Coordinated Monitoring Strategy for Blanding's Turtle in the Northeastern United States
Project Overview and Implementation Protocols

- Updated April 18, 2017 -

American Turtle Observatory
www.amercanturtles.org

Based on protocols originally prepared in conjunction with the Massachusetts Cooperative Fish and Wildlife Research Unit[1] and the Northeast Blanding's Turtle Working Group[2]

Summary. This document provides an overview of the Northeast Blanding's Turtle coordinated monitoring strategy (CMS) for state coordinators and researchers in each of the five states (ME, NH, MA, NY, PA) participating in the Northeast Blanding's Turtle regional conservation planning and implementation process through the Competitive State Wildlife Grants program (NHFG 2011 and NHFG 2016). The CMS initially called for an extensive two-year effort in 2012 and 2013. The current iteration is intended to serve as a protocol for continued monitoring in 2017 and beyond. The CMS proposes standardized monitoring protocols and a centralized, data repository at coordinated by the American Turtle Observatory. The CMS outlines a monitoring protocol involving two tiers: 1) long-term (LT) or "demographic" assessments, and 2) less intensive rapid assessments (RA) across the region. This document outlines the site selection process and recommended field survey protocols and other implementation details. Data will be entered into Excel sheets by the partners and will be compiled and analyzed by the American Turtle Observatory and Antioch University New England.

CONTENTS

[1] Contact: Lisabeth Willey, lisabwth.willey@gmail.com and Michael T. Jones, mtjones@bio.umass.edu.

[2] See Appendix A for list of Northeast Blanding's Working Group members and their affiliations.

TABLES

FIGURES

OVERVIEW

Background and rationale.

Our purpose in designing this strategy was to develop a robust, flexible, and feasible monitoring framework to quantify the status and trends of Blanding's turtles (*Emydoidea blandingii*) (EMBL) in the Northeastern U.S. at multiple spatial and temporal scales. This effort was initially funded by a U.S. Fish and Wildlife Service Competitive State Wildlife Grant awarded to the state of New Hampshire (NHFG 2011) in which the five states cooperated to develop a regional conservation plan for the species (Willey and Jones 2014). Sampling in 2017-2019 is supported by a second Competitive State Wildlife Grant awarded to the state of New Hampshire (NHFG 2016). Sampling will continue into the future in accordance with this protocol and the regional Conservation Plan (available at www.blandingsturtle.org). Our specific objectives for the monitoring strategy are to:

a) quantify the current abundance of EMBL at the regional scale;
b) quantify long-term trends in EMBL abundance at the regional scale;
c) quantify current EMBL density at selected key sites;
d) quantify long-term trends in EMBL density at key sites;
e) gather additional information at poorly-known EMBL sites throughout the region.

This document is intended to serve as a brief overview of the strategy and to offer guidance for implementation in 2017-2019; modifications have been made from the initial protocol developed in 2012. In developing this monitoring strategy, we drew from previous monitoring protocols designed for Blanding's turtle (e.g., Grgurovic 2007; Chaloux 2010) and other turtle species (e.g., USFWS 2006; USGS 2006; Erb and Willey 2011; USFWS 2011; USFWS 2012), as well as general monitoring guidance documents (e.g., Oakley et al. 2003; Graeter et al. 2008).

Study Design.

The regional Blanding's Turtle monitoring strategy has two tiers: 1) a network of 36 long-term (LT) monitoring sites that are intensively sampled to provide site-specific density estimates using spatially explicit capture-recapture methods (Borchers and Efford 2008) or other capture-mark-recapture models (e.g., Baillargeon and Rivest 2012), and 2) a network of at least 80 rapid assessment (RA) sites, which are analyzed in the 'abundance' framework using N-mixture models (as described in Royle 2004) (Table 1). Rapid assessment sites are sampled using one of two approaches: a series of 3 standardized visual surveys (VRA) at each site during the spring season or a single, four-night trapping event (TRA) at each site during any season. Two types of rapid assessment methods are available in order to apply protocols to a range of habitats that may be more suited to one method or the other, and to allow for varying levels of effort based upon the availability of sampling resources (time, personnel, and equipment). In addition, "TRA-lites" are possible at sites where the complete sampling protocol cannot be implemented due to limited habitat or logistical constraints (see the *Modifications to Design and Field Protocols* section). Sites will be distributed throughout the Northeast Region within the range of Blanding's turtle, with a target of at least one LT site per state (with an ultimate goal of sampling all 36 high priority sites before 2019) and as many RA sites as feasible per state in 2017, recognizing that this will not be possible in all states due to limited resources and/or suitable habitat area.

Table 1. Summary of sampling approach and statistical frameworks.

	Long-term monitoring (LT)	*Rapid assessment (VRA , TRA, and Random TRA-lites)*
Model framework	Spatially-explicit capture-recapture (SECR) (Borchers and Efford 2008) or open/closed population models (Baillargeon and Rivest 2012)	Abundance *N*-mixture models (Royle 2004)
Purpose	Contextualize abundance analyses, evaluate variation in detectability, and track change at key sites	Detect regional trends and allow landscape analyses at regional scale
Target number of sites per state for 2017	≥ 1 site /state with an ultimate goal of sampling the 36 high priority sites across the region	As many as feasible/state
Target time requirement in field for 2017	21 field days per site (48 hr checks) or 36 field days (24 hr checks)	Visual RA: 0.5 days per visit; 1.5 days per site (15 days for 10 sites) Trap RA: 3 days per site (30 days total [incl. 3 days at LT site])

Long-term (LT) monitoring summary.
Long-term sites are trapped for a period of 12 nights in each of three seasons: **Pre-nesting**: April 15 – May 27; **Nesting:** May 28 – July 8; and **Post-nesting:** July 9 – September 1[3]. An optional 4th sampling event could occur in the fall, after September 1, in addition to, or instead of one of the three earlier seasons. During each sampling event, twenty traps will be deployed throughout the site as described in the field implementation section below, for a total of 240 trap-nights per sampling event[4]. Traps will be checked every 48 hours (unless required to be checked more frequently, see *Modifications to Design and Field Protocols* section). Results from the LT trapping will be analyzed in a spatially explicit capture-recapture framework (e.g., Borchers and Efford 2008) or open/closed population models (Baillargeon and Rivest 2012) to estimate population density or size within the trapped area. Standardized, high intensity trapping at a few sites in this manner will allow us to evaluate change in site-specific Blanding's turtle density over time as well as relative age structure and sex ratios at these targeted sites. The trap results will also allow us to assess variation in seasonal and annual trap success to inform the interpretation of results at the rapid assessment sites.

Rapid assessment (RA) summary.
RA sites will be sampled using one of two sampling approaches: visual rapid assessment (VRA) and/or trap-based rapid assessment (TRA). TRA-lites can also be conducted at random sites or where necessary across the region.

Visual rapid assessments (VRAs) consist of a series of three visits to each site during the pre-nesting (spring) season (from April 1 – May 27; note that visual surveys can occur two weeks earlier than trap events), though surveys should cease once vegetation becomes too thick to observe basking turtles (this may likely vary annually and regionally). Each visit consists of eight, 10-minute surveys distributed throughout the site as described in the field implementation section below.

[3] Seasons were delineated using movement distances of EMBL tracked in Massachusetts (Grgurovic 2006) and in Maine (Beaudry et al. 2009).
[4] The necessary number of trap nights required per event was calculated based on average trap rates over 47,547 trap nights in studies conducted throughout the Northeast by Johnson and Crockett (2009), Windmiller (2005 and 2006), Grgurovic (2005-2010), Hartwig et al. (2007), and Yorks (2011). Results from 2012 suggest that the number of trap nights / site was sufficient to reach our sampling goals.

Trap-based rapid assessments (TRAs) consist of four consecutive nights of trapping at a site in any season (April 15 – October 1). TRA events utilize 20 traps / site deployed using the same design as the long-term sampling events, and traps will be checked every 48 hours. If space and/or resources do not allow for a full 20-trap TRA, fewer traps may be deployed in multiples of 5 (see *Modifications to Design and Field Protocols* section).

Random trap-based rapid assessment-lites (Random TRA-lites) will also consist of four consecutive nights of trapping at a site in any season (April 15 – October 1). TRA-lite events utilize the same design as the long-term sampling events and TRA events, except that a single reference plot (rather than 4 reference plots) will be placed with 5 traps. Like the TRA, traps will also be checked every 48 hours for 4 nights.

Long-term sites will be included in the rapid assessment analysis. LT sites do not need an additional four nights of trapping beyond the LT design; rather the 12 night LT events can be sub-sampled to make results comparable to the TRA design.

VRA, TRA, and random TRA-lites will be analyzed in an occupancy/abundance modeling framework where count data are used to assess regional rates of detection and abundance. This will allow us to evaluate changes over time at the regional scale.

BRIEF SUMMARY OF PREVIOUS FIELD EFFORT

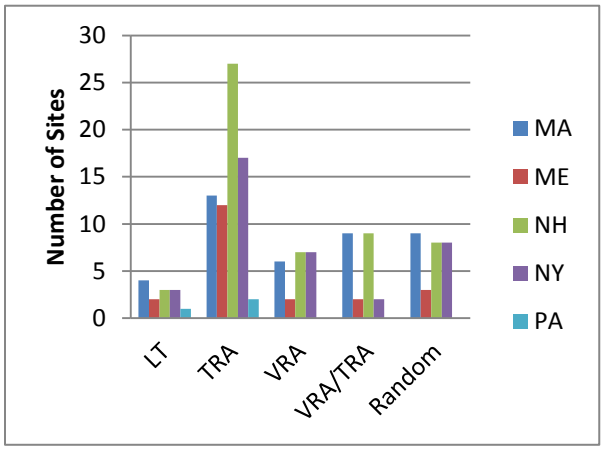

Fig. 1. Distribution of sampling sites 2012-2013.

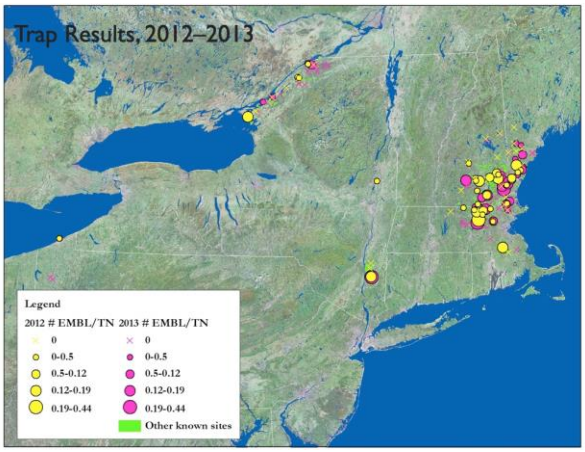

Fig. 2. Distribution of trap sites 2012-2013.

During the 2012-2013 field seasons, field teams across the region sampled a total of 156 sites: of 13 long-term sites, 22 VRA sites, 71 TRA sites, and 22 sites with both VRAs and TRAs, and 28 random plots (Fig. 1 and 2). This effort yielded 10,171 48 hour trap checks, during which Blanding's turtles were caught 1178 times, painted turtles 9162 times, snapping turtles 1585 times, and spotted turtles 110 times (Table 2). Average trap success was 0.058 Blanding's / TN (or 17.3 TN/EMBL). Our results suggest that Blanding's are widely distributed throughout their known range in the northeast, with dense populations distributed patchily on the landscape. Trap success was variable throughout the trapping period, but was not significantly lower until September (Fig. 3).

Fig. 3. Relative trap success, by month, 2012.

2017 TARGET SITE DISTRIBUTION

Target distribution of sites at the regional and state scales.

In 2017, sites will once again be distributed throughout the Northeast region, within the range of Blanding's turtle (Fig. 3). States should focus on high priority sites that were not sampled as part of the 2012-2013 effort, while also sampling previously sampled LT sites and TRAs as possible. As a target, each state should choose at least **1 new LT site to sample in 2017 (with an ultimate goal of sampling all 36 high priority sites region-wide)** (Table 2). Additional LT and RA sites (including site sampled in 2012-2013) are encouraged in each state, depending on resource availability. High priority sites were designated in the 2014 Regional Conservation Plan (Willey and Jones 2014).

Table 2. Total sites sampled across the region in 2012 and 2013, with sampling results by state.

	Maine	Massachusetts	New Hampshire	New York	Pennsylvania	Regional Total
Total sites trapped	19	35	47	30	3	134
Total traps deployed	370	858	907	597	149	2881
Number of 48 hour checks	1251	3287	2780	1931	922	10171
Standardized Blanding's turtles in traps	78	634	290	172	4	1178
Standardized painted turtles in traps	1129	3777	2943	972	341	9162
Standardized spotted turtles in traps	21	58	24	7	0	110
Standardized snapping turtles in traps	211	477	507	116	274	1585
Average Blanding's / Trap night	0.031	0.096	0.052	0.045	0.002	0.058
Total sites visually surveyed	6	19	19	10	1	55
Total vantages	152	523	440	218	12	1345
Blanding's turtles observed during visual surveys	29	177	134	38	0	378
Spotted turtles observed during visual surveys	42	23	21	3	0	89
Painted turtles observed during visual surveys	223	3998	3405	437	4	8067
Average Blanding's / Vantage	0.191	0.338	0.305	0.174	0.000	0.281

SITE SELECTION

Site Selection Process.

LT, VRA, and TRA sites will be selected in each state by the State Coordinator with help from the ATO/AUNE team and/or Principal Field Investigators where appropriate. Known Blanding's turtle observations were delineated as 'sites' and ranked at the regional scale as part of the regional Conservation Plan (www.blandingsturtle.org) using a series of metrics to identify potential priority conservation sites in each state. The methodology for ranking sites is described in the Conservation Plan. Site boundaries were provided to State Coordinators in a shapefile (embl_sites.shp). Site boundaries and ranks are meant to serve only as guides for the 2017 site selection process. The best Blanding's turtle habitat in the vicinity of the "site" should be the focus of the monitoring; sampling can occur well outside of the site boundaries delineated in the shapefile.

ALLOCATING RESOURCES

Allocation of field personnel and equipment.

The target time required to sample a single new LT site is 21 days (if conducting 48 hour checks) or 36 days (if conducting 24 hour checks), assuming a single person is working independently, visiting only one trap

site/day. Realistically, teams of people could be used to install and breakdown traps and/or check traps. Recognizing that states have varied resources and amounts of Blanding's turtle habitat, the number of sites that each state is able to visit will vary.

VRA surveys are conducted only in the spring season, whereas TRA sampling events can occur any time from April 15 – October.

In order to prevent results of the VRA at a site from being confounded with observer effects, multiple observers should visit VRA sites if possible, and observers should visit multiple sites. One way this could be accomplished is to have observers work in pairs, each conducting four of the eight surveys at a site on a given day, then switching observation points on the next visit to the site. Alternatively if there are multiple observers working in a state, they could alternate who goes to which sites.

The trapping protocol requires that 20 traps are deployed at each site at a time, therefore traps should be purchased in multiples of 20 (plus extra traps in the event of damage). Because traps are checked every 48 hours, it is possible for a field team to operate traps at two sites at a time, which would require having 40 traps on hand.

IDENTIFYING REFERENCE POINTS WITHIN LT AND RA SITES

Reference point selection within sites.
Within each LT, VRA and TRA site, four references points will be selected for the purposes of sampling using the following protocol. For random sites, the reference plot has already been drawn.

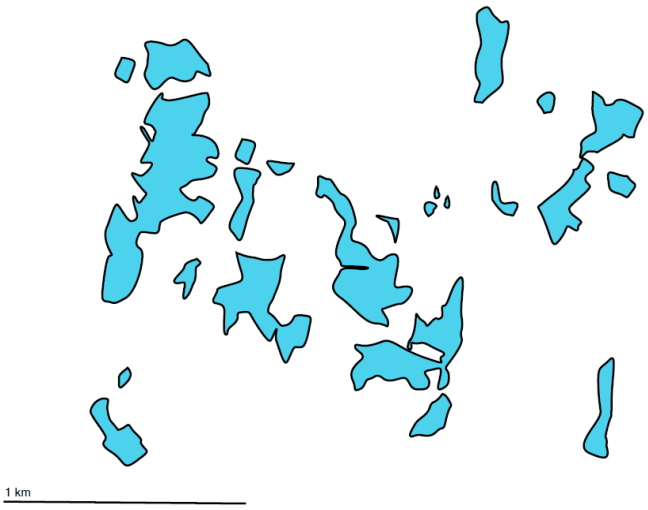

Fig. 4. Sample **focus area** with diverse wetlands suitable for Blanding's turtle.

1. Within a site, use aerial photographs or field reconnaissance to identify a **focus area** with diverse wetlands suitable for EMBL. As an approximate guide, the focus area should be ≥2km² and ≤6km² (smaller sites can be accommodated using the modifications suggested below). When possible, wetlands suitable for EMBL should be diverse and broadly distributed throughout the focus area. The focus area does not need to be entirely within the area delineated in the shapefile; rather, it should include the most suitable Blanding's habitat nearby (see Fig. 4).

2. Within the focus areas, identify four **reference points** separated by 800 to 1600 m[5] (depicted as stars in Fig. 5). Reference points should be centered on areas of high suitability Blanding's habitat (high potential use wetlands, HPUs, as described in the field implementation section). They may fall in a wetland area, or in an upland area centered on a constellation of wetlands. Around reference points, delimit **circular plots** with 400 m radius (shown as dashed circles on Fig. 5). Sampling will be conducted within the circular plots.

Fig. 5. Sample distribution of **reference points** within a **focal area**. The stars represent reference points, which are placed 800 to 1600 m apart. Circular plots with a radius of 400 m are centered on each reference point.

MODIFICATIONS TO DESIGN AND FIELD PROTOCOLS

TRA-lites for small sites / limited personnel or trap resources.
If focus areas within a site are too small to place all four reference points, or if there are not enough personnel or traps available for four plots, fewer reference points may be placed, but continue to use 5 traps/reference plot (for a total of 5, 10, or 15 traps). Priority sites chosen for monitoring should typically be at least large enough to accommodate three reference points 800 m apart, but even single reference plots are useful and can be analyzed in the regional framework if location, deployment dates, and results are recorded for each trap.

24 hour trap checks.
If required to check the traps every 24 hours, consider leaving the animals in the trap until the 48 hour period. In all cases, clearly note the actual frequency of checks when submitting results, which animals were observed on which day(s), which animals were left in traps, which animals were there the next day, and which escaped.

Capturing animals during VRA.
The 10-minute observation period is not intended to focus on hand captures. If possible, the 10 minute period should take place before moving to capture observed turtles. Animals hand-captured during and after VRA events, as well as during trap checks and while walking between sites, should be processed using the individual turtle form (discussed below).

Addition of nesting/upland surveys.
Nesting and upland surveys may be included in some SECR and mark-recapture analyses if they are broadly conducted within the circular plots outlined in the previous section and the level of effort within each plot is recorded.

[5] Distance requirements between reference points are based on average movement distances of turtles radiotracked in two studies in Massachusetts (Grgurovic 2007; Windmiller 2005 and 2006) and a study in Maine (Beaudry et al. 2007).

FIELD IMPLEMENTATION PROTOCOL

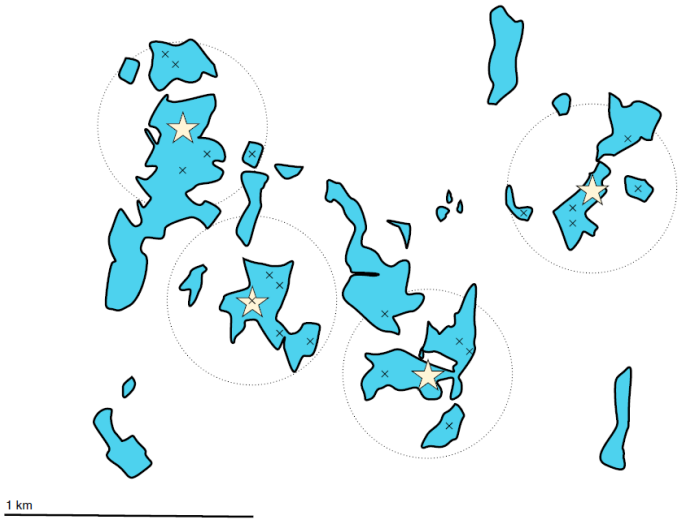

Fig. 6. Example configuration of traps in relation to reference points, with "x" marking trap locations. The circular plots have a radius of 400 m from the reference point.

Overview.

Field protocols for sampling sites follow one of four methodologies as outlined above: 1) Long-term (LT); 2) Visual Rapid (VRA) and 3) Trap Rapid (TRA) assessments, 4) Random TRA-lite. At each **priority** site, regardless of what type of monitoring occurs there, four reference points should be delineated as described above. The 400m radius buffer around each reference point serves as the circular sampling ***plots*** for the methods described below. For **random** sites, a TRA-lite assessment is conducted, in which only a single 400m circular reference plot is sampled. Random plots are drawn in the random plot shapefile, and should generally not be moved.

Long-term (LT) assessment implementation.

Each new long-term site will be sampled for three, 12-night trap events during the 2017 field season: once in the spring (April 15 – May 27), once during nesting (May 28 – July 8), and once post-nesting (July 9 and on). An optional fourth sampling event can be conducted in the fall. For maximum efficiency, traps can be deployed for 12 consecutive nights. If this is not possible, traps can be pulled for intervals (e.g., weekends) within the sampling period, so long as 12 nights are trapped in total. During each sampling event, 20 traps will be deployed for the 12 nights, for a total of 240 trap nights / site / sampling event. Traps are deployed in the configuration shown in Fig. 6.

Within each of the four circular sampling plots, place five traps 0 to 400 m from the reference point at the plot center (= 20 traps total) in **high potential use** (HPU; see below) wetlands, as determined by the researcher in accordance with criteria outlined below. Traps can be placed in one large wetland, or in a constellation of up to five smaller wetlands (constrained only by # of traps).

Ideally, traps should be placed at 80 m intervals, in different directions, from the reference point (e.g., 80 m to NW; 160 m to NE, etc.), but this is only the ideal. Emphasis should be placed on habitat suitability rather than strict adherence to the distance rules, but traps should be at least 20 m apart so that they are trapping slightly different parts of the wetland. If possible, field researchers should determine potential HPUs remotely prior to setting out into the field, recognizing that field conditions may alter the selection of wetlands once in the field.

Suitable wetland habitat should be selected according to the following criteria:

High potential use (HPU):

1. Deep (≥0.4 m) scrub-shrub and emergent wetlands;
2. Deep (≥0.4 m) vegetated vernal pools with abundant amphibian egg masses;
3. Vernal pools in close proximity to nesting habitat;
4. Deep (≥0.4 m) emergent and shrub vegetated sections within river and stream floodplains;
5. Deep (≥0.4 m) and vegetated sections of beaver impounded wetlands;
6. Wetlands with EMBL observed.

Low potential use (LPU) (these areas should be avoided when setting traps):

1. Deep open water habitats (i.e., ponds, lakes, reservoirs, etc.)
2. Dense canopy forested wetlands.
3. Shallow bogs

Trap placement criteria.
Visual reconnaissance prior to trapping is helpful and proper trap placement is essential to prevent turtle mortality and maximize trap night efficiency. Traps should be located within the HPUs as follows:

- In deep (≥0.3 m, ≤trap diameter) channels between vegetation, sedges, shrubs, logs, debris
- At the edge of thick vegetation
- Surrounded by good cover and relatively deep water
- Proximal to basking sites
- At sites with good solar exposure

Traps should be placed on tall (>1.2 m) stakes, posts, or rebar, and **firmly** affixed to prevent snappers, beavers, etc. from moving them. The trap should be secured such that it will not collapse during the 48 hour period. Ideally the trap should be firmly staked at 3 points to prevent collapse, though 2 may be used if stakes are firmly secured. The traps should be set so that turtles have adequate headspace to breathe. GPS coordinates should be recorded at each trap once they are placed, and traps should be flagged or marked in accordance with each researcher's preference. On the day of trap deployment, complete the *trap set-up field form* including habitat suitability information. At each trap, note on the field form the coordinates of the trap, and the immediate habitat characteristics within a 5m diameter circle (water depth, wetland type, % canopy, shrub, herbaceous emergent and submerged vegetation, the dominant plant species of any layer, and the distance from shore). For additional details, see field-form instructions.

Traps should be baited with sardines in soybean oil (e.g., Beach Cliff), checked, and re-baited every 48 hours and left in place for 12 days in the same **season**. If heavy rain is expected during the trap event, traps should be checked more frequently to ensure that there is ample headspace in the event of rising water levels. On each trap-check day, the *trap-check field form* should be completed, and the *turtle observation field form* should be completed for each Blanding's turtle captured in the trap (see protocol for processing individual turtles, below). Air and water temperature should be recorded once in each reference plot. Air temperature should be measured in the shade. Water temperature should be measured 10 cm below the surface, adjacent to a trap. For additional details, see field-form instructions. The 12 night run comprises a single **LT trap event.** Three LT trap events are conducted throughout the year (1 during pre-nesting, 1 during nesting, and 1 post-nesting). Turtles observed will be processed as described below.

Visual Survey Assessment (VRA) Protocols.
VRA surveys consist of three separate visits to each VRA site within a two week period in the spring season (April 1 – May 27, though surveys should cease once vegetation becomes too thick to observe basking turtles. This may likely vary annually and regionally). Each visit requires a total of 80 minutes of active visual survey time throughout the site allocated in the following way. Within each 400m radius circular plot, select two **vantage points** (total of 8 per site)(Fig. 7). Vantage points should be located where an expanse of high suitability EMBL habitat is visible from shore, and should be focused on a particular wetland resource of less than 1 ha (e.g., a vernal pool, or cove of a larger wetland). Prior aerial reconnaissance or field visits should be used to select potential vantage points where Blanding's turtle are likely to be observed basking (e.g., a wetland area with ample downed logs, hummocks, or

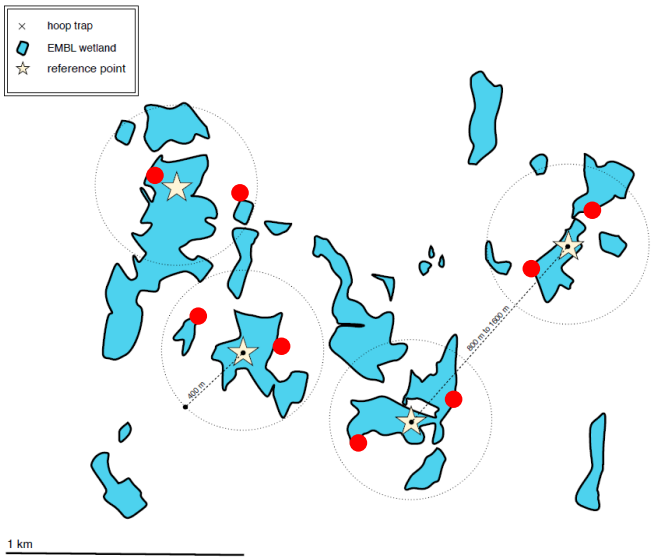

Fig. 7. Example distribution of visual vantage points, each pair located within 400 m of a reference point. Visual vantage points are shown as red dots.

other basking sites), but vantage points may be modified in the field. Record selected vantage points with a GPS in the field on the *VRA survey form*.

During each survey, stealthily approach the vantage point in the field, taking care to avoid disturbing basking turtles. Once the wetland is visible, begin the 10 minute timed survey. Using binoculars, scan basking sites, the water surface, and the shore for turtles and record all EMBL observed during the 10-minute period. If the wetland has been thoroughly scanned using binoculars and no turtles are visible basking, or turtles were scared into the water, the observer may use the remainder of the 10 minute period to approach the wetland and survey the upland surrounding the wetland, or wade into the wetland to look for submerged animals. At the end of the 10 minute period, the survey is over, and the observer should complete the field form, and move to the next vantage point. Once the two vantage points in the plot have been completed, move to the next circular plot and assume a new vantage point there, and repeat. During subsequent visits to the site, visual vantage points can be moved to different areas within the circular plots, or can remain the same, but all points should be recorded on the field form, along with habitat, vantage, and environmental characteristics. Ideally, visual surveys will be conducted by 30% overlap in observers to quantify observer effects.

Seasonal and weather requirements for visual surveys.
The start day of visual surveys is dependent on spring conditions; no visual surveys should be conducted prior to expected emergence (April 1 in most years, though this will vary with the year). Ideally, visual surveys should end once vegetation becomes too thick to readily observe basking turtles. This will likely vary annually and regionally and may occur prior to the end of the spring sampling period (May 27). Visual surveys should not be conducted on days cooler than 55^0F. Weather should ideally be sunny and $>65^0$F. Weather should be recorded on the field form.

Trap-based Rapid Assessment (TRA) implementation.
TRA sampling events can be conducted any time during the Blanding's turtle activity season (April 15th – October 1). TRA sampling events follow the same procedures as LT events, but traps are only left in place for 4 consecutive nights, rather than 12 (4 nights x 20 traps = 80 TN), and only 1, 4-night TRA trap event is required rather than three. As with LT sites, complete the *trap set-up field form* upon trap placement, check traps every 48 hours, and report all trap-specific captures on the *trap-check field form*.

Random, TRA-lite implementation.
For points selected from the random sampling network, the TRA implementation is followed, except that only a single 400m reference plot with 5 traps is placed, rather than 4 reference plots. As with LT and TRA sites, complete the *trap set-up field form* upon trap placement, check traps every 48 hours, and report all trap-specific captures on the *trap-check field form*. Random plots generally should not be moved.

Protocol for Processing Individual Turtles.
When a turtle is captured (either during trapping or following visual surveys), the *turtle observation field form* should be completed, and the following protocols are recommended.

Morphometrics: Record shell dimensions in mm. At a minimum, record SCLmin (straight carapace length) and SPLmin (straight plastron length). Optionally, also record: PW @ H-P seam (plastron width at humeral/pectoral seam), and CW @ 8th marginal (carapace width at the 8th marginal). Use dial calipers 12"/300mm.

Weight. Record animal mass in g (Pesola scale ≥2500 g for adults and a smaller scale for juveniles).

Age and Plastral Wear: Assess the animal's age if new growth is visible along the medial seams and the plastral scutes are only lightly worn. Otherwise, report the minimum number of annuli visible and whether the plastral scutes are "not worn" (≤10% wear), "partly worn" (<50%), "mostly worn" (50%-90%) or "worn" (>90%).

Individual marking. Turtles should be individually notched as directed by state coordinators. Secondary recognition is recommended using photographs, injuries, deformities, etc.

Photographs. Photograph carapace and plastron with animal ID visible in photo (or sorted/ tagged post-capture). If possible, photograph lateral head shot and limbs/tail, as well as obvious injuries or deformities.

Injuries and general health. Note missing or injured limbs, tail, eyes, etc., as well as the presence of skin or upper respiratory tract infection or lethargic condition.

Scute morphology and other deformities. Note any major scute or other deformities.

Required Equipment.

The following equipment is required to complete the protocol: field forms, writing implements, flagging for marking traps, binoculars (for visual surveys), dial calipers (> 12 in), Pesola scale ≥2500 g, file (for marking turtles), air and water thermometers, and 20 traps/site operated at a time with associated stakes, ties, and bait. Additional optional equipment may also be necessary including waders, polarized sun glasses, disinfecting equipment, blood sampling equipment, or a kayak/canoe. Because researchers currently have a range of available equipment, specifications are flexible. Any traps >0.5 m in diameter with < 5 cm mesh are acceptable. These variations will be incorporated as a covariate in the modeling process. To help standardize future equipment purchases, we recommend 0.8 m (2.5') diameter, ≤3.8 cm (1.5") mesh traps, and offer the following additional suggestions:

Trap dimensions: ~0.8 m diameter (2.5'); <3.8 cm (1.5") mesh; steel frame hoop trap (any 3 to 5-hoop trap ≥0.5 m diameter with mesh < 5.1 cm is appropriate if already in use).

Trap identification: Assign unique ID to each trap and label trap in the field.

Trap location/operation: Record trap ID, lat/long, and functional period (mm/dd-mm/dd), and complete appropriate field form upon trap placement.

Bait: Sardines in soybean oil (Beach Cliff or other brand).

Re-bait frequency: 48 hr (puncture can, do not open entirely).

Trap check frequency: 48 hr with more frequent checks as required by agencies/partners or flood conditions.

Retrofits: "Snapping turtle excluders" are optional.

General protocols to reduce likelihood of disease transfer.

Several states and research teams within the region already have a standard decontamination procedure in place to prevent the spread of disease, and therefore the Northeast Blanding's Turtle Working Group decided in a 3/2012 meeting not to adopt a standardized decontamination protocol through the region. For those teams without a decontamination protocol, we suggest several precautionary measures to prevent the spread of disease. A 10% bleach solution may be used to disinfect traps and clothing between sites. After bathing or spraying tools and clothing in the bleach solution, items should be rinsed with clean water. Captured turtles from different sites and those displaying signs of illness should be held separately during processing, and equipment should be sterilized between turtles. Calipers should be swabbed with alcohol, files can be burned, and notches should be dabbed with Betadyne. Latex gloves for handling turtles are an additional precautionary suggestion.

Post-processing: data entry.

All survey details, habitat and traps details, turtle details, and photographs will be recorded on the appropriate field form as noted below, and entered electronically by the observer into the Excel template provided by AUNE.

- **Form 1: Site designation** should be completed prior to the field season, recognizing that information may change due to realities in the field.
- **Form 2: Trap set-up field form** should be completed when traps are placed for an LT, TRA, or Random trap event.

- **Form 3: Trap-check field form** should be completed when checking traps at LT, TRA, and Random sites.
- **Form 4: VRA survey form** should be completed at each visit to VRA sites.
- **Form 5: Turtle observation field form** should be completed following all EMBL captures (including recaptures).

Entering these data electronically as soon as possible will allow the ATO/AUNE team to recalculate detection rates, critically evaluate our starting assumptions, analyze results in real time, and adapt the sampling plan if necessary. It will also allow the entire team to identify errors and missing data as soon as possible, and track our progress and know which sites have been sampled, and when.

ACKNOWLEDGMENTS

This monitoring strategy is a collaborative effort of the Northeast Blanding's Turtle Working Group with members from Maine, Massachusetts, New Hampshire, New York, and Pennsylvania. We are grateful to the U.S. Fish and Wildlife Service, New Hampshire Fish and Game Department, Maine Division of Inland Fisheries and Wildlife, Massachusetts Division of Fisheries & Wildlife, New York Dept. Environmental Conservation, and Pennsylvania Fish and Boat Commission for their support, as well as the USGS Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst, State University of New York Potsdam, Swampwalkers, Inc., Grassroots Wildlife Conservation, and Oxbow Associates. Thank you to G. Johnson, M. Grgurovic, B. Compton, B. Windmiller, and D. Yorks for sharing their Blanding's turtle trap and telemetry datasets with us as we prepared this sampling strategy. Finally, thank you to R. Chandler for his help in designing this strategy.

LITERATURE CONSULTED

Baillargeon, S., and L. Rivest 2012. Rcapture: Loglinear Models for Capture-Recapture Experiments. R package version 1.3.1. http://CRAN.R-project.org/package=Rcapture.

Beaudry, F. 2007. Road Mortality Risks for Spotted and Blanding's Turtle Populations. Unpubl. Ph.D. diss., University of Maine, Orono.

Beaudry, F., P.G. deMaynadier, and M.L. Hunter. 2007. A Study of Movement, Habitat Selection, and Population Viability of Spotted and Blanding's Turtles in Southern Maine. Final Report 2007. University of Maine. 39 pp.

Beaudry, F., P.G. deMaynadier, and M.L. Hunter. 2009. Seasonally Dynamic Habitat Use by Spotted (*Clemmys guttata*) and Blanding's Turtles (*Emydoidea blandingii*) in Maine. Journal of Herpetology 43(4): 636–645.

Borchers, D.L. and M.G. Efford. 2008. Spatially explicit maximum likelihood methods for capture-recapture studies. Biometrics. 64(2):377-85.

Chaloux, A.M. 2011. Blanding's turtle (*Emydoidea blandingii*) in Saratoga County, New York: Survey methods, spatial ecology and conservation. Unpublished M.S. Thesis. University at Albany, State University of New York. Albany, NY.

Chaloux, A.M. 2010. Blanding's turtle (*Emydoidea blandingii*). In: Surveying for New York's High Priority Reptiles and Amphibians: Implications for Standardized Protocols. Final Report. New York Natural Heritage Program, Albany, NY.

Compton, B.W., F. Beaudry, K. McGarigal, and P.R. Sievert. 2007. Habitat Modeling for Blanding's Turtle (*Emydoidea blandingii*) in the Northeast. Final Report.

Compton, B.W. 2007. Status Assessment for the Blanding's Turtle (*Emydoidea blandingii*) in the Northeast. Unpublished U.S. Fish & Wildlife Service Report.

Erb, L. and L. Willey. 2011. Appendix 10.10: Massachusetts Eastern Box Turtle Monitoring Protocol. Draft, April 2011. In: Erb, L. 2010. Eastern Box Turtle Conservation Plan for Massachusetts. Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program. Westborough, MA.

Graeter, G.J., K.A. Buhlmann, L.R. Wilkinson, and J. Whitfield Gibbons (Editors). 2008. Inventory and Monitoring: Recommended Techniques for Reptiles and Amphibians, with application to the United States and Canada. PARC Technical Report. Aiken, South Carolina.

Grgurovic, Mark. 2006. Habitat selection and movement patterns of Blanding's turtles (*Emydoidea blandingii*) in Massachusetts. MS Thesis, University of Massachusetts Amherst.

Grgurovic, M. 2007. Blanding's turtle (*Emydoidea blandingii*) survey protocol. A report prepared for the Northeast Blanding's Turtle Working Group. Swampwalkers Wetland Ecosystem Specialists.

Hartwig, T., E. Kiviat, and A. Worley. 2007. Blanding's turtle monthly trapping surveys in the towns of Clinton and Milan, Dutchess County, New York, 2006 with recommendations for assessment protocols. A report prepared for Hudsonia Ltd. 18 pp.

Jackson, A.J., A, C. Broderick, W. J. Fuller, F. Glen, G. D. Ruxton and B.J. Godley, 2008. Sampling design and its effect on population monitoring: How much monitoring do turtles really need? Biological Conservation 141(12): 2932-2941.

Johnson, G. and T. Crockett. 2009. Distribution, population structure and habitat relationships of Blanding's turtle populations in northern New York Final Report AMO5122, Grant T-2-1. New York State Department of Environmental Conservation 144 pp.

Kéry, M., J.A. Royle, and H. Schmid. 2005. Modeling avian abundance from replicated counts using binomial mixture models. Ecological Applications 15(4):1450-1461.

Oakley, K.L., L. P. Thomas, and S. G. Fancy 2003. Guidelines for long-term monitoring protocols. Wildlife Society Bulletin 31(4):1000–1003.

Pollock, K.H. 2000. Capture-recapture models. Journal of the American Statistical Association 95:293-296.

Royle, J.A. 2004. *N*-mixture models for estimating population size from spatially replicated counts. Biometrics 60:108-115.

Royle, J.A., and J.D. Nichols. 2003. Estimating abundance from repeated presence-absence data or point counts. Ecology 84(3):777-790.

Royle, J.A., M. Kéry, and J. Guélat. 2011. Spatial capture-recapture models for search-encounter data. Methods in Ecology and Evolution 2(6):602-611.

U.S. Fish and Wildlife Service (USFWS). 2006. Guidelines for bog turtle surveys (revised). www.fws.gov/northeast/nyfo/es/BT%20SURVEY_April%202006.pdf.

U.S. Fish and Wildlife Service (USFWS). 2011. Revised recovery plan for the Mojave population of the desert tortoise (*Gopherus agassizii*). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. 222 pp.

U.S. Fish and Wildlife Service (USFWS). 2012. 2012 Desert Tortoise Monitoring Handbook. Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, Nevada. Version: 2. February 2012.

U.S. Geological Survey, western ecological research center. (USGS) 2006. USGS Western Pond Turtle (*Emys marmorata*) Visual Survey Protocol for the Southcoast Ecoregion. Survey Protocol, version 1. Sacramento, California

APPENDIX A.

NORTHEAST BLANDING'S TURTLE WORKING GROUP, MONITORING SUBGROUP

Michael Marchand
Loren Valliere
Brendan Clifford
New Hampshire Fish and Game Department

Michael T. Jones
Massachusetts Division of Fisheries & Wildlife

Philip deMaynadier
Jonathan Mays
Justin Sweitzer
Derek Yorks
Maine Division of Inland Fisheries and Wildlife

Chris Urban
Kathy Gipe
Pennsylvania Fish and Boat Commission

Angelena Ross
New York Dept. Environmental Conservation

Lisabeth Willey
Becca Settele
Jessica Meck
Antioch University New England, Keene, NH / American Turtle Observatory

Glenn Johnson
State University of New York Potsdam

Mark Grgurovic
Swampwalkers, Inc.

Bryan Windmiller
Grassroots Wildlife Conservation, Inc.

Stephen Najjar
New Boston Air Force Station

Stephanie Koch
Alison Whitlock
Anthony Tur
U.S. Fish and Wildlife Service

Paul R. Sievert
Patrick Roberts
UMass Amherst, Dept. of Environmental Conservation