for completing natural resource surveys were asked to estimate the portion of their time in a typical year dedicated to activities associated with conducting surveys: data analysis and summary, data management, monitoring, research, and supervision. The time dedicated to surveys was converted to weeks. The time required to implement an annual iteration of a survey was also estimated using past experiences with established protocols or anticipated commitment for protocols that have yet to be developed.

Results: Selected Surveys

The prioritization and cost benefit analysis were used in deliberative selection of surveys to be completed over the life of the IMP. In addition to the priority scores, the level of effort required to complete a survey as well as input from Region 3 Migratory Birds Division and Rock Island Ecological Services was considered in the selection process. Selected surveys include surveys identified for completion with FY2014 levels of staffing and support (Table 1). The list of surveys selected for implementation with existing resources represents a commitment to implementation by refuge staff. Changes in available capacity, CCP objectives, or other factors that alter the list of selected surveys through addition or removal of selected surveys will trigger a revision of this IMP (701 FW 2) and updates to the PRIMR database.

The process identified 6 surveys that can be completed with current staffing levels and budget for the duration of this IMP (Table 1). Survey names were updated after the ranking exercise based on national and regional lists of standardized names, available protocols and companion surveys that must be completed simultaneously to maximize value.

² Planning and Reporting Inventory and Monitoring at Refuges (PRIMR) Database (<https://ecos.fws.gov/primr/index.gsp>). A database developed by the I&M initiative that describes and archives the surveys conducted on refuges, and which is also used to generate summaries for an IMP.

List of Selected Surveys and Rationale for Selection

Name	Rationale
Integrated Waterbird Management & Monitoring Initiative	Most of the refuge's habitat management efforts are focused on managing wetlands for multiple waterbird guilds. Eight of the focal species listed in the Habitat Management Plan are addressed by this survey. The refuge will also use this protocol to track management actions, water levels, and vegetation communities in important wetland impoundments.
Swan Lake Habitat Monitoring	A key objective of the habitat management plan calls for restoring aquatic vegetation in the middle unit of Swan Lake. This survey will monitor turbidity and percent cover of aquatic vegetation in the refuge's largest and most challenging management unit.
<i>Boltonia decurrens</i> surveys	The refuge will ensure that populations of this federally listed plant species are monitored on a routine basis.
Invasive Species Inventory	A baseline inventory of invasive species in all herbaceous habitats will support an early detection and control approach to invasive species management.
Bathymetry Surveys	Detailed elevation data for Swan Lake, Gilbert Lake, and Batchtown management units is required to inform decisions on water level manipulations.
Forest Inventory	Provides a baseline forest composition and structure information for refuge divisions dominated by forest cover. Expands US Army Corps of Engineers' Forest Inventory beyond General Plan lands.

Fish community surveys, invasive treatment monitoring, and moist-soil seed production are three surveys with high priority rankings that were not selected for implementation. However, all three will received further consideration after committing resources to the selected surveys. The fish community survey would require the expertise of a fisheries biologist, most likely attained through cooperation with the Carterville Fisheries Office, or as a contract with the Illinois Natural History. Invasive treatment monitoring would follow the methods outlined in Wood and Blomquist 2011. This approach is labor intensive but could be done by engaging temporary survey crews comprised of volunteers, interns, or youth crews. In past years, moist-soil seed production surveys have provided Kcal estimates for the two Swan Lake units following the methodology of Gray (2009). The estimates are rapid, cost only a few hundred dollars for analysis and will likely be implemented only in draw-down years, provided the effort does not interfere with the implementation of the selected surveys.

Table 1. Surveys selected for conduct at Two Rivers National Wildlife Refuge 2014—2028.

Survey Priority ¹	Survey ID Number ²	Survey Name ³	Survey Type ⁴	Survey Status ⁵	Mgmt. Objective Id ⁶	Survey Area ⁷	Staff Time (FTE) ⁸	Avg. Ann Cost (OPR) ⁹	Survey Timing ¹⁰	Survey Length ¹¹	Survey Coord. ¹²	Protocol Citation ¹³	Protocol Status ¹⁴
1	FF03RT RW00-033	Integrated Waterbird Management and Monitoring Initiative	CM	Current	HMP / 5.B, 1.B, 7.B, 3.F, 7.A., 3.E, 7.E, 1.A	Multiple management units: Calhoun, Gilbert Lake and Batchtown Division	FWS: 0.0	\$2,700	weekly/Recurring every year	2010-Indefinite	Refuge Biologist	Loges et al. 2014	National In Review
3	FF03RT RW00-031	Swan Lake Habitat Monitoring	M	Current	HMP / 5.B, 1.B, 4.B. , 7.A., 1.A	Single management unit: Swan Lake	FWS: 0.04	\$1,500	spring/summer/fall/Recurring every year	2013-Indefinite	Refuge Biologist	Yin et al 2000	Initial Survey Instructions
4	FF03RT RW00-021	Boltonia decurrens Survey	CM	Expected	HMP / 3.C., 7.E	Single management unit: Gilbert Lake Unit	FWS: 0.02	\$1,000	August/Sep t/Recurring every two years	2013-Indefinite	Refuge Biologist	USFWS Rock Island ES	Initial Survey Instructions
5	FF03RT RW00-019	Invasive Species Inventory	M	Expected	HMP / 1.A	Entire station	FWS: 0.02, Other: 0.04	\$1,000	Recurring every year	2014-2028	Refuge Biologist	Edvarchuk, K. and C. Ransom. 2012	Initial Survey Instructions
7	FF03RT RW00-026	Bathymetry	M	Current	HMP / 4.B.	Multiple management units: Calhoun, Gilbert Lake, and Batchtown Divisions	FWS: 0.04	\$1,000	Recurring every five years	2013-Indefinite	Refuge Biologist	(none)	Initial Survey Instructions
10	FF03RT RW00-015	Forest Inventory	CB	Current	HMP / 7.B, 2.B. , 2.A, 7.A.	Multiple management units: Gilbert Lake, Portage Island, Batchdown, Clarksville Island	FWS: 0.1, Other: 0.1	\$0	spring/summer/fall/Recurring every decade	2013-2028	Refuge Biologist	USACE St Louis District	Initial Survey Instructions

¹ The rank for each survey listed in order of priority.

² A unique identification number assigned by the computer. This number is prefaced by the station cost-center code 33621.

³ Short titles for the survey name, preferably the same names in station work plans.

⁴ Type of survey: I = Inventory; M = Monitoring; CM = Cooperative Monitoring. Inventory (I), Cooperative Baseline Monitoring (CB), Monitoring to Inform Management (M), Cooperative Monitoring to Inform Management (CM), Research (R), and Cooperative Research (CR).

⁵ Current: surveys that are either continued or scheduled to begin in the year of IMP, Expected :previously conducted or new surveys that have a likely chance of being conducted during the span of an IMP .

⁶ The management plan and objectives that justify the described survey.

⁷ Station management unit names, entire station, or names of other landscape units included in survey.

⁸ Estimates of Service (FWS) and non-Service (Other) staff time needed to complete the survey (1 work year = 2080 hours = 1 FTE).

⁹ Average annual operations costs for conducting the survey (e.g., equipment, contracts, travel) not including staff time. \$ = \$0 to 4,999; \$\$ = \$5,000 to 24,999; TBD = to be determined.

¹⁰ Timing and frequency of survey field activities.

¹¹ The years during which the survey has been or will be conducted.

¹² Name and position of the Survey Coordinator for each survey.

¹³ Title, author, and version of the survey protocol (if there is no protocol to cite, enter None).

¹⁴ Scale of intended use (National Framework, Regional Framework, Site-specific) and stage of approval of the survey protocol (Initial Survey Instructions, Complete Draft, In Review, or Approved).

Narratives for Selected Surveys

Survey: *Integrated Waterbird Management and Monitoring Initiative (FF03RTRW00-033)*

Refuge: *Two Rivers National Wildlife Refuge*

Priority: *1*

Which station management objective does the survey support? Is the objective derived from the CCP, interim objectives, HMP, or other?

HMP Objective 1.A. Provide permanently flooded wetlands for wetland-dependent wildlife.

HMP Objective 1.B. Protect, enhance, and maintain isolated backwaters and ephemeral wetlands for wetland-dependent species.

HMP Objective 3.E. Plant seed and browse crops.

HMP Objective 3.F. Utilize agriculture as a management tool.

HMP Objective 7.A. Monitor habitat communities to evaluate the effects of current management actions and gather data to improve future management practices.

HMP Objective 7.B. Monitor wildlife response to habitat management efforts, and to contribute to systematic scale evaluations on the Mississippi River with our partners.

HMP Objective 7.E. Develop and implement an effective record-keeping and data analysis system, compatible with HNA, to facilitate adaptive management decision-making.

Why is it important to conduct the survey? Describe how survey results will be used to make better informed refuge management decisions. If survey results are used to trigger a management response, identify the management response and threshold value for comparison to survey results.

The Integrated Waterbird Management and Monitoring Initiative protocol records bird use, water levels, general habitat condition and management activities at the management unit scale. The data may be used to generate unit specific use-day estimates, document migration chronologies, and explore relationships between count data and habitat condition. Data summaries will guide state dependent decision making at the unit scale, such as choosing a soil disturbance prescription or a seasonal flood regime. Unit level data can be scaled up to refuge or refuge complex as guild specific or species utilities for broad habitat types. Data can be used to assess the efficacy of management actions (accounting for management costs in terms of use-days for targeted populations) and support learning to improve management. Raw count data are also used to answer public inquiries regarding refuge-wide waterfowl populations. Water levels must be monitored to ensure optimum depths are achieved for waterfowl feeding, especially during peak migration. Data are used during drawdowns to inform management as the drawdown progresses.

What is the population or attribute of interest, what will be measured, and when?

Biological Integrity; Other Biota; Aves (Birds); Anseriformes (Screamers, Ducks, Swans, Geese, Waterfowl); Charadriiformes (Plovers, Auks, Alcids, Oystercatchers, Shore Birds, Gulls); Suliformes (Cormorants); Podicipediformes (Grebes); Gaviiformes (Loons); Pelecaniformes (Ibises, Pelicans, Herons); Ciconiiformes (Storks); Gruiformes (Cranes, Rails); Recurring -- every year; weekly

Nonbreeding waterbirds

Is this a cooperative survey? If so, what partners are involved in the survey?

Yes. USGS Patuxent Wildlife Research Center provides protocol and Midwest Avian Data Center provides online database support.

Survey: *Swan Lake Habitat Monitoring (FF03RTRW00-031)*

Refuge: *Two Rivers National Wildlife Refuge*

Priority: 3

Which station management objective does the survey support? Is the objective derived from the CCP, interim objectives, HMP, or other?

HMP Objective 1.A. Provide permanently flooded wetlands for wetland-dependent wildlife.

HMP Objective 5.B. Manage refuge lands for wildlife first, while considering UMR floodplain functions and contributing to improving those values.

HMP Objective 7.A. Monitor habitat communities to evaluate the effects of current management actions and gather data to improve future management practices.

HMP Objective 1.B. Protect, enhance, and maintain isolated backwaters and ephemeral wetlands for wetland-dependent species.

HMP Objective 4.B. Reduce sedimentation and improve overall water quality.

Why is it important to conduct the survey? Describe how survey results will be used to make better informed refuge management decisions. If survey results are used to trigger a management response, identify the management response and threshold value for comparison to survey results.

This survey monitors the floating-leaved and submersed aquatic vegetation community within Middle Swan Lake to evaluate the effects of current management actions, and/or verify a response to habitat management efforts. Management actions designed to mitigate flocculent sediments and high turbidity will be used when aerial coverage of aquatic vegetation is less than and not trending towards 30%. This survey is to assess if aquatic vegetation is approaching or exceeding a known threshold, or if it is responding to a management action or system stressor in a specific manner.

Aquatic vegetation reestablishment is a management goal in Middle Swan Lake but that goal has not been met. Turbidities exceeding a value of 40 nephelometric turbidity units have been identified as a factor limiting the presence of aquatic vegetation in Swan Lake. This survey will be used to monitor growing season turbidity following management actions with a goal of reestablishing aquatic vegetation.

What is the population or attribute of interest, what will be measured, and when?

Biological Integrity; Other Biota; Plantae (plants); Echinodiaceae (No common name); Polygonaceae (knotweed, buckwheat); Recurring -- every year; spring/summer/fall

Biological Integrity; Other Biota; Plantae (plants); Cyperaceae (sedges); Polygonaceae (buckwheat, knotweed); Echinodiaceae (No common name); Sporadic or Ad Hoc; late summer/fall

Water; Water Quality; Recurring -- every year; spring/summer/fall

Is this a cooperative survey? If so, what partners are involved in the survey?

NO

Survey: *Boltonia decurrens* Survey (FF03RTRW00-021)

Refuge: *Two Rivers National Wildlife Refuge*

Priority: 4

Which station management objective does the survey support? Is the objective derived from the CCP, interim objectives, HMP, or other?

HMP Objective 3.C. Provide wet meadow areas.

HMP Objective 7.E. Develop and implement an effective record-keeping and data analysis system, compatible with HNA, to facilitate adaptive management decision-making.

Why is it important to conduct the survey? Describe how survey results will be used to make better informed refuge management decisions. If survey results are used to trigger a management response, identify the management response and threshold value for comparison to survey results.

Document status, trends and response to management for a federally threatened species known to occur on the refuge. Ensure that population targets within the recovery plan are met. This plant is not a shade tolerant species and responds well to disturbance and woody vegetation control.

Comparing monitoring results with recovery plan individual plant estimates for the site may show a need for initiating, intensifying or altering management actions.

What is the population or attribute of interest, what will be measured, and when?

Biological Integrity; At-risk Biota; *Boltonia decurrens* (Decurrent false aster) - T; Recurring -- every two years; August/Sept

Number of seed producing plants present.

Is this a cooperative survey? If so, what partners are involved in the survey?

Yes, Coop Monitoring to Inform Management; USFWS Rock Island ES , Illinois Department of Natural Resources, Division of Natural Heritage, Southern Illinois University Edwardsville.

Survey: *Invasive Species Inventory (FF03RTRW00-019)*

Refuge: *Two Rivers National Wildlife Refuge*

Priority: 5

Which station management objective does the survey support? Is the objective derived from the CCP, interim objectives, HMP, or other?

HMP Objective 1.A. Provide permanently flooded wetlands for wetland-dependent wildlife.

Why is it important to conduct the survey? Describe how survey results will be used to make better informed refuge management decisions. If survey results are used to trigger a management response, identify the management response and threshold value for comparison to survey results.

Early detection of invasive plant species and treatment effectiveness monitoring is a prerequisite to cost-effective invasive species management. Early detection will be used to minimize the spread of invasives. Inventories conducted will be used as a “first step” in an integrated pest management strategy with the objective of creating accurate species-distribution maps that will be used in priority setting and management strategy selection.

What is the population or attribute of interest, what will be measured, and when?

Biological Integrity; Invasive Species; Plantae (plants); Osteichthyes (bony fishes); Poaceae (grasses); Recurring -- every year;

Is this a cooperative survey? If so, what partners are involved in the survey?

NO

Survey: *Bathymetry (FF03RTRW00-026)*
Refuge: *Two Rivers National Wildlife Refuge*
Priority: 7

Which station management objective does the survey support? Is the objective derived from the CCP, interim objectives, HMP, or other?

Refuge Objective 4.B. Reduce sedimentation and improve overall water quality.

Why is it important to conduct the survey? Describe how survey results will be used to make better informed refuge management decisions. If survey results are used to trigger a management response, identify the management response and threshold value for comparison to survey results.

This survey will collect elevation data for the bottom of Swan Lake either through a LIDAR capture during a drawdown event, echosounders, or extrapolation of points with measured depths. A high resolution contour map is needed to document long term sedimentation rates in the lake, estimate capacity in acre-feet for pumping decisions, and quantify the extent of desired shallow water zones at various lake levels.

What is the population or attribute of interest, what will be measured, and when?

Water; Water Quality; Recurring -- every five years;

Is this a cooperative survey? If so, what partners are involved in the survey?

NO

Survey: *Forest Inventory*

(FF03RTRW00-015)

Refuge: *Two Rivers*

National Wildlife Refuge

Priority: *11*

Which station management objective does the survey support? Is the objective derived from the CCP, interim objectives, HMP, or other?

HMP Objective 2.A. Conserve and enhance floodplain forest block size and spatial distribution for forest-dependent wildlife. Refuge Objective 2.B. Conserve and enhance forest structure and diversity (age and species).

HMP Objective 7.A. Monitor habitat communities to evaluate the effects of current management actions and gather data to improve future management practices.

HMP Objective 7.B. Monitor wildlife response to habitat management efforts, and to contribute to systematic scale evaluations on the Mississippi River with our partners.

Why is it important to conduct the survey? Describe how survey results will be used to make better informed refuge management decisions. If survey results are used to trigger a management response, identify the management response and threshold value for comparison to survey results.

The CCP and HMP both called for the completion of a Forest Inventory to determine the current state of forest health and make management recommendations in a Forest Management Plan.

What is the population or attribute of interest, what will be measured, and when?

Biological Integrity; Other Biota; Plantae (plants); Fagaceae (No common name); Salicaceae (willows); Recurring -- every decade; spring/summer/fall

Composition and size structure for canopy layer. Composition of understory and herbaceous.

Is this a cooperative survey? If so, what partners are involved in the survey?

Yes USACE St. Louis District

Revising the IMP

The Project Leader will review the refuge capacity and status of surveys annually and determine which of the selected surveys will be implemented in that year. The PRIMR database was updated along with this IMP; it will be updated as approved protocols are linked to the selected surveys and when surveys are added or removed from the set of selected surveys.

The IMP will be revised according to I&M Policy and as CCP and HMP plans are modified (see Revision Signature Page, Appendix D). An IMP revision is triggered when surveys are added or removed from the set of selected surveys. IMP revisions require signatures from refuge staff, Regional I&M staff, Regional Refuge Biologist/Natural Resources Division Chief, but not the Refuge Supervisor or Regional Chief of Refuges.

References

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Appendix A. Criteria and Weights Used to Prioritize Surveys

- 1) **Station purpose:** Does the survey provide information to evaluate if the station is achieving its purpose(s)?
Note: Refuge purpose is defined in Appendix 1. A survey addressing wilderness character addresses purpose for a station with proposed or designed wilderness.
 1. No
 2. Yes
- 2) **Other legal mandates:** Does the survey provide information to evaluate whether or not the station is addressing legal mandates besides refuge purposes such as Biological Integrity, Diversity, and Environmental Health (BIDEH); NWR Resources of Concern (e.g., migratory birds, anadromous fishes, marine mammals); maintaining water rights; and compatibility of refuge uses especially wildlife-dependent recreation?
Note: Federally listed species are addressed under criterion #7 so they should not be considered as a NWR Resources of Concern under this criterion. For BIDEH, only consider surveys addressing the highest measure of biological integrity, which is viewed as those intact and self-sustaining habitats and wildlife populations existing during historic conditions (see 601 FW 3.10). Example 1: Because 99% of the wet prairie habitat has been lost throughout the Willamette Valley, remnant prairie on WL Finley NWR represents the highest order of BIDEH on the refuge where habitat monitoring is a priority survey. Example 2: The refuge staff at Two Rivers NWR is currently preparing its hunt plan where monitoring the population of white-tailed deer during the hunting season on refuge would inform this plan.
 1. No
 2. Yes
- 3) **Large investment in management actions:** Does the survey inform whether or not the station is achieving one or more CCP, HMP, or other management plan objectives involving management actions requiring substantial expenditure of funding and staff time?
Example: If conducting wetland management actions requires considerable staff time and funding annually, then surveys that evaluate response of vegetation and waterfowl to wetland management actions could be considered a high priority.
 1. No
 2. Yes
- 4) **Controversy:** Does the survey support decision making to assess a suspected or known controversial refuge management action, refuge use, or species?
Note: Terms are defined in Appendix 1. Examples of suspected or known controversial refuge management actions include mammalian predator control and use of pesticides. Examples of suspected or known controversial refuge uses (recreational and economic) can include establishing new close areas from waterfowl hunting, opening a refuge to white-tailed deer hunting, use of genetically modified crops, and livestock grazing.
 1. No
 2. Yes
- 5) **Known or suspected threats:** Will the survey provide information to potentially reduce the duration of the threat(s) to the station, cost to the station due to those threat(s), or effect station resources of concern due to those threat(s) during the current or future CCP planning cycles?
Examples of known or suspected threats include the following: proposed water withdrawal within the station's watershed, a new invasive species, impacts of proposed development, combinations of

threats such as increased fire cycles promoting invasive species, and man-made and natural disasters (e.g., hazardous spills, hurricanes).

1. The survey does not address threat(s)
 2. Low: The survey potentially informs 1 of 3 factors (duration, cost, or effect on resources)
 3. Medium: The survey potentially informs 2 of 3 factors (duration, cost, or effect on resources)
 4. High: The survey potentially informs all 3 factors (duration, cost, and effect on resources)
- 6) **Baseline data:** Does the survey provide high-priority information that contributes to baseline data needs? *Example: Inventories of species guilds (e.g., invertebrates, plants, reptiles) or abiotics (soils, waters).*
1. No
 2. Yes
- 7) **Species or vegetation community with a listing status:** Is the species or vegetation community (the focus of the survey) federally listed under ESA, state listed (threatened or endangered only), ranked by the state's natural heritage program (S1 or S2 rank only), globally ranked by NatureServe (G1 or G2 rank only), or globally listed on the IUCN Red List of Threatened Species (Critically Endangered, Endangered, or Vulnerable only)?
- Example 1: An inventory of small mammals where one or more of the species likely or suspected to be found on the refuge is state or globally listed. Example 2: Surveys of abiotic factors affecting species should be considered under this criterion. Monitoring water quality parameters in wetlands inhabited by state-listed aquatic birds to assess potential effects to avian species.*
1. Not state or federally listed nor globally ranked
 2. State listed or ranked by state's natural heritage program
 3. Globally listed only (G1 or G2)
 4. Federally listed (Endangered, Threatened, or Candidate)
- 8) **FWS priorities:** Does the survey provide information that directly contributes to evaluating the status and trends of resources that are a priority for the NWRS or other FWS regional or national program (e.g., Migratory Birds, Fisheries, T&E species, Water Resources/Hydrology) or the national I&M initiative (e.g., phenology, baseline inventories, water quality)?
- Example 1: North American Breeding Bird Survey, Woodcock Singing Ground Counts, North American Amphibian Monitoring Program, Mid-Winter Waterfowl Survey, and Circumpolar Biodiversity Monitoring Network are priority surveys for regional or national FWS programs. Example 2: A survey to determine the status and trends of a federally listed landbird species would be a priority for both the Migratory Birds and T&E Species programs.*
1. Does not address a management priority identified by a FWS regional or national program or initiative
 2. Addresses a management priority identified by 1 FWS regional or national program or initiative
 3. Addresses a management priority identified by 2 FWS regional or national programs or initiatives
 4. Addresses a management priority identified by ≥ 3 FWS regional or national programs or initiatives
- 9) **Survey coverage for species or vegetation community:** What proportion (%) of the species' (sub)population or vegetation communities' geographic range under U.S. jurisdiction will be covered by the survey on the station?
- Example 1: 75% of Laysan Albatross population nest on Midway NWR. Conducting a survey to monitor the breeding population size on the refuge would cover >10% of the entire species' population and score 3.*

Note: Surveys of abiotic factors affecting these species or vegetation communities should also be considered for this criterion. Example 2: 60% of the wintering waterfowl in the Pacific Flyway use wetlands in the Central Valley of California including the San Luis NWR. Monitoring water levels by reading staff gauges weekly from October to March in managed wetlands is an important abiotic survey to indicate if there are sufficient acres of suitable foraging habitat to support 60% of the wintering waterfowl. Because water is essential to maintain refuge wetlands for wintering waterfowl, "survey coverage" would equate to waterfowl population surveys and score 3.

1. Low: Survey covers <1% of the species' or communities' population/range
2. Medium: Survey covers 1-10% of the species' or communities' population/range
3. High: Survey covers ≥10% of the species' or communities' population/range

10) Survey utility: How many station CCP, HMP, or other management plan objectives can be evaluated by the survey?

Example 1: A survey of staff gauge readings for water levels in representative units can be used to evaluate a range of wetland habitat objectives including seasonal, emergent, and permanent types.

Example 2: An Early Detection Rapid Response survey can be used to discover the presence of highly invasive plant species in multiple refuge habitats.

1. Does not address an objective
2. Addresses 1 objective
3. Addresses 2 objectives
4. Addresses 3 or more objectives

11) Survey leveraging: Is the survey conducted or integrated with one or more other surveys? Applies to multiple stations and/or on/off refuge property.

Note: This criterion applies to surveys that were designed to be conducted in conjunction with each other in order to fully evaluate the status and trends of the target resource and its habitat. Example 1: The landbird point count protocol requires habitat parameters be collected in conjunction with avian data. Example 2: Habitat parameters and avian population counts are collected for the Integrated Waterbird Management and Monitoring project.

1. Survey is not integrated with other surveys
2. Survey is integrated with 1 other survey
3. Survey is integrated with >1 other surveys

12) FWS partners: Does the survey address high or medium priorities of relevant Landscape Conservation Cooperatives (LCC), state agencies, or other conservation partners?

1. Does not address a management priority identified by FWS partners (e.g., LCC, state agency).
2. Addresses a management priority identified by 1 FWS partner (e.g., LCC, state agency).
3. Addresses a management priority identified by 2 FWS partners (e.g., LCC, state agency).
4. Addresses a management priority identified by ≥3 FWS partners (e.g., LCC, state agency).

13) Cooperative surveys: At what scale does the survey most benefit the science information needs required for resource management?

Note: Only surveys with a standard protocol and established systems of data management and analysis are scored higher than a 1. Terms are defined in the Appendix. This criterion is applicable to surveys covering areas on and adjacent to the station. Example: If a refuge participates and contributes to a regional survey involving neighboring US Forest Service lands, then this criterion would apply.

1. Small scale: Applicable to only 1 refuge.
2. Medium scale: Applicable to a smaller group of refuges or single refuge complex.
3. Large scale: Applicable to multiple refuges/complexes across an entire ecoregion, LCC, or region.

4. Continental scale: Component of a large landscape level survey (e.g., North American Breeding Bird Survey, Woodcock Singing Ground Counts, North American Amphibian Monitoring Program, and Circumpolar Biodiversity Monitoring Network).
- 14) **Survey duration:** Over what time scale will the objective(s) addressed by the survey need to be evaluated?
- Note: Long-term surveys will need to be consistently implemented over multiple generations of the species or successional stages of habitat to evaluate achievement of objective(s).*
1. Short-term: 1-15 years
 2. Long-term: >15 years.
- 15) **Cost of data collection, analysis, and reporting:** What is the cost (e.g., staff time, contractor cost, equipment, sample analysis/processing, annual funding) for survey design, implementation, data management, data analysis, and reporting?
- Note: Surveys requiring novel techniques, many repeated visits or large numbers of staff will likely be more expensive to implement. Similarly, surveys requiring assistance for the development of protocols and analysis of data will be more costly. Conversely, if a standardized protocol, database, analysis, and/or reporting system are available, then the costs of implementing such a survey may be much lower than if these elements must be designed and tested upfront. Also, consider partners (e.g., universities), who assist or fully implement surveys, as a basis for estimating costs.*
1. High: >5% of annual funding or staff time for the refuge biological program is dedicated to the survey
 2. Medium: 1-5% of annual funding or staff time for the refuge biological program is dedicated to the survey
 3. Low: 0.1- 1% of annual funding or staff time for the refuge biological program is dedicated to the survey
 4. Very Low: <0.1% of annual funding or staff time dedicated for the refuge biological program is dedicated to the survey
- 16) **Data analysis:** Are the survey data analyzed for use at the station level?
- Note: The frequency and intensity of management is dependent upon station objectives. In some cases, baseline inventory or monitoring is appropriate if active management is not anticipated for the foreseeable future. In contrast, monitoring to detect threshold conditions or for adaptive management may be needed to maintain certain habitats (e.g., moist-soil wetlands) requiring considerable, annual management activities to achieve desired conditions.*
1. None: Study design does not allow data to be analyzed
 2. Low: Data have not been analyzed but they are available for analysis
 3. Medium: Data can/have been analyzed on infrequent basis
 4. High: Data can/have been analyzed on regular basis
- 17) **Data use:** Are the survey results reported and used to inform current and future management decisions?
- Note: See description from criterion #15.*
1. None: Study design does not allow results to be readily reported. Therefore, results are not used in management decisions.
 2. Low: Data have not been analyzed but are available for reporting so they may be used to inform management at the refuge(s).
 3. Medium: Results can/have been reported, but these results have not been used to guide management at the station, regional, or larger landscape levels.
 4. High: Currently reported on regular intervals and used to inform management at the refuge(s), regional, or larger landscape levels.

Table A1. Weight Applied to Prioritization Criteria.

The following 17 criteria were weighted by refuge staff at Two Rivers NWR (relative values in parentheses with highest values representing criteria that are most important to refuge staff) and used to rank surveys through a Simple Multi-Attribute Ranking Technique (SMART tool).

	Criteria	Station-specific weight	Comparison to even weight
1	Station purpose	0.09	0.03
2	Other legal mandates	0.02	-0.04
3	Large investment in management actions	0.09	0.03
4	Controversy	0.02	-0.04
5	Known or suspected threats	0.02	-0.04
6	Baseline data	0.09	0.03
7	Species or vegetation community listing status	0.09	0.03
8	FWS priorities	0.07	0.01
9	Survey coverage for species or vegetation community	0.02	-0.04
10	Survey utility	0.07	0.01
11	Survey leveraging	0.07	0.01
12	FWS partners	0.07	0.01
13	Survey spatial context	0.05	-0.01
14	Survey duration	0.02	-0.04
15	Cost of data collection, analysis, and reporting	0.02	-0.04
16	Data analysis	0.09	0.03
17	Data Use	0.09	0.03

Appendix B. Prioritization Scores of All Ranked Surveys

Values used to prioritize and select the surveys likely to be conducted through 2029 at Two Rivers National Wildlife Refuge. Prioritization scores were generated for candidate surveys by refuge staff using 17 criteria for each survey (Appendix A). Candidate surveys represent specific surveys or general information needs and were not always associated with specific protocols. In certain instances surveys were combined after the ranking exercise into one survey, IWMM and Swan Lake Habitat Monitoring being two examples. Scores were then used as a starting reference to assign the surveys into tiers.

Table of priority scores from the SMART tool for all considered surveys.

	Survey Name	Prioritization Score	Tier ^a	Tiered Priority
1	Waterfowl Surveys	0.708	1	1.01
2	Fish Community Surveys	0.610	1	1.02
3	Aquatic Vegetation Cover - Swan Lake	0.591	1	1.03
4	Boltonia decurrens Survey	0.587	1	1.04
5	Invasive Species Inventory	0.587	1	1.05
6	Turbidity - Swan Lake	0.583	1	1.06
7	Impoundment Study	0.576	1	1.07
8	Shorebird Surveys	0.534	2	2.01
9	Moist-soil Seed Production	0.534	2	2.02
10	Bathymetry	0.500	2	2.03
11	Invasive Treatment Monitoring	0.496	2	2.04
12	Waterbird Surveys	0.481	2	2.05
13	Tree planting Assessment	0.481	2	2.06
14	Water Level Monitoring	0.477	2	2.07
15	American Lotus (cage experiments)	0.398	3	3.01
16	Vegetation Response in Managed Impoundments	0.390	3	3.02
17	Forest Inventory	0.390	3	3.03
18	Acoustic Bat Inventory	0.360	3	3.04
19	Deer Population and Impact Assessment ^b	0.318	3	3.05
20	Midwinter Waterfowl Survey	0.318	3	3.06
21	Landbird surveys	0.307	3	3.07
22	Aquatic Invertebrate Biomass Monitoring	0.292	3	3.08
23	Dove Production Surveys	0.284	3	3.09
24	Grassland Vegetation Structure	0.273	3	3.10
25	Midwinter Eagle Counts	0.254	3	3.11
26	Pollinator Survey	0.242	3	3.12
27	Sedimentation Rate Survey	0.235	3	3.13
28	Bald Eagle Wintering	0.136	3	3.14

- ^a Tier 1--The highest priority surveys that the Project Leader estimates can be conducted with existing staffing and funding.
Tier 2--Surveys that the Project Leader sees as second priority for the station, or high priority surveys that would require an increase in operational capacity.
Tier 3--Lower priority surveys that are currently being conducted or are anticipated but would require the major reallocation of staff and capacity.
When no tier is designated it means that Refuge staff determined that survey was no longer necessary to conduct.
- ^b Recon rather than survey

Appendix C. Non-selected Surveys

A status of future denotes surveys that have been prioritized but have low chance of being conducted during the span of the IMP because of low priority or because the capacity to conduct the survey will be difficult to secure. Historic status surveys have been recently completed or discontinued.

<i>Survey Name</i>	<i>Survey ID Number</i>	<i>Survey Priority</i>	<i>Survey Status</i>
Acoustic Bat Inventory	FF03RTRW00-030	11	Future
American Lotus Enclosure Experiments	FF03RTRW00-009	NA	Historic
Aquatic Invertebrate Biomass Monitoring	FF03RTRW00-029	14	Future
Bald Eagle Wintering	FF03RTRW00-024	NA	Historic
Breeding Landbird Survey	FF03RTRW00-022	13	Future
Deer Population and Impact Assessment	FF03RTRW00-023	12	Future
Fish Community Surveys	FF03RTRW00-028	2	Future
FWS Mourning Dove Call Count Surveys	FF03RTRW00-017	NA	Historic
Grassland Vegetation Structure	FF03RTRW00-006	15	Future
Invasive Treatment Monitoring	FF03RTRW00-027	8	Future
Moist-soil Seed Production	FF03RTRW00-012	6	Future
Mourning Dove Banding	FF03RTRW00-003	NA	Historic
National Midwinter Bald Eagle Survey	FF03RTRW00-016	16	Future
Pollinator Survey	FF03RTRW00-018	17	Future
Sedimentation Rate Survey	FF03RTRW00-025	18	Future
Timing of Impoundment Drawdowns ... managed Wetlands	FF03RTRW00-004	NA	Historic
Tree planting Assessment	FF03RTRW00-010	9	Future

Appendix D. Environmental Action Statement (EAS)

Within the spirit and intent of the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (NEPA) (40 CFR 1500-1508), and other statutes, orders, and policies that protect fish and wildlife resources, I have established the following administrative record and determined that the following proposed action does not require additional NEPA documentation.

Proposed Action, Alternatives, and NEPA Documentation

The proposed action is to implement an Inventory and Monitoring Plan (IMP) for the Two Rivers National Wildlife Refuge. This IMP is a refinement of the 2004 Comprehensive Conservation Plan (CCP) and associated Environmental Assessment (EA) for the Refuge. This IMP provides more-specific guidance for surveys of Refuge's fish, wildlife, plant, habitat, and abiotic resources to fulfill the Refuge's purposes and help achieve Refuge's goals and objectives.

The EA for Two River's CCP included goals and objectives for the refuge and assessed the impacts associated with a range of reasonable alternatives to achieve those goals and objectives. The rationale for selection of one specific alternative for implementation is explained in the Finding of No Significant Impact (FONSI) accompanying the final CCP. The goals, objectives, and survey strategies included in this IMP fall within the bounds of those described and assessed in the CCP and EA or EIS.

Pursuant to 40 CFR 1502.9, no additional NEPA documentation is required to implement this IMP beyond the EA and FONSI prepared concurrently with the CCP. No substantial changes to the proposed action alternative that was identified, analyzed, and selected for implementation within the CCP, EA, and FONSI are proposed through this IMP. Similarly, no significant new information or circumstances exist relevant to environmental concerns and bearing on the proposed action or its impacts.

In accordance with 43 CFR 46.205 and 40 CFR 1508.4, some surveys within this IMP are covered by the following Departmental categorical exclusion because they would not have significant environmental effects.

"Research, inventory, and information collection activities directly related to the conservation of fish and wildlife resources which involve negligible animal mortality or habitat destruction, no introduction of contaminants, or no introduction of organisms not indigenous to the affected ecosystem." 516 DM 8.5B(1)

Project Leader/Refuge Manager

Date

[Note: this signature and dating is not required if a statement is placed below the IMP signature page indicating that the Project Leaders signing of that page applies to all contents of this IMP].

Reference: U.S. Fish and Wildlife Service. 2004. *Comprehensive Conservation Plan and Environmental Assessment and for Mark Twain National Wildlife Refuge Complex*. USFWS Region 3. Bloomington MN.

Appendix E. Cost-benefit Analysis

We used linear programming to find the optimum sets of ranked surveys using the total of all frequency adjusted scores as an objective function. Main constraints included costs (weeks) and surveys selected prior to solving the linear function (summation of frequency adjusted scores across all surveys). Portfolios represent alternative sets of selected surveys and are used for decision support; they do not dictate survey selections.

Table C-1 Efficiencies in terms of frequency adjusted benefit for 5 potential IMP portfolios. A through D were optimized for maximum 15 year benefit from all selected surveys (1= selected, 0= not selected).

Survey	Portfolio:				
	A	B	C	D	E
American Woodcock Fall Migration Ecology	1	1	1	0	0
Bat Surveys	1	1	1	1	1
Botanical Inventory	1	1	1	0	0
Contaminants	1	1	1	1	1
Deer Spotlight Survey	0	1	1	0	0
Franklin's Ground Squirrel Survey	0	0	0	0	0
Frog and Toad Breeding Survey	0	0	0	0	0
Hydrology Monitoring	0	1	1	1	1
Invasive Plant Inventory	1	0	0	1	1
King Rail Breeding Status	0	0	0	0	0
Lepidoptera Survey	0	0	0	0	0
Mammal Inventory	0	0	0	0	0
Marshbird Surveys	1	0	0	1	0
Massasauga Survey	0	0	0	0	0
Moist-Soil Survey	0	0	0	0	0
oak regen. surveys	1	0	1	0	0
Odonata Survey	1	0	0	0	0
proth. Warbler Density	1	1	1	1	1
Rare Plant Survey	1	1	1	0	0
Reed Canary Grass ARM	0	0	0	0	0
Silver & Swan Veg	0	0	0	0	0
Snake Inventory	0	0	0	0	0
Turtle Study	0	0	0	0	0
Veg Community/Habitat Surveys	1	1	0	1	0
Water Level Surveys	0	0	0	0	0
Waterbird Surveys	0	1	1	1	1
Winter Raptor Survey	1	1	1	0	0
Wood Duck Banding	0	0	1	1	1
Total frequency adjusted benefit	1.40	1.09	1.04	1.01	0.75
15 year cost	15.20	15.20	15.20	19.30	15.30
total number of surveys	12	11	12	9	7

Constraints in optimization routines. Portfolio A: Weeks, Portfolio B: Group a and weeks, Portfolio C: Group a surveys, wood duck, weeks. Portfolio D: Groups a & b (exceeds weeks threshold of 15.3). Portfolio E: top-down selection of surveys with highest scores & weeks.

Appendix F. Estimated Annual Costs for Implementing Surveys

(Historic surveys are excluded, total cost includes operating and staff time costs).

Survey Name	Survey ID Number	Survey Priority	Survey Status	FWS Staff Total	Total Cost
Integrated Waterbird Management and Monitoring Initiative	FF03RTRW00-033	1	Current	\$10,769	\$13,469
Fish Community Surveys	FF03RTRW00-028	2	Future	\$1,923	\$2,423
Swan Lake Habitat Monitoring	FF03RTRW00-031	3	Current	\$3,846	\$5,346
Boltonia decurrens Survey	FF03RTRW00-021	4	Expected	\$1,538	\$2,538
Invasive Species Inventory	FF03RTRW00-019	5	Expected	\$1,538	\$4,076
Moist-soil Seed Production	FF03RTRW00-012	6	Future	\$962	\$1,462
Bathymetry	FF03RTRW00-026	7	Current	\$3,846	\$4,846
Invasive Treatment Monitoring	FF03RTRW00-027	8	Future	\$962	\$1,462
Tree planting Assessment	FF03RTRW00-010	9	Future	\$1,923	\$1,923
Forest Inventory	FF03RTRW00-015	10	Current	\$5,769	\$5,769
Acoustic Bat Inventory	FF03RTRW00-030	11	Future	\$1,923	\$3,923
Deer Population and Impact Assessment	FF03RTRW00-023	12	Future	\$1,923	\$2,423
Breeding Landbird Survey	FF03RTRW00-022	13	Future	\$5,769	\$5,769
Aquatic Invertebrate Biomass Monitoring	FF03RTRW00-029	14	Future	\$4,808	\$5,308
Grassland Vegetation Structure	FF03RTRW00-006	15	Future	\$962	\$1,162

National Midwinter Bald Eagle Survey	FF03RTRW00-016	16	Future	\$385	\$385
Pollinator Survey	FF03RTRW00-018	17	Future	\$1,538	\$1,638
Sedimentation Rate Survey	FF03RTRW00-025	18	Future	\$1,154	\$11,154
				Staff Total	Total Cost
Total for selected (current and expected) surveys:				\$27,306	\$36,044
Total for future surveys:				\$24,232	\$39,032

Appendix G. Estimated Annual Work Schedule for Selected Surveys, January – December.

Survey Name	Priority	Jan-March	April-June	July-Sept	Oct-Dec
Integrated Waterbird Management & Swan Lake Habitat Monitoring	1	FW,DE,A,R	FW,DE,P	T,FW,DE	FW,DE
<i>Boltonia decurrens</i> surveys	3	DE,A,R	P	FW	FW,DE
Invasive Species Inventory*	4		P	FW	FW,DE,A,R
Bathymetry Surveys*	5	A,DE,R,P	FW	FW	FW,DE,
Forest Inventory*	7	A,R	P	FW,DE	FW,DE
	11	FW, A,DE,R,P	FW	FW	FW,DE

P=Planning, T=Training, FW=Field Work, DE=Data Entry, A=Analysis, R=Reporting

*Denotes Inventory or Monitoring conducted at 2-20 year intervals (not annual work).

IMP Revision Signature Page

IMP Revisions Two Rivers National Wildlife Refuge

<i>Action</i>	<i>Signature /Printed Name</i>	<i>Date</i>
Survey list and priority changed:		
Submitted By:	Refuge Manager/Project Leader	
Reviewed By:	Regional I&M Coordinator	
Approved By:	Refuge Supervisor	