

Wildlife Inventory Plan  
Alaska Maritime National Wildlife Refuge  
Protocol #19

Version 1.2

Parameter: Survival

Species: Least auklets

## PURPOSE

To estimate and detect trends in average overwinter survival rates for adult least auklets. Survival estimates are needed for population models, and have been shown to be a particularly sensitive parameter in long-lived seabirds. Annual survival of least auklets apparently covaries with broad-scale climate patterns (e.g., Jones et al. 2002) and is intended to provide insight into causes of population change.

## BREEDING BIOLOGY

Least auklets (*Aethia pusilla*) are small, crevice-nesting seabirds that breed in often massive colonies on islands in the Bering Sea, Sea of Okhotsk, and Aleutian Islands. They occur on 17 islands in Alaska, as well as many colonies in Russia. Although they are one of the most abundant seabirds in Alaska (Stephensen and Irons 2003), they nest in concealed breeding sites in rock crevices, making them difficult to count.

During the breeding season, adults are typically present on land during two daily activity periods (morning and evening) when they socialize on the colony surface above their nesting crevices. Timing and duration of activity periods vary among colonies and sometimes within a season at a colony. As chick-rearing progresses, adults gradually spend less time socializing on the surface (Jones 1993).

Most fundamental demographic variables, such as population trends (see Renner et al. 2006), are difficult to obtain for auklets because they nest in usually inaccessible rock crevices. Because auklets socialize on the surface of the colony, however, adult survival can be readily estimated through mark-recapture techniques (see White and Burnham 1999). Adult least auklet survival has also been suggested to vary with environmental conditions in the Bering Sea (Jones et al. 2002).

## PROCEDURE

**Resighting.**—Resight birds banded in previous years as many days as possible during the early part of the breeding season (before egg laying to early chick-rearing; generally mid-May through late June). Some birds are observed attending the colony only during the early part of the season, and will be missed if you start too late. After hatching, when adults begin carrying food to chicks, they linger on the colony surface for less time and socialize less.

Many shorter resighting sessions (3-4 hours in length) are more effective than fewer all-day resighting bouts (Harding 2003). Continue resighting until you are reasonably confident you have seen all birds present that year (e.g., you are no longer seeing new birds). There is no hard and fast rule for exactly how much time you will need to spend before you no longer see any new birds, as this can vary among sites, years, and observers. Use resighting efforts in prior years as a rough guide of what to aim for (see attachments for island-specific details) and track the cumulative number of birds seen over the season to know when you have stopped seeing any new individuals. If you band new birds in the current year, it is important to conduct at least three resighting sessions after banding to confirm banded birds are actually plot residents.

Plan most of your resighting effort during peak hours of auklet socialization, which will vary among colonies (see attachments for island-specific details). Some birds are present on the plot all day,

while others seem to appear only at certain times of day, so be sure to resight at least a few times outside of peak hours (e.g., early in the morning, late in the afternoon, and even the evening activity period just before dusk) to increase your chances of seeing all banded birds. Record the start and end times of every resighting session to calculate resighting effort.

Record the color combinations of all banded birds you observe on the survival plot (10x binoculars are probably the best choice of optics). Data can be recorded either in a Rite-in-the-Rain<sup>®</sup> notebook or on a blank banding matrix (see Figure 1); some find it faster to write out band combinations in a notebook to avoid searching for the correct square in a large matrix, while others think it easier to simply check off boxes in the matrix. When deciding on a method, consider which will lead to fewer recording errors. Whichever you choose, make sure you use a fresh page in your data book or a new banding matrix *every day* you resight, as we ultimately will report how many times a bird was seen in a season and not just whether it was seen once.

Each bird is banded with a unique three-color band combination, with one color (and one metal band) on the left leg and two colors on the right leg. Band combinations should be read (1) left leg, (2) right leg top to bottom. Record band combinations using the following codes for colors:

BK	Black	DG	Dark green	R	Red
BN	Brown	LB	Light blue	W	White
DB	Dark blue	O	Orange	Y	Yellow

For example:

- a bird with a metal and red band on the left, dark blue over white on the right = R DB/W
- a bird with a metal and black band on the left, two orange bands on the right = BK O/O

It is easy to misread or misrecord band combinations (especially reversing the order of color bands on the right leg), especially when birds are hopping in and out of the rocks and you get only a brief glimpse, so use care when making observations. Only record the band combinations that you are certain about and avoid the temptation to write down partial or “probably was” sightings; if a bird is present that year and you resight enough, you will almost certainly see the bird again. Look carefully at all bands to ensure they are the color they first appear. Distinguishing colors in poor light is difficult. Differences between brown and black, and between white and light blue, can be particularly challenging. It may be helpful to place a string of colored bands within the plot for reference. In addition, some bands can fade or become discolored over time, especially white bands, which can become stained pinkish or light orange.

Auklets don’t honor plot boundaries, and although most birds banded in the plot stay roughly within the borders, some birds can stray. Usually, birds that stray outside the plot were ones that nest just outside the plot boundaries and were caught within the plot as they were passing through. These birds are still included in the survival sample, so make an effort while resighting to also scan areas just outside the plot. The areas several meters uphill from the blind and behind (i.e., to the west of) the blind have been used by a number of banded birds in recent years. Rarely, birds banded on the plot were never residents to the area and are never seen again; see analysis section).

Sometimes you will see auklets with only a single metal band. These are probably birds that were banded as subadults and have now returned to the plot as breeding adults. They cannot be included because they cannot be uniquely identified through binoculars, but if they are recaptured during banding then colors can be added to bring them into the survival population. On rare occasions, you may see birds with missing or damaged color bands. Note which rocks these birds seem to frequent so that you can strategically place noose carpets during banding efforts to attempt to capture these individuals. With the bird in hand, you can read the numbered metal band to identify the individual and replace the missing or broken band. (In a few instances, birds have lost one leg, presumably by getting the bands stuck in the rocks, making it impossible to replace missing bands. If you capture these birds, record the metal band number so that we can remove them from analysis).

At the end of the day (or at the very least, before you take your data notebook into the field again), enter the day’s resight data in the electronic data file provided on your camp computer. If you recorded a color combination that does not exist in the computer file, assume that it is an error but record it at the bottom of the list and check with the unit biologist in Homer at the end of the season to confirm it wasn’t simply a banding record that got accidentally deleted.

**Banding.**—By early to mid-June, you should have resighted enough times to be able to estimate if you will come close to reaching the target sample size of 200 banded birds. If it seems likely you will end up with fewer birds, you will need to band new birds to bring the banded population back up to around 200 (in most years, you may need to band 15-30 birds to maintain the population; in some years you may need to band more if it has been several years since birds were last banded). Depending on weather conditions and experience of banders, it should be possible to capture and band 20-40 birds per banding day.

It is possible for a person with a lot of prior auklet banding experience to capture and band auklets alone, but it is very helpful to have a second person present (e.g., one to band and measure while the other records data and watches the nooses for additional captures). For less experienced aukleteers, a second person is critical.

**Noose carpet preparation:** Prior to banding, check noose carpets to make sure nooses in good condition. Ideally, last year's crew should have done this at the end of the season, but it is important to check because poor noose carpets will result in poor capture success. Check that all nooses are firmly attached to the net and that no damaged nooses remain. If nooses pull free, auklets can escape with monofilament snugly wrapped around their legs or necks – a thing to be avoided at all costs.

If you need to tie new nooses, use 10-12 lb test monofilament to tie nooses as described in Figure 6. Attach nooses with a fisherman's clinch knot, so that they project at a 45° angle from the surface of the net. Test every knot to be sure it will not pull free. Then tie each noose using a simple overhand knot. Tie each noose knot loosely enough that it will close easily, but snugly enough that it will not untie itself under an auklet's weight or get hung up on the clinch knot the fail to close. About 2½ cm of line should be left projecting from the noose knot, which can be pulled on to closed noose to release a captive. Finished noose apertures should be about 4 cm in diameter (too large of nooses can result in birds being caught around the neck). Be patient, it takes practice to tie good quality nooses of the appropriate size – if you determine a noose isn't up to standard after tying it, simply cut it off and start again.

Long lengths of parachute cord should be tied to each corner of every carpet for securing the carpet to the rocks. Ensure these are unknotted and not too frayed; otherwise replace them. (Alternately, if available you can use bungee cords with plastic hooks on one end and parachute cord on the other for securing carpets; see Figure 1).

Before capture begins, it is also helpful to create some way to hang multiple bird bags at the blind so that you can contain several birds at a time but process them one by one. One suggestion is to jam several sticks or rods horizontally into cracks between rocks in the blind to act as bird bag hangers.

**Noose carpet deployment:** On capture day, aim to be at the auklet colony early in the morning to set up carpets before birds begin attending the colony surface. Place noose carpets on the surface of suitable boulders and anchor them by tying the parachute cord at every corner around a 2-4 kg (1-2 lb) rock left to dangle over the side of the boulder, stretching the carpet tautly and securely between its four corners (Figures 2 and 3). Check and adjust nooses to ensure they are all open and upright (make sure you didn't set up the carpet upside-down!). Throughout the day when fetching birds from the carpets, re-open any nooses that close when auklets walk over them or are captured, keeping the maximum number of nooses operational. At the end of the capture session, untie all rocks and return noose carpets to their cardboard holders for storage and repair.

Place noose carpets on boulders within the banding plot that have been popular socialization rocks during resighting sessions. Try to avoid capturing birds on rocks that are used primarily for landing, rather than socializing (birds coming in from sea tend to land on large rocks and then disperse to socializing areas), because birds captured there might not be associated with the banding plot and will not be resighted easily. Carpets situated on flat or convex rock faces are generally most effective; it is difficult to get carpets to lay flush against the surface on rocks with concave surfaces or large holes or crevices. Auklets tend to stand on the highest point on a boulder, so place your noose carpets accordingly.

**Capture:** Try to capture birds only on cool, heavily overcast, dry days when birds that are not struggling can be left alone until an adequate number of birds are captured, giving you a chance to collect multiple birds at once. If possible, time your retrieval to moments when birds flush naturally from the plot, giving

you the opportunity to slip out and collect your captives with the least amount of disturbance. Depending on your experience, you should be able to capture about 4-8 birds at a time and process them comfortably, without feeling that any of them are kept for too long.

Retrieve birds from noose carpets without waiting for auklets to fly off on their own if there is any risk of captive birds becoming harmed. For example, if a bird is struggling excessively and beating its wings against the rocks, or if it is caught with a noose around its neck, retrieve it immediately. Pay attention to “bully” auklets that occasionally try to peck captured birds with viscous enthusiasm. If it is sunny or exceptionally warm out, or if the rocks are wet or a light mist is falling, do not leave auklets in the noose carpets for more than a couple minutes to prevent them from overheating or becoming bedraggled. (It may seem ironic, but although auklets are adapted for harsh conditions in a marine environment, they do not fare well when handled in wet conditions!)

When removing a bird from a noose, first grasp the auklet securely with one hand to prevent it from struggling. Bring the auklet towards the noose carpet so that the noose line is slack, then pull the tag end of the noose and slip the captured appendage out. Some auklets become entangled in numerous nooses, and to untangle and loosen them all may be too time consuming and stressful for the bird; if you have a bad entanglement that you cannot easily resolve, carefully snip the lines with a small pair of blunt-ended scissors to free the bird quickly. The nooses can then be removed fairly easily. (If in doubt, err on the side of caution to the bird and cut the noose – new nooses are fast and easy to tie back home at the end of the day, whereas new auklets are not so simple to create!)

Place captured birds in bags and cinch/tie them tightly shut (auklets are able to wriggle their way out of amazingly small holes). Hang bags by blind until each bird can be banded and processed.

Wait at least two days after banding before returning to capture birds again. Once auklets are observed carrying food for their chicks, do not band on excessively windy or stormy days, since the number of birds attending the talus will be minimal, and it's not worth depriving chicks of their hard-won meals.

**Banding:** Try to keep each bird's captivity as brief as possible. If you have multiple birds at once, process birds one at a time in the order that they were captured, unless a bird is struggling excessively. Auklets overheat easily, and if at any time during the banding process a bird's bare parts begin to feel warm or the bird looks dazed and begins panting, quickly finish what you are doing, even if it means not recording all the information, and put the bird down gently on the rocks until it recovers and flies away.

Each adult bird will be weighed, banded, and measured. Only adult birds receive color band combinations, as sub-adult birds (two-year-olds) are not guaranteed to return to the banding plot once they are mature breeders. Sub-adults can be tricky to identify because they are variable in appearance, but are generally distinguished from adults by the worn and pale or brownish color of their primaries and secondaries, and brownish foreheads with less conspicuous plumes, in contrast to the dark grey or slate color and crisp white plumes of adults (Figures 4 and 5). In addition, sub-adults may have spotted or barred throats (adults are pure white) and bills that are fainter red or brown (adults are bright red). If you capture sub-adults and you have the time, band them with a metal band only. This should be a low priority if you have other birds waiting in the queue, because the proportion of birds banded as sub-adults and recaptured as resident adults in later years on the survival plot is very low.

While the bird is still in the bag, weigh it to the nearest gram with a Pesola® scale. Then choose an available color combination from the banding matrix (Figure 1), record it in your data notebook, and cross off the combination on the matrix datasheet so that you don't use it again. Doing all this while the bird is still in the bag and not struggling in your hand reduces the chances of misrecording the band combination or using a duplicate color combination.

Once a bird has been weighed and a color combination has been selected, apply a size 2 stainless steel USFWS band to the *left leg*. Some people prefer to remove the bird from the bag to band it - holding it in your left hand, with its back against your palm and its head between your index and middle fingers and grasping the leg to be banded by the foot between thumb and index finger (Figure 6). Alternately, you can keep the bird in the bag and hold it snug against your body to prevent it from struggling, and extract the leg to be banded out through the cinched hole in the top of the bag (this method may be helpful for people with smaller hands, but extra care must be taken to ensure you are putting bands on the correct legs - it is easy to get this confused when the rest of the bird is still hidden in the bag!).

Metal bands should be closed using needle-nosed or banding pliers until the two ends are flush

against each other. There should be no overlap and no gap wide enough that a fishing line or piece of netting could slip through (a good rule of thumb is the fingernail test: if you can fit your fingernail through the gap, it is too wide). Although you should band birds as quickly as possible to minimize handling time, be exacting and do not release birds with shoddy bands that may cause them harm!!! Stainless steel bands used for auklets are strong and somewhat springy, so most people find it easiest to use needle-nose pliers once they are experienced banders. If you feel more comfortable using banding pliers to close bands most of the way, you will probably end up with a slight gap that needs a final close with needle nose pliers to make the band ends flush. Always apply metal bands before any color bands in case the bird becomes stressed and needs to be released early; the banding permit **requires** all color-banded birds to have an accompanying metal numbered band.

After metal bands, apply three color bands to each bird based on the color combination selected: one on the proximal portion (closer to the foot) of the left tarsus and two on the right tarsus. Color bands can be tricky to put on and it is helpful to practice beforehand on a small twig or similar sized item before attempting it on a living auklet. Hold the color band in your right hand, with the outer end slightly open. The open end should face up, with the top corner propped against an index finger and the bottom corner lifted away from the rest of the band (Figure 6). That open corner is then hooked around the underside of the tarsus, with the rolled portion of the band still held in the right hand. To unfurl the band onto the tarsus, the top of the curled portion is grasped with the needle nose pliers and twisted firmly clockwise, with the free end of the band supported against the thumb of your left hand to keep from stressing the bird's tarsus. The process is then repeated, gripping only the innermost coil of the band with the pliers. As the rest of the band goes on, the free end remains on the outside of the fitted band. Ideally, the band will go on in two quick twists, in two or three seconds. Speed is important because a band stretched out for too long will fail to return to its original shape. A quick tight squeeze with your fingers or the pliers immediately after application helps mildly stretched bands regain their form.

**Color combinations should be double-checked before each bird is released**, paying special attention to which band is top and bottom on the right tarsus. If you have made a mistake with the color combination, such as banding a bird as red over orange when you were supposed to do orange over red, this **MUST** be fixed before the bird is released!). Also check that the metal band is on the correct leg (if you have put the bands on the incorrect legs, with metal on right leg instead of left, make a note of it in the banding data and shame yourself, but do not take the time to remove and replace all the bands). Ideally, double-checking of bands should be done by someone other than the person who did the banding.

After banding, record the following additional data as time/bird stress levels allows (see Figures 7 and 8):

Top priority:

- **Wing chord:** Measure the right wing from the bend in the wing to the tip of the longest primary using a 150 mm wing rule. With the right wing resting naturally against the bird's body, slide the wing ruler under the wing and press the vertical stop gently against the wrist joint. Measure this distance to the nearest mm. Wing should be relaxed, not flattened.
- **Diagonal tarsus:** Hold bird's right leg so both the foot and tarsal joints are bent at right angles. Place the inner jaw of the calipers into the notch at the tarsal joint and slide the outer jaw until it contacts the end of the tarsus just where the foot bends. Measure this distance to the nearest 0.1 mm. Always measure the right leg.

Secondary priority:

- **Brood patch development:** Classify as absent (0), partial (0.5), or full (1); find by running an index finger under the feathers, up along the side of the auklet from the base of the leg towards the head (against the direction of feather growth).
- **Exposed culmen:** Open the calipers so that the opening is wider than the length of the bill. Place the outer caliper jaw against the base of the bill (base of cere or feathering). Slide the inner caliper jaw until it just contacts the tip of the bill. Record culmen length to the nearest 0.1 mm.

- **Bill depth:** Open the calipers so that the opening is wider than the depth of the bill. At the widest part of the bill, place jaws against the top and bottom of the bill and slide closed until just barely touching bill on each side. Make sure calipers remain perpendicular to the bill length. Record bill depth length to the nearest 0.1 mm.

Record all information in Rite-in-the-Rain® data books (Figure 9). Before releasing the bird, make sure to double-check the color band combination and cross off that combination on the matrix of available band combinations. Weight of the empty bird bag after the bird is released.

If you encounter a bird that appears diseased (e.g., avian pox), take care to prevent spreading to other birds at the colony. Destroy the bird bag used with that bird (do not reuse with other birds) and clean all measuring and banding instruments with 70% ethanol.

If you recapture birds banded in previous years, record all the information you normally record for newly-banded birds. Check the condition of all bands (metal and colors) and replace any that are worn or damaged. To remove metal bands, use band spreaders to open bands enough to slip off the tarsus; to remove color bands, carefully peel bands open with your fingers. If you catch an adult bird that has only a metal band, this bird was banded as a sub-adult in a previous year: now that it is an adult and confirmed plot resident, add color bands. If you catch the same bird twice in the same year, you can just let him go.

At the end of the day (or at the very least, before you take your data notebook into the field again), enter the day's banding data in the electronic data file provided on your camp computer.

#### *Additional safety considerations for handling birds*

Monitor the condition of birds you are handling at all times and look for signs of injury or stress (e.g., panting, droopy eyelids, appearing dazed, shivering). If a bird starts having problems, release it immediately. If you encounter a bird that appears diseased (e.g., avian pox), take care to prevent spreading to other birds at the colony. Destroy the bird bag used with that bird (do not reuse with other birds) and clean all measuring and banding instruments with 70% ethanol.

#### **End of Season:**

At the end of the season when you are done with banding and food collection (uses noose carpets; see food collection protocol):

- Prepare noose carpets for next season. Clean globs of dried auklet droppings and food from the carpets as best as you can, cut off all damaged nooses and those that do not pass the highest levels of inspection (be ruthless!), and tie fresh nooses where needed.
- Update the banding matrix and the list of band and color combinations used based on what you banded this year.
  - Count how many band combinations are available for use next year. If there are fewer than 20-30 remaining, check to see if any previously-banded combinations can be made re-available. Birds not observed for at least 7 years can be considered dead and their combinations can be reused. Make a clear note in the banding database that this bird is considered dead and the combination will be reused, and make the combination available in the banding matrix. If fewer than 20-30 band combinations will be available for next year even after reusing those combinations that can be reused, speak to the biologist about adding an additional color to the banding dataset.
  - Print updated copies of the banding matrix and the band list for the notebooks for next year.
- Determine band needs for next year. Do a careful inventory of remaining bands. Using the updated banding matrix for next year, determine what bands need to be ordered for the next season.
- Prepare the resight database for next year. Make sure you add all birds you banded this year to the list.

Back in Homer:

- Ensure that banding data gets imported into Bandit and submitted to the Bird Banding Lab (check with your biologist).
- Advise the biologist on bands that need to be ordered for next year.

**Data analysis.**—Estimates of survival are based on the assumption that birds return to the same area of the talus each year. For auklets, to eliminate birds that were banded but were not really plot residents, we include birds in analysis only if they are resighted once after banding (either in the year they were banded or a subsequent year). This may bias our results slightly towards higher survival, as birds that die the winter after banding may not ever be added to the sample even if they were plot residents. You can lessen this effect by making an effort to resight auklets at least several times after you band to confirm residency status of as many newly banded birds as possible.

The resight datasheet on your computer contains a list of all birds ever banded (if band combinations are reused after 7 years without an observation, combinations should be clearly denoted “a” for original bird, “b” for second bird, etc.). From the raw resight data that you entered after every day, tally the number of times each bird was seen during the season. These totals should be entered in the tables for auklet resight history on your computer and in the report. Generally, a bird needs to be resighted only once to be counted as “seen” for the year. For birds seen only once, however, we apply a rule of parsimony to exclude those that appear to have been errors based on resight history. If a bird is seen just once and is either known to be dead or has not been seen for five years, assume the resight record was a mistake and do not include it in your data.

We summarize survival data by calculating apparent annual survival (true survival estimates are made irregularly in the Program MARK, but require detailed model fitting based on the question at hand.) Apparent survival is the ratio of the number of birds resighted in the current year to the number of birds alive the previous summer. Birds banded in the current year aren’t included in any survival calculations until next year. To summarize survival data, you will use resight history to calculate:

No. birds banded in cohort year: essentially the sample size of banded birds and equals the sum of all birds banded in a year and subsequently resighted at least once. This does not include birds banded but never again seen on the plot.

No. birds resighted in each year: how many birds you physically resighted (saw once) in the current year, broken up into each cohort year.

Birds seen in current year (A): the sum, across all cohorts, of birds you physically resighted in the current year, NOT INCLUDING birds you banded and resighted that year. This becomes your numerator in your estimate of apparent annual survival.

Birds potentially alive in previous year (B): the number of birds alive at the end of the prior season and thus potentially resightable going in to the current year. This includes the sum of (1) all birds resighted in the *prior* year, (2) any birds not resighted in the prior year but resighted in the *current* year and thus known to have been alive in the prior year (but just missed somehow), and (3) the number of new birds banded in the *prior* year (remember, only those resighted once afterwards are included). This becomes your denominator in your estimate of apparent annual survival.

Apparent annual survival (A/B): equals the number of birds seen in current year (A) divided by the number of birds potentially alive in the current year (B).

For the most part, you will enter and calculate values only for your current year. The exception is if you resight birds that had never been resighted before, which brings new birds into the sample. When this occurs, fill in the bird’s resight history in any past years (which would have been blank) with 0’s back to the year it was banded, and for whatever year the bird was banded, add this bird to the “Number of birds banded in cohort year”. Since you know now that this bird had been alive in previous years but just had

not been resighted, you may have to adjust “Birds potentially alive in previous year (B)” and “Apparent annual survival (A/B)” for whatever past years are applicable.

Only birds with unique color-band combinations can be used in survival estimates, so birds with metal bands only, birds missing bands, or birds with duplicate band combinations are not included in final survival calculations. For birds that were banded as sub-adults with a metal band only and then recaptured as an adult and given color bands in later years, consider the year banded or cohort year to be the year the bird banded with color bands (and not the earlier year when it was banded with metal only).

Also summarize your annual resighting effort by calculating the total number of resighting days, the average number of hours per day resighted, and the total number of hours spent resighting.

### **Literature Cited**

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ST GEORGE LEAST AUKLET BAND COMBOS (2003-2010)										
Right		Left (Metal on top, color on bottom)								
Upper	Lower	BK	BN	DB	DG	LB	O	R	W	Y
BK	BK		█	█						
BK	BN									
BK	DB			█						
BK	DG			█						
BK	LB									
BK	O			█						
BK	R			█						
BK	W									
BK	Y		█							
BN	BK									
BN	BN									
BN	DB			█						
BN	DG				█					
BN	LB									
BN	O					█				
BN	R						█			
BN	W							█		
BN	Y			█	█		█	█	█	█
DB	BK			█						
DB	BN									
DB	DB	█	█	█	█	█	█	█	█	█
DB	DG	█	█	█	█	█	█	█	█	█
DB	LB	█	█	█	█	█	█	█	█	█
DB	O	█	█	█	█	█	█	█	█	█
DB	R	█	█	█	█	█	█	█	█	█
DB	W	█	█	█	█	█	█	█	█	█
DB	Y	█	█	█	█	█	█	█	█	█
DG	BK									
DG	BN									
DG	DB	█	█	█	█	█	█	█	█	█
DG	DG	█	█	█	█	█	█	█	█	█
DG	LB	█	█	█	█	█	█	█	█	█
DG	O	█	█	█	█	█	█	█	█	█
DG	R	█	█	█	█	█	█	█	█	█
DG	W	█	█	█	█	█	█	█	█	█
DG	Y	█	█	█	█	█	█	█	█	█
LB	BK									
LB	BN									
LB	DB			█	█	█	█	█	█	█
LB	DG			█	█	█	█	█	█	█
LB	LB			█	█	█	█	█	█	█
LB	O			█	█	█	█	█	█	█
LB	R			█	█	█	█	█	█	█
LB	W			█	█	█	█	█	█	█
LB	Y			█	█	█	█	█	█	█

Right		Left (Metal on top, color on bottom)								
Upper	Lower	BK	BN	DB	DG	LB	O	R	W	Y
O	BK									
O	BN									
O	DB	█	█	█	█	█	█	█	█	█
O	DG	█	█	**	█	█	█	█	█	█
O	LB	█	█	█	█	█	█	█	█	█
O	O	█	█	█	█	█	█	█	█	█
O	R	█	█	█	█	█	█	█	█	█
O	W	█	█	█	█	█	█	█	█	█
O	Y	█	█	█	█	█	█	█	█	█
R	BK	█	█	█	█	█	█	█	█	█
R	BN	█	█	█	█	█	█	█	█	█
R	DB	█	█	█	█	█	█	█	█	█
R	DG	█	█	█	█	█	█	█	█	█
R	LB	█	█	█	█	█	█	█	█	█
R	O	█	█	█	█	█	█	█	█	█
R	R	█	█	█	█	█	█	█	█	█
R	W	█	█	█	█	█	█	█	█	█
R	Y	█	█	█	█	█	█	█	█	█
W	BK	█	█	█	█	█	█	█	█	█
W	BN	█	█	█	█	█	█	█	█	█
W	DB	█	█	█	█	█	█	█	█	█
W	DG	█	█	█	█	█	█	█	█	█
W	LB	█	█	█	█	█	█	█	█	█
W	O	█	█	█	█	█	█	█	█	█
W	R	█	█	█	█	█	█	█	█	█
W	W	█	█	█	█	█	█	█	█	█
W	Y	█	█	█	█	█	█	█	█	█
Y	BK	█	█	█	█	█	█	█	█	█
Y	BN	█	█	█	█	█	█	█	█	█
Y	DB	█	█	█	█	█	█	█	█	█
Y	DG	█	█	█	█	█	█	█	█	█
Y	LB	█	█	█	█	█	█	█	█	█
Y	O	█	█	█	█	█	█	█	█	█
Y	R	█	█	█	█	█	█	█	█	█
Y	W	█	█	█	█	█	█	█	█	█
Y	Y	█	█	█	█	█	█	█	*	█

\* indicates bands are reversed (metal and single color on right, double color on left)  
 \*\* indicates bird observed dead

Figure 1. Sample band matrix data sheet used for selecting and recording color band combinations for auklets. White cells represent combinations available for use, grey cells are combinations already applied on birds. When using band matrix to record resight data, use a blank uncolored version of the matrix.

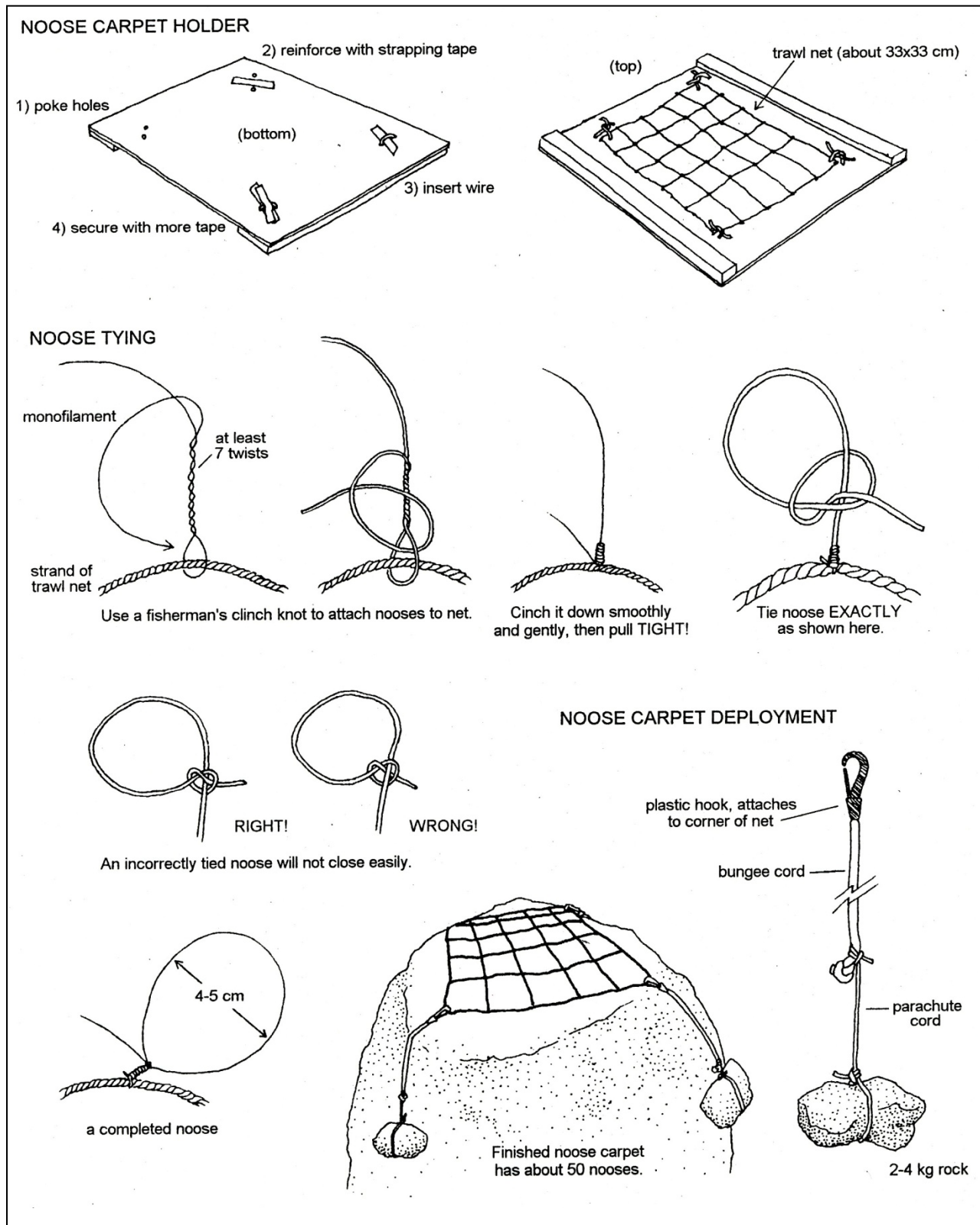


Figure 2. Diagram of noose carpet construction, storage, and deployment. Monofilament should be 10lb or 12lb test.



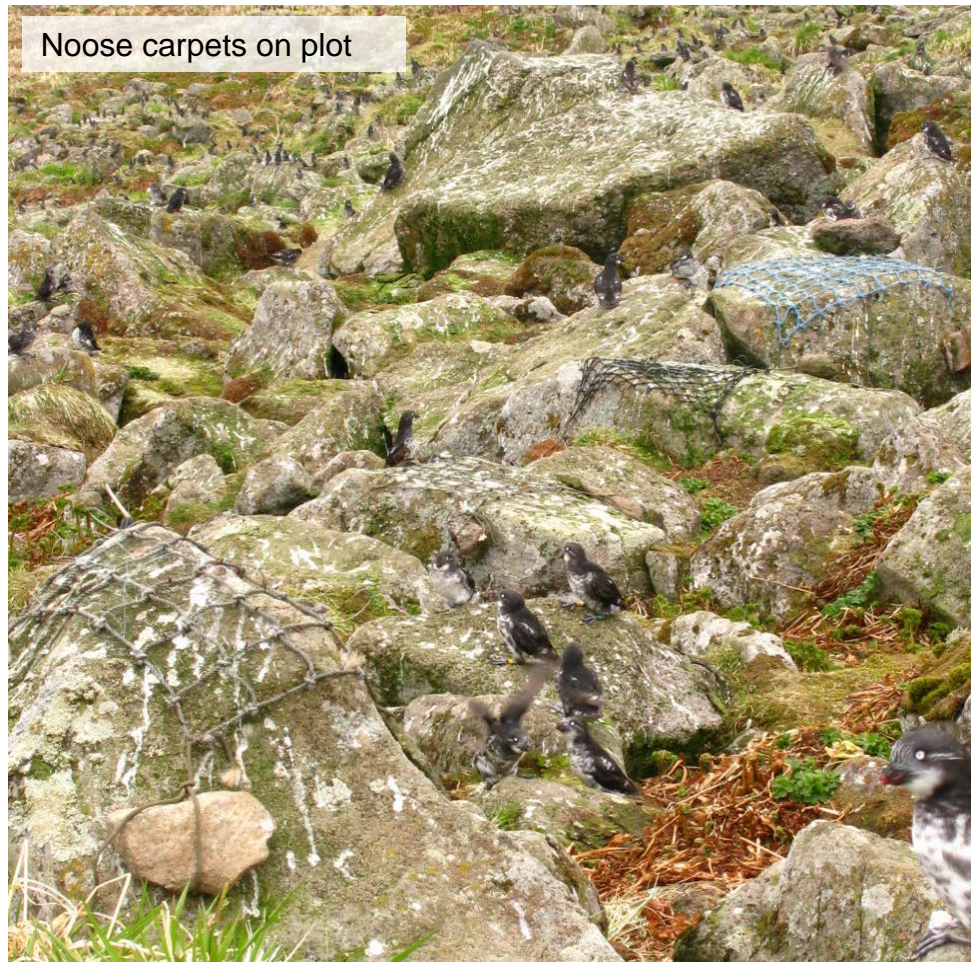
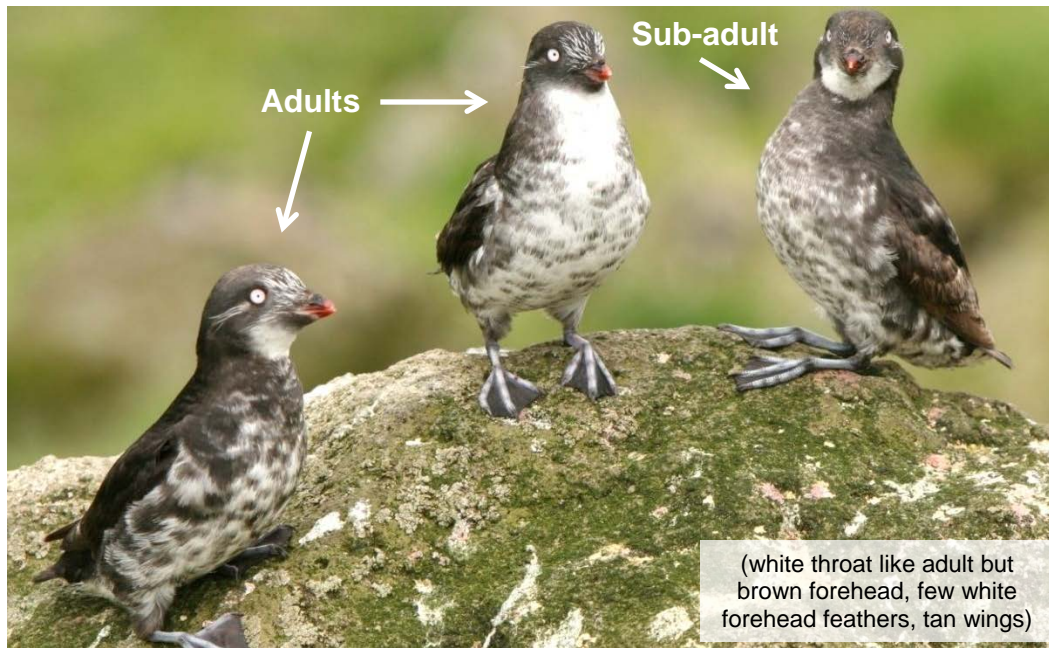


Figure 3. Pictures of noose carpets deployed at auklet colony.





### Sub-adult characteristics

Sub-adults can be tricky to identify because they are variable in appearance. They generally have some or all of the following characteristics (asterisks indicate the most common signs):

- Brown forehead\*
- Few and/or small white forehead feathers\*
- Light brown wing tips (worn looking)\*
- Bill lighter red or sometimes brownish
- White throat patch speckled or grey
- General goofy or awkward social behavior



Figure 4. Characteristics of sub-adult least auklets.





Figure 5. Additional examples of sub-adult least auklet variations.

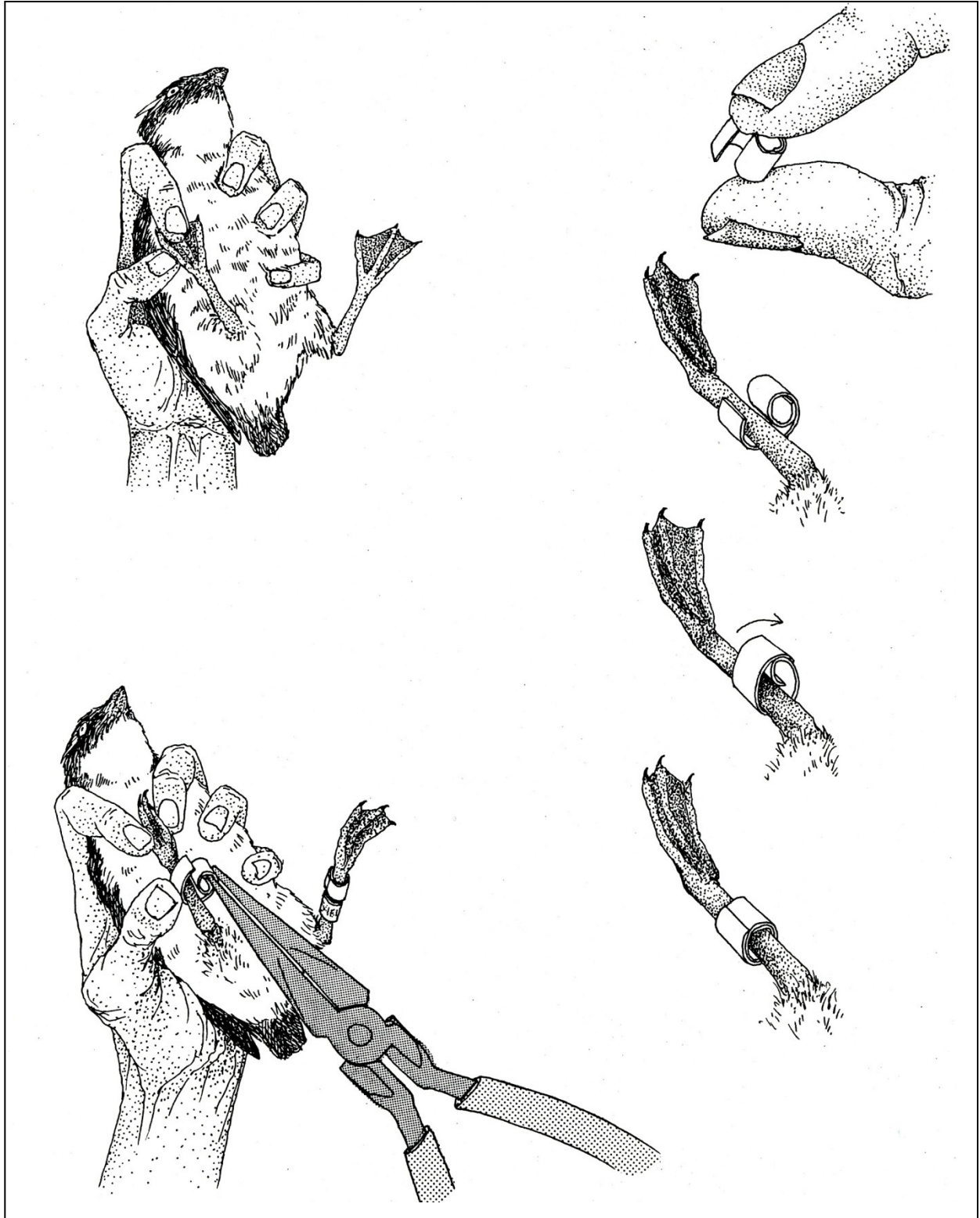
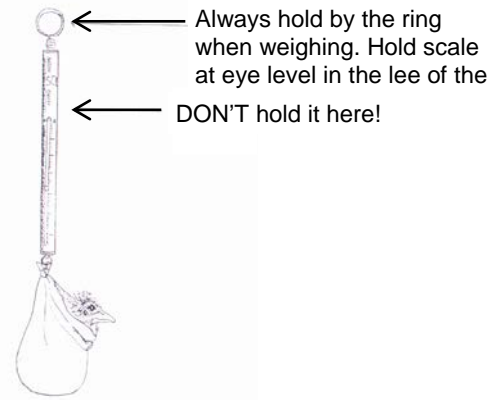


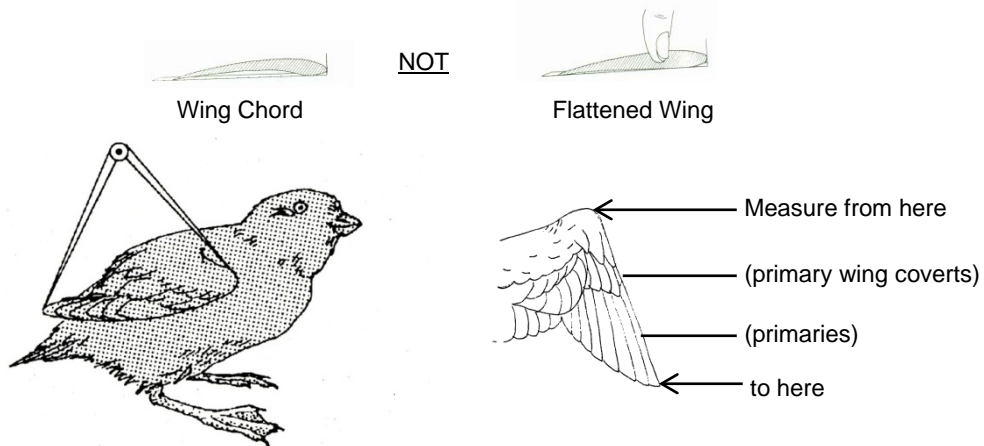
Figure 6. Techniques for holding auklets and putting on Darvic leg bands. Bands should go on with two quick twists of the pliers, while the strain is supported by the bander's thumb rather than the bird's tarsus.



**Mass** - Weigh birds using a Pesola® scale. Weigh the bag and bird and then the bag separately at end. Check bag occasionally for dryness.



**Wing chord** - holding the wing next to the body and using a metal ruler with a stop, measure to the furthest feather tip possible. Always measure the right wing.



**Diagonal tarsus** - length between the intertarsal joint and the distal end of the last leg scale before the toes emerge. Always measure the right leg.

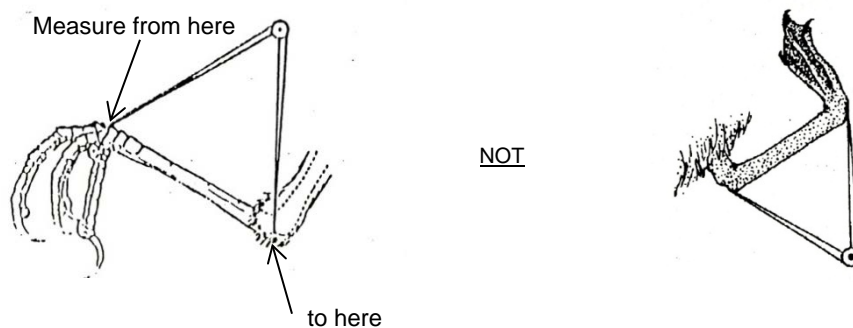
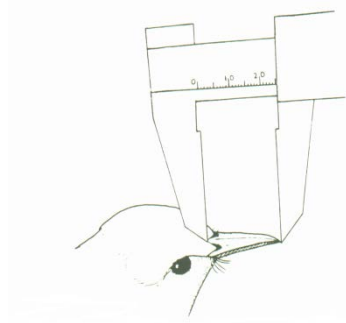
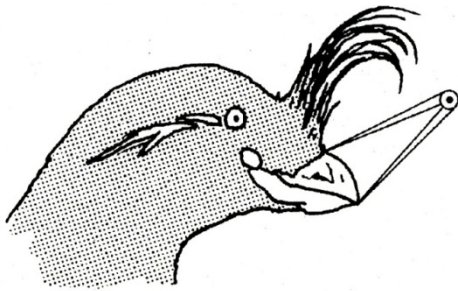
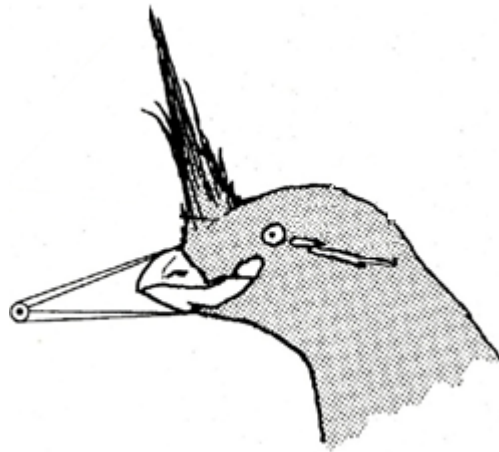


Figure 7. Diagram of standard auklet measurements taken during banding on the Alaska Maritime National Wildlife Refuge.

**Exposed culmen** - distance between the bill's tip and the edge of the feathering at the base.



**Bill depth** - distance between the bill's top and base, at the widest point.



**Brood patch development**

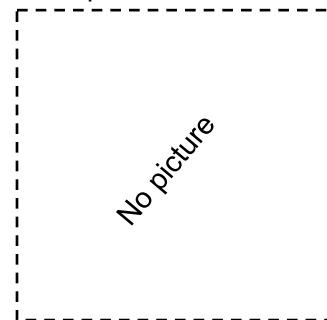
Full (1) – Large area fully bare and vascularized



Partial (0.5) – Some pink but small and not fully bare and vascularized



Absent (0) – Fully feathered brood patch, no bare areas



Note: Above photos are songbird brood patches; auklets have two brood patches, one on either side of their chest. Seabird brood patches are typically harder to find than songbirds because of thick feathers and down.

Figure 8. Diagram of additional auklet measurements taken during banding on the Alaska Maritime National Wildlife Refuge.



Least Auklet Banding							St. George Island 2004				
Date	FWS Band #	Colors	Mass w/leg	bag	Age	BP	Wing chord	Diag. Tarsus	Culmen	Bill Depth	Notes
16 June 04	802-01229	DB Y/W	90	15	Ad	1	92	19.1	8.0	6.2	
16 June 04	802-01230	DB Y/W	95	15	Ad	0.5	95	20.2	7.8	6.1	
16 June 04	802-01231	LB Y/W	90	15	Ad	1	100	19.5	8.2	6.5	
16 June 04	802-01232	—	80	12	Sub	0	90	19.0	7.5	6.1	Subadult, no colors
16 June 04	(R) 802-00010	R 010	90	14	Ad	1	101	18.2	8.1	6.3	Recap! Replaced worn R band on left
16 June 04	802-01233	Y Y/W	95	14	Ad	1	—	—	—	—	No measurements - stressed

Figure 9. Sample data book for recording banding data.

Attachment A. St. George Island specifics (includes Table A1, Figures A1-7)

## **BACKGROUND AND DESCRIPTION OF STUDY AREA**

On St. George Island, approximately half of the least auklets breeding on the island nest in a large, inland colony on Ulakaia Ridge, about 1 km from the sea. The colony is approximately 1 km long and contains about 90,000 auklets (Renner and Renner 2010). The remaining birds nest in scattered pockets in the sea cliffs and beach boulders around much of the island. Rubble from recent construction on the southern harbor has created additional new habitat for least auklets on St. George.

A survival plot was established at the Ulakaia colony (Figures A1-4) on St. George in 2003 following a rockslide that destroyed the least auklet survival plot on neighboring St. Paul Island (Harding 2003). Unlike similar colonies in the Aleutians, the colony contains no other auklet species. The 10m x 10m plot is located part way up Ulakaia Ridge in an area with relatively high nesting density and low vegetative cover. A low stone wall constructed in one corner provides acts as a blind for resighting (Figures A4-5). Plot boundaries were originally marked by white stakes in the corners but these markers have been missing since 2008. Plot markers for surface count plots at the Ulakaia colony are sometimes removed or destroyed by local children over the fall and winter so keeping the banding plot unmarked and thus relatively unobtrusive to observers from below may help minimize disturbance to the plot. It may be helpful to paint the corner rocks every few years to define the plot boundaries better.

Arctic foxes are common predators at the Ulakaia colony and are frequently observed catching birds throughout the season. Large groups of auklets will flush from the colony surface as a fox comes through but birds usually return relatively quickly. Aerial predators at Ulakaia are relatively rare: there are occasionally snowy owls but no gulls, which prey heavily at many auklet colonies in the Aleutian Islands. The local community is permitted to harvest eggs for subsistence at the colony and the degree to which this happens varies from year to year.

## **PROCEDURE DETAILS SPECIFIC TO ST. GEORGE**

The auklet socialization period at the Ulakaia colony at St. George is typically 1000h to 1600h but can vary somewhat between years and during the season (birds may end socialization by about 1400h early in the season but may stay until 1600-1700h as the season progresses).

In some years of heavy snow cover, the banding plot may be covered with snow in May - this makes for ideal resighting conditions because the birds socialize on the snow surface without any rocks or vegetation to obscure your view, so make every effort to begin resighting immediately upon arriving on the island in the spring (see Figure A6). Use Table 1 as a rough guide of what resighting effort to aim for; continue resighting until you have stopped seeing any new individuals.

### Special considerations for working at the Ulakaia colony at St. George

The Ulakaia Ridge colony is about a half-hour hike over the tundra from town (on a clear day, you can see the ridge from town). To get to the trailhead from the Washhouse or Cottage C, go behind the health clinic, cross the empty lot with the large standing pole (used for the grease for the 4<sup>th</sup> of July), cross the boardwalk made of pallets, and head for the last arch of houses before the tundra begins. The trailhead is located in between two houses (Figure A7). The trail deteriorates once you get up over the first ridge, so it isn't the end of the world if you aren't able to find the trailhead (and some people make their own trails). Simply walk straight south towards Ulakaia Ridge and look for flags and painted rocks (you can use the coordinates for the least auklet blind [N 56.58652°, W 169.55038° in WGS84] to orient to the productivity area, see Figures A3-4). In some past years, crews have driven up to the Conex by the water tower and walked from there, but the community asks that we do not leave vehicles there; either get someone to drop you off or walk the whole way.

Young kids from town are often curious about where you're going when heading off into the tundra and will sometimes attempt to follow you to the colony. While it is great to educate them with the biology that the refuge is doing on their island, you should not let them tag along to Ulakaia Ridge. Few kids in town hike much around the island off the road system, so they can get lost easily when trying to find their way back to town on their own. Even though it may seem that kids roam free unsupervised, never take children anywhere without first speaking to their parents.

As with other places on St. George, foxes are present at the auklet colony and will happily mark anything you leave on the ground away from your direct supervision. Never walk away from your pack or anything else, even for a short time, unless you are prepared for foxes to pee on it.

You will likely get sweaty hiking over the tundra to the auklet colony and then uphill to the survival plot, consider bringing a complete change of clothes. You will be much happier and collect better data if you are warm and dry instead of shivering in damp clothes for a 3-4 hour resight session.

When entering or leaving the blind, approach the plot from the west side to minimize disturbance to the survival plot. Birds will flush upon your arrival but will return more quickly if you attempt to sneak in from the side and don't walk across the plot itself.

Table A1. Resighting efforts for least auklet survival at St. George 2003-2010.

	2003	2004	2005	2006	2007	2008	2009	2010
Resighting effort								
Days	20	28	26	28	22	13	24	20
Hours	>52	53	95	62	?	51	86	79
Resighting dates								
First	9 Jul	12 May	19 May	18 May	18 May	18 May	18 May	17 May
Last	1 Aug	22 Jun	?	8 Jul	14 Jun	20 Jun	19 Jun	20 Jun

#### Literature Cited

- Harding, A.M.A. 2003. Least auklet adult survival and colony mapping: St. George 2003. U.S. Fish and Wildl. Serv. Rep., AMNWR 03/14. Rev. 1. Homer, Alaska.
- Renner, H.M. and M. Renner. 2010. Counting the countless: estimating the number of least auklets attending the colony at St. George Island, Alaska. *Western Birds* 41:168-173.

#### **Specific Requirements for St. George**

##### **Resighting**

Dates: Begin as soon as you arrive on St. George (mid-May ideal), continue through the early breeding season (mid- to late June) until you no longer see any new birds.

Optimal sample size: Record every banded bird you see; we attempt to maintain a banded population of 200 birds.

Time of day: Anytime during auklet socialization period, most productive in recent years between 1000h and 1600h.

Weather: Any type of weather, although attendance may be lower on the stormiest of days. The blind faces north, however, so when raining and very windy out of the north, it can be difficult to keep binoculars clean long enough to resight effectively.

Equipment needed: 10x binoculars, Rite-in-the-Rain<sup>®</sup> notebook, clipboard, two pencils, lens cleaning cloth, warm clothes and extra layers, hand warmers, snacks and thermos full of hot drink, watch, crazy creek chair, old pillow stuffed inside drybag (optional for comfy seating and booster seat for short people, can be left on plot for season).

**Banding**

Dates: Mid- to late June.

Optimal sample size: We attempt to maintain a banded population of 200 birds. Use the number of birds resighted in the current year as a judge of how many you need to band to keep the population up at that number.

Time of day: During peak auklet attendance period (in recent years between 1000h and 1600h).

Weather: Optimal weather conditions consist of cool, overcast days with light winds and no precipitation. Caution should be exercised when it is warm and sunny, or wet and windy. Avoid handling birds in the rain.

Equipment needed: 10x binoculars, Rite-in-the-Rain<sup>®</sup> notebook, clipboard, two pencils, noose carpets and accoutrements, tackle box with banding supplies (size 2 stainless steel USFWS bands, size 2 Darvic color bands, needle-nosed pliers, banding pliers, 300 g Pesola<sup>®</sup> scale, 100 g Pesola<sup>®</sup> scale, calipers, 150 mm wing rule, small scissors or knife), 10-15 bird bags, color combination matrix (for ease of telling which band combinations are available to use), warm clothes and extra layers, hand warmers, snacks and thermos full of hot drink, watch, crazy creek chair, old pillow stuffed inside drybag (optional for comfy seating and booster seat for short people, can be left on plot for season).

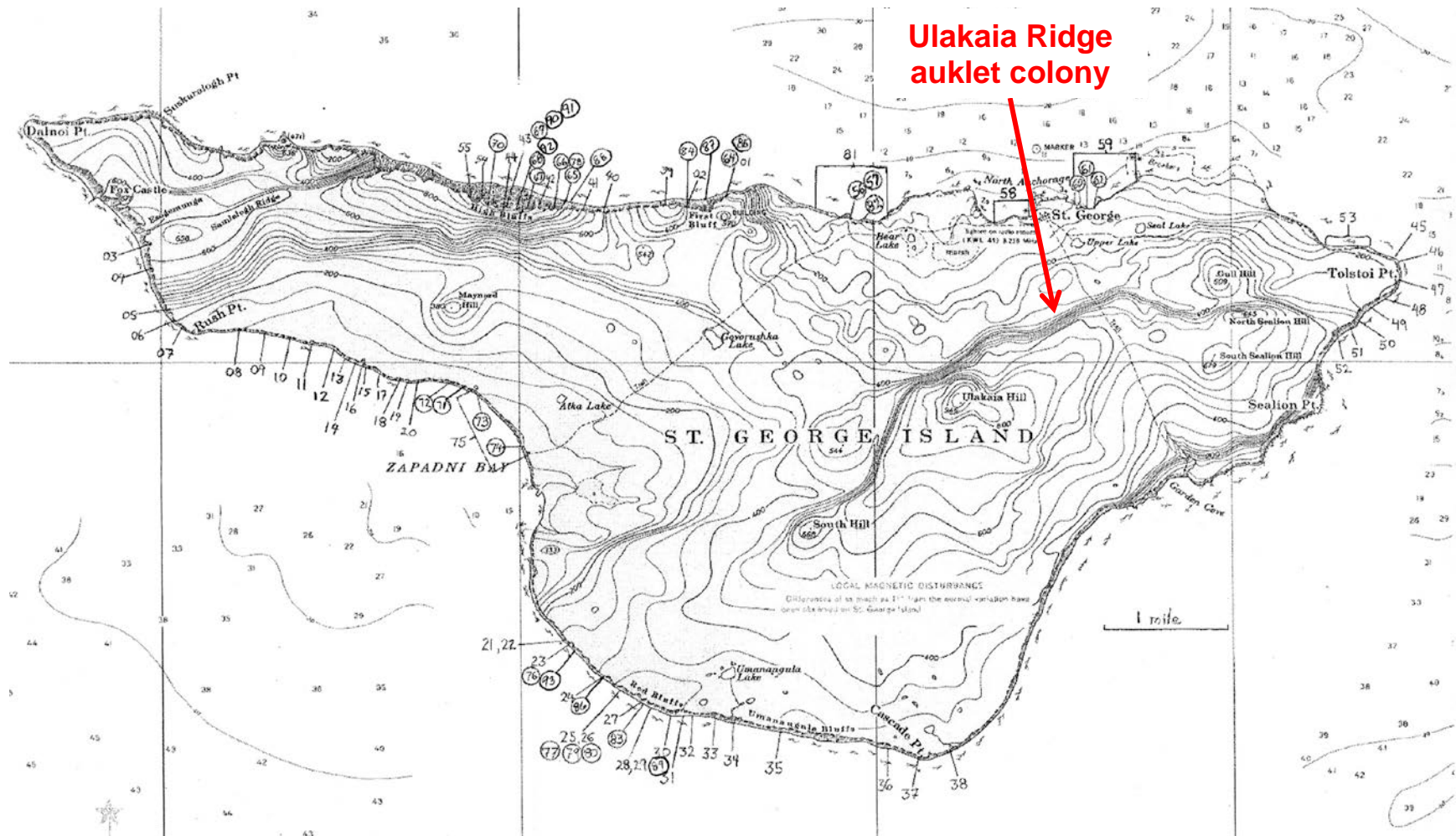


Figure A1. Map of Ulakaia Ridge colony location on St. George Island.



**Ulakaia Ridge Colony**  
View from north

**General locations of auklet plots**

- Yellow – survival plot
- Red – productivity nests
- Blue – artificial nest boxes



Figure A2. View of Ulakaia Ridge colony, St. George Island, from the north (the approach from town).



**Least Auklet Survival Plot**  
View from blind looking NE

Plot is 10m<sup>2</sup> square in front of blind  
Yellow arrows indicate corners of plot (4<sup>th</sup> corner is blind)  
Dashed lines indicate rough boundaries (not accounting for 3-  
dimensional terrain)

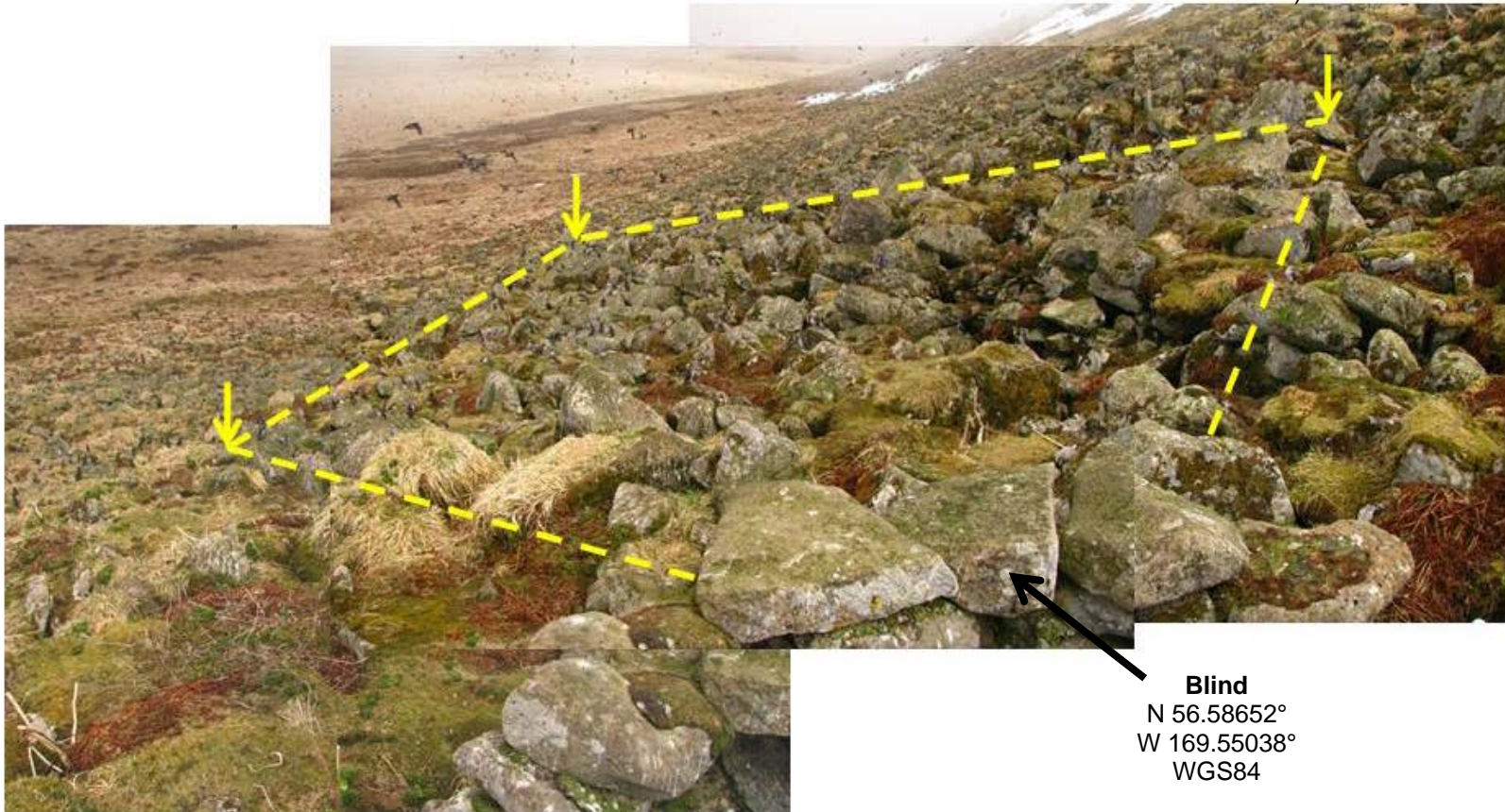


Figure A3. View of the least auklet survival plot at St. George Island looking northeast from stone wall resighting blind.



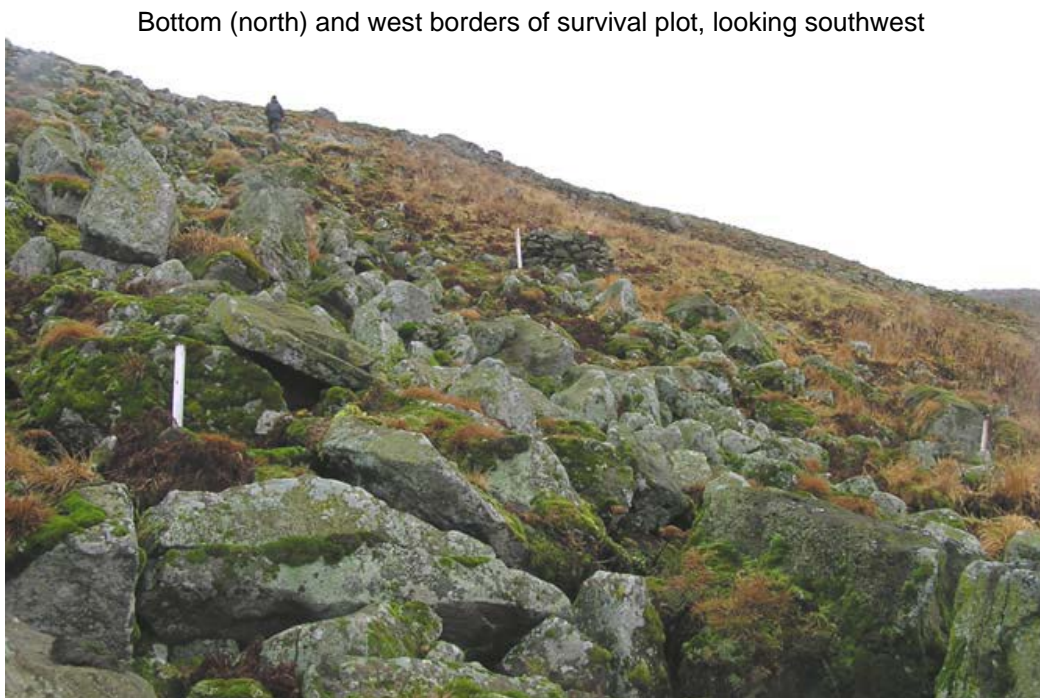


Figure A4. Views of least auklet survival plot at St. George Island. Photos show original white plot markers installed in 2003; these markers are no longer present.



Blind with plot in front



Banded auklet



Resighting from the blind



Figure A5. Resighting and banding pictures from St. George Island.

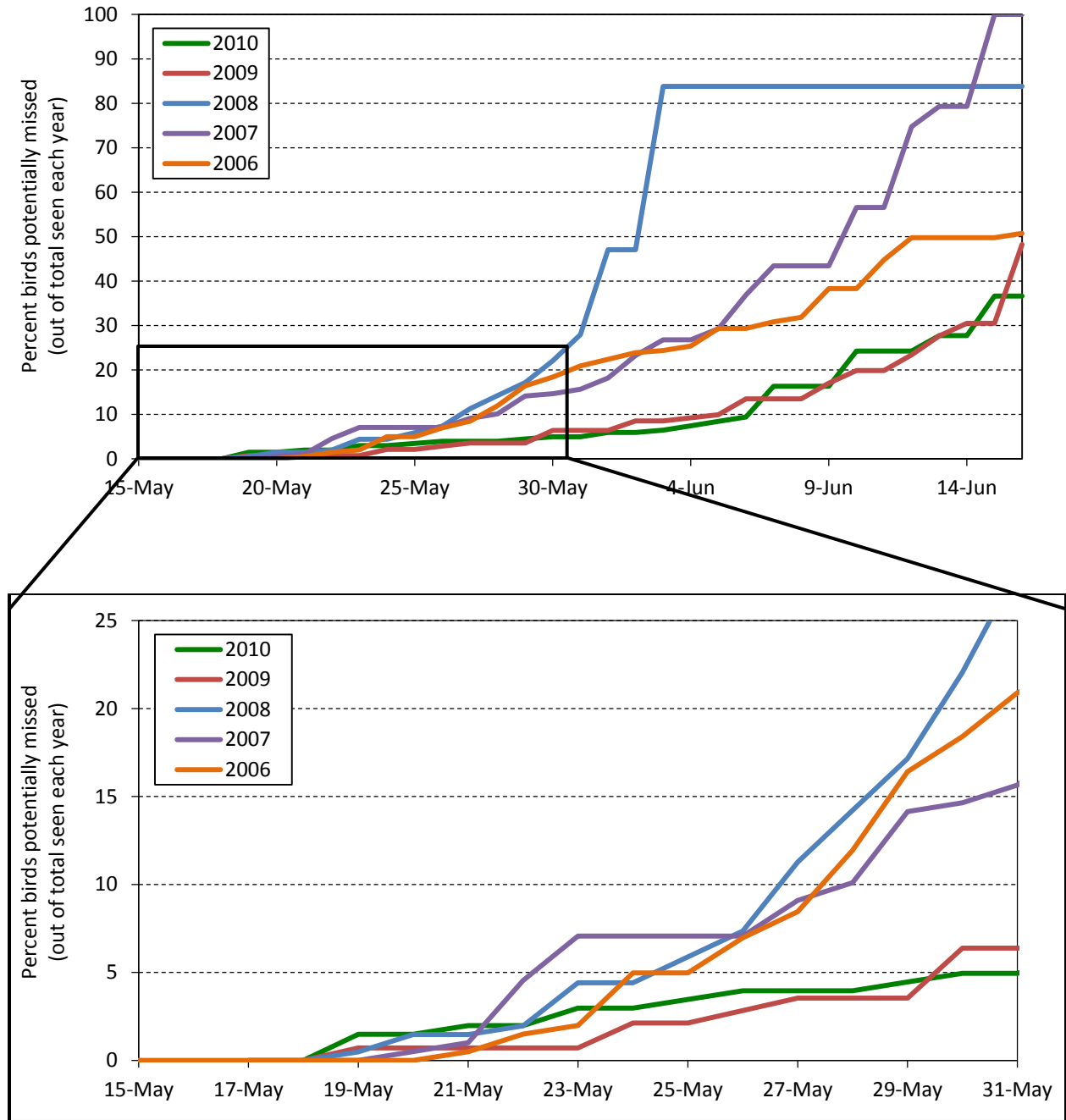


Figure A6. Importance of early-season resighting of least auklets at St. George Island. Values represent the percent of banded birds that would have been missed each year if resighting had begun on dates (x-axis) in late May and June. For example, if resighting in 2007 had begun on 23 May (instead of the actual start date of 18 May), 7% of birds would have been missed. Differences among years may represent variation in both auklet timing of breeding and resight effort.



**Trailhead to Ulakaia Auklet Colony**

N 56.59926°

W 169.54727°

Datum WGS84

(trail ends when you reach tundra at top of first ridge)



Figure A7. Trailhead to Ulakaia Ridge colony, St. George Island. Walk straight south (by compass or GPS) from here to the colony.

**Protocol Revision History Log**

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Revision Date	Changes made	New version #
April 2015	Made several minor changes and additions per IACUC	1.2
April 2014	Changed font to Arial, added revision history log, replaced revision date with version # on first page, added protocol # to first page, changed number format of tables and figures in island attachment, changed page number format to include protocol #, made minor grammatical edits	1.1
May 2011	Protocol developed in standardized format from historic protocols, includes St. George attachment	1.0

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