

Wildlife Inventory Plan  
Alaska Maritime National Wildlife Refuge  
Protocol #8

Version 1.3

Parameter: Productivity, phenology, and chick growth

Species: Rhinoceros auklet

## PURPOSE

To estimate annual productivity and phenology of burrow-nesting rhinoceros auklets and track differences among years. Seabird reproductive parameters can serve as indicators of change in the marine ecosystem (Cairns 1987, Montevecchi 1993). In addition, at some sites, to examine patterns in growth rates of rhinoceros auklet chicks as a potential indicator of foraging conditions for adults. Chick growth rate in many seabird species has been associated with spatial and temporal variability in food availability (e.g., Suryan et al. 2002).

## BREEDING BIOLOGY

Rhinoceros auklets (*Cerorhinca monocerata*) are colonial, piscivorous seabirds that breed on remote islands in Alaska, Japan, Russia, and south to California. The vast majority of birds breed in British Columbia; the Gulf of Alaska represents the northern extent of their distribution. Rhinoceros auklets are closely related to *Fratercula* puffins but are nocturnal at Alaskan breeding colonies, appearing at dusk and leaving again before dawn. All colony social activity takes place at night (Gaston and Dechesne 1996).

Rhinoceros auklets nest primarily in soil burrows, where they lay a single egg. The incubation period lasts about 45 days, after which chicks are brooded for about four days before adults leave their chick unattended in the burrow while foraging. Chicks fledge at about 50 days of age. Both parents share incubation and chick provisioning duties. (Leschner 1976, Wilson 1977, Summers and Drent 1979). Timing of breeding varies across sites, with later phenology at higher latitudes. At colonies in Alaska, rhinoceros auklets generally lay eggs in May and June, hatch chicks from mid-June through July, and fledge chicks in August and September (Gaston and Dechesne 1996, Drummond and Slater 2012).

## PROCEDURE – REPRODUCTIVE SUCCESS BY INDIRECT EVIDENCE OF APPARENT OCCUPANCY (CHOWIET, ST. LAZARIA)

**Data collection.**—When burrows are too deep to access nest contents, indirect evidence of burrow apparent occupancy at different times in the breeding season is used as an index of rhinoceros auklet reproductive performance. We assume that apparent occupancy during early and late season checks represent the presence of eggs and large chicks/potential fledglings, respectively. From these data, a residency index can be calculated (representing a surrogate of reproductive success). These data are usually collected simultaneously with population surveys for burrow density and apparent occupancy (see Burrow-nester Population Protocol and island-specific details).

Burrows are checked twice during the season, timed to occur around hatching and during late chick-rearing (these are often done in conjunction with population surveys, which have an additional third check earlier in the season at some sites, so don't be confused if you check rhinoceros auklet plots three times at your island – data for reproductive success will just come from the later two). On each check, observers locate all medium (9.5-14.5 cm) and large (>14.5 cm) burrows within specified plots and assess each for any evidence of apparent occupancy. Burrow size is categorized as small, medium, or large (small: <9.5 cm, medium: 9.5-14.5 cm, large: >14.5 cm) and measured using a "burrow board" or "burrow measuring device" (Figure 1). Measure each entrance horizontally at the widest spot: if the

smallest end of the board does not slide in to the entrance, it is assigned to the “small” category; if the small end will slide in, it is assigned to the “medium” category; if the largest section slides in, it is assigned to the “large” category. By definition, a burrow must be at least 30 cm deep to be counted. You can use your arm as a measuring device for burrow depth (starting at your finger tips, determine where 30 cm hits your arm, for an average-sized person elbow length will suffice). Assign a status of apparently occupied or unoccupied to each burrow on each visit, based on indirect (usually) evidence that the nest site is being used by a breeding pair.

**Evidence of apparent occupancy is defined as the presence of at least one of the following within the burrow:**

- feathers
- guano
- fish deep inside the burrow
- egg shell fragments or membrane(s)
- egg(s)
- chick(s)
- *fresh vegetation at least 20 cm inside the burrow entrance (ST. LAZARIA ONLY)*
- *clipped vegetation or roots inside the burrow entrance (ST. LAZARIA ONLY)*

Also record *which evidence was observed at each burrow* (this will help us understand and improve the rhinoceros auklet protocol). Feathers should be of the proper color and size for a rhinoceros auklet (e.g., if other burrow nesters are present at your site, you should not count feathers known to be from other species). Guano will often be in a “pocket” at the end or side of a tunnel (if you can reach that far) but also can be present within the burrow section accessible from the entrance. Fresh digging and fish at the entrance are *not* indicators of occupancy. Fish presence is tricky because they may have been dropped by a bird flying over, so be sure fish are deep enough in a burrow that they couldn’t have simply fallen from above before using them as evidence of occupancy (use a reasonable person’s judgment that fish were brought into the burrow and not haphazardly dropped near/in the burrow’s entrance). At sites with multiple burrow nester species, egg shell fragments and membranes should be of proper size and color. Fresh vegetation should be pulled inside the entrance or deep in the burrow. At some sites, a “runway” of packed vegetation or dirt may extend from a burrow entrance but this alone is not enough to determine apparent occupancy (you may record runways in your data collection, but don’t use them for anything).

All burrows should be marked with individually-numbered flags or other identifiers near the entrance. It is helpful to choose a standard flag location relative to the entrance for all your nests (e.g., always putting flag on right side of burrows as you face uphill; see island specifics for details on flag locations) to avoid confusing nests. In high density areas, tunnels and nest chambers may be everywhere, so be sure that the flag shaft does not pierce into the tunnel or chamber of another nest. It is helpful to create a map indicating approximate location and number of each burrow within your plot to assist in relocating burrows (Figure 2).

**Data analysis.**—From data, tally the following for each plot:

- Medium/large burrows with apparent occupancy Early (b) – number of medium/large ( $\geq 9.5$  cm) burrows with evidence of apparent occupancy at early check (around hatching); surrogate of number of eggs
- Medium/large burrows with apparent occupancy Late (f) – number of medium/large ( $\geq 9.5$  cm) burrows with evidence of apparent occupancy at late-season check (during late chick-rearing) that also had evidence of apparent occupancy at the early-season check (b); surrogate of number of large chicks/fledglings

From the above values, calculate for each plot:

- Overall Residency Index (f/b) – surrogate of overall reproductive success

This index represents a ratio of nests occupied at the end of the season compared to at the beginning. Therefore, for this calculation it is important to use *only those nests that were occupied during the first visit*. If a nest was not apparently occupied the first visit but it was the last visit, this nest should be excluded.

For example:

Early visit	Late visit	Use in Overall Residency Index calculations?
Occupied	Occupied	Yes
Occupied	Not occupied	Yes
Not occupied	Occupied	No
Not occupied	Not occupied	No

If your residency index is greater than 1, you are doing something wrong!

## PROCEDURE – PHENOLOGY AND CHICK GROWTH (ST. LAZARIA)

**Data collection.**—Rhinoceros auklet phenology is monitored by manually checking individually numbered burrows at 5-7 day intervals throughout the breeding season. Hatch dates are calculated either from nest observations or from chick growth measurements. Because rhinoceros auklet burrows are usually very long, deep, and difficult to monitor, artificial nest boxes may be used supplementally at some sites. Historically, rhinoceros auklet reproductive success was also estimated using direct observations of nest statuses at some sites, but this has been discontinued.

Begin examining burrows and nest boxes for very young chicks and/or brooding birds in early chick-rearing (depends on site, see island-specific details for more information). Aim for a sample of 30 active nests for phenology and chick growth. Ideally, use only burrows for which you can examine in its entirety (obviously, this is usually not a problem with nest boxes). At some sites, you may use and make additional excavations to observe nest contents and extract chicks. This may be done only in areas where the soil depth is sufficient to support the observer's weight and where vegetation is robust. Do not examine burrows in areas where there is extensive bare ground between shrubs and trees (e.g., much of Rhino Point on St. Lazaria).

Mark all active burrows and nest boxes with individually-numbered flags near the entrance. Always place the flag at the right side of the entrance (as you face uphill) to avoid confusing nests. In high density areas, tunnels and nest chambers may be everywhere, so be sure that the flag shaft does not pierce into the tunnel or chamber of another nest. Be aware that vegetation will grow throughout the season, sometimes a meter or more, so it may be helpful to use additional markers, such as flagging tape tied around vegetation, to find burrows in areas of thick vegetation. Drawing a map of nest locations will also help locate nests during subsequent visits.

If an incubated egg is found during the first status check, wait 7-10 days before checking the burrow again. Any non-brooded chicks can be measured immediately. Aim to measure chicks every 5-7 days until you obtain three wing chord measurements. Thereafter, take all measurements every other visit (i.e., 10 days apart) until chicks have lost most of their down and have adult feathers (e.g., having just wisps of down (especially on the rump or flanks), a "topknot" of down on the crown, and/or a "necklace" [an indentation ringing the base of the neck]). Then increase visits to every five days again to obtain fledging data. Rhinoceros auklet chicks can be difficult to extract, especially when they get larger and more mobile. It may take two people to work one burrow, blocking certain paths that the chick may run to escape your grasp. In addition, be careful if measuring chicks in adverse conditions. Protect chicks from wind, rain, and the observant eyes of predators by using an umbrella when needed. Wind will also affect the accuracy of the scale.

On each visit, record the status of nest sites and all measurement data. For nest statuses, record the status of each nest each visit using the appropriate standardized code (see pages 8-8 to 8-10). Record only what you saw and be sure to use the standardized codes *exactly* as instructed (e.g., you must literally see the chick to record the presence of a chick; hearing it alone or seeing eggshells/membranes is not enough). If a rhinoceros auklet adult is encountered in a burrow, quietly and carefully back away to avoid further disturbance; check the burrow again in 5-7 days to minimize disturbance. *Rhinos are highly sensitive to disturbance prior to egg-laying and during incubation!* There is sometimes a rudimentary nest composed of *Angelica*, false lily-of-the-valley, or fern leaves.

Rhinoceros auklets do not exhibit reliable incubating or brooding postures (nor are we often able to actually view them), so if you see/feel an adult bird but cannot reach under it or see an egg or chick, you must record the nest status as BU (Bird Unknown). If you do see/feel a rhino-sized 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 (see 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"). Bear in mind that "Ep" and "Co" statuses would be extremely rare observations because it's likely that a parent would be present and susceptible to disturbance (so we wouldn't intentionally be reaching into a burrow at that point).

For measurements, refer to Figure 3:

- **Mass:** Weigh chicks (to the nearest gram (g)) in bird bags using Pesola® spring scales. Be sure to weigh the empty bag after each chick weighing, because its weight can change due to moisture or chick feces. Bag weight is subtracted from the total to yield the chick's mass. Keep a free hand under the chick as it's being weighed to catch it in case the scale clip fails.
- **Relaxed Wing chord:** Measure the right wing from the bend in the wing to longest tip (pin feather or longest primary, depending on chick age; ignore any downy tufts stuck to the end of wings or feathers) to the nearest 1 mm using a wing rule. With the right wing resting naturally against the chick'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. Both relaxed and flattened wing chords are measured at St. Lazaria. Only begin measuring wing chord once pin feathers erupt. Take care: pin feathers are very sensitive and will bleed if broken, which can lead to chick death; over-zealous handling can maim the developing wing.
- **Flattened wing chord:** Measure wing as described above, but gently press wing flat against wing rule and measure to the longest primary. Do not bend any feathers or joints, or otherwise harm the bird.
- **Diagonal tarsus:** Hold chick'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.

Be sure the scale has been calibrated and zeroed prior to using it and recheck that it's zeroed before weighing each chick. Similarly ensure calipers and scales are zeroed before use.

**Data analysis.**—Calculations for phenology and chick growth parameters for rhinoceros auklets are not yet automated in an Access database so analysis needs to be conducted by field crews.

**Phenology:** Hatch dates for rhinoceros auklet phenology can be calculated by nest statuses or by chick wing chord measurements, depending on which data are available.

Nest status method: If data contain enough observations of eggs, chicks, and empty nests, dates for chick hatching and fledging can be 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; *in leap years, be sure to use a leap year-specific Julian date calendar!*). 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, or a reasonable calculation of estimated hatch date based on chick measurements. 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.

For example:

Julian Dates:	165	172	178	182	190	198	212	218	223	Hatch date	Fledge date
Nest 1	BE	BE	BC	BC	C	C	C	C	N	175	220
Nest 2	BE	BEp	C	C	C	C	C	N	N	173 (pipped egg)	214
Nest 3	BE	BE	BCw	C	Cd	N	N	N	N	178 (wet chick)	-
Nest 4*	BE	BU	BC	C	C	C	C	N	N	Not used, >7d interval	214

\* Hatch date may be calculated if enough measurements were taken in the linear phase of growth (as

described below).

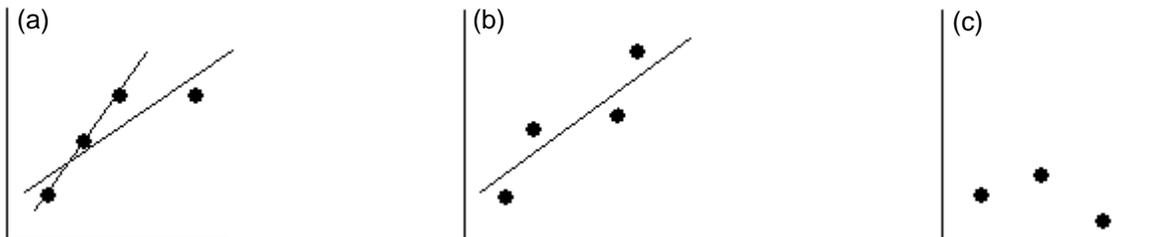
**Chick wing chord method:** If nest status data have a lot of unknown statuses (i.e., BU and U) but chick growth measurements are available (see chick growth below), hatch dates can be estimated using wing chord measurements (Leschner 1976). Chick age at measurement can be calculated as:

$$\text{Chick age} = \ln [(165 / \text{WC}) - 1] / (-0.07) + 27.8$$

where  $\ln$  is the natural log and WC is a wing chord measurement taken during the linear growth period (50-80 mm).

Then calculate hatch date by subtracting the chick age from the date it was measured. If a chick has more than one wing chord measurement during the linear growth period, average the calculated hatch dates to derive a single estimate for each chick.

**Chick growth:** Chick growth is summarized during the linear growth period only. In rhinoceros auklets, this corresponds roughly to 5-30 days old. After this age, chick size approaches an asymptote. Because you may not know exact hatch dates and thus accurate chick ages, it is helpful to graph data for each chick and visually inspect graphs for any leveling off towards the end of measurements. Truncate any data points that appear to be beyond linear growth. [Note - if you have only three measurements, it may be difficult to determine from the plot if the last measurement is outside the linear growth window; in these instances, mass is a particularly useful indicator, i.e., chicks are usually within the linear growth phase when <350 g.] Use the  $r^2$  value of the linear regression line as a guide to the data's goodness of fit. There is no concrete rule for this value. Closely examine growth data in which the  $r^2$  value is <0.80. If the poorness of fit is due to an early or late data point and the fit can be improved markedly by removing it (see "a" below), consider that point outside of the linear growth period and remove it. If the poorness of fit seems to be due simply to variability in measurements (see "b" below), consider keeping all data points. If the poorness of fit is because the chick just didn't seem to exhibit any linear growth at all (this can happen with dying chicks, for instance; see "c" below), consider removing the entire chick from the sample, as we are only interested in chicks for which we can calculate a rate of *linear* growth.



Once all data have been inspected and truncated to include only those measurements occurring during the linear growth period, calculate the growth rate for each chick by running a simple linear regression for each parameter (mass, wing chords, diagonal tarsus). The slope of each regression line represents the growth rate. Present the average annual growth rate for each species as the mean slope (and standard deviation) of all chicks. Include only chicks that have been measured at least three times during the linear growth phase. If a chick dies after three measurements, it can be included in the dataset.

#### Literature Cited

- Cairns, D.K. 1987. Seabirds as indicators of marine food supplies. *Biological Oceanography* 5:261-271.
- Drummond, B.A. and L. Slater. 2012. Biological monitoring at St. Lazaria Island, Alaska in 2011. U.S. Fish and Wildlife Service Report, AMNWR 2012/02. Homer, Alaska.
- Gaston, A.J. and S.B.C. Dechesne. 1996. Rhinoceros auklet (*Cerorhinca monocerata*). In *Birds of North America*, No. 212 (A. Poole and F. Gill, eds.). The Birds of North America, Philadelphia.

- Leschner, L.L. 1976. The breeding biology of the rhinoceros auklet on Destruction Island. MS thesis, Univ. Washington, Seattle.
- Montevocchi W.A. 1993 Birds as indicators of change in marine prey stocks. Pp 217-266 *in* Birds as Monitors of Environmental Change (R.W. Furness and D.J. Greenwood, Eds.) London: Chapman and Hall.
- Summers, K.R. and R.H. Drent. 1979. Breeding biology and twinning experiments of rhinoceros auklets on Cleland Island, British Columbia. *Murrelet* 60:16-22.
- Suryan, R.M., D.B. Irons, M. Kaufman, J. Benson, P.G.R. Jodice, D.D. Roby, and E.D. Brown. 2002. Short term fluctuations in forage fish availability and the effect on prey selection and brood-rearing in the black-legged kittiwake (*Rissa tridactyla*). *Marine Ecology Progress Series* 236: 273–287.
- Wilson, U.W. 1977. A study of the biology of the rhinoceros auklet on Protection Island, Washington. MS thesis, Univ. Washington, Seattle.

**Standardized Productivity Codes: List of Productivity Codes (RHINOCEROS AUKLETS)**

Always use CAPITAL LETTERS for productivity codes

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

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<b>B Bird</b>	Adult bird occupying a nest site, with no egg or chick present. Used when the observer is <u>sure</u> 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.
<b>BU Bird w/ Unknown</b>	Adult bird occupying a site, with no egg or chick <b>visible/felt</b> . Used when the observer cannot see or feel the entire nest contents to be sure whether there is an egg, a chick, or nothing.
<b>BE Bird w/ Egg</b>	Adult bird with an egg.
<b>E Egg</b>	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)
<b>BC Bird w/ Chick</b>	Adult bird with chick.
<b>C Chick</b>	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)
<b>U Unknown</b>	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.
<b>N Nest</b>	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.
<b>NC Not Checked</b>	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.

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**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

*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
  
- 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 murre) 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 chick, 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

**\*\*NOTE\*\*** These standardized codes and modifiers should be used for ALL species, even those that we are still summarizing by hand this year (e.g., storm-petrels, cormorants, oystercatchers, gulls, ancient murrelets). The ultimate goal in future years is to use the database to summarize productivity data for all species and the more consistent we can make the data now, the easier it will be to make that transition.

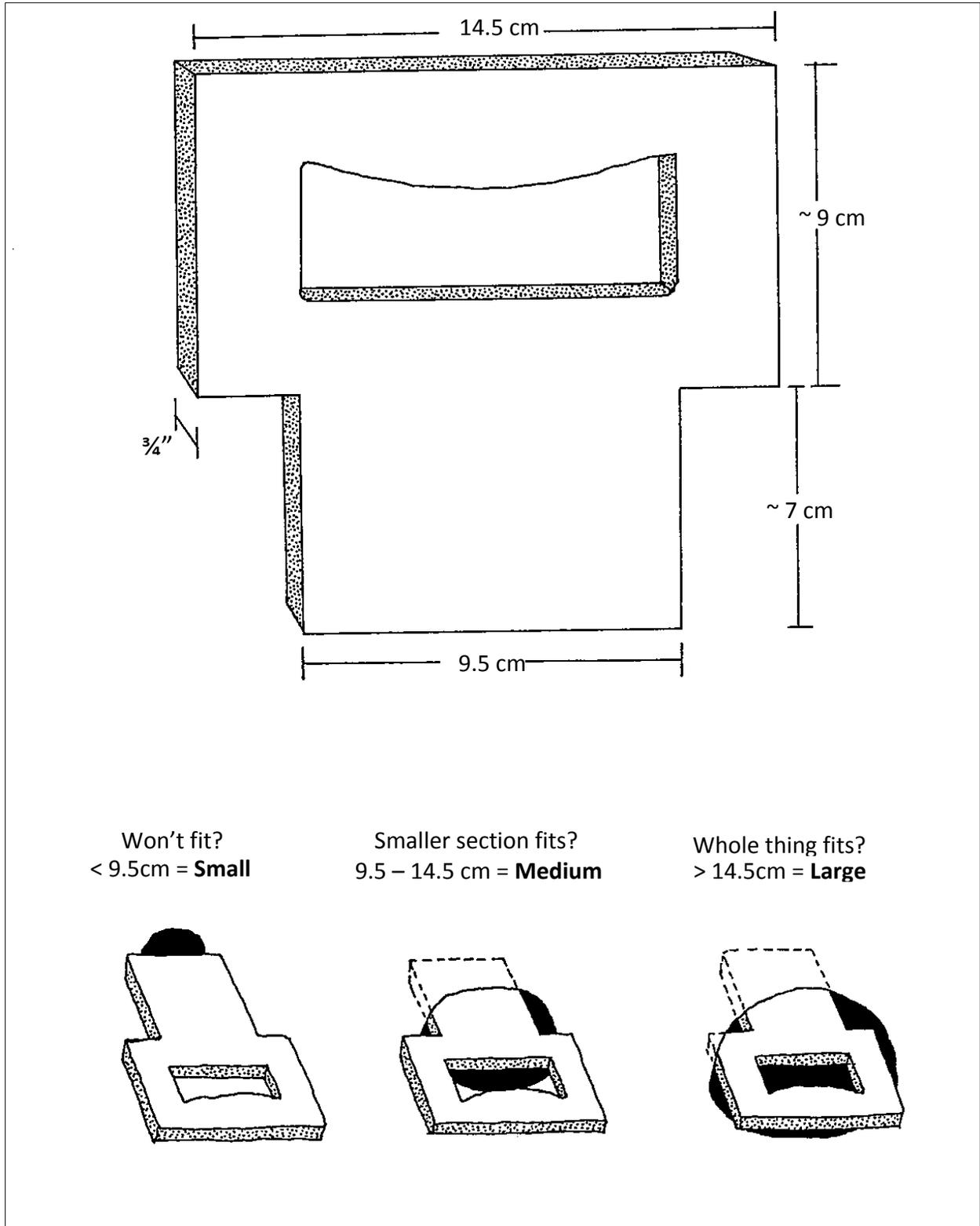


Figure 1. Diagram of burrow-measuring device and examples of burrows with entrances of different sizes.

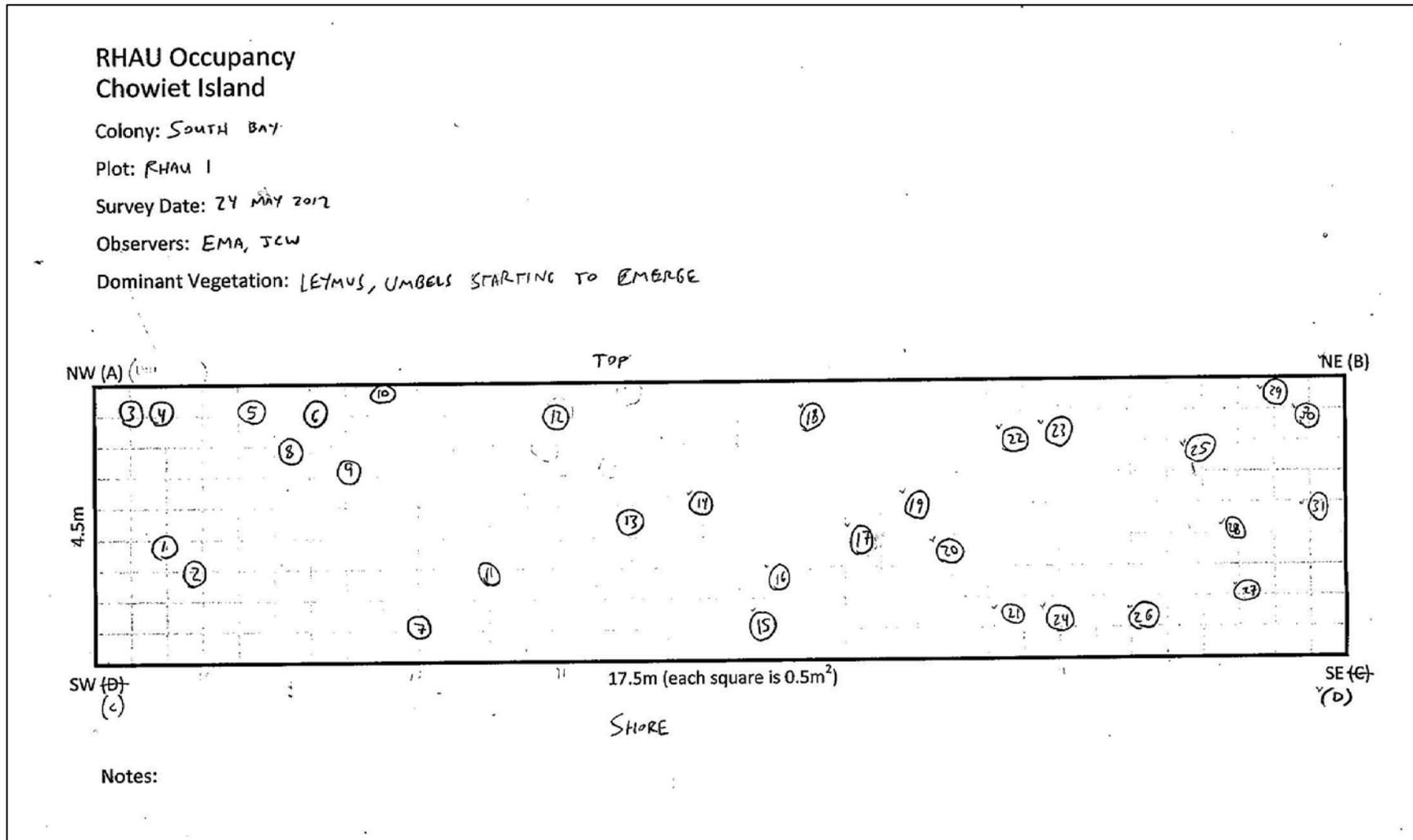
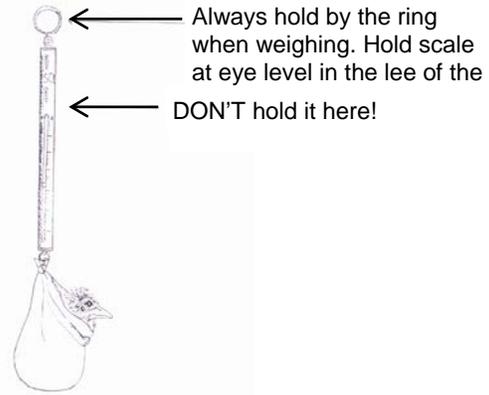
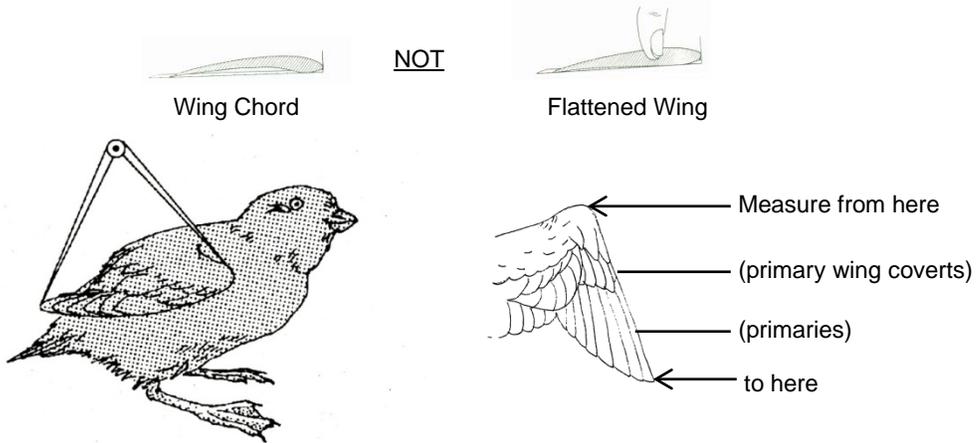


Figure 2. Example of map of rhinoceros auklet burrow locations within a plot. Circled numbers indicate flag numbers.

**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.

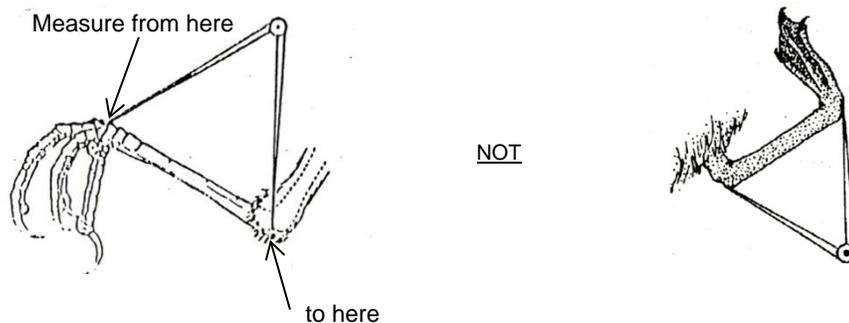


Figure 3. Diagram of rhinoceros auklet chick measurements taken on the Alaska Maritime National Wildlife Refuge.

Attachment A. Chowiet Island specifics (includes Table A1)

### **PROCEDURE DETAILS SPECIFIC TO CHOWIET**

Rhinoceros auklet productivity at Chowiet is estimated using indirect evidence of apparent occupancy on three plots at the South Bay colony and three plots at the Spruce Cove colony. Historically, some reproductive success data were collected at Chowiet by directly monitoring accessible nests using flashlights and/or burrow cameras, but this has been halted due to concerns of erosion and disturbance at the colony.

Plots used for reproductive success are also used for population indices and data are collected simultaneously (Table A1). See Burrow-nester Population Protocol for data collection procedures.

To calculate overall residency index ( $f/b$ ), use data from *second visit* for the number of medium/large burrows with apparent occupancy Early (b) and data from the *third visit* for the number of medium/large burrows with apparent occupancy Late (f) that also had evidence of apparent occupancy at the early-season check (b).

#### ***Specific Requirements for Chowiet***

All data collected at the same time as rhinoceros auklet population monitoring (see Burrow-nester Population Protocol)

Table A1. Summary of work conducted during three visits to rhinoceros auklet plots for population and reproductive success indices at Chowiet Island. The first and third visits are used for calculating population indices (density and apparent occupancy); the second and third visits are used for estimating reproductive success.

Visit:	1	2	3
Dates:	Late May to mid-June	Late June to early July	Mid- to late August
Tasks:	Flag, measure size of, and count all burrows <b><i>use for density</i></b>	Check all medium/large burrows for evidence of apparent occupancy <b><i>use for reproductive success</i></b>	Check all medium/large burrows for evidence of apparent occupancy <b><i>use for reproductive success and apparent occupancy</i></b>

## Attachment B. St. Lazaria Island specifics (includes Figure B1)

**PROCEDURE DETAILS SPECIFIC TO ST. LAZARIA**

Rhinoceros auklet productivity at St. Lazaria is estimated using indirect evidence of apparent occupancy on three monitoring plots (Figure B1). Phenology and chick growth are measured by locating burrows (both within and outside of plots) that contain eggs or chicks, which are then followed through the duration of the breeding season. Phenology burrows are a mix of natural and artificial burrows.

**Reproductive success:**

Burrows are surveyed for evidence of apparent occupancy twice during the season: around hatching (late June to mid-July) and during late chick-rearing (late July to mid-August). Plots used for reproductive success are also used for population indices and data are collected simultaneously. See Burrow-nester Population Protocol for details on plots and procedures specific to St. Lazaria.

To calculate overall residency index (f/b), use data from *first visit* for the number of medium/large burrows with apparent occupancy Early (b) and data from the *second visit* for the number of medium/large burrows with apparent occupancy Late (f).

**Chronology and chick growth:**

On St. Lazaria, chronology and chick growth data are obtained by visiting rhinoceros auklet plots BN1-1, BN1-2, and BN1-3, as well as artificial burrows, which are located in various locations throughout the colony, and random burrow sites (referred to as Rhino Night, Rhino Valley, Rhino Lookout, Rhino Point). The initial visit to all three plots, artificial burrows, and random burrows should be during early July (preferably the first 5-7 days in July), concurrent with the initial population/productivity checks for plots BN1-1, BN1-2, and BN1-3. **Note: rhinoceros auklets are very susceptible to human disturbance. While in the colony, voices should be kept to a whisper and stomping avoided.**

The desired sample size for chronology and chick growth is 30, although this is difficult to attain at St. Lazaria. If your sample size is small (e.g., you have only located 8 eggs and 5 chicks), attempt to increase your sample size by digging an excavation in burrows that had strong evidence of apparent occupancy (e.g., nest of *Angelica* leaves found, lots of guano inside, etc.). Excavations are holes dug above the nest chamber to facilitate viewing and accessing the nest. They may be used when you have found strong evidence of apparent occupancy but cannot see the nest contents, or when you have found an egg or chick but can't reach the nest chamber for chick measurements. **Only create an excavation in thick, stable soils.** To create an excavation, first determine the exact location of the nest chamber that you want to access. You can minimize the number of excavations by using a stick to extend your reach and establish the direction of the tunnel. Gently insert the stick to avoid harming any burrow occupants. Having a second observer available may be helpful. Once you have determined the location, use a pointed trowel to carefully remove small chunks of soil at a time. Bear in mind that you may also encounter storm-petrels in shallower soil, or within a rhino burrow, so proceed carefully when digging. Continue digging until you have broken through the soil to the tunnel or nest chamber. Reach in as far as needed or as far as possible in all directions to locate all occupants or determine where next to dig. Once an auklet is found, widen the excavation to allow enough room to remove a chick and your two hands out of it (~15 cm in diameter). Use a folding saw to cut through roots, as needed. After replacing the chick, close all excavations by using excavation covers and hardware cloth (secured with staples), and sprinkle with soil to restore it to a natural looking state. Use an orange pinflag to mark each excavation. Pinflags should always be placed on the uphill side of each excavation, and inserted in the soil securely to keep crows, ravens, and rhinos from pulling them up.

Whenever you check excavations on subsequent visits, have several excavation covers and staples on hand. Before opening an excavation, cover the front of all burrow entrances using a wood cover secured with staples (or use a daypack) to prevent adults that may be home from flushing from the burrow. Once you have finished visiting a burrow, be sure to remove blockages from all entrances.

**Specific Requirements for St. Lazaria**

Dates: early July to late August/early September (every 5-7 days).

Optimal sample size: 30 chicks, however, this is very difficult to obtain, so try for as many as possible; start with burrows excavated in previous years.

Time of day: Any time.

Weather: *Phenology:* Any weather, but for your sake, try to avoid excessively wet and windy conditions if possible, given that grubbing requires minimal clothing.

*Chick growth:* Avoid wet and windy conditions.

Equipment needed: *Phenology:* Grubbing gauntlets, Nitrile<sup>®</sup> gloves with the finger tips cut off to about the first knuckle, raincoat with sleeves cut off, plot maps, Rite-in-the-Rain<sup>®</sup> notebook, flags (for initial visit; white and pink, and orange), burrow measuring board (for initial visit), two permanent markers per person, pencils, paper towels (lots!).

*Creating excavations:* trowel, folding saw, hardware cloth, metal shears, staples, excavation covers, orange pinflags, Sharpie<sup>®</sup> permanent marker, plot map.

*Chick growth:* weigh bag and/or Ziploc<sup>®</sup> bag, Pesola<sup>®</sup> scales (100g, 300g 500g, and 600g), wing ruler (150mm), calipers, umbrella, Rite-in-the-Rain<sup>®</sup> notebook, pencils, papertowels, several to many excavation covers, staples.

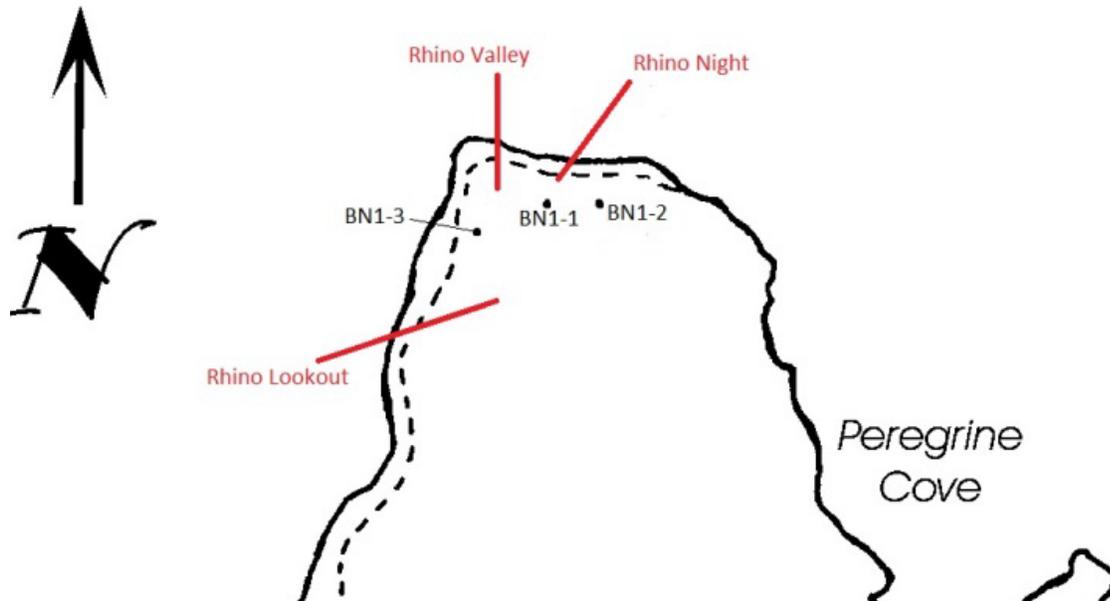


Figure B1. Locations of rhinoceros auklet sites used for productivity, phenology and chick growth at St. Lazaria Island.

### 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 <b>or equal to 7</b> days apart for that site to be used	1.3
Jan 2016	Fixed page number references in text	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 attachments, changed page number format to include protocol #, made minor grammatical edits, added clarification to main protocol about recording evidence types and runways, clarified that final calculations should use subset of nests occupied early, added clarification to Chowiet appendix about runways, clarified St. Lazaria sections, and corrected chick growth rate equation.	1.1
May 2013	Protocol developed in standardized format from historic protocols, includes Chowiet and St.Lazaria attachments	1.0