U.S. Fish and Wildlife Service
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National Wildlife Refuge System

National Protocol Framework for the Inventory and Monitoring of Nonbreeding Waterbirds and their Habitats

An Integrated Waterbird Management and Monitoring Initiative (IWMM) Approach

Version 2.1 **July 2021**

ON THE COVER
Northern pintails in a shallow managed wetland. Photo Credit: William Coatney, St Louis, MO.

National IWMM Protocol Signature Page

Protocol Title: National Protocol Framework for the Inventory and Monitoring of NonBreeding Waterbirds and their Habitats.
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Approvals

Action	**Appropriate Signature/Name**	**Date**
Survey Coordinator[2] Submitted by:	N/A	
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Regional I&M[4] Approval:	N/A	
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1.0	2014	Loges et al.	N/A	N/A
2.0	2018	Loges et al.	Incorporated review comments to Data Management and Analysis section and SOP2: standardized formating.	To address review comments
2.1	2021	Loges et al.	Expanded survey objective examples. Assigned certain survey metrics as optional. Added habitat resource type metric to vegetation surveys	Improves framework applicability

[1] Version is a decimal number with the number left of decimal place indicating the number of times this protocol has been approved (e.g., first approved version is 1.0.; prior to first approval all versions are 0.*x*; after first approval, all minor changes are indicated as version 1. *x* until the second approval and signature, which establishes version 2.0, and so on).
[2] Signature of station representative designated lead in development of a site-specific survey protocol.
[3] Signature signifies approval of a site-specific survey protocol.
[4] Signature by Regional I&M Coordinator signifies approval of a protocol framework to be used at multiple stations within a Region.
[5] Signature by National I&M Coordinator signifies approval of a protocol used at multiple stations from two or more Regions.
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Survey Protocol Summary

This protocol framework describes procedures for rapidly assessing local habitat conditions and quantifying waterbird use of wetlands during non-breeding periods. The majority of survey techniques described herein involve whole-wetland visual assessments of habitat conditions or counts of waterbirds conducted from the wetland perimeter. Waterbirds are defined as predominantly waterfowl, shorebirds, wading birds, and other birds closely associated with wetlands. This protocol framework was developed as part of the Integrated Waterbird Management and Monitoring (IWMM) program, a large-scale waterbird habitat conservation strategy. A primary purpose of this protocol is to standardize waterbird and habitat monitoring during the non-breeding period. Data can then be compiled and analyzed across broader geographic units. The content and structure of the protocols described below follows standards set forth in the U.S. Fish and Wildlife Service's *How to Develop Survey Protocols: a Handbook (Version 1.0)*. Each of eight elements is addressed, including protocol introduction, sampling design, field methods, data management, analysis, reporting, personnel requirements and training, operational requirements, and references. Additionally, a series of standard operating procedures provides greater detail on recommended methods and technical aspects of this protocol. Data entry, archival, and multi-scale analysis are handled through an online database that is a node of the Avian Knowledge Network. USFWS Regions and partners are encouraged to use this framework to develop site-specific protocols for their waterbird and habitat condition surveys where appropriate.

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Element 1: Introduction

Background

The Integrated Waterbird Management and Monitoring (IWMM) program was initiated following a series of structured decision-making (SDM) workshops that established a need for an operational framework for management and monitoring of waterfowl, shorebirds, and wading birds, collectively referred to as waterbirds, at the local, regional and flyway spatial scales (Coppen et al. 2007, Laskowski et al. 2008, Lor et al. 2008). The focus of this framework is a multi-species group of waterbirds during winter and migration that are readily detected visually. Cryptic and secretive waterbirds, mainly rails and other marshbirds (Conway 2011), may be recorded when encountered but are not part of this framework's focus. The program includes a monitoring component included herein that assesses management actions, habitat conditions, and waterbird use.

This protocol framework was developed to guide the local monitoring component of the IWMM program at units within the National Wildlife Refuge (NWR) System. As a protocol framework it intentionally defers site-specific information necessary to implement the protocol as a survey at an individual site (USFWS 2013). The framework should be used by those cooperating in the IWMM program to develop either site-specific or regional protocols with survey objectives that address specific questions to be addressed by monitoring nonbreeding waterbirds and their habitats. Although this protocol framework was originally intended to inform management within and among NWRs in the Atlantic and Mississippi flyways, it can also be used by cooperators of the IWMM program in other flyways and has minor modifications in this version for the Pacific Flyway.

Many state and federal lands are managed to provide habitat resources for migrating or wintering waterbirds. Likewise, many state agencies have developed regional approaches to waterbird monitoring. For example, Illinois has conducted continuous inventories of the middle Mississippi and Illinois River valleys since 1948 (Havera 1999). Several other states in the Midwest and lower Mississippi Valley have recently developed or are developing aerial inventories with statistically valid sampling designs. Despite several limitations, the mid-winter waterfowl survey has proven useful in assessing American black duck abundance and distribution in the Atlantic Flyway and other uses (Heusmann 1999, Brook et al. 2009). In addition to the benefits gained from the midwinter survey and many regionally coordinated efforts, a strategic approach to waterbird conservation will benefit from the integration of waterbird monitoring at national wildlife refuges, state, regional, and flyway scales (Soulliere et al. 2013).

Because every species has its own set of habitat needs, managers must consider many factors when integrating management of multiple species or groups. These factors include the annual wetland hydrological cycle, targeted portions of species' annual life cycles (Williams et al. 1996), budget and staff resources (i.e., capacity), and physical constraints of the wetlands being managed. The dynamic and interactive nature of these factors often presents different management opportunities or problems. Consequently, managers typically adjust objectives for different wetland units on an annual basis to take into consideration changing conditions. Site-specific or regional versions of this protocol will be needed to develop survey objectives to

inform local management decisions.

Objectives

This framework focuses on a standardized approach and data management, but it does not constitute a complete survey with explicit survey objectives, sampling design, target universe, timeframes, etc. The framework offers guidance and provides flexibility for adding details as needed to complete survey protocols stepped-down from this framework. Management and sampling objectives should be considered when using this framework to develop project-specific guidance (USFWS 2013). In addition, a "road map" outlining steps for designing and implementing a monitoring program was recently developed and should be consulted early in the stepped-down protocol development process (Reynolds et al. 2016). Objective statements should be sufficiently detailed, preferably following the SMART model (specific, measurable, achievable, results-oriented, time-fixed, and supported by a rationale statement; Adamick et al. 2004). Sampling objectives should be deduced from details provided in management objectives to help ensure suitable information is collected to inform management decisions. Elzinga et al. (2001:265–270) provide examples of detailed sampling objectives.

Both management and sampling types of objective statements can vary according to spatial and temporal scales. In general, the results of surveys that follow this protocol will be useful for informing active management of waterbird habitat at the unit scale with little additional development. Broader waterbird conservation across larger geographic scales may also be addressed by adding sampling objectives and sampling design for each scale. Sampling objectives will typically entail grouping units by direct assignment to groups or by using measures of habitat conditions and the survey unit use by multiple species of waterbirds. In a spatial context, these efforts may range from individual impoundments to Bird Conservation Regions. Temporally, survey efforts may range from short periods, minimum of 5-7surveys recommended, to the entire nonbreeding portion of waterbirds' annual life cycle.

This framework may be applicable to a number of local management or conservation objectives, which in turn, will require varying kinds of sampling objectives. We anticipate that local management objectives will require knowledge about waterbird use, guide habitat management decision making (choosing a soil disturbance prescription or flood regime), assess the efficacy of management actions (accounting for management costs in terms of use-days or supported populations), or learning to improve management (Lyons et al. 2008). Also, depending on the management objective, the survey activity will often entail assessing status and trends of habitat conditions or waterbird use. Resulting data may be used to calculate unit-specific seasonal use-days, document migration chronologies, and explore relationships between waterbird counts and survey unit condition. Waterbird surveys resulting in assessments of relative abundance, density, general habitat factors, or species richness could also be designed under this framework.

Numerous examples of studies using one or more of these attributes to inform management or conservation can be found in the literature. These include use of: 1) abundance and richness of waterbirds from whole-area counts to design restored wetlands (Sebastián-González and Green 2013), 2) biweekly counts of non-breeding waterbirds at playa wetlands to identify factors influencing distribution and richness in Nebraska's Rainwater Basin (Webb et al. 2010), 3) estimates of use-days to understand the influence of refuge status on waterbird use in the Illinois and Central Mississippi valleys (Stafford et al. 2007), 4) a migration index used to expand refuge-scale population densities to the entire migration season to inform carrying capacity models.

(Ringelman et al. 2017), and 5) long term trend analyses for wintering waterbird populations (Sung et al. 2021).

The following are additional specific examples of surveys and reports, sorted by spatial scale and type, which have used IWMM methods and/or IWMM data. Survey types include: inventory, estimating change over time, bird community composition, effectiveness monitoring, adaptive management, and habitat associations, see Knutson et al. (2016) for type definitions. Trend estimation is not represented currently but anticipated as data collection continues. Efforts to identify long term trends in nonbreeding waterbird populations will require project-specific power analyses

Survey Unit Scale:

1. ***Estimate Change over Time: changes in abundance following habitat treatment.***

IWMM waterbird counts can be used to document changes in bird-use associated with management activities and changes in habitat conditions at the individual survey unit scale. At Shiawassee NWR in central Michigan, IWMM bird survey data from pre and post treatment periods was used to demonstrate an increase for all waterbirds, waterfowl, and dabbling ducks following successful treatments for invasive cattail, *Typha* × *glauca*. (Lishawa et al. 2020).

Table 1.1 Observed changes in seasonal use-day totals for pre/post-harvest periods for a single survey unit evaluated in a hybrid cattail control experiment conducted at Shiawassee NWR, Michigan (data from Lishawa et al. 2020).

	Pre-harvest	Post-harvest	% change in use-days
Dabbling Ducks	1,372	2,163	57.7
Waterbirds	1,925	4,670	142.6
Waterfowl	1,742	3,075	76.5

2. ***Effectiveness Monitoring: assessing seasonal waterfowl carrying capacity in a survey unit.***

IWMM waterfowl counts can also be used to assess the relation of energetic demand of observed waterfowl populations to estimates of available energy at the survey unit scale. Daily ration energetic models are typically applied at larger scales for planning purposes but can also scaled down to survey unit applications.

The TRUEMET model simulates carrying capacity for waterfowl (Penmetcha et al. 2016). Available for use in *R*, it can be populated with IWMM waterbird observations while IWMM water depth estimates and unit spatial attributes can be used to generate a habitat availability vector as a model input. Additional inputs include daily energetic requirements by species, species group, or guild that are widely available in the literature. Model results can be used to interpret how well the seasonal energetic needs of an observed bird population was met by resources concurrently available within the survey unit (Figure1.1).

Waterfowl energy-day (WED) values from general habitat resource types assessed in the annual vegetation surveys can be used for coarse unit level estimates of available energy. Supplemental sampling using more specialized techniques can also be used to derive estimates of unit-scale

energy which are also storable in the IWMM database. For moist-soil systems, core sampling of seed crops (Hagy et al. 2011) or measures of seed bearing morphology (Laubhan & Fredrickson 1992, Gray et al. 2009) can be used to generate seed mass estimates that can be converted into kcals/unit area. Vegetative mass sampling can also be used to assess energy available from submersed aquatic vegetation (Vonbank et al. 2016). In addition, rapid assessments of expected yield or actual yield observation can be used to generate energy contribution of flooded agricultural crops (Lauer 2002).

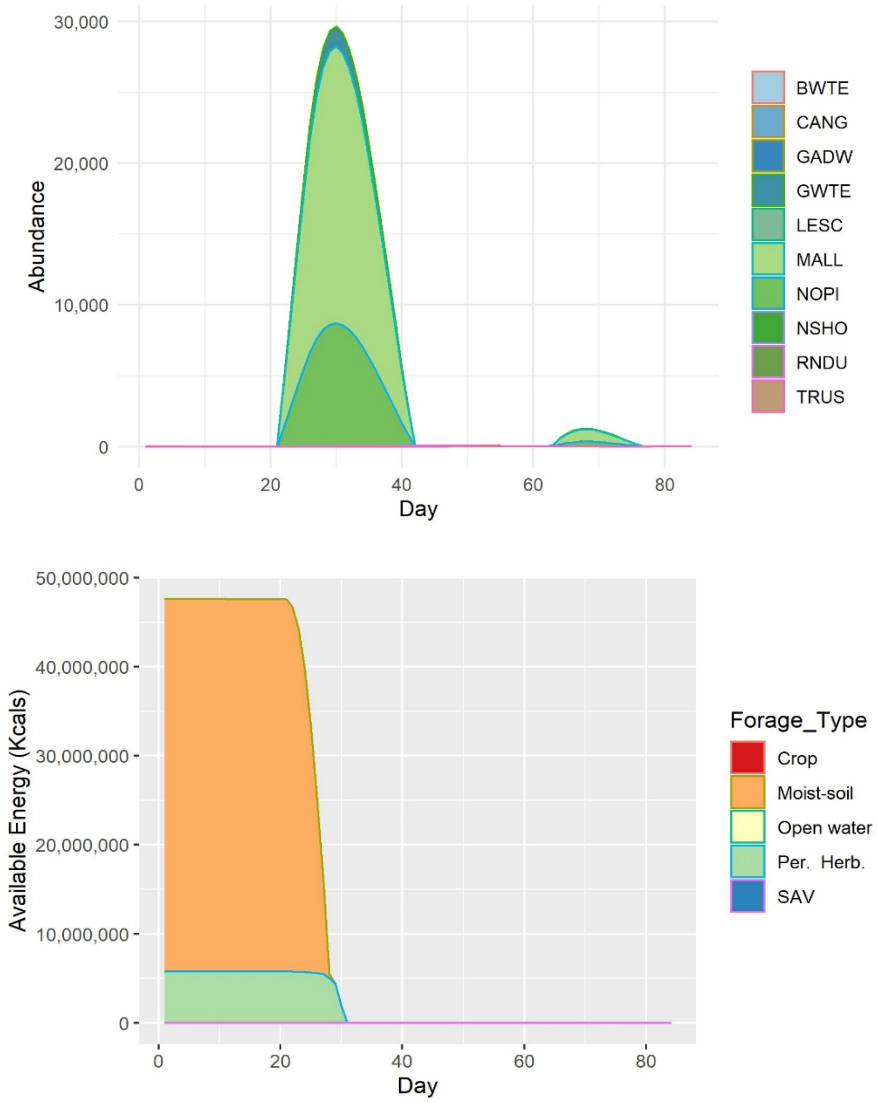


Figure 1.1 TRUMET model output as abundance curve fit from IWMM observations (top) and available kcals by habitat type for fall 2019 migration season (bottom) for the Rice Paddies Unit, Loess Bluffs NWR, MO-010-RP. Day 1 = Oct 8, 2019. Modeled depletion date was day 31 or Nov 7th 2019. Energy estimates derived from seed production samples from the unit's moist-soil community plus static literature-based values applied to perennial herbaceous (Per. Herb.) portions of the survey unit (Loges and Welchert 2021).

Site (Refuge) Scale:

1. ***Effectiveness Monitoring: assessing relative management efficiencies across units managed as a complex.***

IWMM waterbird counts and management actions data can be used to evaluate operational efficiencies across multiple units within a single site. At Two Rivers NWR, IL large discrepancies in gross operating costs exist between two large (>1000 acres) units and a set of smaller moist-soil impoundments led to inquiries from refuge staff regarding the relative efficiencies of their management costs across all units. Using IWMM data, the cost of a dabbling duck use-day (DUD) for an acre of flooded wetland was calculated as the final performance measure for comparing units. The flooding adjustment was derived from bird survey water depth covariates. Costs were derived from fixed costs applied to documented management actions. Results from the 2016/17 season identified the two large units as the most efficient options for desired bird response despite the high management cost. A DUD on Swan Lake ranged from $0.004 to $0.008/DUD. Most of the moist-soil units were far less efficient. Seven of the 10 MSUs had returns that exceeded a ten-fold increase in the cost per DUD (Loges 2017).

Table 1.2. Estimated management costs for the 2016/17 migration season with costs per water acre-use-day (DUD) as adjusted for area of surface water and efficiency ratios to the most efficient unit.

Unit	Unit Code	Total Cost	Unit Cost /acre	DUD /acre	DUD Cost	ratio to most efficient
Office	IL-004-A	$1,753	$112	3881	$0.029	7
Duck Club	IL-004-B	$1,794	$108	1452	$0.074	17
Lower Calhoun	IL-004-C	$6,537	$86	1101	$0.078	18
Upper Calhoun	IL-004-D	$3,894	$82	255	$0.322	76
Pump Station	IL-004-E	$3,705	$87	3205	$0.027	6
Schoolhouse Marsh	IL-004-F	$2,499	$73	729	$0.100	23
Lower Headquarters	IL-004-G	$1,889	$65	152	$0.428	101
Little Swan	IL-004-I	$944	$47	1716	$0.027	6
County Road	IL-004-J	$2,496	$78	1843	$0.042	10
Lower Swan Lake	IL-004-K	$43,637	$31	2149	$0.015	3
Middle Swan Lake	IL-004-L	$15,025	$15	3443	$0.004	1
Brushpile	IL-004-M	$1,239	$80	1676	$0.048	11

2. ***Adaptive Management: informing a refuge-scale decision framework for waterfowl and shorebird management.***

Mattamuskeet National Wildlife Refuge manages a complex of wetland impoundments through a variety of water level and vegetation manipulations in coastal North Carolina. A decision support tool was developed for three different management objectives: shorebird-use days during fall and spring migrations, and waterfowl-use days during the nonbreeding season. The tool includes a Bayesian Belief Network (BBN) model that predicts shorebird- and waterfowl-use days. The model incorporates discrete vegetation states defined from IWMM vegetation survey metrics, guild use-days generated from IWMM waterbird observation data, and management actions related to manipulating hydroperiods and vegetation (Tavernia et al. 2017).

Table 1.3. Habitat condition states used to create a Bayesian Belief Network model for predicting shorebird and waterfowl use-days. (Tavernia et al. 2017).

Shallow/mudflat	<66%	% impoundment in mudflat and (or) shallow water (<5 cm)
	66 to 90%	
	>90%	
Waterfowl Energy	Low Energy	seed production index value below 15
	Moderate Energy	seed production index value 15 to 30
	High Energy	seed production index value greater than 30
Interspersion of bare ground or water to vegetation	S	impoundment includes small, disconnected patches ofwater/bare ground
	M	impoundment contains discernible regions of interspersionstates L and S
	L	impoundment includes large and connected patches of water/bare ground

3. Effectiveness Monitoring: valuating trade-offs for competing wetland management objectives at the refuge scale.

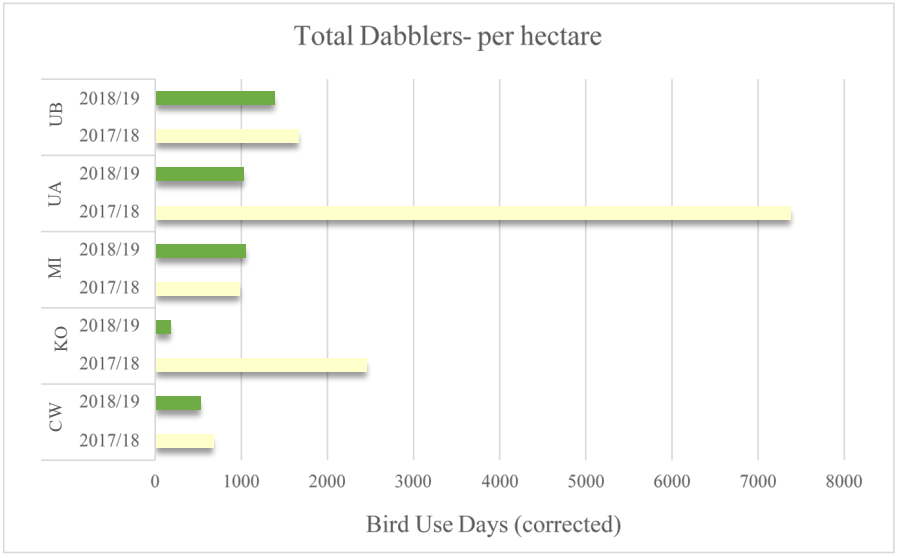
The Clarence Cannon NWR in Missouri provides high quality emergent marsh and moist-soil wetlands for locally rare nesting marsh birds and migrating waterfowl. Migrating waterfowl benefit from units dominated by annual vegetation following growing season drawdowns (moist-soil); whereas, nesting king rails benefit from marshes with some late successional vegetation and shallow water during the growing season. IWMM waterfowl observation and habitat data linked waterfowl responses to different vegetation states allowing decision makers to empirically define expected waterfowl benefits instead of relying solely on expert judgment that tended to overestimate expected dabbler use in moist-soil units. A constrained optimization (linear programming) was used to create refuge-wide scenarios of competing management approaches each summarizing refuge-wide utilities for both king rails and migrating waterfowl (Loges et al. 2017).

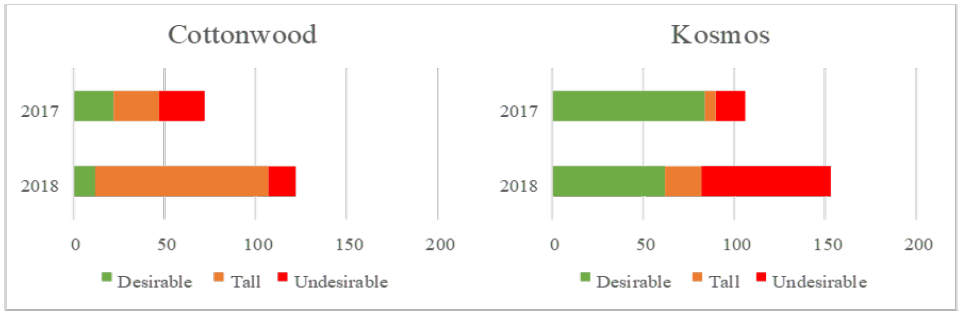
4. Inventory of waterbird migration and vegetation quality with status update for CCP/HMP objectives.

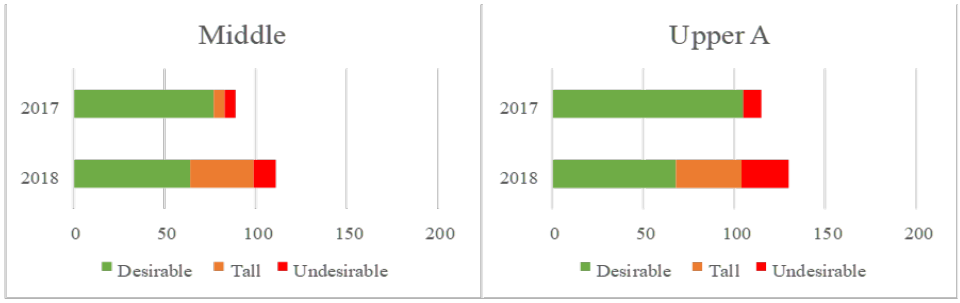
Cold Springs National Wildlife Refuge (Oregon) manages wetlands via water management and vegetation treatments to encourage moist-soil vegetation and discourage undesirable plants for wintering and migrating waterfowl. Objective 2.1 (draft CCP) states "*Enhance and annually maintain 138 acres of managed, seasonal wetlands for migratory waterfowl, including 40 acres of moist-soil vegetation annually*".

- >60% cover of desirable and/or native wetland plants, including moist-soil annuals
- <20% cover of native emergent species that are >5 feet tall (e.g., cattail, hardstem bulrush)
- <40% cover of undesirable/invasive plants.

The objectives of the survey are to document changes in vegetation condition and waterbird use over time; and relate waterbird use to vegetation condition. The IWMM database is used to calculate waterbird guild use-days, seed production index, and % annual vs perennial vegetation. In addition, the number and % cover of desirable plant taxa as defined by refuge staff is tallied by unit.







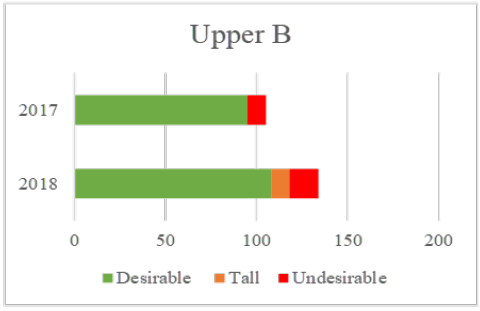


Figure 1.2. Dabbling duck-use days and vegetation cover of plant groups for a two-year period on Memorial Marsh Unit Cold Springs NWR, Oregon. Plant groups defined by refuge staff and sorted to species observed in IWMM annual vegetation surveys. UB = Upper B; UA = Upper A; MI = Middle, KO = Kosmos; CW = Cottonwood. *Figures reproduced from: D. Meliopoulos and J. Barnett. 2019. IWMM Surveys on Cold Springs NWR Winter 2018-19. USFWS Unpublished Report. 13pg.*

Multiple-Site (Regional) Scale:

1. ***Habitat Associations: Regional assessments of waterbird abundance and diversity across different management treatments.***

   IWMM bird survey methods were used in a regional study evaluating the restoration of shallow lakes in the Des Moines lobe area of the prairie pothole region and the influence of lake restoration on waterbird use and diversity during the spring migration season (Vanausdall and Dinsmore 2019). The study covered 30 natural lakes across 12 counties for three spring seasons. Whole area counts were conducted from the perimeter of the lakes and included % cover of estimates of open water, emergent, bare ground, and shrub-scrub/forest. Lakes with management interventions had higher abundance and richness than non-restored lakes. Model results also indicated that percent emergent cover was an important variable for total waterbird abundance, dabbling ducks, diving ducks, and species richness.

   A second study used IWMM's waterbird survey methodology to document bird-use as a key part of evaluating the influence of supplemental management funding. Bird surveys were grouped by reference wetlands and wetlands managed with supplemental funds from NRCS' Migratory Bird Habitat Initiative in Arkansas, Louisiana, Mississippi, and Missouri. Higher numbers of dabbling ducks, all ducks, and non-waterfowl waterbirds, and shorebirds were observed on wetlands that received initiative funding (Tapp et al. 2018)

2. ***Habitat Associations: Peak and relative density during migration for waterbird guilds across multiple survey units.***

   IWMM whole area counts can be used to identify peak migration periods for guilds targeted in management objectives and identify differences in abundance across survey unit groups. IWMM bird survey methods were used in a study of wetlands managed through the Migratory Bird Habitat Initiative and non-managed wetlands. Waterbird densities in managed units were twice that in unmanaged units and seasonal peaks occurred in February after hunting seasons had closed (Weegman 2013).

3. ***Effectiveness Monitoring: Relative comparison of the contribution of survey units to conservation objectives across region(s).***

   A Unit Contribution Index (UCI) was developed using species richness, population abundance, and waterbird species' conservation score (Aagaard et al 2017). Data were pulled from 729 IWMM survey units across USWS legacy administrative regions 3, 4, and 5. Abundance is represented by seasonal bird use-days per unit acre, richness reflects the number of species by unit from IWMM whole-area counts. Whereas the conservation status is derived from the International Union for Conservation of Nature (IUCN) Red List. The index values can be used to compare management units within a refuge, across the region or across any other spatial scale whenever the units forming the conglomerate are surveyed in a consistent manner following a standardized protocol (Figure 1.4). The index can also be customized to a particular interest in species richness, species abundance or species conservation status by changing their respective

weights. The tool quantifies the relative contribution of an individual survey to conservation objectives and can be used to assess unit specific performance relative to all survey units.

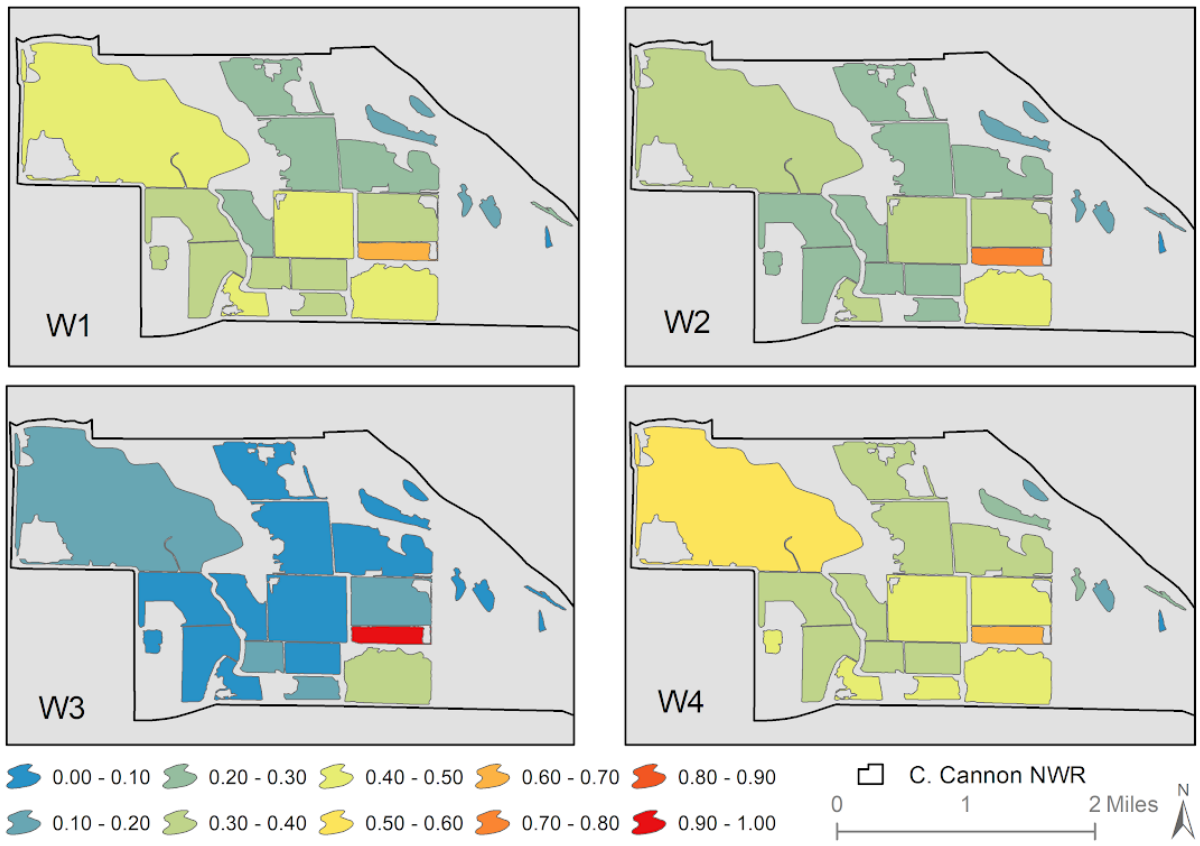


Figure 1.4. Maps of Unit Contribution Index (UCI) values for IWMM survey units at Clarence Cannon NWR, MO, 1.0 = highest performing unit. Each map version generated with a variant of weight scenarios applied to seasonal totals for species richness, species abundance and species conservation status. Values derived from waterbird data collected between 2010 and 2014 from 163 Midwestern survey units (Aagaard et al 2017).

Linking survey objectives to management objectives:

Hypothetical examples of survey objectives derived from common management objectives following the format of Elzinga et al. (2001) are provided for reference and illustration (**Box 1.1**).

Box 1.1. Examples of project-specific management and sampling objectives.

Mingo NWR:

- Management objective: Through water manipulation, planting, mechanical, and chemical treatments provide quality moist soil habitat and high energy food resources for waterfowl. Provide a minimum of 800 acres of managed moist soil units that annually produce an average of 3 million DEDs in support of the average of 11 million DED objective at Mingo NWR (USFWS 2011).

- Sampling Objective: The cooperator needs to be 90% confident that the estimated acres of quality moist-soil habitat with high energy food resources are within 20% of actual acres.

Muscatatuck NWR:

- Management objective: Annually maintain moist-soil units … to provide annual food crops and resting habitat for migratory waterbirds, Wood Duck habitat, and mudflats for shorebirds. ... Average annual target use-day levels for all managed wetlands combined are as follows: waterfowl (ducks, geese, swans) ~500,000 use-days; shorebirds ~200,000 use-days; wading birds (egrets, herons, etc.) ~40,000; cranes (sandhill and whooping) ~40,000 (USFWS 2012).

- Sampling Objective: The cooperator needs 80% confidence that the estimated annual mean waterbird guild use-days is within 10% of the actual mean.

Multi-refuge study of spring flooded emergent habitats:

- Management objective: On refuges *x*, *y*, and *z*, estimate the Jan 15th—May 15th waterfowl use-days in emergent dominated management units with concurrent hydro-regimes increasing the extent and depth of flooding.

- Sampling objective: Attain 80% confidence that the use-day estimates are within 20% of the estimated true value. Attain 80% confidence ($\alpha=\beta=20\%$, one-tailed test) of detecting a 50% increase in flooded acres and mean water depth, with a 20% chance of inferring an increase in flooded acres and mean water depth when one does not exist.

Element 2: Sampling Design

For meeting local-scale objectives, census techniques are used to assess environmental conditions and waterbird use within each survey unit. A spatial sampling design is not required when the set of management units or individual unit represents the population of interest. Temporal design is contingent on the period of interest, but these are readily grouped as fall migration, wintering, or late winter/spring migration. Details related to setting up bounds for the survey unit (typically a 'management unit') are described in Standard Operating Procedures (SOP) 1. Since a theoretical design is not used to allocate a sample of survey locations, we refer to the units as survey units instead of sample units.

Sample units and sampling frame

A survey (sample) unit is a single managed or unmanaged wetland on a single date during the non- breeding season. A management unit is defined as a fixed area where recurring waterbird management actions are frequently applied. Boundaries of the survey unit should be fixed through the season and across years to ensure data comparability (SOP 1). A survey unit surface visibility threshold of 70% has been established as the recommended target. Vantage points should be added as needed to meet/exceed this threshold but in certain cases lower values may be acceptable.

To retain flexibility for the development of site-specific protocols, this framework does not provide a sampling design that selects representative management units for inference across a larger spatial scale (e.g., NWR, complex, region). Inferences are therefore germane only to each management unit from where the census was conducted. If inference needs to be extend to a spatial scale beyond a single management unit, then representative samples should be drawn following a theoretically based design and appropriate sampling frame. Surveys developed within this framework may be refined to select a sample of units from a complex as the population of interest using well-established or innovative sampling designs (random, random stratified, cluster, convenience, etc.).

Temporally, the sampling frame for the vegetation survey spans all dates during the latter portions of the growing season while the frame for waterbird surveys spans all dates during the non-breeding period. This non-breeding period should be defined based on the station's desired scope of inference and can include or exclude fall migration, overwintering, and spring migration. Selected survey dates should fall within the defined non-breeding period to ensure data are relevant for producing period-specific summaries; common applications include migration chronology curves and bird use-days estimates. It is anticipated that observers will be able to use existing monitoring data, regional weather patterns, and regional habitat information to judge the beginning and ending dates for the non-breeding period on a year-to-year basis.

A complete census of all waterbird management units is not necessary to approximate abundance at the site (refuge) scale. Censusing all management units as part of routine IWMM survey route is often impractical, can be costly, and may interfere with the application of a consistent effort to survey the most important management units. Past waterbird counts can be used to create a selective sampling scheme that was shown to retain 90% accuracy of a site's seasonal waterbird abundance while reducing survey effort to 2/3 of the units or 75% of the total survey area (Kumar & Rice 2018).

Sample selection, sample size, survey timing and schedule

The exact timing and length of the survey season depends on the period of interest as identified in site-specific survey objectives but a minimum of 5 surveys in sequence is required for the database to produce migration curves. The selection of a wetland for monitoring is based on the information needs of NWR staff or other cooperators. For managed wetlands, bird count data can inform conservation planning activities and the evaluation of management actions. For example, managers can use migration curves to time management actions and resulting habitat conditions to bird arrival. Monitoring of an unmanaged wetland might be justified if the station desires an understanding of non-breeding use of the wetland.

A practical approach for selecting survey dates during the non-breeding season is to systematically conduct Waterbird and Unit Condition Surveys on a weekly or biweekly basis. Subjective selection of survey dates should be avoided because it can introduce bias into migration curves and bird use-day estimates. As an example, only conducting counts when many birds are present in a wetland could positively bias bird use-day estimates. When estimating the total use-day parameter, the frequency of counts is the sample size for a single non-breeding season, which influences the estimate of sampling error (see Element 4). Survey replication should be maximized (with at least 5-surveys / season) to reduce variation in use day estimates.

The IWMM Population Monitoring Protocol Team (unpublished data) conducted a simulation to explore the relationship of survey frequency to use-day estimate error. In this analysis, the team, (1) set bird use-days to a fixed value, (2) distributed bird use-days across a season to simulate a unimodal migration curve, (3) simulated semi-weekly, weekly, and biweekly counts during the survey season and (4) estimated bird use-days from the simulated counts. After 10,000 iterations, results showed that the average sampling error for seasonal use-day estimates was 14.7%, 20.5%, and 36.7% for semi-weekly, weekly, and biweekly counts, respectively. Based on these results, weekly counts represent a compromise between greater precision and logistical feasibility. Species or guilds with rapid migration periods and short stopover duration (e.g., shorebirds) may require greater sampling frequencies to generate reasonable migration curves (e.g., 2-3 surveys/week).

Sources of error

Detection of individual waterbirds is likely to be imperfect during surveys, thus biasing estimates from raw or naïve (uncorrected) counts. In the context of this protocol, bias refers to the difference between the expected value for an estimator and its true value for a waterbird use or habitat parameter, whereas precision refers to variation among repeated estimates of a waterbird use or habitat metric (Thompson et al. 1998). The inaccuracy occurs when some individuals are unavailable for detection (e.g., waterbirds behind vegetation), or when individuals that are available are not perceived by the observer. Many factors can influence detectability, including observer ability and attention, species, habitat conditions, and weather. The use of raw counts to infer waterbird response to habitat management assumes that detectability remains constant as habitat conditions change. This assumption can be problematic if, for example, detectability is inversely related to actual habitat use. There are available techniques, such as distance sampling (Buckland et al. 2004) or concurrent multiple observers (Bart and Earnst 2002, Forcey et al. 2006), that would allow cooperators to estimate detectability, unbiased counts, and appropriate sampling variances. The application of these techniques can increase the reliability of survey results, but

usually incur additional costs. Unadjusted counts targeting guilds with large populations and a large magnitude of change, often the case for migrating waterfowl, can be useful to assess changes over time, however adjusting for detectability is critical for surveys targeting rare species in low densities (Thompson 2002).
The need to adjust for detectability also depends on the context of decisions being informed by the survey results. Decisions that will influence expensive or controversial actions for rare species will likely require methods with greater rigor and results with greater precision. This framework is developed for unadjusted counts but does not preclude accounting for detectability adjustments if bias estimated as part of the count process or constants are available for use (Gilbert et al. 2021).

The habitat-use patterns of waterbirds can differ between diurnal and nocturnal periods (McNeil et al. 1992, Tamisier 1976, Cox and Afton 1997, Davis et al. 2009). Consequently, for some species, diurnal counts and associated habitat assessments would ideally be complemented by efforts to assess nocturnal use (Anderson and Smith 1999). When diurnal and nocturnal habitat- use are known or expected to differ, the potential influence of nocturnal activity on use estimated solely from diurnal counts should be acknowledged. However, waterbird use in sanctuaries where disturbance is minimal during the day is likely useful in informing management decisions (Hagy & Kaminski 2012, Hagy et al. 2017).

Sampling objectives addressing habitat metrics should also consider the potential impact of bias, inaccurate estimates, and the level of achievable precision. The accuracy of IWMM visual estimates of annual percent cover, perennial percent cover, and total vegetation cover at the unit scale were similar to plot-based estimates in a 2012 validation study. Overall map accuracy for cover type maps averaged 93%. Perimeter-based estimates of emergent vegetation cover underestimated those from cover maps by an average of 4.7% (95% CI: -10.9%; 1.5%), but this difference did not differ from 0 ($t_{13} = -1.6$, $p = 0.13$; Tavernia et al. 2016).

A second validation study completed in the fall of 2014 evaluated the relationship between a seed production index (SPI) and the mass of seeds produced in moist-soil units (Loges and Tavernia 2018). Quantitative measurement of seed head area in sampling plots were converted to seed mass estimates using the scanned seed head approach outlined in Gray et al. (2009). The correlation between the SPI and plot-based seed production estimates was significant ($r = .69$, $p=.038$, α .05) for one of three observers. SPIs varied considerably across the three observers who had various levels of experience with moist-soil vegetation. One observer had over ten years of experience managing and evaluating moist-soil systems, another observer had 4 years of experience monitoring general vegetation response in moist-soil units, while a third observer had little to no experience with moist-soil vegetation prior to this study. SPI assigned categories based on the following seed production reference values (Gray et al. 1999 and Kross et al. 2008): <200 kg/ha = low production, 200-600 kg/ha = moderate production, >600 kg/ha = high production, agreed with the plausible categories encompassed by the relatively wide confidence intervals (95%) across reference seed production plots in all but one case, a 96% agreement rate (Table 7). Replacing plot-based estimates that are prone to high variability despite the use of recommended sample sizes with SPI would result in a considerable time savings when precise unit-level seed production values are not necessary or practical. Future SPI modifications may include correction factors when converting SPI to seed mass, but we do not recommend the current version of the SPI for predicting total yield (kg/ha). In cases where a categorical assessment of wetland seed production is desired, the SPI mirrored the general seed production categories derived from the plot based results with only 1 of 27 estimates falling outside the categories encompassed by the 95% CI from sample plots. Lastly, it is expected that advanced protocol training could improve consistency

across observers.

Element 3: Field Methods and Processing of Collected Materials

Pre-survey logistics and preparation

Projects are defined as a collection of survey units that are administered as a single unit (e.g., a single NWR) Projects and survey unit codes will be assigned by IWMM staff to ensure that they do not duplicate use by other cooperators. Please contact the Project Coordinator for assistance in assigning codes. If you do not know the codes, please leave them blank, but make sure that you fill in name details so that the codes can be completed subsequently. Please refer to SOPs 2 and 3 for additional information regarding pre- survey logistics and preparation including equipment needed for waterbird and vegetation surveys.

Establishment of sampling units

Information regarding establishing survey units can be found in SOP 1: Delineating Unit Boundaries.

Data collection procedures

Population Metrics—Waterbird surveys will use the direct /whole-area count method for tallying the number of individuals by species. This method attempts to count or estimate all waterbirds listed in SM 1 (AOU Species Codes in Family Order) within a specified area (survey unit). Please see SOP 2: Waterbird and Unit Condition Survey for detailed instructions.

Count all waterbirds observed and identify to species when possible. When species identification is not possible, use aggregate categories (see the "Unidentified Waterbirds" codes in SM 1 or SM 2). Non-waterbirds (e.g., bald eagles, belted kingfishers) may represent species of interest but they will not be encompassed by this protocol; however, the database's survey notes field may be used to track coincidental species.

Familiarization with the American Ornithologists' Union (AOU) four-letter Alpha codes is helpful when conducting the waterbird surveys. AOU codes for waterbirds likely to be encountered are listed in SM 1 (taxonomic order) and SM 2 (alphabetical order). A full list of AOU codes can be found at: http://www.birdpop.org/alphacodes.htm. When counts are entered into IWMM's database, species should be identified by their AOU codes.

Habitat Metrics—Annual vegetation surveys, SOP 3, will be used to generate rapid assessments of plant community composition, moist-soil seed production, and percent of the survey unit near tall edge. Each bird survey will also be accompanied by a range of unit condition measures representing weather, tide, salinity, water depth, percent ice, flood duration, habitat cover, interspersion, vegetation height, and disturbance. For detailed instructions please see SOP 2: Waterbird and Unit Condition Survey.

Recording Management Activities—To develop effective and informed strategies using an adaptive management approach, a reasonable range of management activities must be considered (Williams 2011). Thus, in addition to monitoring waterbird use and habitat response, routine short-term habitat management activities will be tracked for each management unit (SOP 4). Managing wetlands as seral stages of vegetation communities enhanced by hydrological manipulations serves as the foundation of many wetland management programs (Gray et al 2013). Both components involve decisions with short-term consequences repeated within discrete management units, a situation well-suited to decision support based on adaptive management principles. The actions listed in SOP 4 are not meant to function as stand-alone actions in an adaptive management framework. The list is provided as a founding set of actions that can supplement or be compiled into an adaptive management framework.

Processing of collected materials

This protocol framework does not include procedures for routine collecting or processing of biological or abiotic materials. If carcasses of waterbirds are found, follow the guidelines provided in Supplemental Materials 8 and the Mortality Event Response instructions on the Wildlife Health office internal website: https://sites.google.com/a/fws.gov/fws-wildlife- health/products.

End-of-season procedures

All equipment should be accounted for, cleaned, and stored at the end of the season. Data sheets and maps should be turned in to the survey coordinator, who will archive the hard copy data sheets after data entry. Data entry should be kept current throughout the year. IWMM staff may establish entry deadlines on an as-needed basis.

Element 4: Data Management and Analysis

Data entry, verification, and editing

Cooperators should enter data into the IWMM's centralized, online database after each survey and be aware of any data entry deadlines announced by IWMM staff. IWMM's database is a node of the Avian Knowledge Network (AKN), and is a clearing house for bird survey, vegetation survey, and habitat management action data. The database can also be used for managing surveys and collaboration with others.

Anyone can use the AKN including staff from refuges, national parks and forests, states and other cooperators that are conducting waterbird and vegetation surveys using the approach described in the protocol framework. For information about enrolling projects in the database, please see the protocols and data management section of IWMM's webpage: (http://iwmmprogram.org/protocols-data-forms/) or contact the Project Coordinator.

Using the AKN and gaining access to the IWMM 'portal' for data management requires registering a valid e-mail address and setting a password. It will also require knowledge of one or more database protocols that are used for data entry and associated with the design and approach for data collection described by this survey protocol framework. More specific instructions for entering data into this database can be found in SOP 7.

Data entered into the AKN is governed by the IWMM Sharing Policy for Data Owners and Contributors and is not available to the public or collaborators unless specifically allowed by the

project manager: http://www.iwmmprogram.org/documents/IWMM_data_sharing_use_policy.pdf. By contributing data via the IWMM portal, cooperators are agreeing with IWWM's data sharing Policy, and can download all contributed data as a comma-separated (CSV) text file. Data owners share data at a predetermined AKN sharing levels: (http://www.avianknowledge.net/index.php?page=data-access). Note that for the purposes of IWMM only, the standard AKN definition of data sharing level 2 is modified so that IWMM science staff (e.g., Spatial Ecologist) can use IWMM data available to the AKN at data sharing level 2 or greater for analysis and data summaries. IWMM will not make this data available to others for any purpose other than as part of a scientific publication or in a peer-reviewed journal that requires authors to submit the data on which analyses are based. For the purposes of maintaining and managing the database, the IWMM science staff (e.g., Spatial Ecologist) will be a database administrator and will have access to all data submitted to the IWMM centralized database. When summarizing or presenting IWMM data, cooperators should cite the IWMM centralized database using the following example: Integrated Waterbird Management and Monitoring Database, http://data.pointblue.org/partners/iwmm/. Accessed <insert date>.

Metadata

Metadata need to adhere to AKN standards and will be accessible via the IWMM's database. The IWMM maintains a project record that documents administrative details regarding its national program. Each project is encouraged to maintain a project record, as a companion to the site-specific protocol, to record administrative and other historical information about the survey.

Data security and archiving

IWMM users may add completed field-data sheets and notes as a digital holding in ServCat with an appropriate report. Alternatively, data sheets may be archived independently in ServCat with its own metadata reference. Point Blue Conservation Science (PBCS) will host IWMM's database on its servers. For hosted databases, PBCS provides (1) incremental daily backups onsite, (2) weekly offsite backups, and (3) semi-annual backups that occur offsite.

Analysis methods

Data from different management units should be analyzed at the unit scale unless they comprise a representative sample of the target area of interest (e.g., refuge, complex, region). Inferences to larger spatial scales based on unrepresentative data pooled across management units will have unknown reliability for drawing conclusions about the larger area (e.g., refuge, region, flyway). When the intent is to draw an inference for a larger target population or universe, then analysis and estimation by pooling project-specific data from a subset of projects should be restricted to those cases where those projects have been selected according to a theoretically known sampling design. Although this framework does not specifically address such a sampling design, the operating procedures are conducive to surveys that sample a subset of survey units from a target population (Tapp 2013).

Data should be analyzed using the most appropriate means for meeting the sampling objectives and providing the summaries that effectively inform the management objectives. Such analysis includes knowing the key assumptions for using the analytical techniques and whether the data are fit for the intended use, as well as consequences to interpretation of the results when misused.

Many of the typical analyses and summaries of the data provided by the surveys conducted under this protocol are fundamental and explained in basic guides to biological statistical texts (e.g., Krebs 1999, Zar 2010). I&M or IWMM staff or a Regional Biometrician can be consulted for analytical

advice for more complex sampling objectives.

For the local scale, most analyses or summaries beyond the tools provided by IWMM will entail estimation of measures of central tendency or variability. When sampling objectives are similar to the examples in Box 1, confidence intervals or specific statistical tests can be used to evaluate pre-established questions of 'difference'. The methods and estimators for these should be chosen in part by the distributional properties of the focal metrics like waterbird use-days or frequencies of environment or vegetation categories. Where they differ from the general summaries mentioned above, project-specific versions of this protocol should describe or give additional details about the analyses and data summaries that will be used to fulfill local sampling objectives.

Tools and preprogrammed analyses available from IWMM's database include summaries of bird observations, use-days, and vegetation.

Bird Observation Summaries

The bird observation report can be selected for locations, dates, and taxa (species or guild), producing a description of each bird survey event and its sampling effort. Outputs include:

Table of number of visits, total number of birds counted, total number of taxa detected, and a diversity index.

Summary of Visits to Units by Month and Year

CSV

Project	Unit	Year	Month	NumVisits	TotalBirdCount	TotalTaxa	DiversityInd
Two Rivers NWR	COUNTY ROAD MSU	2016	2	2	472	4	2.96
Two Rivers NWR	COUNTY ROAD MSU	2016	3	3	198	4	2.6
Two Rivers NWR	COUNTY ROAD MSU	2016	4	1	14	1	1
Two Rivers NWR	COUNTY ROAD MSU	2016	10	1	0	0	0
Two Rivers NWR	COUNTY ROAD MSU	2016	11	4	50	1	1
Two Rivers NWR	COUNTY ROAD MSU	2016	12	4	4500	2	1.7

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Figure 4.1 Representative product for the table summarizing detections by month and unit.

- Table of the total number of birds counted, relative frequency of each taxon counted (the number of individuals in a taxon counted divided by the total number of birds in all taxa counted in the survey event), average number of individuals counted per survey event, maximum number of individuals counted at an event, birds counted per hour, and birds counted per hectare.

Summary of Bird Observations

CSV

Unit	Date	Species	Count	RelFrequency	avgCount	maxCount	BirdsPerHour	BirdsPerHectare
LOWER CALHOUN MSU	2016-03-03	Killdeer	2	0.6667	2	2	7	0
LOWER CALHOUN MSU	2016-03-03	Wilson's Snipe	1	0.3333	1	1	3	0
LOWER CALHOUN MSU	2016-03-17	Killdeer	15	0.5769	15	15	75	0.01
LOWER CALHOUN MSU	2016-03-17	Pectoral Sandpiper	8	0.3077	8	8	40	0.01
LOWER CALHOUN MSU	2016-03-17	Wilson's Snipe	3	0.1154	3	3	15	0
LOWER CALHOUN MSU	2016-03-25	Wilson's Snipe	7	1	7	7	70	0.01
LOWER CALHOUN MSU	2016-04-12	Greater Yellowlegs	15	1	15	15	450	0.01
LOWER CALHOUN MSU	2016-11-02	Greater Yellowlegs	4	0.0952	4	4	17	0
LOWER CALHOUN MSU	2016-11-02	Killdeer	38	0.9048	38	38	163	0.04
LOWER CALHOUN MSU	2016-11-17	Killdeer	30	1	30	30	138	0.03

Showing 1 to 10 of 10 entries Previous 1 Next

Figure 4.2 Representative product for the table summarizing numbers of detections by species.

The diversity index is the exponential value of the Shannon Diversity Index. In the equation below, pi represents the proportion of counts for species i in the sample:p_i = counts for species *i* / total counts.

$$\text{DiversityInd} = \exp\left(\sum -p_i \log(p_i)\right)$$

Equation 4.1. Shannon Diversity Index

Bird Use-Days Reports

The Bird Use Days (BUD) report includes the calculation of the total number of birds estimated to use the selected area. Thus, BUD is calculated from total counts using the trapezoid method (explained below), and estimates are provided for total BUD and for BUD per hectare. The report also includes the migration curve plot, presented as absolute bird numbers, and adjusted for unit area.

The BUD report necessitates a time interval for calculation, as well as the level of spatial aggregation (unit or project). Importantly, the calculation and plotting of BUD will only be performed if the interval selected includes at least 5 survey dates.

The data are aggregated for the purpose of the BUD calculations as follows. First, from the spatial and temporal selections, the application determines the number of dates where surveys happened. This is the survey effort table. Under the assumption that all species were reported in each survey, the effort table is merged to the observation records for each taxon, so that dates where the taxon was not observed are assigned a zero value for the counts.

The calculation of BUD uses the standard trapezoid method (see Hilborn et al. 1999 for details) to calculate the area under the migration curve. The calculation assumes that the first and last date of the interval have count = 0. If that is not the case, a correction is applied. The correction for the BUD was obtained from Bue et al. (1998) in Millar and Jordan (2013). It is applied in

those cases when either of the first or last date in the time interval is not 0. The calculation includes estimating the average span between survey dates in the time interval, then adding to the BUD value the area of the triangle created by adding the average span to the beginning and/or end of the time interval, and assigning a bird count of 0 at that date. The correction in effect consists in adding the area of one or two triangles to the BUD estimate.

Calculation of variance in BUD follows Millar and Jordan (2013), and uses the uncorrected BUD estimates. It consists of fitting a regression spline model to the count data. The splines have n-1 nodes, where n is the number of dates surveyed in the time interval. The variance in BUD is estimated from the residual variance in the spline model. The confidence limits are estimated for the corrected BUD estimate using the standard normal approach, as BUD +/-1.96 times the standard deviation (i.e., the square root of the variance).

The application generates migration curves for each taxon selected. A maximum of five can be plotted at once to avoid saturating the plot and making it difficult to understand. If the user requests a report for more than five species, the application will use the first five (in taxonomic order) with data to plot. If plotting more than five species is necessary, we suggest selecting them in groups of five or fewer, and plotting these one at a time.

Bird Use Days (adjusted for area) for Big Pond and Year 2013

CSV

Species	Location	StartDate	EndDate	BUD	Corrected_BUD	Variance	LowerLim	UpperLim	Ndays
Bufflehead	Big Pond	2013-09-05	2014-04-30	1.7544	1.7544	32380899005930000	NA	352695992.1217	32
Green-winged Teal	Big Pond	2013-09-05	2014-04-30	447.7793	447.7793	105940.3857	NA	1085.7296	32
Northern Pintail	Big Pond	2013-09-05	2014-04-30	515.1031	515.1031	359199.539	NA	1689.795	32

Showing 1 to 3 of 3 entries Previous 1 Next

Bird Use Days (unadjusted for area) for Big Pond and Year 2013

CSV

Species	Location	StartDate	EndDate	BUD	Corrected_BUD	Variance	LowerLim	UpperLim	Ndays
Bufflehead	Big Pond	2013-09-05	2014-04-30	152	152	2527989386105400000	NA	3116331974.1368	32
Green-winged Teal	Big Pond	2013-09-05	2014-04-30	38796	38796	105940.3857	38158.0497	39433.9503	32
Northern Pintail	Big Pond	2013-09-05	2014-04-30	44629	44629	359199.5385	43454.3081	45803.6919	32

Showing 1 to 3 of 3 entries Previous 1 Next

Figure 4.3. Representative product for the table summarizing raw and area-adjusted use-days by species.

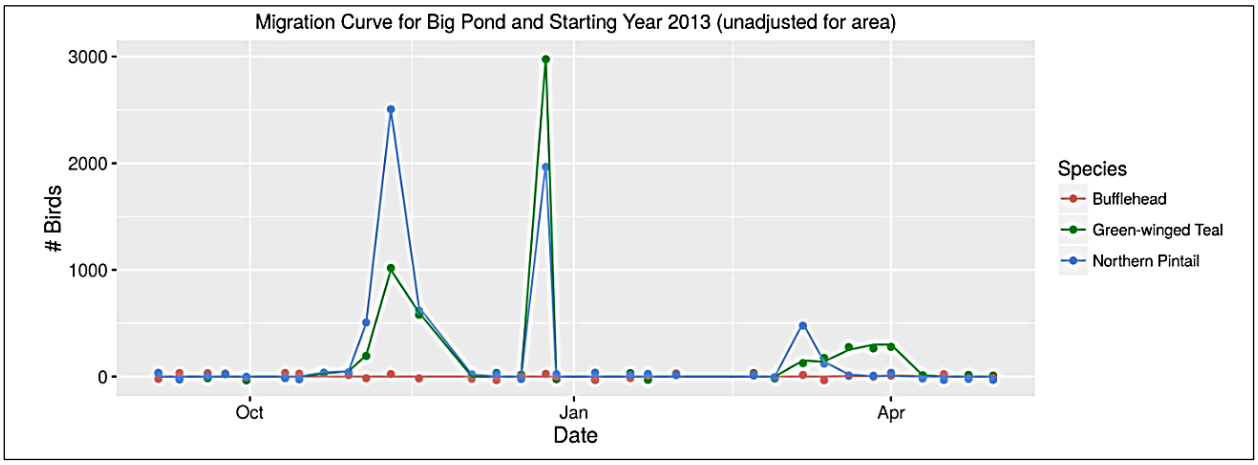

Figure 4.4. Representative product for the migration curve plot.

Vegetation Reports

Habitat resource types (HRT) are summarized in a separate report with energy calculated as waterfowl energy-days (WED). A WED is 300 Kcals, which is the approximate daily energy requirement of a mallard-sized duck during the non-breeding period. "CalculatedEnergy" is the WED total energy (WED) for each HRT by survey unit and season. It is derived from unit area, the proportion of unit in each HRT, and static values for each energy quality class by HRT (table SOP-5.1). User-provided custom energy values for any HRT are used in the calculation instead of default values when added to a vegetation survey. "TotalVisitEnergy" is the cumulative calculated energy (WED) across all HRTs for a survey unit in a single survey season. "UnitEnergyPerAcre" is the sum of "CalculatedEnergy" across all HRTs in a single season divided by unit area (acres). "PercentEnergy" is the proportion of the total unit energy contributed by each HRT within each survey unit by season.

Habitat Resource Type (HRT) Results

CSV

ProjectCode	Unit	LocalityId	ObservationDate	UnitArea	HrtPercentCover	HabitatResourceType	HrtQuality	CalculatedEnergy	TotalVisitEnergy	UnitEnergyPerAcre	PercentEnergy
SEQUOYAHNWR	Sequoyah NWR	SEQUOYAHNWR:OK-001-MA	2020-10-08	21.63	1	Semi-permanent Wooded Wetlands	L	21.63	12058.725	557.50	0.18
SEQUOYAHNWR	Sequoyah NWR	SEQUOYAHNWR:OK-001-MA	2020-10-08	21.63	26	Freshwater Non-persistent Emerge	L	5623.8	12058.725	557.50	46.64
SEQUOYAHNWR	Sequoyah NWR	SEQUOYAHNWR:OK-001-MA	2020-10-08	21.63	70	Freshwater Persistent Emergent M	L	6056.4	12058.725	557.50	50.22
SEQUOYAHNWR	Sequoyah NWR	SEQUOYAHNWR:OK-001-MA	2020-10-08	21.63	2	Aquatic Bed	L	346.08	12058.725	557.50	2.87
SEQUOYAHNWR	Sequoyah NWR	SEQUOYAHNWR:OK-001-MA	2020-10-08	21.63	1	Mudflat	L	10.815	12058.725	557.50	0.09

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Figure 4.5. Representative product for the annual Habitat Resource Type summary for a single survey unit. Energy units presented as waterbird energy-days (300 kcals).

The annual vegetation summary presents the information from the annual vegetation surveys. First, a summary table reports the total plant taxa identified, plant diversity index (Shannon's Diversity Index), and percent cover of all taxa identified as annual and perennial plants, including taxa that have been identified previously as primary foods of waterfowl and those that have not, for each survey. This table is intended to help the user review the completeness and accuracy of the data.

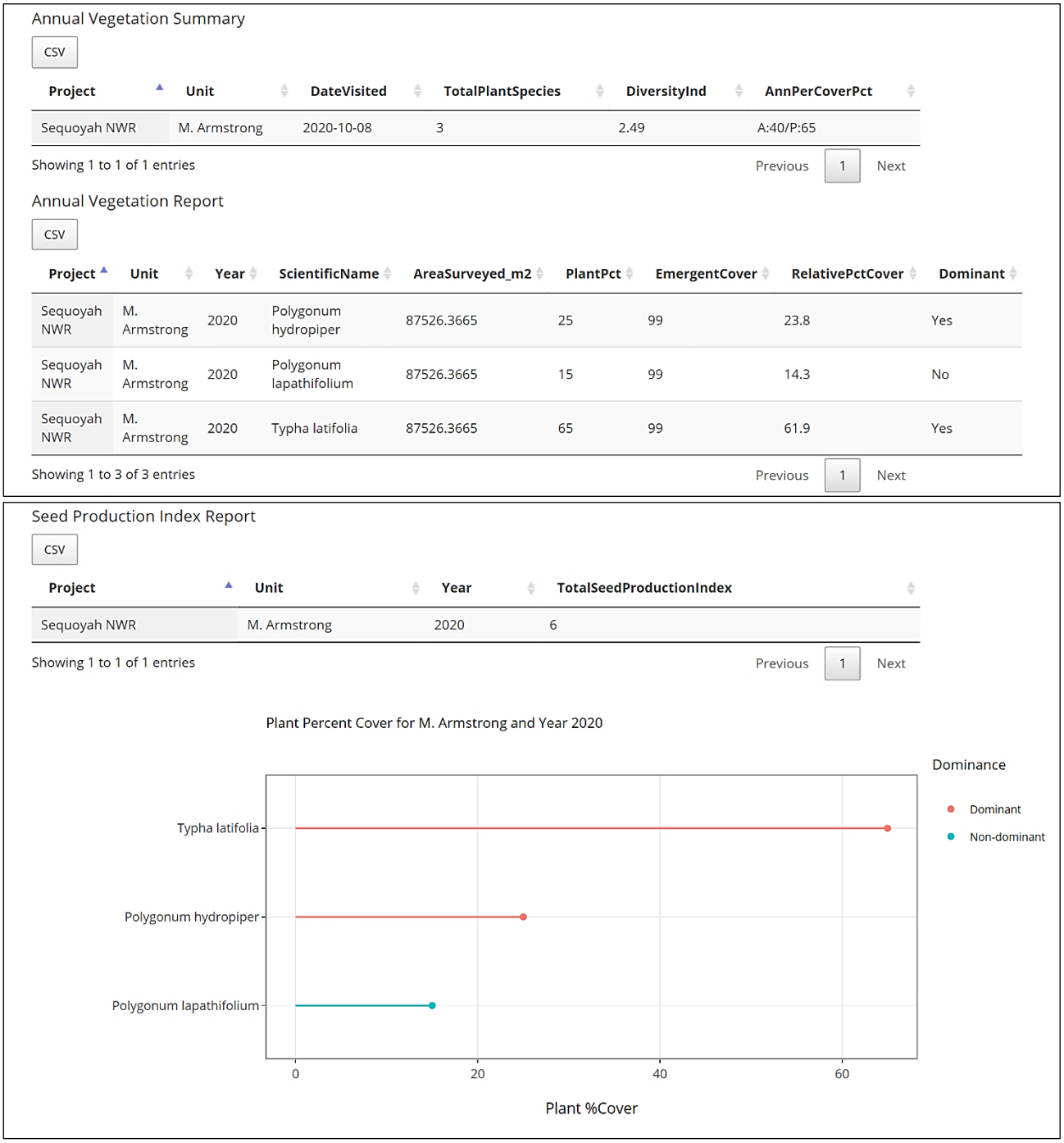

Figure 4.6. Representative products for the annual vegetation survey summary.

Attribution of annual and perennial life strategies is provided by the USDA PLANTS Database (USDA, NRCS 2015). The percent cover for annuals and perennials is totaled by unit and year, and reported together as a pair of values. For example, a total sum of 20% plant cover for annuals and 120% for perennials would be depicted as: A:20/P:120 (% cover annual / % cover perennial). The Diversity Index is calculated as in Equation 4.1 above. NOTE: the total, annual, and perennial plant cover can exceed 100%, as the cover of individual plants can overlap extensively.

The summary table is followed by a report table. The report table includes the following parameters: plant species (Scientific Name), survey unit area (AreaSurveyed_m2), proportion of the vegetated portion of the unit covered by the species (Plant Pct), and percent of the survey unit that is emergent vegetation (Emergent Cover), for each unit and year in the selected data. From these data, the application calculates the following two additional parameters:

-Relative percent cover (RelativePCTCover) for each taxon: a taxon's percent cover divided by the cumulative cover of all plant taxa (i.e., percent of total plant cover represented by the species).

-Dominance: the plant dominance estimated by applying the 50/20 rule (those species that represent the first 50% of the total plant area, plus those species that cover an area > 20%). Any species exceeding 20% of the total cover is dominant. Dominant status is also assigned to any species that contributes to a cumulative cover threshold of 50% of the total cover. The 50% cumulative threshold is calculated in descending order with tied cover values taken together. The 50% and 20% value cut-offs are estimated by calculating the total area covered by plants (i.e., the sum of plant percent cover values) and then obtaining the 50% and 20% cut-off values from that total (i.e., total x 0.5 and total x 0.2).

The last table in the report provides the seed production index (SPI) (Naylor et al. 2005) for each year in the selection. The SPI can be used to track temporal changes in seed production within units. The SPI is calculated only for plant species consumed by waterfowl where the plant percent vegetative cover is > 5%. SPI is calculated for a unit by assigning each species a quality score and multiplying this by a categorical value related to the percent coverage of that species within the unit (e.g., area score). Next, the products from each species are summed to generate an overall SPI for each unit. The area score categorizes the proportion of a survey unit's area covered by a plant (PlantPct*EmergentCover) /100) as follows: 0-10% = 1, 11-25% = 2, 26-50% = 3, 51-75% = 4, and >75% = 5. The quality score is the sum of head size score and head density score. The head size score is as follows: small = 1, large = 2. The head density score is small = 0, medium = 1, and high = 2. Thus, the quality score can be an integer between 1 and 4.

The SPI is estimated for only those plant foods for which the seed head size and density were estimated using measurements provided in the IWMM photographic seed head assessment guide. An SPI of zero indicates that none of the SPI plant species were present or that they were not measured.

Plant taxa included in IWMM photographic seed head assessment guide are:

- Barnyardgrass or wild millet (*Echinochloa crus-galli*)
- Coast cockspur grass or Walter's millet (*Echinochloa walteri*)
- Rice Cutgrass (*Leersia oryzoides*)
- Fall panicgrass (*Panicum dichotomiflorum*)
- Curlytop knotweed (*Polygonum lapathifolium*)
- Pennsylvania smartweed or pinkweed or big seeded smartweed (*Polygonum pensylvanicum*)
- Foxtail (*Setaria*)
- Beggarticks (*Bidens*)
- Yellow Nutsedge (*Cyperus esculentus*)
- Amazon sprangletop (*Leptochloa panicoides*)
- Redroot flatsedge (*Cyperus erythrorhizos*)
- Goosefoot, Lambsquarters (*Chenopodium album*)
- Swamp Timothy, Swamp Pricklegrass (*Crypsis schoenoides* (L.) Lam.)

Average seed head size for selected plant species was calculated using measurements from published botanical keys, herbarium specimens, knowledge of natural seed head variability for selected species across the IWMM study area, and reviews of the following references: National PLANTS Database (USDA, NRCS

2015), Hotchkiss (1972), Martin and Uhler (1939), Beal (1977), and Yatskievych (1999 & 2006).

The values of plant percent cover for up to 25 taxa are plotted in a figure for each unit and year, ordered decreasingly, and color-coded to distinguish dominant vs non-dominant taxa (Figure 4.6).

Element 5: Reporting

Implications and applications

Ideally reporting should restate survey objectives and link findings to the management decisions. As described in other elements, the management decisions, management objectives, and survey objectives articulated in the site-specific protocols will shape the nature of IWMM reports. Some core information or general guidance on reporting is described here.

The data summary tools producing the products introduced in the analysis element will provide a foundation for reporting. The spatial scale, time period, and taxon level of the data summaries can be defined by the database user to customize the database products to their reporting needs. Data summaries can also be downloaded in a csv format allowing cooperators to further summarize data outside of the IWMM database. Examples of a cooperator generated reports using IWMM data summary products supplemented with outside analyses are included in the survey objectives (Element 1).

Data summaries can also be reported across projects for analyses targeting questions beyond the project scale. As the database is populated the IWMM program intends to summarize data across stations as interest in applying the dataset grows. Summaries of pilot season data provided some insight into the dataset's potential (Aagaard et al. 2015, 2016 and 2017).

Procedures for reporting survey results will depend on the type of audience intended to receive the results, needed format, level of review, schedule, distribution, and archiving. All reporting requirements should be documented by cooperators in site-specific protocols. Generally, reports produced by IWMM cooperators will be seasonal summaries, interim project reports, or final project reports.

Reporting Schedule

For progress and final reports, the site-specific protocol should clearly specify the frequency and expected due dates of reports. A short-term inventory effort may produce only a final report soon after all data are collected and analyzed, whereas longer-term monitoring efforts are likely to require both progress and final reports. The established frequency and timing of reports should be integrated with the frequency and timing of the management decision- making process.

Report Distribution

The site-specific protocol should identify to whom reports should be given and the appropriate medium for communications. A strategy for archiving reports should also be described. USFWS cooperators should ensure that field notes and reports are stored in compliance with Service Enterprise Architecture (270 FW 1), Data Resource Management (274 FW 1), and Electronic Records (282 FW 4) policies. Refuge System staff should also create accurate metadata and store data documents, metadata, reports, posters, graphs, maps, and any other documentation of results in ServCat (https://ecos.fws.gov/ServCat/).

Wildlife Health Reporting—Suspicious or unusually high numbers of mortalities should be reported to wildlife health officials regardless of whether materials were collected. Contact information and instructions on reporting collected specimens or wildlife health issues can be found at the Wildlife Health office's internal website: https://sites.google.com/a/fws.gov/fws-wildlife-health/products.

Element 6: Personnel Requirements and Training

Roles and responsibilities

IWMM National Project Coordinator
USFWS, 1201 Oakridge Drive, Suite 320, Fort Collins, CO 80525

IWMM Regional Contacts—Regional contacts communicate with potential cooperators, update groups within USFWS administrative regions on program progress, and identify opportunities for incorporating IWMM in Refuge inventory and monitoring plans. The list of regional contacts is updated frequently and is available at the projects website: http://iwmmprogram.org/contacts/.

IWMM Partners—U.S. Fish & Wildlife Service Legacy Regions 1, 2, 3, 4, 5, and 6; Migratory Bird Program & National Wildlife Refuges; National Park Service; US Army Corps of Engineers; Joint Ventures; States; Ducks Unlimited; and other NGOs. See IMWW Project Record for additional information.

Cooperators—Agency staff, NGO staff, or volunteers conducting surveys and individuals responsible for project scale coordination of surveys.

The survey coordinator for each cooperator is responsible for ensuring that staff members are properly trained to carry out surveys and that surveys are logistically feasible. Within participating USFWS regions, an IWMM regional contact will offer remote training opportunities as needed, and the IWMM will provide access to training materials for the survey coordinator to train cooperator members as needed. The regional contact will also be the point of contact when a cooperator desires clarification about aspects of field protocol. It is the survey coordinator's responsibility to assess whether or not individual staff members possess the necessary competencies, e.g., waterbird identification skills, to conduct surveys. The survey coordinator will budget staff time and financial resources and plan equipment availability to enable survey objectives to be successfully met.

Qualifications

All surveys need to be conducted by qualified individuals. Surveyors should be able to:

- Identify waterbird species
- Identify common wetland plant species
- Estimate large numbers of waterbirds using recommended techniques
- Follow survey protocols

Training

Cooperators should visit the IWMM website at: https://iwmmprogram.org/
for a recorded webinar that will introduce IWMM and introduce the waterbird survey, vegetation

survey, and management actions tracking. Inexperienced waterbird counters are advised to practice their counting and estimation techniques before participating in IWMM. This can be done in the field or at a desktop computer using Wildlife Counts software: https://wildlifecounts.com/index.html.

Data collectors should also be trained for dealing with any local hazards and proper procedures for handling and collecting injured or dead wildlife. For instructions on how to handle and submit waterfowl carcasses for cause of death diagnosis, please see Supplemental Materials (SM-8) as well as the Mortality Event Response instructions on the Wildlife Health office internal website: https://sites.google.com/a/fws.gov/fws-wildlife-health/products.

Element 7: Operational Requirements

Budget

Cooperator Level Costs—First year and annual estimates of staff time and expenses outline the commitment and capacity required to conduct a survey to completion. Unless noted otherwise, the accounting base is a survey unit. Time and expenses for implementing management actions or producing a site-specific protocol for the survey are not included. Staff time commitments are derived from unit average completion times from all whole-area waterbird counts conducted from the spring of 2010 to the fall of 2012 from an earlier version of the IWMM database. Only units surveyed 12 or more times within this period were included. Average unit specific completion times were highly variable ranging from 2 minutes to nearly 5 hours. Due to a strong positive skewness (1.04) in the distribution of completion times, the median value of 29 minutes was used to estimate time required to complete a whole-area bird count for a single unit. Unit- scale time requirements for completing the vegetation surveys were based on prior experience with database entry, reporting tools and the revised vegetation survey procedures. Equipment costs are based on on-line retail prices for moderate quality optical and field survey equipment. Fuel cost estimate is based on a 30-mile survey route @ 15 MPG. Cost amounts are given in 2014 dollars; annual inflation factors of 2 to 4% can be applied to quickly predict costs in subsequent years. If exact budgets are used in site-specific survey protocols, it is recommended that current prices are obtained from vendors.

Costs associated with tasks duplicated across survey units are presented as costs per unit to allow individual projects the ability to generate specific estimates. Survey set-up was estimated at 0.003 FTEs and $1231.25 in equipment and expenses plus an additional 0.001 FTE per survey unit. Survey set-up includes web-based training on the database and procedures and creating GIS layers for each survey unit. Annual staff time commitment was estimated at 0.003 FTE plus an additional 0.012 FTE per survey unit. Annual expenses are estimated at $174.00 per survey.

Using the total value of time and cost estimates assumes a new survey is being started with little or no preexisting resources. However, it is anticipated that most cooperators will already have most of the equipment on hand. Many are also actively completing waterbird surveys using initial survey instructions or as general reconnaissance. For these situations, the budget presented in Table 7.1 will likely produce an overestimate of the actual costs associated with implementing IWMM surveys at the project scale if the per unit costs are represented as a product of the number of units on a project.

Table 7.1. Estimated annual cooperator level costs for an eight-month weekly survey schedule.

		Staff (hours)						Expenses	
		Unit delineation	Protocol review training	Data entry	Data Collection	Data summary	Total FTE[1]	Fuel	Equipment
set up costs	per unit	2					.0001		
	survey		6				.003		$1,224.29
annual costs	per unit			5	16	1	.011	$14.00	
	survey		6				.003	$174.00	

[1] A full time equivalent, one employee or volunteer for a 2080-hour year.

Staff time—The number, size, spatial arrangement, and accessibility of survey units influence the staff time required to complete a survey route. The effort required to complete a survey route is expected to vary considerably among cooperators due to variability in these characteristics. Based on times to complete previous whole-area counts, the majority of cooperators (50^{th} percentile) will average 29 minutes or less per unit while conducting surveys to support IWMM.
Most cooperators (75^{th} percentile) will average 2.5 hours or less per unit while completing whole-area counts. Although average annual time required for design and reporting was not specifically recorded, one should allow for approximately 20 and 8 hours, respectively for these activities, with the assumption that design costs will be >20 hours in the first years of coordinating the surveys and much less in subsequent years.

Program Level Costs—In addition to cooperator generated product, IWMM monitoring information is applicable to potential adaptive management frameworks applied at multiple spatial scales to inform management decisions. Model development, decision support, data analysis, database maintenance, protocol development, and annual reports are all program level tasks that link cooperator generated data to larger spatial scales. Costs are derived from the IWMM project record from FY09 through FY12 (Table 7.2).

Table 7.2. Estimated program level costs Ca. 2014.

Item	Annual Operating	Annual Set-up phase
Cooperators, FWS staff	In-kind	In-kind
Jacobi fellowship		In-kind
USGS Post-doc	$129,006	$126,936
Project Coordinator	$90,000	$85,000
Model Development & revision contract (estimate)		$41,000
DU Cooperative agreement (5 field techs, tech editor)		$119,400
Online Database Development		$83,500
Online Database Maintenance	?	$40,000
Total	$219,006	$495,836

Coordination

IWMM developed the waterbird and vegetation survey SOPs within this document and publicly disseminates them through its website: https://iwmmprogram.org/. These standardized procedures are meant to foster collaborative efforts across cooperators to design and execute research projects examining the effectiveness of alternative habitat management practices for waterbirds. IWMM's Spatial Ecologist can facilitate the design and execution of these research projects.

Schedule

Survey activities are seasonal and some are time-sensitive within the survey period. Please see Figure 7.1 and Element 2: Sampling Design for information relevant to scheduling survey activities.

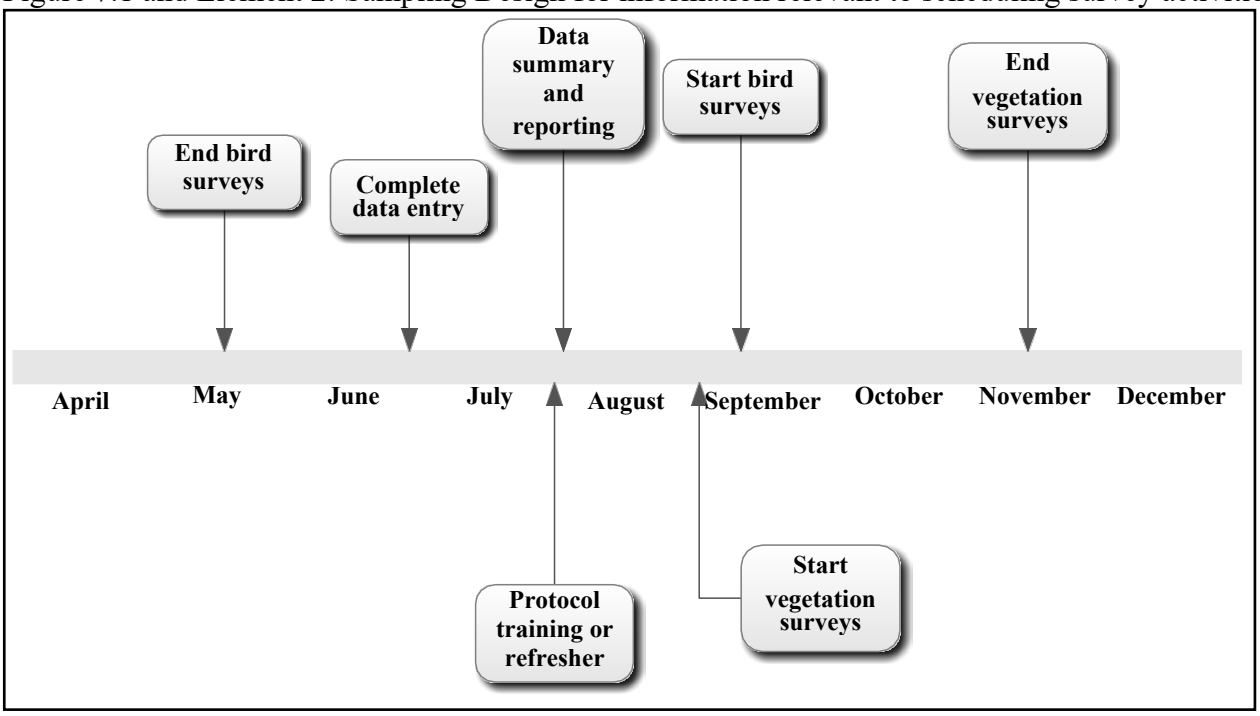

Figure 7.1. Generalized annual schedule for implementing waterfowl surveys, vegetation surveys, data entry, and reporting. Flexibility in assigning start and end dates for key tasks has been retained to facilitate customization of site-specific protocols.

Element 8: References

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Standard Operating Procedures

SOP 1: Delineating Unit Boundaries

Before conducting waterbird and vegetation surveys, follow these instructions to delineate the boundaries of each unit surveyed. Once boundaries are established for a unit those boundaries should remain the same throughout the season and year to year.

Equipment

- GPS
- Printed aerial images
- GIS & digital imagery

Observers should define survey unit boundaries to accommodate whole-area waterbird counts and vegetation surveys. On managed lands, wetlands are often divided into management units. Wherever possible, existing management units will be used as survey units. A management unit is defined as a fixed area where recurring waterbird management actions are applied. Management actions may vary in type and frequency. Cooperators have the discretion to survey units ranging from intensively managed moist-soil systems to protected natural wetlands with no habitat manipulation.

It is expected that the observer will be able to visually assess $\geq$ 70% of the survey/management unit (Figure SOP-1.1). If an observer cannot visually assess $\geq$70% of a unit's area, additional vantage points should be added in lieu of splitting the management unit into multiple survey units. This criterion applies to the surface area of a unit not to the visibility of birds within a unit. While multiple observation points can be established around the perimeter of the unit to meet this criterion, observers should bear in mind the need to complete the count on the unit within a single morning and to minimize multiple counting of individual birds. Note that the boundaries of the unit should be fixed through the season and across years to ensure data comparability. Please see Figure SOP-1.2 for flow chart that will help guide decisions regarding survey units.

Note: for units with less than 70% visibility, data collected at these units can still be managed in the IWMM database, but these units may be excluded from any future larger scale analyses by IWMM.

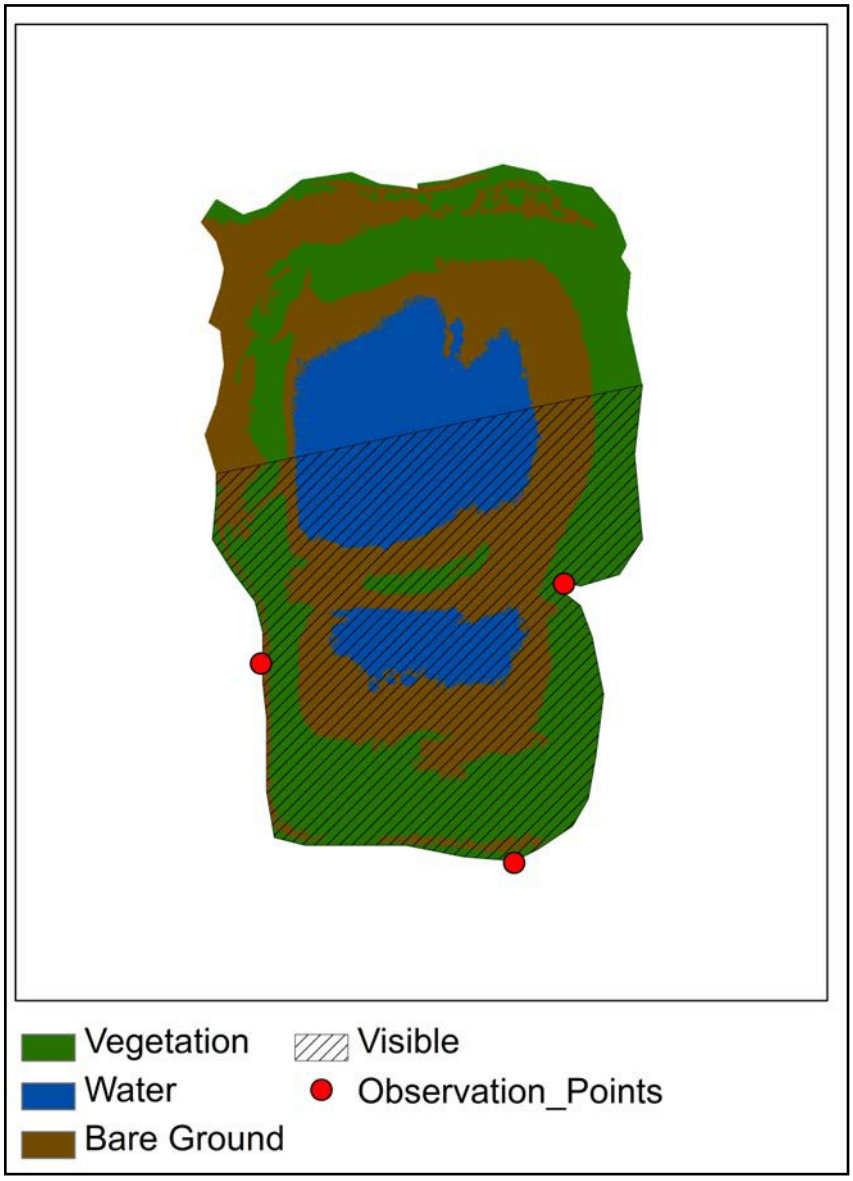

Figure SOP-1.1. Percentage of survey unit within a whole-area count. In this case, 70% of the unit falls within the whole-area count.

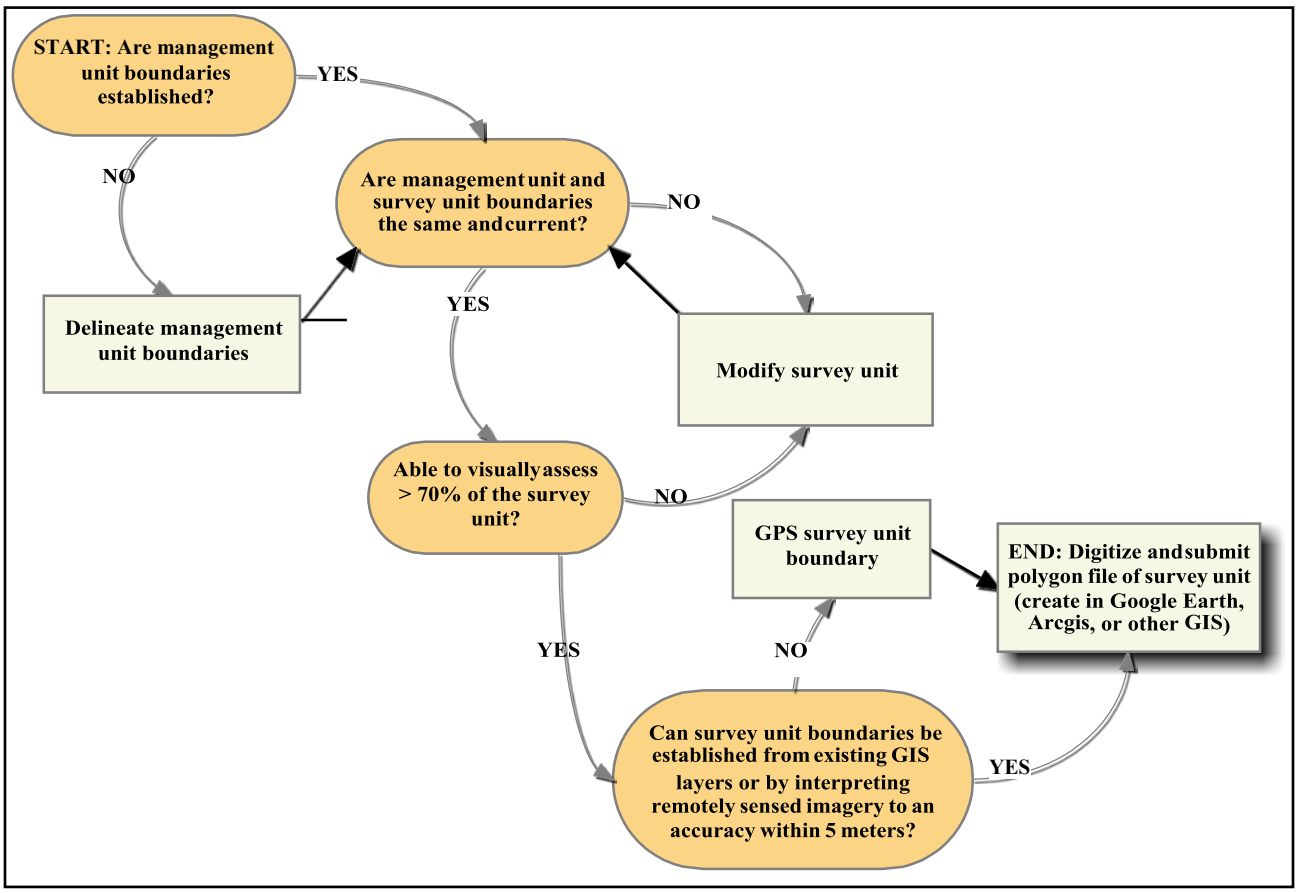

Figure SOP-1.2. Decision Flowchart for creating new or modifying existing management unit into IWMM survey units.

Full pool (spillway elevation) levels in managed impoundments or seasonal high water marks in areas with uncontrolled water levels can be used to delineate unit boundaries. Units may include areas above these high-water marks. Observers may use remote sensing resources to identify the boundaries of the wetland basin or GPS permanent topographic or other physical features in the field to define the management unit's extent. GPS accuracies meeting or exceeding 3–16 feet (1–5 meters) are acceptable (USFWS 2012).

Geospatial files with identified accuracy, projections, and coordinate systems (ArcGIS shape files or KML files digitized from Google Earth) can be submitted through the on-line database. Survey units can also be digitized over imagery using the database's "Digitize Location" tool. To facilitate inter-year comparisons of observations, survey unit boundaries should not be altered. Observers should create and maintain printed maps and geospatial layers as aids in maintaining consistent boundaries.

References

[USFWS] U.S. Fish and Wildlife Service. 2012. Data Delivery Standards and Specifications Template. USFWS, Pacific Southwest Region. Sacramento, California.

SOP 2: Waterbird and Unit Condition Survey

Follow these instructions for preparing and conducting waterbird counts and assessing site conditions for each unit at time of survey. Associated data collection sheets can be found in Supplemental Materials 3 and 4.

Note: Bird Surveys have to include all data for the measurements highlighted in bold on the following list for the survey to be entered in the IWMM database. Measurements not highlighted in bold are optional. Surveys with missing data for one or more required metrics cannot be saved in the IWMM online database. All other measurements are considered optional and/or site-specific.

Measurements

- **Counts of waterbirds by species**
- **Visibility (%)**
- **Wind speed (mph class)**
- Air temperature
- Tide position (class)
- Salinity (ppt)
- Gauge level
- **Water depth (cm class)**
- **Ice (% cover class)**
- Habitat cover (% of cover class)
- Interspersion (class)
- Disturbance severity (class)
- Disturbance source (class)
- **Chronic human disturbance (class)**

Equipment

- Good optical equipment, including a spotting scope or binoculars
- Thermometer (˚F - optional)
- Refractometer or hydrometer (optional)
- Map of the project and unit boundaries
- AOU species code sheet (Supplemental Materials 1: alphabetical order or Supplemental Materials 2: taxonomic order)
- Waterbird Survey Form (Supplemental Materials 3: Single unit and Supplemental Materials 4: multiple units) or tablet with IWMM app.

Survey Schedule

Waterbird surveys should ideally be conducted at least once per week throughout the season of interest for waterfowl and shorebirds (see Element 2: Survey timing and schedule). Estimates of use-days using weekly counts have greater statistical power than those conducted on a biweekly schedule (B. Tavernia,

USGS, personal communication). Therefore, weekly counts are preferred, but biweekly counts are also acceptable if staff time is constrained. Species or guilds with rapid migration periods and short stopover duration (e.g., shorebirds) may require greater sampling frequencies to generate reasonable migration curves (e.g., 2-3 surveys/week). The exact timing and length of the survey season depends on site-specific survey objectives but a minimum of 5 surveys per season of interest is required for the database to produce migrations curves.

It is best to designate a particular day of the week for the surveys so that they are spaced as evenly as possible in time. In coastal areas, surveys should be conducted within two hours of high tide to control for the effect of the tidal state of nearby mudflats. At inland sites, the time of a 24-hour period for conducting surveys should be based on the management objective. For example, if a manager is interested in supporting roosting activities, the counts should occur during a period when birds are most likely to be roosting in a site. Flexibility in the timing of surveys is needed to address constraints such as staffing, other activities taking place within units (e.g. hunting or management), and weather.

If multiple units are surveyed, it is good practice to change the order of surveys by choosing different starting units on each visit (wherever possible). If counts are expected to be compiled across units in a single set of surveys, counts for all units should be completed in one day to minimize double-counting birds. If birds regularly flush from units during counts, then efforts to minimize disturbance during surveys or concurrent surveys may be needed to minimize the multiple-counting of birds. If birds are observed moving from one unit to another, include waterbirds in the estimate for only the first unit in which they were encountered. Waterbirds observed outside the unit boundaries during flood events, as flyovers or on adjacent dry land should not be included in survey unit observations.

There is no time limit for surveys, although ideally, all units within a project should be surveyed on the same day. For aerial counts, unit condition information should be collected on the same day the waterbird count is conducted. If this is not possible, the survey date recorded should be the date the waterbird count was conducted. The date the unit conditions were collected should be included in the notes section of the database. Participants collecting unit conditions data on a different day than the waterbird count should evaluate the potential for the unit conditions to have changed significantly. If unit conditions have changed, the survey event should be censored.

NOTE: During the waterfowl hunting season it is important to avoid conflict with hunting interests. Conflict can be minimized when surveying units open to hunting by surveying from accessible points around the perimeter and by avoiding surveys during periods of high hunting activity.

Site and unit codes

Please contact the Project Coordinator for assistance on assigning codes. Project names and survey unit codes must be assigned by IWMM staff to ensure that they do not duplicate codes in use by other cooperators. If you do not know these codes, please leave them blank, but make sure that you provide enough detail (e.g., name of observer, location of surveys) so that the codes can be completed subsequently.

Percent Visibility

To conduct whole-area counts, $\geq$70% of the survey unit must be visible from one or multiple vantage points placed around the unit's perimeter. If an impoundment or area with natural

boundaries typically considered a “unit” for management by local staff is not 70% visible, the IWMM survey unit may not include the entire management unit. Estimate the percentage of the survey unit assessed for the whole-area count (Figure SOP-2.1).

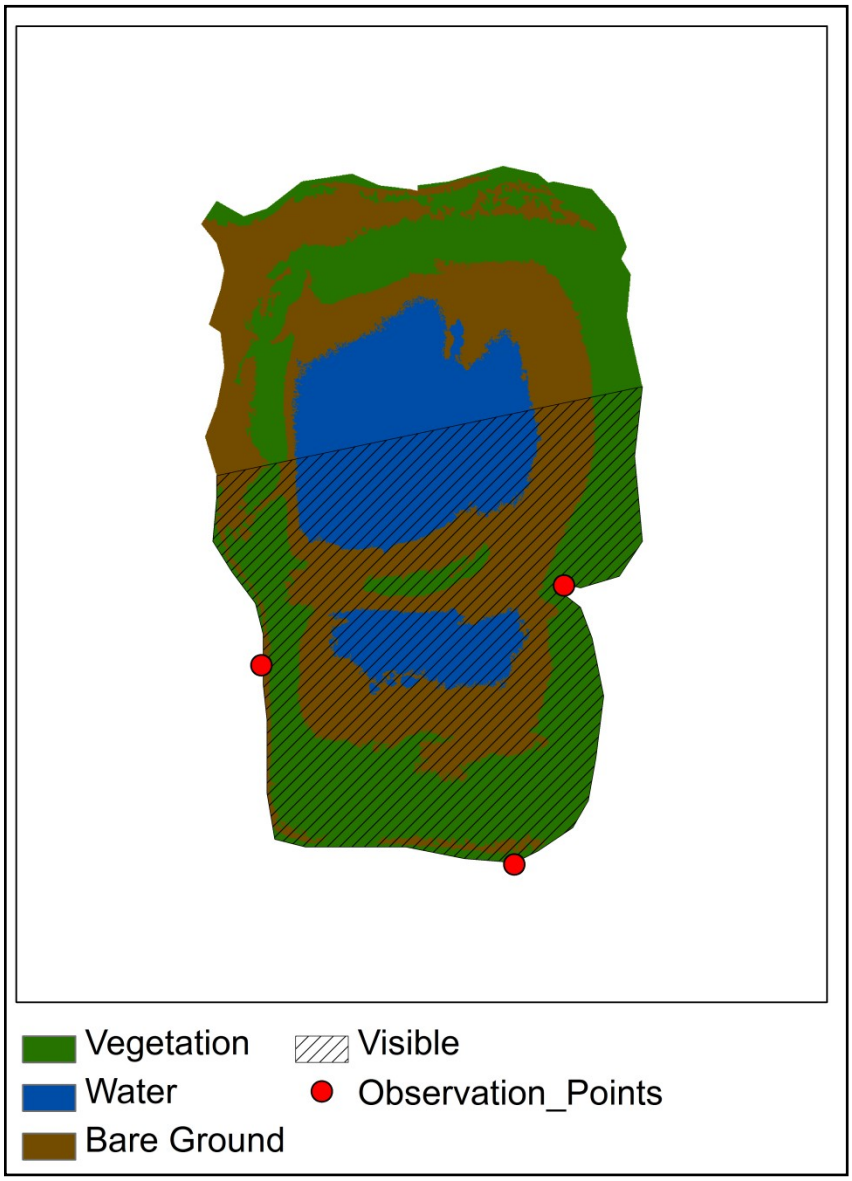

Figure SOP-2.1. Percentage of survey unit within whole-area count. In this case, 70% of the unit falls within the whole-area count.

Appropriate Weather

Surveys during inclement weather should be avoided. Whenever possible, do not survey waterbirds in fog, rain or strong winds (Beaufort force $\geq$ 3). Temperatures (˚F) at the start of the survey and Beaufort wind scale (Table SOP-2.1) are to be recorded. Estimate average wind speed (Beaufort scale) at the start of the survey.

Table SOP-2.1. The Beaufort Wind Scale

MPH	Beaufort	Description	Appearance of wind effects
<1	0	Calm	Calm, smoke rises vertically
1-3	1	Light Air	Smoke drift indicates wind direction, still wind vanes
4-7	2	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move
8-12	3	Gentle Breeze	Leaves and small twigs constantly moving, light flags extended
13-18	4	Moderate Breeze	Raises dust and loose paper; small branches are moved
19-24	5	Fresh Breeze	Small trees in leaf begin to sway
25-31	6	Strong Breeze	Large branches in motion; umbrellas used with difficulty

Local Tide Conditions (optional)

Please classify local tide conditions into one of the categories found in Table SOP-2.2 (from International Shorebird Survey protocol; http://ebird.org/content/iss/).

Table SOP-2.2. Local Tide Conditions.

Class	Description
1	High
2	Almost high and rising
3	Almost high and falling
4	Half tide, rising
5	Half tide, falling
6	Almost low, rising
7	Almost low, falling
8	Low
9	Not observed, not applicable, or observations made during more than one of these periods

Salinity (optional)

If your unit is exposed to saltwater, then measure salinity using a either a hydrometer or a refractometer (SOP 3); salinity should be reported in parts per thousand (PPT).

Salinity may vary throughout your unit, so careful consideration needs to be given to the number and distribution of salinity samples taken. No single sampling approach will apply universally, but the following considerations are offered as guides:

- Seek background on your unit, looking for information specific to factors that may cause salinity to vary (e.g., location of freshwater inlets)
- Ensure that selected sampling locations can be safely and legally accessed
- Select sampling locations that will have standing water under most circumstances
- Use a GPS unit to record the position of sampling locations.
- Sampling designs should be clearly documented to allow a consistent approach to be used by the same observer across multiple years or by multiple observers

If multiple samples are taken, report the mean value. If you do not take readings, report "NA". If you are certain that the unit is never subject to saltwater incursion, report "**< 0.5"** (the numerical definition of freshwater).

Water Gauge Reading (optional)

If the unit has a water level gauge, please record a reading each time a count is conducted. Be sure to provide the measurement units of the water level gauge.

Water Depth

Estimate the percent of the unit in each of five water depth categories (Table SOP-2.3) corresponding to waterbird guild use (Ma et al. 2010). Percent cover estimates should sum to 100% across the six depth categories.

Table SOP-2.3.
Categories of water depth.

Category
Dry
Saturated/mudflat to 5 cm (up to 2 in)
5 to 25 cm (2 to 10 in)
>25 cm (> 10 in)

If ice is present, **do not** treat it as dry – instead estimate the total depth of water & ice by including ice as part of the water column when estimating water depths. Water depth cover estimates are independent of vegetation cover (i.e., areas with flooded vegetation should be included in water depth estimates).

There are two alternative approaches for estimating percent covers for water depth categories: (1) the preferred alternative is to use a water bathymetry map in conjunction with a water gauge reading to estimate percent covers (SOP 4); (2) the non-preferred alternative is to use an ocular assessment or other method.

Percent of ice cover

Across the entire survey unit, visually estimate and record the percent of the water surface that is covered by ice. Sheet water present on thawing ice should be treated as ice.

Habitat Cover (optional)

Use visual estimation to assess what percentage of a survey unit is open water, bare ground/mudflat, emergent, scrub-shrub, or forest. These classes are defined using classes found in the *Classification of Wetland and Deepwater Habitats of the United States* (Cowardin et al. 1979). See Table SOP-2.5 for a crosswalk between IWMM's habitat classes and those found in Cowardin et al. (1979).

Table SOP-2.4. Habitat classification crosswalk between the IWMM Initiative Protocol and Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979).

IWMM Habitat Class	Wetlands and Deepwater Habitats Class
Open Water	See rock bottom, unconsolidated bottom, aquatic bed
Scrub-shrub	See scrub-shrub
Forest	See forest
Emergent	See emergent, vegetated unconsolidated shore
Bare ground	Streambed, rocky shore, unvegetated unconsolidated shore (i.e. mudflat)

The following conditions apply when estimating cover of the different habitat classes:

- Percent covers for individual classes are considered mutually exclusive, so percent cover estimates across all habitat classes must sum to 100%.
- Open water can include submerged aquatic vegetation and floating-leaved aquatics such as American lotus (*Nelumbo lutea*) and watershield (*Brasenia schreberi*).
- Both open water and bare ground classes can include scattered emergent or woody vegetation up to 30% cover.
- Mowed or harvested vegetation should be treated as emergent unless submersed which would then make it open water.
- Crops planted in wetlands should be treated as emergent.
- Disked areas should be treated as bare ground unless litter residue >30% cover.
- Because this measure is intended to assess habitat structure not energy content, senesced (dead) vegetation should be included in percent cover estimates for applicable habitat classes.

Interspersion (optional)

The configuration of vegetation and water/bare ground patches within a survey unit can potentially influence habitat quality and bird use. For this metric, vegetation patches are defined to include scrub-shrub, forest, and emergent vegetation areas whereas water/bare ground patches are defined to include open water, submerged aquatic vegetation, floating-leaved aquatic vegetation, and bare ground. Units with little or no vegetation (60-100% open water) would fall into class L as a single large patch of open water, likewise units with 100% vegetation cover would fall into the S class. A survey unit can fall into one of three configuration classes (Figure SOP-2.2) based on Suir et al. (2013). The three configuration classes are:

- Class L includes large and connected patches of water/bare ground features
- Class S contains small, disconnected patches of water/bare ground
- Class M contains discernible regions of both classes L and S

These classes reflect the interspersion, or inter-mixing, of vegetation and water/bare ground patches. Assign the survey unit to one of the configuration classes as an indicator of interspersion. Note that, when water/bare ground covers >60% of a unit, the only possible configuration class is L.

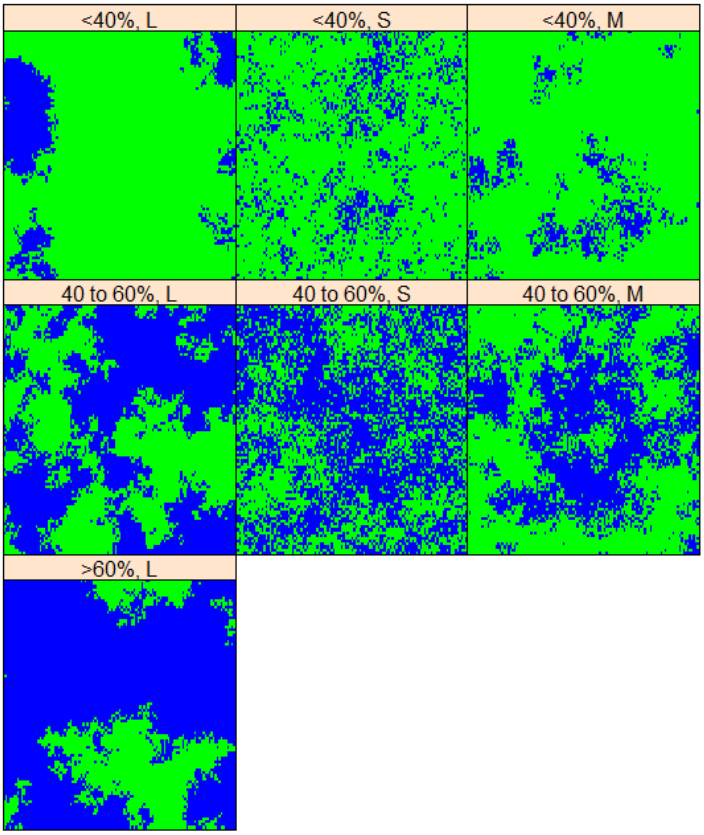

Figure SOP-2.2. Examples of three configuration categories (L; S; M). The three categories are illustrated for different levels of water/bare ground cover (<40%; 40 to 60%; >60%). Water/bare ground areas are represented in blue above whereas vegetated areas are represented in green.

Disturbance severity (optional)

Please record whether there is a disturbance affecting the behavior or number of waterbirds in the survey unit either during your survey or immediately prior to it. Cooperators can conduct "flush counts" (surveys designed to intentionally flush a majority of birds in an effort increase detectability) to get more accurate counts of waterbirds in large or densely vegetated areas. Here, we are interested in disturbances that negatively influence your ability to get an accurate count. Score the disturbance on a scale 1 to 4 (Table SOP-2.7):

Table SOP-2.5. Severity scale and associated definitions of waterbird response to disturbance.

Scale	Severity	Definition
1	Light/none	no effect on waterbirds
2	Moderate	some waterbirds move but stay within unit
3	Heavy	some waterbirds leave unit
4	Limiting	most/all waterbirds leave the unit

Disturbance source (optional)

If there is a disturbance of waterbirds (see *Disturbance Severity* above), check the appropriate box to identify its source. Several sources can be ticked. For example, a fisherman in a boat should be

ticked as both "Fishing" and "Boats". Potential sources are listed in Table SOP-2.8.

Table SOP-2.6. Types of disturbance.

Code	Description
1	Pedestrian
2	Loose dog
3	Hunting
4	Fishing
5	Boats
6	Motor vehicles
7	Aircraft
8	Raptor
9	Other

Chronic Human Disturbance

Characterize the unit for the period between the last and the current waterbird survey (Table SOP-2.9). For private lands, ask the area manager or landowner. For public lands, check site regulations or consult with management or law enforcement staff.

Table SOP-2.7. Chronic disturbance classes and their definitions.

Class	Description
1	Closed to all public use with infrequent entry only by resource managers or designees for management activities, surveys, or other non-hunting and non-recreation activities (i.e., sanctuary conditions) during conservation planning period of interest.
2	Managed access for all activities including firearms hunting with use levels regulated through temporal closures during conservation planning period of interest (e.g., hunting restricted to 3 days/week).
3	Open access for non-hunting recreation activities via trails, viewing platforms, etc., within the unit boundaries. No firearms hunting allowed during the survey period or week prior during conservation planning period of interest.
4	Open access to public for firearms hunting and other forms of recreation within the unit during conservation planning period of interest (open access 7 days/week).

Counting and estimating waterbird numbers

Counts of individual waterbirds (see list in SM1) are recorded by species on either the Waterbird Count or Survey Condition form for an individual survey unit (SM-3), or on the alternate form for surveying multiple management units (SM-4). Alternatively, USFWS observers may record both bird counts and the site conditions described above by utilizing the IWMM mobile app on an iPad or iPhone running Survey123. Counts of species listed in SM1 & SM2 should always be recorded. Scientific names are based on the 58th Supplement to the American Ornithological Union's (AOU) checklist (Chesser et al. 2017).

Be careful not to count individual waterbirds more than once. When in doubt about whether an individual waterbird was already seen, err on the side of not double-counting and assume it was already counted. If you find that no waterbirds are present, still record survey condition information (e.g., disturbance, depth, etc.), and enter the survey condition data into the database. In these cases, the database will automatically fill in zeros for bird counts, adding information that is vital for analysis.

Visually scan the wetland systematically, enumerating birds by species using Supplemental Materials 1. For larger projects, or projects where there are large numbers of waterbirds, it is often more practical to estimate numbers. Estimating numbers may also be necessary if waterbirds move around the wetland or are in very tightly packed flocks.

To count waterbirds in a flock, first estimate a 'block' of waterbirds (e.g. 5, 10, 20, 50, 100, 500, 1000 waterbirds) depending on the total number of waterbirds in the flock and the size of the waterbirds. To do this, count a small number of waterbirds (e.g., 10) to gain a sense of what a group of 10 waterbirds "looks like." Then count by 10s to 50s or 100 waterbirds to gain a sense of what 50 or 100 waterbirds "looks like." The block is then used as a model to measure the remainder of the flock. In the example below (Figure SOP-2.3), we use 'blocks" of 20 birds to arrive at an estimate of 320 waterbirds.

In some instances, it might not be possible to get an accurate count of each species in a mixed flock, particularly if the flock contains similar species, such as scaup or small shorebirds (i.e., "peeps"). In such cases, try to estimate the percentage of the flock belonging to each species by "sub-sampling". To do this, choose several subsets of waterbirds across the flock, then count and identify all individuals within those subsets. Then use these estimates to provide an extrapolated estimate of numbers of each species in the entire flock. When using this method, be mindful of the fact that species may not be distributed evenly among the flock, so carry out several sub-samples. As an example, in the raft of ducks in Figure SOP-2.3, you might count the waterbirds in 3 subsamples of 20 waterbirds, identifying 12, 10 and 14 Redheads among them. These 36 Redheads represent 60% of the 60 waterbirds in those 3 subsamples - extrapolating this to the whole flock (previously estimated to be 320 waterbirds) would produce an estimate of 192 Redheads.

SURVEY TIP: If you are surveying projects with large numbers of waterbirds, it is often best to count in teams of two, one person counting while the other records the numbers on the field sheet. Alternatively, some people like to use audio recording devices, so that they are not constantly interrupting counts to record information.

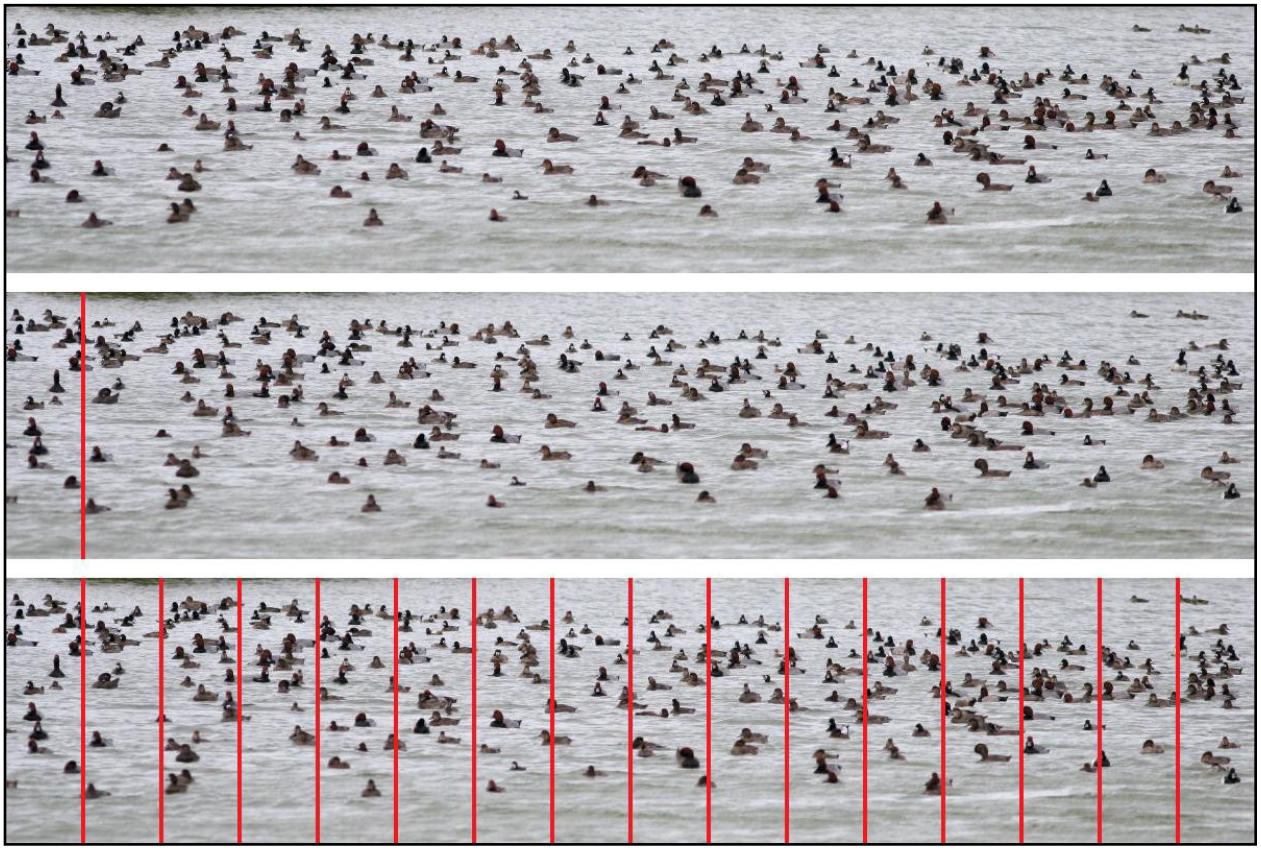

Figure SOP-2.3. Estimating flock size for a raft of ducks. Count members within a visualized group, for example 20 individuals, then see how many groups there are in the flock. In this example 16 groups x 20 individuals/group = 320 individuals in the flock.

Training—First-time IWMM cooperators should view the survey overviews located at http://iwmmprogram.org/protocols-data-forms/.

Inexperienced waterbird counters are advised to practice their counting and estimation techniques before participating in IWMM. This can be done in the field or at a desktop computer using Wildlife Counts software: http://wildlifecounts.com/index.html.

Young waterbirds/broods—Do not include dependent young waterbirds in counts. For geese, swans and ducks, assume juveniles are independent when they can fly. Any juveniles that did not hatch in the immediate vicinity should be included in counts (e.g., juvenile swans migrating in family groups).

Special survey techniques

Aerial Surveys— Aerial survey data can be incorporated into the IWMM database. Aerial survey data should include the same information as a standard ground-based whole-area count and unit condition, and use the same waterbird survey form. If aerial surveys are employed, the cooperators should note this in the IWMM database. In the bird survey database form select

"Aerial Surveys" in the "Survey Type" dropdown box.

Flush Counts—Cooperators can conduct "flush counts" by intentionally disturbing birds into flight in order to get more accurate counts of waterbirds in large or densely vegetated areas. Flush counts are not required by IWMM, but if this method is employed, the cooperators should note this in the IWMM database. In the bird survey database form in select "Flush Counts" in the "Survey Type" dropdown box.

References

Chesser RT, Burns KJ, Cicero C, Dunn JL, Kratter AW, Lovette IJ, Rasmussen PC, Remsen JV, Rising JD, Stotz DF, Winker K. 2017. Fifty-eighth supplement to the American Ornithological Society's Check-list of North American Birds. The Auk 134:751-773.

Cowardin LM, Carter V, Golet FC, LaRoe ET. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Washington, D.C.

Fredrickson LH, Reid FA. 1991. 13.1.1 Nutritional values of waterfowl foods, Waterfowl Management Handbook. U.S. Fish and Wildlife Service, Washington, D.C.

Ma Z, Cai Y, Li B, Chen J. 2010. Managing wetland habitats for waterbirds: an international perspective. Wetlands 30:15–27.

Suir GM, Evers DE, Steyer GD, Sasser CE. 2013. Development of a reproducible method for determining the quantity of water and its configuration in a marsh landscape. Journal of Coastal Research, Special Issue 63:110–117.

SOP 3: Measuring Salinity

If measuring salinity with a hydrometer, you will also need a large, clear jar and a thermometer. The protocol for measuring salinity with a hydrometer (EPA 2006):

1. Put the water sample in a hydrometer jar or a large, clear jar.
2. Gently lower the hydrometer into the jar along with a thermometer. Make sure the hydrometer and thermometer are not touching and that the top of the hydrometer stem (which is not in the water) is free of water drops.
3. Let the hydrometer stabilize and then record the specific gravity and temperature. Read the specific gravity (to the fourth decimal place) at the point where the water level in the jar meets the hydrometer scale. Do not record the value where the meniscus (the upward curvature of the water where it touches the glass) intersects the hydrometer (Figure SOP-3.1).
4. Record the specific gravity and the temperature on your data sheet.
5. Use a hydrometer conversion table that comes with your hydrometer to determine the salinity of the sample at the recorded temperature. Record the salinity of the sample on the data sheet.

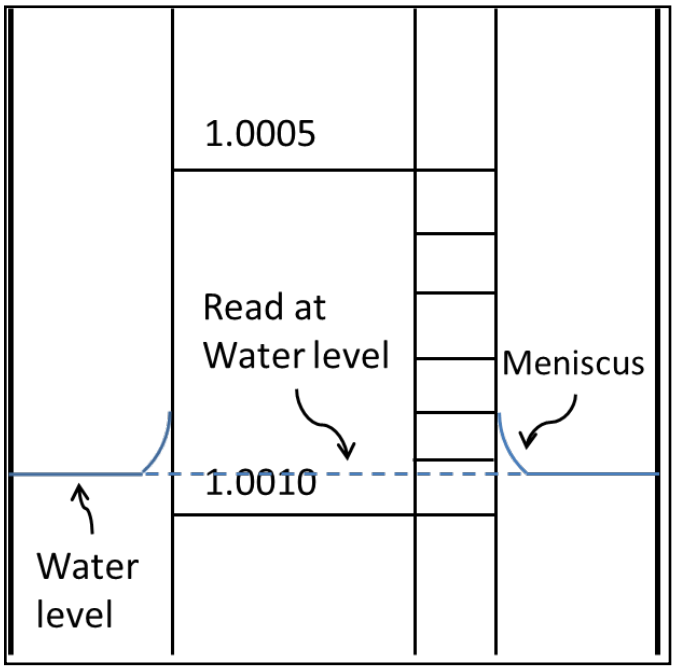

Figure SOP-3.1. Reading specific gravity from a hydrometer. Note that the reading should be taken at the water level NOT the meniscus. Redrawn from EPA (2006).

If measuring salinity with a refractometer, you will also need a dropper and a container of distilled water. The protocol for measuring salinity with a refractometer (EPA 2006):

1. Lift the lid that protects the refractometer's specially angled lens.
2. Place a few drops of your sample liquid on the angled lens and close the lid.
3. Peer through the eyepiece. Results appear along a scale within the eyepiece.
4. Record the measurement on your data sheet.

Rinse the lens with a few drops of distilled water, and pat dry, being very careful to not scratch the lens' surface.

References

[EPA] Environmental Protection Agency. 2006. Chapter 14: Salinity Pages 1–8 in Ohrel RL J., Register KM, editors. Volunteer estuary monitoring manual, a methods manual. 2nd edition. Washington, D.C.: EPA-842-B-06-003. Available: http://water.epa.gov/type/oceb/nep/monitor_index.cfm (January 2015).

SOP 4: Bathymetry Mapping

Adapted from Lyons et al. 2006.

Goal

Create a basin contour map that will provide estimates of the quantity of different water depth categories for any given water level (measured at a permanent water gauge).

Personnel

Survey unit basin contour mapping will require two individuals.

Equipment

Highly accurate GPS receiver (e.g., Trimble GeoXM or GeoXT, or similar), meter stick or sounding line marked in cm, Bathymetry data sheet. A disc of ¼ inch plywood or similar material may be attached to the bottom of the meter stick to facilitate depth measurements over unconsolidated bottoms.

Timing

Once per survey unit, preferably early in spring when the unit is at full pool. *Measurements should be made on a calm day* following a period of stable water levels to be sure that water is evenly distributed within the unit. Permanent water gauge readings should be made at the beginning and end of each day.

General Methods

The bathymetry method outlined below involves measuring the depth of the unit across a grid of points *when the impoundment is at full pool* and water levels have been stable for at least a few days before the survey. The basin contour map will allow us to estimate the amount of mudflat and proportions of the impoundment in various water depth classes throughout the drawdown.

This procedure *requires* the use of a highly-accurate GPS unit, such as a Trimble GeoXT or GeoXM, or similar. Recreational handheld GPS units made by Garmin, Magellan, and others are not likely to be accurate enough (± 1 m). If the cooperator is a member of the USFWS and needs access to an adequate GPS unit, he or she may be able to borrow one from regional staff or a nearby refuge if possible.

In the field, GPS locations and water depth measurements will be collected in a spatial arrangement approximating a grid; this does not require the creation of a grid of sampling points ahead of time with a GIS. Grid spacing (typically between 25 to 100 m) will determine how frequently data points will be collected and should be informed by the size of the survey unit and the variability of water depth conditions within the unit. The resulting file of GPS points will resemble a grid once imported to GIS (see Figure A6.1). It may be possible, depending on the GPS unit used, to enter water depth measurements directly into the GPS unit as the data points are collected. This will reduce data entry required after field work and the likelihood of data entry errors. In addition, field crews are encouraged to record water depth data on the paper data sheets as well as a hard-copy back-up.

Steps

1. Before starting, obtain an appropriate GPS unit, if necessary, or prepare your GPS unit to collect bathymetry data for your survey unit. If you are not familiar with the GPS technology you are using, IWMM staff can provide detailed step-by-step instructions for its use.
2. Record the water level at the permanent water gauge at the start of each day of bathymetry work.
3. Starting with one edge of the impoundment, traverse a series of parallel transects, taking periodic readings.
    a. Place points along transects at a standardized frequency.
    b. As necessary, collect additional sampling points along each transect whenever there is a significant change in slope. For example, if a low spot or ditch is encountered, collect a point at the edge of it, at its lowest point, and at a point where elevation rises again. *These extra points are critical for accurate mapping of the basin contour.*
    c. If areas with a significant change in slope occur between transects, data points should be collected in those locations as well. (See Figure A6.1 for a diagram of this data collection process.)
4. At each sampling point:
    a. Collect the location with the GPS. GPS points are automatically numbered in sequence as they are collected in the field. A Point ID and UTM coordinates will be stored in the unit.
    b. Record the water depth (cm) using the meter stick or the sounding line. (Begin sampling points at the edge of the impoundment. Water depth at this location will be 0.) Water depth can be typed into the GPS unit directly and/or written on the data sheet. If entering the water depth data directly into the GPS unit, the use of the data sheet as a hard-copy backup is optional, but highly encouraged.
    c. Record comments for impoundment edge, ditch, change slope, top slope, bottom slope, etc.
    d. When using the data sheet, Point ID is simply a sequentially assigned number given to the points in the order they are collected (1, 2, 3, etc.). Thus, written depth data should be collected in the same order as GPS data points, so that the data corresponds correctly.
5. Once the entire impoundment has been sampled, record the water level at the permanent water gauge at the end of each day. Since staff gages mounted on posts can be dislodged, the staff gage present at the time of the survey should also be referenced against multiple points on a more permanent structure such as a culvert bottom, concrete water control structure, bridge footing, etc. to maintain a consistent datum. Although not required, mean sea level surveys could establish elevation references for all staff gages and permanent reference points.

For an example converting field data to bathymetry maps for use, please refer to Los Huertos and Smith (2013).

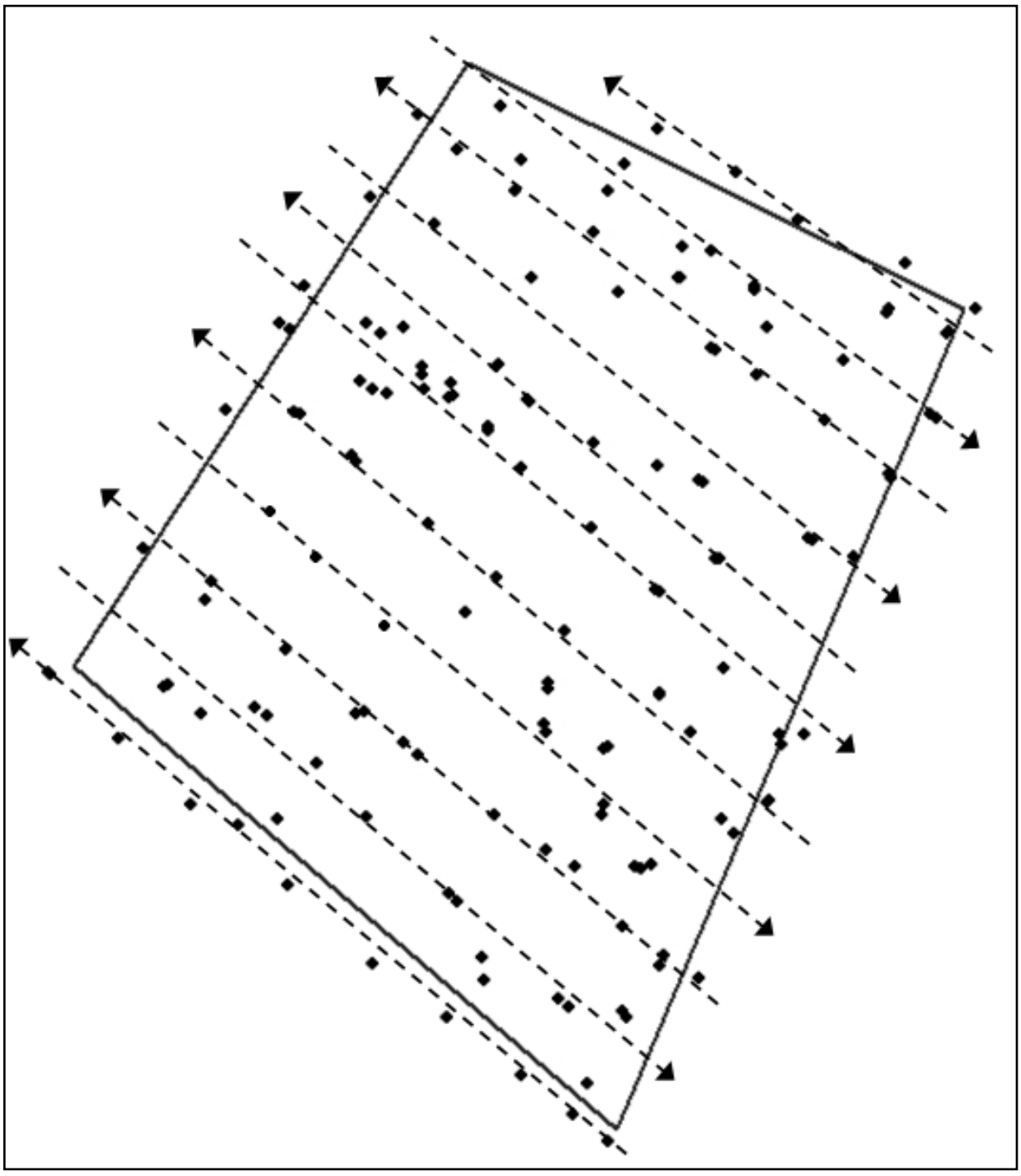

Figure SOP-4.1. Example data from bathymetry work at Prime Hook NWR, illustrating the arrangement of parallel data collection transects approximately 50 meters apart, and the collection of data points along the transects. Note that data points are not always spaced 50 meters apart; some are clustered and/or located between transects, as necessary, to capture areas with changes in slope.

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SOP 5: Vegetation Survey

Follow these instructions for preparing and conducting vegetation surveys and assessing site conditions of each unit. Associated data collection sheet can be found in Supplemental Materials 7.

Equipment

- Map of the project and unit boundaries as a printed map(s) or within a mobile GIS application. Grid overlays may be added as an aid for percent cover calculations (Fig SOP 5.1) when using printed maps.
- Annual Vegetation Survey Form (See Supplemental Materials 4)
- Seed Head Photographic Guide in areas where annual emergent vegetation (i.e., moist-soil) is present (See Supplemental Materials 5)
- Plastic bags or plant press, camera, and cell phone/tablet with ID app (e.g., iNaturtalist) for species identification (optional)

Figure SOP 5.1 Example of a printed field survey map with 1 acre grid overlay.

Survey schedule

Vegetation surveys are to be completed once annually, typically late in the growing season when dominant plant species have matured, but before they senesce (August – October depending on local conditions). In moist-soil wetlands, surveys should be completed once seed heads have matured but prior to the shattering of seed heads for species included in the Seed Production Index.

Percent vegetation cover

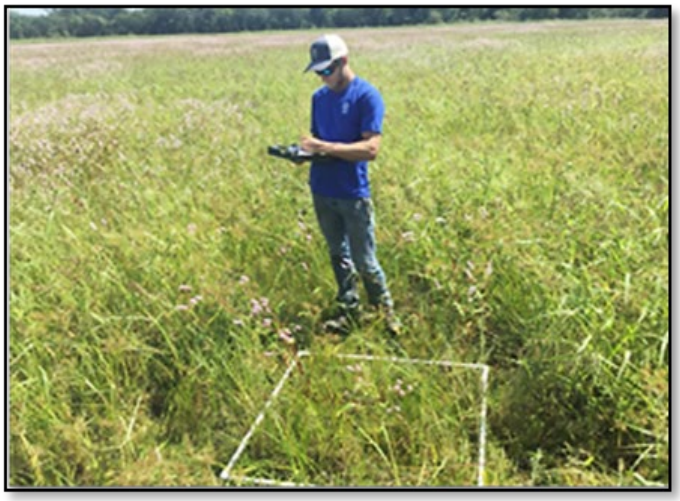
The extent of all types of vegetation across the survey unit should be visually estimated. Exclude

areas where vegetation is thin, covering less than 30% of substrate, with the balance being: bare ground, water without floating-leaved or submersed vegetation, or plant litter (Cowardin 1979). Litter includes vegetation killed by herbicide application. For example, a recently disked area with scattered living plants and a cover of only 15% should be assessed as non-vegetated. Mowed or harvested areas should be assessed as vegetated when the minimum threshold is met for living plants ($\geq$30% of substrate) or as non-vegetated when litter or bare ground dominate (such as in late season mowing of mature annuals).

General Habitat Resource Type & Yield/Energetic Quality (required)

For each survey unit, record all habitat resource types (HRT) present and estimate the proportion of the total unit area represented by each type (see Appendix VV for definitions). To standardize interpretations of the HRTs, each natural vegetation type has been related to classifications that use detailed descriptions for delineating types: the National Vegetation Classification Standard (2008) and Classification of Wetlands and Deepwater Habitats (Cowardin 1979 – see Table SOP 5.2.). HRTs should not overlap and should sum to 100% across all types. In some situations, HRTs may gradually transition from one type to another creating indistinct transitional edges or ecotones. When assessing the extent of these transitional areas, use the dominant type and ignore inclusions of subdominant types that are less than 5% of the unit's size. Also, select a waterfowl energetic quality class (High, Medium, Low) for each HRT using the guidelines provided in Table SOP-5.1. Custom energy values, if known for a unit, may be entered into the database optionally to replace the default values.

Low energetic quality unit (<500 lbs./acre) showing expansive stands of undesirable vegetation (*Sesbania*, tall brown vegetation in background) with short and patchy stands of desirable seed producing annuals. 2019 White River NWR (AR), core sample estimate of 331 lbs/acre.



Moderate energetic quality unit (500 -1000 lbs./acre) dominated by desirable seed producing annuals with relatively short stature. 2019 Swan Lake NWR (MO), seed head morphology estimate of 545 lbs/acre.

High energetic quality unit (>1000 lbs./acre) showing thick and robust stands of desirable seed producing annual grasses with few undesirable species. 2018 Two Rivers NWR (IL), core sample estimate of 1052 lbs/acre.

Figure SOP 5.2. Photographs illustrating high degree of variability in seed production in the Habitat Resource Type of Freshwater Non-persistent Emergent Marsh. See energetic quality guidance in table SOP 5.1.

Table SOP5.1.
Habitat Resource Types and guidelines for assigning waterfowl energetic quality scores.

Resource Category	Habitat Resource Type	Definition	Energetic Quality in Waterfowl Energy Days (WED) = 300kcals High	Moderate	Low
Natural Wetlands	Semi-permanent Wooded Wetlands	Wooded (e.g., swamp forest, scrub-shrub) wetlands where water is present during most of the non-breeding season for waterfowl and for at least 60 days during the growing season, such as cypress-tupelo brakes, narrow bayous, and other swamps with <10% oak component and covered by ≥30% woody vegetation (>2 m in height)	Structurally diverse with high plant diversity and relatively natural hydrology; **300 WED/ac**	Structurally diverse with moderate plant diversity with altered hydrology; **200 WED/ac**	Low plant & structural diversity unnatural hydrology; **100 WED/ac**
	Seasonal Wooded Wetlands	Wooded floodplain forests where water is present at some point during the non-breeding season for waterfowl, but typically not for more than 90 days and typically not for >60 days during the growing season (e.g., bottomland hardwood forest with an oak component >10%); area covered by ≥30% woody vegetation (>2 m in height)	Oak composition >40%, flooding from natural water sources; **300 WED/ac**	Oak composition 20-30%, flooding from natural water sources; **200 WED/ac**	Oak composition <20%, flooding primarily using pumped ground/well water; **100 WED/ac**
	Freshwater Persistent Emergent Marsh	Areas of primarily persistent emergent vegetation (e.g., *Typha* sp., *Zizaniopsis* sp., *Phragmites* sp.), such as semi-permanent emergent marshes, with <30% woody vegetation, bare ground, or open water during the growing season	Areas of perennial emergent vegetation that produces seeds (e.g., Zizania sp.) interspersed with shallow open water and submersed aquatice vegetation; **1,000 WED/ac**	Areas of perennial emergent vegetation that produces seeds (e.g., Juncus sp., Scirpus sp., Schoenoplectus sp.) interspersed with shallow open water; **700 WED/ac**	Areas of dense, perennial emergent vegetation (e.g., Typha sp., Phragmites sp., ??? sp.) in dense stands or with limited open water or flooding; **400 WED/ac**

Resource Category	Habitat Resource Type	Definition	**High**	**Moderate**	**Low**
Natural Wetlands	Freshwater Non-persistent Emergent Marsh	Areas of primarily nonpersistent emergent vegetation (e.g., *Cyperus* sp., *Echinochloa* sp., *Panicum* sp.), such as managed moist-soil wetlands, with <30% woody vegetation, bare ground, or open water during the growing season	Excellent seed production (>1,000 lb/ac); primarily seed-producing annual vegetation with >75% grasses (e.g., *Echinochloa* spp., *Leptochloa* spp.) or redroot flatsedge; large seeds heads with dense coverage and SPI >45; **2,500 WED/ac**	Average seed production (500-1000 lb/ac); mix of seed-producing annual vegetation with 25-75% grasses (e.g., *Seteria* sp., *Panicum* sp.) and other annual broadleaf plants (e.g., *Polygonum* sp., *Bidens* sp.); SPI 35-45; **1,800 WED/ac**	Poor seed production (<500 lb/ac); <25% grasses and other annual broadleaf plants (e.g., *Polygonum* sp.); abundant bare ground, sparse vegetation, and coverage of undesirable (e.g., *Sesbania* sp., *Xanthium* sp.), and/or low energy-producing species (e.g., *Sagitarria* sp., *Echinodorus* sp.); SPI <35; **1,000 WED/ac**
	Brackish Emergent Marsh	Areas of persistent and non-persistent emergent vegetation in brackish (1-30 ppt) areas with interspersed areas of open water (<1 ac). Includes tidal zones, brackish impoundments, and other areas with >30% emergent vegetation and periodic flooding.	High marsh (<10 ppt) with interspersion of seed-producing plants and open water, possibly including some SAV species occurring sporadically; **900 WED/ac**	Intermediate marsh (<10-20 ppt) with some seed-producing plants but typically ≥40% open water or emergent vegetation (limited interspersion); **500 WED/ac**	Low marsh (>20 ppt) with monocultures of vegetation or primarily open water devoid of vegetation; **200 WED/ac**
	Aquatic Bed	Lake, pond, reservoir or other area of semi-permanently or permanently flooded water with areas of >30% submersed (SAV) and/or floating-leaf vegetation (FLAV) and <30% emergent vegetation	High SAV cover, low FLAV cover; **3,000 WED/ac**	Moderate SAV cover, moderate FLAV cover; **1,600 WED/ac**	Low SAV cover and high FLAV cover; **800 WED/ac**

Resource Category	Habitat Resource Type	Definition	**High**	**Moderate**	**Low**
Natural Wetlands	Open Water	Lake, pond, reservoir, bay, sound, or other area of open water with <30% emergent, submersed, or floating-leaf vegetation	Abundant macroinvertebrates; **6 WED/ac***	Some macroinvertebrates; **3 WED/ac***	Few macroinvertebrates; **1 WED/ac***
	Riverine	River, stream, canal, or ditch channel with dynamic water levels, typically flowing water during most of the year, and limited flooded vegetation (<30%) under normal water levels	Abundant macroinvertebrates; **6 WED/ac***	Some macroinvertebrates; **3 WED/ac***	Few macroinvertebrates; **1 WED/ac***
	Mudflat	Mainly unvegetated areas (<30% vegetation) such as wet or dry mud, bare ground, or beach.	High levels of organic material; **200 WED/ac**	Moderate levels of organic material; **100 WED/ac**	Low levels of organic material (sand, silt, clay) such as beach; **50 WED/ac**
Cropland	Unharvested Rice	Unharvested rice, including ratoon or volunteer rice that may have a reduced yield	Very good yield; ~150 bu/ac; **35,000 WED/ac**	Typical yield on NWRs; ~110 bu/ac; **25,000 WED/ac**	Very poor yield or low planting rates, ratoon and volunteer rice; ~60 bu/ac; **14,000 WED/ac**
	Unharvested Grain Sorghum	Unharvested grain sorghum (milo)	~70 bu/ac; **20,000 WED/ac**	~50 bu/ac; **15,000 WED/ac**	~30 bu/ac; **9,000 WED/ac**
	Unharvested Corn	Unharvested corn	~140 bu/ac; **43,000 WED/ac**	Typical yield on public lands from June or July planting; ~105 bu/ac; **33,000 WED/ac**	Includes grassy corn, ~70 bu/ac; **22,000 WED/ac**
	Unharvested Soybean	Unharvested soybean or similar bean	~50 bu/ac; **12,000 WED/ac**	~40 bu/ac; **9,600 WED/ac**	~30 bu/ac; **7,000 WED/ac**
	Unharvested Millet	Unharvested millet, including Japanese, proso, golden, white, Chiwapa, or other	**8,000 WED/ac**	**5,000 WED/ac**	**2,000 WED/ac**

Resource Category	Habitat Resource Type	Definition	**High**	**Moderate**	**Low**
Cropland	Green Browse	Wheat, clover, or other forage planted in uplands where shoots are the primary food available to waterfowl	Lots of growth and consumption to base of plant; **3000 WED/ac**	Moderate growth and consumption primarily above plant base; **1900 WED/ac**	Limit growth or limited consumption of only outermost leaves/blades; **1000 WED/ac**
	Unharvested Other	Unspecified unharvested crop that produces seeds or tubers as the primary food source for waterfowl, such as buckwheat, sunflower, chufa, or other.	**8,000 WED/ac**	**5,000 WED/ac**	**2,000 WED/ac**
	Harvested Crops	Any harvested crop that may be flooded during the non-breeding period and accessible to waterfowl.	Rice or milo or other crops harvested in late fall; **800 WED/ac**	Corn or other grain crops harvested mid-fall; **500 WED/ac**	Soybeans or other crops harvested in early fall; **200 WED/ac**
Non-Waterfowl Habitat	Not Applicable	Any cover type not available to be used by waterfowl that may occur within the survey unit (e.g., upland forest, upland grassland, etc.). All croplands and wetlands should be assigned to an existing HRT.	NA	NA	NA

Energy values were derived from values obtained from multiple sources: Bauer 2018, Bowyer et al.2005, Bradbeer et al. 2012, Brasher et al.2007, Brasher et al.2018, Creamer and Baldwin 1999, Donnermeyer 1982, Evans-Peters 2010, Foster et al. 2010, Gray et al. 2013, Greer 2004, Greer et al. 2009, Gross et al. 2020, Hagy and Kaminski 2012, Korschgen et al.1988, Kross et al. 2008, Martin 2021 - UAM, Marty 2017, McClain et al. 2019, McClain et al. 2019, McClanahan 2015, Naylor 2002, Osborn et al. 2017, Ringelman et al. 2017, Sherfy 1999, Stafford et al. 2006, Stafford et al. 2011, Straub 2012, Tapp 2013, Weegman 2013. * Macroinvertebrate abundances are assumed to be low across all classes and class designation can be based on general understanding of the local system (not assessed in any sampling SOP). Custom energy values can be used when macroinvertebrates are expected to make more significant energetic contributions.

Table SOP 5.2. Crosswalk of Habitat Resource Types in the natural wetlands resource category to the National Vegetation Classification Standard (NVCS) and National Wetland Classification System (Cowardin 1979).

Habitat Resource Type	Definition	NVCS	National Wetland Classification System: Class
Semipermanent Wooded wetlands	Wooded (e.g., swamp forest, scrub-shrub) wetlands where water is present during most of the non-breeding season for waterfowl and for at least 60 days during the growing season, such as cypress-tupelo brakes, narrow bayous, and other swamps with <10% oak component and covered by ≥30% woody vegetation (>2 m in height)	All Forest and woodland, class 1, alliances and Shrub and herb wetlands, Class 2.C , alliances that are wetlands dominated by woody vegetation	All systems: Scrub-shrub & Forested wetlands with the following water regimes: permanently flooded, intermittently flooded, intermittently exposed, semipermanently flooded.
Seasonal Wooded Wetlands	Wooded floodplain forests where water is present at some point during the non-breeding season for waterfowl, but typically not for more than 90 days and typically not for >60 days during the growing season (e.g., bottomland hardwood forest with an oak component >10%); area covered by ≥30% woody vegetation (>2 m in height)	All Forest and woodland, class 1, alliances and Shrub and herb wetlands, Class 2.C , alliances that are wetlands dominated by woody vegetation	All systems: Scrub-shrub & Forested wetlands with the following water regimes: seasonally flooded, temporarily flooded, intermittently flooded, & saturated.
Freshwater Persistent Emergent Marsh	Areas of primarily persistent emergent vegetation (e.g., Typha sp., Zizaniopsis sp., Phragmites sp.), such as semi-permanent emergent marshes, with <30% woody vegetation, bare ground, or open water during the growing season	All perennial dominated alliances except shrublands within Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland Formation (2.C.4).	Lacustrine & Palustrine: persistent emergent
Freshwater Non-Persistent Emergent Marsh	Areas of primarily nonpersistent emergent vegetation (e.g., Cyperus sp., Echinochloa sp., Panicum sp.), such as managed moist-soil wetlands, with <30% woody vegetation, bare ground, or open water during the growing season	All annual dominated alliances within the Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland Formation (2.C.4).	Lacustrine & Palustrine: Unconsolidated shore when pioneering vegetation ≥30% cover & non-persistent emergent.
Brackish Emergent Marsh	Brackish marsh with interspersed areas of open water (<1 ac) and emergent vegetation and other aquatic vegetation	All alliances within Salt Marsh Formation (2.C.5)	Estuarine: emergent and Lacustrine Palustrine: Emergent & unconsolidated shore with saline or mixosaline water chemistry
Aquatic Bed	Lake, pond, reservoir or other area semi-permanently or permanently flooded water with submersed and/or floating-leaf vegetation	All alliances within the North American Freshwater Aquatic Vegetation Division (5.2.B.na)	Lacustrine Palustrine: Aquatic Bed
Open Water	Lake, pond, reservoir or other area of permanently flooded and without vegetation	NA	Lacustrine Palustrine: Unconsolidated bottom, rock bottom,
Riverine	River, ditch, or stream with dynamic water levels, strong flow, and limited flooded vegetation under normal water levels	NA	Riverine: Unconsolidated bottom, rock bottom, Streambed
Mudflat	Mainly unvegetated areas (<30% vegetation) such as wet or dry mud, bare ground, or beach.	NA	All Systems: Unconsolidated Shore when pioneering vegetation is below 30%

Plant community composition/species assessment (optional)

Plant community composition is assessed by measuring the canopy cover of individual plant species within the **vegetated portion of the survey unit**. Only vegetation from the current growing season should be included in plant community composition assessments. Herbaceous agricultural or planted crops should also be included (e.g., rice, millet, sorghum, etc.) if left unharvested. Two major steps are involved in the assessment of plant community composition: (1) assessment of percent vegetation (emergent, floating leaved, woody, or submersed) cover within the survey unit and (2) species inventory and species-specific percent cover assessments within areas of vegetation.

Cooperators should determine the location of all wetland vegetation patches within a survey unit. This could be done through a visual assessment around the perimeter of the survey unit or by traversing across the unit; recent aerial photographs may also be helpful. Once the cooperator is confident they have identified all emergent vegetation patches, they should estimate and record the percent of the survey unit covered by emergent vegetation. Percent cover is defined as the percentage of the survey unit covered by vertical projections from the outermost perimeter of plants' foliage (Anderson 1986). Again, for this metric, percent cover assessments should exclusively consider vegetation from the current season's growth.

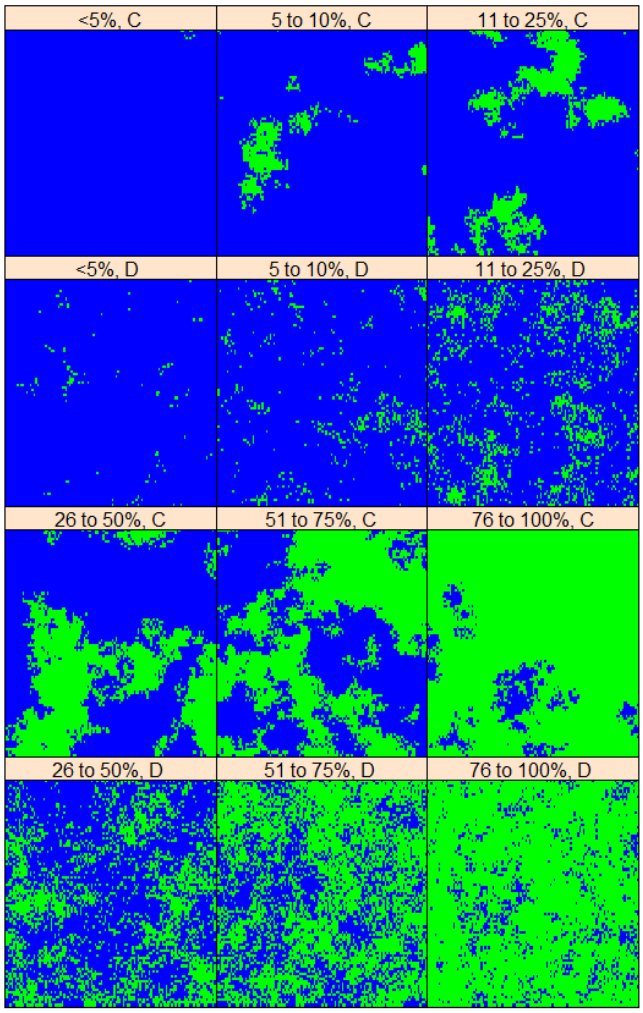


Figure SOP-5.3. Different levels of vegetation cover (green patches). Panels labeled with a "C" show clumped patches of vegetation and water whereas those with a "D" show dispersed or spread out patches.

For a single composite representing all areas of emergent vegetation (may span multiple HRTs), cooperators will compile a list of common (>5% canopy cover) plant species and estimate each species' percent cover. For this assessment, the following pertains to percent cover estimates:

- For individual plant species, cover is defined as above except that it is *estimated as a percentage of the unit's vegetation area* **not** as a percentage of total survey unit area. As an example, consider a survey unit that contains only cattail as an emergent plant species. Cattail may cover 50% of the total survey unit area, but as an individual plant species, it covers 100% of the unit's vegetation area within a survey unit; report 100% as the estimate.
- Cover should be estimated only for the most common species, species covering >5% of the wetland vegetation area.
- Total cover across species can exceed 100% due to the stratification of plant species with varying heights and growth forms.

Seed head assessments

Choose a category for seed-head size and density (Naylor et al. 2005) whenever a moist-soil species listed in SM 6: Seed Head Assessment Guide for Selected Wetland Plants with Food Value to Waterfowl, is assessed for % cover. Use the "Not Assessed" category for species that have deteriorated seed heads at the time of assessment or difficult to assess seed heads.

Plant taxa included in SM6:

- Barnyardgrass or wild millet (*Echinochloa crus-galli*)
- Coast cockspur grass or Walter's millet (*Echinchloa walteri*)
- Rice Cutgrass (*Leersia oryzoides*)
- Fall panicgrass (*Panicum dichotomiflorum*)
- Curlytop knotweed (*Polygonum lapathifolium*)
- Pennsylvania smartweed, pinkweed or big seeded smartweed (*Polygonum pensylvanicum*)
- Foxtail (*Setaria*)
- Beggarticks (*Bidens*)
- Yellow Nutsedge (*Cyperus esculentus*)
- Amazon sprangletop (*Leptochloa panicoides*)
- Redroot flatsedge (*Cyperus erythrorhizos*)
- Goosefoot, Lambsquarters (*Chenopodium album*)
- Swamp Timothy or Swamp Pricklegrass (*Crypsis schoenoides* (L.) Lam.)

Using ocular estimation, qualitatively assess seed head size for a given species as average, smaller, or larger than the average size for the species. For example, *Polygonum pensylvanicum* would be compared to average size of seed heads for this species.

For each common plant species, visually assess seed head density based on two considerations:

1. The density of stems for a species (i.e., thick or thin stands)
2. The proportion of stems with seed heads, low or high proportional of stems with inflorescences.

Through ocular assessments, seed head density is assigned to ordinal categories including low, moderate, or high. Low seed head density is characterized by large areas of bare ground and a low proportion of seed heads to plant stems. High stem density is assigned to areas with little bare ground and a high proportion of seed heads to stems. Moderate stem densities fall between these two extremes.

Finally, please use the checkbox to note if a species-level assessment was completed for the unit or not. This is helpful to know in the event no species are recorded.

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SOP 6: Recording Management Actions

Follow these instructions for recording and tracking management actions for each unit surveyed. Associated management record sheet can be found in Supplemental Materials 7.

Resources

- Map of the project and unit boundaries
- Wetland management activities record (Supplemental Materials 7) for recording implemented actions.

To develop effective and informed strategies in an adaptive management approach, a reasonable range of management activities must be considered (Williams 2011). Therefore, in addition to monitoring waterbird use and habitat response, periodic habitat management activities should be tracked for each management unit. The details of timing, extent, and frequency will be recorded by cooperators via a wetland management record (Supplemental Materials 9) to document individual actions (as listed in Table SOP-6.1) as planned and implemented prescriptions. Infrequent management activities involving major modifications or infrastructure development are excluded.

1. Create wetland management activities record (Supplemental Materials 9) for each unit and fill in all planned actions. Use annual habitat management plans or other annual goals & objectives to match planned activities for a unit to an action code in Table SOP-6.1. Broad classes are provided to narrow the search for matching actions. Start the annual tracking period at the beginning of the growing season that precedes the subsequent nonbreeding period.

2. Update the record through the season as actions are implemented. Create a new entry for repeat applications that are necessary to maintain effective treatment (e.g. mowing). Record the geographic extent (footprint as the proportion of a management unit) for each log entry. Total percent manipulated may exceed 100% since applications may overlap.

3. Cooperators should enter information from the management action record into IWMM's centralized, online database on a routine basis, concurrent with their waterbird surveys, or as actions are completed.

Start Date (required) – Initiation date for applications and treatments (e.g. date of planting, spraying, flooding, etc.)

End Date (required) – Completion date for applications and treatments (e.g. harvest date, drawdown date, etc.). May be the same as Start Date if action completed on the same day.

The following treatment categories are provided to guide the selection of individual actions:

Crop cultivation —Includes all activities related to the production of a harvested crop or a crop left standing. Cultivation or other actions commonly used in agriculture are excluded if a crop was not produced. Sowed stands of millet cultivars should be included here but not volunteer stands.

Chemical—Use of herbicides or fertilizers to manage vegetation not related to crop production. Estimate of actual costs should be used to interpret weed control density low<$54.00/acre, mod $54-$212/acre and high >$212/acre (NRCS 2012, NRCS 2014 a, b).

Fire-Prescribed—Controlled burns completed within a range of prescriptions described in an approved burn plan.

Mechanical—Managing soil, herbaceous vegetation, or light woody vegetation <4.5 inches diameter at breast height (dbh) with mechanized equipment. Action includes common agricultural tillage practices not related to the production of a crop in the current year.

Mechanical-woody—Removal or other manipulation of tree size (> 4.5 inches dbh) woody vegetation.

Prescribed grazing—Controlled grazing completed within a range of prescriptions described in an approved grazing plan.

Restoration herbaceous—Introducing seed of desired non-crop herbaceous vegetation.

Restoration woody—Actions relating to the direct planting or promotion of woody vegetation through natural succession.

Water level—Actions applied to manipulate water levels through adjusting water control structures, pumping, or facilitating water movement through flooding and/or draw-down. The term “draw-down” refers to total dewatering that exposes the bottom substrate of a wetland. The % of unit affected is the same as the % of the unit exposed during a drawdown. Reductions in water level that do not expose the bottom substrate should be assigned as “other water”.

Treatment Details (optional) – Use this field to capture additional details regarding treatment action, such as chemical rate, contract source (if applicable), weather conditions, etc.

Cost Estimate (calculated) – General cost information is automatically populated using a strategy list from the Refuge Lands Geographic Information System (RLGIS, USFWS 2010) which served as foundation for a compiled list of actions (Table SOP-6.1). The RLGIS Actions were modified and fitted with costs from Natural Resources Conservation Service (NRCS) cost-share practices (NRCS 2012, NRCS 2014 a, b). Pumping logs, pump specifications, power source fuel use, and an irrigation study served as a basis for the fuel-use based pumping cost estimates (SRS Crisafulli Inc. 2014, University of NE 2011, Henggeler 2012). Crop input costs are based on production agriculture cost estimates (Dhuyvetter et al., Dobbins et al. 2012, Duffy 2014, Greer et al. 2012, USDA 2012). Estimates for prescribed goat grazing in wetlands and mechanical marsh shredders are derived from Greenfield et al. (2006). Costs for chemical control of woody invasive plants based on Rathfon and Ruble (2006) and NRCS (2012).

All default cost estimates are generalized and apply to actions with highly variable costs. These estimates are not recommended for use in budgeting purposes, cost benefit analysis, or other exercises requiring a high degree of accuracy.

Note: Drawdown costs are based on acre-feet and may require modification to generate a more accurate measure of the true costs. For example a wetland that is full pool and 18 inches deep on average at the initiation of a 100% unit area drawdown would have a cost increased by 1.5 times the acre foot cost and entered in database as a custom cost. Consult volume charts when available.

Custom Cost (optional) – Participants may input their own cost information when known as a separate entry which will overwrite the default value(s). Cooperator-generated cost estimates should be used whenever available and included in a site-specific survey protocol. To provide decision support, management actions are classified into high, moderate, or low cost. For example, estimated costs for weed control based on density are classified as: low<$54.00/acre, mod $54-$212/acre, and high >$212/acre (NRCS 2012, NRCS 2014 a, b).

A strategy list from the Refuge Lands Geographic Information System (RLGIS, USFWS 2010) served as foundation for a compiled list of actions (Table SOP-6.1). The RLGIS Actions were modified and fitted with costs from Natural Resources Conservation Service (NRCS) cost-share practices (NRCS 2012, NRCS 2014 a, b). Pumping logs, pump specifications, power source fuel use, and an irrigation study served as a basis for the fuel-use based pumping cost estimates (SRS Crisafulli Inc. 2014, University of NE 2011, Henggeler 2012). Crop input costs are based on production agriculture cost estimates (Dhuyvetter et al., Dobbins et al. 2012, Duffy 2014, Greer et al. 2012, USDA 2012). Estimates for prescribed goat grazing in wetlands and mechanical marsh shredders are derived from Greenfield et al. (2006). Costs for chemical control of woody invasive plants based on Rathfon and Ruble (2006) and NRCS (2012).

All costs estimates are very general and applied to actions with highly variable costs. The estimates are not recommended for use in budgeting purposes, cost benefit analysis, or other purposes requiring increased accuracy. Cooperator generated cost estimates should be used in these situations and included in the site-specific survey protocol. In a decision support context, the costs

will be used to classify actions into high, moderate, or low cost.

Table SOP-6.1 Wetland Management Actions.

Strategy group	Strategy	unit	unit cost	cost class
crop cultivation	aerial seeding-ag	acre	$9	low
crop cultivation	buckwheat	acre	$74	low
crop cultivation	conventional corn	acre	$312	mod
crop cultivation	conventional rice	acre	$469	high
crop cultivation	dirty rice	acre	$234	mod
crop cultivation	grain harvest	acre	$28	low
crop cultivation	grain sorghum	acre	$253	mod
crop cultivation	grassy corn	acre	$160	mod
crop cultivation	irrigation	acre	$100	low
crop cultivation	millet (cultivars)	acre	$73	low
crop cultivation	other crop	acre	~	~
crop cultivation	post-harvest mowing	acre	$15	low
crop cultivation	soybeans	acre	$148	mod
crop cultivation	wheat	acre	$177	mod
chemical	aerial boom	acre	$242	mod
chemical	aerial spray	acre	$20	low
chemical	basal bark, low	acre	$242	mod
chemical	broadcast	acre	$18	mod
chemical	chemical injection	acre	$242	mod
chemical	Common chemical	acre	$12	low
chemical	cut stump, low	acre	$242	mod
chemical	Dry-flowable spreader (excludes chem)	acre	$9	low
chemical	Fertilizer (excludes application)	acre	$340	high
chemical	foliar spray, low	acre	$83	low
chemical	foliar spray, high	acre	$383	high
chemical	hack and squirt, low	acre	$31	low
chemical	herbaceous weed control high density	acre	$707	high
chemical	herbaceous weed control low density	acre	$54	low
chemical	herbaceous weed control mod density	acre	$212	mod
chemical	Lime	acre	$23	low
chemical	liquid soil injection (application only)	acre	$14	low
chemical	spot spray	acre	$54	low
fire-Prescribed	prescribed burn	acre	$27	low
mechanical	amphibious mechanical shredder	acre	$982	high
mechanical	backhoe excavation of macrophytes	acre	$2,142	high
mechanical	Biomass harvester	Acre	$982	High
mechanical	chisel	acre	$15	low
mechanical	conventional tillage	acre	$13	low
mechanical	cookie cutter	acre	$526	high
mechanical	cultipacked	acre	$8	low
mechanical	disking (cutting/offset)	acre	$16	low
mechanical	disking (finish)	acre	$13	low
mechanical	drum chop	acre	$324	mod
mechanical	floating aquaplant harvester	acre	$9,130	high
mechanical	harrow	acre	$9	low
mechanical	hay	acre	$12	low
mechanical	mow	acre	$16	low
mechanical	other mechanical	acre	~	~
mechanical	packing	acre	$8	low
mechanical	plow	acre	$19	low
mechanical	raked	acre	$5	low
mechanical	roller (smooth drum)	acre	$19	low
mechanical	roller Chop	acre	$19	low
mechanical	subsoiler	acre	$17	low
mechanical woody	bank axe	acre	$385	high
mechanical woody	brush control high	acre	$795	high
mechanical woody	brush control low	acre	$385	high
mechanical woody	brush control moderate	acre	$636	high
mechanical woody	chainsaw	acre	$576	high
mechanical woody	dozer	acre	$877	high
mechanical woody	drum chop-woody	acre	$324	mod
mechanical woody	feller buncher bar saw head	acre	$324	mod

mechanical woody	feller buncher high speed head	acre	$324	mod

Strategy group	Strategy	unit	unit cost	cost class
mechanical woody	feller buncher intermittent head	acre	$324	mod
mechanical woody	hydro-Axe	acre	$324	mod
mechanical woody	mulching mower fecon/gyro track	acre	$324	mod
mechanical woody	other mechanical woody	acre	~	~
mechanical woody	Tree shear	acre	$467	high
mechanical woody	wood gator	acre	$324	mod
prescribed Grazing	flash grazing goats - emergent	acre	$1,251	high
prescribed Grazing	traditional biweekly rotation	acre	$85	low
restoration herbaceous	broadcast seeding-aerial	acre	$9	low
restoration herbaceous	broadcast seeding-terrestrial	acre	$23	low
restoration herbaceous	other restoration herbaceous.	acre	~	~
restoration woody	direct seeding	acre	$722	high
restoration woody	hand plant container	acre	$490	high
restoration woody	mechanical tree planter	acre	$554	high
restoration woody	other restoration. woody	acre	~	~
restoration woody	allow natural succession	acre	$0	low
water level	active draw down pumped (>18,000 GPM)	acre-foot	$6	low
water level	active draw down pumped (3000 -18,000 GPM diesel)	acre-foot	$15	low
water level	active draw-down gravity flow	acre-foot	$0	low
water level	active draw-down pumped (<3000GPM diesel)	acre-foot	$23	low
water level	active draw-down pumped (<3000GPM electric)	acre-foot	$11	low
water level	active draw-down pumped (>3000GPM electric)	acre-foot	$8	low
water level	drain completely	acre-foot	$0	low
water level	excavation	acre	$413	high
water level	flood up gravity flow	acre-foot	$0	low
water level	flood up opportunistic	acre-foot	$0	low
water level	flood up pumped (<3000 -18,000 GPM diesel)	acre-foot	$15	low
water level	flood up pumped (<3000GPM diesel)	acre-foot	$23	low
water level	flood up pumped (<3000GPM electric)	acre-foot	$11	low
water level	flood up pumped (>18000 gpm diesel electric)	acre-foot	$6	low
water level	Flood up pumped (>3000GPM electric)	acre-foot	$8	low
water level	levee removal, ditch plugs and floodplain features	acre	$116	mod
water level	natural draw-down	acre-foot	$0	low
water level	other water	acre-foot	~	~
water level	sediment removal ditch plug	acre	$1,307	high
water level	tile removal	acre	$445	high
water level	topographic feature creation, high	acre	$1,356	high
water level	topographic feature creation, low	acre	$728	high
water level	water level maintenance (<3000GPM diesel)	acre-foot	$23	low
water level	water level maintenance (<3000GPM electric)	acre-foot	$11	low
water level	water level maintenance (>18,000 GPM)	acre-foot	$6	low
water level	water level maintenance (3000 -18,000 GPM diesel)	acre-foot	$15	low
water level	water level maintenance (>3000 GPM electric)	acre-foot	$8	low

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SOP 7: Data Entry and Management Instructions

Data collected using this survey protocol and IWMM approach will need to be entered into the IWMM – AKN database. This SOP provides instructions for access, data entry, data verification, and database administration.

Gain Access to the Database

If the project is not already setup in the AKN database, the first step is to contact your regional contact for IWMM or IWMM project coordinator to create the project. If this is an ongoing survey, the project should already exist in the AKN database. Once the project is created, the Survey Coordinator will need to register for an account to gain access to the IWMM portal. Instructions for registering are at http://www.iwmmprogram.org/documents/Instructions-registration-access.pdf.

Cooperators will submit unit boundaries shortly after gaining access to the database. The regional contacts or survey coordinator will work with cooperators on the naming of units and uploading GIS files of the survey units into the online database.

Terminology

Using the AKN database to enter or manage data requires knowledge of a few salient terms:

- **Citizen Scientist:** The user has permission to access the Citizen Scientist and the Biologist applications. However, the user is only sent an explicit link to the Citizen Scientists application. The Citizen Scientists application is intended for use by volunteers to enter and proof data that they (or others) have collected. It is only for specific projects that employ area search protocols and where the data entry has been designed to be more constrained and simplified.
- **Biologist**: The user has permission to access the Biologists (and the Citizen Scientist) application. However, the user is only sent an explicit link to the Biologists application. The Biologists application is intended for use by researchers/interns to enter and proof data that they (or others) have collected. The projects represented within this application employ point count, area search and rail point count protocols.
- **Analyst**: The user has permission to access the Analysts application. The user is sent an email containing a link to the Analysts application. The Analysts application gives the user read-only access to analyzing project data. The user can download data from the warehouse for further analysis on their local machines.
- **Project Leader**: The user has permission to access the Biologist, Citizen Scientist, Analyst and the Project Leader applications. The user is sent an email containing links to all of the applications. The Project Leader application allows the user all management activities for project data, including creating and managing sampling units, assigning protocols used, and data access level decisions. They decide who gets access to their project(s) and what role they play. They can download all of their project data. Users assigned this role are able to create and manage sampling units, download and review field observations and all metadata about the project, grant other users access to the project as researchers or additional project leaders, select the protocol(s) used, enter field observations, and set sharing levels.
- **Researcher:** A Researcher is how individuals are identified in a Project. For your project you would give a Researcher access rights to your Project. Users assigned this role are able to

enter and review field observations, and download data.

Proof and Archive the Data Sheets

Data entry errors influence the quality and utility of collected data. However, many of these types of errors can be controlled through data organization, checking and entry techniques. The following steps should be used to reduce errors in the data base and make original data recording materials available for future reference, back-up or checking.

1. Organize data sheets by survey unit to facilitate data upload. Proofread the data sheets ensuring that they have been filled out completely. If more than one person is collecting data, have someone that did not collect these particular data conduct the review.

2. Mark corrections on copied data sheets with red pen. Any corrected errors, or changes made by the data "proofer" (that are entered differently into the database than they appear on the data sheet) should be circled, initialed, and corrected. Notes should be written in the margins or in the comments section whenever necessary to document the reason for the corrections.

3. Scan the data sheets to have a digital archive. If a portable computer or personal digital assistant (PDA) is used, export the file that is uploaded into AKN, or as a csv file, to an appropriate digital storage. The process and location of this back-up information should be specified in a site-specific survey protocol.

4. After data entry into AKN, archive the scanned data sheets or exported PDA file. If the data are associated with a survey report, include these data as an Appendix to the report and archive the report in ServCat. The original completed data forms or PDA file can also be stored on site in a safe place, preferably in a designated fireproof safe or cabinet.

Enter the Data

To prepare for data entry:

1. Organize your data and guidance materials to aid data entry process.
2. A data form will help verify that you have all the required data entry fields for your project.
3. A description or knowledge of the methods used for this survey.
4. The name and address of the Survey Coordinator (the person who can be contacted regarding questions about these data, once entered).

Enter the data into the AKN database:

1. Navigate through the IWMM website (http://iwmmprogram.org/protocols-data-forms/) and select "Connect to the IWMM Data Management Portal." using your email address and password.
2. After logging into the portal, select either "Bird Survey", "Vegetation Survey", or "Management Action" options under the "Data Entry" tab on the upper right of the home page screen.
3. Step-by-step instructions for data entry are available at: http://iwmmprogram.org/protocols-

data-forms/.

Verify and validate

In general, AKN uses a tiered set of levels for indicating the data validation and access (Table SOP-7.1). Once the person entering data is finished, he or she needs to notify the "Project Leader" responsible for AKN data management (for the Refuge System, this is typically the survey coordinator) that data are ready to be proofed in the database. The Project Leader will:

1. Ensure all datasheets have been initialed.
2. Compare the data sheets with the data records in the database and if there are no errors, then change the status of the records to the next appropriate level (see Table SOP-7.1).
3. Discuss any questionable data entry or field observer errors with the Data Entry Technician and/or Field Observer. If there are errors, the Project Leader will open up the records for editing.
4. After all errors are satisfactorily resolved in the database, set the status back. Then the Project Leader will change the status of the records in the database from clean to appropriate access level.
5. IWMM has a data sharing policy that governs how data collected by participants are used and shared, available at http://www.iwmmprogram.org/documents/IWMM_data_sharing_use_policy.pdf. IWMM recommends that once data are cleaned, cooperators set access to at least a level 2 so data can be available to IWMM science staff for use in analyses and data summaries.

Table SOP-7.1. The following are the Avian Knowledge Network's data access levels. These are applicable to each and every record in the network individually, so that different records may have different access levels. Data published using one of the five Levels below are stored in the AKN's primary data warehouses. The warehouses serve as the primary archives of all AKN data. No applications connect directly to the warehouses, but data from a warehouse are ported to separate data views created specifically to optimize the performance of an application that connects to it. Data owners can specify how their data can be used in the data views, with the option that their data are not exposed to the public at all.

Validation / Access Code [1]	Definition and Description
Level 1	Some information is made available to others than project members about the data. Specifically, only metadata about the datasets are made available to any application or service.
Level 2	Same as Level 1 with the following addition: data can be used in certain publicly available, predefined visualizations (i.e. maps and graphs), but direct access to the data is restricted.
Level 3	Data are used in publicly available, predefined visualizations (i.e. maps and graphs). Additionally, the complete BMDE data set is available upon request, subject to approval from the original data provider.
Level 4	Data can be used in publicly available, predefined visualizations (i.e. maps and graphs) and also may be available upon request. Additionally, some components of the data are made available to existing bioinformatic efforts (GBIF and ORNIS). These bioinformatic efforts only provide the data "marked-up" to Darwin Core, used to describe primary occurrence (location, date and species for example).
Level 5	Data are used in publicly available, predefined visualizations (i.e. maps and graphs) and are available to existing bioinformatic efforts. Additionally, the complete BMDE data set is available for download directly via download tools.
Raw	Data were input but no further review or processing has taken place. Data are available for project use only and not to the AKN.
Clean	Data were input and reviewed by member(s) of the project team. Data are available for project use only and not to the AKN.
Approved	Data were reviewed by project management, but no indication has been made of AKN data sharing levels. Data are available for project use only and not to the AKN.
Restricted	Same as APPROVED and not distributed and shared to other AKN partners automatically. All access to data must come through requests to the contributing institution project management.

[1] Some nodes have extended levels to help users manage the entire data lifecycle (Raw, Clean, Approved, Restricted).

Data Maintenance and Archiving

AKN is responsible for performing periodic backups of all data residing in the database. Editing of data that has already been "verified" in the database must be made in the AKN database by the Project Leader via the interface. Contact IWMM staff for assistance if numerous edits are needed. A detailed log identifying any changes to records already verified as correct and dates of the change must be maintained by the Survey Coordinator and stored along with the archived datasets in the annual reports stored in ServCat.

Supplemental Materials

SM 1: AOU Species Codes in Family Order.

AOU Species Codes in Family Order		
common name	code*	species
Black-bellied Whistling-Duck	BBWD	*Dendrocygna autumnalis*
Fulvous Whistling-Duck	FUWD	*Dendrocygna bicolor*
Greater White-fronted Goose	GWFG	*Anser albifrons*
Snow Goose (all morphs)	SNGO	*Anser caerulescens*
Blue Goose	*BLGO*	*Anser caerulescens*
Ross's Goose	ROGO	*Anser rossii*
Unidentified Snow, Blue or Ross's Goose	*RSGO*	~
Brant	BRAN	*Branta bernicla*
Cackling Goose	CACG	*Branta hutchinsii*
Canada Goose	CANG	*Branta canadensis*
Mute Swan	MUSW	*Cygnus olor*
Trumpeter Swan	TRUS	*Cygnus buccinator*
Tundra Swan	TUSW	*Cygnus columbianus*
Wood Duck	WODU	*Aix sponsa*
Gadwall	GADW	*Mareca strepera*
Eurasian Wigeon	EUWI	*Mareca penelope*
American Wigeon	AMWI	*Mareca americana*
American Black Duck	ABDU	*Anas rubripes*
Mallard	MALL	*Anas platyrhynchos*
Mottled Duck	MODU	*Anas fulvigula*
Blue-winged Teal	BWTE	*Spatula discors*
Cinnamon Teal	CITE	*Spatula cyanoptera*
Unidentified Cinammon or Blue-winged Teal	*CBTE*	~
Northern Shoveler	NSHO	*Spatula clypeata*
Northern Pintail	NOPI	*Anas acuta*
Green-winged Teal	GWTE	*Anas crecca*
Canvasback	CANV	*Aythya valisineria*
Redhead	REDH	*Aythya americana*
Ring-necked Duck	RNDU	*Aythya collaris*
Greater Scaup	GRSC	*Aythya marila*
Lesser Scaup	LESC	*Aythya affinis*
Common Eider	COEI	*Somateria mollissima*
Harlequin Duck	HADU	*Histrionicus histrionicus*
Surf Scoter	SUSC	*Melanitta perspicillata*
White-winged Scoter	WWSC	*Melanitta fusca*
Black Scoter	BLSC	*Melanitta americana*
Long-tailed Duck	LTDU	*Clangula hyemalis*
Bufflehead	BUFF	*Bucephala albeola*
Common Goldeneye	COGO	*Bucephala clangula*
Barrow's Goldeneye	BAGO	*Bucephala islandica*
Hooded Merganser	HOME	*Lophodytes cucullatus*
Common Merganser	COME	*Mergus merganser*
Red-breasted Merganser	RBME	*Mergus serrator*
Ruddy Duck	RUDU	*Oxyura jamaicensis*
Unidentified Goose	*UNGO*	~
Unidentified Swan	*UNCY*	~
Unidentified Teal	UNTE	*Anas (sp)*

AOU Species Codes in Family Order		
common name	code*	species
Unidentified Dabbling Duck	*UDAD*	~
Unidentified Diving Duck	*UDID*	~
Unidentified Scaup	*UNSC*	~
Unidentified Goldeneye	*UNGL*	~
Unidentified Duck	UNDU	*Anatinae (gen, sp)*
Unidentified Waterfowl	*UNWF*	~
Pied-billed Grebe	PBGR	*Podilymbus podiceps*
Horned Grebe	HOGR	*Podiceps auritus*
Red-necked Grebe	RNGR	*Podiceps grisegena*
Eared Grebe	EAGR	*Podiceps nigricollis*
Western Grebe	WEGR	*Aechmophorus occidentalis*
Unidentified Clark's or Western Grebe	*WCGR*	~
Clark's Grebe	CLGR	*Aechmophorus clarkii*
Yellow Rail	YERA	*Coturnicops noveboracensis*
Black Rail	BLRA	*Laterallus jamaicensis*
Ridgway's Rail	RIRA	*Rallus obsoletus*
Clapper Rail	CLRA	*Rallus crepitans*
King Rail	KIRA	*Rallus elegans*
Virginia Rail	VIRA	*Rallus limicola*
Sora	SORA	*Porzana carolina*
Purple Gallinule	PUGA	*Porphyrio martinicus*
Common Gallinule	COGA	*Gallinula galeata*
American Coot	AMCO	*Fulica americana*
Limpkin	LIMP	*Aramus guarauna*
Sandhill Crane	SACR	*Antigone canadensis*
Whooping Crane	WHCR	*Grus americana*
Black-necked Stilt	BNST	*Himantopus mexicanus*
American Avocet	AMAV	*Recurvirostra americana*
American Oystercatcher	AMOY	*Haematopus palliatus*
Black Oystercatcher	BLOY	*Haematopus bachmani*
Black-bellied Plover	BBPL	*Pluvialis squatarola*
American Golden-Plover	AMGP	*Pluvialis dominica*
Unidentified American or Pacific ("Lesser") Golden Plover	*LGPL*	~
Pacific Golden-Plover	PAGP	*Pluvialis fulva*
Snowy Plover	SNPL	*Charadrius nivosus*
Wilson's Plover	WIPL	*Charadrius wilsonia*
Semipalmated Plover	SEPL	*Charadrius semipalmatus*
Piping Plover	PIPL	*Charadrius melodus*
Killdeer	KILL	*Charadrius vociferus*
Mountain Plover	MOPL	*Charadrius montanus*
Upland Sandpiper	UPSA	*Bartramia longicauda*
Whimbrel	WHIM	*Numenius phaeopus*
Long-billed Curlew	LBCU	*Numenius americanus*
Hudsonian Godwit	HUGO	*Limosa haemastica*
Marbled Godwit	MAGO	*Limosa fedoa*
Ruddy Turnstone	RUTU	*Arenaria interpres*
Black Turnstone	BLTU	*Arenaria melanocephala*
Red Knot	REKN	*Calidris canutus*
Surfbird	SURF	*Calidris virgata*
Stilt Sandpiper	STSA	*Calidris himantopus*
Sanderling	SAND	*Calidris alba*
Dunlin	DUNL	*Calidris alpina*
Rock Sandpiper	ROSA	*Calidris ptilocnemis*

AOU Species Codes in Family Order		
common name	code*	species
Purple Sandpiper	PUSA	*Calidris maritima*
Baird's Sandpiper	BASA	*Calidris bairdii*
Least Sandpiper	LESA	*Calidris minutilla*
White-rumped Sandpiper	WRSA	*Calidris fuscicollis*
Buff-breasted Sandpiper	BBSA	*Calidris subruficollis*
Pectoral Sandpiper	PESA	*Calidris melanotos*
Semipalmated Sandpiper	SESA	*Calidris pusilla*
Western Sandpiper	WESA	*Calidris mauri*
Short-billed Dowitcher	SBDO	*Limnodromus griseus*
Long-billed Dowitcher	LBDO	*Limnodromus scolopaceus*
Wilson's Snipe	WISN	*Gallinago delicata*
Spotted Sandpiper	SPSA	*Actitis macularius*
Solitary Sandpiper	SOSA	*Tringa solitaria*
Wandering Tattler	WATA	*Tringa incana*
Greater Yellowlegs	GRYE	*Tringa melanoleuca*
Willet	WILL	*Tringa semipalmata*
Lesser Yellowlegs	LEYE	*Tringa flavipes*
Wilson's Phalarope	WIPH	*Phalaropus tricolor*
Red-necked Phalarope	RNPH	*Phalaropus lobatus*
Red Phalarope	REPH	*Phalaropus fulicarius*
Unidentified Ringed Plover, Sandpiper or Stint	*PEEP*	~
Unidentified Godwit	*UNGD*	~
Unidentified Dowitcher	UNDO	*Limnodromus sp.*
Unidentified Yellowlegs	*UNYE*	~
Unidentified Phalarope	*XPHL*	~
Unidentified Shorebird	*UNSH*	~
Bonaparte's Gull	BOGU	*Chroicocephalus philadelphia*
Laughing Gull	LAGU	*Leucophaeus atricilla*
Franklin's Gull	FRGU	*Leucophaeus pipixcan*
Heerman's Gull	HEEG	*Larus heermanni*
Mew Gull	MEGU	*Larus canus*
Ring-billed Gull	RBGU	*Larus delawarensis*
Western Gull	WEGU	*Larus occidentalis*
Unidentified Western / Glaucous-winged Gull	*WGGU*	~
Yellow-footed Gull	YFGU	*Larus livens*
California Gull	CAGU	*Larus californicus*
Herring Gull	HERG	*Larus argentatus*
Thayer's Gull	THGU	*Larus gaucoides thayeri*
Iceland Gull	ICGU	*Larus glaucoides*
Unidentified Iceland / Thayer's Gull	*ITGU*	~
Lesser Black-backed Gull	LBBG	*Larus fuscus*
Glaucous-winged Gull	GWGU	*Larus glaucescens*
Glaucous Gull	GLGU	*Larus hyperboreus*
Great Black-backed Gull	GBBG	*Larus marinus*
Unidentified Gull (Laridae spp)	*UNGU*	~
Unidentified Larus Gull (Laridae spp)	UNLG	*Larus (sp)*
Unidentified Small Gull	*UNSG*	~
Unidentified Large Gull	*XLGU*	~
Least Tern	LETE	*Sternula antillarum*
Gull-billed Tern	GBTE	*Gelochelidon nilotica*
Caspian Tern	CATE	*Hydroprogne caspia*
Black Tern	BLTE	*Chlidonias niger*
Common Tern	COTE	*Sterna hirundo*

AOU Species Codes in Family Order		
common name	code*	species
Forster's Tern	FOTE	*Sterna forsteri*
Royal Tern	ROYT	*Thalasseus maximus*
Sandwich Tern	SATE	*Thalasseus sandvicensis*
Elegant Tern	ELTE	*Thalasseus elegans*
Black Skimmer	BLSK	*Rynchops niger*
Unidentified Large Tern	*UNLT*	~
Unidentified Small Tern (Sterna spp)	*UNST*	~
Unidentified Tern (Sterna spp)	*UNTN*	~
Red-throated Loon	RTLO	*Gavia stellata*
Pacific Loon	PALO	*Gavia pacifica*
Common Loon	COLO	*Gavia immer*
Unidentified Loon	*UNLO*	~
Wood Stork	WOST	*Mycteria americana*
Brandt's Cormorant	BRAC	*Phalacrocorax penicillatus*
Neotropic Cormorant	NECO	*Phalacrocorax brasilianus*
Double-crested Cormorant	DCCO	*Phalacrocorax auritus*
Great Cormorant	GRCO	*Phalacrocorax carbo*
Pelagic Cormorant	PECO	*Phalacrocorax pelagicus*
Unidentified Cormorant	*XXCO*	~
Anhinga	ANHI	*Anhinga anhinga*
American White Pelican	AWPE	*Pelecanus erythrorhynchos*
Brown Pelican	BRPE	*Pelecanus occidentalis*
American Bittern	AMBI	*Botaurus lentiginosus*
Least Bittern	LEBI	*Ixobrychus exilis*
Great Blue Heron	GBHE	*Ardea herodias*
Great Egret	GREG	*Ardea alba*
Snowy Egret	SNEG	*Egretta thula*
Little Blue Heron	LBHE	*Egretta caerulea*
Tricolored Heron	TRHE	*Egretta tricolor*
Reddish Egret	REEG	*Egretta rufescens*
Cattle Egret	CAEG	*Bubulcus ibis*
Green Heron	GRHE	*Butorides virescens*
Unidentified Heron	*UNHE*	~
Black-crowned Night-Heron	BCNH	*Nycticorax nycticorax*
Yellow-crowned Night-Heron	YCNH	*Nyctanassa violacea*
Unidentified Night-heron	*UNNH*	~
White Ibis	WHIB	*Eudocimus albus*
Glossy Ibis	GLIB	*Plegadis falcinellus*
White-faced Ibis	WFIB	*Plegadis chihi*
Unidentified Glossy/White-faced Ibis	*XPLE*	~
Roseate Spoonbill	ROSP	*Platalea ajaja*
* codes not included in the 58th AOU supplement in italic.		

SM 2: AOU Species Codes in Alphabetical Order

AOU Species Codes in Alphabetical Order		
common name	code*	species
American Avocet	AMAV	*Recurvirostra americana*
American Bittern	AMBI	*Botaurus lentiginosus*
American Black Duck	ABDU	*Anas rubripes*
American Coot	AMCO	*Fulica americana*
American Golden-Plover	AMGP	*Pluvialis dominica*
American Oystercatcher	AMOY	*Haematopus palliatus*
American White Pelican	AWPE	*Pelecanus erythrorhynchos*
American Wigeon	AMWI	*Mareca americana*
Anhinga	ANHI	*Anhinga anhinga*
Baird's Sandpiper	BASA	*Calidris bairdii*
Barrow's Goldeneye	BAGO	*Bucephala islandica*
Black Oystercatcher	BLOY	*Haematopus bachmani*
Black Rail	BLRA	*Laterallus jamaicensis*
Black Scoter	BLSC	*Melanitta americana*
Black Skimmer	BLSK	*Rynchops niger*
Black Tern	BLTE	*Chlidonias niger*
Black Turnstone	BLTU	*Arenaria melanocephala*
Black-bellied Plover	BBPL	*Pluvialis squatarola*
Black-bellied Whistling-Duck	BBWD	*Dendrocygna autumnalis*
Black-crowned Night-Heron	BCNH	*Nycticorax nycticorax*
Black-necked Stilt	BNST	*Himantopus mexicanus*
Blue Goose	*BLGO*	*Anser caerulescens*
Blue-winged Teal	BWTE	*Spatula discors*
Bonaparte's Gull	BOGU	*Chroicocephalus philadelphia*
Brandt's Cormorant	BRAC	*Phalacrocorax penicillatus*
Brant	BRAN	*Branta bernicla*
Brown Pelican	BRPE	*Pelecanus occidentalis*
Buff-breasted Sandpiper	BBSA	*Calidris subruficollis*
Bufflehead	BUFF	*Bucephala albeola*
Cackling Goose	CACG	*Branta hutchinsii*
California Gull	CAGU	*Larus californicus*
Canada Goose	CANG	*Branta canadensis*
Canvasback	CANV	*Aythya valisineria*
Caspian Tern	CATE	*Hydroprogne caspia*
Cattle Egret	CAEG	*Bubulcus ibis*
Cinnamon Teal	CITE	*Spatula cyanoptera*
Clapper Rail	CLRA	*Rallus crepitans*
Clark's Grebe	CLGR	*Aechmophorus clarkii*
Common Eider	COEI	*Somateria mollissima*
Common Gallinule	COGA	*Gallinula galeata*
Common Goldeneye	COGO	*Bucephala clangula*
Common Loon	COLO	*Gavia immer*
Common Merganser	COME	*Mergus merganser*
Common Tern	COTE	*Sterna hirundo*
Double-crested Cormorant	DCCO	*Phalacrocorax auritus*
Dunlin	DUNL	*Calidris alpina*
Eared Grebe	EAGR	*Podiceps nigricollis*
Elegant Tern	ELTE	*Thalasseus elegans*

AOU Species Codes in Alphabetical Order		
common name	code*	species
Eurasian Wigeon	EUWI	*Mareca penelope*
Forster's Tern	FOTE	*Sterna forsteri*
Franklin's Gull	FRGU	*Leucophaeus pipixcan*
Fulvous Whistling-Duck	FUWD	*Dendrocygna bicolor*
Gadwall	GADW	*Mareca strepera*
Glaucous Gull	GLGU	*Larus hyperboreus*
Glaucous-winged Gull	GWGU	*Larus glaucescens*
Glossy Ibis	GLIB	*Plegadis falcinellus*
Great Black-backed Gull	GBBG	*Larus marinus*
Great Blue Heron	GBHE	*Ardea herodias*
Great Cormorant	GRCO	*Phalacrocorax carbo*
Great Egret	GREG	*Ardea alba*
Greater Scaup	GRSC	*Aythya marila*
Greater White-fronted Goose	GWFG	*Anser albifrons*
Greater Yellowlegs	GRYE	*Tringa melanoleuca*
Green Heron	GRHE	*Butorides virescens*
Green-winged Teal	GWTE	*Anas crecca*
Gull-billed Tern	GBTE	*Gelochelidon nilotica*
Harlequin Duck	HADU	*Histrionicus histrionicus*
Heerman's Gull	HEEG	*Larus heermanni*
Herring Gull	HERG	*Larus argentatus*
Hooded Merganser	HOME	*Lophodytes cucullatus*
Horned Grebe	HOGR	*Podiceps auritus*
Hudsonian Godwit	HUGO	*Limosa haemastica*
Iceland Gull	ICGU	*Larus glaucoides*
Killdeer	KILL	*Charadrius vociferus*
King Rail	KIRA	*Rallus elegans*
Laughing Gull	LAGU	*Leucophaeus atricilla*
Least Bittern	LEBI	*Ixobrychus exilis*
Least Sandpiper	LESA	*Calidris minutilla*
Least Tern	LETE	*Sternula antillarum*
Lesser Black-backed Gull	LBBG	*Larus fuscus*
Lesser Scaup	LESC	*Aythya affinis*
Lesser Yellowlegs	LEYE	*Tringa flavipes*
Limpkin	LIMP	*Aramus guarauna*
Little Blue Heron	LBHE	*Egretta caerulea*
Long-billed Curlew	LBCU	*Numenius americanus*
Long-billed Dowitcher	LBDO	*Limnodromus scolopaceus*
Long-tailed Duck	LTDU	*Clangula hyemalis*
Mallard	MALL	*Anas platyrhynchos*
Marbled Godwit	MAGO	*Limosa fedoa*
Mew Gull	MEGU	*Larus canus*
Mottled Duck	MODU	*Anas fulvigula*
Mountain Plover	MOPL	*Charadrius montanus*
Mute Swan	MUSW	*Cygnus olor*
Neotropic Cormorant	NECO	*Phalacrocorax brasilianus*
Northern Pintail	NOPI	*Anas acuta*
Northern Shoveler	NSHO	*Spatula clypeata*
Pacific Golden-Plover	PAGP	*Pluvialis fulva*
Pacific Loon	PALO	*Gavia pacifica*
Pectoral Sandpiper	PESA	*Calidris melanotos*
Pelagic Cormorant	PECO	*Phalacrocorax pelagicus*
Pied-billed Grebe	PBGR	*Podilymbus podiceps*

AOU Species Codes in Alphabetical Order		
common name	code*	species
Piping Plover	PIPL	*Charadrius melodus*
Purple Gallinule	PUGA	*Porphyrio martinicus*
Purple Sandpiper	PUSA	*Calidris maritima*
Red Knot	REKN	*Calidris canutus*
Red Phalarope	REPH	*Phalaropus fulicarius*
Red-breasted Merganser	RBME	*Mergus serrator*
Reddish Egret	REEG	*Egretta rufescens*
Redhead	REDH	*Aythya americana*
Red-necked Grebe	RNGR	*Podiceps grisegena*
Red-necked Phalarope	RNPH	*Phalaropus lobatus*
Red-throated Loon	RTLO	*Gavia stellata*
Ridgway's Rail	RIRA	*Rallus obsoletus*
Ring-billed Gull	RBGU	*Larus delawarensis*
Ring-necked Duck	RNDU	*Aythya collaris*
Rock Sandpiper	ROSA	*Calidris ptilocnemis*
Roseate Spoonbill	ROSP	*Platalea ajaja*
Ross's Goose	ROGO	*Anser rossii*
Royal Tern	ROYT	*Thalasseus maximus*
Ruddy Duck	RUDU	*Oxyura jamaicensis*
Ruddy Turnstone	RUTU	*Arenaria interpres*
Sanderling	SAND	*Calidris alba*
Sandhill Crane	SACR	*Antigone canadensis*
Sandwich Tern	SATE	*Thalasseus sandvicensis*
Semipalmated Plover	SEPL	*Charadrius semipalmatus*
Semipalmated Sandpiper	SESA	*Calidris pusilla*
Short-billed Dowitcher	SBDO	*Limnodromus griseus*
Snow Goose (all morphs)	SNGO	*Anser caerulescens*
Snowy Egret	SNEG	*Egretta thula*
Snowy Plover	SNPL	*Charadrius nivosus*
Solitary Sandpiper	SOSA	*Tringa solitaria*
Sora	SORA	*Porzana carolina*
Spotted Sandpiper	SPSA	*Actitis macularius*
Stilt Sandpiper	STSA	*Calidris himantopus*
Surf Scoter	SUSC	*Melanitta perspicillata*
Surfbird	SURF	*Calidris virgata*
Thayer's Gull	THGU	*Larus gaucoides thayeri*
Tricolored Heron	TRHE	*Egretta tricolor*
Trumpeter Swan	TRUS	*Cygnus buccinator*
Tundra Swan	TUSW	*Cygnus columbianus*
Unidentified Cinnamon or Blue-winged Teal	*CBTE*	~
Unidentified American or Pacific ("Lesser") Golden Plover	*LGPL*	~
Unidentified Clark's or Western Grebe	*WCGR*	~
Unidentified Cormorant	*XXCO*	~
Unidentified Dabbling Duck	*UDAD*	~
Unidentified Diving Duck	*UDID*	~
Unidentified Dowitcher	UNDO	*Limnodromus sp.*
Unidentified Duck	UNDU	*Anatinae (gen, sp)*
Unidentified Godwit	*UNGD*	~
Unidentified Goldeneye	*UNGL*	~
Unidentified Goose	*UNGO*	~
Unidentified Gull (Laridae spp)	*UNGU*	~
Unidentified Heron	*UNHE*	~
Unidentified Iceland or Thayer's Gull	*ITGU*	~

AOU Species Codes in Alphabetical Order		
common name	code*	species
Unidentified Large Gull	*XLGU*	~
Unidentified Large Tern	*UNLT*	~
Unidentified Larus Gull	UNLG	*Larus (sp)*
Unidentified Loon	*UNLO*	~
Unidentified Night-heron	*UNNH*	~
Unidentified Phalarope	*XPHL*	~
Unidentified Ringed Plover, Sandpiper or Stint	*PEEP*	~
Unidentified Scaup	*UNSC*	~
Unidentified Shorebird	*UNSH*	~
Unidentified Small Gull	*UNSG*	~
Unidentified Small Tern (Sterna spp)	*UNST*	~
Unidentified Snow, Blue or Ross's Goose	*RSGO*	~
Unidentified Swan	*UNCY*	~
Unidentified Teal	UNTE	*Anas (sp)*
Unidentified Tern (Sterna spp)	*UNTN*	~
Unidentified Waterfowl	*UNWF*	~
Unidentified Western / Glaucous-winged Gull	*WGGU*	~
Unidentified Yellowlegs	*UNYE*	~
Unidentified Glossy/White-faced Ibis	*XPLE*	~
Upland Sandpiper	UPSA	*Bartramia longicauda*
Virginia Rail	VIRA	*Rallus limicola*
Wandering Tattler	WATA	*Tringa incana*
Western Grebe	WEGR	*Aechmophorus occidentalis*
Western Gull	WEGU	*Larus occidentalis*
Western Sandpiper	WESA	*Calidris mauri*
Whimbrel	WHIM	*Numenius phaeopus*
White Ibis	WHIB	*Eudocimus albus*
White-faced Ibis	WFIB	*Plegadis chihi*
White-rumped Sandpiper	WRSA	*Calidris fuscicollis*
White-winged Scoter	WWSC	*Melanitta fusca*
Whooping Crane	WHCR	*Grus americana*
Willet	WILL	*Tringa semipalmata*
Wilson's Phalarope	WIPH	*Phalaropus tricolor*
Wilson's Plover	WIPL	*Charadrius wilsonia*
Wilson's Snipe	WISN	*Gallinago delicata*
Wood Duck	WODU	*Aix sponsa*
Wood Stork	WOST	*Mycteria americana*
Yellow Rail	YERA	*Coturnicops noveboracensis*
Yellow-crowned Night-Heron	YCNH	*Nyctanassa violacea*
Yellow-footed Gull	YFGU	*Larus livens*
* codes not included in the 58th AOU supplement in italic.		

SM 3: Waterbird Survey Form Single Unit

This is the standard field recording form for weekly waterbird counts. ONE FORM PER SURVEY UNIT (MAY BE SEVERAL UNITS PER project). Refer to the website for the most up-to-date data form: http://iwmmprogram.org/protocols-data-forms/

Integrated Waterbird Management Monitoring

Waterbird Survey Form

Unit Code	**Start time**	:	**Observer(s)**		
Date	**End time**	:	Temp (f)	Wind (Beaufort)	
Visibility	Local tide	Salinity (ppt)	Water gage	(units)	

Water Depth *Dry*	*Saturated to 5 cm*	*Shallow:5-25cm*	*Deep: >25 cm*	**% Ice**	**Disturbance:**	
Sum to 100%					Severity	
Habitat Cover Water/SAV	*Scrub-shrub*	*Forest*	*Emergent*	*Bare Ground*	Interspersion	Source
Sum to 100%						Chronic

Species	Count	Species	Count	Species	Count

Categorical Assessments : Local Tide: 1 = high; 2 = almost high, rising; 3 = almost high, falling; 4 = half tide, rising; 5 = half tide, falling; 6 = almost low, rising; 7 = almost low, falling; 8 = low; 9 = not observed, NA. **Water Gage Units**: 1=feet/tenths, 2=feet/inches, 3=meters **Interspersion:** class "L" = includes large water/bare ground features with connected patches and linear edge; Class "S"= contains small, disconnected patches of water/bare ground with increased random distribution and fewer instances of connection; Class "M" = consists of patterns that contain discernible regions of both configuration classes L and S. **Disturbance Severity:** 1 = no effect on waterbirds; 2 = some waterbirds move but stay within unit; 3 = some waterbirds leave unit; 4 = most/all waterbirds leave unit **Disturbance Source** (>1 code allowed): 1=Pedestrian, 2=Loose dog, 3=Hunting, 4= Fishing, 5=Boats, 6=Motor Vehicles, 7=Aircraft, 8=Raptor. **Chronic Disturbance:** 1 = Closed to all public use with entry into unit by resource managers or designees only; 2 = Managed public access including firearms hunting; 3 = open access via trail, viewing platforms etc. No firearms hunting allowed. 4 = Open access with firearms hunting.

Notes:

Required Metric Optional Metric *ppt = parts per thousand*

SM 4: Waterbird Survey Form Multiple Units (2 sides)

This is the standard field recording form for weekly waterbird counts - **for up to six units surveyed on the same day**. ***Print double-sided***. If printed single sided, be sure to add project, unit and date to the second sheet! Either Ctrl+Click anywhere on data sheet or refer to the website for the most up-to-date data form: http://iwmmprogram.org/protocols-data-forms/

IWMM - Waterbird & Unit Condition Survey

Recording form for multiple units

Project Name		**Observers**					
Start temp (°F)		**Date**		**Wind** (Beaufort 0-6)		**notes**	

Unit Code:							
Survey start/end time		/	/	/	/	/	/
% Visibility							
Local Tide Conditions[a]							
Salinity							
Water Gauge[b] (units=)							
Water Depth % of unit in each category (sum to 100)	Dry						
	Saturated/mud to 5cm						
	5 to 25 cm(≈ 2-9")						
	>25 cm(≈ >10")						
Estimation method: Bathymetry +gage, Ocular, or Other							
Percent of ice cover							
Habitat Cover % of unit in each category (sum to 100)	Water (Include SAV.[d] & Floating-Leaved						
	Scrub-shrub						
	Forest						
	Emergent						
	Bare Ground						
Interspersion[c]							
Disturbance severity[d]							
Disturbance sources[e]							
Chronic human disturbance[f]							

NOTES:

GRAY BOXES ARE REQUIRED FOR EACH UNIT

To be completed if not printed double-sided:	Project Name			Date		
Species	**unit code:**	**unit code:**	**unit code:**	**unit code:**	**unit code:**	**unit code:**

a, local tide conditions: 1 = high; 2 = almost high, rising; 3 = almost high, falling; 4 = half tide, rising; 5 = half tide, falling; 6 = almost low, rising; 7 = almost low, falling; 8 = low; 9 = not observed, NA.

b, Water Gage Units: 1=feet/tenths, 2=feet/inches, 3=meters

c, Interspersion: class "L" = includes large water/bare ground features with connected patches and linear edge; Class "S"= contains small, disconnected patches of water/bare ground with increased random distribution and fewer instances of connection; Class "M" = consists of patterns that contain discernible regions of both configuration classes L and S.

d, Disturbance Severity: 1 = no effect on waterbirds; 2 = some waterbirds move but stay within unit; 3 = some waterbirds leave unit; 4 = most/all waterbirds leave unit

e, Disturbance Source (>1 code allowed): 1=Pedestrian, 2=Loose dog, 3=Hunting, 4= Fishing, 5=Boats, 6=Motor Vehicles, 7=Aircraft, 8=Raptor.

f, Chronic Disturbance: 1 = Closed to all public use with entry into unit by resource managers or designees only; 2 = Managed public access including firearms hunting; 3 = open access via trail, viewing platforms etc. No firearms hunting allowed. 4 = Open access with firearms hunting.

SM 5: Annual Vegetation Survey Form

Either Ctrl+Click anywhere on data sheet or refer to the website for the most up-to-date data form: http://iwmmprogram.org/protocols-data-forms/

Integrated Waterbird Management Monitoring

Annual Vegetation Survey Form

Unit Code	Date	Observer(s)	Notes:
% Unit w/vegetation$_a$			

Habitat Resource Type

Natural	% Unit$_a$	Energetic Quality	**Crop**	% Unit$_a$	Energetic Quality
Semi-permanent Wooded Wetlands		*High Mod Low*	Unharvested Rice		*High Mod Low*
Seasonal Wooded Wetlands		*High Mod Low*	Unharvested Grain		*High Mod Low*
Freshwater Non-persistent Emergent Marsh		*High Mod Low*	Unharvested Corn		*High Mod Low*
Freshwater Persistent Emergent Marsh		*High Mod Low*	Unharvested Soybean		*High Mod Low*
Brackish Emergent Marsh		*High Mod Low*	Unharvested Millet		*High Mod Low*
Aquatic Bed / SAV		*High Mod Low*	Green Browse		*High Mod Low*
Open Water		*High Mod Low*	Unharvested Other		*High Mod Low*
Riverine		*High Mod Low*	Harvested Crops		*High Mod Low*
Mudflat		*High Mod Low*			

***Plant community composition** $_b$*		Seed Head Assessment for select moist-soil species$_c$		
Species	% cover$_b$	Seed Head Size	Seed Head Density	
		Large Avg Small	*High Mod Low*	Check box if unit was assessed and no plant species were observed ☐
		Large Avg Small	*High Mod Low*	
		Large Avg Small	*High Mod Low*	
		Large Avg Small	*High Mod Low*	
		Large Avg Small	*High Mod Low*	
		Large Avg Small	*High Mod Low*	
		Large Avg Small	*High Mod Low*	
		Large Avg Small	*High Mod Low*	
		Large Avg Small	*High Mod Low*	
		Large Avg Small	*High Mod Low*	
		Large Avg Small	*High Mod Low*	
		Large Avg Small	*High Mod Low*	

a. Estimate as aerial cover for the entire survey unit, total ≤100% **b.** % cover for individual plants = estimate as a canopy cover percentage of each species within the vegetated area only. Exclude bare ground & water areas lacking vegetation; percent cover total across individuals species may sum to >100% **C.** Assess seed heads for: Wild millet, walter's millet, fall panicum, rice cutgrass, nodding smartweed, Pennsylvania smartweed, goosefoot, swamp timothy, foxtails, bidens, yellow nutsedge, amazon sprangletop, redroot flatsedge. See manual for specifics.

Required Metrics

Optional Metrics

SM 6: Seed Head Assessment Guide for Selected Wetland Plants with Food Value to Waterfowl

Seed head assessments for the purposes of the IWMM habitat protocol will consist of assigning seed head size and density categories to selected emergent plant species based on the methodology developed by Naylor et al. 2005. Naylor et al. developed methods to evaluate percent cover and seed-head characteristics of 6 common moist-soil plant types and used these data to create an index of seed production.

The species selected for this guide originated from pilot IWMM vegetation surveys (Fall 2010 through Spring 2013). Initially, a candidate list included all co-dominant plant species listed on pilot vegetation surveys. We narrowed this list by applying two filters: (1) the species must have a high food value to waterfowl (refer to table SM-6.1) and (2) the species must be listed as a co- dominant on at least 50 vegetation surveys from the pilot survey seasons. **We acknowledge that this guide will not be comprehensive, so we intend this guide to be a living document. Additional species will be added based on suggestions from IWMM cooperators.**

Average seed head size for selected plant species was calculated using technical drawings for each species, knowledge of natural seed head variability for selected species across the IWMM study area, and reviews of the following references: USDA National PLANT Database, Common Marsh, Underwater and Floating-leaved Plants of the United States and Canada (Hotchkiss 1972), Food of Game Ducks in the United States and Canada (Martin and Uhler 1939), and A Manual of Marsh and Aquatic Vascular Plants of North Carolina with Habitat Data (Beal 1977).

How to Use this Guide

Seed head size—Seed head size categorization was plant-type specific and based on the deviation of the average size of inflorescences (for each plant species) within a wetland from that of the observed average size throughout a managed wetland (Naylor et al. 2005). For all the selected species in this guide, an average seed head size by species is indicated by a blue "arrow" to allow you to quantitatively assess seed head size as average, smaller than average, or larger than average (see below).

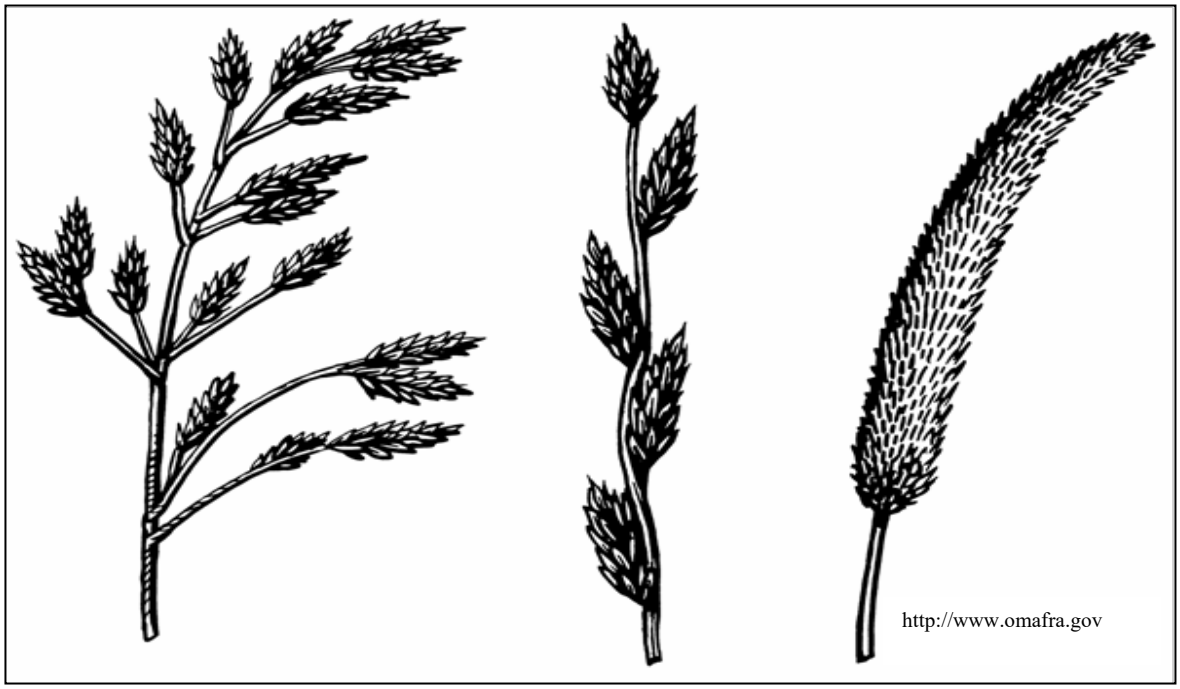
For example, in the field, Pennsylvania smartweed (*Polygonum pensylvanicum*) would be compared to its average size of seed head size for this species. If the seed head size is consistent with the size displayed by the blue arrow, assign it to the "average" category. If the seed head size is greater than average indicated by the blue arrow, assign it to the "large seed" category. Finally, if the seed head size is below the average seed head size as indicated by the blue arrow, assign it to the "small seed" category. Lastly, use the "Not Assessed" category for species that have deteriorated seed heads at the time of assessment or are too difficult to assess seed heads (e.g. damaged).

NOTE**:** Refer to the red arrow on individual plant photos or line drawings to maintain consistency when measuring actual seed heads in the field.

Types of inflorescence (seed heads)—There are three forms of seed heads, but for the purposes of

this guide all three forms of seed heads will be treated collectively as inflorescences.

Panicle (e.g. fall panicgrass) Spike (e.g. smartweed) Spike-like panicle (e.g. foxtail)

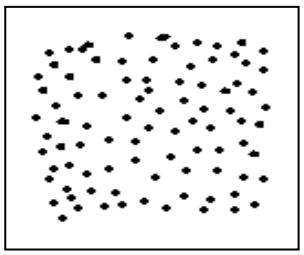


Seed head density—Seed head density should be assigned to ordinal categories by visually assessing the relative abundance of seed heads within a patch of each plant species. In the field, visually assess seed head density based on two considerations: (1) the density of stems for a species; (2) the proportion of a species' stems with seed heads.

Conduct a visual assessment in the field of seed head density by assigning a seed head density category to a species by ordinal categories of high, moderate, or low using the pictorial representation of these ordinal categories below.

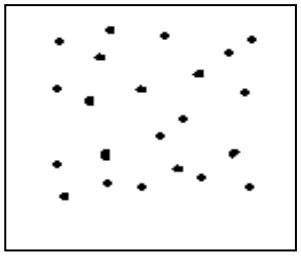
Stem Density—High stem density is assigned to areas with little bare ground, open water, or other plant species and a high proportion of seed heads to stems. Low seed head density is characterized by large areas of bare ground, open water, or other plant species and a low proportion of seed heads to plant stems for the species being assessed. Moderate stem densities fall between these two extremes.

High seed head density & **High** stem density



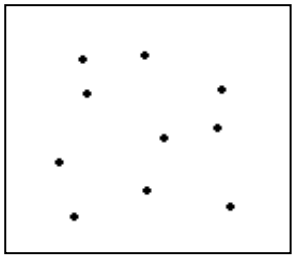
High stem density Low bare ground

Moderate seed head density & **Moderate** stem density



Moderate stem density Moderate bare ground

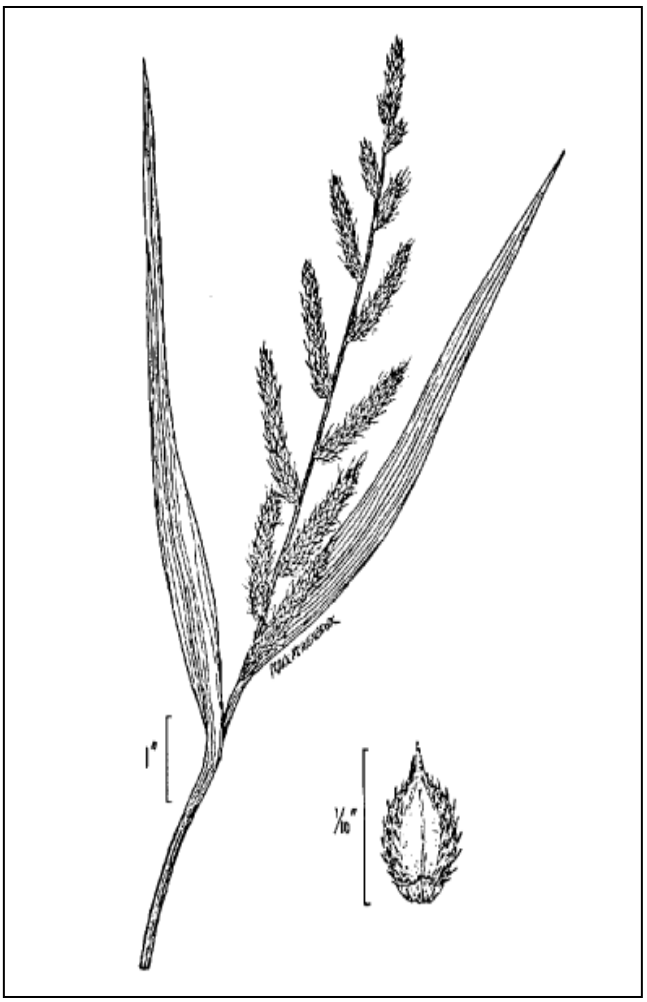
Low seed head density & **Low** stem density



Low stem density High bare ground

Seed Head Size Assessment Guide for Selected Wetland Plants

Barnyardgrass or wild millet (*Echinochloa crus-galli*)



http://plants.usda.gov

http://plants.usda.gov

4-8" AVERAGE

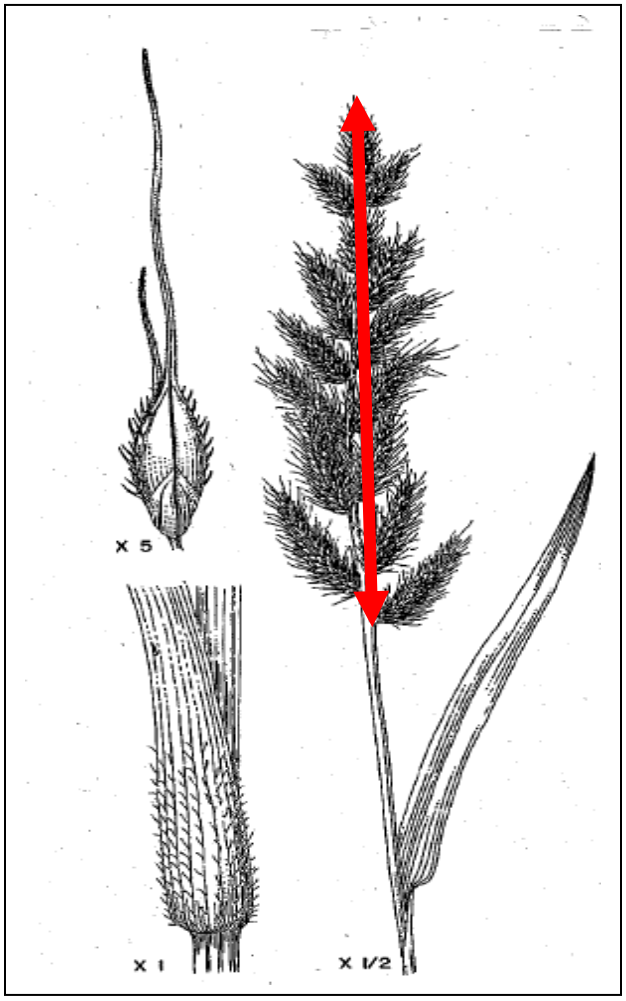
Less than 4 inches **(SMALL)**

Greater than 8 inches **(LARGE)**

- Measure 1 - 2 individual inflorescences from 3-5 separate plants; calculate average for seed head size.

Coast cockspur grass or Walter's millet (*Echinchloa walteri*)

USFWS



Martin and Uhler

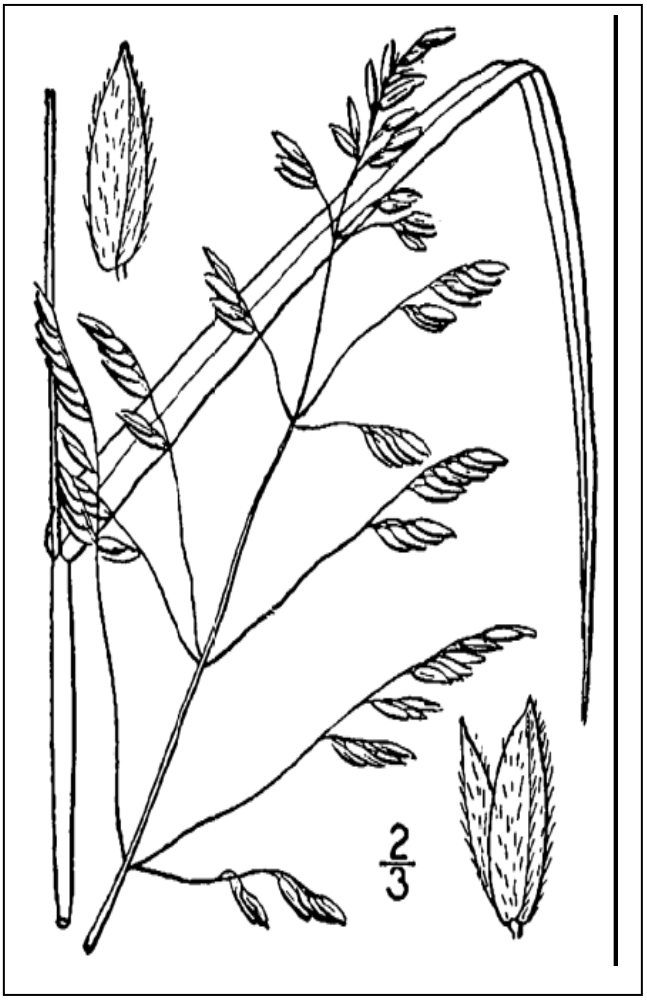
6-10" AVERAGE

Less than 6 inches (**SMALL**) Greater than 10 inches (**LARGE**)

- Measure 1-2 individual inflorescences (for this species it would include the entire seed head cluster) from the top to the bottom of the seed head cluster from 3-5 separate plants; calculate average for seed head size.

Rice Cutgrass (*Leersia oryzoides*)

http://plants.usda.gov



http://plants.usda.gov

5-8” AVERAGE

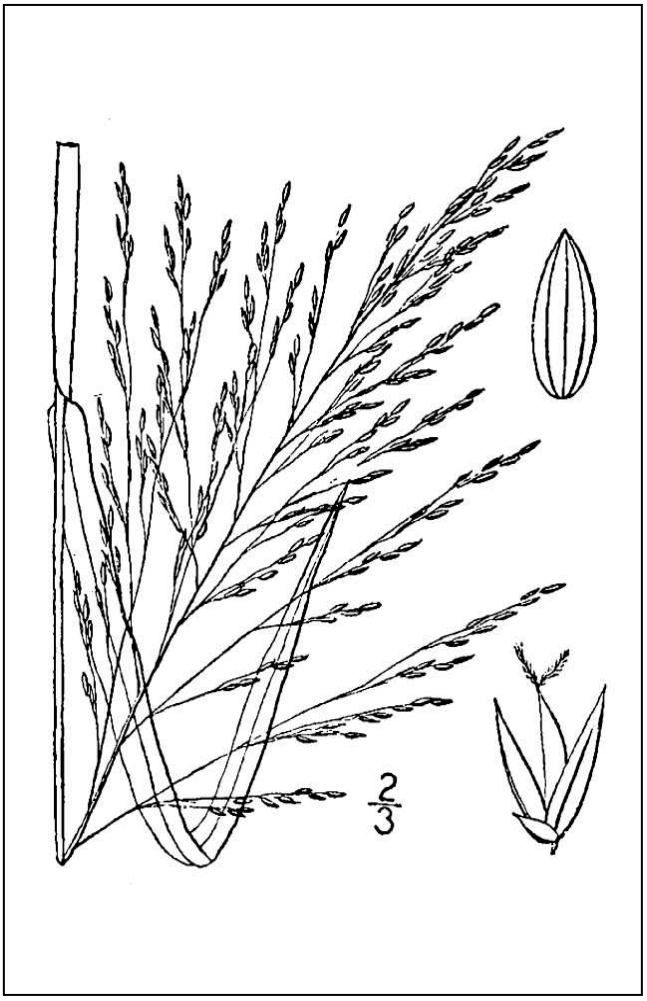
Less than 5 inches (**SMALL**)

Greater than 8 inches (**LARGE**)

- Measure 1-2 individual inflorescences from 3-5 separate plants; calculate average for seed head size.

Fall panicgrass (*Panicum dichotomiflorum*)

USFWS



http://plants.usda.gov

5-8” AVERAGE

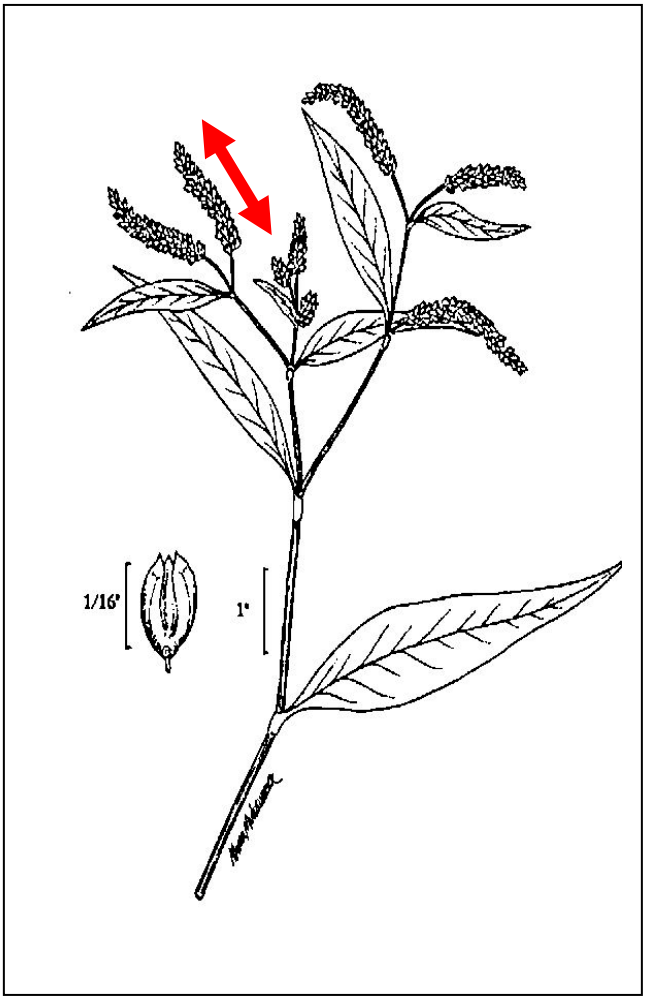
Less than 5 inches (**SMALL**)

Greater than 8 inches (**LARGE**)

- Measure 1-2 individual inflorescences (for this species it would include the entire seed head cluster) from the top to the bottom of the seed head cluster from 3-5 separate plants; calculate average for seed head size.

Curlytop knotweed (*Polygonum lapathifolium*)

USFWS



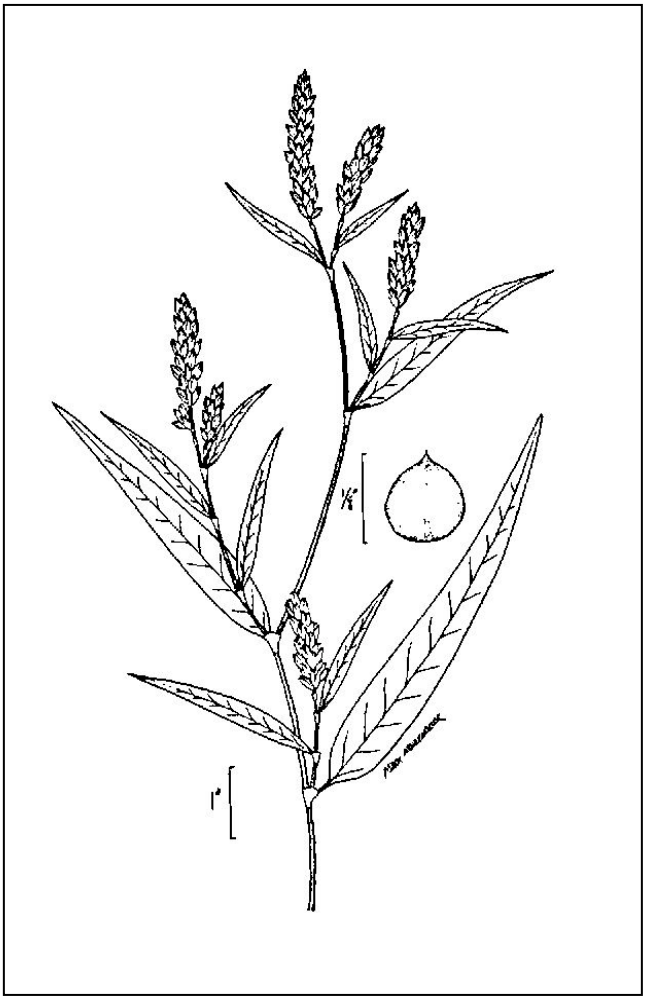
http://plants.usda.gov

2-4" AVERAGE

Less than 2 inches (**SMALL**) Greater than 4 inches (**LARGE**)

- Measure 1-2 individual inflorescences from 3-5 separate plants; calculate average for seed head size.

Pennsylvania smartweed or pinkweed or big seeded smartweed (*Polygonum pensylvanicum*)



http://plants.usda.gov

http://plants.usda.

gov 1-2”AVERAGE

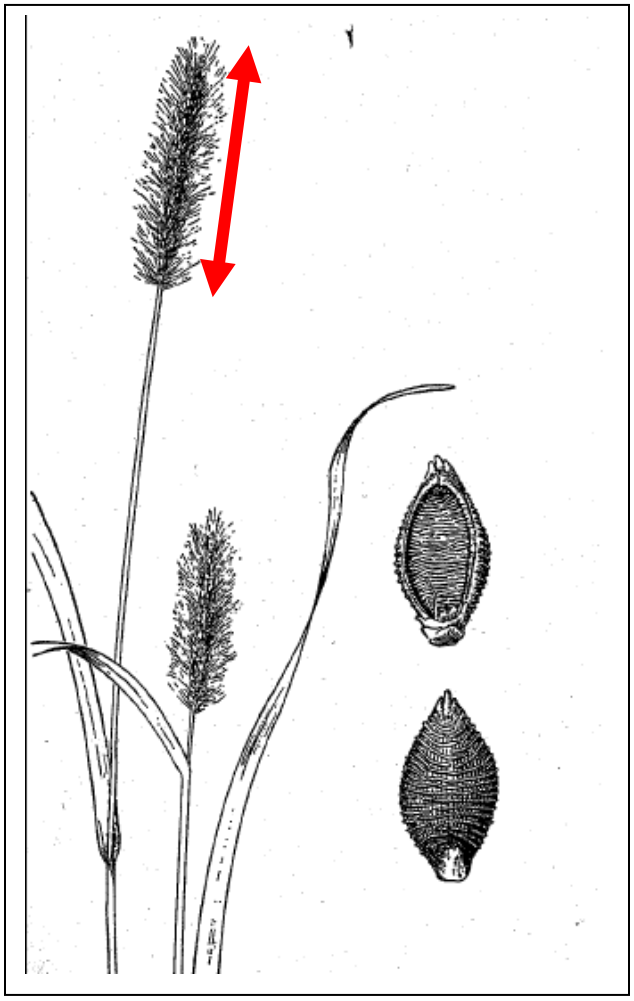
Less than 1 inch (**SMALL**)

Greater than 2 inches (**LARGE**)

- Measure 1-2 individual inflorescences from 3-5 separate plants; calculate average for seed head size.

Foxtail (*Setaria spp*.)

http://plants.usda.gov



Martin and

Uhler Giant Foxtail *S. Faberi*
2-4" AVERAGE

Less than 2 inches (**SMALL**)

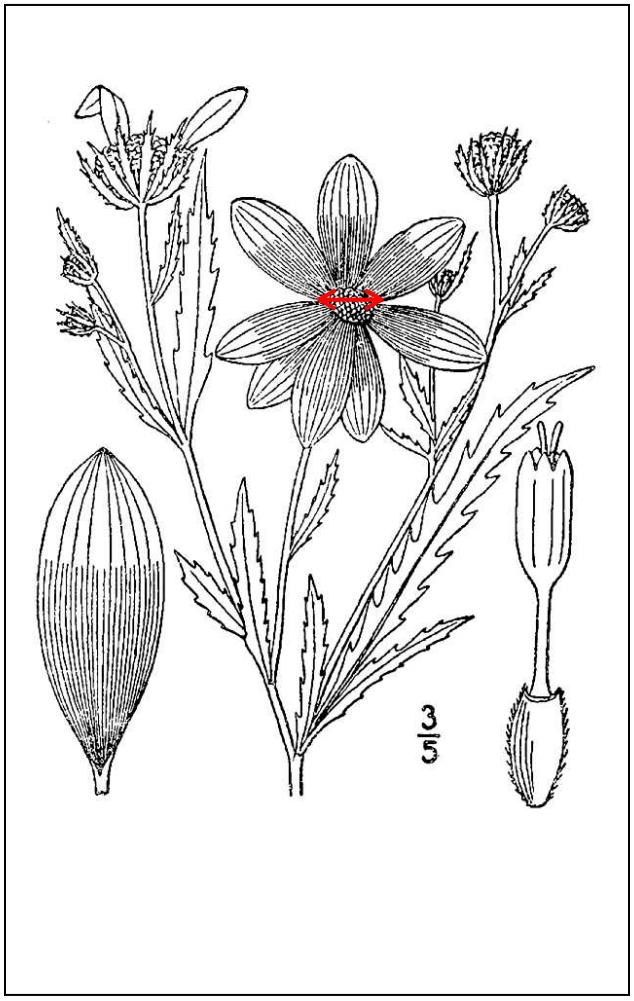
Greater than 4 inches (**LARGE**)

Green & yellow Foxtail S. pumila & S. viridis
1-2" AVERAGE

- Measure 1-2 individual inflorescences from 3-5 separate plants; calculate average for seed head size.

Beggarticks (*Bidens spp.*)

http://plants.usda.gov



http://plants.usda.f

gov AVERAGE

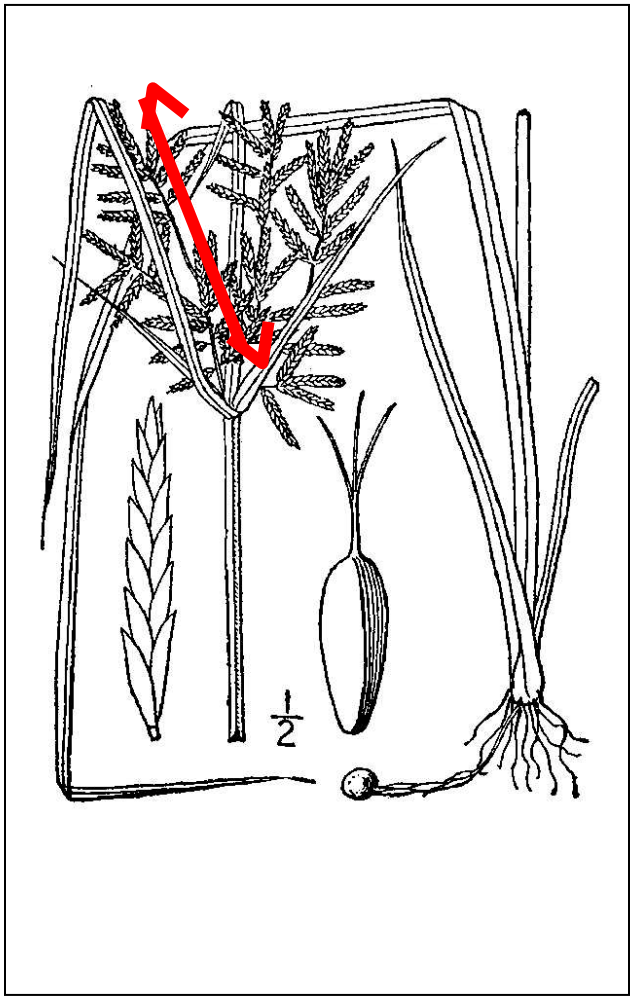
Less than 0.375 inches **(SMALL)**

Greater than 0.375 inches **(LARGE)**

- Measure the width of 1-2 seed heads (excluding the flower petals) from 3-5 separate plants; calculate average for seed head size.

Yellow Nutsedge (*Cyperus esculentus*)

http://plants.usda.gov



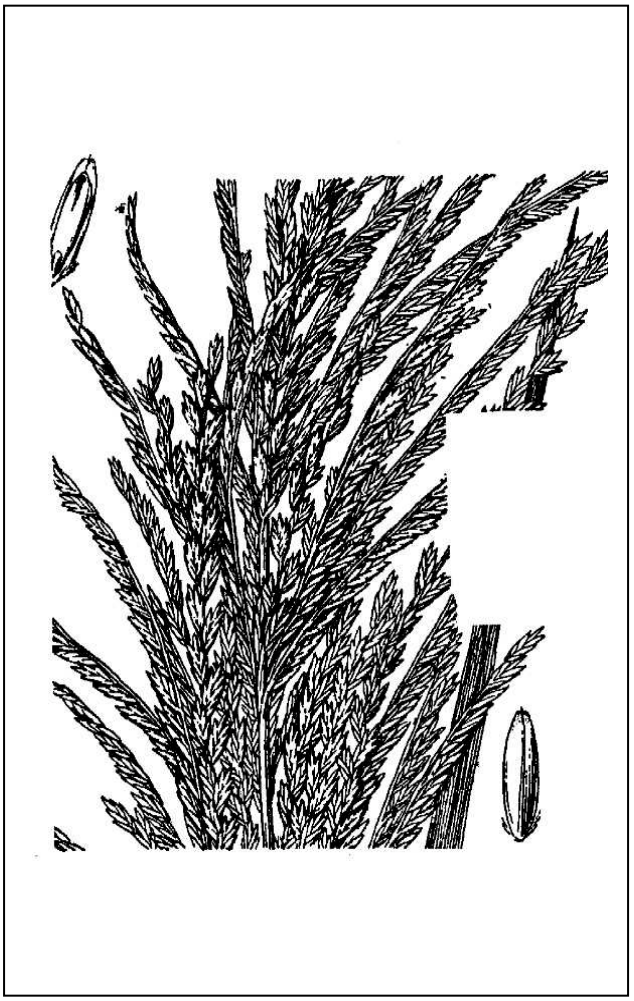
http://plants.usda.

gov 2-4" AVERAGE

Less than 2 inches **(SMALL)** Greater than 4 inches **(LARGE)**

- Measure 1-2 individual inflorescences (for this species it would include the entire seed head cluster) from the top to the bottom of the seed head cluster from 3-5 separate plants; calculate average for seed head size.

Amazon sprangletop (*Leptochloa panicoides*)



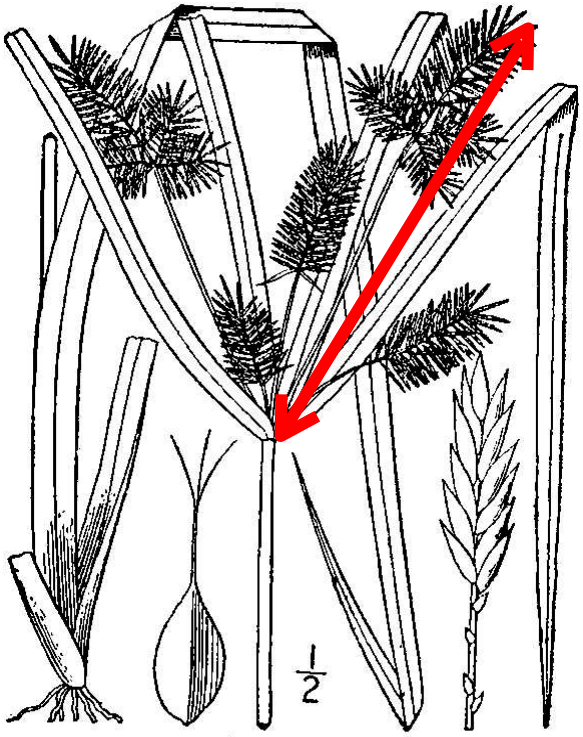
http://courses.missouristate.edu/pbtrewatha/amazon_sprangletop.htm

6-8 ” AVERAGE

Less than 6 inches **(SMALL)** Greater than 8 inches **(LARGE)**

- Measure 1-2 individual inflorescences (for this species it would include the entire seed head cluster) from the top to the bottom of the seed head cluster from 3-5 separate plants; calculate average for seed head size.

Redroot flatsedge (*Cyperus erythrorhizos*)



http://plants.usda.gov/ 4-

6” AVERAGE

Less than 4 inches **(SMALL)** Greater than 6 inches **(LARGE)**

- Measure 1-2 individual inflorescences from 3-5 separate plants; calculate average for seed head size.

Swamp Timothy, Swamp Pricklegrass (*Crypsis schoenoides* (L.) Lam.)

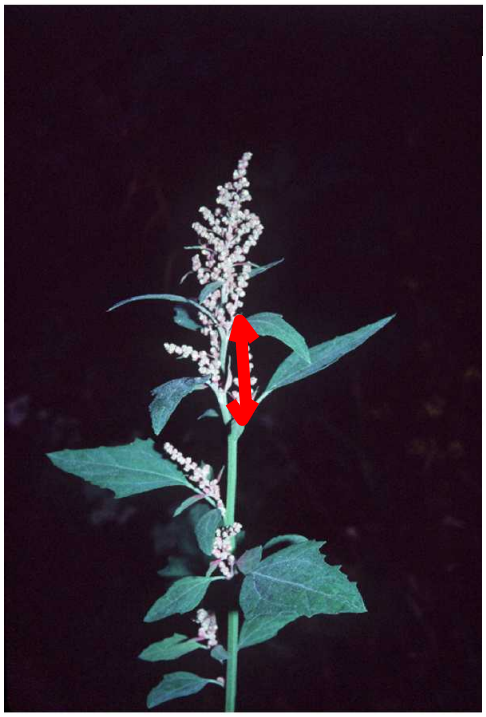
http://plants.usda.gov/

1”-1.5” (2.5-4 cm) AVERAGE

Less than 1.0 inches **(SMALL)** Greater than 1.5 inches **(LARGE)**

- Measure 1-2 individual inflorescences from 3-5 separate plants; calculate average for seed head size.

Goosefoot, Lambsquarters (*Chenopodium album)*



http://plants.usda.gov/ 2-

4” AVERAGE

Less than 2 inches **(SMALL)** Greater than 4 inches **(LARGE)**

- Measure 1-2 individual spikes from 3-5 separate plants; calculate average for seed head size.

References

Beal, EO. 1985. A manual of marsh and aquatic vascular plants of North Carolina with habitat data. The North Carolina Agricultural Research Service, Raleigh, North Carolina. Technical Bulletin 247.

Hotchkiss N. 1972. Common marsh plants of the United States and Canada. New York, New York. Dover Publications.

Martin AC, Uhler FM. 1939. Food of game ducks in the United States and Canada. U.S. Department of Agriculture, Washington, D.C. Technical Bulletin No. 634.

Naylor LW, Eadie JM, Smith WD, Eichholz M, Gray MJ. 2005. A simple method to predict seed yield in moist-soil habitats. Wildlife Society Bulletin 33:1335–1341.

USDA, NRCS. 2014. The PLANTS Database. Available: http://plants.usda.gov. (April 2014). National Plant Data Team, Greensboro, North Carolina.

Table SM-6.1. Relative waterfowl food values for selected wetland plant species.

Plant species	Co-Dominant Count	Food value	Parts Consumed	Seed head size assessment guide*
Acer rubrum	50	L	Seed	
Acer saccharinum	19	L	Seed	
Amaranthus spp.	227	M	Seed	
Ambrosia artemisiifolia	102	L	Seed	
Ammannia spp.	14	L	Seed	
Bacopa spp.	57	H	stem/leaves	
Bidens spp.	240	H	Seed	X
Brasenia schreberi	17	L	Seed	
Carex lacustris	11	M	Seed	
Carex spp.	130	M	Seed	
Cephalanthus occidentalis	239	L	Seed	
Chara spp.	11	M	stem/leaves	
Cyperus erythrorhizos	45	H	Seed	X**
Cyperus esculentus	83	H	seed/tuber	X
Cyperus spp.	60	H	Seed	X
Digitaria spp.	39	L	Seed	
Distichlis spicata	106	L	Seed	
Echinochloa crus-galli	655	H	Seed	X
Echinochloa esculenta	28	H	Seed	
Echinochloa muricata	13	H	Seed	
Echinochloa spp.	23	H	Seed	
Echinochloa walteri	58	H	Seed	X
Eleocharis parvula	63	H	Seed	
Eleocharis quadrangulata	15	H	Seed	
Eleocharis spp.	249	H	Seed	
Eragrostis spp.	12	M	Seed	
Fagopyrum esculentum	17	L	Seed	
Glycine max	86	H	Seed	
Juncus spp.	101	L	Seed	
Lachnanthes caroliniana	11	H	Seed	
Leersia oryzoides	153	H	seed/roots	X
Lemna spp.	133	M	Leaves	
Leptochloa fascicularis	47	H	Seed	
Leptochloa panicoides	11	H	Seed	X**
Ludwigia palustris	10	L	Seed	
Ludwigia spp.	159	L	Seed	
Myriophyllum spp.	22	L	stem/leaves	
Najas guadalupensis	15	H	stem/leaves	
Nelumbo lutea	87	L	Seed	

Nuphar spp.	58	L	seed	
Nymphaea odorata	83	L	seed	
Panicum dichotomiflorum	187	H	seed	X
Panicum spp.	138	H	seed	
Phalaris arundinacea	433	L	seed	
Polygonum coccineum	300	M	seed	
Polygonum hydropiperoides	125	M	seed	
Polygonum lapathifolium	130	H	seed	X
Polygonum pensylvanicum	169	H	seed	X
Polygonum punctatum	10	M	seed	
Polygonum sagittatum	11	M	seed	
Polygonum spp.	422	L	seed	
Pontederia cordata	35	M	seed	
Potamogeton pectinatus	41	H	stem/turions/leaves	
Potamogeton spp.	37	H	seed/leaves	
Rumex spp.	47	M	seed	
Ruppia maritima	44	H	stem/leaves	
Sagittaria spp.	45	M	seed	
Salicornia europaea	13	M	stem/leaves	
Salicornia spp.	36	M	stem/leaves	
Schoenoplectus fluviatilis	306	L	seed	
Schoenoplectus spp.	67	L	seed	
Scirpus americanus	81	M	seed	
Scirpus cyperinus	61	L	seed	
Scirpus robustus	110	M	seed	
Scirpus spp.	24	L	seed	
Scirpus validus	59	M	seed	
Sesbania spp.	139	L	seed	
Setaria spp.	122	H	seed	X
Sorghum vulgare	36	H	seed	
Sparganium spp.	51	M	seed	
Spartina alterniflora	213	L	seed	
Spartina cynosuroides	140	L	seed	
Spartina patens	306	L	seed	
Spartina pectinata	11	L	seed	
Typha angustifolia	10	L	tuber	
Typha spp.	1106	L	tuber	
Zea mays	258	H	seed	
Zizania aquatica	30	H	seed	
Zizania miliacea	31	H	seed	

*Plants with >50 records and High food value

⁎⁎Some selected plants with <50 records and high food value.

SM 7: Wetland Management Record

This is the standard field recording form for management activities. ONE FORM PER SURVEY UNIT (MAY BE SEVERAL PAGES PER UNIT). Either Ctrl+Click anywhere on data sheet or refer to the website for the most up-to-date data form: http://iwmmprogram.org/protocols-data-forms/

Wetland Management Record

Unit Name	Unit Code	Activity Year[1]

Log of Planned and Implemented Actions[2]: Page 1 of _____

Action Code[3]	Planned start date	Planned end date	Planned % of unit	Actual start date	Actual end date	Implemented % of unit[4]

1. Start of growing season year one through start of the growing season for year two (2014/15).
2. Create a new entry for repeated applications of an action when the interval between applications exceeds the time required for a single application.
3. See Wetland Management Action Table (Table SOP-4.1).
4. Report as surface coverage of manipulated water for water level actions.

SM 8: Updated Employee Health and Safety Guidance for Avian Influenza Surveillance and Control Activities in Wild Bird Populations, 2014.

This is document guides procedures for protecting personal while handling wild birds. Also refer to the Wildlife Health office internal website at https://sites.google.com/a/fws.gov/fws- wildlife-health/products.

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

July 17, 2014

Memorandum

To: Bureau/Office Heads
Solicitor
Inspector General

Attention: Bureau/Office Emergency Coordinators
DOI Safety Council

From: Laurence Broun
Director, Office of Emergency Management

Diane Schmitz
Director, Office of Occupational Safety and Health

Subject: *Updated Employee Health and Safety Guidance for Avian Influenza Surveillance and Control Activities in Wild Bird Populations, 2014*

This memorandum announces a revision of the guidance document, *Employee Health and Safety Guidance for Avian Influenza Surveillance and Control Activities in Wild Bird Populations*. The original guidance was developed in 2006 during interagency/intra-departmental pandemic/avian influenza planning efforts. The revised guidance reflects recent research findings and shifts in the ecology of influenza viruses.

The revised guidance provides additional information related to handling birds including the need for influenza vaccinations and anti-viral medication for DOI personnel, and the need for personal protective equipment (PPE).

In addition to providing updated guidance, this memo serves as a reminder to DOI personnel, as well as their supervisors and managers, to be mindful of the tendency to normalize risk where behaviors are accepted because they have not resulted in adverse effects to the individual in the past. Managers, supervisors and employees need to be watchful of this tendency and must implement robust management and supervisory controls to prevent this from occurring in all types of field operations.

Please distribute this guidance to the appropriate personnel in your bureaus. If you have questions regarding this document, please contact your Bureau Safety Manager of CAPT Tim Radtke, Office of Occupational Safety and Health, at (303) 236-7128 ext. 226.

Updated Employee Health and Safety Guidance for Avian Influenza Surveillance and Control Activities in Wild Bird Populations, 2014

This document provides guidance for protecting Department of the Interior (DOI) employees involved in handling wild birds. The risk of exposure to influenza viruses, and consequent safety recommendations, are dependent on the suspected presence of one or more zoonotic avian influenza viruses (strains that are infectious to humans) in wild birds in North America or the Pacific Islands. Zoonotic avian influenza outbreaks in poultry or other domestic birds may or may not present risk to wild birds or people handling wild birds. Discuss any questions or concerns with your regional Wildlife Health Office or Health and Safety Office.

I. Personal Protective Equipment (PPE)

Instruction and up-to-date information must be provided to personnel at risk of coming in contact with zoonotic avian influenza:

- while handling infected animals - trapping and handling of wild birds, euthanasia, carcass collection and disposal
- while working with contaminated objects or surfaces - cleaning and disinfection of equipment/vehicles/non-disposable PPE
- through contact with infected persons

DOI agencies are required to provide the necessary PPE to at-risk personnel. PPE use and training is done in accordance with 29 CFR 1910.132 – 134.

The table below describes conditions and general activities and the protective measures required to minimize exposure to zoonotic avian influenza. It specifies the **minimum personal protective equipment** to be used for each activity. Other PPE and safety precautions may be necessary depending on specific conditions of the worksite or the tasks.

It is important to note that the table does not attempt to cover all tasks that may be assigned to DOI personnel. High exposure tasks not anticipated in the table should be evaluated in consultation with DOI health and safety officers.

Guidance on PPE will continue to be re-evaluated as more information becomes available and as the characteristics of different avian influenza viruses are better defined.

July 2014

GUIDANCE FOR HANDLING WILD BIRDS DEPENDING ON THE CURRENT CONDITIONS:			
CONDITIONS	**ACTIVITY**	**PPE**	**WORK PRACTICE**
1.a. Zoonotic avian influenza is **not known or suspected** in wild birds within North America or the Pacific Islands.	Handling apparently healthy birds.	Follow all PPE and standard work practices recommended for normal operations at your station. Consult regional health and safety expertise regarding zoonotic disease risks in your area.	1. Wash your hands often and thoroughly for at least 30 seconds (using soap/water or alcohol-based hand sanitizer) before eating, smoking, using cell phone and touching your face, hair, or exposed skin. 2. If working indoors, work in well-ventilated areas. When working outdoors, work upwind of animals to decrease the risk of inhaling airborne particulate matter such as dust, feathers, or dander. 3. Gloves, aprons, goggles, face shields, rubber boots, and coveralls that can be easily disinfected may also be worn to prevent skin and mucous membrane contact with biological materials, and prevent movement of biological materials to other sites.
1.b. Zoonotic avian influenza is **not known or suspected** in wild birds within North America or the Pacific Islands.	Handling sick or dead birds.	Follow all PPE and standard work practices recommended for normal operations at your station. Consult regional health and safety expertise regarding zoonotic disease risks in your area.	1. Remove gloves and wash your hands often and thoroughly for at least 30 seconds (using soap/water or alcohol-based hand sanitizer) before eating, smoking, using cell phone and touching your face, hair, or exposed skin. 2. If working indoors, work in well-ventilated areas. When working outdoors, work upwind of animals to decrease the risk of inhaling airborne particulate matter such as dust, feathers, or dander. 3. Aprons, goggles, face shields, rubber boots, and coveralls that can be easily disinfected may also be worn to prevent skin and mucous membrane contact with biological materials, and prevent movement of biological materials to other sites.
2.a. Zoonotic avian influenza is **confirmed**[1] **or presumed to be present** in wild birds within North America or the Pacific Islands.	Handling, investigation, or disposal of any healthy or sick, live or dead wild birds.	• Impermeable gloves (pvc or nitrile) or heavy duty rubber work gloves • Goggles • NIOSH-approved disposable N-95 particulate respirator[2]. Workers must be fit-tested and medically cleared annually prior to wearing a respirator. • Disposable Tyvek coveralls or raingear that can be disinfected • Waders, hip-boots, rubber boots or boot covers	In addition to the work practices listed above: 1. Suppress dust at the work site using water 2. Minimize direct contact with birds and their secretions, feathers, and dander. 3. Minimize contact with carcasses when bagging birds. 4. Contact recipient laboratories prior to collection and shipping; follow their guidelines. Remove PPE in the following order: 1. Carefully remove coveralls and boot covers and discard as contaminated material if disposable. 2. Disinfect rubber boots. 3. Remove gloves and immediately wash hands thoroughly with soap and water (or an alcohol-based hand gel when soap and clean water are not available). 4. Remove eye protection and place in designated receptacle for subsequent cleaning and disinfection. 5. Remove N-95 disposable respirator and discard. 6. Immediately after all PPE has been removed, wash hands thoroughly a second time and wash face.

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2.b. Zoonotic avian influenza is **confirmed**[1] **or presumed to be present** in wild birds within North America or the Pacific Islands	Cleaning and disinfecting equipment known or suspected to be contaminated with zoonotic avian influenza	• Impermeable gloves (pvc or nitrile) or heavy duty rubber work gloves • Goggles • NIOSH-approved disposable N-95 particulate respirator[2]. Workers must be fit-tested and medically cleared annually prior to wearing a respirator. • Disposable Tyvek coveralls or raingear that can be disinfected • Waders, hip-boots, rubber boots or boot covers	In addition to the work practices listed above: 1. Clean surfaces of equipment and reusable PPE with detergent and water, then disinfect with a virucide (such as Virkon®) that kills avian influenza viruses. Follow the label instructions. 2. www.epa.gov/pesticides/factsheets/avian.htm lists registered products. If a registered product is not available, use 3/4 cup of household bleach (5.25-6.00% sodium hypochlorite) per gallon of water for hard, non-porous surfaces. 3. Avoid generating mists with water sprayers during equipment decontamination procedures. 4. Do not touch any part of exposed person (especially the face) with gloved hands. Replace torn or damaged gloves immediately. 5. Additional protection (such as aprons and face shields) may be desired during equipment decontamination to prevent contact with contaminated material. 6. If there is known exposure to body fluids of the carcass (examples: knife cut, needle stick) contact your health care professional and provide a complete history of your activities. Carefully remove PPE in the order as described above in section 2a.
Key for colored conditions sections:	Green - Low risk conditions	Orange - Medium risk conditions	Red - High risk conditions

[1] Refers to situations where the National Veterinary Services Laboratory confirmed the presence of an avian influenza virus that is pathogenic for humans in a wild bird or a presumptive diagnosis of an avian influenza virus from a wild bird found dead or moribund.

[2] Use of respirators including N-95 filtering facepiece respirators requires implementing a Respiratory Protection Program as required by the Occupational Safety and Health Administration. This includes training, fit-testing, and fit-checking to ensure appropriate respirator selection and use. To be effective, respirators must provide a proper sealing surface on the wearer's face. Detailed information on respiratory protection programs is provided at: www.osha.gov/SLTC/etools/respiratory/index.html and www.cdc.gov/niosh/topics/respirators/. Under certain high risk conditions such as handling large numbers of birds in a confined area confirmed to have the HPAI virus, it may be necessary to upgrade respiratory protection to powered air purifying respirators (PAPR) or other protection options.

Opening carcasses in the field is not recommended as this may increase the risk of disease transmission and decrease the diagnostic value of the carcass. Consult DOI health and safety officers for more guidance if this activity is necessary.

Designated protective measures should be applied for at least 30 days after the date of the last detection of zoonotic avian influenza in wild birds within North America or the Pacific Islands.

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