DRAFT MONITORING METHODOLOGY AND PROTOCOL OF THE NORTHERN GREAT PLAINS PIPING PLOVER

Prepared by the U.S. Fish and Wildlife Service
Missouri River Recovery Office

Draft February 28, 2024

Table of Contents

Planning Surveys

Observers can make efficient use of field time prior to the start of the field season by examining satellite images of survey cells and obtaining information from landowners to determine areas to park vehicles and the best paths to potential piping plover habitat. Observers should mostly focus on searching for piping plovers along sparsely vegetated or unvegetated shorelines. Each survey cell should have defined boundaries so observers can fully search survey cells each visit to keep efforts consistent across time which will benefit future analyses. Thus, observers may have multiple survey cells on the same body of water, especially if nesting habitat occurs heterogeneously around large wetlands. In general, piping plovers are unlikely to nest in densely vegetated areas and observers do not need to search dense vegetation. Observers should also avoid traveling through suitable habitat that is not part of the survey to avoid disturbing other nesting areas and to avoid being followed by adult plovers from non-surveyed areas into surveyed areas.

Prior to leaving for the field, crews should ensure sufficient equipment is available.

Equipment Needed for Site Monitoring

Survey Equipment	**# Needed and Comments**
Binoculars	1 per observer
Spotting Scope	1 per group
Pencils & Marker	2 - but good idea to always have extras
Data Cards	As many as needed - dependent on anticipated number of survey locations
Tablet for Survey 123	1 per group- data sheets can be used then transferred digitally
Mobile Internet/Hotspot	Used to connect to Survey 123
GPS	1 per group –good idea to carry incase tablet GPS does not connect
Additional Equipment Needed for Nest Monitoring	**# Needed and Comments**
Fanny Pack	1+ pack to hold egg floating equipment
Nest Marker	20+ popsicle sticks in the field - additional in vehicle
Egg Floating Cup	Unused urine specimen cups or plastic freezer canning containers with lids (additional details on Pg. 7)

In addition, crews should be aware of established monitoring restrictions.

Piping Plover Monitoring Restriction

1. **Weather Conditions**
    a. Activities may only be conducted when the ambient temperature is between 40 and 90° Fahrenheit.
    b. Surveys will not be conducted if it is precipitating.
    c. Surveys will not be conducted if the wind speed is greater than 25 mph, or if sand is blowing across the survey area.
2. **Surveying Piping Plover Nesting Sites**
    a. Surveys for nesting piping plover or time spent at each piping plover area will be completed so that an individual bird may not be kept off a nest or prevented from brooding chicks for more than 30 minutes. Because of the size of some nesting colonies, the entire habitat unit take much longer than 30 minutes, but surveyors shall ensure that they move through the area quickly enough so that disturbance at individual ness is less than 30 minutes in duration.
    b. Surveys of a nesting area for nests, chicks, and fledglings may be conducted no more frequently than once every two days and to the extent practicable, nests, chicks and fledglings will be observed from a distance of 200 feet or greater to minimize disturbance. Nests may be checked daily when eggs are observed pipping or if eggs are expected to hatch within 24 hours to determine nest fate.
    c. Nests may be checked daily following written permission from the project leader to check on specific concerns (e.g. suspected nest predation - steps may be taken to reduce risk).
    d. To the extent possible during surveys, nesting piping plovers, piping plovers observed returning to their nests, and least terns are not to be disturbed.
    e. All mortalities must be reported to the project leader and the Resident Agent in Charge 24 hours.

Data Form Types

Survey data will be cataloged within the following data forms:

- Site Visit Form- information related to the site
- New Nest Form- information related to the discovery of a new nest
- Nest Visit Form- information related to the current state of a previously discovered nest
- New Brood Form- information related to recently hatched brood or discovery of a new brood
- Productivity Records- information related to a previously discovered brood

Site Monitoring

The first step of monitoring in the field is to conduct a site visit. Site visit data should be imputed within the **Site Visit Form** every time a site is searched for birds and/or nests to document a site has been visited. A site visit should still be documented even if piping plover activity was not detected on that visit. Data collected within the Site Visit Form are as follows:

Site Visit Form:

Data Recorded	# Needed and Comments
Observer Name	First, Middle, Last initials
Observer Affiliation	Organized entity of which the observer is monitoring for
Survey Date	Date of current visit
Survey Cell	Survey cell number (assigned from pipl coordinator)
Location	GPS coordinates

When monitoring a site, observers should use binoculars or spotting scopes to detect piping plover presence and should listen for plover vocalizations upon approaching suitable nesting habitat. Densely vegetated areas can usually be disregarded as nesting habitat in normal or low water years. Moderately vegetated areas may contain nests if the more desireable, sparsely vegetated areas are not available (i.e., if the water level is high). While in potential nesting habitat, observers should walk slowly, closely watching where they step to avoid trampling nests or juveniles. The eggs of plovers and other ground nesting bird species in similar habitats are highly camouflaged and visually blend into the substrate. Therefore, approaching from heavily vegetated areas can help observers focus on the nesting habitat while not completely focusing on the ground trying to prevent stepping on a nest. It is still possible to step on a non-plover nest within the heavily vegetated areas, but the chances of stepping on a piping plover nest are greatly reduced.

Locating Nests

Locating nests is a crucial part of evaluating productivity. A piping plover nest consists of a shallow depression in the substrate containing at least one viable egg. Observers can use the previously described plover behaviors to be more confident and efficient in determining the correct plover breeding phase for individual birds. To locate nests using plover behavioral cues, observers should watch for incubating plover adults from a location that gives the best view of the nesting habitat but does not make their presence known to the birds. Many times, observing plovers prior to them becoming aware of the observers' presence can lead to finding adults shading or incubating nests or direct the observer to a general area to focus nest searching. If incubating adult plovers are not visible, observers can watch other visible adults that may eventually go to their nest. After thoroughly scanning the area multiple times, the observers should begin approaching the potential nesting habitat while listening for plover vocalizations and continuing to visually scan the area. If the presence of a plover is confirmed, and the bird's origin

within the nesting area is unknown, the observers should retreat from the area to a distance where the nesting area is still visible but that would allow plovers to resume normal activities. If the plovers are near or in the incubation phase, adults return to nest incubation relatively quickly. The haste at which adults returns to their nest will likely increase for adults with higher tendencies toward nest attentiveness, time of day (more likely to be on nest during mid-day), ambient air temperature (returns faster with warmer temperatures), and incubation stage (returns faster at later stages).

If piping plover presence is not confirmed upon initial approach, observers should carefully walk through the best available nesting habitat. Observer presence will cause plover adults to leave their nests and be more visible or vocal making them easier to detect. If plover presence is confirmed after walking toward or into the nesting habitat, observers can retreat to allow plovers to return to normal activity and potentially indicate if and where there are nests after plovers return to incubate their nests. If it is not possible to view the area suspected to have a nest while observers are at a distance that allows plovers to return to normal behavior, the observers may hide for 10-15 minutes (e.g., lay down in grass away from nesting area). After hiding, observers can approach the area quickly while looking for movements from potential incubating birds leaving their nests. If quickly approaching the nesting area, observers should not walk directly in potential plover nesting habitat to reduce the chances of stepping on a nest. If observers are in potential nesting habitat, they will need to slow down their pace and carefully observe the area in their desired path.

When an adult piping plover returns to its nest or the area where the nest is suspected, observers can use objects in the immediate area as landmarks (i.e., vegetation, large rock, trash, etc.) to aid in finding the exact nest location when approaching the habitat area. Carefully noting the nest location relative to several items in the foreground, and one directly behind a suspected nest location, is important to improve chances of finding the nest quickly and safely when approaching it. Once the visual cues are determined, observers should proceed to the area, locating the nest with care, and record required data. If the nesting area does not contain adequate visual cues, one observer should keep a “line of sight” on the nest while directing another observer to that location. Another option is to take a picture of the nest location from afar or through a spotting scope and use visual markers present in the image to aid in finding the nest while approaching the location.

Another option is to approach the shoreline nesting area from water in a kayak, canoe, or boat to help locate nests. Plovers typically continue normal activities longer and tolerate closer proximities to observers when the observers use watercraft. If a nest is suspected but cannot be located and permitted time allows, a quick grid-searching method (Figure 1) may be utilized. Grid searching may be done with one or multiple observers to quickly cover an area. Grid searching is a systematic method to search all targeted habitat. Observers evenly space themselves at a distance that allows observers to visually cover the ground to either side and up to the area the adjacent observer can visually cover. The observers will walk concurrently across the habitat and then pivot on the observer closest to the unsearched area to realign for the walk back across the area. This process should be completed for the full suspected area containing the nest and must be completed in the allotted permit time.

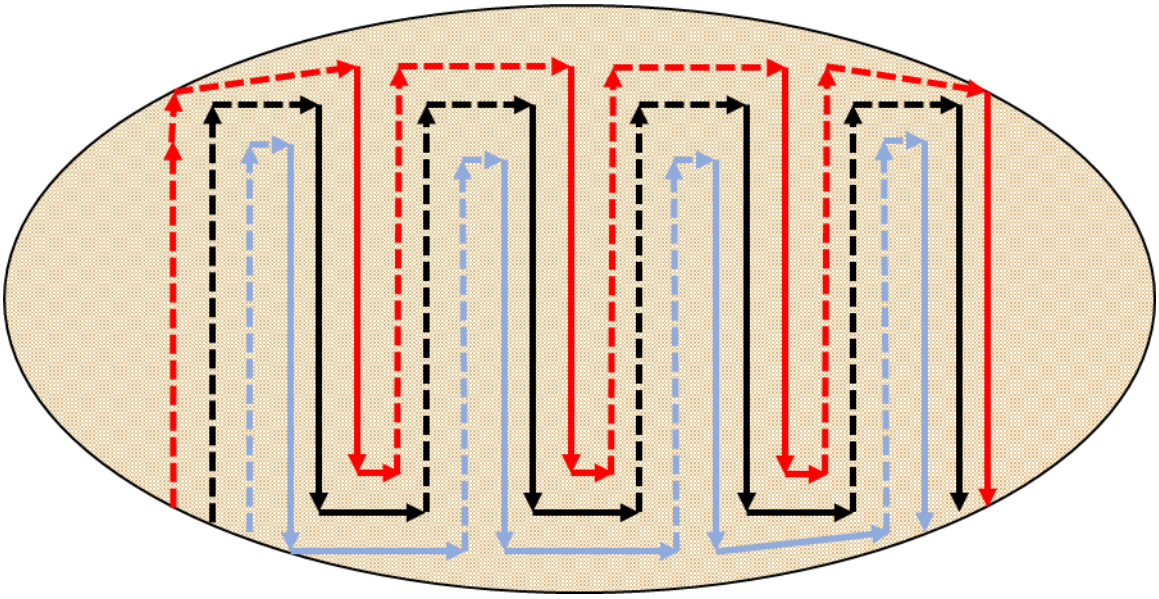


Figure 1. Example of a grid searching method to locate a nest within piping plover nesting habitat. Each line represents a different observer's walking path.

Discovery of a New Nest

When a piping plover nest is confirmed, the appropriate data should be recorded. Nest success is a common and important part of productivity estimations. While there may be many covariates of interest for evaluating factors affecting nest success, some data are essential to being able to calculate nest survival estimates properly and accurately.

Nests may be marked using inconspicuous methods, e.g., tongue depressors, wooden dowels, driftwood, or rock cairns. The marker shall be no closer than 10 feet from the nest. Permittees should use GIS/GPS to mark and re-locate nests as markers may make nests more visible to predators.

One of the easiest ways to find plover chicks is to look in the nest bowl. Newly hatched chicks will remain in the nest bowl for several hours. **If chicks observed in the nest bowl appear wet, leave the area immediately.** A wet chick indicates that it just hatched, and a newly hatched chick will not be able to thermoregulate itself, making it vulnerable to temperature fluctuations. Chicks may die from heat or cold exposure if not attended by the adult. Likewise, if chicks are found panting in the nest bowl, this is evidence of chicks overheating due to hot temperatures and substrate. Leave the area so the adult can return to thermoregulate the chicks.

Observers should maximize efforts to minimize disturbance to a nesting area. It is unnecessary for observers in a large field crew to gather around a nest when collecting the data. Typically, only one or two observers are needed at the exact nest location. Observers should coordinate with each other to minimize disturbance. Each observer should be given a responsibility and be solely responsible for that task.

New Nest Form:

Data Recorded	# Needed and Comments
Observer Name	First, Middle, Last initials
Observer Affiliation	Organized entity of which the observer is monitoring for
Survey Date	Date of current visit
Survey Cell	Survey cell number
Nest ID	A unique number (this number will be used for future visits)
Number of Eggs	# of viable eggs at each visit
Incubation Stage	Number of incubation days as determined by laying sequence or egg floatation and the time elapsed between visits
Estimated Initiation Date	Date the first egg was laid. Determined by formula (below)
Estimated Hatch Date	Date the first egg is expected to hatch. Determined by formula (below)
Fate	Current status or fate of the nest. Determined by evidence at the nest (dendrogram below)
Comments	Comments about nest should be recorded every visit. May help determine fate

Determining Incubation through Egg Floating

The incubation stage refers to the number of days of development the embryo has undergone. It is important to establish the incubation stage of a newly found nest to determine the initiation date and expected hatch date. Observers should use the egg floatation method described by Westerkov (1950) to determine the incubation stage of plovers. As the embryo develops, the resources in the egg are used, and it becomes lighter and less dense due to evaporated moisture and gaseous metabolic waste from the respiring embryo; hence depending on the incubation stage, the height and angle at which the egg floats will differ (Figure 3).

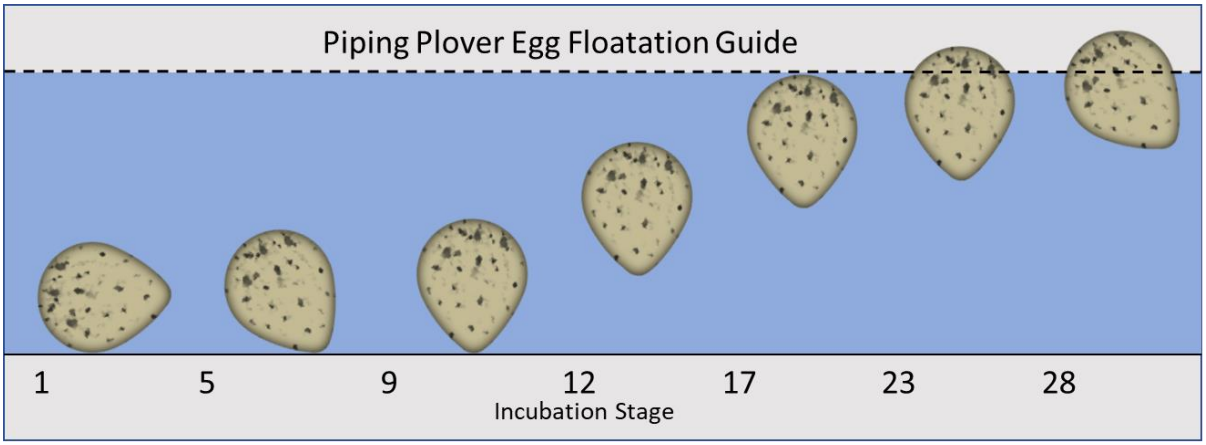


Figure 2. Piping plover egg floatation guide to estimate the incubation stage (adapted from Hays and LeCroy 1971).

Float Cup & Water

Cups used to float the egg(s) should be made of clear plastic and have a smooth bottom if possible. It should NEVER be made of glass. Unused urine specimen cups and plastic freezer canning containers with lids work well, but the top of the cup must be large enough to easily permit observers holding the egg to put multiple fingers in the top. This cup should be filled ¾ full with clean water from the immediate body of water. It's important to always consider the water temperature, as both water that is too cold or too warm can shock the eggs. Water body temperature will vary with the season. When it is colder, such as early in the season, it is important to fill the cup early in that day and use this water throughout the day. It is equally important to ensure that the water in the cup is not too warm either; if it feels warmer than human skin, it is too warm to use. This will be more of a concern later in the season when the water temperature is warm, and the air temperatures are high.

How to Float an Egg

Determining the incubation stage will require training and practice to obtain reliable data. Incubation stage may be determined using egg floatation by those permitted by the USFWS. Hands should be washed with unscented soap or wiped with unscented towelette prior to nest searching to minimize the risk of predators drawn to scent; a brisk scrubbing with sand is also an option. (Note: anyone handling eggs must rewash hand before/after eating, and particularly after application of sunscreen or insect repellant). The observer responsible for handling the eggs should make certain they have a firm footing on the ground before touching eggs. Eggs should be picked up individually, and delicately held with 3-4 fingertips (Figure 4). Eggs should be thoroughly inspected for any cracks, holes, or signs of pipping. **If there are any cracks, holes, blood, or signs of pipping the egg should NOT be floated.** If the shell is cracked but the embryo is alive, submersing it in water could potentially drown the embryo. If the egg is intact, then the observer should proceed by placing the egg gently at the bottom of the float cup. The egg should NEVER be dropped or carelessly put in the cup. After the egg stabilizes, compare its position to that of the egg float chart (Figure 2). Determine the incubation stage by looking at the number below the position selected on the float chart. After the incubation stage has been determined, gently remove the egg from the cup and place it back in its original position in the nest. It is not necessary to dry the egg before returning it to the nest; never shake the egg to remove excess water.

Figure 3. Observers determining incubation stage through egg floatation.

When to Float Eggs

One egg from the nest should always be floated upon nest discovery because determining nest age allows for estimates of nest detection and survival and there may not be another opportunity to age the embryos if the nest is depredated. There are exceptions to this rule described within the following paragraph. There are circumstances however where it may be necessary to float more than one egg. If the egg selected for floating floats to the top of the water with the pointed end up rather than down, this indicates an addled egg (an egg where the embryo has died). The egg should then be placed back into the nest and another egg should be floated. If this occurs, include this information in the nest comment.

It is also sometimes necessary to re-float an egg from the nest if the nest is suspected of abandonment early in incubation. Knowing the exact incubation stage can help determine if and when the nest was abandoned.

When NOT to Float Eggs

If there are any cracks, holes, blood, or signs of pipping then the egg should NOT be floated (Figure 5). When in doubt, do not float an egg. If the clutch is predicted to hatch within a few days or there are star-shaped cracks in the shell (typically at the bulbous end of the egg), the eggs are likely pipping. If an egg is floated under any of these conditions, then water could enter the egg and drown the embryo.

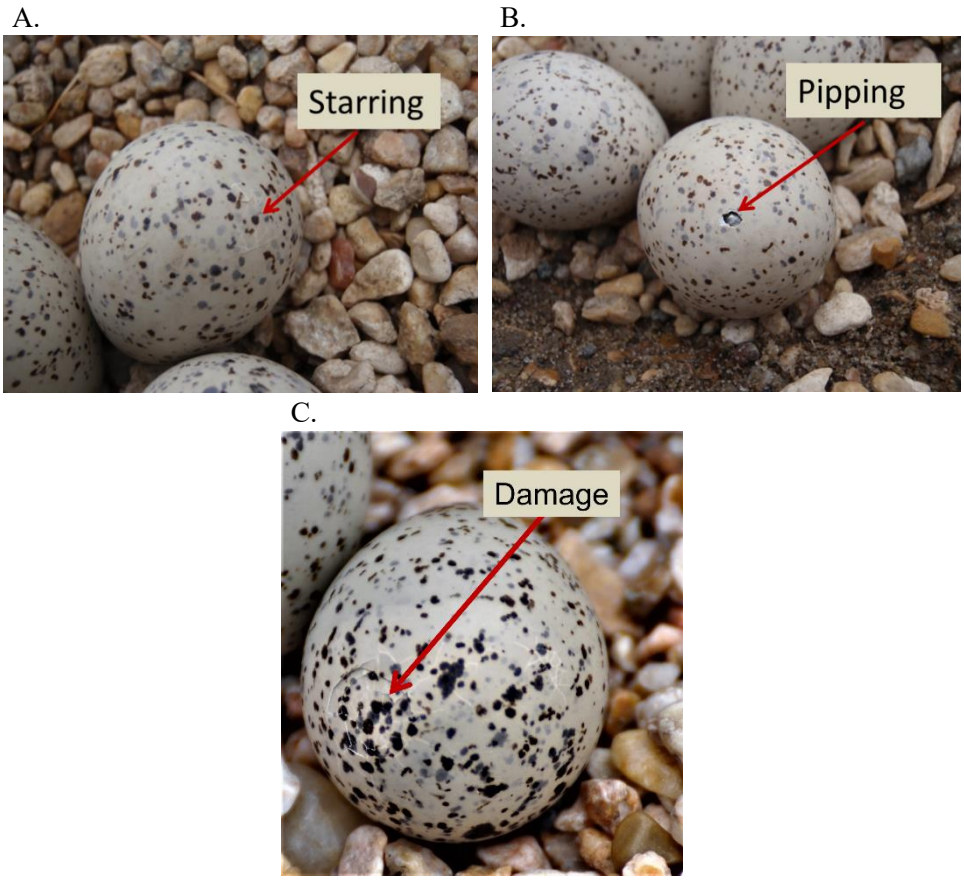


Figure 4. Examples of piping plover eggs that should not be floated because of A) starring cracks (first stages of pipping), B) pipping holes, or C) damage to the eggshell.

Calculating Nest Initiation Date

The initiation date is the date the first egg was laid in the nest. Determining the nest initiation date provides an estimate of how long a nest has been active and is needed for calculation of the nest's estimated hatch date. To calculate the nest initiation date, subtract the estimated days of incubation (as determined by floatation) and 2 days per plover egg (except for the first egg) from the visit date. For example, if a 3-egg piping plover nest was found on May 22nd with 5 days incubation, you would subtract 10 days (5 days for incubation + 6 days for 3 eggs – 1 day for the first egg) from May 22nd resulting in May 12th as the estimated nest initiation date. Initiation date does not need to be computed in the field, but rather can be done later using the formula:

Initiation Date: Visit Date – [Estimated Incubation Stage + (#Eggs * 2) – 1]

NOTE: Nest initiation date will be automatically calculated once incubation stage has been inputted to the Survey 123 New Nest Form

Calculating Estimated Hatch Dates

The estimated hatch date is the anticipated date the first egg will hatch in the nest. Determining an estimated hatch date is important for observers preparing to document egg hatch and for determining the fate of a nest. If a nest bowl is found empty with no signs of hatching or disturbance, the proximity to the estimated hatch date will play a role when assigning the fate of the nest. This type of scenario will be covered in greater detail in the section on *Fating a Nest*. To calculate the estimated hatch date for piping plovers, add the incubation length (Elliott-Smith and Haig 2020) and 2 days per each egg in the full clutch (except for the first egg) to the initiation date.

Estimated Hatch Date: Nest Initiation Date + Incubation Length + [#Eggs in full clutch*2]-1

NOTE: Estimated hatch date will be automatically calculated once incubation stage has been inputted to the Survey 123 New Nest Form

Fating a Nest

The fate of a nest is an observer-assigned outcome that falls into the categories listed below and is determined by the observed evidence. A nest may be terminated on an observer's visit when no viable eggs remain in the nest bowl. Possible fates have been divided into 4 categories: Successful, Probable Successful, Failed, and Unknown. The ratio of nests assigned to the Unknown fate to all other fate categories will depend on the length of return interval or return frequency to nests. Long return intervals to nests (e.g., ≥7 days between visits) will increase the number of Unknown nest fates because potential evidence to determine nest fate is more likely to be lost compared to shorter return intervals to nests (Andes et al 2019). An example dendrogram is provided below (Figure 6).

Incubating nests are those that are not of age to have hatched. Following the anticipated hatch date, eggs should continue to be monitored until there is clear indication of abandonment where the nest will then receive a failed fate.

Successful nests are defined by hatching at least 1 juvenile. In order to fate a nest Successful, there must be indisputable evidence that the nest hatched at least 1 juvenile (i.e., juvenile is found in or within a few centimeters of the nest bowl). Juveniles found near the bowl, but not in the bowl, are not enough evidence to assign the fate as Successful. It is possible that the juvenile(s) came from another nest

nearby that hatched around the same time, especially with the high nest density experienced in some nesting areas.

Probable Successful nests have signs and evidence of hatching, usually multiple signs, to support that the nest likely hatched. Signs of hatching include pipping fragments, eggshells, juvenile feces, juvenile tracks, and appropriately aged juveniles in the vicinity of the nest (can only be used with other evidence of hatching). Depending on the frequency of nest monitoring visits, this may be the dominant category of positive nest fate assigned.

Failed nests have strong physical evidence that they did not hatch (eggs destroyed or missing multiple days prior to the estimated hatch date) or incubation was terminated due to some other cause. In order to attribute an exact reason as to why a nest failed, you must observe indisputable evidence at the nest bowl of what caused nest failure. In a typical year, many nests will be assigned a nest fate of Failed.

Unknown nests do not possess evidence at the nest site strong enough to determine that it was Successful, Probable Successful, or Failed. If return intervals are long, the number of nests assigned an Unknown fate may be high.

Nest Visits

Multiple attributes about a nest must be collected upon nest discovery and revisits. Documented nests should be visited 2x per week prior to and after the estimated hatch date. Each visit to a nest should be documented within the Nest Visit Form in addition to the Site Visit Form. Shorter intervals between nest visits will provide more accurate and precise nest survival estimates and more accurate nest fates (Shaffer et al. 2013 and main text of this article).

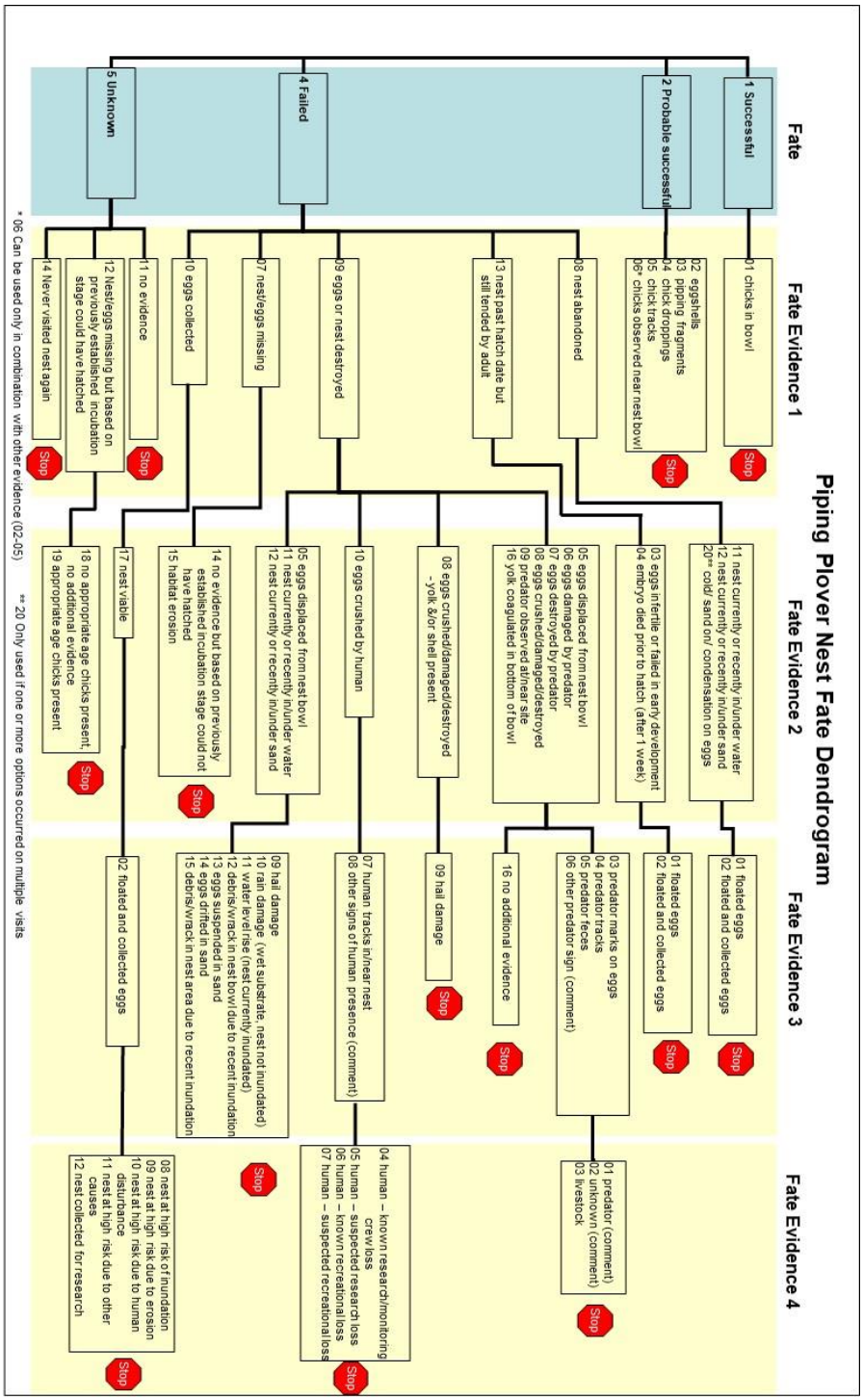
Below are the basic data needs that should be recorded at each nest visit. Proper data collection can be used for a nest survival analysis. In the process of collecting data near nests, it is important to avoid holding any objects directly over top of a nest to prevent the object from falling on the eggs if it is accidentally dropped. It also helps to ensure items such as binoculars are securely attached to the observers and other items such as spotting scope tripods will not be blown by wind onto the nest.

Nest Visit Form:

Data Recorded	# Needed and Comments
Observer Name	First, Middle, Last initials
Observer Affiliation	Organized entity of which the observer is monitoring for
Survey Date	Date of current visit
Survey Cell	Survey cell number
Nest ID	Nest ID is a unique ID number assigned to each nest (this number will be used for future visits to the nest.
Number of Eggs	# of viable eggs at each visit
Incubation Stage	Number of incubation days as determined by laying sequence or egg floatation and the time elapsed between visits

Estimated Initiation Date	Date the first egg was laid. Determined by formula (below)
Estimated Hatch Date	Date the first egg is expected to hatch. Determined by formula (below)
Nest Fate	Current status or fate of the nest. Determined by evidence on the nest (dendrogram below) If hatched- fate should be successful and chick age should be updated within the nest visit form each visit (Figure 5)
# of Chick Within Age Category (Figure 6)	1-5
	6-10
	11-15
	16-24
Comments	Comments about nest should be recorded every visit. May help determine fate

Figure 5. Below is one example of a nest fating dendrogram. Observers determine the fate and follow the dendrogram paths to select supporting evidence until a stop sign is reached. The data should be recorded on the nest data card under the corresponding headings (Fate, Fate Evidence 1, etc.).



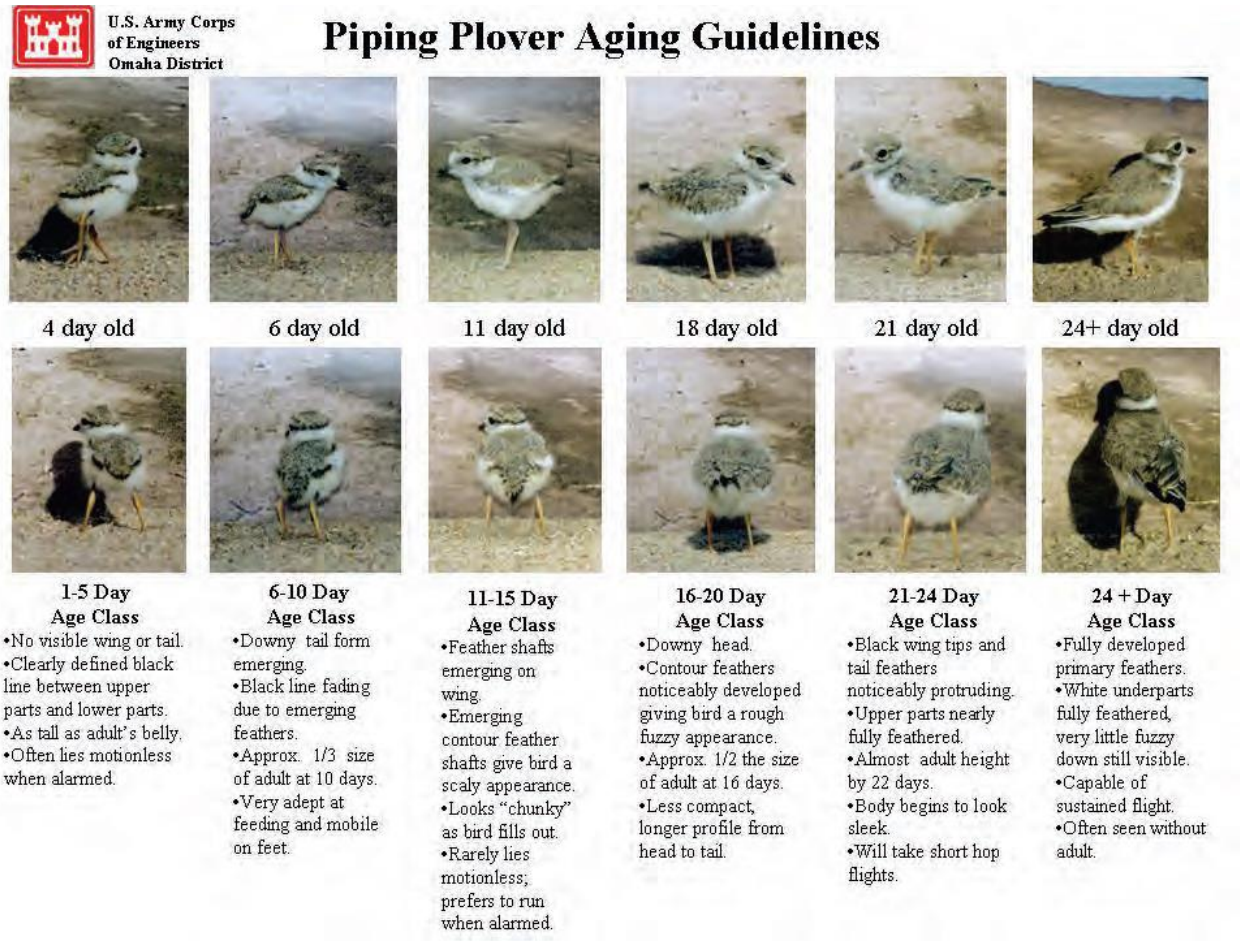


Figure 6. Chick ageing guide with physical description and photos.

New Broods

Despite the most diligent efforts, it is possible that a crew will not find all the nests at a given site. For example, a crew may pull up to the shore and observe a brood of unfledged chicks at a site where no nests were previously documented. To account for this, a brood record will be created. However, the crew must be absolutely certain that the chicks cannot be associated with any previously known nest before creating a brood record.

Once a nest has hatched or a brood unassociated with a nest is discovered, the brood should continue to be monitored until fledged (able to fly). After hatching, it takes from 21-28 days for piping plover chicks to fledge.

In addition to counting chicks, crew members need to determine the approximate ages of the chicks. Piping plover chicks are divided into five age classes: 1-5 days, 6-10 days, 11-15 days, 16-20 days and 21-24 days (Figure 6). Determining chick age will aide with tracking the total number of chicks and whether a nest hatched successfully. If a brood of four one-day old plover chicks are observed on June 12, it would be expected that four 6-10 day old chicks would be seen the next week. Additionally, counting and aging chicks during the weekly surveys allows us to document the number of fledglings produced.

A device to assist in aging chicks is the **Chick Aging Guide found in Figure 6.** The Guide shows plover chicks at various age classes with descriptions and behavior clues. (A separate laminated card set should be available to take in the field.)

Determining whether a chick has fledged is a critical component of monitoring because it is a measure of productivity. A chick is considered fledged when it is able to fly. There are two ways to determine if a chick is fledged. The first is straightforward— the chick is observed flying. This need not be sustained flight. A juvenile that performs short-hop flights is considered fledged. Do not harass a chick in any way to force it to try to fly by running toward the chick, making noises, throwing objects in the direction of the chick, or doing anything to disturb the chick.

The second way of determining fledging is more subjective and based on the size of the chick. If the chick appears to be the correct size of a fledgling, comparable in size to an adult, then the chick should be counted as fledged.

New Brood Form:

Data Recorded	# Needed and Comments
Observer Name	First, Middle, Last initials
Observer Affiliation	Organized entity of which the observer is monitoring for
Survey Date	Date of current visit
Survey Cell	Survey cell number
Brood ID	Unique identifier number assigned to the nest (this number will be used for future brood visits.
Amount of Chicks	# of chicks observed
Chick Age	Estimated age of chicks