Integrated Waterbird Management and Monitoring (IWMM) Approach for Nonbreeding Waterbirds

Monitoring Manual

Version 10: August 2020

Northern Pintails and Northern Shovelers. Photo Credit: FWS

Contents

INTRODUCTION

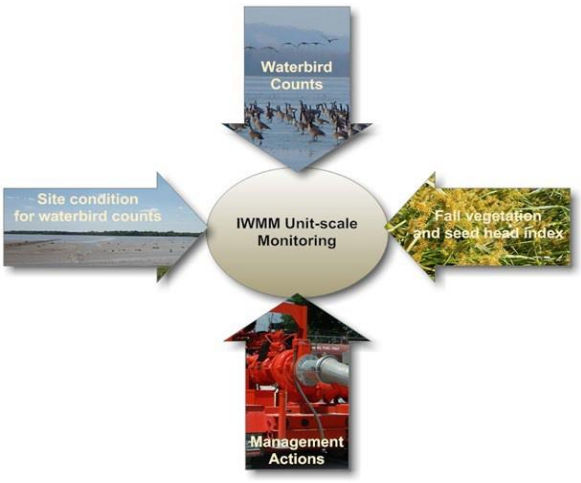
The Challenge - Sustaining healthy populations of waterbirds that migrate long distances is a major challenge for land managers. How does a manager know which species to manage for at a specific site? How important is a single site in the big picture? How can many managers coordinate their management of impoundments across the landscape so that the birds have the right amount and quality of habitat, at the right time, in the right places? As part of the IWMM approach, managers and scientists are working together to develop integrated monitoring protocols, decision support models, and a database that will inform waterbird management decisions at multiple spatial scales. These products will support clear and transparent decision making processes with respect to waterbird habitat management.

The Integrated Waterbird Management and Monitoring (IWMM) approach was initiated by conducting structured decision-making (SDM) workshops to develop 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). Through these workshops IWMM developed a multi-scaled adaptive management process that will inform local, regional/state, and flyway managers about how they can best meet the needs of migrating and wintering waterbird populations. Waterbird needs during the migration and winter phases of their life-cycle are just as critical as those during the breeding season. However,

IWMM is the only landscape scale monitoring effort developed to date that tracks and links waterbird habitat use, habitat conditions and management actions during the migration and wintering periods. The approach includes the standardized monitoring methods within this manual.

This manual provides survey techniques that can be incorporated into a wide variety of waterbird survey needs at multiple scales. (Vanausdall & Dinsmore 2019, Lishawa et al. 2020, Aagaard et al. 2017, Tapp et al. 2018). The procedures described herein involve visual assessments of whole-wetland unit habitat conditions and counts of waterbirds conducted from the perimeter of the wetland unit. A series of standard operating procedures provides greater detail on recommended methods and technical aspects of this protocol, and were used to develop a national protocol framework to guide the local monitoring component of the IWMM approach at units within the National Wildlife Refuge System. Data entry, archival, and multi-scale analysis are handled through an online database that is part of the Avian Knowledge Network.

The 2020 protocol framework is being updated to include revision contained in this manual version:



Why Monitor Waterbirds and their Habitats?

We anticipate that setting and obtaining local management objectives will require knowledge about waterbird use, setting habitat condition objectives, the ability to assess the efficacy of management actions (e.g. accounting for management costs in terms of use-days or supported populations), and / or the ability to learn how 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 numbers. Resulting data may be used to calculate wetland unit-specific waterbird use-days, document migration chronologies, and explore relationships between waterbird counts, management actions and habitat condition.

Survey Units

A survey unit is a single managed or unmanaged wetland unit. Boundaries of the unit should be fixed throughout the season and across years to ensure data comparability. See Standard Operating Procedure (SOP 1).

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.

Survey timing and schedule
Waterbird and unit condition surveys are completed weekly or biweekly during the non-breeding waterbird season. See SOP 2.

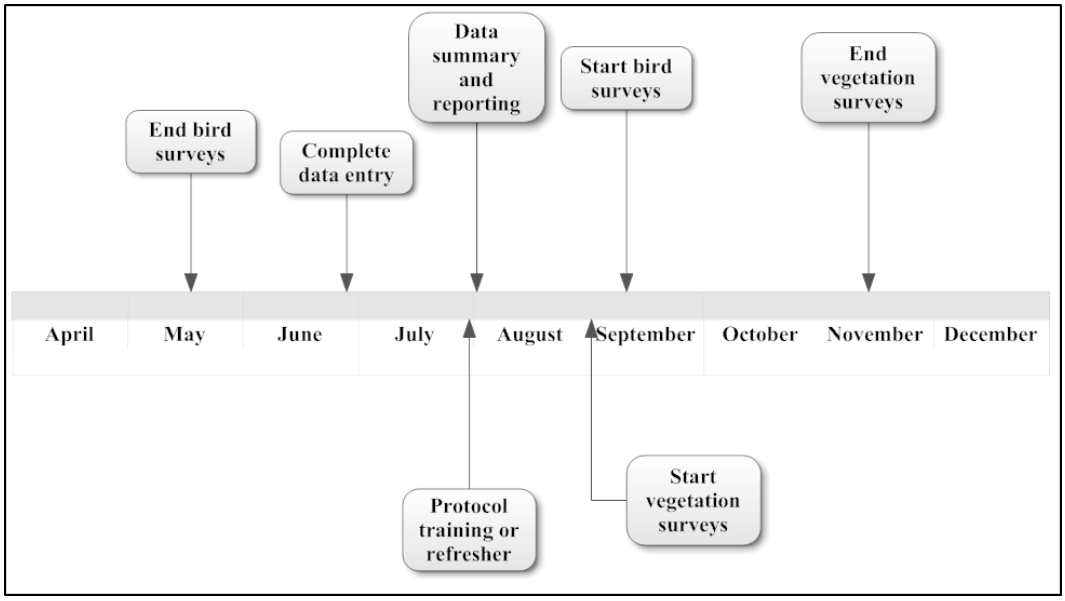


Figure 1. Generalized annual schedule for the Midwest for implementing waterfowl surveys, vegetation surveys, data entry, and reporting. Flexibility in assigning start and end dates for key tasks has been retained to facilitate customization of site-specific protocols.

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.

Vegetation surveys are completed once late in the growing season. See SOP 5.

Recording Management Actions: in addition to monitoring waterbird use and habitat response, routine short-term habitat management activities from the start of the current year's growing season to the start of the next year's growing season will be tracked for each management unit. See SOP 6.

Data Entry
Cooperators should enter collected 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 compiles bird survey, vegetation survey, and management action data. The database can also be used for managing surveys and collaboration with others. The database is available to the public. 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. More specific instructions for entering data into this database can be found in SOP 7.

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

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

Dead birds
If carcasses of waterbirds are found, follow the guidelines provided in SM 8.

Training
Cooperators should visit the IWMM website at: http://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.

In-person protocol training can be scheduled on an as-needed basis. Contact the individuals listed below for more information on arranging in-person protocol training

For More Information:

- National & Midwest - **Brian Loges**, U.S. Fish and Wildlife Service, Two Rivers National Wildlife Refuge, HC 82 Box 107 Brussels, IL. Brian_Loges@fws.gov
- National & Southeast - **John Stanton**, U.S. Fish and Wildlife Service, North Carolina Migratory Bird Field Office, 155 L.A. Keiser Drive, Suite A, Columbia, North Carolina 27925. John_Stanton@fws.gov
- Northeast - **Jennifer Casey**, U.S. Fish and Wildlife Service, North Atlantic/Applachian Region. Jennifer_Casey@fws.gov
- Southeast - **Heath Hagy** U.S. Fish and Wildlife Service, Hatchie National Wildlife Refuge. Heath_Hagy@fws.gov
- Pacific – **Jenny Barnett,** U.S. Fish and Wildlife Service, Zone I&M Biologist Mid-Columbia River NWR Complex. Jenny_Barnett@fws.gov
- Mountain Prairie Region - **Mick Hanan** U.S. Fish and Wildlife Service Lake Andes NWR Complex. Mick_Hanan@fws.gov

References:

Kevin Aagaard, James E. Lyons, Wayne E. Thogmartin, Quantifying the relative contribution of an ecological reserve to conservation objectives, Global Ecology and Conservation,Volume 9, 2017,Pages 142-147,ISSN 2351-9894, https://doi.org/10.1016/j.gecco.2017.01.002.

Coppen JL, Heglund PJ, Delehanty, Fox ST, Johnson R, Jones MT, Kenow K, Lonsdorf E, Thogmartin WE. 2007. Waterfowl migration case study from the structured decision making workshop, 25—29 March 2007, Upper Mississippi River Environmental Science Center, La Crosse, Wisconsin.

Rachel A. Vanausdall, Stephen J. Dinsmore "Habitat Associations of Migratory Waterbirds Using Restored Shallow Lakes in Iowa," Waterbirds, 42(2), 135-153, (27 June 2019).

Laskowski H, Stanton J, Lonsdorf E, Lyons J, Brown S, Coppen J, Durbian F, Jones T, Leger T, Milliken A, Seamans M, Brewer DC, Runge MC. 2008. Application of structured decision making to access multiple scale monitoring needs for waterbird management. A case study from the structured decision making workshop, January 28—February 1, 2008, National Conservation Training Center, Shepherdstown, West Virginia.

Lishawa, S.C., Dunton, E.M., Pearsall, D.R., Monks, A.M., Himmler, K.B., Carson, B.D., Loges, B. and Albert, D.A. 2020. Wetland Waterbird Food Resources Increased by Harvesting Invasive Cattails. Jour. Wild. Mgmt., 84: 1326-1337. doi:10.1002/jwmg.21912

Lor S, Casey J, Lonsdorf E, Seamans M, Anderson M, Chambers C, Chmielewski A, Granfors D, Hinds L, Holcomb K, Brewer DC, Runge MC. 2008. Habitat management for multiple wetland bird objectives on national wildlife refuges. A case study from the structured decision making workshop, 21—25 July 2008, National Conservation Training Center, Shepherdstown, West Virginia.

Lyons JE, Runge MC, Laskowski HP, Kendall WL. 2008. Monitoring in the context of structured decision-making and adaptive management. Journal of Wildlife Management 72:1683–1692.

Tapp, J.L., Weegman, M.M., Webb, E.B., Kaminski, R.M. and Davis, J.B. (2018), Waterbird communities and seed biomass in managed and reference-restored wetlands in the Mississippi Alluvial Valley. Restor Ecol, 26: 591-599. doi:10.1111/rec.12598

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 larger scale analyses by IWMM.

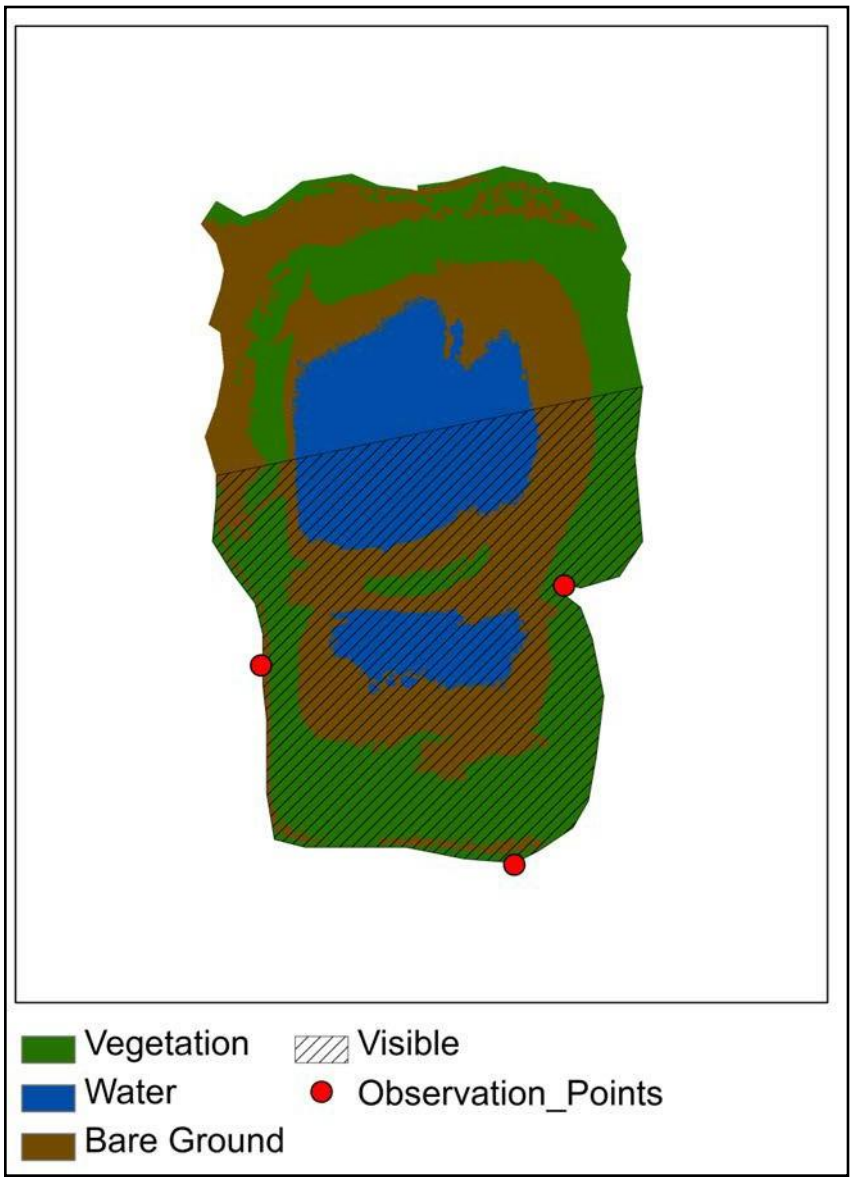


Figure SOP-1.1. Percentage of survey unit within a whole-area count. In this case, 70% of the unit falls within the whole-area count.

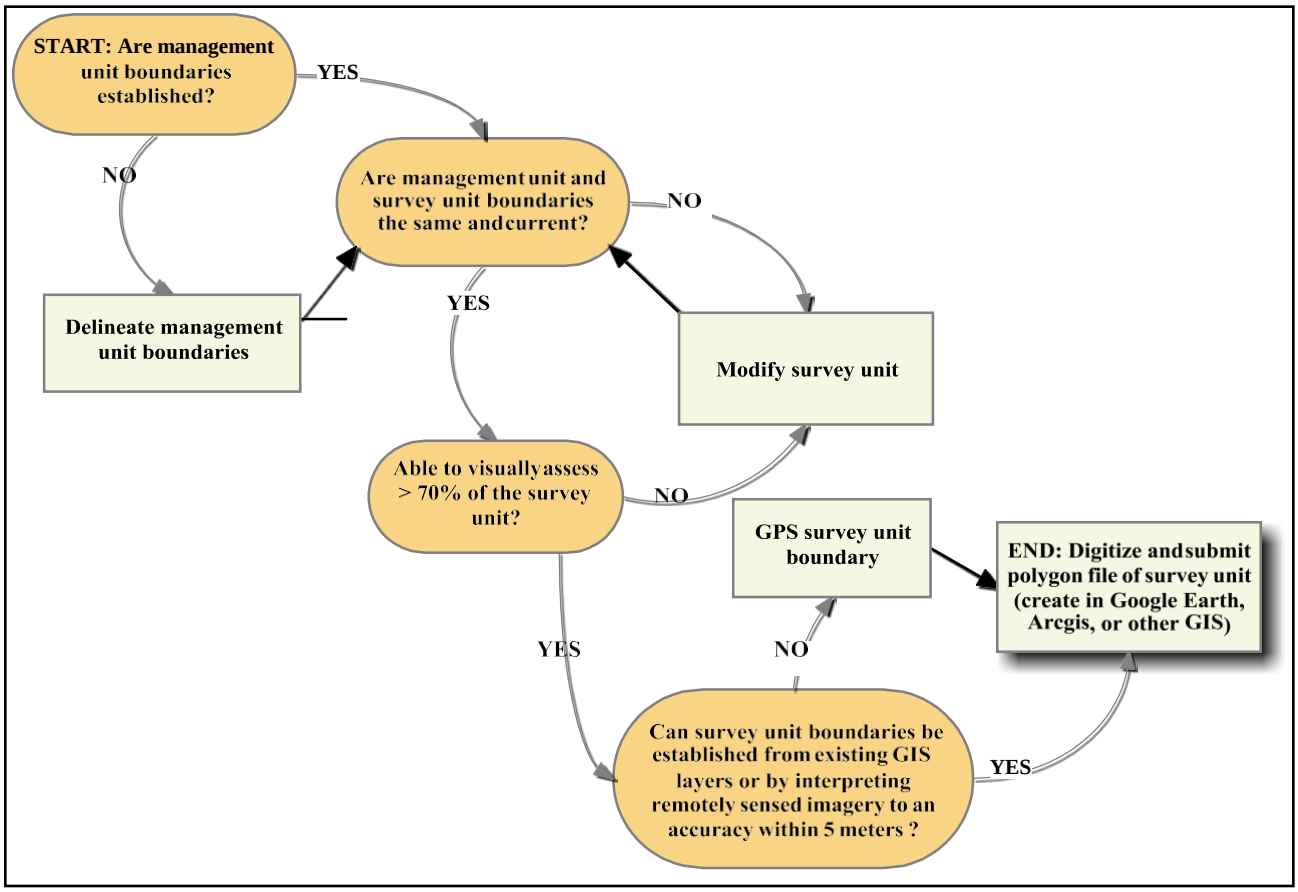


Figure SOP-1.2. Decision flowchart for creating new or modifying existing management unit into IWMM survey units.

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):

- Commercial-grade GPS receivers with WAAS enabled (to provide differential correction) should be used.
- Relatively inexpensive GPS receivers or hand-held (cell phones) devices do not provide the needed 3–16 feet meter accuracy.
- Position averaging is recommended to meet the accuracy requirement.
- Metadata should reflect estimated accuracies from field personnel during data collection activities.

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 are required to include data for measuremnts 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)**
- Habitat Cover (% cover)
- Interspersion (class)
- Disturbance severity (class)
- Disturbance source (class)
- **Chronic human disturbance (class)**

Equipment

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

Survey Schedule

Waterbird surveys should be conducted weekly or biweekly during the majority of the migration and/or wintering periods for waterfowl and shorebirds (see Element 2: Survey timing and schedule). Weekly counts have greater statistical power than those conducted on a biweekly schedule and a larger sample size reduces variability, uncertainty and risk of missing "peaks" numbers (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).

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 tidal stage on 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 at 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 should be made 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 waterfowl hunting season in some areas, it may be important to avoid conflict with hunting interests. Disturbance can be avoided by surveying from accessible points around the perimeter of wetlands, conducting an aerial survey, and by avoiding surveys when hunting activity is highest.

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, ≥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).

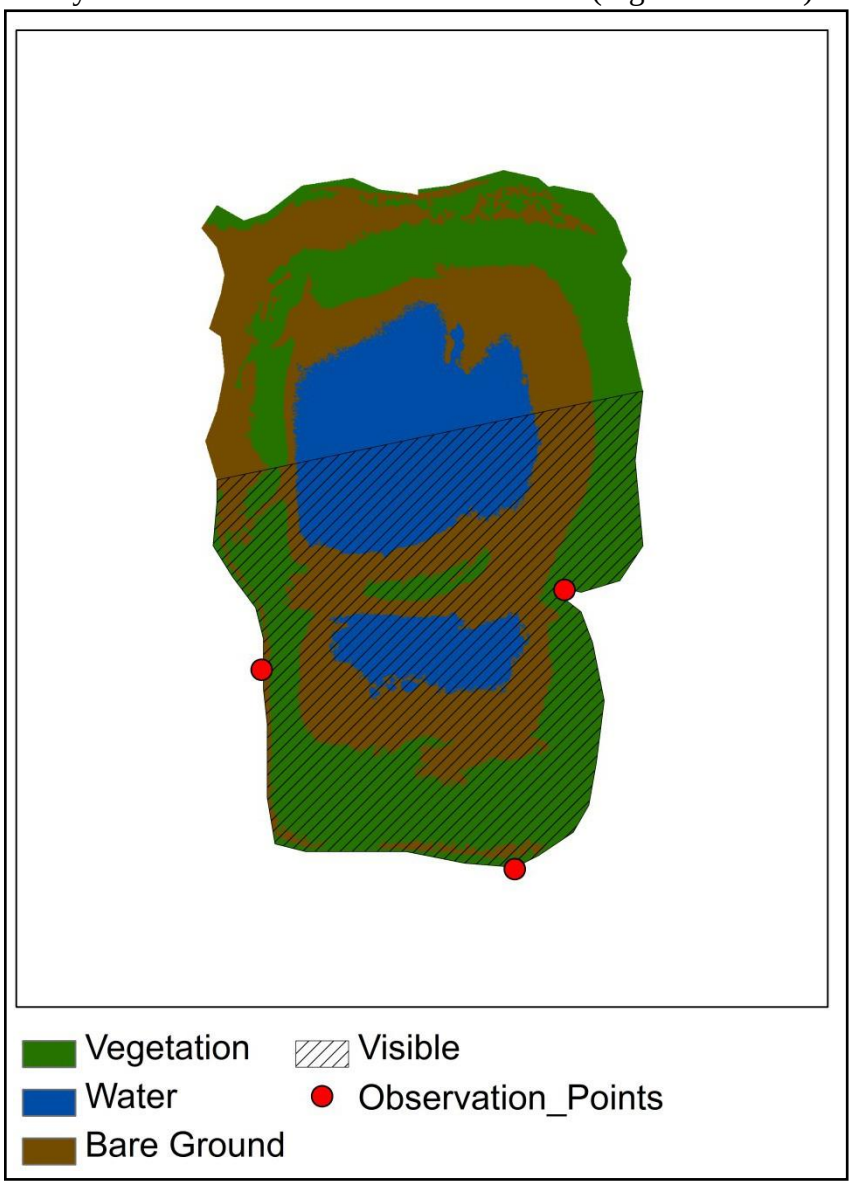


Figure SOP-2.1. Percentage of survey unit within whole-area count. In this case, 70% of the unit falls within the whole-area count.

Appropriate Weather

Surveys during inclement weather should be avoided. Whenever possible, do not survey waterbirds in fog, rain, or strong winds (Beaufort force ≥ 4). 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, if applicable, 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 four 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 four categories.

Table SOP-2.3.
Water Depth Categories

Dry
Saturated/mud to 5 cm (2 in)
5-25 cm (2-10 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 acceptable methods for estimating percent covers for water depth categories: (1) the preferred approach 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 a visual assessment or other method.

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.

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) would fall into class L as a single large patch. 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) as follows:

- 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.

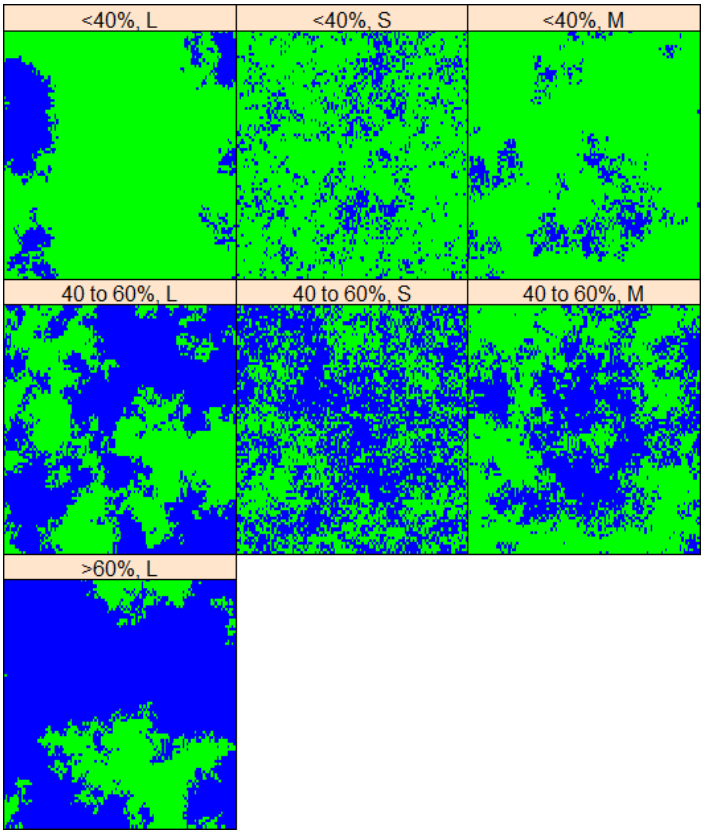


Figure SOP-2.2. Examples of three configuration categories (L; S; M). The three categories are illustrated for different levels of water/bare ground cover (<40%; 40 to 60%; >60%). Water/bare ground areas are represented in blue above whereas vegetated areas are represented in green.

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-2.4):

Table SOP-2.4. 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-2.5.

Table SOP-2.5. 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-2.6). 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-2.6. 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) may be 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, 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 all observed species should 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 site conditions (e.g., disturbance, depth, etc.), and enter this information into the IWMM database. In this case, 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 guidance in 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 100s 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 materials located at https://iwmmprogram.org/protocols-data-forms/. Additional training resources for both mobile app and database operations can be found on the IWMM Support page at https://iwmmprogram.org/support/.

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, provided that it includes the same site information as a standard ground-based whole-area count.

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 may conduct "flush counts" by intentionally disturbing birds into flight in order get more accurate estimates of waterbirds in large or densely vegetated areas. If flush counts are employed, cooperators should select "Flush Counts" in the IWMM database using the "Survey Type" dropdown box.

References

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SM 3: Waterbird Survey Form Single Unit (1 side)

ONE FORM PER SURVEY UNIT . Right-click over form then select *Acrobat Document Object>open* or 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 / Sum to 100%	Saturated to 5 cm	Shallow:5-25cm	Deep: >25 cm	% Ice	Disturbance: Severity
Habitat Cover Water/SAV / Sum to 100%	Scrub-shrub	Forest	Emergent	Bare Ground	Interspersion / Source / 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*

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.

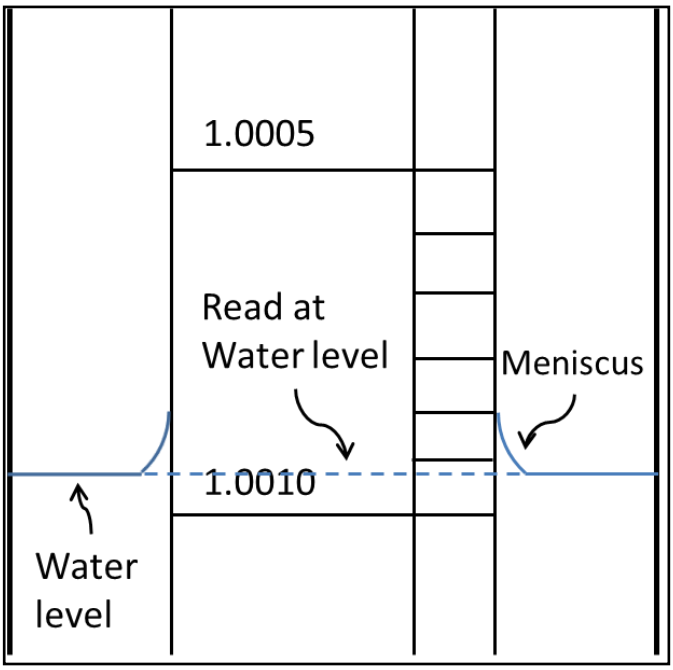

Figure SOP-3.1. Reading specific gravity from a hydrometer. Note that the reading should be taken at the water level NOT the meniscus. Redrawn from EPA (2006).

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 SOP-4.1). 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 (approx. 50 meters apart).
    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.
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).

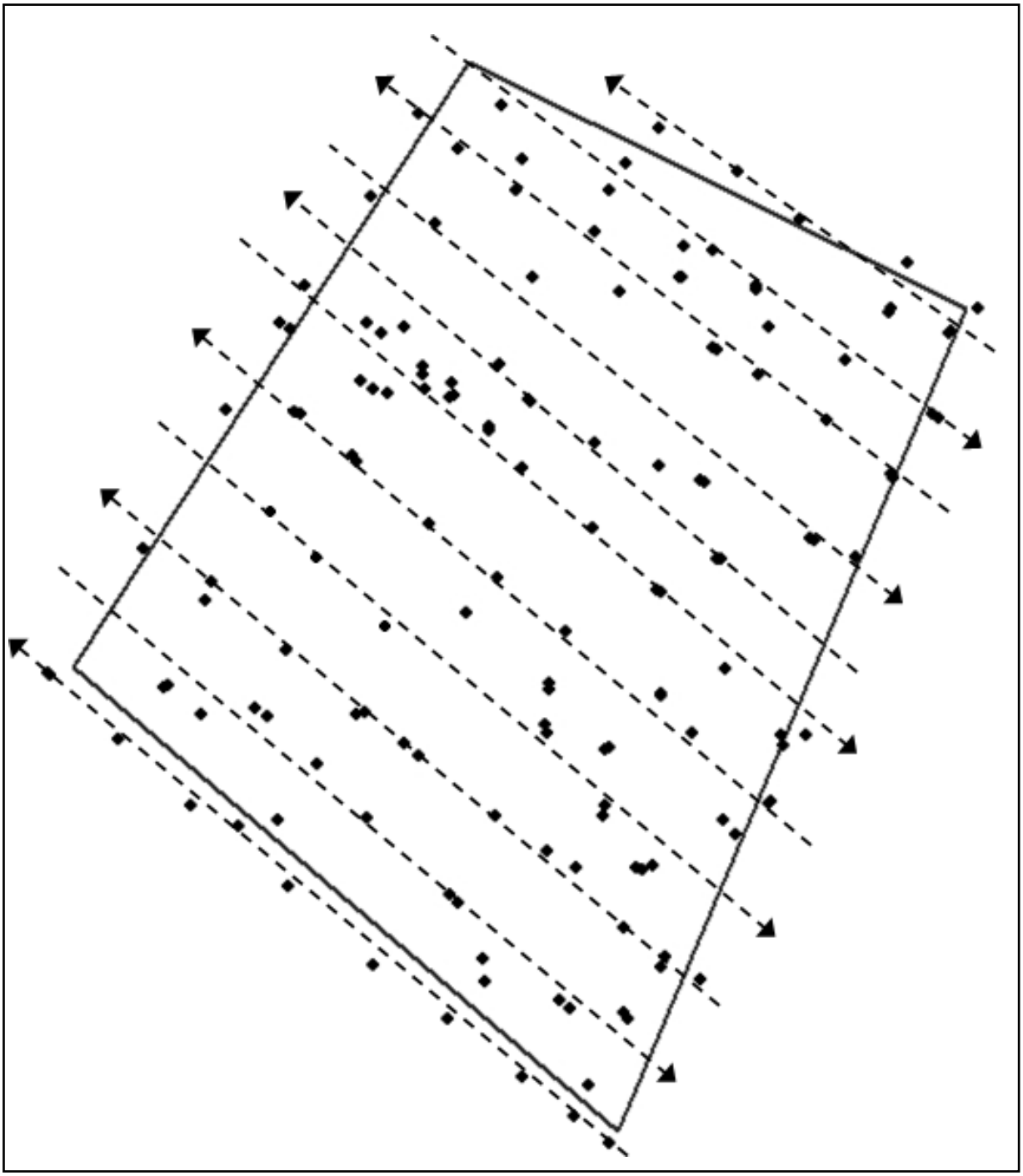

Figure SOP-4.1. Example data from bathymetry work at Prime Hook NWR, illustrating the arrangement of parallel data collection transects approximately 50 meters apart, and the collection of data points along the transects. Note that data points are not always spaced 50 meters apart; some are clustered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

References

Lyons JE, Runge, MC, Kendall WL, Laskowski H, Lor S, Talbott S. 2006. Timing of impoundment drawdowns and impact on waterbird, invertebrate, and vegetation communities within managed wetlands:.Study Manual Final Version Field Season 2006. USGS-Refuge Cooperative Research Program. Laurel, Maryland.

Los Huertos M, Smith D. 2013. Wetland Bathymetry and Mapping. Pages 49–86 in Anderson JT, Davis CA, editors. Wetland Techniques: Foundations. Volume 1. Secaucus, New Jersey: Springer.

SOP 5: Annual Vegetation and Productivity Survey

Follow these instructions for preparing and conducting yearly vegetation surveys and assessing annual productivity of each unit. The associated field data sheet is in Supplemental Materials 7.

Equipment
-Map of the project and unit boundaries
-Annual Vegetation Survey Form (See Supplemental Materials 4)
-Seed Head Photographic Guide in areas where annual emergent vegetation (i.e., moist-soil) is present (Supplemental Materials 5)
-Plastic bags or plant press, camera, and cell phone/tablet with ID app (e.g., iNaturtalist) for species identification (optional)

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 latitude and elevation). In moist-soil wetlands, surveys should be completed once seed heads have matured but prior to seed head shattering for species included in the Seed Production Index.

Percent of Unit with Vegetation (required)
The proportion of the unit covered by vegetation (include SAV) should be visually estimated. Exclude areas where vegetation is thin, covering less than 30% of substrate, the balance being: bare ground, water without floating-leaved or submersed vegetation, or plant litter (Cowardin 1979). For example, a recently disked area with scattered living plants covering only 5% of the area should be assessed entirely as non-vegetated. Litter includes vegetation killed by herbicide application. Mowed or harvested areas should be assessed as vegetated when the minimum threshold is met for living plants 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 table SOP5.1 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 Appendix SOP5.1. HRT 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 subdominant inclusions 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 below. Custom energy values, if known for a unit, may be entered optionally to replace the default values.

Table SOP-5.1.
Habitat Resource Types and guidelines for assigning waterfowl energetic quality scores.

Resource Category	Habitat Resource Type	Definition	Energetic Quality in Waterfowl Energy Days (WED)		
			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., Juncas 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., *Echinocloa* 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 occuring 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	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

Plant community composition/species assessment (optional)

Plant community composition is assessed by estimating the canopy cover of individual plant species within the **vegetated portion of the survey unit** (i.e., across all HRTs with vegetation). 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 cover (emergent, floating leaved, or submersed) within the survey unit and (2) species inventory and species-specific percent cover assessments within the areas of vegetation.

Observers 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 observer is confident they have identified all vegetation patches, they should estimate and record the percent of the survey unit covered by vegetation. Percent cover is defined as a canopy cover measurement being the percentage of the survey unit covered by vertical projections from the outermost perimeter of plants' foliage (Anderson 1986) (Figure SOP- 5.1). Again, for this metric, percent cover assessments should exclusively consider vegetation from the current season's growth.

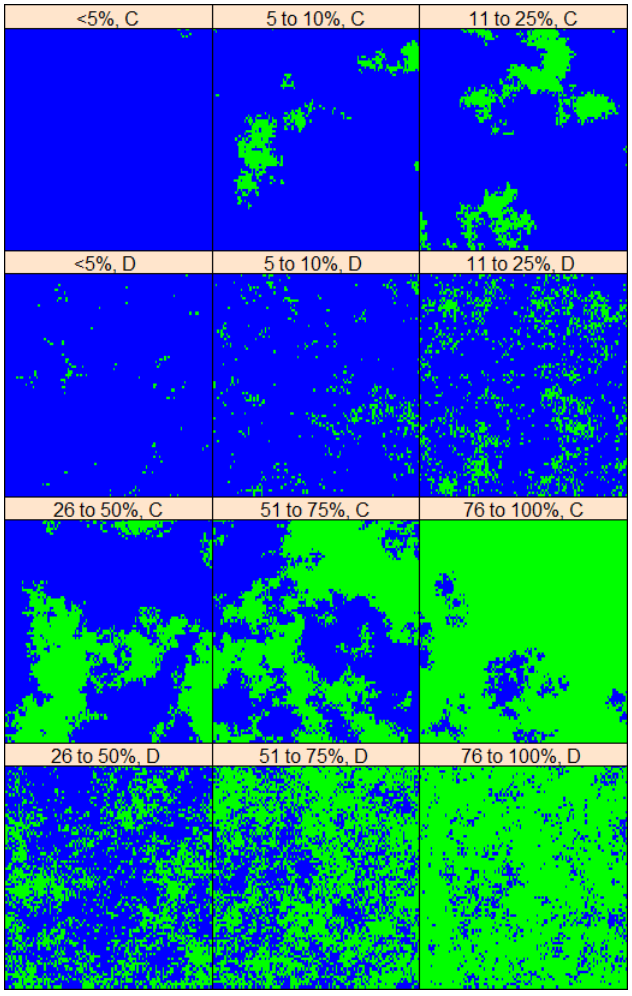

Figure SOP-5.1. Different levels of vegetation cover (green patches). Panels labeled with a "C" show clumped patches of vegetation and water whereas those with a "D" show dispersed or spread out patches.

For a single composite representing all areas of emergent vegetation, cooperators may 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 wetland vegetation area within a survey unit; report 100% as the estimate.
- Cover should be estimated only for 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 (optional)

For the moist-soil species listed in SM 6: Seed Head Assessment Guide for Selected Wetland Plants with Food Value to Waterfowl, choose a category for seed-head size and density for each species (Naylor et al. 2005).

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. Use the "Not Assessed" category for species that have deteriorated seed heads at the time of assessment or difficult to assess seed heads.

We provide a photographic guide to assist you in making seed head size assessments (see Supplemental Materials 6). The guide includes many common waterfowl food sources but may exclude some regionally important species. If you encounter a species that is energetically important and not listed in the photographic guide, please email one of the regional contacts to suggest the species as an addition to the guide.

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

- The density of stems for a species (i.e., thick or thin stands)
- 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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Appendix SOP5.1. Crosswalk of Natural Habitat Resource Types to the National Vegetation Classification Standard (NVCS) and National Wetland Classification System.

Resource Category	**Habitat Resource Type**	**Definition**	**NVCS**	**National Wetland Classification System, Class:**
Natural Wetlands	Forested/Scrub-Shrub	Forested and scrub-shrub wetlands where water will be present at some point during the non-breeding season for waterfowl	All Forest and woodland, class 1, alliances and Shrub and herb wetlands, Class 2.C , alliances that are dominated by woody vegetation	All systems: Scrub-shrub & Forested wetlands
	Early Successional Freshwater Emergent (moist-soil)	Areas of primarily nonpersistent annual emergent vegetation (e.g., *Echinochloa* sp., *Panicum* sp.)	All annual dominated alliances within the Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland Formation (2.C.4).	Lacustrine & Palustrine: Unconsolidated shore & some emergent wetland (subclass nonpersistent)
	Freshwater Emergent	Areas of primarily persistent emergent vegetation (e.g., *Typha* sp., *Zizaniopsis* sp.)	All perennial dominated alliances except shrublands within Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland Formation (2.C.4).	Lacustrine & Palustrine: emergent wetland (subclass persistent)
	Brackish/Saline 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 / SAV	Lake, pond, reservoir or other area of permanently flooded and deep (> 3 ft mean depth) 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	Streambed, Rocky Shore, Unconsolidated shore, rock bottom

SM 5: Annual Vegetation Survey Form

Right-click over form then *Acrobat Document Object* to open 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	Notes:
% Unit w/vegetation[a]		

Habitat Resource Type

Natural	% Unit[b]	Energetic Quality	Crop	% Unit[b]	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*	Other nonwaterfowl habitat		NA

Plant community composition[c]		Seed Head Assessment for select moist-soil species[c]						
Species	% cover[c]	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 portion of entire survey unit with veg, total ≤100% . **b.** Habitat Resource Types cover should sum to 100%.

c. % cover for individual plant taxa. Estimate as a canopy cover percentage of each species within the vegetated area only. Exclude bare ground & water portions of the unit lacking vegetation; percent cover total across species may exceed 100%. 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

SOP 6: Recording Management Actions

Follow these instructions for recording management actions for each unit surveyed. An 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. Infrequent management activities involving major modifications or infrastructure development are excluded.

1. Create a wetland management activities record (Supplemental Materials 9) for each unit that documents individual treatment actions as listed 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 as necessary to maintain effective treatment (e.g. mowing). Record the geographic extent (footprint as the proportion of a management unit) for each entry. Total percent manipulated may exceed 100% since applications may overlap.

3. Cooperators should enter management action records 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.

% of Unit Treated (required) – Out of the total unit extent (100%). Important to understand treatment costs and effectiveness within and across units.

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 treatment method — Use of herbicides, insecticides, fungicides, or fertilizers to manage vegetation not related to crop production.

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

Mechanical treatment — Managing soil, herbaceous vegetation, or light woody vegetation (<4.5" DBH) with mechanized equipment. Action includes common agricultural tillage practices and mowing not related to the production of a crop in the current year.

Woody removal — cutting/removal of large diameter woody vegetation (>4.5" DBH) with tree shear, mulcher, excavator, or other means.

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

Restoration — Establishment of non-crop herbaceous, aquatic, or woody vegetation.

Water level management — 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.

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).

Table SOP-6.1 Wetland Management Actions.

Strategy group	Strategy	unit	unit cost	cost class
agriculture	aerial seeding-ag	acre	$9	low
agriculture	buckwheat	acre	$74	low
agriculture	conventional corn	acre	$312	mod
agriculture	conventional rice	acre	$469	high
agriculture	dirty rice	acre	$234	mod
agriculture	grain harvest	acre	$28	low
agriculture	grain sorghum	acre	$253	mod
agriculture	grassy corn	acre	$160	mod
agriculture	irrigation	acre	$100	low
agriculture	millet (cultivars)	acre	$73	low
agriculture	other crop	acre	~	~
agriculture	post-harvest mowing	acre	$15	low
agriculture	soybeans	acre	$148	mod
agriculture	wheat	acre	$177	mod
Chemical application	Specialty chemical (excludes application)	acre	$19	low
Chemical application	Common chemical (excludes application)	acre	$12	low
Chemical application	aerial boom (excludes chemical)	acre	$16	low
Chemical application	aerial spray (excludes chemical)	acre	$20	low
Chemical application	basal bark, low	acre	$242	mod
Chemical application	broadcast	acre	$242	mod
Chemical application	chemical injection, low	acre	$242	mod
Chemical application	cut stump, low	acre	$242	mod
Chemical application	foliar spray, low	acre	$83	low
Chemical application	foliar spray, high	acre	$383	high
Chemical application	hack and squirt, low	acre	$31	low
Chemical application	herbaceous weed control high density	acre	$707	high
Chemical application	herbaceous weed control low density	acre	$54	low
Chemical application	herbaceous weed control mod density	acre	$212	mod
Chemical application	Dry-flowable spreader (excludes chem./fertilizer)	acre	$9	low

Chemical application	Fertilizer (excludes application)	acre	$340	high
Chemical application	lime	acre	$23	low
Chemical application	Liquid soil injection (excludes chemical)	acre	$14	low
Chemical application	spot spray	acre	$54	Low
Fire-Prescribed	prescribed burn	acre	$27	low
mechanical	backhoe excavation of macrophytes	acre	$2,142	high
mechanical	chisel	acre	$15	low
mechanical	conventional tillage	acre	$13	low
mechanical	floating mechanical shredder (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	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	amphibious mechanical shredder	acre	$982	high
mechanical	Floating (aquaplant) harvester	acre	$9,130	high
mechanical	biomass harvester	acre	$982	high
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
mechanical woody	feller buncher intermittent head	acre	$324	mod
mechanical woody	hydro-axe	acre	$324	
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 pumped (3000-18,000 gpm electric)	acre-foot	8	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	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	active flood up pumped (3000-18,000 gpm electric)	acre-foot	8	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)	acre-foot	$6	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 (3000-18,000 gpm electric)	acre-foot	8	low

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SM 7: Wetland Management Record
This is the standard field data collection form for management activities. ONE FORM PER SURVEY UNIT (MAY BE SEVERAL PAGES PER UNIT). Refer to the IWMM website for the most up-to-date data form: http://iwmmprogram.org

Wetland Management Record

Unit Name	*Unit Code*	*Activity Year*[1]

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

Action [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 (e.g. 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 Habitat Management Action Table (Table SOP-6.1).
4. Report as surface coverage of manipulated water for water level actions.

SOP 7: Data Entry and Management Instructions

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 setup as an AKN project, the first step is to contact your regional contact for IWMM or IWMM project coordinator to have the project created in the database. 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.

Terminology

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

- **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.

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.

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. Once reviewed and corrected, 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

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 right 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/) to the IWMM data management portal and log in to the data entry website 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 the user's manual for the database).

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.

SOP 8: Data Entry using the IWMM Mobile App (IMA)

This SOP provides instruction for participants to set up and use IMA to collect and enter bird count and site condition directly into AKN via Survey123 and ArcGIS online (AGOL). This is the same information contained in the Quick Start Guide for IMA.

ArcGIS Online (AGOL) Sign Up

Follow the steps below to Sign up for a new account if you do not already have one.

FWS Staff (i.e., @fws.gov email) Only

1. On your computer, go to http://fws.maps.arcgis.com/home/.

2. Select "Sign In" in the upper right-hand corner.

3. Select "U.S. Fish and Wildlife Service Account" option. You will automatically be logged into AGOL using single sign-on (SAML).

    - Your user name is your FWS email address with "_fws" tagged onto the end (e.g., robert_fenwick@fws.gov_fws).

    - Your password is your FWS active directory password.

Important! - Once you have logged in for the first time, please email susan_wahl@fws.gov to be added to the IWMM ArcGIS Online group. This will grant access to download the IMA 2.0 – Waterbird & Unit Condition Survey in Survey123. This step will only take a few minutes in most cases.

Survey123

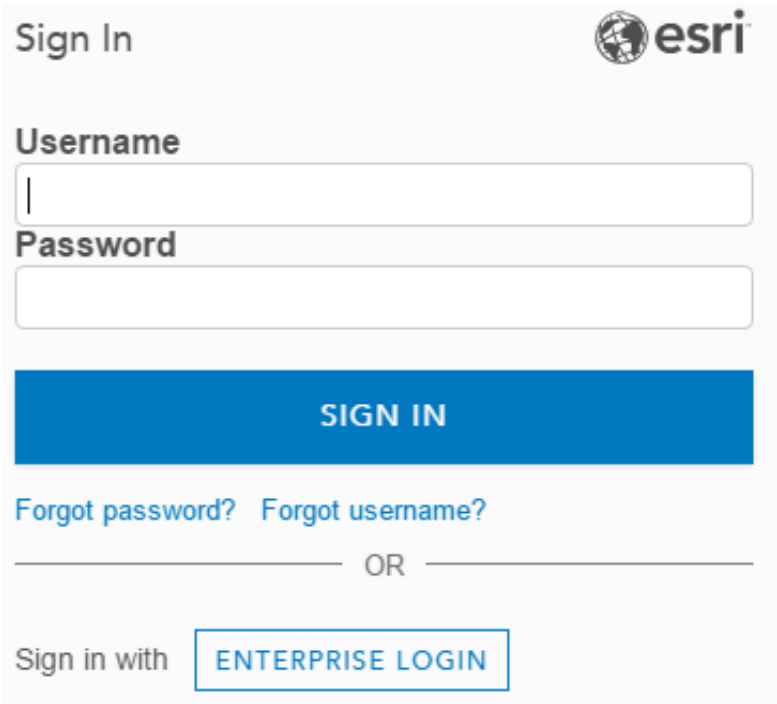
The Survey123 application by ESRI is used to digitally record data collected in the field. Users must download a local copy of the IMA 2.0 – Waterbird and Unit Condition Survey while they have either WiFi or mobile data, fill out the survey on the iPad while in the field, and then submit the information once they again have an internet connection.

The Survey123 app can be downloaded from the Apple App Store on your tablet. For more information on Survey123, please visit http://doc.arcgis.com/en/survey123/.

Download Surveys to tablet—

1. Open the Survey123 application on a mobile tablet while connected to Wifi or mobile data.

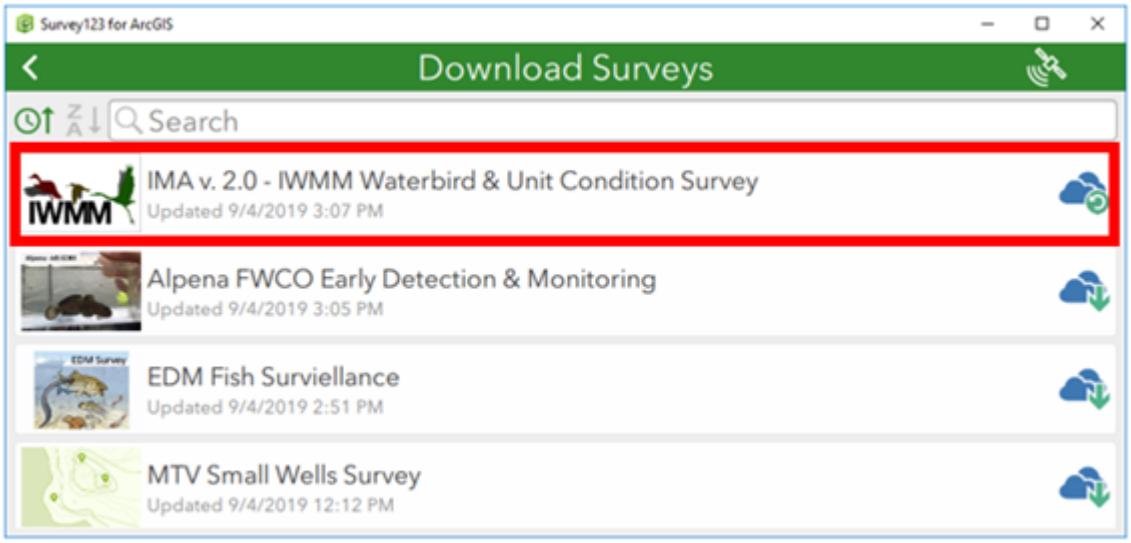
2. You will be asked to sign in to ArcGIS Online (AGOL).



   a. Click on **'Enterprise Login'** at the bottom of the window
   b. Type 'fws' into the text box and select 'CONTINUE'
   c. Select 'U.S. Fish and Wildlife Service'
   d. Enter your active directory credentials (full email address and AD password)

3. Access downloadable surveys either by clicking on the 'Get Surveys Now' button (This will only show up if no other surveys have been downloaded on your device), or by clicking the three lines in the top right of the screen, then "Download Surveys'.

4. Select IMA 2.0 to download from options available in the **Download Surveys** window by tapping on the **Download** icon . Choosing the Refresh icon on an already downloaded survey will replace the locally-saved survey with the latest update.

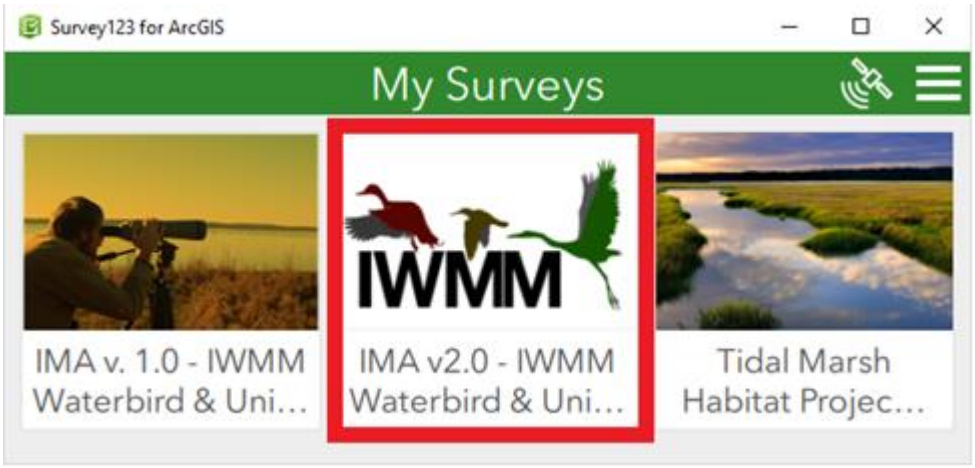


Important! - A project must already exist or be created in the AKN database to give your survey data a place "to land" upon upload. Check the Data Catalog to see if a project for your station already exists. If no project is found, use the new project form to submit your request to the IWMM database administrator who will create your project, assign a project code, and notify you when the process is complete.

Complete and Submit Surveys—

1. Select the back arrow to return to the **My Surveys** gallery on the device.

2. Select IMA 2.0 – Waterbird & Unit Condition Survey to open it.



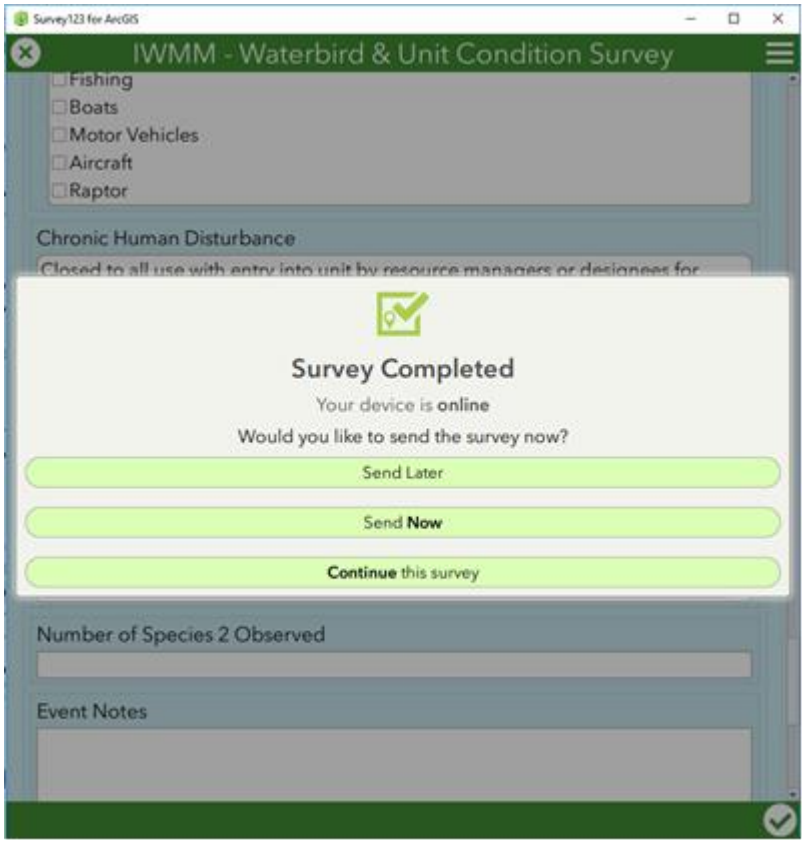
3. Tap on **Collect** to start entering information into the survey. Because the survey has been downloaded onto the device, data can be collected while offline.

4. Select your project and sampling unit(s) to complete the survey according to the IWMM protocol. Additional guidance can be found in ServCat HERE. Please see the Data Formatting Instructions for additional guidance.

5. Once data collection is complete, proceed to the record summary on the third page of the form to review and edit entries as necessary.
6. Following review, submit the survey by tapping on the check mark in the lower right-hand corner of the application (see next page).

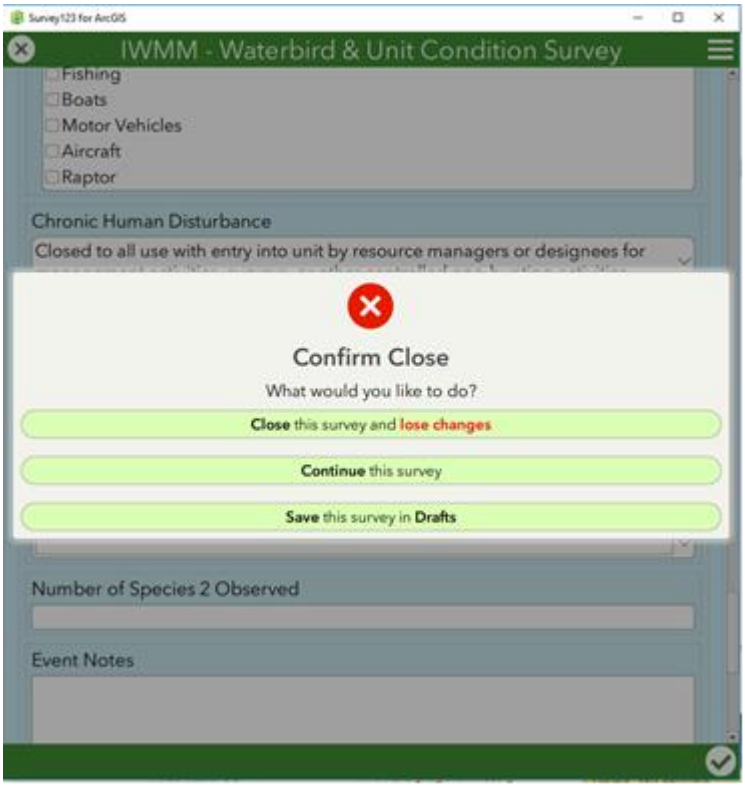
- Select **Send Later** if the survey is not complete or if there is no WiFi or cellular service. This survey will remain in the **Outbox** until manually submitted by the user (no automatic submission).

- Select **Send Now** to submit the survey to AGOL if you have an active WiFi connection..

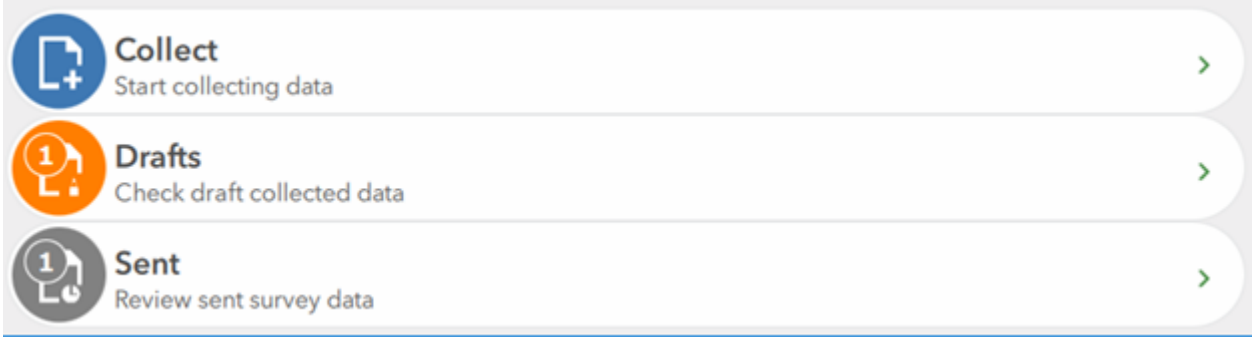


Exit and Save a Draft Survey—

1. While collecting data with a survey open, tap the "X" at the top left of the survey screen. This will prompt you to select one of the three options below:



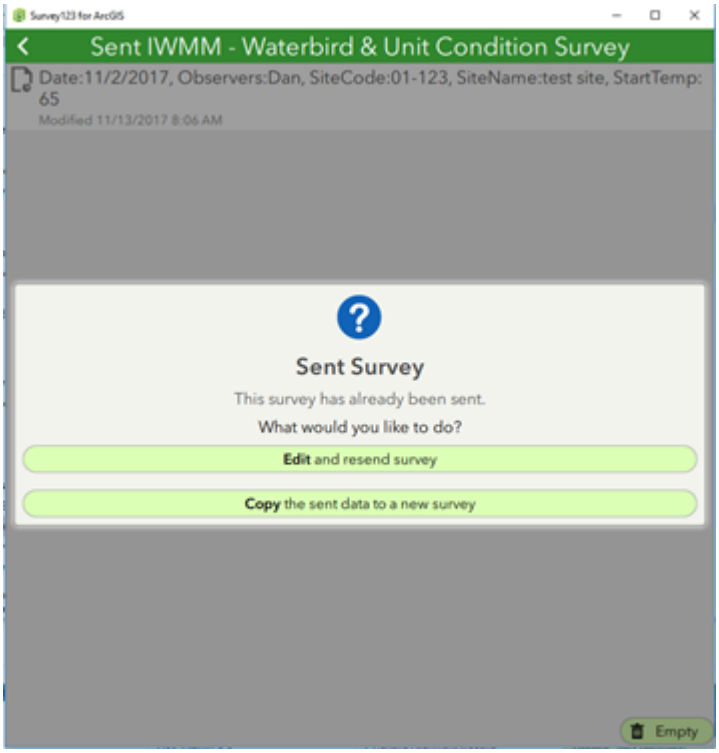
2. If a Draft is saved, you will be able to access and continue this survey at a later time from the "Drafts" box on the home screen:



View and/or Clone Previously Submitted Surveys—

1. You can view and even clone submitted surveys on your iPad through your Sent box.

2. You will see a list of all of the surveys that have previously been submitted under your user name on this device. Tapping a survey will open the options below. Choose the "Edit" option to review survey information.



Note: Survey edits are best accomplished in the app PRIOR to submitting the survey. The record summary on page 3 of the form provides the ability to quickly review your data for errors prior to sending. **Records should be as complete and correct as possible prior to transmission.** Once data has arrived in AKN, the last step in the survey process is to use the IWMM portal to conduct a final review of the data, make any final edits, and then promote the data to the desired sharing level.

3. For cloning, choose a survey to clone, and select "Copy the sent data to a new survey". Please note that ALL fields in the cloned survey will already be populated, so review and edit each field carefully before submitting as a new survey.

Data transfer to Point Blue —

Data submitted using the app goes first to ArcGIS online (AGOL). Survey data must then undergo a transfer process in order to populate in the AKN data management system. An API has been developed to automate this process and render survey data sent from the app every 24 hours.

Sharing Data with other Users—

Important! - Survey data will be submitted to the AKN at a sharing level of 'Raw'. You are **REQUIRED** to access your data via the IWMM database portal to review and promote your data to the proper sharing levels. See the Help guide for information about this process.

While it is recommended that data be promoted to sharing Level 5, at a minimum all data must be promoted to sharing Level 2 in order to contribute to regional and national analysis (see SOP 7 for details). Proper data sharing is necessary to support regional management actions and overall health of waterbird populations, and more information on IWMM's sharing policy can be found on the IWMM program website: http://iwmmprogram.org/protocols-data-forms/.

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 Cinnamon 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*

AOU Species Codes in Family Order		
common name	code*	species
Sanderling	SAND	*Calidris alba*
Dunlin	DUNL	*Calidris alpina*
Rock Sandpiper	ROSA	*Calidris ptilocnemis*
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*	~

AOU Species Codes in Family Order		
common name	code*	species
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*
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*
Unidientified 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*

AOU Species Codes in Alphabetical Order		
common name	code*	species
Eared Grebe	EAGR	*Podiceps nigricollis*
Elegant Tern	ELTE	*Thalasseus elegans*
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*

AOU Species Codes in Alphabetical Order		
common name	code*	species
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*
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 Cinammon 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*	~

AOU Species Codes in Alphabetical Order		
common name	code*	species
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*	~
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*	~
Unidientified 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 6: Seed Head Assessment Guide for Selected Wetland Plants with Food Value to Waterfowl

(2005). Naylor et al. (2005) evaluated 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

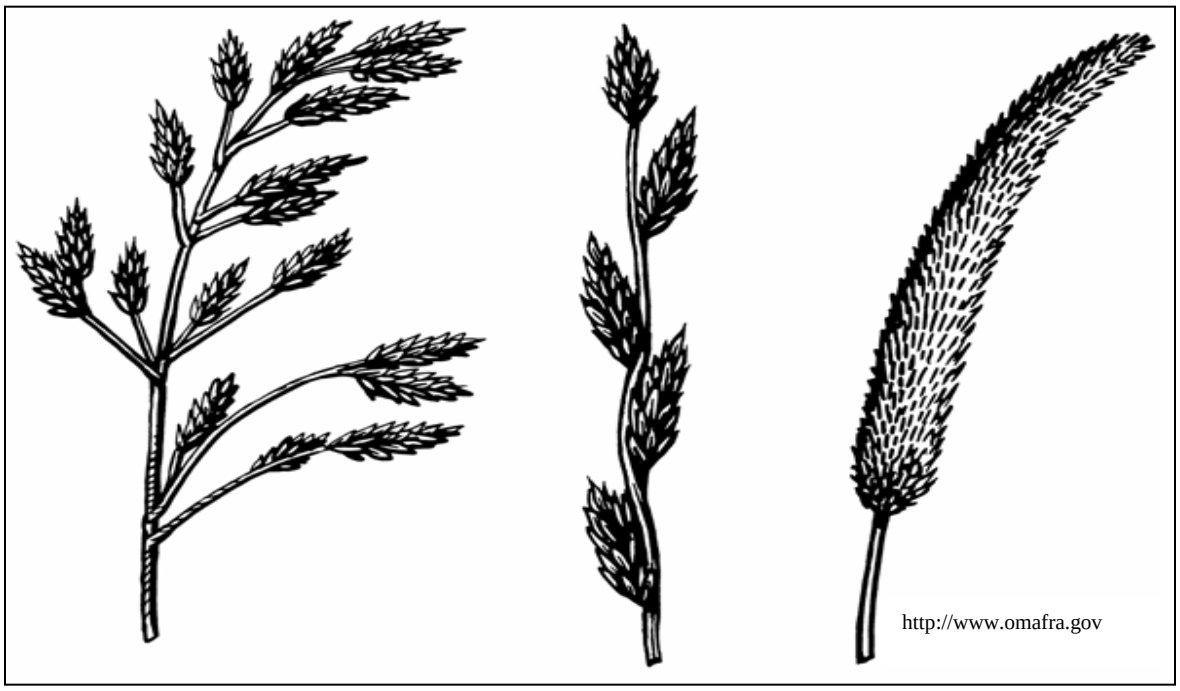
Seed head size—Seed head size categorization was plant-type specific and based on the deviation of the average size of inflorescences (for each plant species) within a wetland from that of the observed average size throughout a managed wetland (Naylor et al. 2005). For all the selected species in this 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.

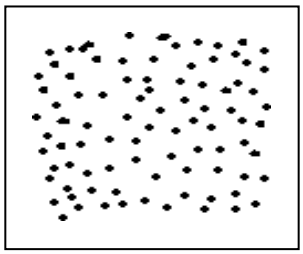
Panicle (e.g. fall panicgrass) Spike (e.g. smartweed) Spike-like panicle (e.g. foxtail)



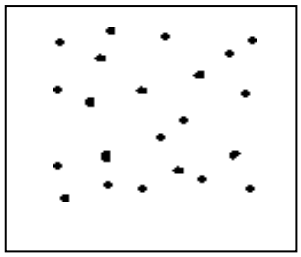
Seed head density—Seed head density should be assigned to ordinal categories by visually assessing the relative abundance of seed heads within a patch of each plant species. In the field, visually assess seed head density based on two considerations: (1) the density of stems for a species; (2) the proportion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

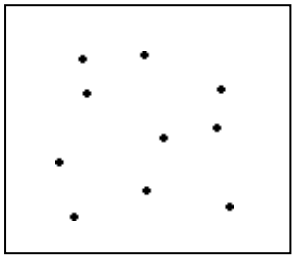
Stem Density—High stem density is assigned to areas with little bare ground, open water, or other plant species and a high proportion of seed heads to stems. Low seed head density is characterized by large areas of bare ground, open water, or other plant species and a low proportion of seed heads to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



High seed head density



Moderate seed head density

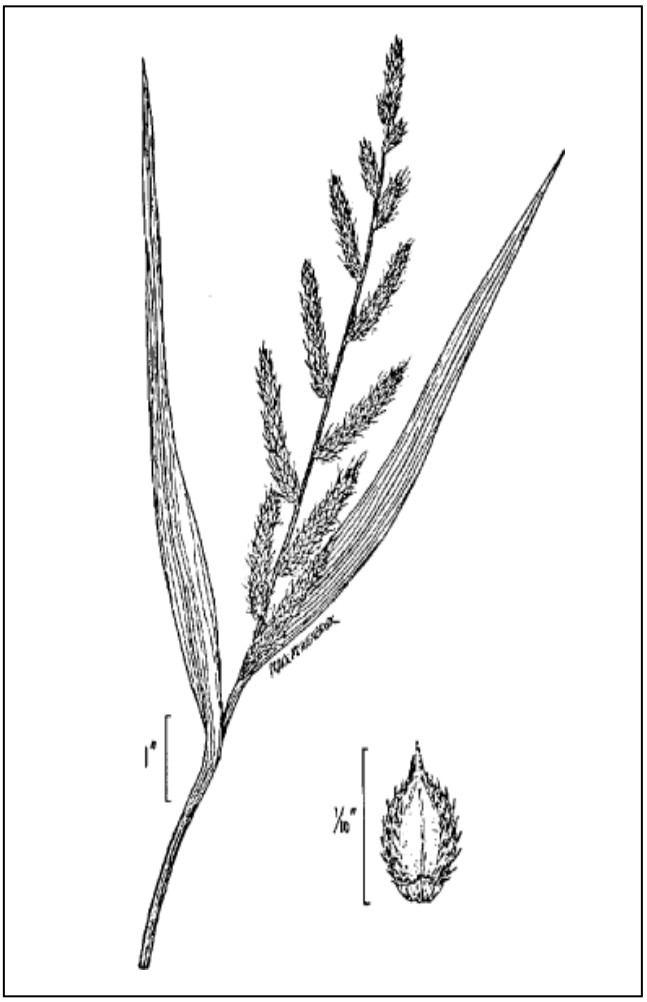


Low seed head density

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

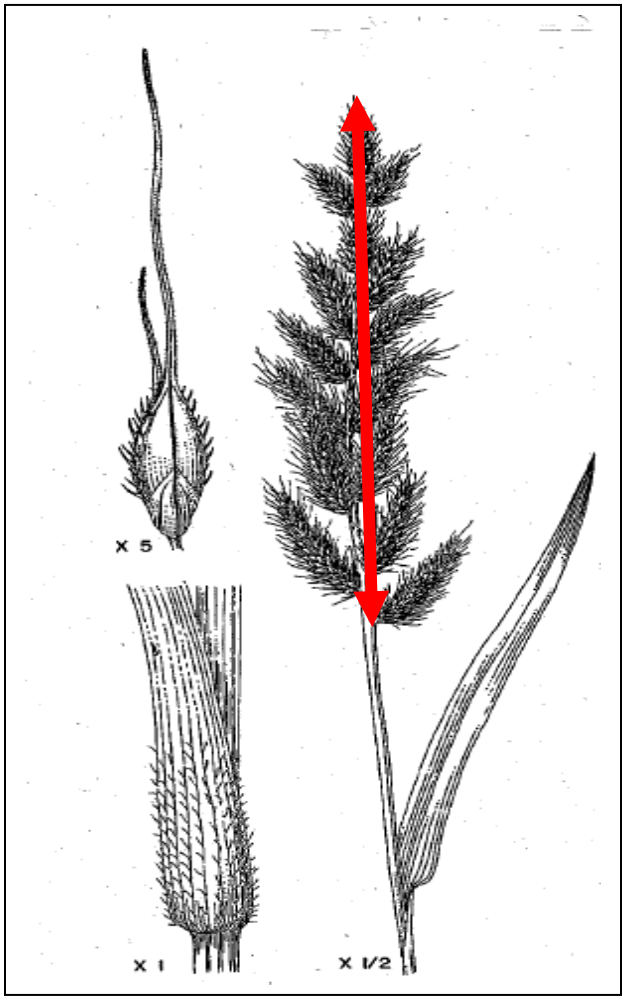
Less than 4 inches **(SMALL)**

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 (*Echinochloa walteri*)

USFWS



Martin and Uhler

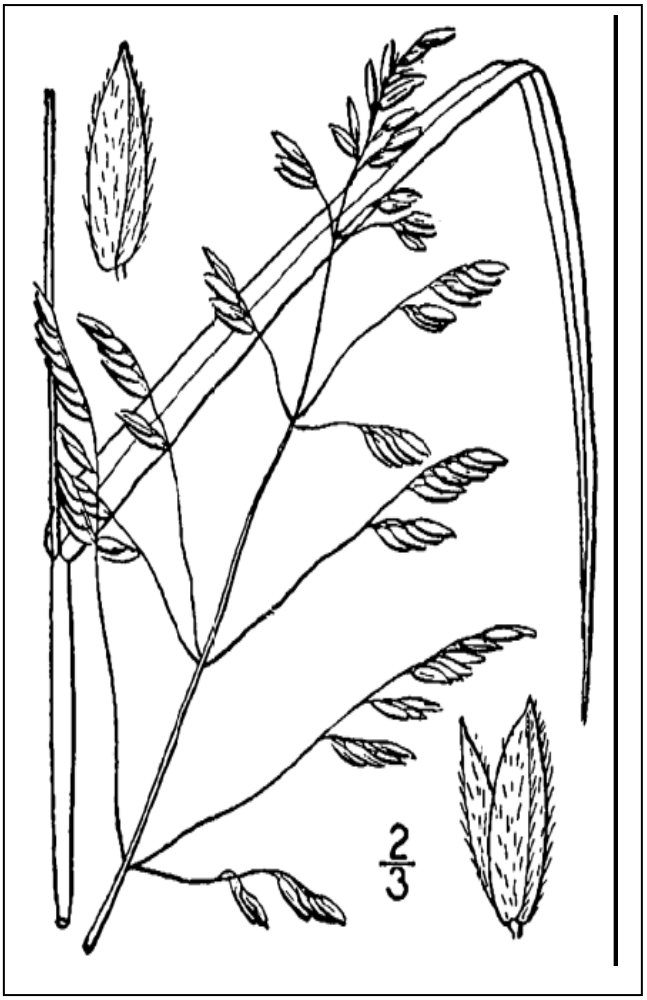
6-10" AVERAGE

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

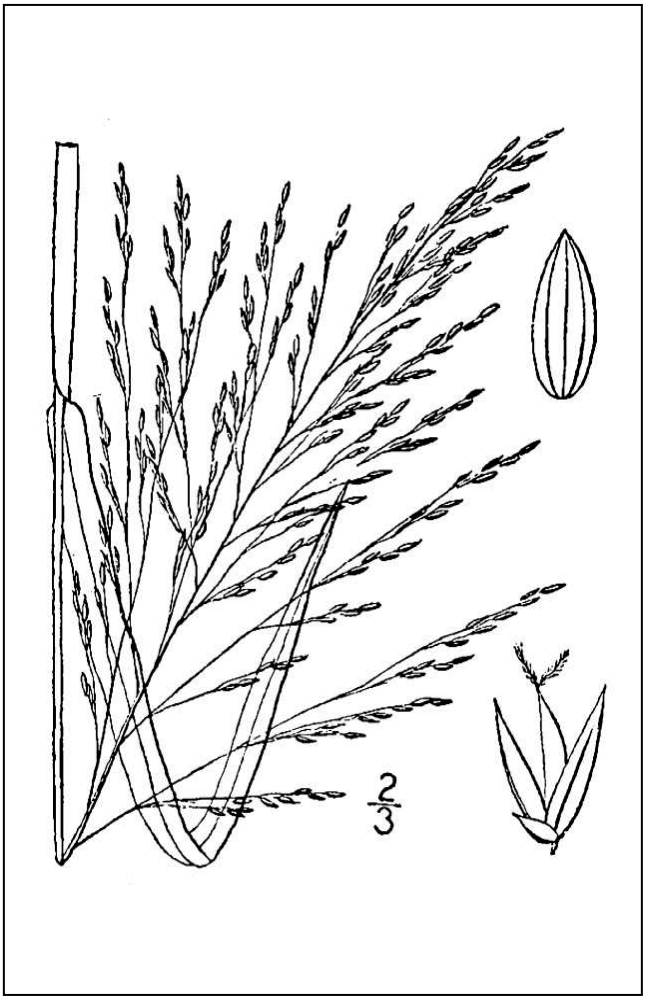
5-8" AVERAGE

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

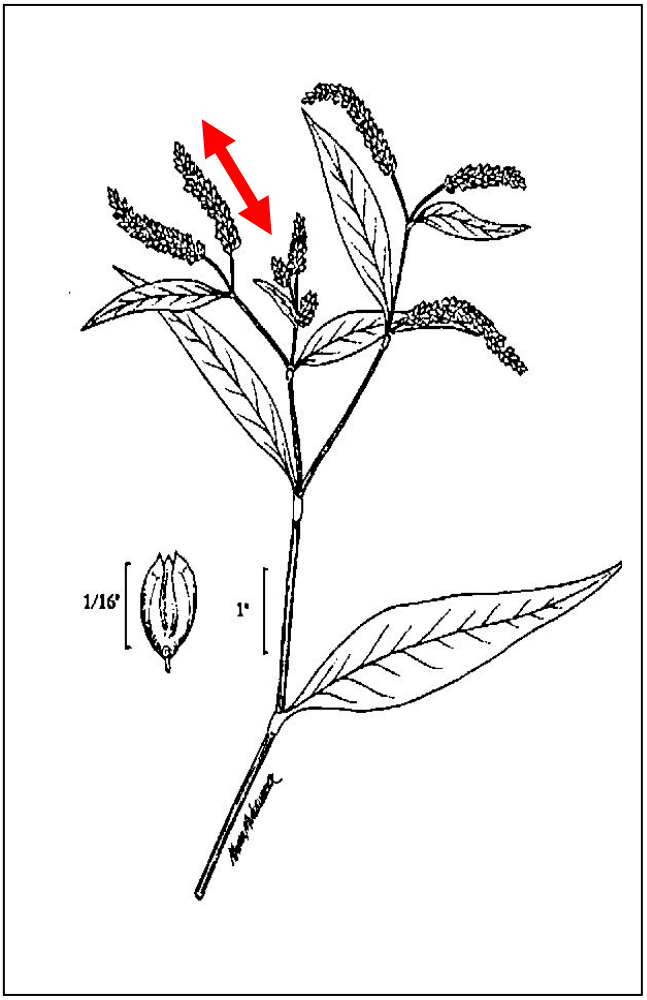
Less than 5 inches (**SMALL**)

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

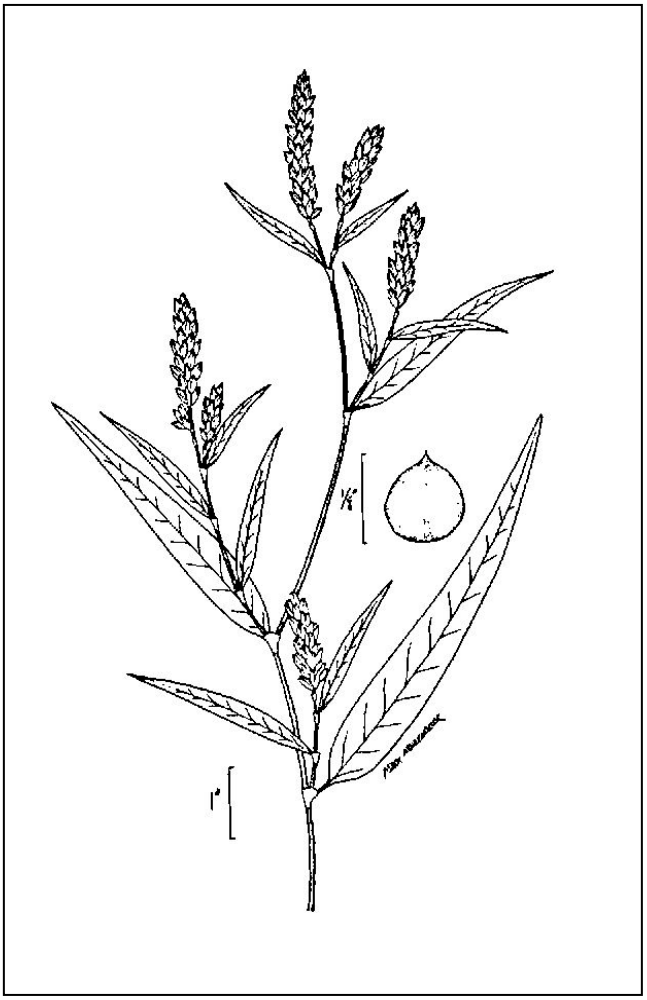
2-4" AVERAGE

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, pinkweed, 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

<1.75 inches (**SMALL**)  >1.75 inches (**LARGE**)

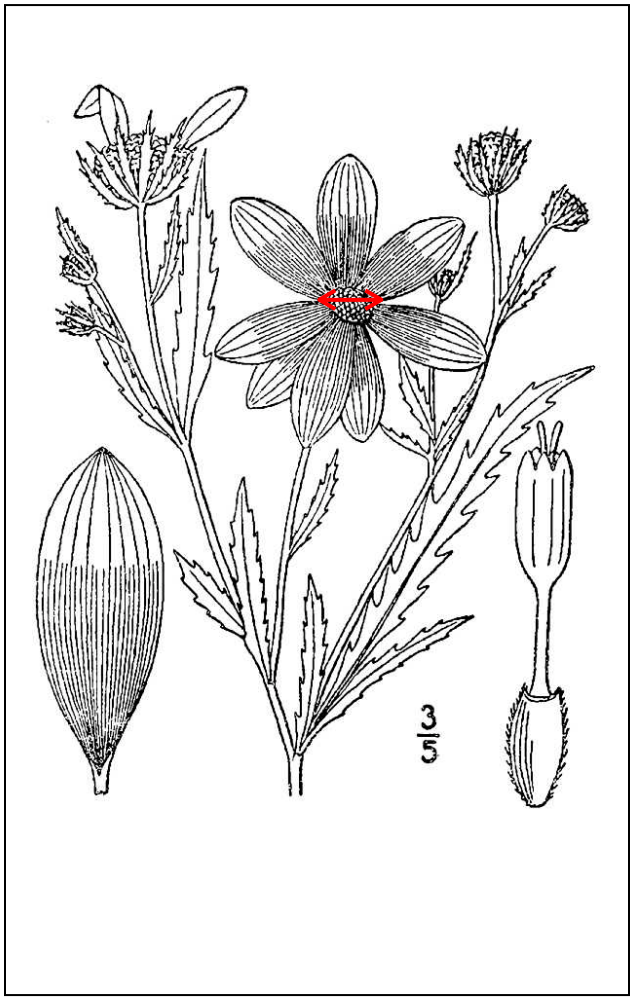
Green & yellow Foxtail S. pumila & S. viridis

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.gov

0.375 inches AVERAGE

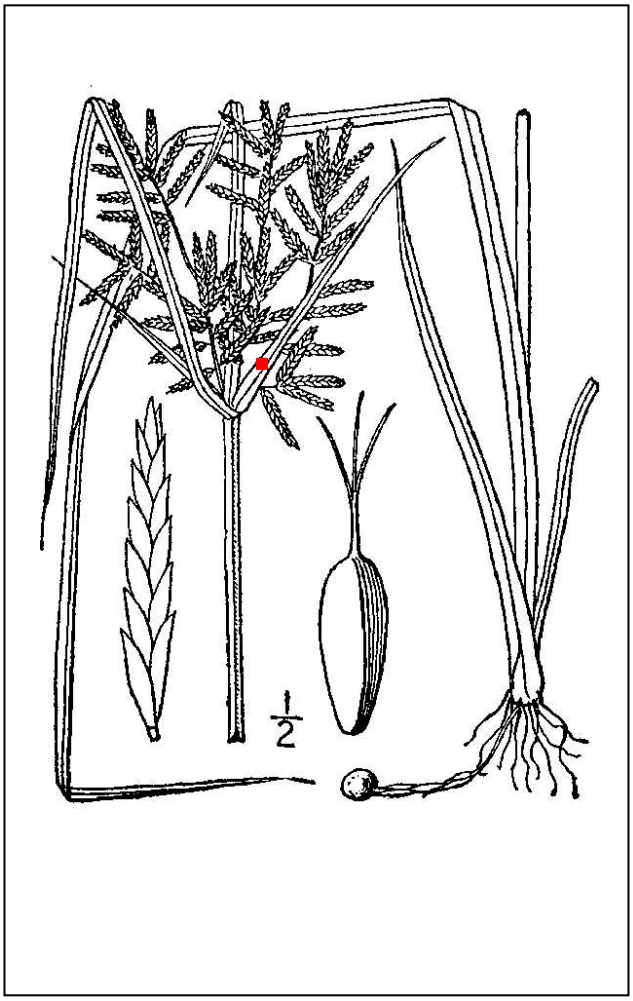
Less than 0.375 inches **(SMALL)**

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



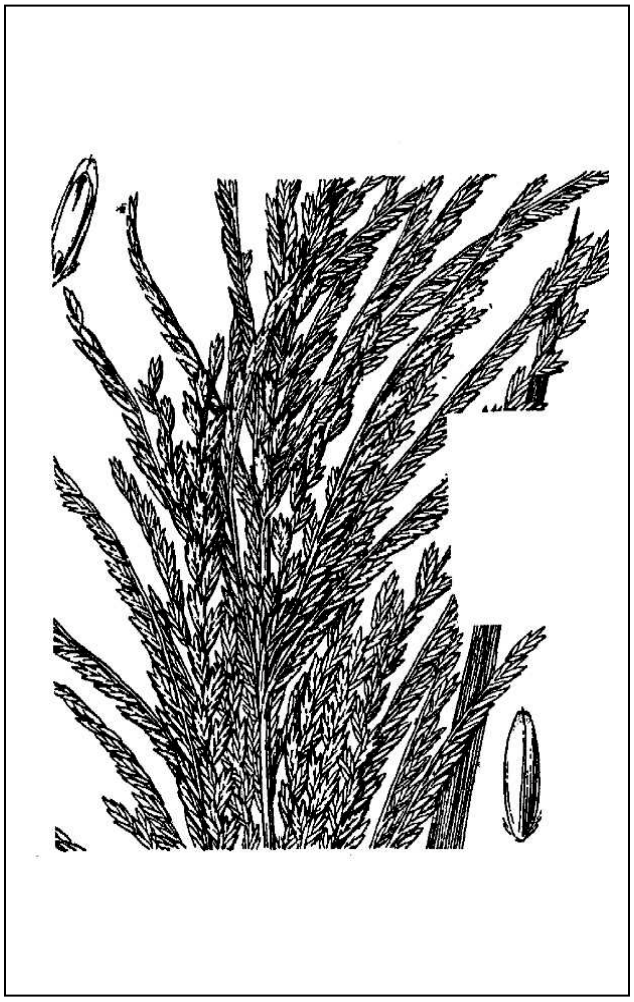
http://plants.usda.gov

2-4” AVERAGE

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

□ Measure 1-2 individual spikes of the inflorescence (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.

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

http://plants.usda.gov/

http://plants.usda.gov

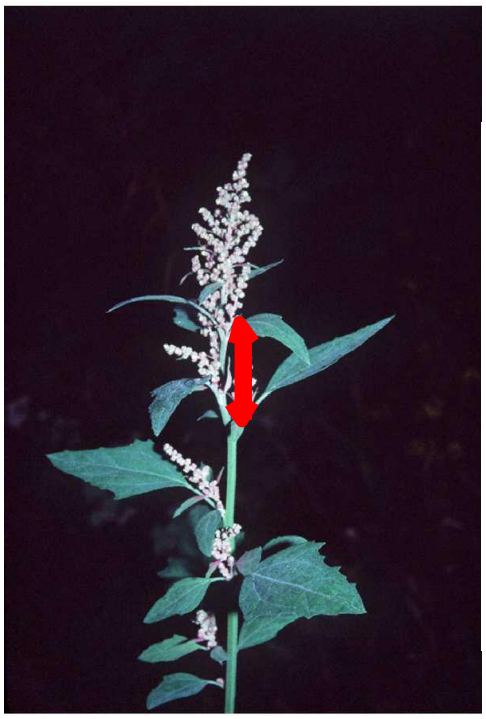
1”-1.5” (2.5-4 cm) AVERAGE

Less than 1.0 inches **(SMALL)**

Greater than 1.5 inches **(LARGE)**

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

Goosefoot, Lambsquarters (*Chenopodium album)*



http://plants.usda.gov/

http://plants.usda.gov

2-4” AVERAGE

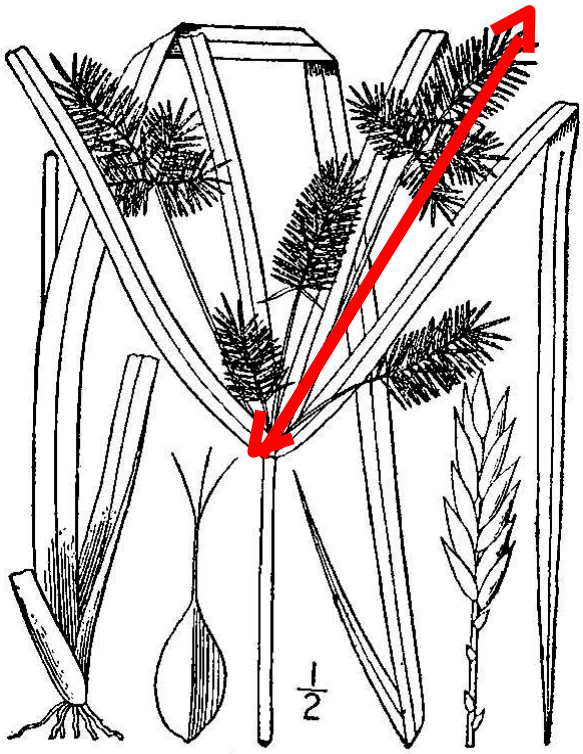
Less than 2 inches **(SMALL)**

Greater than 4 inches **(LARGE)**

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

Redroot flatsedge (*Cyperus erythrorhizos*)

http://plants.usda.gov/



http://plants.usda.gov

4-6” AVERAGE

Less than 4 inches **(SMALL)**

Greater than 6 inches **(LARGE)**

□ Measure 1-2 individual spikes of inflorescence 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

Table SM-6.1. Relative waterfowl food values (high =H; medium = M; low = L) for selected wetland plant species.

Plant species	No. of Veg. surveys in which spp. was recorded as a co-dominant	Food value	Parts Consumed	Included in 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[1]
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	X[1]

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 were included with <50 records and high food value.

[1]We did not generate seed assessment page for this genus because of the wide variation in seed head size for this genus.

SM 8: Health and Safety Guidance for Handling Sick or Dead Wild Birds.

This document guides procedures for protecting personnel 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 for additional information.

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.

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