Wildlife Inventory Plan
Alaska Maritime National Wildlife Refuge
Protocol #7

Version 1.6

Parameter: Productivity and phenology

Species: Least, crested, whiskered, and parakeet auklets; horned puffin (and sometimes tufted puffin)

PURPOSE

To estimate annual productivity and phenology of crevice-nesting auklets and puffins and to detect between-year differences of 0.2 fledglings/pair (power = 90% at 0.1 level of significance). Seabird reproductive parameters can serve as indicators of change in the marine ecosystem (Cairns 1987, Montevecchi 1993). Auklets are the most abundant plankton-feeding seabirds in the Bering Sea, and puffins are important nearshore piscivores in the region, making them potentially valuable indicator species of marine resources in the Bering Sea.

BREEDING BIOLOGY

Auklets (*Aethia sp.*) and horned puffins (*Fratercula corniculata*), and sometimes tufted puffins (*F. cirrhata*), are colonial crevice-nesting seabirds that breed on remote islands throughout the Aleutian Islands and the Bering Sea. Least and crested auklets (*A. pusilla* and *A. cristatella*) occur together on many islands, often in dense colonies. Birds nest predominantly in crevices formed by old lava flows and talus slopes adjacent to the sea, although they will also nest in crevices in cliff faces. In mixed colonies, crested auklets tend to use larger boulders and crevices than least auklets. Parakeet and whiskered auklets (*A. psittacula* and *A. pygmaea*) often nest in areas similar to those used by least and crested auklets, although not as densely. Parakeet auklets may use a greater variety of habitat types, including earthen burrows and more vegetated areas of the talus, compared to the other auklet species, and are often found alone in loose colonies on lower cliffs just above the beach. Horned puffin nest sites may be more variable, but typically include larger rock crevices in talus slopes and cliffs and among beach boulders. Tufted puffins primarily nest in soil burrows but will also use crevices in talus slopes, among beach boulders, and in sea cliffs (Bedard 1969; Knudtson and Byrd 1982; Hipfner and Byrd 1993; Piatt and Kitaysky 2002a,b).

Timing of breeding varies across sites, with later phenology at higher latitudes. In the Aleutian and Pribilof Islands, auklets generally lay eggs from late May to mid-June, hatch from mid-June to mid-July, and fledge from late July to mid-August (see island-specific attachments for details at each monitoring site). In mixed auklet colonies, whiskered auklets may hatch earliest, followed in turn by least, crested, and finally parakeet auklets. Puffins breed later than auklets, with egg laying in late June or early July, hatching from mid-July to early August, and fledging in late August through September.

Both parents share incubation and feeding, with one off feeding while the other incubates or broods the chick. Length of breeding period for each species is listed in Table 1. Chicks of some species (notably crested and whiskered auklets) often stay in crevices long after they are old enough to fly. Once chicks fledge, most adults leave the colony for the season (Byrd and Williams 1993; Jones 1993a,b; Jones et al. 2002; Piatt and Kitaysky 2002a,b). Whiskered auklets are unique among the other species in that both adults and fledglings often return to the colony at night for a month or more after fledging, visiting nesting crevices and sleeping on the surface of the colony (Konyukhov and Zubakin 1994, Zubakin and Konyukhov 2001).

During the breeding season, auklets and puffins congregate and socialize to varying degrees above their nesting sites during a daily activity period. Timing and duration of activity periods vary dramatically between sites, but in general least and crested auklets and puffins are diurnal (although a peak of activity may occur in the evening or just before dusk). Parakeet auklets have less defined activity periods and may occur on the surface at all times, although activity generally peaks at dusk. Whiskered

auklets are almost solely nocturnal (Byrd and Williams 1993; Jones 1993a,b; Jones et al. 2002; Piatt and Kitaysky 2002a,b).

Table 1. Average incubation period lengths and minimum chick fledge age conventions for auklets and puffins. Chick fledge age conventions are the ages at which chicks are assumed fledged if they disappear at or after that date (chicks disappearing before that date are considered failed). Some of these fledge age conventions are currently under review by AMNWR biologists and may change in the future.

Species	Incubation period	Chick fledge age convention
Least auklet	30 d	25 d
Crested auklet	34 d	26 d
Parakeet auklet	30 d	29 d
Whiskered auklet	30 d	32 d
Horned puffin	40 d	34 d
Tufted puffin	45 d	38 d

PROCEDURE

***Data collection*.—**Auklet and horned puffin reproductive performance is monitored by viewing individually numbered crevices at 4-7 day intervals (depending on the time of the breeding season). Use flashlights to determine nest contents as quickly and unobtrusively as possible. Most tufted puffin reproductive success is monitored by following nests in soil burrows, described in a separate burrow-nesting protocol, but any tufted puffins found in rock crevices can be monitored following this crevice-nesting protocol described here.

Begin searching rock crevices for eggs in early to mid-June (depends on site and species, see island-specific details for more information). Check any marked nests you can find from previous years and look for additional new nests. Our sample size goal is 70 (minimum) to 100 (ideal) nests with known fate at the end of the season (a sample of 70 is needed to estimate productivity each year at an acceptable level of power, a sample of 100 is needed to compare productivity among years and sites; Thompson et al. 2010). Because it is not possible to obtain known fates for all crevices, you should begin by monitoring an extra 20 to 30 nests. (*Note - due to differences in population size, nest accessibility and work load, 70 may not be possible for all species at each site. Refer to island-specific attachments for sample size goals for each site*). Reuse of nests from one year to the next may vary across sites and years, so the number of new nests you need to find will depend on how many old nests are active in a given year.

When searching for and subsequently re-checking nests throughout the season, move stealthily through the talus to avoid scaring birds off their eggs – even the lightest footstep vibrates and reverberates down through the rocks in the crevices below. To minimize disturbance, limit your activity to times when auklets are not attending the surface of the colony whenever possible, and do not search an area more than once a day. You will have to contort yourself into awkward positions in order to get your face far enough into the entrance of a crevice to see its entire contents (Figure 1). Try to select only those crevices for which you can see the entire chamber. If there is anywhere for the chick to hide, you may be unable to determine the fate of that chick, and the crevice will have to be excluded from analysis (hint: if the adult bird can escape out of view when you check a nest, a chick will probably be able do so too). To facilitate getting down amidst the rocks and contorting your body into weird angles, wear kneepads and carry your supplies in a small fanny pack, as a backpack will severely limit your mobility (if you must carry more gear, such as extra clothes, stash your backpack in one place while checking a group of nests and then move it as you move to another part of the colony, rather than wearing it on your back).

Mark and number nests with waterproof paint pens initially, which is fast and unobtrusive and should last the summer. An effective way to mark a crevice is to paint its number in a conspicuous place, and then at the entrance put three painted dots at the corners of an equilateral triangle, the center of

which affords the best view of the site (Figure 1 and 2). This will help you check the crevice quickly and efficiently on future visits. Be sure to scrape away all moss or algae off rock faces with a wire brush before applying paint, or it will wash away (be quick and superficial on the initial visit to avoid scaring birds, you will do this more thoroughly at the end of the season). Draw maps of nest locations (Figure 3). To minimize time spent looking for the nest chamber on subsequent visits, it may be helpful to make a few notes outlining the best way to position yourself and which direction to look once your face is in among the rocks.

During initial nest searches and all re-checks during the season, attempt to determine the status of all nest sites and record it in a field notebook using the appropriate standardized code (see pages 7-8 to 7-10 and Figure 4). Record only what you saw and be sure to use the standardized codes *exactly* as instructed. Weird and unpredictable things can happen during observations and you may feel tempted to describe every detail and feel limited by the standardized list of codes and modifiers available. However, lengthy text explanations and comments tend to cause confusion later and cannot be interpreted by the database used to summarize the data. Choose a code then and there and stick with it-as the field biologist, you are the only person who can make a decision about what you saw that day. If you absolutely must record additional information about a nest, you can enter text in the comments section of the productivity data entry database, but keep in mind that this text is not used in any data summary so it should not contain any information pertinent to how the reproductive success data should be interpreted. Before leaving each nest, check to see that your recorded status makes sense based on what you saw last time (e.g., if you had a chick last visit, you shouldn't have an egg this visit). Data strings that don't make sense will have to be discarded. If you decide a particular nest site is problematic and should be tossed (e.g., grass grew during the season and obscured your view, or you aren't certain of the species), don't erase the data from your field notebook and electronic productivity data entry database but simply mark it as "exclude from analysis" in both places and indicate your reasons in the comments section for that nest in the database (see Database User's Manual).

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 plot data in the productivity data entry database (see Database User's Manual).

Check nests every 7 days throughout the breeding season, except around expected hatching and fledging periods, when intervals should be decreased to every 4 days to obtain more precise hatch and fledge dates. It is important to continue visiting a crevice even after the chick has reached minimum fledging age, in order to ensure the chick fledged (and did not die in the nest) and to calculate fledge dates and length of nestling period. Once a chick is gone, check the nest at least one more time to ensure the nest is indeed empty and the chick wasn't hiding somewhere (e.g., you end up with two N codes in a row). To minimize disturbance to other birds across the colony, try to stick to a regular route when checking crevices. To maintain optimal data integrity and to minimize the amount of time spent searching for exact nest chambers amidst painted dots (and thus lessen disturbance to birds), it is best for one person to check the same nests throughout the entire season.

Never purposefully disturb an auklet in your efforts to determine whether or not an egg has hatched. Try not to illuminate a crevice with your flashlight for more time than you need to determine nest status. Afterwards depart swiftly and quietly, much as a stealthy data ninja would do. Auklets do not exhibit reliable incubating or brooding postures, so if you see an adult bird but cannot see an egg or chick, you must record the nest status as BU (Bird Unknown). Birds sometimes run into a crevice at your approach and then hunker down as if incubating, so if no egg is ever seen, you must at least see the bird on two consecutive visits to assume the presence of an egg and include it as an active nest in your sample. If you find an unattended egg and it doesn't look like a leftover from last year, continue to monitor it. However, if you never see a bird attending it, exclude the nest from your sample (by manually excluding the nest as an inactive nest in the productivity data entry database; choose "inactive nest" from the drop-down box in the "exclude for productivity" field). If it never hatches, you won't know if it failed or if it was an abandoned egg from the year before. If it does hatch, it is likely the chick will hide in the same place the adult was hiding every time you checked the egg, resulting in a crevice with unknown fate.

If you see an egg or a chick, there are a few cases when you will need to record additional modifiers that provide more detailed information about the nest status (list of standardized code modifiers). For eggs, record if you see an old egg clearly from last year (Ely), a broken, crushed, or otherwise dead egg (Ed), an egg ejected from the nest (Ej), or an egg pipping just before hatch (Ep). Similarly, for chicks, record if you see a chick in the actual act of hatching (Co), a chick still wet from having recently hatched (Cw), or dead chick (Cd).

You must literally see the chick to record the presence of a chick; hearing it alone or seeing eggshells/membranes is not enough. If it is close to predicted hatch, or if you see fresh eggshells or hear chick sounds, scrutinize the nest extra carefully for a potential chick. Look for down poking up under the adult's wing or for tiny feet or bills sticking out. If you suspect a chick but the adult simply won't show you what it's hiding, here are some tips to aid you in seeing the chick:

- Focus your flashlight on the back of the adult - a chick will sometimes react to the light and move its head up for you to see, or sometimes it will wriggle enough that you can see the movement, or the adult will move enough for you to see the chick itself.
- Look at the adult's wings - sometimes they will shake or vibrate when the adult is brooding a chick and you can eventually see the chick underneath. In particular, look for a small bill sticking out from the top or sides of the adult's wing.

If you still cannot see an egg or chick and have to record BU (Bird Unknown), record any supplementary evidence of freshly-hatched eggshells (BUsh) or sounds of chick calling (BUcall; see list of standardized code modifiers). These do not provide enough evidence of a chick to determine hatch dates, but may be used by the database in analysis to help determine the overall fate of the nest in some cases. It is particularly important to minimize unknown nest status codes around expected hatching or fledging dates. In other words, ***it is important to see the nest contents the check before and after a chick hatches and fledges, and to reduce the visit interval as much as possible at those times. Even a single unknown status between observations of egg and a chick (e.g., BE BU C) may mean the nest could be discarded due to uncertainty during analysis.***

If your colony has multiple auklet/puffin species, you may not be able to identify the species on the first check (e.g., an unattended egg, or a brief view of the bird's butt without seeing enough identifying characteristics. Continue to monitor the nest, leave the species column in your data book blank for now, and fill in the appropriate species when it is determined (if species is never determined, use the species code to denote unknown species; see Figure 5 for some species identification hints and see Data Entry Protocol for species codes).

If your colony has puffins, some puffin nests will still be active when you leave the island at the end of the season. It is important to conduct a final nest check as close as possible to when you depart in order to get the best data on nest fate. Please keep this in mind when scheduling your nest checks towards the end of the season, and if you need to shorten the last check interval to get a final check completed, definitely do so!

End of Season:

At the end of the season when chicks have fledged and auklets have departed the colony:

- Mark nests more permanently for future years. You will need to paint any new nests you found in the current year, and probably repaint nests from previous years (including old nests that were not occupied in the current year but appear to be good quality sites). Do not bother permanently painting poor quality nests that did not yield a known fate – if you wouldn't monitor a nest again, chances are someone else won't want to either.
  - With a wire brush, scape away moss, lichen, and algae off rock face where you plan to paint to prevent paint from washing away (remember to scrape where you will be painting dots too). Then paint dots and a nest number with red acrylic paint. Paint can be applied with short, stiff paint brushes or popsicle sticks. It is important *not* to glob on paint heavily, as it will take longer to dry and flake off more easily over the winter. Try to paint only on dry days; paint that does not cure properly will not last the winter.
- Update final map (on the computer or hard copy) and ensure a clean copy is printed and ready to go for next year.

***Data analysis*.—**Since 2010, calculations for productivity and phenology parameters for these species have been automated in an Access database. Data should be entered and proofed as soon as possible each day after returning from the field (see Data Entry Protocol). Proofed data will be uploaded into the database for analysis at the end of the season.

Before your data is uploaded into the main productivity database for analysis at the end of the season, some nests need to be manually excluded for productivity to allow for proper analysis. Look through your data and ensure that nests with the following situations are manually excluded for

productivity:

- Nests with an egg for which you never saw an adult and can't confirm it was an active nest this year (e.g., E E E E E E E) (exclusion reason = "inactive nest")
- Nests that you stopped monitoring before the end of the season for any reason (exclusion reason = "stopped monitoring" or one of the other exclusion reason options that is appropriate)
- Nests that were just crappy and in retrospect you don't trust the data or are uncertain of the final nest status (exclusion reason = "poor quality nest")

  **This is essential for nests in which an egg was observed but later nest statuses are unknown U codes with no chick ever observed. Nests with data such as:

  BE BE E E E U U U U
  E BE E U U U U U
  U U BE U U U U U

  will be coded as "egg loss" when they should be discarded as "unknown fate". Please look extra hard for these kinds of nests in your data. For some reason, this seems to happen most often with puffin nests.

Check your Productivity Data Entry Manual for further details and explanations of appropriate reasons to manually exclude data from analysis.

The below analysis summary is included to help you to understand how your codes will be interpreted by the database. This should give you an idea of what constitutes "good" data vs. data that have to be discarded, which should help you schedule and prioritize your data collection efforts in the field. The intent is not to reproduce the detailed documentation for the database and analysis process.

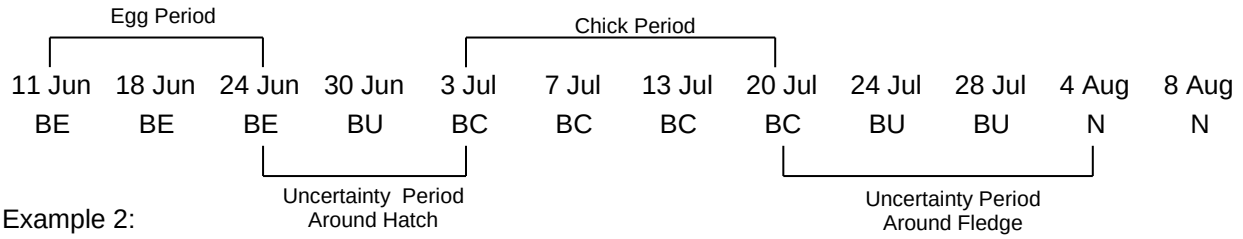
Phenology: Dates for chick hatching and fledging are calculated using the midpoint dates. The hatch date is the midpoint between the last time an egg was confirmed to be present and the first time a chick was confirmed to be present (if there was no midpoint [i.e., an even number of days between visits], we use the even Julian date closest to the midpoint; a leap-year specific Julian date calendar is used in leap years). Not all nest sites are included in phenology calculations; we require a confirmed egg and then a confirmed chick less than or equal to 7 days apart for that site to be used. Because of this, try to project when each nest is expected to hatch and focus extra attention on getting known statuses with short visit intervals around those times.

Occasionally, we record data that give us more exact information on hatching and fledging dates. If you observe an event occurring (e.g., the actual hatching and fledging) during your visit, we use the day of the observation as the date the event occurred and not the midpoint between observations. Similarly, if a pipped egg is observed, we assume it will hatch the following day; if a wet chick is seen, we assume it hatched that day.

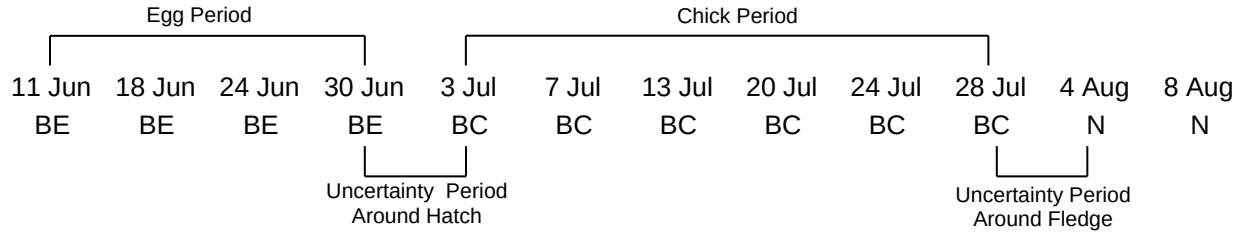
Productivity: Reproductive success is calculated as the number of known fate nest sites that fledged a chick. If a nest "fails", we keep track of what stage this happens (egg or chick period). Determination of the fate of eggs and chicks is not always straightforward because we visit nests only every 4-7 days. As a result it is necessary to adopt some conventions for consistency in interpretation.

Unless you actually saw the chick departing the nest, "fledging" is determined arbitrarily based on the age of the chick on the last date you saw it. This is determined by calculating the "egg period", "chick period", and "uncertainty periods" for every nest. The "egg period" is the number of days from the first definite observation of an egg to the last definite observation of an egg. The "chick period" is from the first definite observation of a chick to the last definite observation of a chick. There are some rules about what is and isn't allowed to be within the egg and chick periods but in short, the data should make logical sense (for example, an egg in the middle of a chick period would indicate a problem with the data and the nest site would be discarded). The "uncertainty period" accounts for both the visit interval and any visits with unknown statuses (e.g., BU's) around hatch and fledge events.

Example 1:



Example 2:



From the length of the chick period and the uncertainty periods, we determine the minimum and maximum possible age for the chick when it was last seen: a chick was at least as old as the length of the chick period itself, and could possibly have been as old as the chick period + both uncertainty periods. This information is then compared against fledging age conventions (see Table 1) to determine if the chick failed, fledged, or if the nest should be discarded due to too much uncertainty. If a chick would have been too young to fledge even at its maximum potential age (chick period + uncertainty), it is called failed. If a chick would have been old enough to fledge even at its minimum age (chick period), it is called fledged. If the chick would have fledged or failed based on the length of the uncertainty period, it is considered unknown fate and discarded from the sample.

In general, the larger the uncertainty period, the more likely a nest will be discarded because the chick's fate cannot be determined. Therefore, large check intervals and/or many BU/U statuses around hatch and fledge dates can cause a nest to be discarded from analysis. Keep this in mind when collecting data (e.g., keep check intervals short and take the extra seconds to look extra hard for chicks around expected hatch or fledge dates).

A practical note for auklets and puffins, however: you WILL get BU codes and there is often nothing you can do about it. Some birds will sit tight on their eggs/newly hatched chicks no matter what you do, and unlike kittiwake or murre productivity where you can sit for an hour waiting for a bird to move, we keep nest checks as brief as possible to limit disturbance to the breeding birds. In fact, it is ironic that the best, a stealthy data ninja who sneaks up on birds without disturbing them may actually end up with more BU codes than someone who bumbles all over the rocks creating lots of noise, making birds move off their eggs or chicks. Never under any circumstances purposefully disturb a bird (physically or by making noise) to see the nest contents. If hatch is expected, you can take an extra moment to look particularly hard in that nest for clues (using the tips listed above), but in the end if the bird doesn't move then you have to move on to the next nest and hope for a better nest status on the next check. Monitoring more than the target sample size of 70 to 100 nests will help make up for the inevitable loss of a number of your nests to unknown fate/uncertainty.

After determining a fate of each nest, the database will calculate summary statistics using all nests with a known fate (not including any nests excluded manually by the data collector or discarded by the database due to poor quality, unknown fate, etc.). For crevice-nesting auklets and puffins, the database will calculate:

- Nest sites with eggs (B) – number of nest sites containing any eggs
- Nest sites with chick (D) – number of nest sites containing any chicks
- Nest sites with chicks fledged (F) – number of nest sites that fledged chicks

From the above values, the following summary parameters are generated:

- Nesting success (D/B)
- Fledging success (F/D)
- Reproductive success (F/B)

For horned and tufted puffins, some additional summary values will be calculated. Puffin chicks often do not fledge before field crews leave islands at the end of the summer, so we also calculate a maximum potential reproductive success that includes all chicks still present at last check, even those too young to be called fledged (and thus excluded from conventional analysis). For this, the database will also calculate:

- Nest sites w/ young chicks still present (H) – number of nest sites containing chicks too young to determine if fledged or failed

From that, the following summary parameters are generated:

- Max. potential nesting success [(D+H)/(B+H)]
- Max. potential fledging success [(F+H)/(D+H)]
- Max. potential reproductive success [(F+H)/(B+H)]

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Standardized Productivity Codes: List of Productivity Codes (CREVICE-NESTERS)

Always use CAPITAL LETTERS for productivity codes

See list of "Important Rules to Follow" for more details on correct use

B	**Bird**	Adult bird occupying a nest site, with no egg or chick present. Used when the observer is sure the bird has no egg or chick (this code means a site is confirmed empty other than the adult bird, there is no need to combine B and N codes into BN). For kittiwakes, used between the time a nest is constructed and the first egg is laid, or after egg(s) or chick(s) is lost.
BU	**Bird w/ Unknown**	Adult bird occupying a site, with no egg or chick **visible**. Used when the observer cannot see the entire nest contents to be sure whether there is an egg, a chick, or nothing.
BE	**Bird w/ Egg**	Adult bird with an egg.
E	**Egg**	Egg present, with no adult. Use numbers and/or "+" to indicate more than one (e.g., E2+ = at least two eggs) Use standardized modifiers to describe special egg status (e.g., Ed = dead egg)
BC	**Bird w/ Chick**	Adult bird with chick.
C	**Chick**	Chick present, with no adult. Use numbers and/or "+" to indicate more than one (e.g., C2+ = at least two chicks) Use standardized modifiers to describe special egg status (e.g., Cd = dead chick)
U	**Unknown**	Nest site with nothing clearly visible. Seldom used - only when the observer is not sure of the nest contents (e.g., cliff nest site obscured by fog or other birds, crevice nest site offering a poor, incomplete view, etc). If an observer records "U" many times, especially at crucial times (hatch and fledge), the nest site may not be included in analysis.
N	**Nest**	Empty nest site. Used when an egg or chick that was in the nest has been lost and no adult is present. For kittiwakes, this code indicates that a nest structure from the current year is physically present, either before eggs are laid or after the nest fails.
NC	**Not Checked**	Used between the previous and current check, when a site was not checked (e.g., it was skipped on purpose) or could not be found on that date. This code does not have to be used at the very beginning or end of the season before checks begin or after checks end for a particular nest.

Standardized Productivity Codes: List of Modifiers

Always use lowercase letters for modifiers!

See list of "Important Rules to Follow" for more details on correct use

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Modifiers to egg status codes

Eo	**Egg lay observed**	Observer sees egg being laid; used only when event was actually observed, not simply suspected lay
Ep	**Egg pipped**	Hole in egg, sometimes chick bill poking through; hatch date determined to be following day. Note: do ***not*** use for eggs just starred (localized cracks in shell resulting from chick's chipping action, often occurs before egg is pipped)
Ed	**Egg dead**	Egg is obviously damaged or broken
Ej	**Egg ejected**	Egg once in a nest ejected outside the nest cup
Ely	**Egg last year**	Egg assumed to be from last year from appearance or other evidence

Modifiers to chick status codes

Co	**Chick hatch**	Observer sees chick hatch; used only when event was actually observed, not for pipping **observed** eggs, observations of newly-hatched wet chicks, or other reasons leading to suspected "probable" hatch. Do not combine Co modifier with Cw (see below) if you observe a hatching event that results in a wet chick; simply use Co to indicate hatch and not Cow/Cwo
Cw	**Chick wet**	Newly-hatched wet chick observed; indicates chick hatched that day but hatching event was not actually observed
Cd	**Chick dead**	Chick actually observed dead (not simply disappeared from nest)
Cf	**Chick fledged**	Chick actually observed in the act of flying (or jumping for murres) from the nest; very rare!

Additional clues to nest fate

sh	**eggshells**	Presence of fresh eggshell fragments in the nest. Used ONLY with Bird Unknown or Unknown status codes (BUsh or Ush) to give more information about potential hatch; there is no need to use with known status codes (such as C or N)
poop	**poop**	Presence of fresh poop in or at the entrance of the nest. Used ONLY with Unknown status code (Upoop) to give more information about potential presence of a chick; there is no need to use with known-status codes (such as C or N)
call	**chick calling**	Chick heard calling but not actually observed. Used ONLY with Bird Unknown or Unknown status codes (BUcall or Ucall) to give more information about potential presence of a chick; not appropriate to use with known-status codes (such as C or N)

Standardized Productivity Codes: Important Rules to Follow

Use capital letters for basic productivity codes and lowercase letters for modifiers. Do not use superscripts or subscripts for any modifiers. Do not put spaces between any characters.

Use numbers to indicate quantities of birds, eggs, or chicks greater than one (do NOT use 1 to indicate single numbers). Numbers should always go AFTER the code that the number describes.

e.g., B2E means two adult birds with a single egg
BE2 means a single adult bird with two eggs

Use a plus sign (+) when you can see at least some but not all nest contents in multiple-egg clutches. As with numbers, the plus sign should always go AFTER the letter code (and when more than one, also after the number) that is being described.

e.g., BE+ means an adult bird and at least one egg were observed but entire nest contents could not be seen to determine if there was anything more

BE2+ means an adult bird and at least two eggs were observed but entire nest contents could not be seen to determine if there was anything more

Some codes and modifiers can be combined when appropriate as long as order (see below) is maintained. For instance, with multiple-egg species, if one egg hatches before another so that there is an adult bird present with both an egg and a check, enter BEC.

The specific order in which these codes and modifiers are used is VERY IMPORTANT. The codes BEC and BCE, or BE2+ and BE+2, may mean the same thing to us but they are NOT the same to the computer database. Follow these rules for the correct order of codes and modifiers:

(1) Always write codes in the order of adult - egg - chick.

e.g., BE and not EB

(2) When adding modifiers (numbers, letters, or symbols that give more information), always follow the order of: main productivity code - letter modifier - number - plus sign

e.g., BEp2+ for adult bird with at least two pipped eggs
BE2Cd for adult bird with two eggs and one dead chick
B2E+Cd for two adult birds with at least one egg and one dead chick

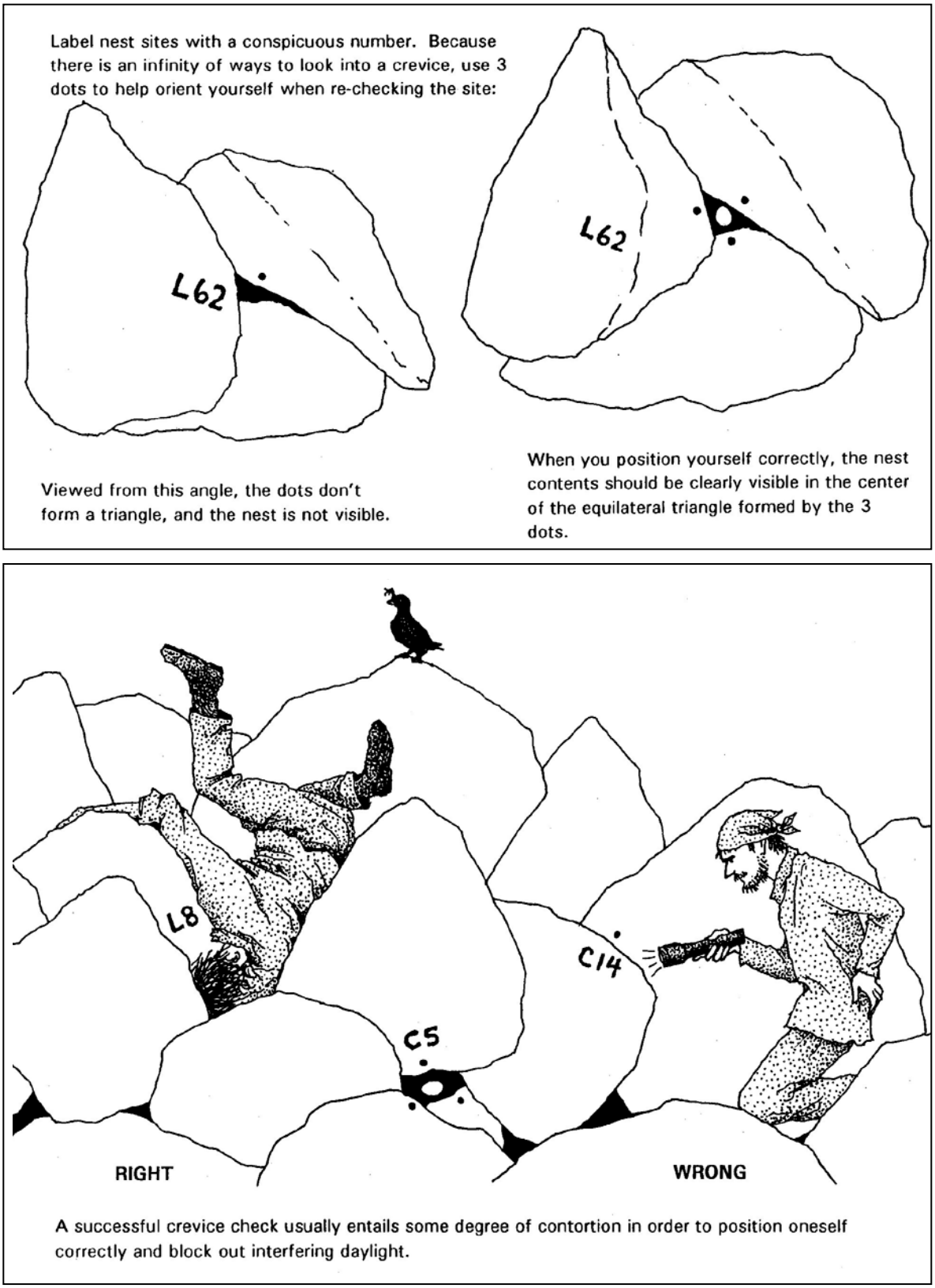
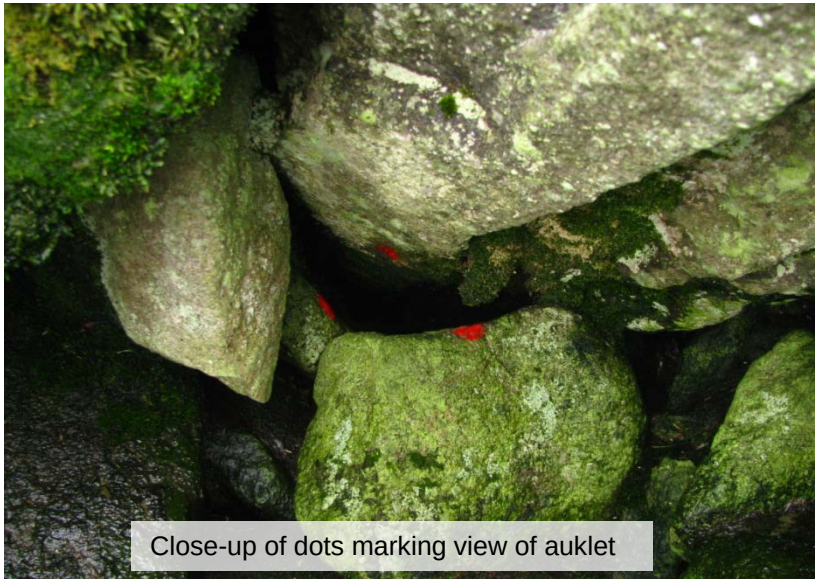


Figure 1. Diagram showing techniques for marking and viewing nest sites in crevices.

Auklet nest numbered and marked with flag



Close-up of dots marking view of auklet

Checking crevices

Figure 2. Examples of crevice-nesting breeding sites in talus rock fall areas in the Bering Sea.

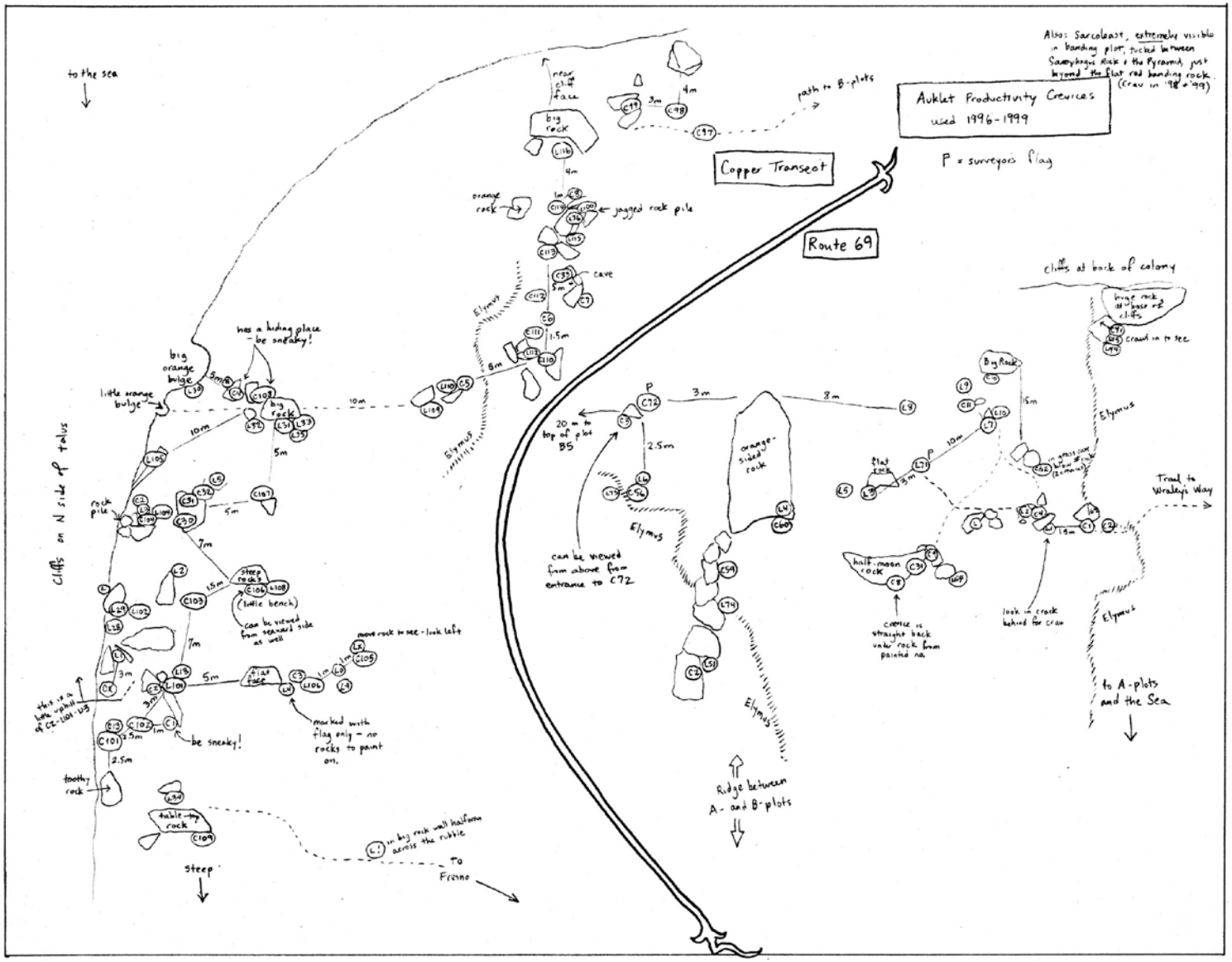


Figure 3. Example of map showing locations of nesting crevices used for monitoring productivity and chronology of crevice-nesting auklets and puffins.

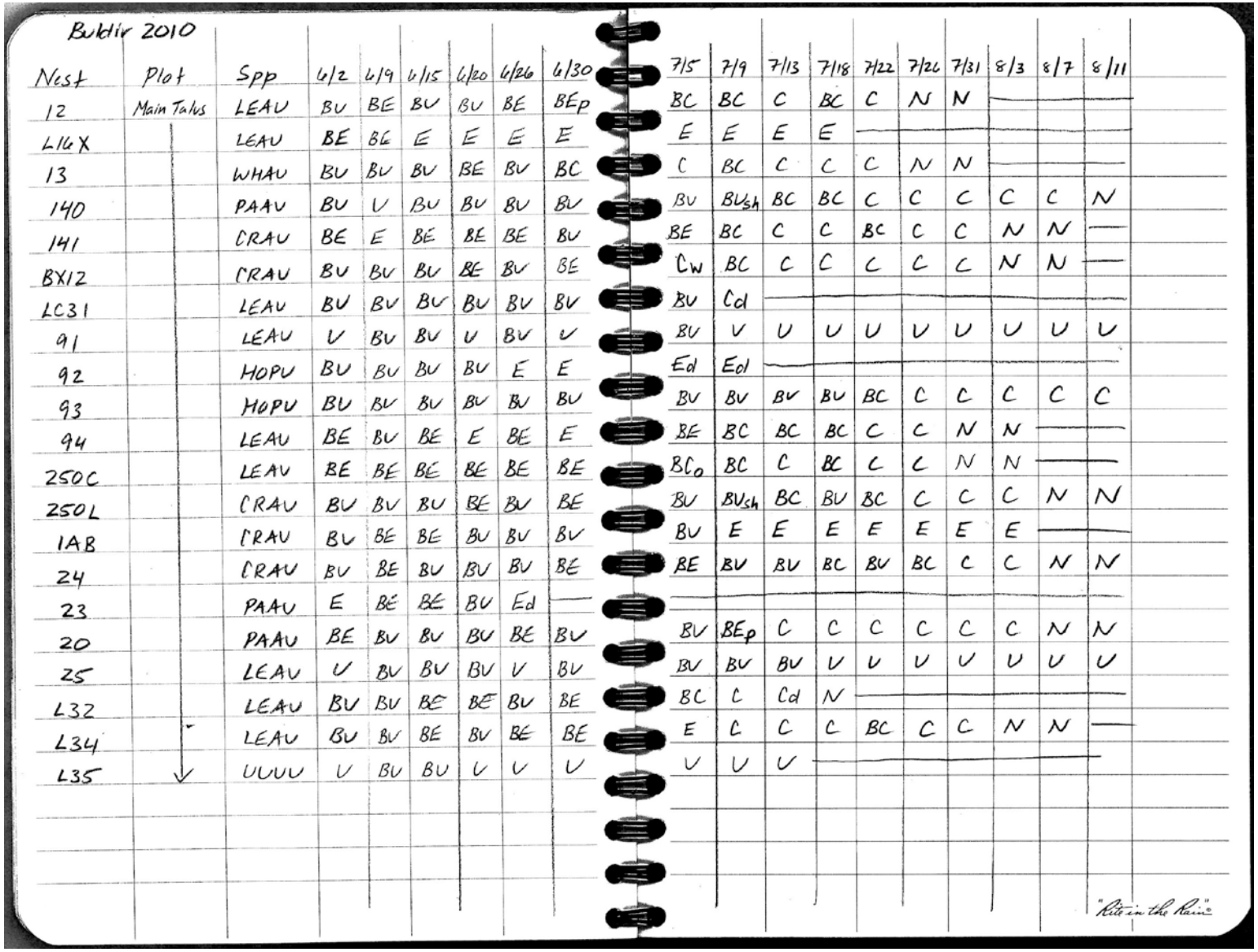


Figure 4. Example of data notebook page for recording crevice-nesting auklet and puffin productivity data.

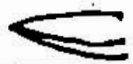
Size →	LEAU	WHAU	CAAU	CRAU	PAAU	HOPU	TUPU
Vent	Variable white with flecking	White/light	White	Dark	White w/ few dark feathers on side	White	Dark
Breast	Variable white with flecking	Dark	White	Dark	White	White	Dark
Feet							
Bill	Small-red with knob 	Orange/White 	Long, narrow chisel; Black 	Orange w/rictal plate 	Uplumed; Small lower mandible 	Large, bicolor: yellow/red 	Ridge on cere; Orange/ yellow, grn. 
Ornaments	White flecks on forehead	Auricular, super- and sub-orbital plumes, crest	White eyebrow	Auricular plume, crest	Auricular plume	Auricular stripe, eye projection	Blonde tufts
Habitat	Crevice: smaller rocks on talus	Crevice: talus, beach boulder, NW ridge	burrow: med-size 9-14 cm	Crevice: larger	Crevice: w/dirt floor or some earth component	Crevice: large	Burrow: large (>14 cm)

Figure 5. Clues for identifying crevice-nesting auklet and puffin species.

Attachment A. Aiktak Island specifics (includes Figure A1)

PROCEDURE DETAILS SPECIFIC TO AIKTAK

Horned puffins are the only crevice-nesting seabirds monitored for productivity and phenology at Aiktak Island. Several hundred horned puffins nest at Aiktak. Highest concentrations occur where suitable nesting habitat is most abundant, specifically Petrel Valley Cove, Pleasure Cove, Arch's Cove, and the coves adjacent to Four Sisters.

Monitor any accessible nest sites you find for productivity and phenology. In past years, most nests were located in crevices among the beach boulders of Petrel Valley Cove, with a few also in Pleasure Cove and around Four Sisters (Figure A1). You will *not* be able to find 70-100 crevices to monitor so just do as many as you can (you can use past years' sample sizes in the summary report as a guide).

Begin searching for nests in mid-July (mid-incubation). Use previous years' maps to check old nests and search for new ones. Horned puffins may be especially susceptible to disturbance and high rates of egg abandonment have been noted on Aiktak in past years, so please use care to be as quiet and unobtrusive as possible. Be aware that noise will reverberate loudly through rocks to the birds nesting beneath as you walk overhead or crawl about.

At the end of the season, paint nests well for next year and update any maps. Because good quality horned puffin nests are so few on Aiktak, every potential one for future years counts so try to document it for next year's crew well!

In some years, horned puffin chick growth is measured at Aiktak. This is only worth doing if you have at least five crevices that you think you can access for chick growth measurements. If so, refer to the Tufted Puffin Productivity Protocol for puffin chick growth instructions.

Specific Requirements for Aiktak

Dates: *Mid-July*: Search for crevices.
Mid-July to late August: Check nests every 4-7 days until chicks fledge (4-day intervals around peak hatch and fledge dates; 7-day intervals otherwise).
Late August: Paint and map nests for the next year.

Optimal sample sizes: As many as you can (70-100 is not realistic at Aiktak).

Time of day: Any time.

Weather: Any weather. Take extra care when rocks and vegetated slopes are wet because they can be dangerously slippery. On bright sunny days, your eyes take a long time to adjust to dark crevices and it can be difficult to see dark chicks against dark rocks.

Equipment needed: Fanny pack, knee pads, two bright flashlights (ALWAYS have a spare!) preferably with lanyards to prevent them from getting lost down crevices, spare batteries, small wire brush (for cleaning algae and lichen off rocks before paining them), paint pens, Rite-in-the-Rain® notebook, two pencils, maps of crevice locations.

Additional equipment needed for painting at end of season: Acrylic paint with brushes or popsicle sticks (for applying paint).

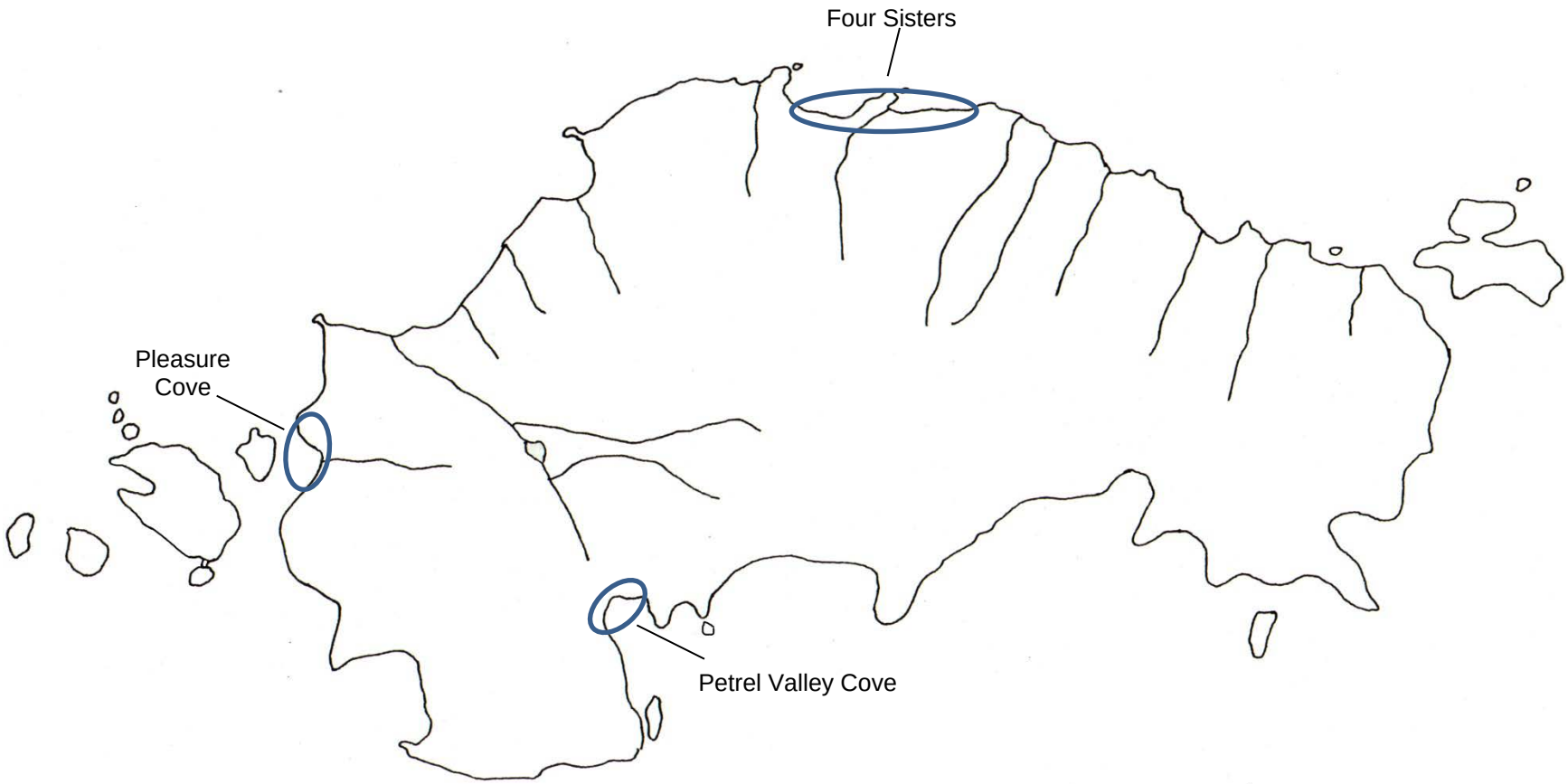


Figure A1. Map showing past concentrations of horned puffin nests at Aiktak Island. Locations are not exclusive, feel free to search for horned puffin nests elsewhere along the coast.

Attachment B. Buldir Island specifics (includes Figures B1-4)

BACKGROUND AND DESCRIPTION OF BULDIR ISLAND STUDY AREAS

Least, crested, parakeet, and whiskered auklets as well as both horned and tufted puffins nest extensively on Buldir Island. Despite their wide dispersal across the island there are four main areas where monitoring is conducted (Figure B1). Main Talus (Figure B2) is the largest crevice-nester monitoring plot and is about a 20-30 minute hike east from Main Camp along the north beach. It is divided into five sub-plots; Lower West, Lower East, Upper, Super Upper, and Puffin Annex. These areas are comprised of large fields of massive boulders and least, crested, and whiskered auklets and both species of puffin can be found within these plots. Note that East Puffin Annex suffered damage in the 2014 earthquake and in 2015, only the upper portion was used (see Figure B2); crews can use lower areas if it seems safe. In addition, the upper and middle blinds on Main Talus were removed in 2015, so these are no longer useful as geographic markers.

Northwest Ridge (Figure B3) is another plot located fairly close to Main Camp. It is divided into east and west halves and is accessed from the north beach to the west of camp. These hillside plots are characterized by steep slopes with considerably more soil and vegetation than Main Talus. This is a good area for monitoring whiskered and parakeet auklets and, with some extra effort, both species of puffin can be found here as well.

The south side of the island has two more plots. Bottle Hill (Figure B4) is located just east of the cabin at Spike Camp. Like Main Talus and Northwest Ridge, this plot is divided to facilitate searching and monitoring. The main species followed in these sub-plots are parakeet auklets and horned puffins with higher numbers of puffins in the upper plot. Farther along the trail to the west of the cabin, near the base of Peregrine Point is a small plot where parakeet auklet crevices have been found.

Hand drawn maps indicating the locations of previously marked and monitored crevices and the route through each plot are available in the “Auklet, Puffins, Petrels Maps” binder as well as on the camp laptop. These should be kept up to date throughout each season.

PROCEDURE DETAILS SPECIFIC TO BULDIR

With four species of crevice-nesting auklets and two species of puffins at Buldir, it is very important to spend time at the beginning of the season (before going to the field, even) learning how to identify the different species. Memorize the distinguishing characteristics of each species (Figure 5) and, if possible, spend some time in Adak studying up with the specimen collection (this may not be possible in years when crews ride the ship from Homer).

Whiskered auklets are generally the first of the crevice-nesters to begin laying, least and crested auklets are next while parakeet auklets and puffins tend to be the latest to initiate laying. Try to focus search efforts to reflect these differences in phenology in order to reach sample size goals. For instance, checks for whiskered auklets should begin within the first few days of June while searching for new puffin sites can continue well into July. Keep in mind that in areas such as Northwest Ridge where later-nesting parakeet auklets and puffins nest in addition to earlier-nesting whiskered auklets, some crevices that are unused during early checks may become active later on.

Buldir has the most crevice-nesting species monitored for productivity at AMNWR sites, so the ideal goal of 70-100 nests for crevice-nesting species isn’t practical here in most years. The following table provides some general guidelines of sample size goals and number of nests to start with (since a number of crevices end up being excluded from analysis because the fate is impossible to determine, you need to start with a larger number of sites to achieve the target sample size; this table is based on rough percentages of known-fate crevices in past years to assist in achieving adequate sample sizes).

	WHAU	CRAU	LEAU	PAAU	HOPU	TUPU
Goal	60	60	60	50	40-50	40-50
Start with	85-90	80-90	85-90	70-80	60-80	60-80
Top locations	Northwest Ridge Main Talus	Main Talus	Main Talus	Lower Bottle Hill	Upper Bottle Hill Main Talus	Upper Main Talus (Northwest Ridge)

For auklets,

- Sample sizes for **least and crested auklets** at Main Talus are the easiest to attain with a good search effort capable of yielding about 100 crevices for each species.
- **Whiskered auklet** sample size should be attainable through thorough searching of both Northwest Ridge and Main Talus (generally most on Main Talus, less from Northwest Ridge).
- **Parakeet auklets** can be more challenging since the majority of them seem to nest in dirt cliffs that are inaccessible so it's important to put in extra effort! Most parakeet auklet nests will be found at Lower Bottle Hill; if you need more nests, search other areas around Spike Camp (Historically they were plentiful at Northwest Ridge but recent crews have had trouble finding good sample sizes there). Don't be discouraged if you only find a few active nests on your first checks, you can get more while searching thoroughly for horned puffin nests in the Bottle Hill area later in the season. Also, historically many parakeet auklet nests were found in a plot near Peregrine Point; this plot no longer exists but for someone who is gung-ho, it may be worth searching the area and establishing a new plot there if enough nests are found.

For puffins, tufted puffin targets are harder to hit but every plot can yield at least a few sites. Never stop searching for or checking potential puffin sites as they may start late and seemingly unattended eggs may hatch.

- For **horned puffins**, Upper Bottle Hill is likely to have the most sites that can be monitored, although there are also many at Main Talus.
- For **tufted puffins**, Super Upper and East Puffen Annex on Main Talus are generally the most profitable plots. There are also lots of tufted puffin burrows above Northwest Ridge but likelihood of crushing burrows is very high there so most crews don't go there; if you do follow nests there, take boards to repair burrows and flag a single route to minimize disturbance.

Crevice checks can be conducted at any time of day but it is best to work around the schedule of the birds as well as that of any other researchers. Since peak surface activity on Main Talus occurs in the morning this is the best time for capture, banding and resighting efforts. Therefore it is best to conduct crevice searches and checks for Main Talus plots in the afternoons when disturbance will be kept to a minimum. You can check Northwest Ridge any time of day.

Start searching for auklet crevices on Main Talus and Northwest Ridge in early June (note that whiskered auklets nest earlier than the other species - you need to start nest searches immediately in early June to pick them up before chicks hatch!). For puffins, start searching for nests (especially on Bottle Hill and Main Talus) in the second week of June (if you find puffin nests on earlier nest searches, then by all means mark them for later, but don't actively search them out until the later date).

When beginning to search for crevices, it is most effective to try to find previously-used crevices first using last year's plot maps, and then look around those nests for new ones. If you cannot find crevices on the map or aren't sure about what the crevice ID is don't worry too much about it. Maintaining the same crevice ID year to year isn't important (so rename it) and you only need to use a fraction of the crevices on your maps. To top it off, many of them are poor quality. They are often hard to find or poorly marked because they haven't been used in many years and haven't been removed from the map. Leave a few blank lines on each page in your notebook in order to easily add new nest you find on later checks (this should help keep your nests in roughly the order you check them). Keep searching new portions of each area and continue until you find your desired sample size; for an initial nest searching bout, it usually takes about 2 days at Northwest Ridge and 3 days at Main Talus to cover all the area (crews can thoroughly search only about 1/3 to 1/2 of plot areas each day). In general, do an initial search at Northwest Ridge first (to concentrate on whiskered auklets), then spend a few days doing initial nest searches at Main Talus, then go back to Northwest Ridge for the first re-checks, etc. If you need to increase sample sizes, spend additional time searching for new nests during the first few re-checks (both entirely new nests and nests from previous years that were inactive the first checks); this is especially useful for picking up late laying birds, which commonly happens with parakeet auklets and puffins. Because there are so many different species nesting in the same locations on Buldir it can be very helpful to make sure puffin nests have a crevice ID identifying themselves as puffin nests (HP32, TP4, PU5 etc.). This is particularly helpful on Main Talus where in one small cave there may be five or more visible

crevices. If you have a crevice to check that you know is going to be a puffin you can leave it alone for the first few rounds in the hopes of not disturbing its' nesting attempt.

Initially these checks will take a long time, perhaps over multiple days as you become familiar with your plots and find your desired sample sizes. Don't get discouraged! Productivity checks will become less time consuming as the season progresses as you get to know the route and the individual nests, and as chicks get bigger and then eventually fledge. Most crews find that checking nests on Northwest Ridge and Main Talus in a single day is too much until much later in the season when nest checks go relatively quickly.

At the end of the season approaches, take advantage of any dry sunny day to get a start on painting crevices – new maps and fresh crevice markers are crucial for next year's crew.

Specific Requirements for Buldir

Dates: *Early June*: Search for crevices at Northwest Ridge and Main Talus.
Mid-June: Search for crevices at Bottle Hill and Peregrine Point.
Early June to late August: Check nests every 4-7 days until chicks fledge (4-day intervals around peak hatch and fledge dates; 7-day intervals otherwise).
Mid-Late August: paint and map nests for the next year.

Optimal sample sizes: 70-100 not realistic at Buldir due to work load, so aim for:
WHAU, CRAU, LEAU: 60
PAAU: 50
HOPU, TUPU: 40-50

Time of day: Ideally when auklets are not socializing and when not disruptive to other research activities (primarily pertains to LEAU and CRAU at Main Talus).

Weather: Overcast, dry days are ideal, but auklet productivity can be done in any weather conditions. Take extra care when rocks and vegetated slopes are wet because they can be dangerously slippery. On bright sunny days, your eyes take a long time to adjust to dark crevices and it can be difficult to see dark chicks against dark rocks.

Equipment needed: Fanny pack, knee pads, two bright flashlights (ALWAYS have a spare!) with lanyards to prevent them from getting lost down crevices, spare batteries, small wire brush (for cleaning algae and lichen off rocks before paining them), paint pens, Rite-in-the-Rain® notebook, two pencils, maps of crevice locations.

Additional equipment needed for painting at end of season: Acrylic paint with brushes or popsicle sticks (for applying paint), flags, sharpies.

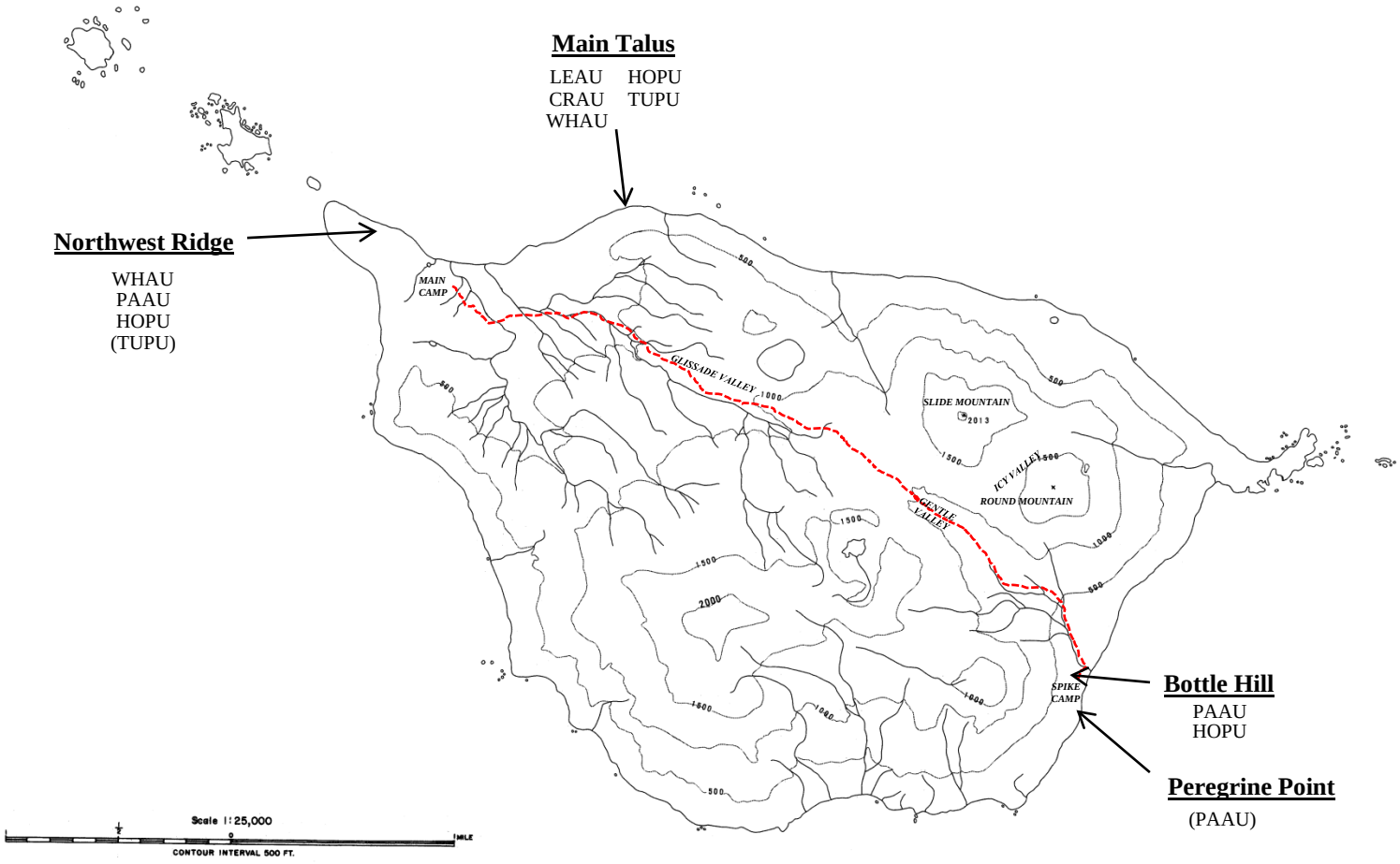


Figure B1. Map of crevice-nester plot locations on Buldir Island. The dashed line indicates the approximate route to Spike Camp.

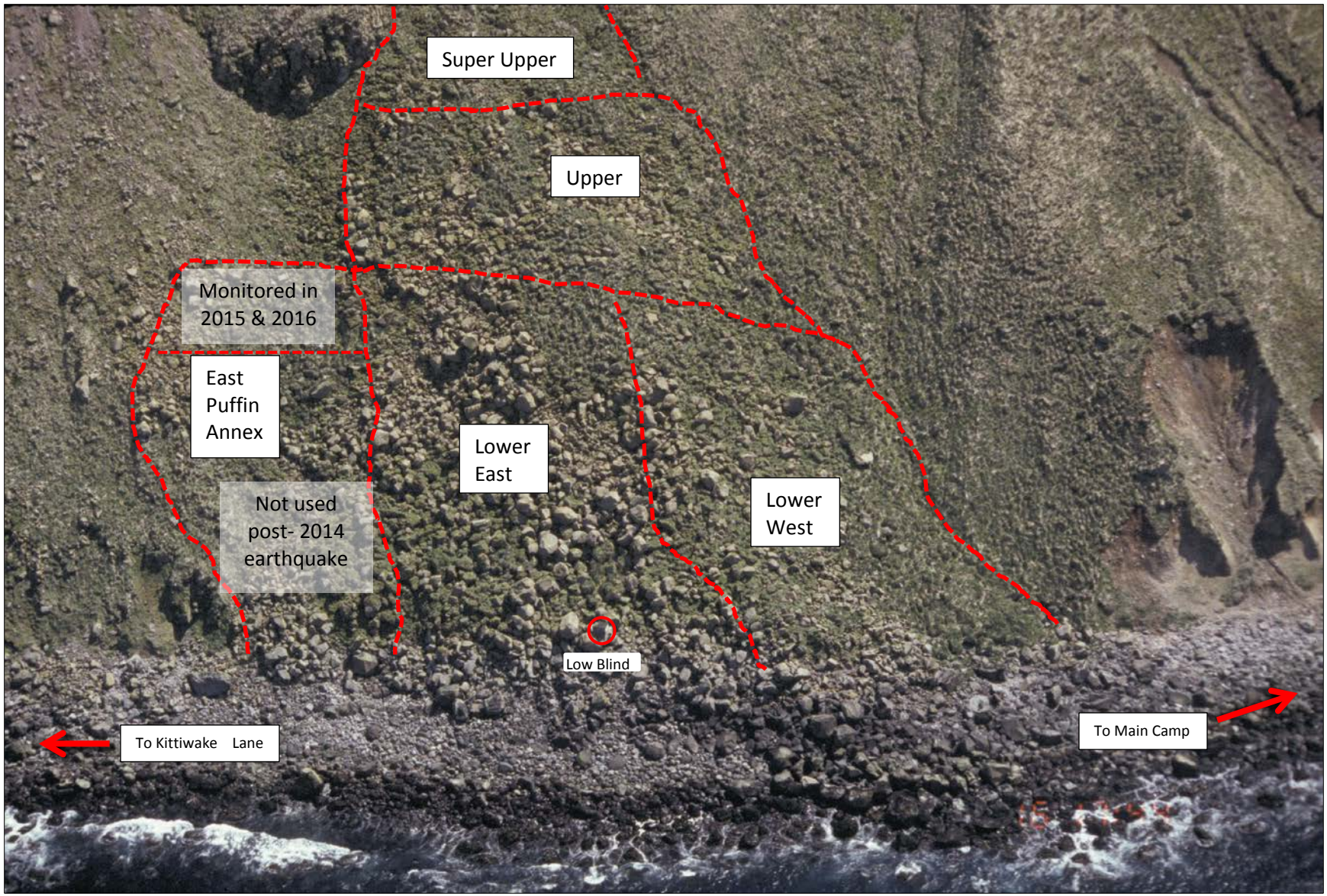


Figure B2. View of Main Talus, Buldir Island showing the approximate boundaries of auklet crevice plots.

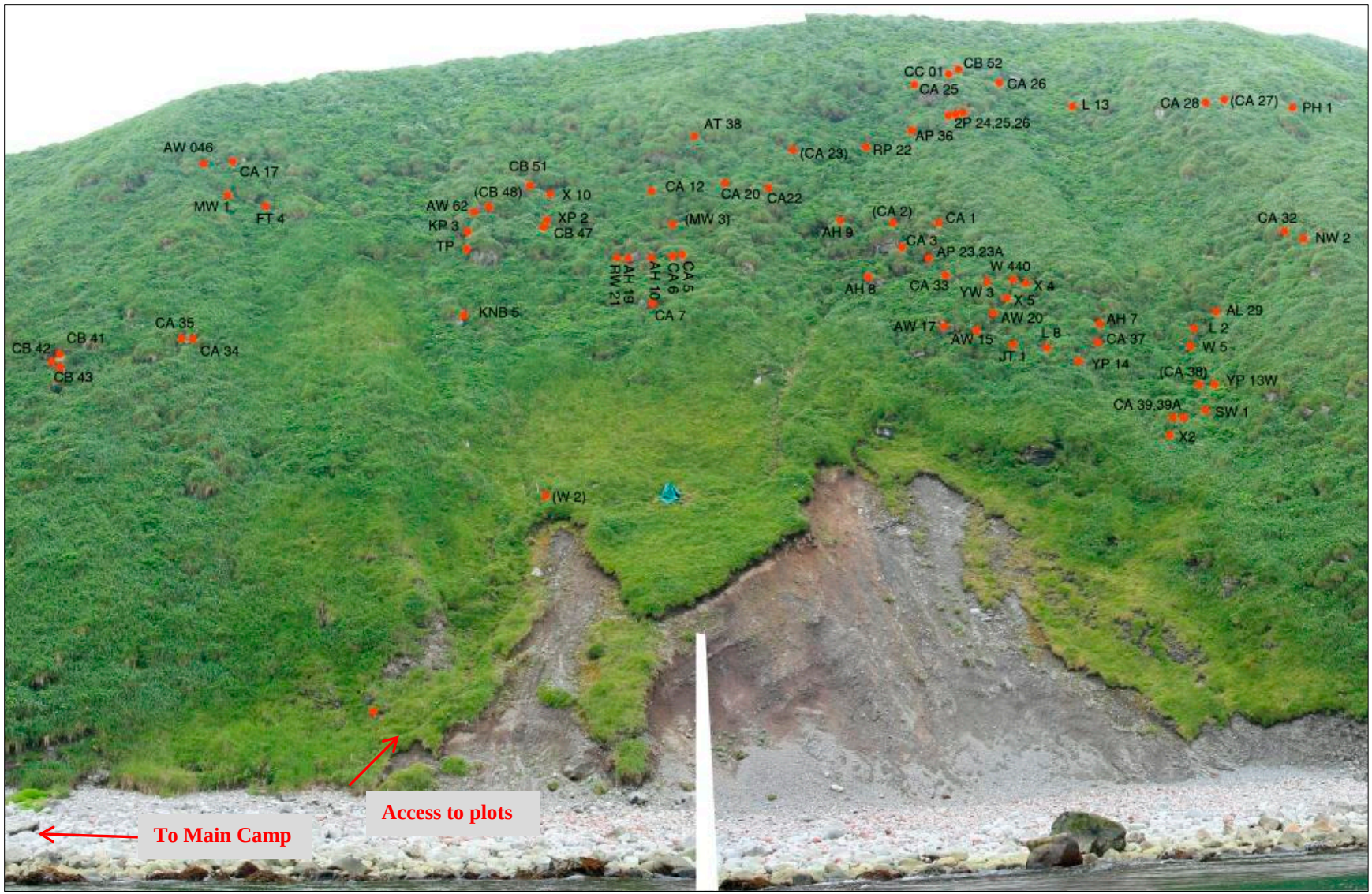


Figure B3. View of Northwest Ridge crevice plots, Buldir Island, from the north.

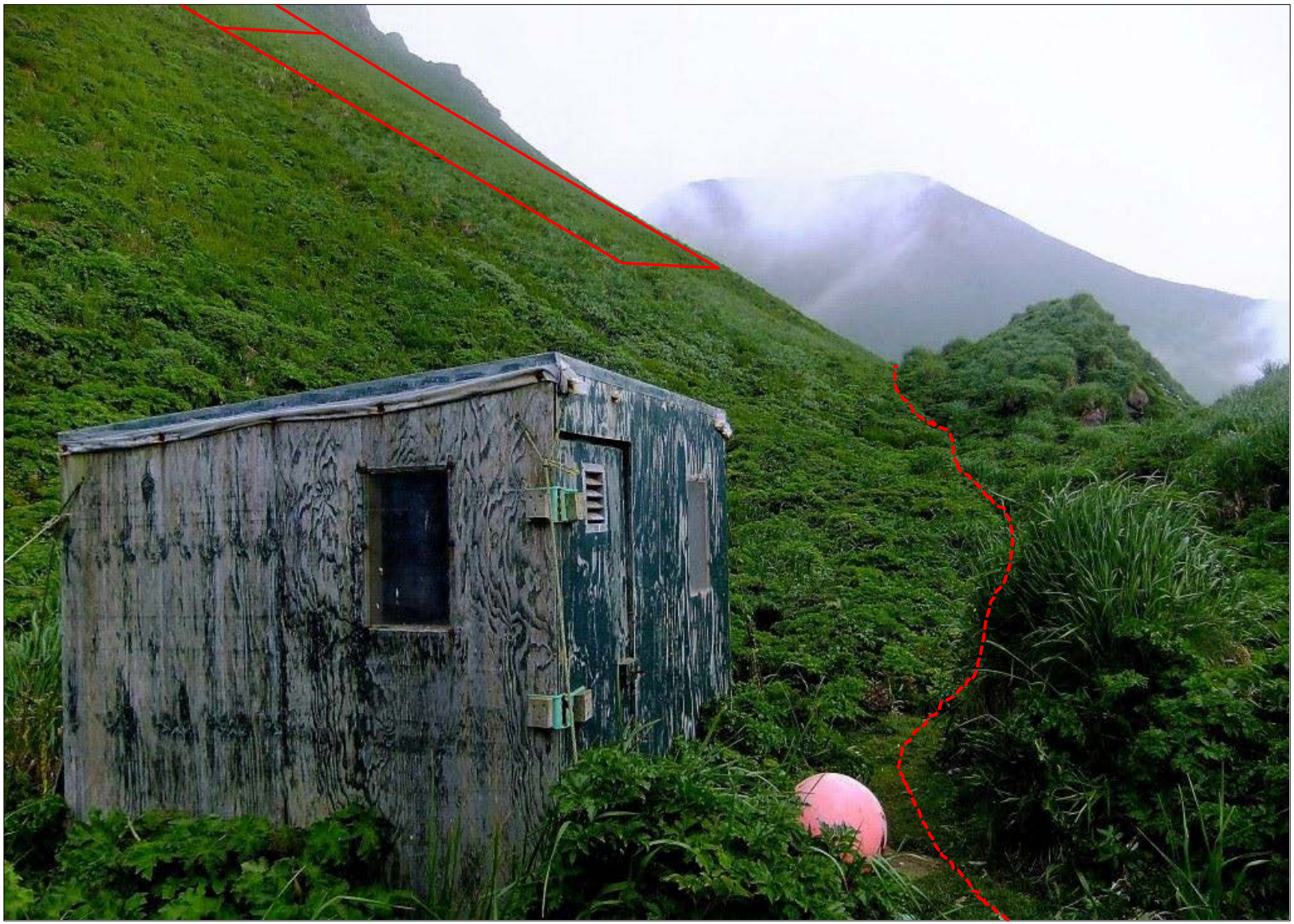


Figure B4. View of Bottle Hill plots from the cabin at Spike Camp, Buldir Island. The dashed line indicates the trail to Main Camp.

Attachment C. Chowiet Island specifics (includes Figures C1-4)

PROCEDURE DETAILS SPECIFIC TO CHOWIET

Crevice-nesting seabirds monitored for productivity and phenology at Chowiet Island consist of parakeet auklets and horned puffins, and some tufted puffins (tufted puffins are primarily burrow nesters). Highest concentrations occur where suitable nesting habitat is most abundant (Figure C1), specifically within Chowiet Bay in areas referred to as Landing Cove, Mini Main, Constant Colony, Clay Lick (Figure C1-2), and West Rough (Figures C1, 3-4), as well as at South Bay (Figure C1).

Monitor any accessible nest sites you find for productivity and phenology. You may *not* be able to find 70-100 crevices of each species to monitor so just do as many as you can (you can use past years' sample sizes in the summary report as a guide).

Aim for at least 30 active nests, but more than 30 has been possible in recent years (with an accumulation of marked crevices from previous years). Start with a larger number of sites to achieve the target sample size as a number of crevices will end up being excluded from analysis because the fate is impossible to determine. You will need to search in more than one area for each species.

Horned and tufted puffins may be especially susceptible to disturbance and high rates of egg abandonment have been noted on Chowiet in past years, so please use care to be as quiet and unobtrusive as possible. Be aware that noise will reverberate loudly through rocks to the birds nesting beneath as you walk overhead or crawl about.

Parakeet auklets – For parakeet auklets, begin searching for nests in late May to early June and attempt to monitor at least 30 nest sites (in good years >50 nests have been monitored). In past years, the highest concentration of parakeet auklets were found in the West Rough area, and then east of Landing Cove in a large talus pile called Mini Main (see drawn crevice maps in plot photos notebook). Small numbers have been located in Landing Cove, Constant Colony, Clay Lick, and South Bay. However, note that South Bay is Chowiet's main tufted puffin monitoring area. Great care needs to be taken when searching for parakeet auklets at South Bay during puffin peak egg laying (early to mid-June). It's best to search South Bay as early in the season as possible for parakeet auklets, then wait for the puffin searching period (overlap with puffin egg laying may be unavoidable, but try to keep it to a minimum).

Parakeet auklets often nest deep within the talus on Chowiet. In the Landing Cove area, predation on nesting adults and chicks by arctic ground squirrels has been recorded over several years, and may be a contributing factor in their nest selection. Talus piles not directly associated with heavy vegetation and soil – talus piles at the base of cliffs, or in large, rocky areas – should be sought out and thoroughly searched (such as at Mini Main and West Rough's western point). Some areas may have many birds flying in and out of the rocks, with large rafts attending directly offshore, but in your search you may not find a single crevice (western end of South Beach). Keep trying and eventually you will find a hot-spot or two. As time allows, search out new areas.

Horned puffins – For horned puffins, begin searching for nests in late June (>20 June; some may be located earlier during searching for parakeet auklets) and attempt to monitor at least 30 nest sites (in good years >50 nests have been monitored). Whenever possible, limit searching and subsequent re-checks to times when puffins are not attending the surface of the colony. Horned puffins nest on most coasts around the entire island. In past years, the highest concentration of horned puffins was found in the West Rough area, as well as Landing Cove and Mini Main. Smaller numbers have been found at Constant Colony, Clay Lick, and South Bay.

On Chowiet, horned puffin nests are often found in large rock crevices, but they are sometimes found in dirt burrows near rock piles and they can also be found in deep caverns under large boulders on coastal cliffs. Refer to crevice maps in plot photos notebook for locations of historical horned puffin nest locations. These areas should be checked as well as the surrounding areas to find new crevices.

Tufted puffins –For tufted puffins, begin searching for nests in late June (>20 June) and attempt to monitor at least 30 nest sites (in good year >40 nests have been monitored). Whenever possible, limit searching and subsequent re-checks to times when puffins are not attending the surface of the colony. Small numbers of tufted puffins nests have been found in rock crevice areas of West Rough, Landing

Cove, and Clay Lick. The majority of tufted puffin nests are found at South Bay, within the gull colony, as burrows (see separate Tufted Puffin Productivity Protocol). Refer to crevice maps in plot photos notebook for locations of historical tufted puffin nest locations. These areas should be checked as well as the surrounding areas to find new nests.

At the end of the season, paint nests well for next year and update any maps. Because good quality crevice nests are so few on Chowiet, every potential one for future years counts so try to document it for next year's crew well!

Specific Requirements for Chowiet

Dates: *Late May to early June*: Search for PAAU crevices
Late June (>20 June): Search for HOPU and TUPU crevices.
June to early September: Check nests every 4-7 days until chicks fledge (4-day intervals around peak hatch and fledge dates; 7-day intervals otherwise).
Late August to early September: Paint and map nests for the next year.

Optimal sample sizes: **As many as you can** – a minimum of at least 30 of each species (more than 30 is now possible in most years; 70-100 of PAAU and HOPU in exceptional years and with good searching skills; TUPU are most difficult).

Time of day: Any time.

Weather: Any weather. Ideally when auklets and puffins are not socializing on surface of colonies. Take extra care when rocks and vegetated slopes are wet because they can be dangerously slippery. On bright sunny days, your eyes take a long time to adjust to dark crevices and it can be difficult to see dark chicks against dark rocks.

Equipment needed: Fanny pack, knee pads, two bright flashlights (ALWAYS have a spare!) preferably with lanyards to prevent them from getting lost down crevices, spare batteries, small wire brush (for cleaning algae and lichen off rocks before paining them), paint pens, Rite-in-the-Rain® notebook, two pencils, maps of crevice locations.

Additional equipment needed for painting at end of season: Acrylic paint with brushes or popsicle sticks (for applying paint).

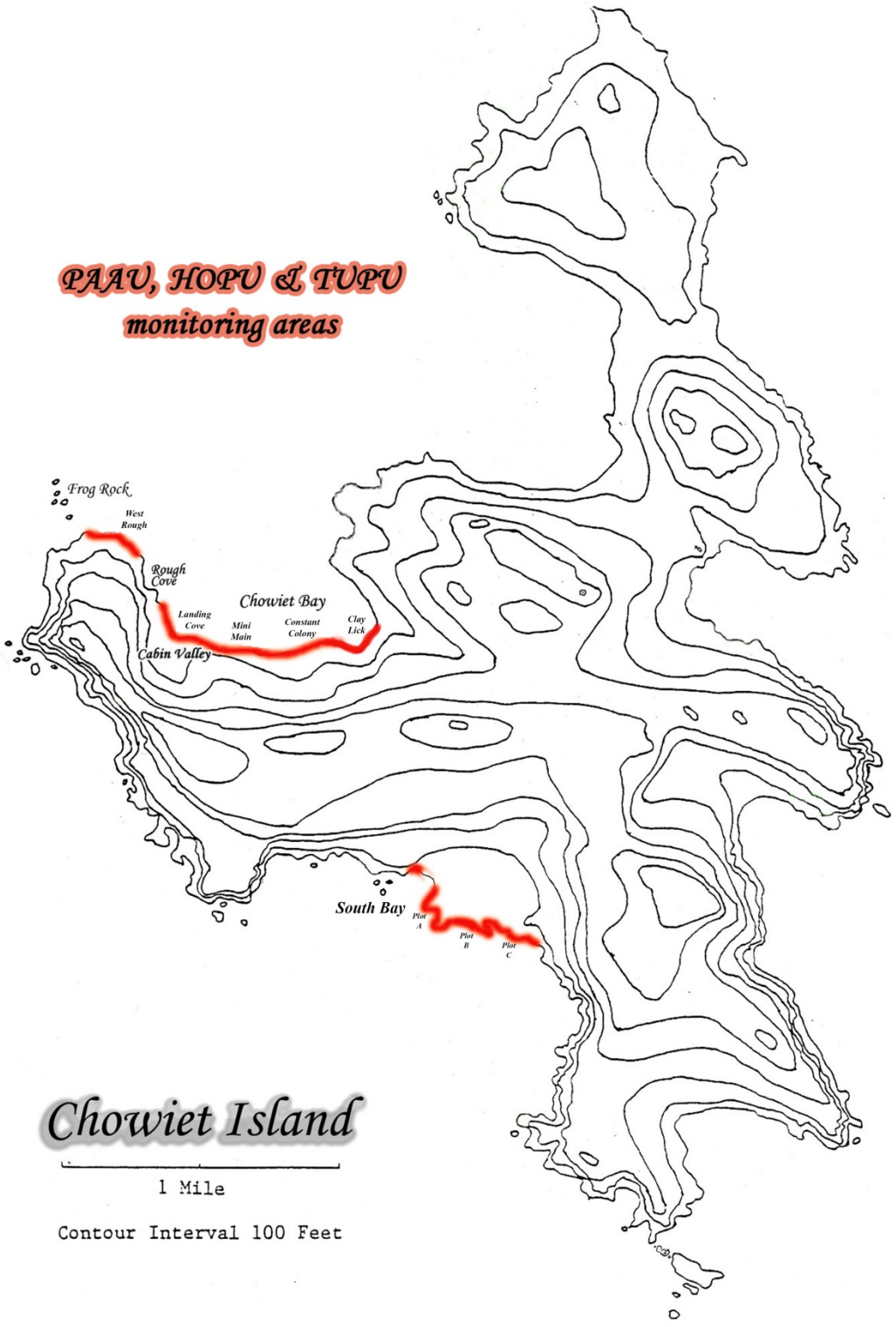


Figure C1. Map of crevice-nester locations on Chowiet Island.

Figure C2. Photo of crevice-nester areas in Landing Cove on Chowiet Island.

Figure C3. Trail to West Rough from cabin on Chowiet Island.

Figure C4. Photo of crevice-nester area at West Rough on Chowiet Island.

Attachment D. St. George Island specifics (includes Figures D1-8)

BACKGROUND AND DESCRIPTION OF ST. GEORGE STUDY AREA

Least, crested, and parakeet auklets and horned puffins nest on St. George Island but productivity monitoring is conducted only on least auklets due to availability of accessible nest sites. 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 is used exclusively by least auklets, containing about 90,000 birds (Renner and Renner 2010). The remaining least auklets on the island nest in scattered pockets in the sea cliffs and beach boulders around much of the island perimeter. Rubble from recent construction on the southern harbor has also created additional new habitat for least auklets on St. George. All productivity monitoring occurs at the Ulakaia colony (Figures D1-3).

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

In the Pribilof Islands, egg laying generally occurs from late May until late June, hatching begins in early July, and fledging usually takes place in August, with most young fledging by late August. Late snow cover can delay phenology at the Ulakaia colony in some years. Begin searching for nests in mid-June; if few birds are found in nests from previous years, it may be too early so wait another week before trying again.

Aim for a sample of 100 nests with known fate at the end of the season (begin by monitoring an extra 20 to 30 because it is not possible to obtain known fates for all crevices). If you have trouble finding enough nest sites or if work load is too high, talk to the unit biologist about reducing the sample to 70 known-fate nests.

Due to fox predation at the Ulakaia colony, auklets nest deeper in the rocks than at some other sites without mammalian predators and good quality nest sites can be difficult to find. For this reason, finding good quality nest sites marked in previous years may be particularly important. Therefore, careful mapping of nest locations and painting at end of the season are especially crucial. It may also be helpful to mark nests with flags, in addition to painting on the rocks, to help future field crews find them.

Artificial nest boxes: Fifty-one artificial nest boxes were installed in fall 2003 at the Ulakaia Ridge colony (Figure D4). These boxes should be monitored *IN ADDITION TO* the normal sample size (70-100) of natural crevices.

Nest boxes are scattered in three clusters within the area where productivity crevices are located (see Figures D2, D5-8). Check all nest boxes for the first time when you begin looking for crevices, and continue checking boxes throughout the season following the protocol described above. After you have determined laying has finished (e.g., no new eggs found for two checks), you can stop checking empty nest boxes for the remainder of the season. All boxes are numbered with engraved metal plates tagged to the box. Because these numbers are often covered by the rock that holds the lid closed, you may find it helpful to mark the box number on this rock with a paint pen. At the end of the season, clean out any unhatched eggs to avoid confusion next season.

To check a nest box, carefully remove the rocks holding down the lid, taking care not to knock the box or make much noise to minimize disturbance to the box inhabitants. The lids of the boxes are hinged, with one half opening while the other half is nailed shut: crouch down by the side that opens and lift the lid <u>just</u> enough to shine a flashlight through and view the contents. Afterwards, gently close the lid and replace the rock on the lid. With foxes patrolling the colony, it is CRITICAL to replace the top rock securely to prevent nest predation. Before moving on to the next nest, double check that the rock covers the lid of the nest box completely and firmly, without rocking or allowing any sort of potential entry into the box.

For now, we are analyzing and presenting data from artificial nest boxes separately from natural crevices. To allow the database to distinguish between natural crevices and artificial nest boxes, enter "Nest boxes" in the Plot column of the datasheet for artificial boxes and "Ulakaia" for any natural crevices. This will be able to separate the two in the database output.

Special considerations for Ulakaia colony at St. George

The Ulakaia Ridge colony is about a half hour hike over the tundra from washhouse (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 4th 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 D3). 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 Figure D2). 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.

Specific Requirements for St. George

Dates: *Mid-June*: Search for crevices.

Mid-June to late August: Check nests every 4-7 days until chicks fledge (4-day intervals around peak hatch and fledge dates; 7-day intervals otherwise).

Late August: Paint and map nests for the next year, clean out nest boxes.

Optimal sample size: 100 (minimum 70)

Time of day: Ideally when auklets are not socializing (at Ulakaia colony, peak socialization in recent years has been between 10am-3pm, getting later throughout the season).

Weather: Overcast, dry days are ideal, but auklet productivity can be done in any weather conditions. Take extra care when rocks are wet because they can be dangerously slippery. On bright sunny days, your eyes take a long time to adjust to dark crevices and it can be difficult to see dark chicks against dark rocks.

Equipment needed: Fanny pack, knee pads, two bright flashlights (ALWAYS have a spare!) preferably with lanyards to prevent them from getting lost down crevices, spare bulbs and batteries, small wire brush (for cleaning algae and lichen off rocks before painting them), paint pens, Rite-in-the-Rain® notebook, two pencils, maps of crevice locations.

Additional equipment needed for painting at end of season: Acrylic paint with brushes or popsicle sticks (for applying paint), flags, sharpies.

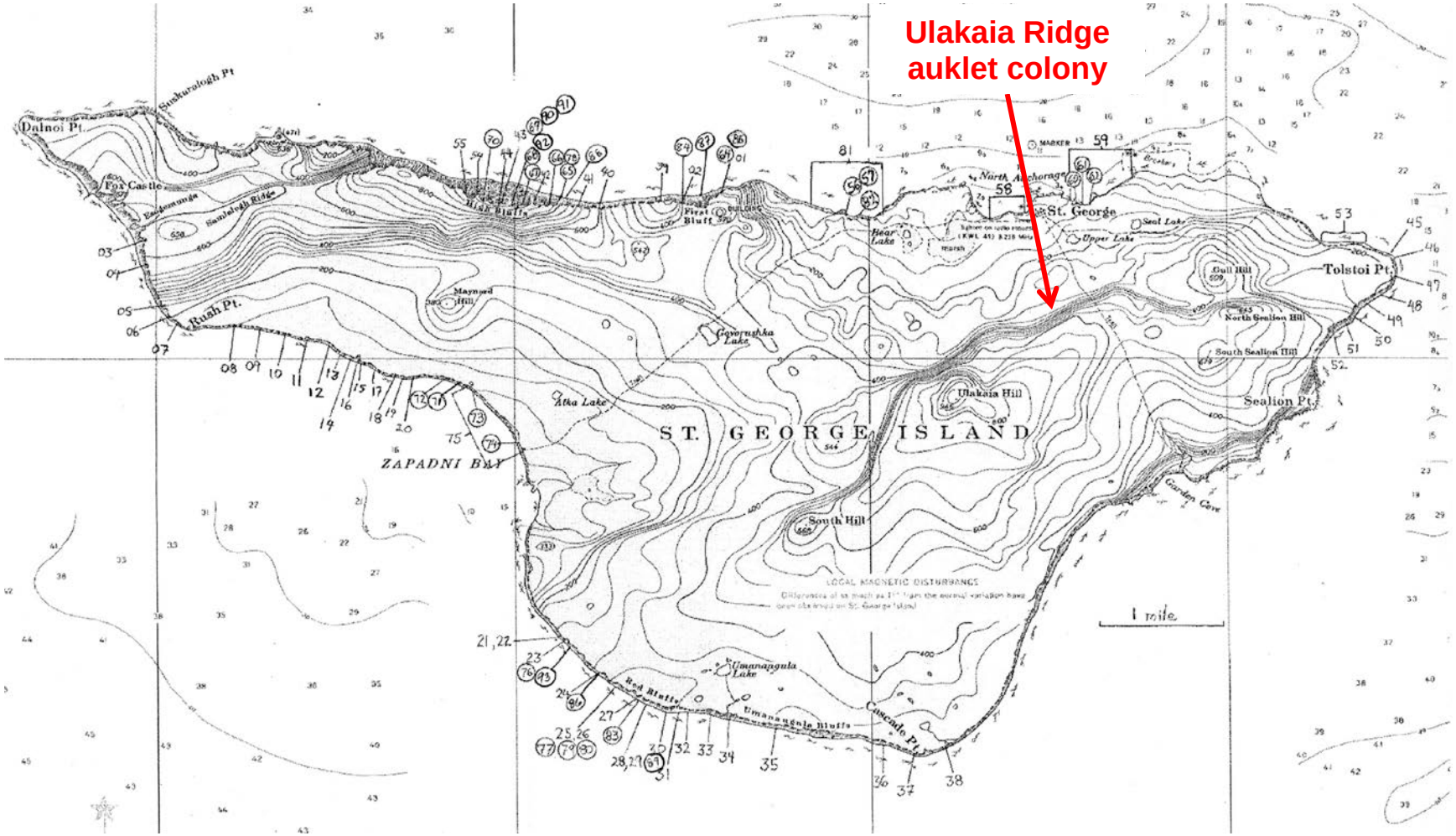


Figure D1. Map of Ulakaia Ridge colony location on St. George Island.

Ulakaia Ridge Colony
View from north

General locations of auklet plots
Yellow – survival plot
Red – productivity nests
Blue – artificial nest boxes

Figure D2. View of Ulakaia Ridge colony, St. George Island, from the north (the approach from town).

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 D3. Trailhead to Ulakaia Ridge colony, St. George Island. Walk straight south (by compass or GPS) from here to the colony.

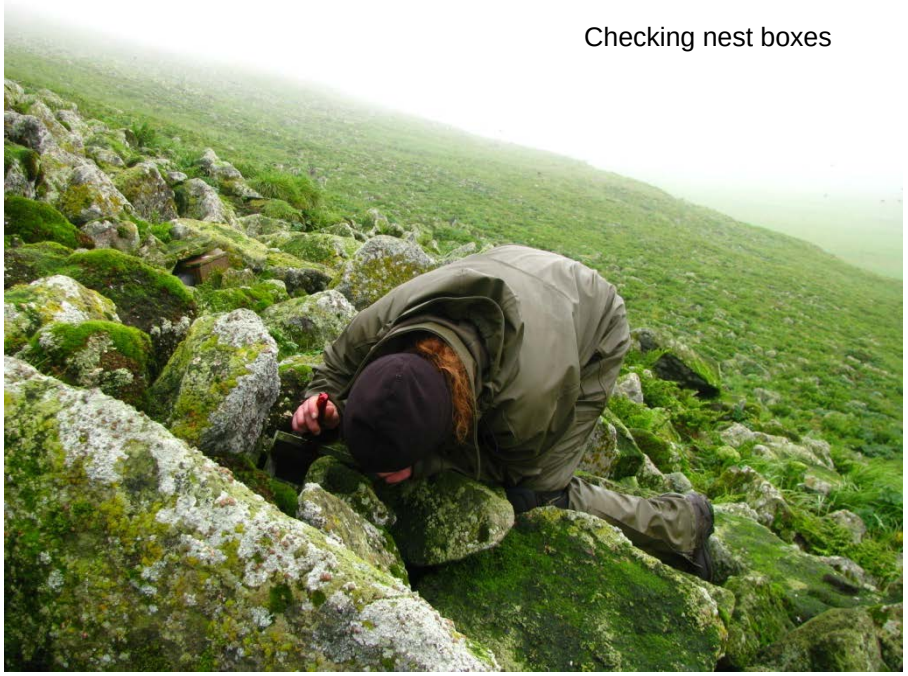


Figure D4. Artificial nest boxes for least auklets at the Ulakaia Ridge colony, St. George Island.

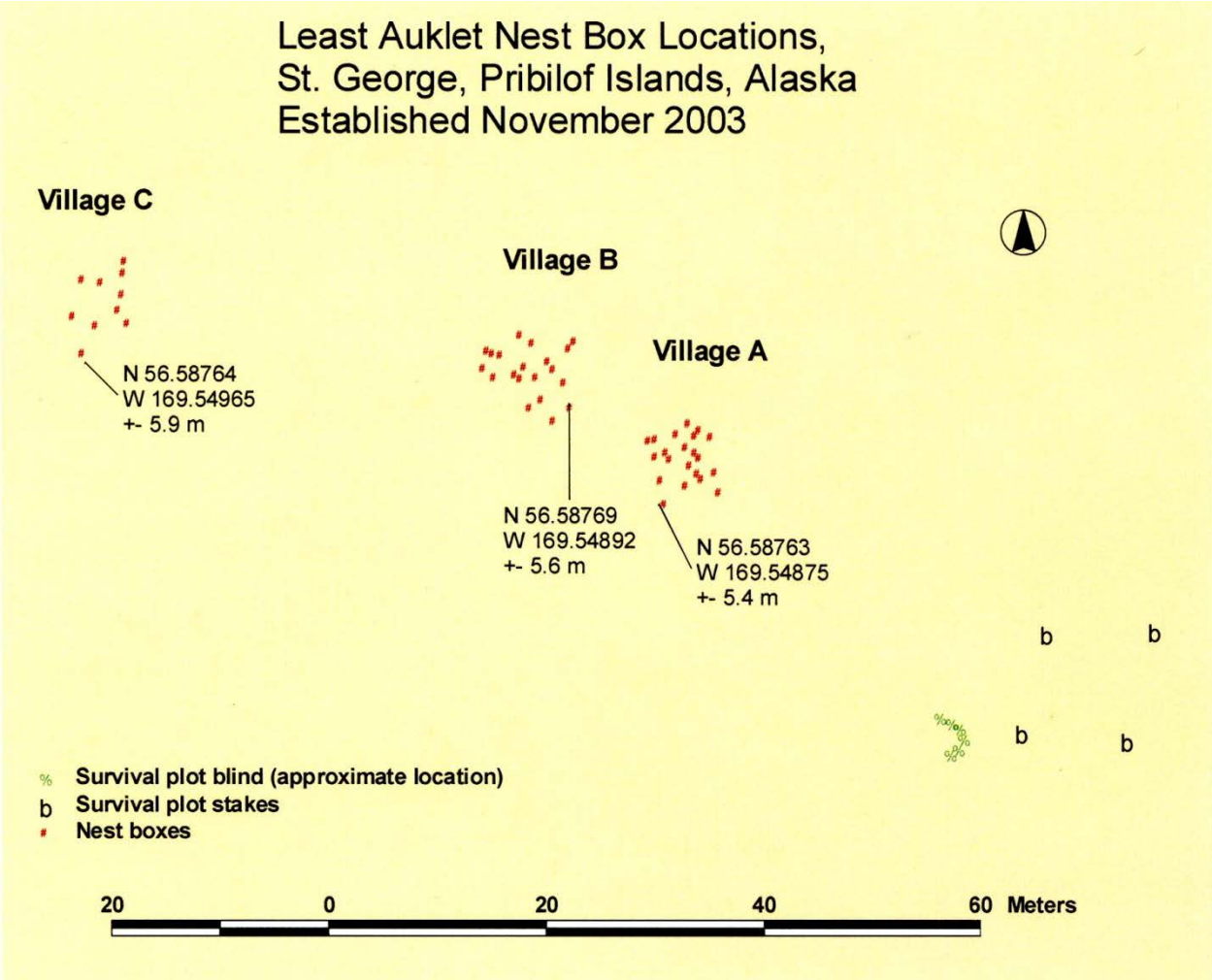


Figure D5. Map showing overview of nest box locations (Village A, B, C) in relation to least auklet survival plot and blind at Ulakaia colony, St. George Island.

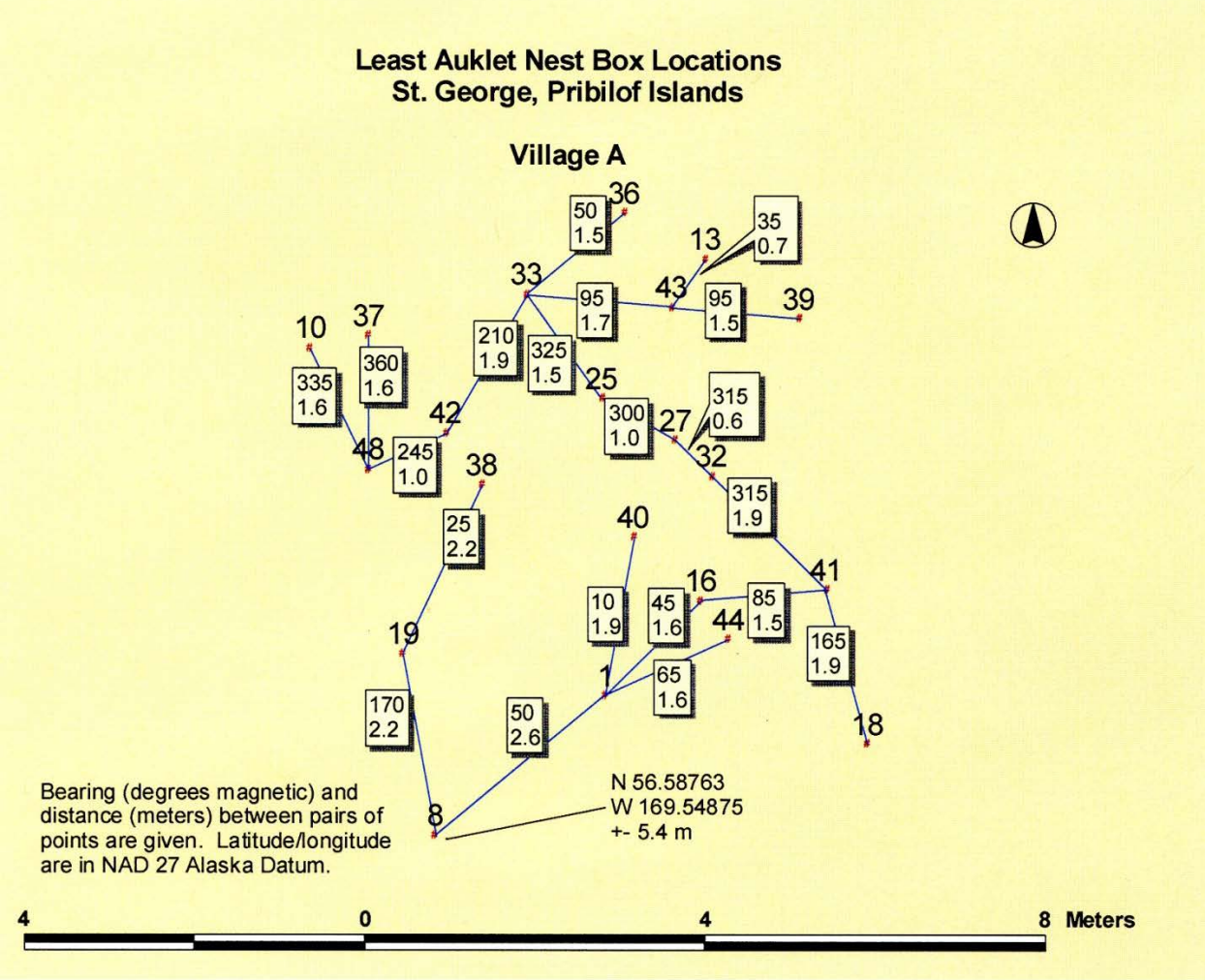


Figure D6. Map showing nest box location, including bearing and distances (m) between boxes, within Village A, Ulakaia colony, St. George Island. GPS locations are given for Box #8 in datum NAD27 (different from other coordinates in this protocol, which are in datum WGS84).

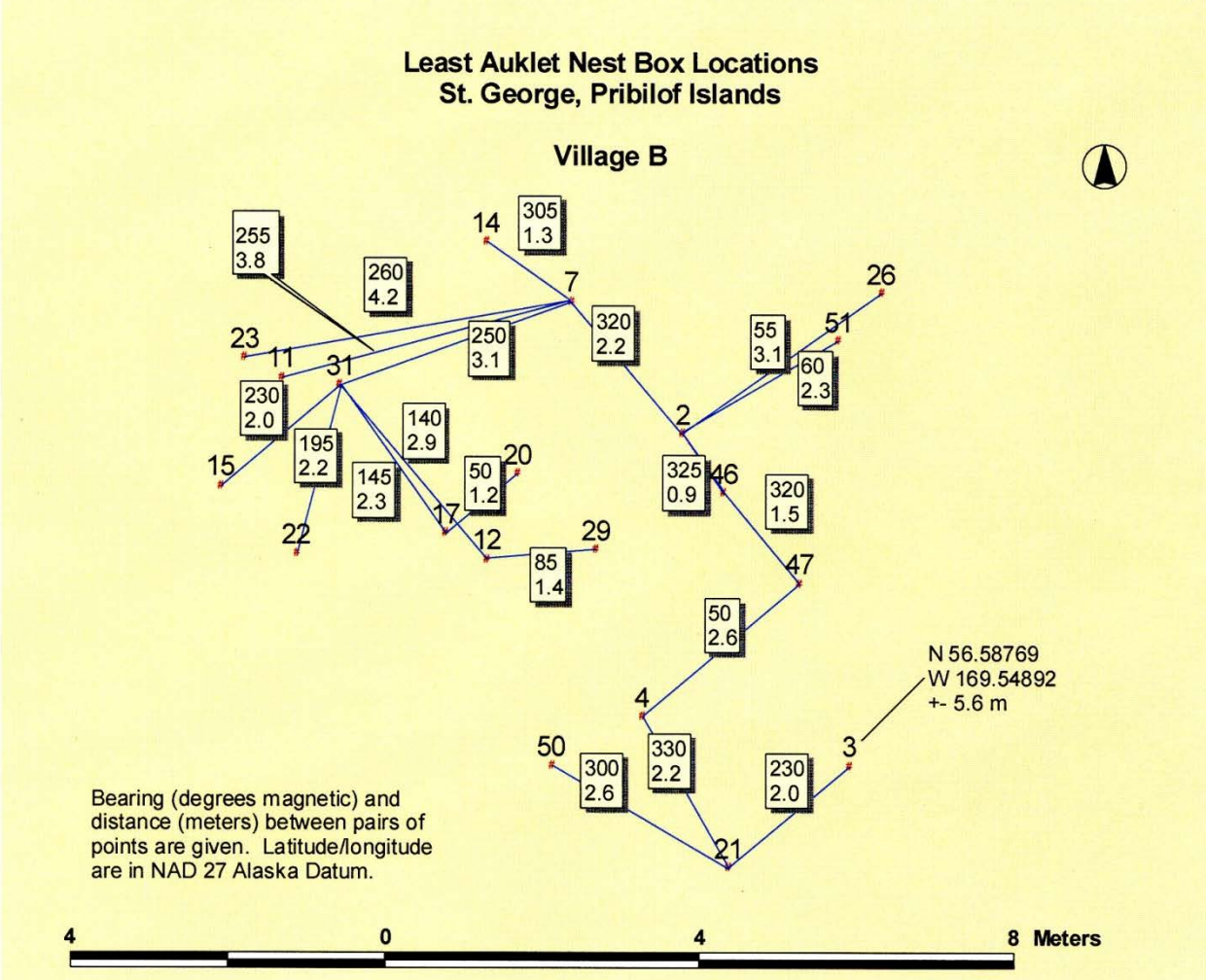


Figure D7. Map showing nest box location, including bearing and distances (m) between boxes, within Village B, Ulakaia colony, St. George Island. GPS locations are given for Box #3 in datum NAD27 (different from other coordinates in this protocol, which are in datum WGS84).

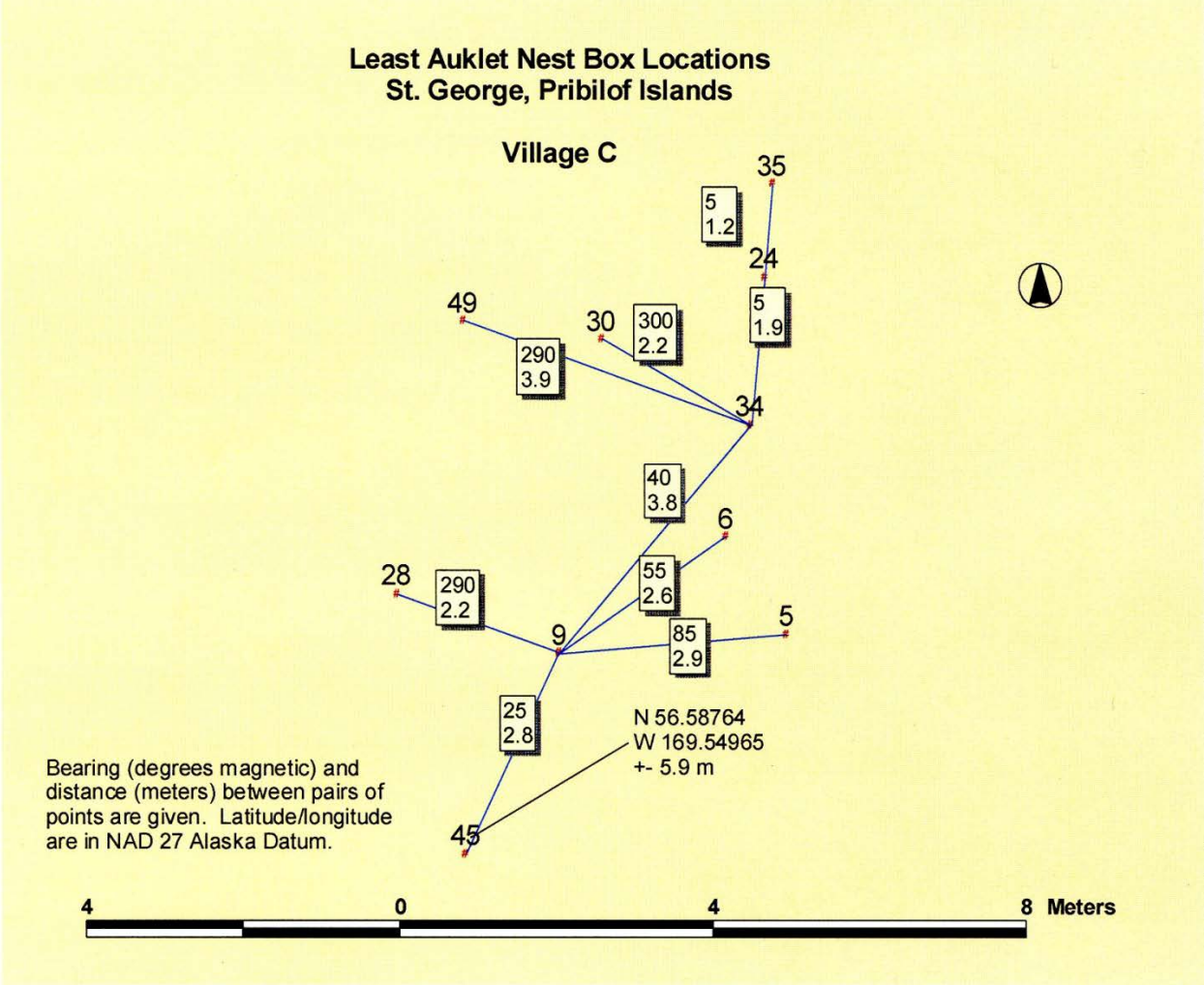


Figure D8. Map showing nest box location, including bearing and distances (m) between boxes, within Village C, Ulakaia colony, St. George Island. GPS locations are given for Box #45 in datum NAD27 (different from other coordinates in this protocol, which are in datum WGS84).

Protocol Revision History Log

Revision Date	Changes made	New version #
April 2017	Specified that a leap year Julian date calendar should be used in leap years, clarified that for phenology calculations we require confirmed visualization of the empty nest site, egg, or chick less than ***or equal to*** 7 days apart for that site to be used, updates to Buldir attachment including increasing number of nests to start with for WHAU, LEAU, and PAAU	1.6
Sept 2015-Jan 2016	Updated Buldir and Chowiet sections, clarified importance of good hatch dates in main protocol, clarified Ep modifier, added details in analysis section for manually excluding nests before import into database, specified getting a last check in before you leave the island, fixed page number references in text	1.5
April 2015	Clarified sample sizes	1.4
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, ordered island attachments alphabetically, changed page number format to include protocol #, made minor grammatical edits, added matrix for auklet/puffin identification (Figure 5), added information on calculations of (H) and associated summary values for puffins	1.3
May 2013	Aiktak and Chowiet attachments added	1.2
May 2012	Buldir attachment added	1.1
May 2011	Protocol developed in standardized format from historic protocols, includes St. George attachment	1.0