EFFECTS OF HARVEST GAPS AND NATURAL CANOPY GAPS ON AMPHIBIANS WITHIN A NORTHEASTERN FOREST

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An Abstract of the Thesis Presented
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Amphibians that inhabit upland forests are in constant contact with the forest floor, relying on moist conditions for respiration. Timber harvesting can have a negative effect on amphibian populations by altering forest floor microhabitats. We tested the hypothesis that creating small-scale canopy gaps modeled after natural disturbance patterns may retain adequate habitat structure for amphibians, thus facilitating the maintenance of amphibian diversity and abundance in managed forests. From spring – fall of 2002 and 2003, we used pitfalls with drift fences to sample 2,930 and 9,060 amphibians, respectively, in 22 large harvest gaps, 22 small harvest gaps, 19 natural canopy gaps, and 36 closed-canopy forest plots located in the Penobscot Experimental Forest of central Maine. Location within large harvest gaps (north vs. south aspect, gap center vs. edge) did not influence capture rates for *Ambystoma maculatum, Notophthalmus viridescens, Plethodon cinereus, Rana catesbeiana, or Rana* *sylvatica*, but higher capture rates at gap edges than gap centers were detected for *Rana clamitans*. Responses among gap types (large harvest, small harvest, and natural) varied by amphibian species and age-class. Metamorphs (young of the year) had relatively lower capture rates in large harvest gaps for *A. maculatum, R. catesbeiana, R. clamitans, and R. sylvatica*. In some cases (*R. clamitans* juveniles, *R. sylvatica* juvenile-adults and metamorphs), capture rates in small harvest gaps were similar to natural gaps. We did not detect statistically significant ($p < 0.1$) differences among gap types for *N. viridescens*, *Rana palustris*, juvenile-adult *A. maculatum* or *P. cinereus*, although for juvenile-adult *A. maculatum*, we caught relatively fewer individuals in all gap types than in closed-canopy areas. We also explored relationships between the size of down woody material and its use by *P. cinereus*, a terrestrial salamander, in harvest-created gaps and closed-canopy forest. Log searches ($N = 231$) for *P. cinereus* indicated that the probability of detecting a salamander is least for small logs in harvest-created gaps, whereas in closed–canopy forest, the probability was both higher and constant among log sizes. These results suggest that harvest gaps, especially small gaps, provided habitat analogous to natural gaps for some amphibian species.

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INTRODUCTION

Conserving biodiversity is often considered to be incompatible with timber harvesting, which removes biomass, alters forest structure and thus modifies habitat for many species. Compared to intensively managed forests, natural forests are often characterized by greater structural diversity, including forest legacies such as down woody material (DWM), snags, and organic soil layers (Franklin et al. 1997). Harvests designed to emulate the structural changes that result from natural disturbances may facilitate meeting both timber production and ecological goals. This concept assumes that native species have adapted to natural disturbance patterns and therefore will be less adversely affected by human-induced disturbances that are modeled after natural disturbance regimes (Seymour and Hunter 1999). In the forests of northeastern North America, small-scale canopy gaps are a common form of natural disturbance (Lorimer 1977, Runkle 1991, Rogers 1996, Seymour et al. 2002). Between 1995 and 1997, the Forest Ecosystem Research Program of the University of Maine implemented a harvesting regime designed to emulate natural canopy gaps in a mixed coniferous-deciduous forest in Maine. Previous research on this regime focused on vegetative dynamics (Schofield 2003), coarse woody debris dynamics (Fraver et al. 2002), the songbird community (Hartley 2003), insect community dynamics (Jaros Su 1999, Thomas, in preparation) and, in this study, amphibians.

Amphibians have multiple characteristics that render them sensitive to disturbances in the forest canopy (deMaynadier and Hunter 1995). In particular, they are in constant contact with the forest floor, relying on moist habitat for respiration, and thus harvesting can have a negative effect on amphibians by altering forest floor microclimates. Some harvesting methods, notably clearcuts, often negatively affect amphibian populations (Petranka et al. 1994, Ash 1997, deMaynadier and Hunter 1998, Harpole and Haas 1999, Herbeck and Larsen 1999, Chan-McLeod 2003, Renken et al. 2004). In a review of 18 independent studies, deMaynadier and Hunter (1995) found amphibian abundance to be 3.5 times greater in mature forest sites than in clearcut sites. Furthermore, research in an Appalachian hardwood forest showed that terrestrial salamander abundance decreased after group selection, shelterwood, and leave-tree harvests as well as clearcuts (Harpole and Haas 1999, Knapp et al. 2003). In contrast, two studies that examined effects of small-scale canopy gap disturbances did not detect differences in relative amphibian abundances (Messere and Ducey 1998, Greenberg 2001), but low sample sizes (n = 4 and 7 gaps, respectively) may have hindered their ability to identify differences. Residual structure in harvested areas, especially DWM, may ameliorate the effects of canopy openings by providing moist refuges (Whiles and Grubaugh 1993, deMaynadier and Hunter 1995).

To better understand the ecological effects of harvest gaps created to emulate natural disturbance, we investigated patterns of forest amphibians in harvest and natural canopy gaps in a mixed forest in central Maine. Specifically, we: 1) compared relative abundance of forest amphibians *within* harvest-created gaps to determine if location (gap center, edge, north and south aspect) influenced amphibian distributions; 2) compared relative amphibian abundance *among* harvest and natural canopy gaps, using adjacent closed-canopy forest as reference plots; and 3) explored whether eastern red-backed salamander (*Plethodon cinereus*) distribution and body size was affected by DWM size under both open and closed canopy conditions.

METHODS

Study Area

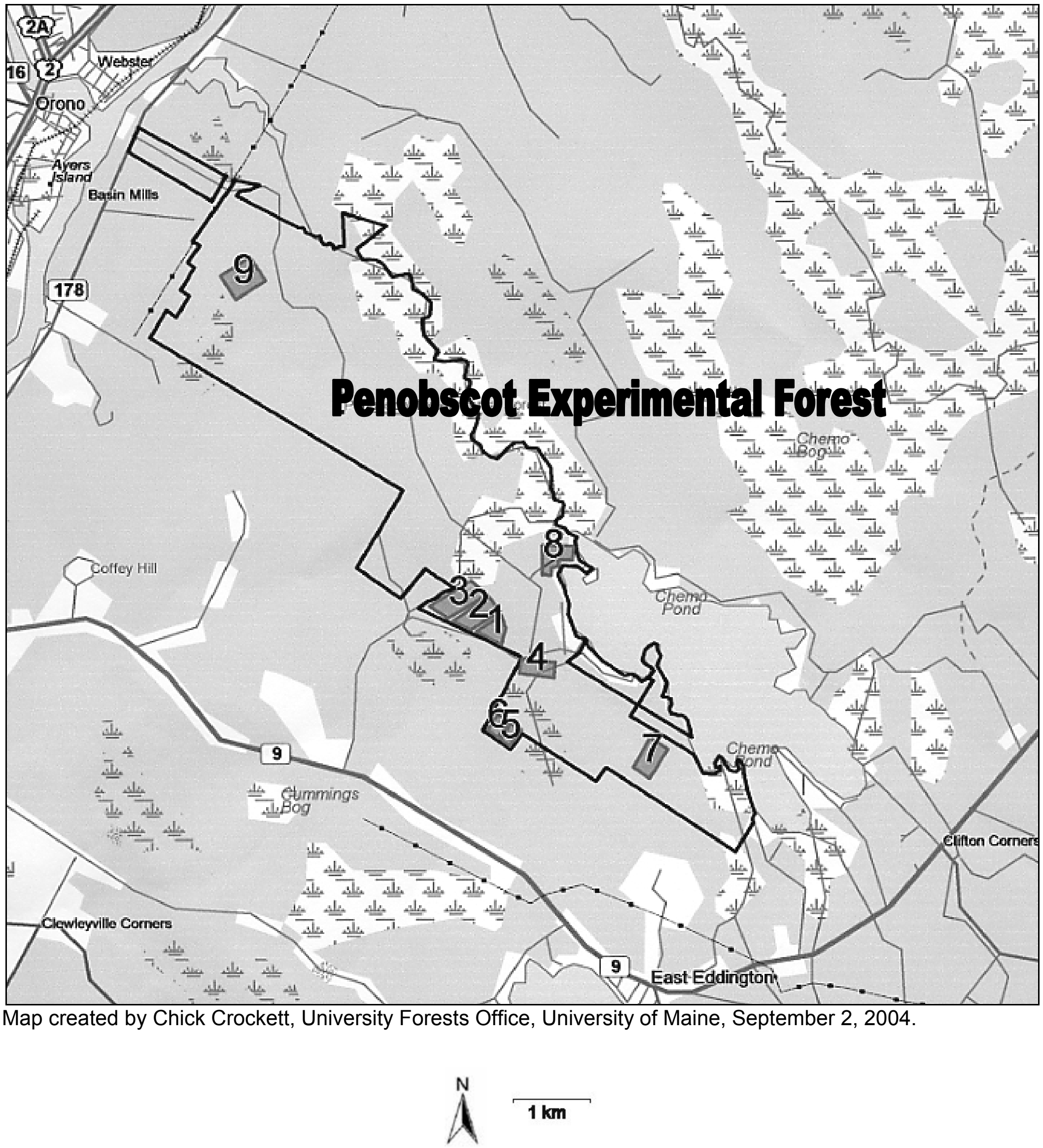
We conducted our research at the Penobscot Experimental Forest (PEF) in Penobscot County, ME (44° 50’ N, 68° 35’ W). The PEF encompasses 1,540 hectares of predominately mixed coniferous-deciduous forest, with seasonal and permanent wetlands dispersed throughout the area (Figure 1). Dominant tree species are *Tsuga canadensis*, *Acer rubrum*, *Pinus strobus*, *Thuja occidentalis*, *Abies balsamea*, *Betula papyrifera*, *Picea rubens*, *Populus tremuloides*, *P. grandidentata*, and *A. saccharum*. We conducted our research within nine approximately 10-ha in size research areas of mature forest in the PEF. Previous cutting in these areas, consisting of single-tree or partial harvests, occurred until the 1940s. Recent natural disturbances also occurred from spruce budworm (*Choristoneura fumiferana*) outbreaks (1911-1920 and the 1980’s) and a 1998 ice storm. The harvest gaps under study are in six research areas that were harvested in 1995 (areas 1 and 2), 1996 (areas 5 and 6), and 1997 (areas 7 and 9). Most harvests were completed by manual felling, delimbing, and topping with chainsaws at the stump. Grapple skidders were used to haul logs in research areas one and two (cut in 1995). All other logs were removed by tree-length skidding using a cable skidder.

Experimental Design

<u>Treatments</u>

We sampled forest amphibians in the nine research areas: three sites had 22 large harvest gaps, three had 22 small harvest gaps, and three had 19 natural

Figure 1. Map showing research areas (1-9) where amphibian sampling was conducted in the Penobscot Experimental Forest.



Map created by Chick Crockett, University Forests Office, University of Maine, September 2, 2004.

canopy gaps (Table 1). Large gaps were created by removing approximately 20% of the canopy, resulting in 7-8 gaps (mean area 0.13 ha). Within the large gaps, 10% of the basal area was left as reserve trees. Small gap harvests removed approximately 10% of the canopy creating 7-8 gaps (mean area 0.067 ha). Within the small gaps, 30% of the basal area was retained as reserve trees. Basal area of reserve trees was lowest in large harvest gaps (11 m^2/ha), and greater in small harvest gaps (14 m^2/ha), natural gaps (24 m^2/ha) and closed-canopy areas (32 m^2/ha) (Schofield 2003). Harvest-gap areas were determined using a Geographic Information System based on ground measurements (Schofield 2003). In the unharvested research areas, natural gaps (mean area 0.025 ha) were defined by any area where at least two tree falls or stem breaks of canopy trees ≥ 25cm in diameter created a gap, exposing understory stems to the sky (Runkle 1992). Gap areas were calculated by using the area for an ellipse (Area = $\pi LW/4$). In each research area, we also sampled forest amphibians in 4 closed–canopy plots (36 total) located between the gaps. These plots were used to test for spatial independence and to control for natural variability among the nine research areas. All of our plots were at least 50 m from the north side of an access road and 30 m from the south side of each gap to avoid edge effects (Fraver 1994, deMaynadier and Hunter 1998).

Vegetative patterns among harvest gaps, natural gaps, and closed-canopy forest areas were described four years post-harvest by Schofield (2003). Total cover for herbs, shrubs, seedlings, saplings, and ferns was highest (34.9%) in harvest gaps, 25.5% in natural gaps, and 10.6% in closed-canopy plots, and in

Table 1. Delineation of the treatments used to explore differences in amphibian abundance in the Penobscot Experimental Forest, Maine.

Treatment	Research Area	Mean Gap Size (m^2) (±1 SE)	Range of Gap Size (m^2)	Number of Plots: Gap	Number of Plots: Closed Canopies
Large harvest gap	1	1,542.33 (142.55)	(940.60 - 2,169.00)	8	4
	6	1,352.91 (224.61)	(347.40 - 2,106.00)	7	4
	9	1,059.64 (206.06)	(319.30 - 1,762.00)	7	4
Small harvest gap	2	350.64 (48.79)	(108.20 - 472.90)	7	4
	5	819.87 (64.37)	(556.70 - 1,000.00)	7	4
	7	830.18 (102.21)	(469.40 - 1,293.00)	8	4
Natural gap	3	270.94 (48.07)	(152.61 - 511.88)	7	4
	4	141.57 (15.21)	(114.06 - 184.54)	4	4
	8	282.83 (43.38)	(139.09 - 475.61)	8	4

the larger harvest gaps (1,170 – 2,106 m^2), gap centers had greater cover than edges. Natural gaps tended to have more conifer regeneration, lichens, and mosses while harvest gaps had more hardwood regeneration, shrubs, and herbaceous cover. DWM characteristics were compared before and after harvests for each treatment at the stand level (Fraver et al. 2002). Research areas with large harvest gaps had the greatest increase in volume and abundance of small-diameter DWM, with less of an increase in small-gap research areas and the least increase in natural-gap research areas. Among decay classes, the greatest harvest-related increase was in decay class 1 (Appendix A). Prior to harvest, logs in decay class 3 contributed the most in volume.

Down woody material sampling

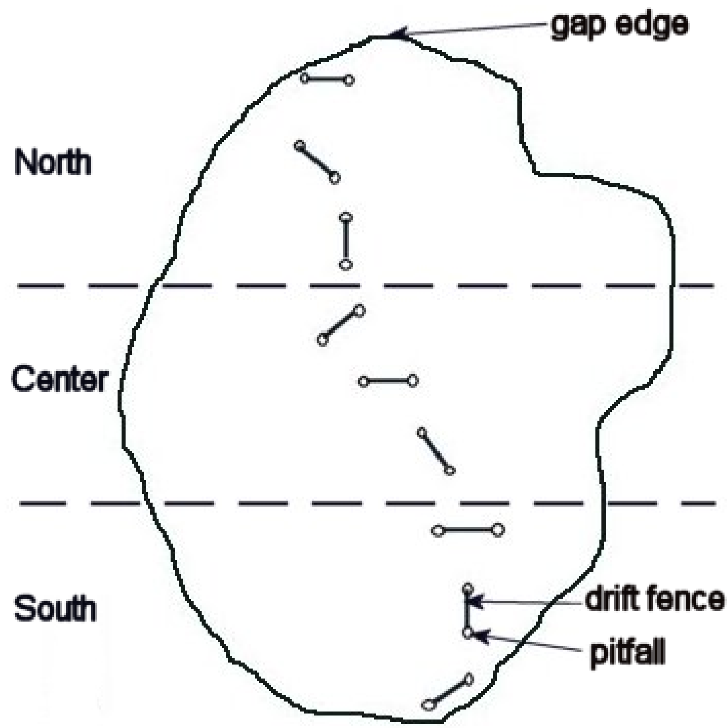
To acquire information specific to the gap and non-gap level, we used line intersect sampling to describe DWM characteristics applicable to our sampling design and interests. Line intercept sampling is a widely used method for estimating down woody material accurately in a relatively short amount of time (Ducey 2003). Nine large harvest gaps, eight small harvest gaps, 19 natural gaps, and six closed-canopy areas were randomly chosen and surveyed with this method. In gaps, line transects were randomly orientated through the plot centers ending at gap edges. In closed-canopy areas, length of transects were fixed at 50 meters. To be tallied, logs intersecting the transect had to have a minimum diameter of 10 cm. We recorded small- and large-end diameters, length, decay class, and portion of log resting on the ground.

Amphibian sampling

We sampled amphibians using pitfall traps with drift fences (pitfall arrays) from May 10th – July 26th and September 4th – October 23rd in 2002, and April 22nd – October 25th in 2003. Traps were checked 1-2 times per week. Pitfall traps were constructed from two #10 aluminum cans taped end-to-end (36 cm deep), buried in the ground at each end of a 3-m long by 0.5-m high plastic fence tucked into the ground. Moss placed in the bottom of the traps provided shelter to amphibians from dry conditions and predators (Enge 2001). Plastic funnels in the pitfall traps were used to prevent the escape of amphibians that are able to climb the sides. Sticks (< 1.5 cm diameter) were placed in pitfalls to facilitate the escape of shrews and mice. Small mammal mortality is 14.5 times higher in pitfall traps without sticks than pitfall traps with sticks, though amphibian capture rates are unaffected (Perkins and Hunter 2002).

To study how treatment differences influenced relative amphibian abundance, each sample plot (large harvest gap, small harvest gap, natural gap, closed-canopy) had three pitfall arrays: 5 m south of the plot center, at center, and 5 m north of the center. To study how location within a gap influenced relative amphibian abundance, 11 large gaps, 12 small gaps, and seven natural gaps were randomly selected to have pitfall arrays positioned every 5 m along the entire north-south transect of each gap (Figure 2). All pitfall arrays were randomly orientated in one of the following directions: north-south, northeast-southwest, northwest-southeast, east-west.

Figure 2. Diagram of a canopy gap and arrangement of pitfalls with drift fences (arrays). This design was used to compare relative amphibian abundance (in capture rates) between north and south aspects (three northernmost versus three southernmost arrays) and edge versus middle (northernmost and southernmost arrays versus two middle arrays).



Amphibians were captured, measured from snout to anterior end of the vent in length (SVL), and released 6-10 m east or west of the trap. During 2002, we marked amphibians with a visible implant elastomer tag under the skin (Davis and Ovaska 2001, Bailey 2004); however, very low recapture rates (< 0.4%) did not warrant repeating this procedure in 2003.

We used an active technique, log searches, to determine how red-backed salamander distribution and body size were affected by DWM size under both open canopies (large harvest gaps) and closed canopies (sites in the same stand as the large gaps, but at least 30-m from any gaps). We sampled during June and July of 2003, at least 24 hours following a significant rainfall event that moistened the forest litter, because the percentage of red-backed salamanders found under logs has been found to increase with leaf litter drying (Heatwole 1962, Jaeger 1980). In closed canopy areas, we located logs by having two people walk 20-m apart along established transect lines within the research areas. Gap areas were searched using the north-south transect as a guide. To balance sampling units (logs) across the range of log diameters, we randomly selected one log every 6 m to search for red-backed salamanders in the following order of priority: large logs (>31 cm), medium logs (21-30 cm), and small logs (10-20 cm). This procedure was implemented because DWM density estimates within the research areas indicated that large logs (>31 cm) were less available than medium and small logs (Fraver et al. 2002). Sample logs had at least 0.5 m of its length resting on the ground, a minimum large-end diameter of 10 cm, and belonged to decay class 2 or 3 (Appendix A). Areas with saturated soils were avoided.

Once a suitable log was identified, it was rolled or lifted. Then two people searched for salamanders within the log and in the organic horizon below the log. We recorded salamander SVL, total length (TL), and mass (±0.01 g). Log parameters included: large and small end diameters, length, and decay class.

Data Analyses

Amphibian abundance was measured by the number of captures per 100 trap nights (TN), with one trap night for every night an individual pitfall was open. Amphibians vary in their sensitivities to habitat conditions at the species level (Stebbins and Cohen 1995, deMaynadier and Hunter 1998) and in age-class of a species (deMaynadier and Hunter 1999, Rothermel and Semlitch 2002). Therefore, we calculated capture rates for each individual species, and for age-classes of spotted salamanders (*Ambystoma maculatum*), red-backed salamanders, bullfrogs (*Rana catesbeiana*), green frogs (*R. clamitans*), pickerel frogs (*R. palustris*), and wood frogs (*R. sylvatica*). For spotted salamanders and wood frogs, age classes (metamorphs vs. juveniles-adults) were determined by observing the relationship between SVL and time of year (Appendix B, Figure B1). Spotted salamanders less than 40 mm SVL and captured after August were categorized as metamorphs. Wood frogs less than 30 mm SVL and captured after mid-July were considered metamorphs. Red-backed salamanders were divided into immature (≤33 mm SVL) and adult (>33 mm SVL) age classes (Sayler 1966). We estimated metamorph, juvenile, and adult SVL sizes for bullfrogs, green frogs, and pickerel frogs by selecting the middle value for the range of overlap between age classes from data collected in Rhode Island (Appendix B, Table B1). Data from 2002 and 2003 were analyzed independently because of different sampling periods.

Relative abundance within gaps

To test for differences in capture rates between 1) northern and southern areas of the gaps, and 2) edges and center areas of the gaps, we calculated probabilities using BLOSSOM'S (Midcontinent Ecological Science Center, U.S. Geological Survey) multiple response permutation procedures (MRPP) for paired samples, with a probability value < 0.1 considered significant (Cade and Richards 1999). Because our samples were variable in distribution and low in replication, permutation procedures were the most efficient test. We chose to analyze the 11 largest gaps because they represented the most extreme canopy removal conditions with the greatest likelihood of detecting differences in relative amphibian abundance, and they had relatively large distances (10-20 m) between clusters of arrays. We only analyzed species that occurred in all 11 plots. For comparisons between northern and southern areas within a gap, we measured capture rates for the three northern-most and three southern-most arrays. For comparisons of edges and centers of gaps, we were concerned that aspect may obfuscate edge effects, so we combined captures for the northern-most and southern-most arrays to quantify edge capture rates. Then we combined captures for the two middle arrays to derive gap-center capture rates.

Relative abundance among gap types

In comparing treatment types (large gap, small gap, natural gap), analyses were only conducted on species and age-classes of species that were detected in all nine research areas (Table 2). We pooled all captures to calculate rates for each plot type (gap or closed-canopy) with weighting based on each plot's sampling effort. In order to use individual gaps as the experimental units to compare gap types, we took two measures to guard against confounding factors such as spatial autocorrelation and natural variation among research areas. First we used an analysis of variance (ANOVA) to test for differences in amphibian abundance among the closed-canopy plots for each treatment, using the research areas as the units of replication. A difference would indicate a potential site-related bias on all plots within one or more of the research areas. From this test, juvenile bullfrogs in 2003 were excluded from analyses due to a higher capture rate in closed-canopy plots of the large-gap treatment ($F\text{-ratio}_{2,6} = 6.01$, $p = 0.04$). Second, to account for natural variation, our response variable was calculated as follows: for each research area, the mean capture rate of the four closed-canopy plots was subtracted from each gap capture rate value (for gaps in that same research area) to derive a "difference value." Therefore, all values reported for gap type are in reference to capture rates of the closed-canopy plots in the same research area, to decrease the likelihood of site-specific effects biasing results. This method is limited in precision because there were only four closed-canopy plots and the method does not account for the variability among them. An alternative approach, using randomly selected single plot capture rates

Table 2. Counts of amphibian species and their age-classes captured in the Penobscot Experimental Forest, Maine, in 2002 and 2003.

	Counts[1]	
Species	**2002[2]**	**2003[3]**
Blue-spotted Salamander (*Ambystoma laterale*)	(21)	(75)
Spotted Salamander (*A. maculatum*)	712	2,252
Juveniles and adults only	381	901
Metamorphs only	331	1,350
Eastern Newt (*Notophthalmus viridescens*)	501	1,363
Four-toed Salamander (*Hemidactylium scutatum*)	(0)	(2)
Eastern Red-backed Salamander (*Plethodon cinereus*)	163	687
Adults only	116	522
Immatures only	46	162
American Toad (*Bufo americanus*)	(1)	(1)
American Bullfrog (*Rana catesbeiana*)	198	554
Adults only	(2)	(6)
Juveniles only	128	273
Metamorphs only	68	273
Green Frog (*Rana clamitans*)	875	2,528
Adults only	(0)	(8)
Juveniles only	(64)	141
Metamorphs only	804	2,359
Pickerel Frog (*Rana palustris*)	144	353
Adults only	(4)	(4)
Juveniles only	(21)	61
Metamorphs only	(116)	281
Northern Leopard Frog (*Rana pipiens*)	(41)	(278)
Mink Frog (*Rana septentrionalis*)	(63)	(66)
Wood Frog (*Rana sylvatica*)	209	910
Juveniles and adults only	102	169
Metamorphs only	106	741
Summary		
Total captures	2,930	9,069
Trap nights (tn)	98,457	152,597
Captures/100 tn	2.98	5.94
# recaptures	11	N/A

[1] Numbers in parentheses did not occur in all 9 research areas and were not included in analyses.
[2] Sampling period from May 10 – July 26 and September 4 – October 23, 2002.
[3] Sampling period from April 22 – October 25, 2003.

to calulate difference values, accentuates the variabilty of difference values (Appendix C).

Given the range of gap areas within the harvested treatments, we used linear regression (SYSTAT version 10.2.01) to examine the relationships between difference values and gap area. Presence of a significant relationship ($\alpha < 0.1$) would influence interpretation of gap type effects, where an effect may be present at one end of the size-range and not at the other. Results of this analysis, presented in Appendix D, indicate gap area did not confound treatment (large harvest gap, small harvest gap) effects.

We used SYSTAT's (ANOVA) tool to test for treatment effects on ranks of the difference values at the $\alpha = 0.1$ level. All pairwise comparisons for treatment differences were made using Tukey's multiple comparison procedure. We estimated 90% confidence intervals around the difference value medians of each treatment with a bootstrapping procedure, sampling 5,000 times with replacement (SYSTAT) to compare and contrast treatments. We also compared difference values of harvest gaps (n=10) that occurred within the size range of natural gaps (n=19). Because of unequal sample sizes and variation, this test was done with BLOSSOM's MRPP as a nonparametric equivalent of the classical t-test (Cade and Richards 1999).

<u>Red-backed salamander use of logs</u>

We tested for a difference in proportion of logs with red-backed salamanders between harvest gaps and closed-canopy areas using a Chi-square goodness of fit test, with the proportions observed in the closed-canopies as expected values. Logistic regression was used to determine the probability of detecting a red-backed salamander as log diameter increased under both canopy conditions. We also used linear regression to examine the relationship between mass and SVL of salamanders against log diameter. To provide a context for inferences from these tests, we estimated relative abundance of red-backed salamanders between large harvest gaps and closed-canopy plots from pitfall capture data, using a two-sample t-test. We also compared the relative availability of logs in harvest gaps and closed-canopy areas from the results of line intersect sampling (42 transects), testing for differences with an ANOVA.

RESULTS

Eleven species were caught in 2002, for a total of 2,930 captures in 98,457 TN (2.98 captures per 100 TN) (Table 2). In 2003, we captured 9,069 amphibians representing 12 species over 152,597 TN (5.94 captures per 100 TN). Results were focused on analyses of amphibian captures in 2003 because of the longer sampling period and higher capture rates.

Relative Abundance Within Gaps

Location within a gap (north vs. south or edge vs. center) had no effect on relative amphibian abundance, except for green frogs (Table 3). Mean green frog capture rates were higher at gap edges (2.52 captures/100 TN) than in gap centers (1.74 captures/100 TN) ($p = 0.02$ in 2003, $n = 11$). Patterns in 2002 were consistent with those of 2003 although we did not analyze wood frogs and red-backed salamanders due to sample limitations. In 2002, mean green frog capture rates were higher at edges (1.05 captures/100 TN) than gap centers (0.61 captures/100 TN) ($p = 0.05$, $n = 11$). Edge effects were no longer evident for green frogs after including six additional smaller harvest gaps, 30-35 m in length ($p = 0.18$, $n = 17$). Because of the within-gap patterns for green frogs, subsequent analyses of their distributions only used data from the center three arrays of the 11 large gaps.

Relative Abundance Among Gap Types

In 2003, gap type had statistically significant effects on difference values for eight of 12 groups: spotted salamander metamorphs, immature red-backed salamanders, green frog juveniles, bullfrog and green frog metamorphs, juvenile

Table 3. Mean relative abundance (captures per 100 trap nights) of amphibians captured in 11 harvest-created gaps[1] in 2003, comparing capture rates between a) northern and southern edges of a gap, and b) edges and gap centers.

a) Aspect (north vs. south)

Species (number captured)	Mean (±1 SE) North	South	Difference	p[2]
Spotted Salamander (382)	1.97 (0.80)	1.21 (0.41)	0.76 (0.45)	0.13
Juveniles and adults (129)	0.59 (0.19)	0.48 (0.09)	0.11 (0.14)	0.38
Eastern Newt (183)	0.86 (0.31)	0.66 (0.11)	0.19 (0.28)	0.59
Eastern red-backed salamander (79)	0.30 (0.06)	0.36 (0.09)	-0.06 (0.10)	0.64
Immatures only (18)	0.05 (0.02)	0.10 (0.03)	-0.05 (0.03)	0.19
Adults only (61)	0.25 (0.06)	0.26 (0.09)	-0.01 (0.09)	0.93
Bullfrog (101)	0.35 (0.10)	0.49 (0.12)	-0.14 (0.10)	0.13
Green Frog (506)	1.90 (0.52)	2.33 (0.57)	-0.43 (0.50)	0.33
Wood Frog (85)	0.32 (0.06)	0.39 (0.10)	-0.07 (0.09)	0.60
Metamorphs only (61)	0.47 (0.11)	0.59 (0.18)	-0.11 (0.16)	0.40

b) Edge vs. gap center

Species (number captured)	Mean (±1 SE) Gap Edge	Gap Center	Difference	p[2]
Spotted Salamander (249)	1.43 (0.57)	1.69 (0.86)	-0.27 (0.66)	0.52
Juveniles and adults only (81)	0.50 (0.11)	0.52 (0.22)	-0.02 (0.22)	0.80
Eastern Newt (103)	0.81 (0.31)	0.49 (0.08)	0.32 (0.28)	0.38
Eastern red-backed salamander (49)	0.30 (0.09)	0.32 (0.10)	-0.02 (0.14)	0.70
Adults only(35)	0.23 (0.10)	0.22 (0.07)	0.01 (0.13)	0.79
Bullfrog (72)	0.47 (0.11)	0.43 (0.08)	0.04 (0.09)	0.53
Green Frog (336)	2.52 (0.68)	1.74 (0.50)	0.78 (0.31)	0.02
Wood Frogs (57)	0.42 (0.10)	0.29 (0.09)	0.13 (0.11)	0.29
Metamorphs only (40)	0.62 (0.19)	0.43 (0.14)	0.19 (0.13)	0.23

[1] North-south transects of the gaps were between 35-61 m long.

[2] Probabilities were calculated using a multiple response permutation procedure, α = 0.10.

pickerel frogs, and juvenile-adult and metamorph wood frog groups (Table 4, Figure 3). Results from 2002 showed treatment differences for six of 10 groups: spotted salamander metamorphs, immature red-backed salamanders, green frog metamorphs, and wood frog metamorphs (as in 2003), as well as juvenile-adult spotted salamanders and eastern newts (unlike 2003) (Table 5). In contrast to 2003's results, we did not detect treatment effects for juvenile-adult wood frogs and bullfrog metamorphs in 2002.

Pairwise comparisons among gap types illustrated how sensitivity to gap size or gap origin varied among species groups (Figure 3). For the following comparisons, when capture rates in gaps were lower than capture rates in the associated closed-canopy sites (i.e., difference values were negative) we refer to this as a reduction in abundance within gaps. Conversely, when gaps had higher capture rates than the associated closed-canopy plots (i.e., positive difference values), we refer to this as an increase in abundance. The underlying assumption in using this terminology is that amphibian abundances were relatively uniform across each research plot prior to harvesting.

Two of five salamander groups showed treatment differences in 2003: spotted salamander metamorphs and immature red-backed salamanders (Table 4). For spotted salamander metamorphs, both large and small harvest gaps showed decreases in abundance while natural gaps showed no change. For immature red-backed salamanders, abundance was relatively high in small gaps and relatively low in large gaps, and natural gap treatment values overlapped with both large and small gap treatments. No differences among gap types were

Table 4. 2003 ANOVA results of ranked difference values[1] and Tukey's pairwise comparisons among gap treatments.

	Mean (SE) Difference Values of Gap Type				Pairwise Comparisons		
Species	**Large Harvest Gap (n=22)**	**Small Harvest Gap (n=22)**	**Natural Gap (n=19)**	**p**	**Large Gap vs. Small Gap**	**Large Gap vs. Natural Gap**	**Small Gap vs. Natural Gap**
Salamanders							
Spotted Salamander							
Juveniles and adults only	-0.25 (0.10)	-0.39 (0.09)	-0.20 (0.08)	0.18			
Metamorphs only	-1.52 (0.54)	-1.96 (0.57)	0.33 (0.54)	0.00	0.95	0.00	0.00
Eastern Newt	-0.19 (0.09)	-0.26 (0.15)	0.20 (0.39)	0.42			
Eastern Red-backed Salamander							
Adults only	0.00 (0.09)	0.00 (0.07)	-0.19 (0.06)	0.10			
Immatures only	-0.06 (0.02)	0.03 (0.03)	-0.03 (0.04)	0.08	0.07	0.76	0.337
Anurans							
American Bullfrog							
Metamorphs only	-0.16 (0.03)	-0.07 (0.02)	0.13 (0.06)	0.00	0.00	0.06	0.02
Green Frog							
Juveniles only	-0.09 (0.02)	0.01 (0.02)	0.03 (0.03)	0.00	0.00	0.01	0.88
Metamorphs only	-0.91 (0.14)	-0.13 (0.07)	0.30 (0.16)	0.00	0.00	0.00	0.05
Pickerel Frog							
Juveniles only	0.00 (0.02)	0.06 (0.02)	0.01 (0.02)	0.05	0.88	0.05	0.16
Metamorphs only	0.06 (0.06)	0.24 (0.07)	0.59 (0.30)	0.19			
Wood Frog							
Juveniles and adults only	-0.07 (0.02)	0.05 (0.04)	0.06 (0.02)	0.00	0.00	0.00	0.31
Metamorphs only	-0.65 (0.06)	0.10 (0.17)	-0.25 (0.13)	0.00	0.00	0.00	0.58

[1] Difference values (reported in captures per 100 trap nights) calculated by subtracting the mean closed-canopy capture rate of a 10-ha research area from the gap capture rate.

Figure 3. Median difference values with 90% confidence intervals for species/age groups of amphibians captured in the Penobscot Experimental Forest, 2003. Difference values were calculated by subtracting the mean capture rates of closed-canopy plots from gap capture rates for their respective research areas. The x-axis shows treatment type: large harvest gap (n=22), small harvest gap (n=22), and natural gap (n=19). Letter values at the base of each plot show Tukey's pairwise comparison results on the ranked difference values. Shared letters indicate no difference (α > 0.10).

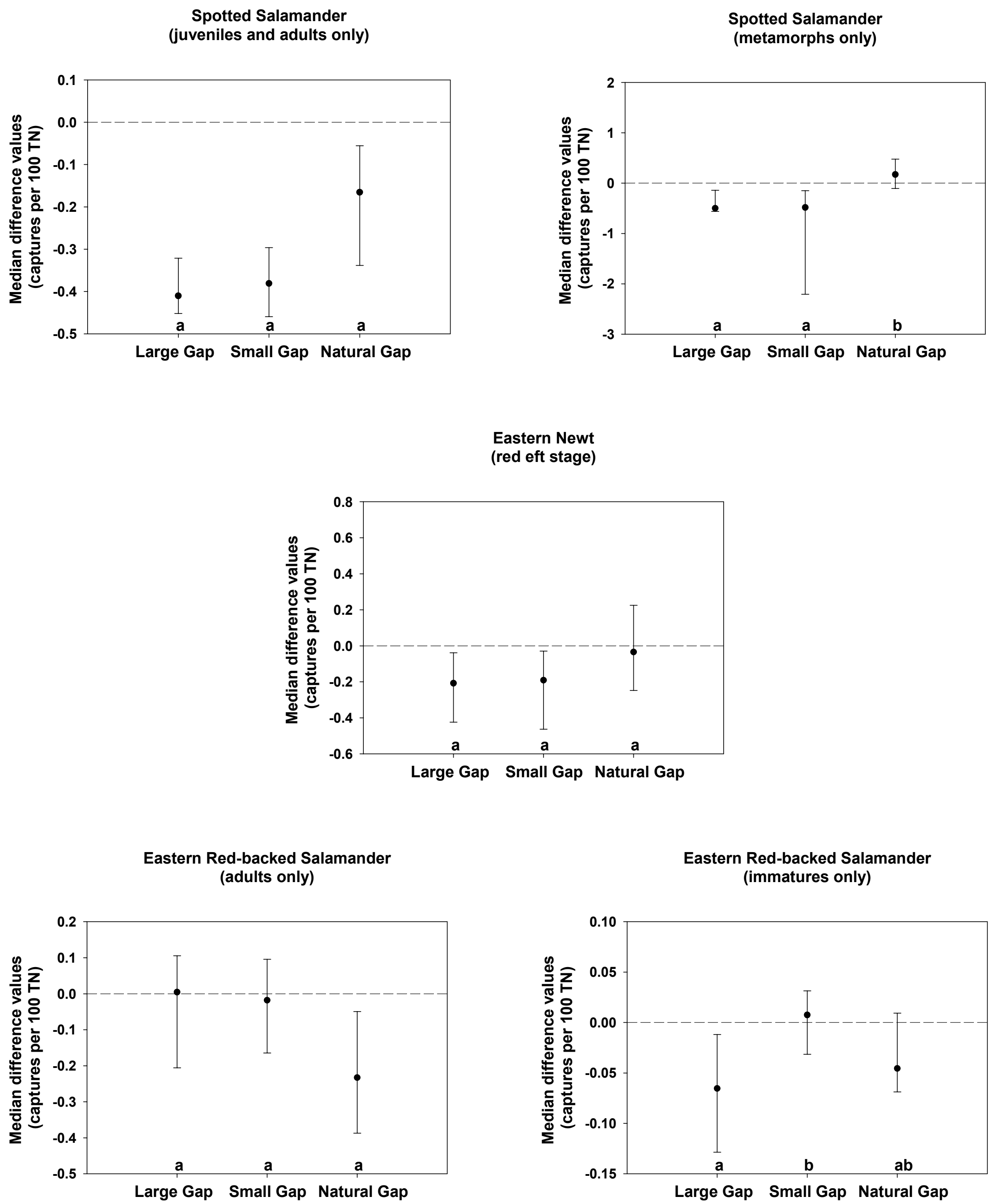

Spotted Salamander
(juveniles and adults only)
Median difference values
(captures per 100 TN)
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
a a a
Large Gap Small Gap Natural Gap
Spotted Salamander
(metamorphs only)
Median difference values
(captures per 100 TN)
2
1
0
-1
-2
-3
a a b
Large Gap Small Gap Natural Gap
Eastern Newt
(red eft stage)
Median difference values
(captures per 100 TN)
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
a a a
Large Gap Small Gap Natural Gap
Eastern Red-backed Salamander
(adults only)
Median difference values
(captures per 100 TN)
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
a a a
Large Gap Small Gap Natural Gap
Eastern Red-backed Salamander
(immatures only)
Median difference values
(captures per 100 TN)
0.10
0.05
0.00
-0.05
-0.10
-0.15
a b ab
Large Gap Small Gap Natural Gap

Figure 3 continued.

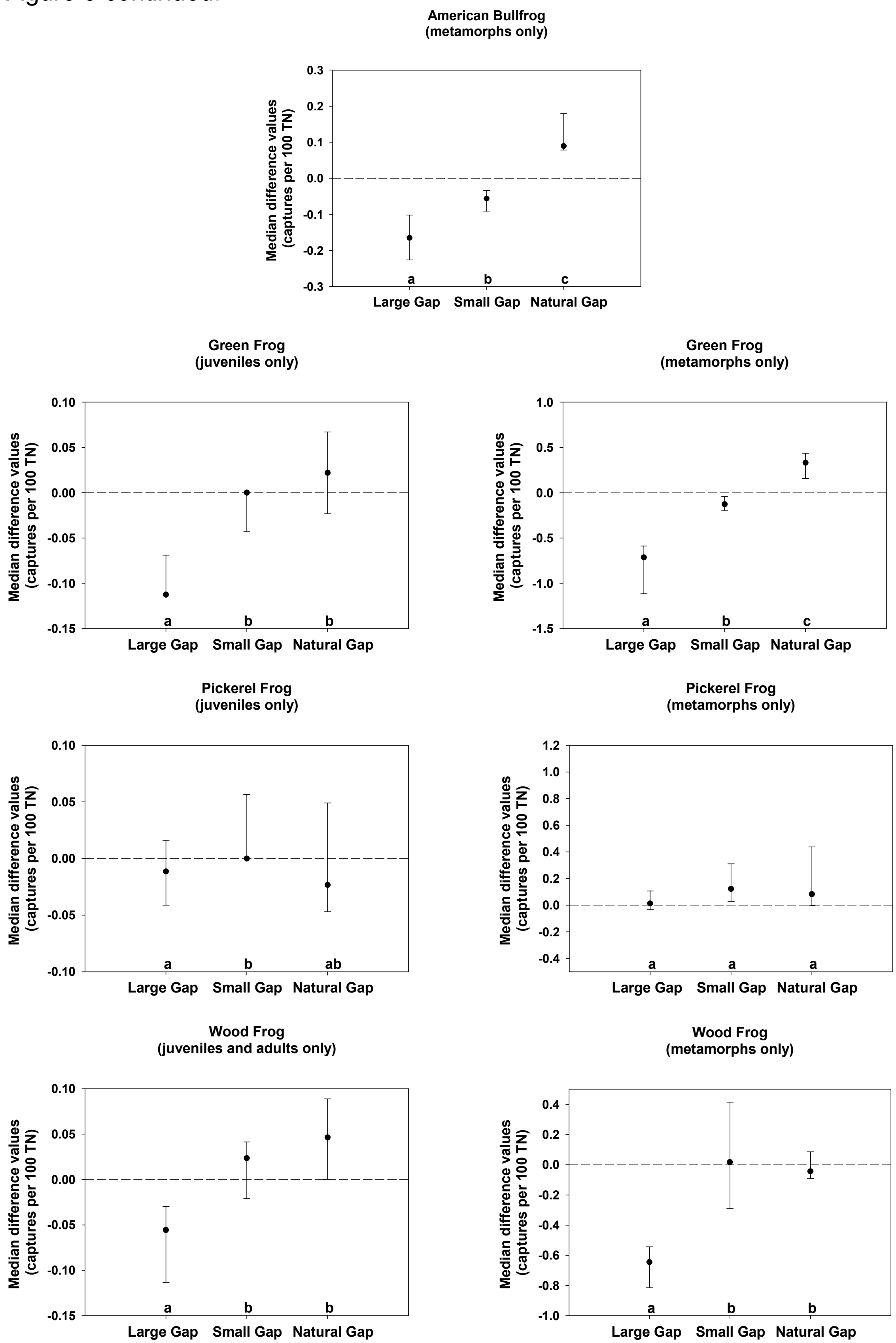


Table 5. 2002 ANOVA results of ranked difference values[1] and Tukey's pairwise comparisons among gap treatments.

	Mean (SE) Difference Values of Gap Type				Pairwise Comparisons		
Species	Large Harvest Gap (n=22)	Small Harvest Gap (n=22)	Natural Gap (n=19)	p	Large Gap vs. Small Gap	Large Gap vs. Natural Gap	Small Gap vs. Natural Gap
Salamanders							
Spotted Salamander							
Juveniles and adults only	-0.38(0.10)	-0.51(0.07)	-0.07(0.06)	0.00	0.06	0.82	0.00
Metamorphs only	0.08(0.14)	-0.87(0.27)	0.08(0.14)	0.00	0.00	0.78	0.01
Eastern Newt	-0.35(0.06)	-0.18(0.11)	0.14(0.10)	0.00	0.00	0.00	0.12
Eastern Red-backed Salamander							
Adults only	-0.05(0.03)	0.02(0.04)	-0.01(0.02)	0.37			
Immatures only	-0.04(0.02)	0.01(0.01)	0.01(0.01)	0.08	0.16	0.10	0.95
Anurans							
American Bullfrog							
Juveniles only	0.04(0.04)	0.00(0.03)	0.00(0.02)	0.80			
Metamorphs only	0.00(0.02)	-0.01(0.02)	0.00(0.02)	0.97			
Green Frog							
Metamorphs only	-0.30(0.16)	0.57(0.27)	0.14(0.15)	0.00	0.00	0.00	0.99
Wood Frog							
Juveniles and adults only	0.00(0.02)	-0.01(0.04)	0.00(0.03)	0.66			
Metamorphs only	0.04(0.05)	0.04(0.07)	-0.09(0.03)	0.00	0.71	0.00	0.04

[1] Difference values (reported in captures per 100 trap nights) calculated by subtracting the mean closed-canopy capture rate of a 10-ha research area from the gap capture rate.

detected for red efts, adult red-backed salamanders, and juvenile-adult spotted salamanders. Although there was no difference among gap types for juvenile-adult spotted salamanders, all gaps had lower relative abundance than closed-canopy sites in both 2002 and 2003 (Tables 4, 5). In 2002, eastern newts showed a greater decrease in abundance in large gaps than in small and natural gaps (Table 5). Immature red-backed salamander results were partially consistent with 2003 results, where large gaps exhibited greater reductions in captures than natural gaps (Tables 4,5).

In 2003, we detected treatment differences in six of seven anuran groups: bullfrog metamorphs, juvenile pickerel frogs, and juvenile and metamorph groups of green frogs and wood frogs. Three metamorph groups (bullfrogs, green frogs, and wood frogs) showed the largest decrease in abundance within large gaps (Table 4, Figure 3). Bullfrog and green frog metamorph abundance was reduced in small gaps as well, and increased within natural gaps. Difference values between small and natural gaps were similar for juvenile-adult and metamorph wood frogs, and juveniles of pickerel frogs and green frogs (Table 4, Figure 3). Of five anuran groups tested in 2002, we detected treatment differences for green frog metamorphs (greatest decrease in abundance in the large gap treatment) and wood frog metamorphs (natural gap treatment showed reduced abundance and no change within harvested treatments) (Table 5).

When we limited comparisons to harvest gaps that were similar in size (< 512 m^2) to natural gaps, we detected significantly greater reductions in relative abundance within harvest gaps for bullfrog metamorphs, green frog juveniles and metamorphs, and juvenile-adult wood frogs (Table 6). No significant trends were detected for the remaining species groups.

Red-backed Salamander Use Of Logs

We detected red-backed salamanders more often under logs in closed-canopy areas (45 of 116) than in large harvest gaps (16 of 115) (Table 7, $X^2_{\alpha < 0.01,1} = 0.000$). Our logistic model, with the predictive variables of log diameter, habitat type (gap or closed-canopy), and an interaction term (log diameter x habitat type), showed a significant interaction between log diameter and habitat type ($p = 0.07$, $\alpha = 0.10$). However, the predictive ability of the model was relatively weak, with an overall correct prediction rate of 64.8%. Overall, the probability of detecting a salamander is least for small logs in harvest gaps, and remained constant under closed-canopy conditions (Figure 4). We tested the ranks of SVL and mass against the ranked values of large-end log diameter for both habitat types, and found no relation between either SVL ($p_{1,13} = 0.80$ in harvest gaps, and $p_{1,43} = 0.54$ in closed-canopy areas) or mass ($p_{1,13} = 0.35$ in harvest gaps, and $p_{1,43} = 0.60$ in closed-canopy areas).

Both red-backed salamander abundance and log abundance were similar between large harvest gaps and adjacent closed canopy areas. Mean capture rates from pitfall sampling within the 22 large harvest gaps (0.40 captures/100TN) and 12 adjacent closed-canopy plots (0.48 captures/100TN) were similar ($p = 0.59$). Our line-intercept sampling estimates of down woody material for harvest gaps (n = 17), natural gaps (n = 19), and closed-canopy areas (n = 6) were 2,550, 1,676, and 2,374 logs/ha, respectively (Table 8). No

Table 6. Comparing difference values[1] of natural gaps to difference values of similar-sized harvest gaps (less than 512 m^2 in area) in the Penobscot Experimental Forest, Maine, 2003.

	Mean (SE) Difference Values		
Species	**Harvest Gap (n=10)**	**Natural Gap (n=19)**	**p[2]**
Salamanders			
Spotted Salamander			
Juveniles and adults only	-0.17 (0.12)	-0.20 (0.08)	0.80
Metamorphs only	-0.54 (0.25)	0.33 (0.54)	0.32
Eastern Newt	-0.29 (0.08)	0.20 (0.39)	0.47
Eastern Red-backed Salamander			
Adults only	-0.20 (0.05)	-0.19 (0.06)	0.79
Immatures only	-0.04 (0.02)	-0.03 (0.04)	0.80
Anurans			
Bullfrog			
Metamorphs only	-0.08 (0.03)	0.13 (0.06)	0.02
Green Frog			
Juveniles only	-0.04 (0.02)	0.03 (0.03)	0.08
Metamorphs only	-0.26 (0.21)	0.30 (0.16)	0.04
Pickerel Frog			
Juveniles only	0.03 (0.02)	0.01 (0.01)	0.47
Metamorphs only	0.04 (0.03)	0.59 (0.30)	0.19
Wood Frog			
Juveniles and adults only	-0.02 (0.03)	0.06 (0.02)	0.02
Metamorphs only	-0.34 (0.12)	-0.25 (0.13)	0.67

[1] Difference values (reported in captures per 100 trap nights) calculated by subtracting the mean closed-canopy capture rate of a 10-ha research area from the gap capture rate.

[2] Probabilities were calculated using a multiple response permutation procedure, $\alpha = 0.10$.

Figure 4. Logistic regression function used the detection rates of logs found with red-backed salamanders in harvest gaps (16 of 115 logs) and adjacent closed-canopy areas (45 of 116 logs) over log size (diameter). Logs were searched from June-July, 2003 in the Penobscot Experimental Forest, Maine.

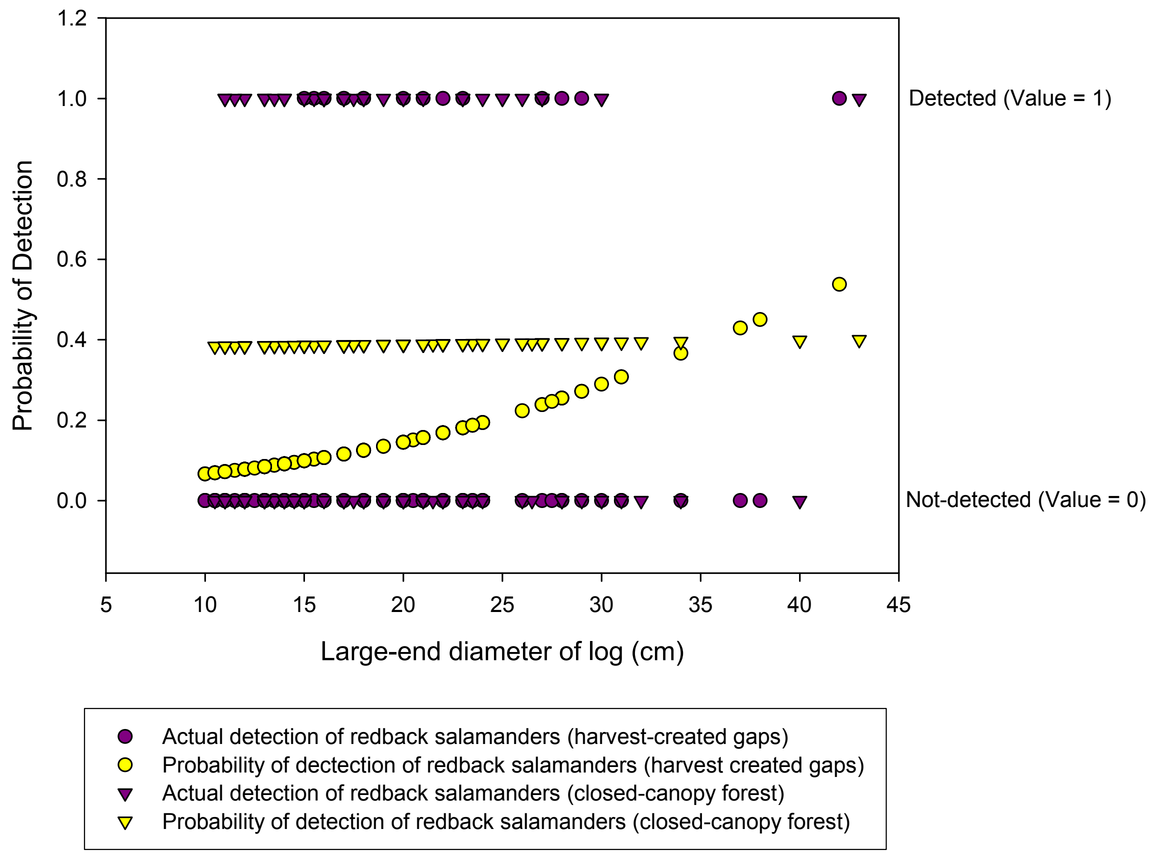


Table 7. Count of logs, by size class, where eastern red-backed salamanders were detected in both large harvest gaps and closed canopy areas of the Penobscot Experimental Forest, June-July 2003.

	Logs with RBs		Total Logs	
Log size (large-end diameter)	Harvest Gap	Closed Canopy	Harvest Gap	Closed Canopy
Small (10 - 14.5 cm)	0	9	48	31
Medium (15 - 20.5 cm)	8	22	31	45
Large (21 – 43 cm)	8	14	36	40
Total	16	45	115	116

difference in log abundance among gap types and closed canopy areas was detected ($F\text{-ratio}_{2,39} = 2.10$, $p = 0.14$). Because our sampling scheme for red-backed salamanders was limited to logs of a certain decay class (2-3) and by length of log resting on the ground (at least 0.5 m), we calculated percents of the logs tallied that met our requirements and found that 64.2%, 67.2%, and 75.4% of logs in harvest gaps, natural gaps, and closed-canopy areas, respectively, were available for log searches (Table 9). Variations around percent of logs tallied could not be calculated due to limitations with the sampling protocol.

Table 8. Summary of down woody material characteristics from line-intercept surveys in harvest gaps, natural gaps, and closed-canopy areas of the Penobscot Experimental Forest, Maine, 2003.

Treatment	n	Total meters surveyed	Mean transect length (± SE)	Total logs tallied	Number of logs per ha (± SE)
Harvest gaps	17	642.3	37.8 (2.2)	221	2,550 (329.6)
Natural gaps	19	357.4	18.8 (1.3)	87	1,676 (314.5)
Closed-canopy areas	6	300	50	89	2,374 (377.5)

Table 9. Delineation of logs tallied during line-intercept sampling in harvest gaps, natural gaps, and closed-canopy areas in the Penobscot Experimental Forest, Maine, 2003, for each decay class.

	Decay Class			
Group	**1**	**2**	**3**	**4**
Logs by diameter size class (%)				
Small (10 - 14.5 cm)				
Harvest gaps	16.8%	65.6%	15.2%	2.4%
Natural gaps	16.7%	55.6%	22.2%	5.6%
Closed-canopies	34.0%	46.0%	16.0%	4.0%
Medium (14.6 - 20.5 cm)				
Harvest gaps	19.0%	51.7%	20.7%	8.6%
Natural gaps	16.7%	62.5%	16.7%	4.2%
Closed-canopies	3.3%	43.3%	43.3%	10.0%
Large (> 20.5 cm)				
Harvest gaps	13.2%	63.2%	15.8%	7.9%
Natural gaps	18.5%	55.6%	18.5%	7.4%
Closed-canopies	0.0%	66.7%	22.2%	11.1%
Logs with > 0.5 m on the ground (%)				
Harvest gaps	40.5%	57.4%	89.2%	100.0%
Natural gaps	13.3%	62.0%	82.4%	100.0%
Closed-canopies	33.3%	66.7%	91.3%	100.0%
Total number of logs tallied				
Harvest gaps	37	136	37	11
Natural gaps	15	50	17	5
Closed-canopies	18	42	23	6

DISCUSSION

We found variation in responses to our treatments among both species (Stebbins and Cohen 1995, deMaynadier and Hunter 1998) and age-classes (deMaynadier and Hunter 1999, Rothermel and Semlitsch 2002). Due to the different treatment types, we can make conclusions about gap aspect, gap type (harvested or natural), gap size, and redback salamander use of logs.

Relative Abundance Within Gaps

Overall, there was little evidence that location within a gap (north or south aspect, edges, center) influenced amphibian abundance. Although green frog capture rates were relatively high at the edges of large gaps in both 2002 and 2003, this result may be a sampling or statistical anomaly. Testing at an alpha level of 0.10, while increasing power, increases probability of false detections (0.1 chance). In smaller gaps there was no indication of gap aspect or edge effects for any of the species. Location within small gaps also did not affect vegetation patterns (Schofield 2003). Sampling could be improved by concentrating efforts (pitfall trapping) in the gap locations that were tested (northern and southern edges and gap center) instead of along the entire north-south transect. This would free up resources to sample more large harvest gaps to increase power.

Relative Abundance Among Gap Types

Juvenile-adult spotted salamanders were the only group with lower abundance in all gap types, and there were no differences among gap types except for in 2002 (Tables 4, 5). Spotted salamander metamorphs showed a decrease in abundance in both large and small harvest gaps, but not in natural gaps (Figure 3). These results were consistent with previous research that detected lower capture rates of spotted salamanders metamorphs in open-canopy areas such as clear-cuts (deMaynadier and Hunter 1998, Renken et al. 2004) and fields adjacent to forest (Rothermel and Semlitsch 2002). Gap type effects for our other two salamander species were less definitive or absent.

Red efts showed reduced abundance in harvest gaps in 2002, but no statistical differences among gap types in 2003 – despite much larger sample sizes (Tables 4, 5). No differences among gap types were detected for adult red-backed salamanders in 2002 or 2003. Inconsistent treatment effects were detected for immature red-backed salamanders, with relatively higher abundance in small gaps and lower abundance in large and natural gaps in 2003, while abundance in large gaps was reduced relative to small and natural gaps in 2002. Because red-backed salamanders have been described as sensitive to forest management (deMaynadier and Hunter 1998, Welsh and Droege 2001), we expected to observe reductions associated with canopy loss. Variation in vegetation among gap types, notably a greater deciduous component in harvest gaps (Schofield 2003), may be affecting the pattern we observed for red-backed salamanders. The amount of structure within our harvest gaps may have provided sufficient refuge for surface populations of salamanders as observed by Grialou et al. (2000). However, we did find logs within harvested gaps to be limiting in active searches for red-backed salamanders (below).

Anurans are more mobile, and therefore thought to be comparatively less physiologically constrained in open habitats than salamanders (Stebbins and Cohen 1995, deMaynadier and Hunter 1998). Nevertheless, in 2003, five of seven groups showed decreases in abundance for at least one of the harvest gap treatments. Decreases in abundance of bullfrog and green frog metamorphs were the greatest in large gaps, less in small gaps, and natural gaps showed an increase in abundance (Figure 3). Furthermore, when we compared harvest and natural gaps of the same size, we observed reduced abundance in gaps of harvested origin (Table 6), thus indicating both size of gap and gap origin are important. Chan-McLeod (2004) also found smaller anurans to be limited by conditions created by timber harvesting. For three other anuran groups (green frog juveniles, wood frog juvenile-adults and metamorphs) large gaps resulted in decreased abundance but small-gap and natural-gap treatments were similar (Figure 3), suggesting that small harvest gaps provided habitat similar to natural gaps even though they were, on average, larger than natural gaps (Table 1). Wood frogs, previously identified as sensitive to forest management (deMaynadier and Hunter 1998, Gibbs 1998), were expected to be less abundant in harvested areas. Both metamorphs and juveniles of pickerel frogs, a species associated with open habitat (Hunter et al. 1999), showed either no change or an increase in abundance within gaps, with no differences among gap type except for the small gap treatment showing relatively higher abundance than the large gap treatment (Figure 3).

The divergence between large and small harvest gaps (observed for metamorphs of bullfrogs, green frogs, wood frogs, and juveniles of green frogs and wood frogs) may be associated with differences in both gap size and residual structure. Per unit area, more reserve trees were left in small gaps (14 m^2/ha basal area) than in large gaps (11 m^2/ha basal area). Presence of residual structure such as reserve trees (Greenberg 2001) and DWM (Moseley et al. 2004) may explain the continuation of observed amphibian activity in harvested areas.

Red-backed Salamander Use Of Logs

Under the assumption that habitat provided by logs increases fitness and productivity of red-backed salamanders, we expected to find more and bigger salamanders under large logs. We expected this relationship to be stronger in harvest gaps where a drier microenvironment made large logs more desirable, in contrast to a closed-canopy forest, where a small log would provide a sufficient microclimate. Our results showed that canopy conditions and log size did influence the rate of detecting red-backed salamanders under logs, with a predicted increase in detection probability as log size increases in harvested areas but not in closed canopy forest (Figure 4). Overall detection rates were higher in closed-canopy areas. We did not find evidence to support a relationship between size of log and size (length or mass) of salamanders. The lack of a relationship between log size and salamander size in both gap and closed-canopy habitats was similar to the results of Gabor (1995) (research conducted in closed-canopy conditions) but different from Mathis (1990) (research conducted in broken-canopy, natural forest conditions). However, Mathis (1990) did observe higher occupancy rates of large cover objects than small cover objects by red-backed salamanders, as we observed in harvest-created gaps. The robustness of our “detection rate vs. log size” model was restricted by the limited number of larger logs in the forest and low detection rate within gaps. Manipulative experiments with placement of larger cover objects would strengthen the predictability of our model, and further clarify any relationship between salamander size and log sizes in open and closed-canopy forest.

IMPLICATIONS FOR MANAGEMENT

To evaluate harvested and natural gaps, we focused on amphibians that inhabit upland forests. Much research effort has focused on amphibian breeding ecology in wetlands, yet little is known about amphibian responses to alterations in their terrestrial habitat, where most of an amphibian's life cycle is spent (Dodd and Smith 2003). For areas where gap harvests are prescribed to maintain an all-aged forest structure, information on the ecological effects will be useful to forest managers. We found that harvest gaps, especially small gaps, can provide habitat comparable to natural gaps for some amphibian groups, but not all. It is important to note that the differences we did detect were at a "local" scale, using the gap as the experimental unit. At a landscape scale, the closed-canopy conditions surrounding the canopy gaps likely aid in maintaining species abundance and biodiversity, as found by Renken et al. (2004).

There is a general consensus that long-term forest management needs to incorporate biological and physical diversity into management goals (Franklin et al. 1997, Seymour and Hunter 1999). Since forest biota and processes are closely related to structural elements (Palik et al. 2002), studies such as ours that identify and quantify differences between artificial and natural disturbances can aid foresters in designing harvests that maintain ecological attributes (deMaynadier and Hunter 1995, Coates and Burton 1997, Guo 2003). Two general points of consensus have already emerged from such studies: retaining large-diameter trees and DWM in a system (Sullivan et al. 2001, Grove 2002, Simila et al. 2003). While many forest processes and biological relationships within the spruce-fir ecosystem are not fully understood, we can expect future stand-level forest operations to focus on what is retained (live trees, snags, and logs) rather than what is removed (O'Hara et al. 1994, Franklin et al. 2002, Harmon et al. 2002), in an effort to minimize structural differences between managed and unmanaged forests.

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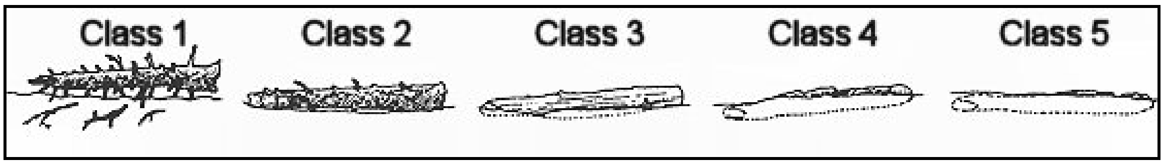
APPENDICES

APPENDIX A: Down woody material decay classes used to describe logs in the Penobscot Experimental Forest, Maine.

Figure A1. Down woody material decay classes as modified from United States Forest Service guidelines (Maser et al. 1979).



Class 1: Wood is sound and cannot be penetrated with thumbnail. Bark intact with smaller to medium-sized branches present. Log often suspended by its branches.

Class 2: Wood sound to somewhat rotten. Bark may or may not be attached and branch stubs are firmly attached but only larger stubs are present. Log retains round shape and lies on duff.

Class 3: Wood substantially rotten. Enough that branch stubs pull out easily and thumbnail penetrates readily. Wood texture soft and may be ‘squishy’ if moist. Bark lightly attached, sloughing off or detached. Bole assuming a slightly oval shape and may be partly buried in duff.

Class 4: Wood mostly rotten, ‘fluffy’ when dry and ‘doughy’ when wet. Branch stubs rotted down and bark detached or absent (for most species). Decidedly oval in cross-section and, usually, substantially buried in duff. The lower cut off point for this class occurs when top of log has been lowered by decay to the general duff level at its sides, making it indistinguishable, except for traces of decayed wood, bark (some species) or plant covering, from the surrounding duff.

APPENDIX B: Categorization and representation of age-classes for amphibian species captured in the Penobscot Experimental Forest, Maine, 2002-2003.

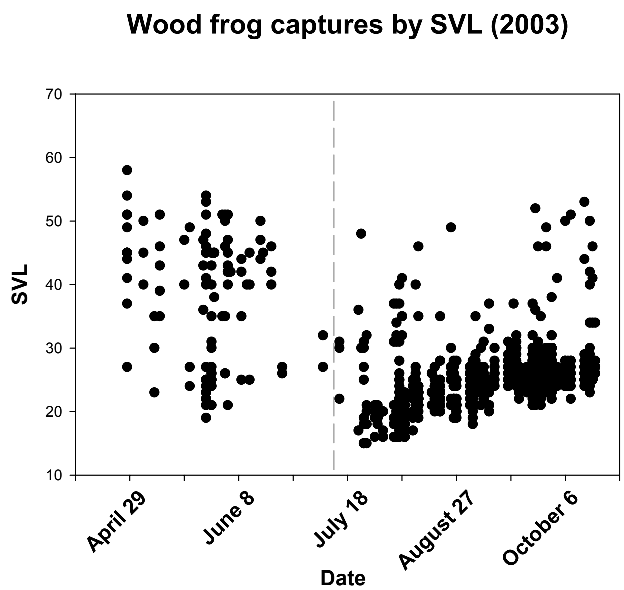
Table B1. Age class categories for bullfrogs, green frogs, and pickerel frogs captured in the Penobscot Experimental Forest, Maine, 2002 - 2003. Category divisions by size (SVL) are based on research in Rhode Island (www.uri.edu/cels/nrs/paton/species.html).

	Age Class (mm SVL)		
Species	**Metamorph (≤)**	**Juvenile**	**Adult (≥)**
American bullfrog	43	44 - 79	80
Green frog	40	41 - 63	64
Pickerel frog[1]	32	33 - 48	49

[1] Metamorph designation after July 20th.

Figure B1. Captures of wood frogs (a) and spotted salamanders (b), plotted by individual SVLs against time to show emergence of metamorphs (young of the year). Vertical dashed line shows estimated date of emergence (July 15th for wood frogs and August 1st for spotted salamanders). All amphibians were captured in the Penobscot Experimental Forest, Maine, 2003.

(a)



(b)

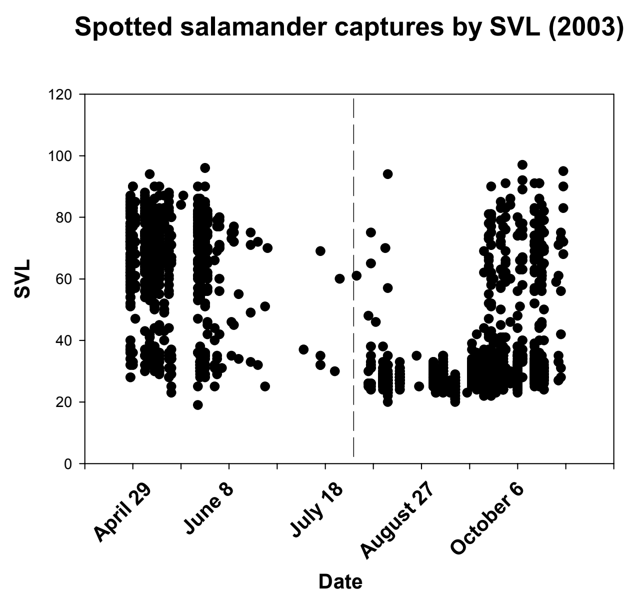
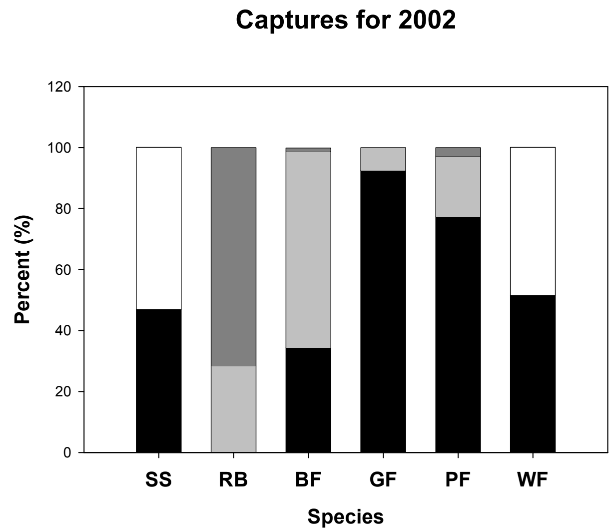
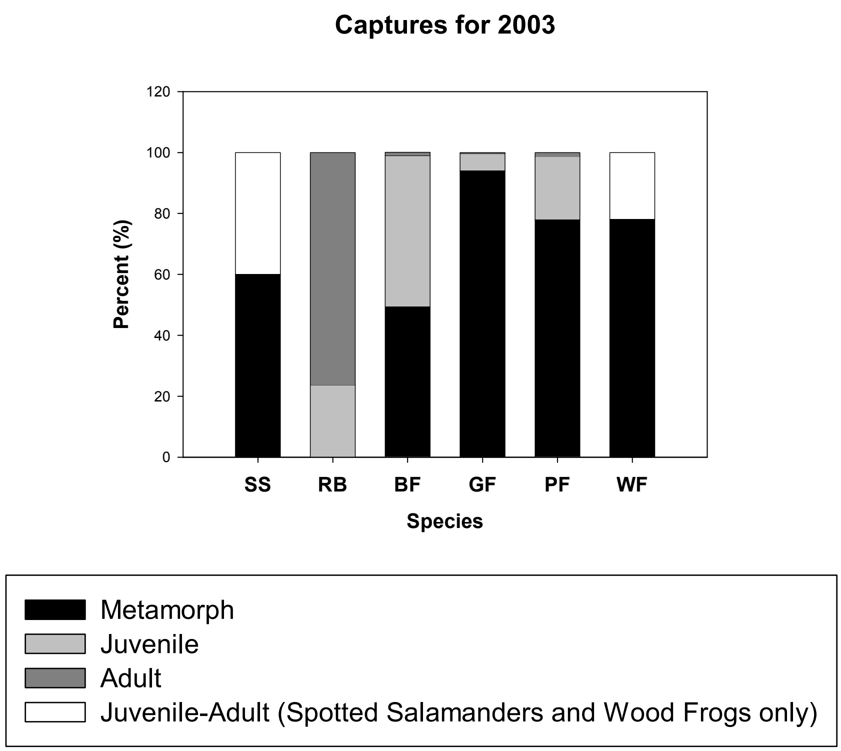


Figure B2. Proportion of spotted salamanders (SS), eastern red-backed salamanders (RB), bullfrogs (BF), green frogs (GF), and wood frogs (WF) captured in their respective age-classes for 2002 (a) and 2003 (b).

(a)

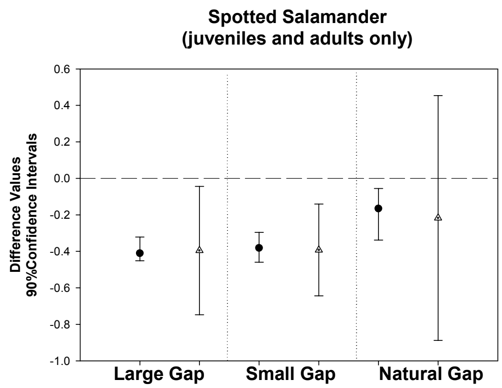


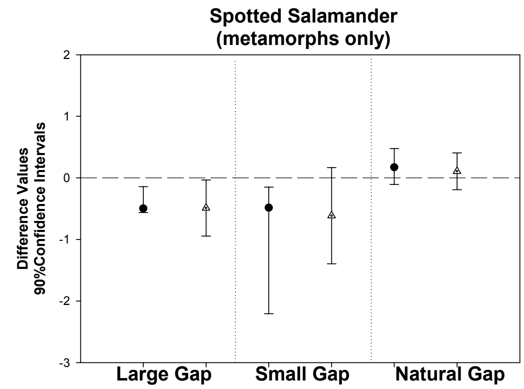
(b)

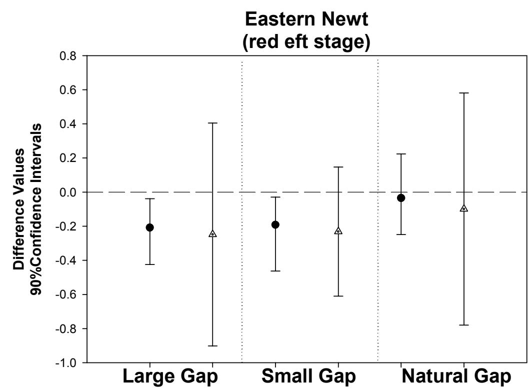


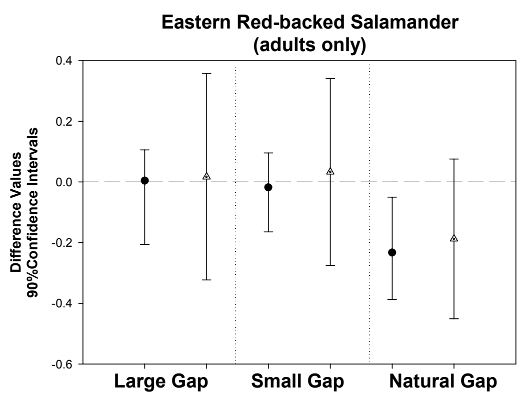
APPENDIX C: A comparison of two methods used to calculate difference values of amphibian capture rates.

Figure C1. Difference values with 90% confidence intervals for species/age groups of amphibians captured in the Penobscot Experimental Forest, 2003. The x-axis shows treatment type: large harvest gap (large gap, n=22), small harvest gap (small gap, n=22), and natural gap (n=19). The circle symbol represents the median of difference values calculated by subtracting the mean capture rates of closed-canopy plots from gap capture rates for their respective research areas. The triangle symbol represents the mean of difference values calculated by subtracting a randomly selected closed-canopy plot from each gap capture rates for their respective research areas (n=5 for each treatment).


Spotted Salamander
(juveniles and adults only)
Difference Values
90%Confidence Intervals
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
Large Gap
Small Gap
Natural Gap


Spotted Salamander
(metamorphs only)
Difference Values
90%Confidence Intervals
2
1
0
-1
-2
-3
Large Gap
Small Gap
Natural Gap


Eastern Newt
(red eft stage)
Difference Values
90%Confidence Intervals
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
Large Gap
Small Gap
Natural Gap


Eastern Red-backed Salamander
(adults only)
Difference Values
90%Confidence Intervals
0.4
0.2
0.0
-0.2
-0.4
-0.6
Large Gap
Small Gap
Natural Gap

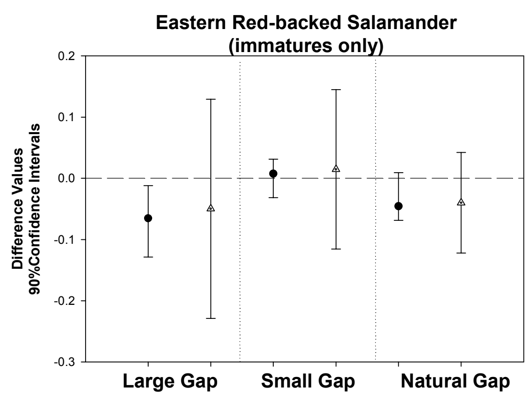
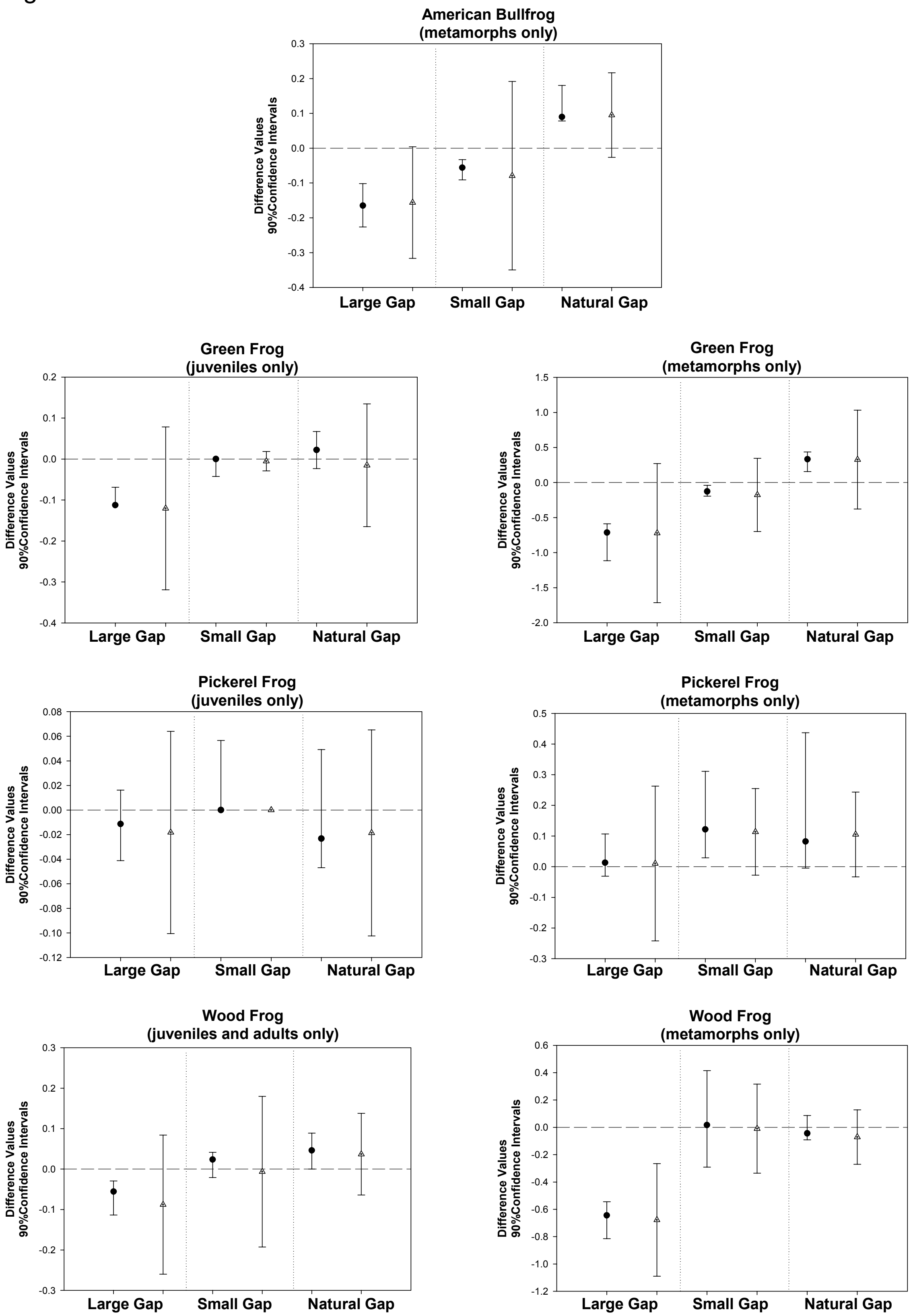

Eastern Red-backed Salamander
(immatures only)
Difference Values
90%Confidence Intervals
0.2
0.1
0.0
-0.1
-0.2
-0.3
Large Gap
Small Gap
Natural Gap

Figure C1 continued.



APPENDIX D: Examining if gap area within a harvested treatment influences the difference values of amphibian capture rates.

METHODS

Given the range of gap areas within the harvested treatments, we used linear regression (SYSTAT version 10.2.01) to examine the relationships between difference values and gap area. Presence of a significant relationship ($\alpha < 0.1$) would influence interpretation of gap type effects, where an effect may be present at one end of the size-range and not at the other.

RESULTS

Statistically significant ($\alpha < 0.10$) relationships using linear regression were found between harvested-gap area and difference values for 6 groups: eastern newts, bullfrog metamorphs, green frog metamorphs, pickerel frog juveniles and metamorphs, and wood frog metamorphs (Table D.1). However, the regression coefficients for these groups were less than or equal to 0.000 indicating a change in gap area of 10,000 m^2 (0.0001 per m^2) would be necessary to detect a change in capture rate. Given that all our harvest gaps are less than 10,000 m^2 , this rate of change is not applicable to the scale of our study; thus treatment effects were not confounded by gap area effects.

Table D1. Linear regression model results for difference values rate of change (slope coefficient) as area increases in large and small harvest gaps. Difference values[1] are calculated from amphibian captures in the Penobscot Experimental Forest, Maine, 2003.

	Large Gaps (20 df)			Small Gaps (20 df)		
Species	**Slope coefficient**	**R^2**	**p**	**Slope coefficient**	**R^2**	**p**
Salamanders						
Spotted Salamander						
Juveniles and adults only	-0.000	0.069	0.237	-0.000	0.001	0.864
Metamorphs only	-0.001	0.084	0.190	-0.002	0.059	0.276
Eastern Newt	-0.000	0.235	0.022	0.000	0.009	0.679
Eastern Red-backed Salamander						
Adults only	-0.000	0.000	0.936	0.000	0.108	0.135
Immatures only	-0.000	0.002	0.846	0.000	0.072	0.227
Anurans						
American Bullfrog						
Metamorphs only	-0.000	0.159	0.066	-0.000	0.002	0.862
Green Frog						
Juveniles only	0.000	0.010	0.657	0.000	0.014	0.594
Metamorphs only	0.000	0.076	0.214	-0.000	0.147	0.078
Pickerel Frog						
Juveniles only	-0.000	0.140	0.087	0.000	0.013	0.612
Metamorphs only	-0.000	0.160	0.065	0.000	0.094	0.165
Wood Frog						
Juveniles and adults only	-0.000	0.024	0.495	-0.000	0.000	0.970
Metamorphs only	-0.000	0.177	0.051	0.000	0.000	0.927

[1] Difference values (reported in captures per 100 trap nights) calculated by subtracting the mean closed-canopy capture rate of a 10-ha research area from the gap capture rate.

APPENDIX E: Observed capture rates for each plot (gap and closed-canopy) sampled in the Penobscot Experimental Forest, ME, 2002 - 2003.

Table E1. Capture rates (captures/100 TN) for each plot (gap or closed-canopy) for salamanders captured in the Penobscot Experimental Forest, ME, in 2002.

Location			Species[1] (age-class)[2]							
RA	Plot Type[3]	Plot Label	BS	SS	SS (JAD)	SS (MET)	EN	RB	RB (ADT)	RB (IMM)
1	cc	f2	0.00	1.34	1.34	0.00	0.67	0.81	0.54	0.27
1	cc	h4	0.00	1.24	1.10	0.35	1.65	0.55	0.41	0.14
1	cc	i5	0.00	2.28	2.28	0.00	0.40	0.00	0.00	0.00
1	cc	j3	0.00	0.13	0.13	0.00	0.67	0.00	0.00	0.00
1	g	e3	0.00	0.57	0.57	0.00	0.43	0.00	0.00	0.00
1	g	g2	0.00	0.00	0.00	0.00	0.27	0.14	0.00	0.14
1	g	g5	0.00	0.29	0.20	0.23	0.34	0.29	0.24	0.05
1	g	h7	0.00	0.80	0.80	0.00	0.50	0.00	0.00	0.00
1	g	i3	0.00	0.43	0.43	0.00	0.29	0.19	0.14	0.05
1	g	j2	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00
1	g	j4	0.00	0.29	0.29	0.00	0.29	0.05	0.00	0.05
1	g	j5	0.13	0.27	0.27	0.00	0.54	0.40	0.13	0.27
2	cc	c3	0.00	0.27	0.27	0.00	0.14	0.00	0.00	0.00
2	cc	d3	0.00	0.54	0.40	0.34	0.54	0.67	0.40	0.13
2	cc	i4	0.00	0.55	0.28	0.73	0.28	0.28	0.28	0.00
2	cc	j5	0.00	1.21	1.08	0.34	0.13	0.13	0.00	0.13
2	g	c4	0.00	0.29	0.24	0.11	0.29	0.10	0.00	0.10
2	g	d2	0.09	0.35	0.09	0.65	0.18	0.00	0.00	0.00
2	g	f3	0.00	0.00	0.00	0.00	0.00	0.13	0.13	0.00
2	g	f4	0.00	0.13	0.13	0.00	0.13	0.00	0.00	0.00
2	g	g4	0.00	0.08	0.08	0.00	0.08	0.25	0.08	0.17
2	g	k3	0.00	0.36	0.18	0.44	0.24	0.18	0.12	0.06
2	g	k4	0.00	0.00	0.00	0.00	0.00	0.40	0.27	0.13
3	cc	a2	0.00	0.00	0.00	0.00	0.00	0.28	0.28	0.00
3	cc	d5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	cc	e2	0.00	0.40	0.13	0.68	0.27	0.00	0.00	0.00
3	cc	g4	0.00	1.80	1.52	0.70	0.28	0.00	0.00	0.00
3	g	a3	0.00	0.38	0.19	0.44	0.51	0.32	0.26	0.06
3	g	c4	0.00	0.68	0.68	0.00	0.27	0.00	0.00	0.00
3	g	d4	0.00	0.28	0.28	0.00	0.28	0.28	0.28	0.00

[1] BS = blue-spotted salamander, SS = spotted salamander, EN = eastern newt, RB = eastern red-backed salamander

[2] JAD = juveniles and adults, MET = metamorphs, ADT = adults, IMM = immatures

[3] g = gap, cc = closed-canopy

Table E1. Continued.

Location			Species[1] (age-class) [2]							
RA	Plot Type[3]	Plot Label	BS	SS	SS (JAD)	SS (MET)	EN	RB	RB (ADT)	RB (IMM)
3	g	e3	0.00	0.14	0.14	0.00	0.14	0.00	0.00	0.00
3	g	e4	0.14	1.12	0.28	2.04	0.00	0.14	0.14	0.00
3	g	j2	0.00	0.67	0.59	0.21	1.18	0.34	0.17	0.17
3	g	j4	0.00	0.59	0.42	0.42	0.42	0.17	0.17	0.00
4	cc	a5	0.00	1.12	0.70	1.06	0.28	0.00	0.00	0.00
4	cc	b4	0.00	0.85	0.43	1.06	1.00	0.00	0.00	0.00
4	cc	b7	0.00	0.28	0.14	0.35	0.00	0.00	0.00	0.00
4	cc	c3	0.00	1.94	1.25	1.77	2.36	0.56	0.42	0.14
4	g	a7	0.00	0.56	0.28	0.71	0.98	0.00	0.00	0.00
4	g	c8	0.00	0.69	0.28	1.06	0.28	0.00	0.00	0.00
4	g	d4	0.00	0.97	0.56	1.06	1.81	0.14	0.14	0.00
4	g	d5	0.00	1.11	0.28	2.13	0.83	0.00	0.00	0.00
5	cc	b4	0.14	3.74	1.72	5.07	2.73	0.14	0.00	0.14
5	cc	d4	0.00	2.30	1.15	2.90	0.57	0.14	0.14	0.00
5	cc	e5	0.00	1.72	1.29	1.09	0.43	0.00	0.00	0.00
5	cc	ef3	0.00	4.31	1.15	7.97	3.45	0.43	0.43	0.00
5	g	a8	0.00	1.72	0.29	3.62	2.73	0.14	0.00	0.14
5	g	b2	0.06	0.76	0.44	0.78	1.13	0.25	0.25	0.00
5	g	b5	0.07	1.56	0.33	2.95	1.56	0.13	0.07	0.07
5	g	c2	0.00	2.30	0.99	2.90	1.97	0.49	0.49	0.00
5	g	d7	0.00	0.29	0.15	0.37	0.58	0.00	0.00	0.00
5	g	e3	0.00	2.40	0.80	3.53	1.20	0.50	0.30	0.20
5	g	e4	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00
6	cc	a6	0.00	2.06	0.32	3.99	0.95	0.63	0.47	0.16
6	cc	c1	0.14	0.98	0.42	1.45	1.54	0.28	0.14	0.14
6	cc	c7	0.14	0.98	0.28	1.81	0.84	0.28	0.00	0.28
6	cc	d5	0.00	0.84	0.56	0.72	0.84	0.28	0.00	0.28
6	g	a3	0.14	1.56	0.43	3.01	0.71	0.28	0.28	0.00
6	g	b4	0.14	1.14	0.00	3.07	0.57	0.14	0.00	0.14
6	g	b7	0.15	0.85	0.55	0.73	0.40	0.15	0.10	0.05
6	g	c2	0.04	0.74	0.28	1.11	0.49	0.07	0.04	0.04
6	g	c6	0.00	1.26	0.70	1.45	0.84	0.00	0.00	0.00
6	g	d6	0.04	1.62	0.18	3.51	0.70	0.25	0.18	0.07
6	g	e4	0.00	1.51	0.17	3.21	0.63	0.21	0.17	0.04
7	cc	b3	0.00	1.09	0.68	1.06	0.00	0.00	0.00	0.00
7	cc	b5	0.00	0.27	0.27	0.00	0.00	0.14	0.14	0.00
7	cc	d5	0.00	0.68	0.55	0.35	0.14	0.27	0.27	0.00

[1] BS = blue-spotted salamander, SS = spotted salamander, EN = eastern newt, RB = eastern red-backed salamander

[2] JAD = juveniles and adults, MET = metamorphs, ADT = adults, IMM = immatures

[3] g = gap, cc = closed-canopy

Table E1. Continued.

Location			Species[1] (age-class) [2]							
RA	Plot Type[3]	Plot Label	BS	SS	SS (JAD)	SS (MET)	EN	RB	RB (ADT)	RB (IMM)
7	cc	f3	0.14	0.56	0.42	0.36	0.00	0.00	0.00	0.00
7	g	b2	0.00	0.40	0.20	0.43	0.00	0.20	0.20	0.00
7	g	b4	0.00	0.27	0.18	0.23	0.00	0.27	0.09	0.18
7	g	b7	0.00	0.44	0.30	0.36	0.30	0.59	0.59	0.00
7	g	c7	0.07	0.07	0.00	0.16	0.07	0.21	0.21	0.00
7	g	d7	0.00	0.28	0.28	0.00	0.00	0.00	0.00	0.00
7	g	f2	0.00	0.45	0.45	0.00	0.00	0.45	0.45	0.00
7	g	f4	0.00	0.32	0.26	0.15	0.06	0.13	0.13	0.00
7	g	f6	0.00	0.00	0.00	0.00	0.14	0.14	0.14	0.00
8	cc	b2	0.29	0.44	0.29	0.40	0.44	0.00	0.00	0.00
8	cc	d6	0.00	0.83	0.55	0.71	0.28	0.14	0.14	0.00
8	cc	e5	0.00	0.71	0.57	0.35	0.14	0.00	0.00	0.00
8	cc	g6	0.00	0.42	0.14	0.72	0.28	0.28	0.28	0.00
8	g	b8	0.00	1.48	1.04	1.10	1.22	0.00	0.00	0.00
8	g	c1	0.09	1.01	0.46	1.35	0.55	0.00	0.00	0.00
8	g	c2	0.00	0.28	0.14	0.37	0.42	0.14	0.14	0.00
8	g	d3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	g	d4	0.00	0.62	0.50	0.29	0.00	0.12	0.12	0.00
8	g	d5	0.00	0.30	0.30	0.00	0.00	0.00	0.00	0.00
8	g	e3	0.00	0.89	0.30	1.42	0.15	0.15	0.00	0.15
8	g	e6	0.14	0.42	0.42	0.00	0.42	0.14	0.14	0.00
9	cc	az8	0.00	0.28	0.28	0.00	0.28	0.28	0.28	0.00
9	cc	f5	0.00	0.56	0.56	0.00	0.56	0.00	0.00	0.00
9	cc	y4	0.00	0.41	0.41	0.00	0.28	0.00	0.00	0.00
9	cc	y7	0.00	0.14	0.14	0.00	0.96	0.00	0.00	0.00
9	g	a8	0.00	0.26	0.26	0.00	0.17	0.43	0.34	0.09
9	g	b8	0.00	0.30	0.30	0.00	0.25	0.10	0.05	0.05
9	g	c4	0.00	0.14	0.14	0.00	0.14	0.28	0.14	0.14
9	g	c6	0.00	0.20	0.20	0.00	0.10	0.15	0.10	0.05
9	g	e4	0.00	0.42	0.42	0.00	0.56	0.42	0.28	0.14
9	g	z5	0.00	0.28	0.28	0.00	1.26	0.00	0.00	0.00
9	g	z8	0.00	0.10	0.05	0.11	0.20	0.10	0.10	0.00

[1] BS = blue-spotted salamander, SS = spotted salamander, EN = eastern newt, RB = eastern red-backed salamander

[2] JAD = juveniles and adults, MET = metamorphs, ADT = adults, IMM = immatures

[3] g = gap, cc = closed-canopy

Table E2. Capture rates (captures/100 TN) for each plot (gap or closed-canopy) for anurans captured in the Penobscot Experimental Forest, ME, in 2002.

Location			Species[1] (age-class) [2]									
RA	Plot Type[3]	Plot Label	BF	BF (JUV)	BF (MET)	GF	GF (JUV)	GF (MET)	PF	PF (ADT)	PF (JUV)	PF (MET)
1	cc	f2	0.13	0.00	0.13	0.40	0.00	0.40	0.00	0.00	0.00	0.00
1	cc	h4	0.27	0.00	0.27	0.96	0.00	0.96	0.00	0.00	0.00	0.00
1	cc	i5	0.13	0.13	0.00	0.81	0.00	0.81	0.13	0.00	1.00	0.00
1	cc	j3	0.13	0.13	0.00	1.21	0.00	1.21	0.40	0.00	1.00	0.51
1	g	e3	0.00	0.00	0.00	0.14	0.00	0.14	0.14	0.00	0.00	0.28
1	g	g2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	g	g5	0.24	0.05	0.20	0.57	0.00	0.57	0.63	1.00	4.00	0.68
1	g	h7	0.25	0.15	0.10	0.15	1.00	0.15	0.00	0.00	0.00	0.00
1	g	i3	0.14	0.10	0.05	0.14	0.00	0.14	0.05	0.00	0.00	0.09
1	g	j2	0.00	0.00	0.00	0.69	0.00	0.69	0.41	1.00	0.00	0.51
1	g	j4	0.43	0.29	0.14	0.68	0.00	0.68	0.10	0.00	0.00	0.17
1	g	j5	0.13	0.00	0.13	0.40	0.00	0.40	0.00	0.00	0.00	0.00
2	cc	c3	0.27	0.14	0.14	0.41	0.00	0.41	0.00	0.00	0.00	0.00
2	cc	d3	0.00	0.00	0.00	0.13	0.00	0.13	0.00	0.00	0.00	0.00
2	cc	i4	0.28	0.14	0.14	0.14	0.00	0.14	0.00	0.00	0.00	0.00
2	cc	j5	0.13	0.00	0.13	0.27	0.00	0.27	0.00	0.00	0.00	0.00
2	g	c4	0.14	0.10	0.05	0.33	0.00	0.33	0.19	0.00	0.00	0.25
2	g	d2	0.09	0.09	0.00	0.35	0.00	0.35	0.09	0.00	0.00	0.17
2	g	f3	0.13	0.00	0.13	0.13	0.00	0.13	0.00	0.00	0.00	0.00
2	g	f4	0.13	0.13	0.00	0.13	0.00	0.13	0.00	0.00	0.00	0.00
2	g	g4	0.08	0.00	0.08	0.25	0.00	0.25	0.00	0.00	0.00	0.00
2	g	k3	0.06	0.06	0.00	0.12	0.00	0.12	0.00	0.00	0.00	0.00
2	g	k4	0.13	0.13	0.00	0.13	0.00	0.00	0.13	0.00	0.00	0.25
3	cc	a2	0.00	0.00	0.00	0.28	0.00	0.28	0.00	0.00	0.00	0.00
3	cc	d5	0.00	0.00	0.00	0.27	0.00	0.27	0.14	0.00	0.00	0.26
3	cc	e2	0.13	0.13	0.00	0.67	0.00	0.67	0.00	0.00	0.00	0.00
3	cc	g4	0.14	0.14	0.00	0.42	0.00	0.42	0.00	0.00	0.00	0.00
3	g	a3	0.00	0.00	0.00	0.45	1.00	0.38	0.00	0.00	0.00	0.00
3	g	c4	0.14	0.00	0.14	0.95	0.00	0.95	0.00	0.00	0.00	0.00
3	g	d4	0.00	0.00	0.00	0.56	0.00	0.56	0.28	0.00	0.00	0.56
3	g	e3	0.27	0.14	0.14	0.96	0.00	0.96	0.27	0.00	1.00	0.26
3	g	e4	0.00	0.00	0.00	0.56	0.00	0.56	0.14	0.00	0.00	0.28
3	g	j2	0.08	0.08	0.00	1.18	1.00	1.10	0.34	0.00	1.00	0.47
3	g	j4	0.25	0.17	0.08	0.51	0.00	0.51	0.08	0.00	0.00	0.16

[1] BF = bullfrog, GF = green frog, PF = pickerel frog
[2] JUV = juveniles, MET = metamorphs, ADT = adults
[3] g = gap, cc = closed-canopy

Table E2. Continued.

Location			Species[1] (age-class)[2]									
RA	Plot Type[3]	Plot Label	BF	BF (JUV)	BF (MET)	GF	GF (JUV)	GF (MET)	PF	PF (ADT)	PF (JUV)	PF (MET)
4	cc	a5	0.42	0.14	0.00	1.26	0.00	1.26	0.00	0.00	0.00	0.00
4	cc	b4	0.71	0.43	0.28	2.71	2.00	2.42	0.00	0.00	0.00	0.00
4	cc	b7	0.14	0.14	0.00	4.72	6.00	3.89	0.00	0.00	0.00	0.00
4	cc	c3	0.00	0.00	0.00	2.92	3.00	2.50	0.00	0.00	0.00	0.00
4	g	a7	0.14	0.14	0.00	1.26	1.00	1.12	0.00	0.00	0.00	0.00
4	g	c8	0.28	0.28	0.00	1.67	2.00	1.39	0.00	0.00	0.00	0.00
4	g	d4	0.42	0.42	0.00	2.08	0.00	1.94	0.14	0.00	1.00	0.00
4	g	d5	0.14	0.14	0.00	2.78	1.00	2.64	0.00	0.00	0.00	0.00
5	cc	b4	0.00	0.00	0.00	1.01	0.00	1.01	0.00	0.00	0.00	0.00
5	cc	d4	0.29	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	cc	e5	0.00	0.00	0.00	0.86	0.00	0.86	0.00	0.00	0.00	0.00
5	cc	ef3	0.29	0.29	0.00	0.14	0.00	0.14	0.00	0.00	0.00	0.00
5	g	a8	0.14	0.14	0.00	6.32	5.00	5.32	0.14	0.00	0.00	0.31
5	g	b2	0.00	0.00	0.00	1.26	1.00	1.20	0.25	0.00	0.00	0.54
5	g	b5	0.46	0.26	0.20	3.52	4.00	3.26	0.33	1.00	0.00	0.40
5	g	c2	0.16	0.00	0.16	0.33	0.00	0.33	0.16	0.00	0.00	0.00
5	g	d7	0.29	0.15	0.15	3.36	1.00	3.07	0.15	0.00	0.00	0.32
5	g	e3	0.20	0.00	0.20	1.50	0.00	1.50	0.30	0.00	0.00	0.57
5	g	e4	0.00	0.00	0.00	1.46	1.00	1.28	0.55	0.00	1.00	0.63
6	cc	a6	0.16	0.16	0.00	3.96	2.00	3.64	0.16	0.00	0.00	0.30
6	cc	c1	0.00	0.00	0.00	0.28	0.00	0.28	0.00	0.00	0.00	0.00
6	cc	c7	0.70	0.42	0.28	1.13	2.00	0.84	0.28	0.00	0.00	0.60
6	cc	d5	0.28	0.00	0.28	0.70	0.00	0.70	0.00	0.00	0.00	0.00
6	g	a3	0.28	0.00	0.28	0.28	0.00	0.28	0.00	0.00	0.00	0.00
6	g	b4	0.00	0.00	0.00	0.43	1.00	0.29	0.00	0.00	0.00	0.00
6	g	b7	1.15	0.70	0.45	2.55	13.00	2.12	0.35	0.00	1.00	0.60
6	g	c2	0.07	0.07	0.00	0.29	0.00	0.29	0.04	0.00	0.00	0.07
6	g	c6	0.14	0.00	0.14	0.56	1.00	0.56	0.14	0.00	0.00	0.30
6	g	d6	0.28	0.11	0.18	4.20	3.00	3.78	0.32	0.00	0.00	0.63
6	g	e4	0.46	0.42	0.04	1.29	5.00	1.01	0.42	0.00	0.00	0.82
7	cc	b3	0.14	0.14	0.00	0.41	0.00	0.41	0.00	0.00	0.00	0.00
7	cc	b5	0.41	0.41	0.00	1.09	0.00	1.09	0.14	0.00	1.00	0.00
7	cc	d5	0.55	0.55	0.00	0.41	0.00	0.41	0.00	0.00	0.00	0.00
7	cc	f3	0.28	0.14	0.14	0.84	0.00	0.84	0.00	0.00	0.00	0.00
7	g	b2	0.61	0.61	0.00	1.52	0.00	1.52	0.00	0.00	0.00	0.00
7	g	b4	0.45	0.36	0.09	0.36	1.00	0.27	0.00	0.00	0.00	0.00
7	g	b7	0.44	0.44	0.00	0.30	0.00	0.30	0.15	0.00	1.00	0.00
7	g	c7	0.28	0.28	0.00	0.76	2.00	0.62	0.14	0.00	2.00	0.00
7	g	d7	0.28	0.28	0.00	1.11	0.00	1.11	0.00	0.00	0.00	0.00

[1] BF = bullfrog, GF = green frog, PF = pickerel frog
[2] JUV = juveniles, MET = metamorphs, ADT = adults
[3] g = gap, cc = closed-canopy

Table E2. Continued.

Location			Species[1] (age-class)[2]									
RA	Plot Type[3]	Plot Label	BF	BF (JUV)	BF (MET)	GF	GF (JUV)	GF (MET)	PF	PF (ADT)	PF (JUV)	PF (MET)
7	g	f2	0.45	0.30	0.15	1.49	1.00	1.34	0.00	0.00	0.00	0.00
7	g	f4	0.13	0.13	0.00	0.52	0.00	0.52	0.19	0.00	1.00	0.28
7	g	f6	0.14	0.00	0.14	0.28	0.00	0.28	0.00	0.00	0.00	0.00
8	cc	b2	0.15	0.00	0.15	0.15	0.00	0.15	0.15	0.00	0.00	0.29
8	cc	d6	0.00	0.00	0.00	0.83	2.00	0.55	0.00	0.00	0.00	0.00
8	cc	e5	0.14	0.00	0.14	0.14	0.00	0.14	0.28	0.00	0.00	0.53
8	cc	g6	0.28	0.28	0.00	0.42	1.00	0.28	0.00	0.00	0.00	0.00
8	g	b8	0.09	0.00	0.09	1.13	0.00	1.13	0.09	0.00	0.00	0.16
8	g	c1	0.28	0.09	0.18	0.18	0.00	0.18	0.18	0.00	0.00	0.33
8	g	c2	0.00	0.00	0.00	0.42	0.00	0.42	0.70	0.00	1.00	1.09
8	g	d3	0.00	0.00	0.00	0.95	0.00	0.95	0.95	1.00	1.00	0.81
8	g	d4	0.12	0.12	0.00	1.49	0.00	1.49	1.24	0.00	0.00	2.13
8	g	d5	0.00	0.00	0.00	0.49	0.00	0.49	0.49	0.00	1.00	0.65
8	g	e3	0.30	0.15	0.15	0.30	0.00	0.30	0.30	0.00	0.00	0.53
8	g	e6	0.00	0.00	0.00	0.70	0.00	0.70	1.11	0.00	2.00	1.62
9	cc	az8	0.00	0.00	0.00	0.96	0.00	0.96	0.14	0.00	0.00	0.26
9	cc	f5	0.14	0.14	0.00	0.42	0.00	0.42	0.00	0.00	0.00	0.00
9	cc	y4	0.00	0.00	0.00	0.41	0.00	0.41	0.00	0.00	0.00	0.00
9	cc	y7	0.00	0.00	0.00	0.83	0.00	0.83	0.00	0.00	0.00	0.00
9	g	a8	0.00	0.00	0.00	0.60	0.00	0.60	0.00	0.00	0.00	0.00
9	g	b8	0.10	0.10	0.00	0.14	0.00	0.14	0.05	0.00	0.00	0.09
9	g	c4	0.28	0.14	0.14	0.00	0.00	0.00	0.41	0.00	0.00	0.79
9	g	c6	0.15	0.15	0.00	0.99	0.00	0.99	0.00	0.00	0.00	0.00
9	g	e4	0.00	0.00	0.00	0.85	0.00	0.85	0.14	0.00	0.00	0.27
9	g	z5	0.42	0.42	0.00	0.28	0.00	0.28	0.00	0.00	0.00	0.00
9	g	z8	0.05	0.00	0.05	0.42	0.00	0.42	0.00	0.00	0.00	0.00

[1] BF = bullfrog, GF = green frog, PF = pickerel frog
[2] JUV = juveniles, MET = metamorphs, ADT = adults
[3] g = gap, cc = closed-canopy

Table E2. Continued.

Location			Species[1] (age-class)[2]				
RA	Plot Type[3]	Plot Label	LF	MF	WF	WF (JAD)	WF (MET)
1	cc	f2	0.00	0.13	0.00	0.00	0.00
1	cc	h4	0.00	0.00	0.14	0.14	0.00
1	cc	i5	0.00	0.00	0.00	0.00	0.00
1	cc	j3	0.00	0.00	0.13	0.13	0.00
1	g	e3	0.00	0.00	0.14	0.14	0.00
1	g	g2	0.00	0.00	0.14	0.14	0.00
1	g	g5	0.05	0.00	0.24	0.24	0.00
1	g	h7	0.05	0.05	0.10	0.10	0.00
1	g	i3	0.00	0.00	0.19	0.14	0.09
1	g	j2	0.00	0.00	0.00	0.00	0.00
1	g	j4	0.05	0.10	0.05	0.00	0.08
1	g	j5	0.00	0.00	0.13	0.13	0.00
2	cc	c3	0.00	0.14	0.00	0.00	0.00
2	cc	d3	0.00	0.00	0.00	0.00	0.00
2	cc	i4	0.00	0.00	0.14	0.14	0.00
2	cc	j5	0.00	0.00	0.00	0.00	0.00
2	g	c4	0.00	0.00	0.48	0.43	0.08
2	g	d2	0.09	0.09	0.00	0.00	0.00
2	g	f3	0.00	0.13	0.13	0.13	0.00
2	g	f4	0.00	0.00	0.40	0.40	0.00
2	g	g4	0.00	0.00	0.00	0.00	0.00
2	g	k3	0.00	0.00	0.00	0.00	0.00
2	g	k4	0.00	0.13	0.13	0.13	0.00
3	cc	a2	0.00	0.00	0.14	0.00	0.27
3	cc	d5	0.00	0.14	0.14	0.00	0.26
3	cc	e2	0.00	0.00	0.13	0.13	0.00
3	cc	g4	0.00	0.00	0.14	0.14	0.00
3	g	a3	0.00	0.00	0.06	0.06	0.00
3	g	c4	0.00	0.00	0.00	0.00	0.00
3	g	d4	0.00	0.14	0.14	0.14	0.00
3	g	e3	0.00	0.14	0.27	0.27	0.00
3	g	e4	0.14	0.00	0.14	0.14	0.00
3	g	j2	0.00	0.00	0.00	0.00	0.00
3	g	j4	0.00	0.00	0.25	0.17	0.16

[1] LF = northern leopard frog, MF = mink frog, WF = wood frog

[2] JAD = juveniles and adults, MET = metamorphs

[3] g = gap, cc = closed-canopy

Table E2. Continued.

Location			Species[1] (age-class)[2]				
RA	Plot Type[3]	Plot Label	LF	MF	WF	WF (JAD)	WF (MET)
4	cc	a5	0.00	0.00	0.70	0.42	0.55
4	cc	b4	0.00	0.14	0.28	0.00	0.55
4	cc	b7	0.00	0.42	0.42	0.42	0.00
4	cc	c3	0.00	0.00	0.14	0.14	0.00
4	g	a7	0.00	0.56	0.28	0.28	0.00
4	g	c8	0.00	0.28	0.28	0.14	0.27
4	g	d4	0.00	0.28	0.00	0.00	0.00
4	g	d5	0.00	0.14	0.00	0.00	0.00
5	cc	b4	0.00	0.14	0.14	0.00	0.31
5	cc	d4	0.00	0.00	0.43	0.00	0.94
5	cc	e5	0.00	0.00	0.00	0.00	0.00
5	cc	ef3	0.14	0.00	0.43	0.29	0.31
5	g	a8	0.14	0.00	0.29	0.00	0.63
5	g	b2	0.00	0.06	0.38	0.25	0.27
5	g	b5	0.13	0.07	0.33	0.00	0.67
5	g	c2	0.00	0.00	0.16	0.00	0.31
5	g	d7	0.00	0.15	0.44	0.00	0.96
5	g	e3	0.10	0.00	0.30	0.10	0.38
5	g	e4	0.00	0.00	0.36	0.18	0.31
6	cc	a6	0.00	0.00	0.32	0.16	0.00
6	cc	c1	0.00	0.00	0.28	0.28	0.00
6	cc	c7	0.00	0.00	0.00	0.00	0.00
6	cc	d5	0.00	0.00	0.14	0.14	0.00
6	g	a3	0.00	0.00	0.00	0.00	0.00
6	g	b4	0.00	0.00	0.00	0.00	0.00
6	g	b7	0.05	0.30	0.60	0.15	0.90
6	g	c2	0.00	0.00	0.00	0.00	0.00
6	g	c6	0.00	0.00	0.00	0.00	0.00
6	g	d6	0.04	0.00	0.11	0.04	0.14
6	g	e4	0.04	0.00	0.21	0.21	0.00
7	cc	b3	0.00	0.00	0.41	0.27	0.33
7	cc	b5	0.00	0.96	0.41	0.27	0.33
7	cc	d5	0.00	0.00	0.68	0.41	0.65
7	cc	f3	0.00	0.00	0.70	0.28	1.01
7	g	b2	0.10	0.20	0.81	0.30	0.98
7	g	b4	0.09	0.27	0.27	0.09	0.42
7	g	b7	0.00	0.00	0.00	0.00	0.00
7	g	c7	0.21	0.28	0.42	0.14	0.59
7	g	d7	0.28	0.00	0.42	0.14	0.67

[1] LF = northern leopard frog, MF = mink frog, WF = wood frog
[2] JAD = juveniles and adults, MET = metamorphs
[3] g = gap, cc = closed-canopy

Table E2. Continued.

Location			Species[1] (age-class)[2]				
RA	Plot Type[3]	Plot Label	LF	MF	WF	WF (JAD)	WF (MET)
7	g	f2	0.00	0.30	0.60	0.45	0.34
7	g	f4	0.06	0.06	0.91	0.19	1.54
7	g	f6	0.00	0.28	0.00	0.00	0.00
8	cc	b2	0.00	0.15	0.15	0.00	0.29
8	cc	d6	0.00	0.14	0.00	0.00	0.00
8	cc	e5	0.00	0.00	0.00	0.00	0.00
8	cc	g6	0.00	0.14	0.00	0.00	0.00
8	g	b8	0.00	0.09	0.00	0.00	0.00
8	g	c1	0.00	0.28	0.00	0.00	0.00
8	g	c2	0.00	0.14	0.00	0.00	0.00
8	g	d3	0.00	0.00	0.00	0.00	0.00
8	g	d4	0.00	0.00	0.25	0.12	0.21
8	g	d5	0.00	0.00	0.10	0.10	0.00
8	g	e3	0.15	0.00	0.15	0.00	0.26
8	g	e6	0.14	0.00	0.00	0.00	0.00
9	cc	az8	0.28	0.00	0.41	0.14	0.53
9	cc	f5	0.28	0.00	0.56	0.14	0.79
9	cc	y4	0.00	0.00	0.28	0.00	0.53
9	cc	y7	0.00	0.00	0.00	0.00	0.00
9	g	a8	0.09	0.00	0.26	0.00	0.48
9	g	b8	0.20	0.00	0.25	0.00	0.44
9	g	c4	0.00	0.00	0.41	0.14	0.53
9	g	c6	0.15	0.00	0.10	0.05	0.09
9	g	e4	0.42	0.00	0.56	0.28	0.54
9	g	z5	0.00	0.00	0.28	0.14	0.27
9	g	z8	0.15	0.00	0.39	0.05	0.62

[1] LF = northern leopard frog, MF = mink frog, WF = wood frog
[2] JAD = juveniles and adults, MET = metamorphs
[3] g = gap, cc = closed-canopy

Table E3. Capture rates (captures/100 TN) for each plot (gap or closed-canopy) for salamanders captured in the Penobscot Experimental Forest in 2003.

Location			Species[1] (age-class)[2]							
RA	Plot Type[3]	Plot Label	BS	SS	SS (JAD)	SS (MET)	EN	RB	RB (ADT)	RB (IMM)
1	fc	f2	0.00	1.37	0.73	1.32	0.46	0.09	0.09	0.00
1	fc	h4	0.00	0.55	0.46	0.19	0.64	0.64	0.55	0.09
1	fc	i5	0.00	0.90	0.90	0.00	0.72	0.09	0.00	0.09
1	fc	j3	0.00	1.08	0.72	0.74	0.99	0.54	0.18	0.36
1	g	e3	0.00	0.74	0.28	0.96	0.28	0.93	0.74	0.19
1	g	g2	0.00	0.09	0.00	0.19	0.27	0.00	0.00	0.00
1	g	g5	0.00	0.31	0.31	0.00	0.52	0.34	0.28	0.06
1	g	h7	0.00	0.99	0.93	0.13	0.90	0.31	0.19	0.12
1	g	i3	0.00	0.37	0.37	0.00	0.25	0.59	0.55	0.03
1	g	j2	0.00	0.28	0.28	0.00	0.18	0.83	0.65	0.18
1	g	j4	0.00	0.24	0.24	0.00	0.30	0.15	0.12	0.03
1	g	j5	0.00	0.36	0.36	0.00	0.27	0.27	0.27	0.00
2	fc	c3	0.00	1.46	0.82	1.32	0.91	0.27	0.27	0.00
2	fc	d3	0.09	1.19	0.55	1.32	0.73	0.09	0.09	0.00
2	fc	i4	0.00	0.56	0.37	0.39	1.11	1.11	0.83	0.28
2	fc	j5	0.00	0.28	0.18	0.19	0.55	0.18	0.18	0.00
2	g	c4	0.03	0.84	0.25	1.22	0.40	0.28	0.16	0.12
2	g	d2	0.00	1.13	0.74	0.82	0.51	0.06	0.06	0.00
2	g	f3	0.00	0.18	0.18	0.00	0.18	0.09	0.00	0.09
2	g	f4	0.00	0.28	0.00	0.58	0.37	0.19	0.19	0.00
2	g	g4	0.00	0.16	0.16	0.00	0.22	0.33	0.27	0.05
2	g	k3	0.00	0.19	0.16	0.08	0.58	0.23	0.16	0.08
2	g	k4	0.00	0.27	0.27	0.00	0.73	0.36	0.36	0.00
3	fc	a2	0.00	0.36	0.36	0.00	0.36	0.36	0.18	0.18
3	fc	d5	0.09	0.00	0.00	0.00	0.38	0.09	0.09	0.00
3	fc	e2	0.00	1.60	1.22	0.76	0.75	0.38	0.38	0.00
3	fc	g4	0.00	1.40	0.84	1.17	1.21	0.28	0.28	0.00
3	g	a3	0.00	0.86	0.39	0.97	0.43	0.66	0.54	0.12
3	g	c4	0.00	0.73	0.36	0.75	0.82	0.00	0.00	0.00
3	g	d4	0.00	1.01	0.55	0.96	0.65	0.18	0.18	0.00
3	g	e3	0.00	1.00	0.45	1.13	1.00	0.09	0.00	0.09

[1] BS = blue-spotted salamander, SS = spotted salamander, EN = eastern newt, RB = eastern red-backed salamander

[2] JAD = juveniles and adults, MET = metamorphs, ADT = adults, IMM = immatures

[3] g = gap, cc = closed-canopy

Table E3. Continued.

Location			Species[1] (age-class) [2]							
RA	Plot Type[3]	Plot Label	BS	SS	SS (JAD)	SS (MET)	EN	RB	RB (ADT)	RB (IMM)
3	g	e4	0.00	1.47	0.64	1.71	0.64	0.18	0.18	0.00
3	g	j2	0.00	0.89	0.89	0.00	2.77	1.16	0.67	0.50
3	g	j4	0.00	0.55	0.44	0.23	1.21	0.17	0.11	0.06
4	fc	a5	0.09	1.59	0.56	2.14	1.21	0.09	0.09	0.00
4	fc	b4	0.00	1.30	0.75	1.15	0.84	0.47	0.37	0.09
4	fc	b7	0.00	0.96	0.48	0.98	0.19	0.00	0.00	0.00
4	fc	c3	0.00	9.11	2.55	13.48	6.56	1.64	1.46	0.18
4	g	a7	0.09	0.73	0.09	1.31	0.37	0.00	0.00	0.00
4	g	c8	0.00	1.11	0.56	1.15	0.28	0.00	0.00	0.00
4	g	d4	0.00	7.84	1.49	13.15	8.49	0.28	0.09	0.19
4	g	d5	0.00	3.19	0.64	5.24	1.09	0.00	0.00	0.00
5	fc	b4	0.09	3.12	1.19	4.18	1.47	0.28	0.28	0.00
5	fc	d4	0.09	7.26	2.00	11.42	2.99	0.27	0.18	0.09
5	fc	e5	0.27	3.91	1.82	4.55	1.27	1.18	0.91	0.27
5	fc	ef3	0.27	6.20	1.28	10.67	3.10	0.82	0.55	0.27
5	g	a8	0.19	3.64	2.05	3.46	2.71	1.31	1.03	0.28
5	g	b2	0.12	1.29	0.82	1.02	1.57	0.39	0.31	0.08
5	g	b5	0.23	3.79	1.96	4.02	1.41	0.94	0.78	0.16
5	g	c2	0.16	1.28	0.73	1.22	3.57	0.73	0.64	0.09
5	g	d7	0.46	2.37	0.85	3.14	0.76	1.42	0.76	0.66
5	g	e3	0.00	1.27	0.69	1.22	1.50	1.16	0.92	0.23
5	g	e4	0.00	0.23	0.00	0.44	0.23	0.00	0.00	0.00
6	fc	a6	0.30	4.27	0.99	6.75	0.89	0.60	0.50	0.10
6	fc	c1	0.00	5.09	0.38	9.90	0.75	2.07	1.51	0.57
6	fc	c7	0.36	5.89	1.36	9.61	0.91	0.45	0.18	0.27
6	fc	d5	0.27	6.02	0.55	11.76	2.10	0.46	0.46	0.00
6	g	a3	0.28	1.59	0.56	2.25	0.00	0.19	0.19	0.00
6	g	b4	0.00	1.25	0.00	2.71	0.86	0.00	0.00	0.00
6	g	b7	0.03	4.16	1.94	4.86	0.49	0.46	0.43	0.03
6	g	c2	0.11	1.48	0.34	2.49	0.68	0.40	0.30	0.11
6	g	c6	0.00	4.82	1.55	7.11	1.18	0.36	0.27	0.09
6	g	d6	0.13	5.54	0.78	10.38	1.97	0.11	0.06	0.04
6	g	e4	0.03	3.86	0.53	7.26	1.22	0.41	0.23	0.18
7	fc	b3	0.00	0.64	0.55	0.19	0.09	0.64	0.64	0.00
7	fc	b5	0.00	0.56	0.47	0.20	0.19	0.75	0.65	0.09
7	fc	d5	0.00	1.11	0.93	0.39	0.28	0.37	0.28	0.09
7	fc	f3	0.00	0.46	0.37	0.19	0.00	0.83	0.65	0.18

[1] BS = blue-spotted salamander, SS = spotted salamander, EN = eastern newt, RB = eastern red-backed salamander

[2] JAD = juveniles and adults, MET = metamorphs, ADT = adults, IMM = immatures

[3] g = gap, cc = closed-canopy

Table E3. Continued.

Location			Species[1] (age-class) [2]							
RA	Plot Type[3]	Plot Label	BS	SS	SS (JAD)	SS (MET)	EN	RB	RB (ADT)	RB (IMM)
7	g	b2	0.00	0.46	0.39	0.12	0.07	1.25	0.85	0.33
7	g	b4	0.12	0.12	0.12	0.00	0.18	0.36	0.24	0.12
7	g	b7	0.00	0.10	0.00	0.20	0.00	0.60	0.50	0.10
7	g	c7	0.13	0.18	0.13	0.09	0.09	0.84	0.58	0.27
7	g	d7	0.00	0.19	0.19	0.00	0.19	0.68	0.58	0.10
7	g	f2	0.00	0.30	0.20	0.20	1.00	0.70	0.60	0.10
7	g	f4	0.12	0.48	0.32	0.34	0.20	1.28	1.08	0.20
7	g	f6	0.09	0.28	0.19	0.20	0.19	0.09	0.09	0.00
8	fc	b2	0.00	1.15	1.06	0.21	0.58	0.10	0.10	0.00
8	fc	d6	0.10	0.39	0.39	0.00	1.45	0.77	0.48	0.29
8	fc	e5	0.00	1.01	1.01	0.00	0.50	1.41	0.91	0.50
8	fc	g6	0.00	0.59	0.49	0.21	1.07	0.49	0.39	0.10
8	g	b8	0.00	1.25	0.96	0.61	1.25	0.11	0.11	0.00
8	g	c1	0.00	0.60	0.40	0.41	1.13	0.07	0.07	0.00
8	g	c2	0.10	0.39	0.30	0.22	1.48	0.49	0.49	0.00
8	g	d3	0.00	0.15	0.00	0.28	0.73	0.15	0.00	0.00
8	g	d4	0.08	0.92	0.83	0.15	0.83	0.50	0.25	0.25
8	g	d5	0.00	0.66	0.66	0.00	0.60	0.72	0.60	0.12
8	g	e3	0.00	0.68	0.68	0.00	0.49	0.87	0.49	0.39
8	g	e6	0.00	0.38	0.38	0.00	0.38	0.09	0.00	0.09
9	fc	az8	0.00	0.46	0.37	0.19	0.27	0.37	0.18	0.09
9	fc	f5	0.09	0.73	0.73	0.00	1.46	0.37	0.27	0.09
9	fc	y4	0.00	1.18	1.00	0.37	0.09	0.09	0.09	0.00
9	fc	y7	0.00	0.46	0.46	0.00	0.83	0.00	0.00	0.00
9	g	a8	0.00	0.22	0.17	0.12	0.50	0.17	0.17	0.00
9	g	b8	0.03	0.28	0.28	0.00	0.63	0.41	0.28	0.13
9	g	c4	0.19	0.19	0.19	0.00	0.93	0.37	0.37	0.00
9	g	c6	0.00	0.15	0.15	0.00	0.55	0.12	0.06	0.06
9	g	e4	0.00	0.67	0.67	0.00	1.15	1.34	1.15	0.19
9	g	z5	0.00	0.28	0.19	0.20	0.75	0.75	0.66	0.09
9	g	z8	0.00	0.22	0.22	0.00	0.43	0.31	0.22	0.09

[1] BS = blue-spotted salamander, SS = spotted salamander, EN = eastern newt, RB = eastern red-backed salamander

[2] JAD = juveniles and adults, MET = metamorphs, ADT = adults, IMM = immatures

[3] g = gap, cc = closed-canopy

Table E4. Capture rates (captures/100 TN) for each plot (gap or closed-canopy) for anurans captured in the Penobscot Experimental Forest in 2003.

Location			Species[1] (age-class)[2]									
RA	Plot Type[3]	Plot Label	BF	BF (JUV)	BF (MET)	GF	GF (JUV)	GF (MET)	PF	PF (ADT)	PF (JUV)	PF (MET)
1	fc	f2	0.27	0.09	0.18	0.27	0.00	0.27	0.00	0.00	0.00	0.00
1	fc	h4	0.46	0.18	0.28	0.73	0.00	0.73	0.09	0.00	0.00	0.16
1	fc	i5	0.54	0.09	0.45	0.90	0.09	0.81	0.00	0.00	0.00	0.00
1	fc	j3	0.99	0.63	0.36	1.26	0.36	0.90	0.72	0.00	0.36	0.62
1	g	e3	0.00	0.00	0.00	0.47	0.00	0.37	0.19	1.00	0.00	0.16
1	g	g2	0.18	0.09	0.09	0.27	0.00	0.18	0.00	0.00	0.00	0.00
1	g	g5	0.34	0.18	0.15	0.75	0.00	0.75	0.31	0.00	0.03	0.47
1	g	h7	0.53	0.22	0.28	0.39	0.00	0.39	0.00	0.00	0.00	0.00
1	g	i3	0.25	0.03	0.22	0.57	0.09	0.47	0.00	0.00	0.00	0.00
1	g	j2	0.00	0.00	0.00	0.09	0.00	0.09	0.00	0.00	0.00	0.00
1	g	j4	0.27	0.12	0.15	0.64	0.00	0.64	0.52	0.00	0.24	0.37
1	g	j5	0.18	0.09	0.09	0.00	0.00	0.00	0.09	0.00	0.00	0.15
2	fc	c3	0.36	0.00	0.36	0.09	0.00	0.09	0.09	0.00	0.00	0.16
2	fc	d3	0.18	0.18	0.00	0.37	0.09	0.27	0.00	0.00	0.00	0.00
2	fc	i4	0.19	0.19	0.00	0.28	0.09	0.19	0.00	0.00	0.00	0.00
2	fc	j5	0.09	0.09	0.00	0.65	0.00	0.65	0.00	0.00	0.00	0.00
2	g	c4	0.09	0.06	0.03	0.40	0.03	0.34	0.09	0.00	0.03	0.11
2	g	d2	0.06	0.00	0.06	0.45	0.00	0.45	0.06	0.00	0.06	0.00
2	g	f3	0.00	0.00	0.00	0.18	0.00	0.18	0.00	0.00	0.00	0.00
2	g	f4	0.09	0.09	0.00	0.84	0.09	0.74	0.09	0.00	0.00	0.17
2	g	g4	0.05	0.05	0.00	0.22	0.00	0.22	0.00	0.00	0.00	0.00
2	g	k3	0.08	0.04	0.04	0.08	0.04	0.04	0.04	0.00	0.00	0.07
2	g	k4	0.46	0.27	0.18	0.55	0.00	0.55	0.18	0.00	0.18	0.00
3	fc	a2	0.09	0.09	0.00	0.27	0.00	0.27	0.00	0.00	0.00	0.00
3	fc	d5	0.19	0.09	0.09	0.19	0.00	0.19	0.19	0.00	0.09	0.17
3	fc	e2	0.19	0.09	0.09	0.75	0.00	0.75	0.09	0.00	0.00	0.17
3	fc	g4	0.37	0.09	0.19	0.47	0.09	0.37	0.09	0.00	0.09	0.00
3	g	a3	0.12	0.08	0.04	0.31	0.00	0.31	0.00	0.00	0.00	0.00
3	g	c4	0.18	0.18	0.00	0.27	0.00	0.27	0.00	0.00	0.00	0.00
3	g	d4	0.37	0.00	0.37	0.74	0.18	0.55	0.18	0.00	0.09	0.17
3	g	e3	0.27	0.09	0.18	0.73	0.00	0.73	0.00	0.00	0.00	0.00
3	g	e4	0.46	0.27	0.18	0.27	0.00	0.27	0.09	0.00	0.00	0.17
3	g	j2	0.44	0.11	0.33	1.39	0.11	1.28	0.00	0.00	0.00	0.00
3	g	j4	0.22	0.06	0.17	0.94	0.06	0.88	0.17	0.00	0.11	0.10

[1] BF = bullfrog, GF = green frog, PF = pickerel frog
[2] JUV = juveniles, MET = metamorphs, ADT = adults
[3] g = gap, cc = closed-canopy

Table E4. Continued.

Location			Species[1] (age-class)[2]									
RA	Plot Type[3]	Plot Label	BF	BF (JUV)	BF (MET)	GF	GF (JUV)	GF (MET)	PF	PF (ADT)	PF (JUV)	PF (MET)
4	fc	a5	0.56	0.28	0.28	1.12	0.00	1.12	0.09	0.00	0.00	0.17
4	fc	b4	0.37	0.19	0.19	1.58	0.09	1.49	0.28	0.00	0.09	0.34
4	fc	b7	0.29	0.10	0.19	2.21	0.38	1.73	0.10	0.00	0.00	0.17
4	fc	c3	0.55	0.09	0.46	2.46	0.36	2.09	0.00	0.00	0.00	0.00
4	g	a7	0.55	0.09	0.46	0.73	0.09	0.64	0.18	0.00	0.09	0.00
4	g	c8	0.28	0.19	0.09	1.20	0.28	0.93	0.28	1.00	0.09	0.17
4	g	d4	0.84	0.28	0.56	2.89	0.28	2.61	0.00	0.00	0.00	0.00
4	g	d5	0.82	0.46	0.36	2.09	0.09	2.00	0.09	0.00	0.00	0.17
5	fc	b4	0.09	0.09	0.00	1.74	0.00	1.74	0.18	0.00	0.00	0.33
5	fc	d4	0.00	0.00	0.00	2.81	0.27	2.54	0.00	0.00	0.00	0.00
5	fc	e5	0.36	0.27	0.09	2.55	0.00	2.55	0.09	0.00	0.00	0.17
5	fc	ef3	0.36	0.00	0.36	4.10	0.36	3.74	0.46	0.00	0.00	0.83
5	g	a8	0.28	0.19	0.09	2.71	0.09	2.52	0.56	0.00	0.09	0.85
5	g	b2	0.08	0.00	0.08	2.67	0.27	2.39	0.35	0.00	0.00	0.64
5	g	b5	0.16	0.08	0.08	2.82	0.39	2.39	0.27	0.00	0.04	0.43
5	g	c2	0.00	0.00	0.00	2.93	0.00	2.93	0.18	0.00	0.00	0.34
5	g	d7	0.28	0.19	0.09	2.46	0.00	2.46	1.23	0.00	0.47	1.32
5	g	e3	0.17	0.00	0.17	2.43	0.40	2.02	0.75	0.00	0.06	1.23
5	g	e4	0.23	0.12	0.12	1.75	0.12	1.63	0.93	0.00	0.12	1.28
6	fc	a6	1.09	0.79	0.30	2.58	0.20	2.38	0.10	0.00	0.00	0.17
6	fc	c1	0.57	0.09	0.28	2.83	0.09	2.73	0.19	0.00	0.00	0.36
6	fc	c7	1.00	0.54	0.45	2.63	0.36	2.26	0.36	0.00	0.00	0.66
6	fc	d5	0.36	0.09	0.27	1.82	0.18	1.64	0.09	0.00	0.00	0.17
6	g	a3	0.00	0.00	0.00	1.78	0.19	1.59	0.09	0.00	0.00	0.17
6	g	b4	0.10	0.10	0.00	0.67	0.00	0.67	0.29	0.00	0.10	0.35
6	g	b7	0.99	0.59	0.40	2.32	0.46	1.86	0.77	0.00	0.00	1.41
6	g	c2	0.06	0.02	0.04	0.55	0.09	0.46	0.00	0.00	0.00	0.00
6	g	c6	0.45	0.36	0.09	0.82	0.00	0.64	0.27	0.00	0.00	0.50
6	g	d6	0.42	0.19	0.23	1.01	0.00	0.82	0.49	0.00	0.11	0.62
6	g	e4	0.30	0.18	0.13	1.63	0.10	1.53	0.36	0.00	0.08	0.46
7	fc	b3	0.46	0.00	0.46	0.92	0.00	0.92	0.00	0.00	0.00	0.00
7	fc	b5	0.09	0.00	0.09	1.03	0.00	1.03	0.00	0.00	0.00	0.00
7	fc	d5	0.37	0.09	0.28	1.76	0.00	1.67	0.00	0.00	0.00	0.00
7	fc	f3	0.18	0.09	0.09	1.20	0.00	1.20	0.09	0.00	0.00	0.17
7	g	b2	0.66	0.20	0.46	1.12	0.00	1.12	0.33	1.00	0.00	0.43
7	g	b4	0.18	0.12	0.06	0.89	0.18	0.66	0.00	0.00	0.00	0.00
7	g	b7	0.50	0.30	0.20	0.80	0.00	0.70	0.00	0.00	0.00	0.00
7	g	c7	0.04	0.04	0.00	1.16	0.09	1.07	0.22	0.00	0.13	0.16
7	g	d7	0.29	0.10	0.00	1.07	0.00	1.07	0.29	0.00	0.00	0.53

[1] BF = bullfrog, GF = green frog, PF = pickerel frog
[2] JUV = juveniles, MET = metamorphs, ADT = adults
[3] g = gap, cc = closed-canopy

Table E4. Continued.

Location			Species[1] (age-class)[2]									
RA	Plot Type[3]	Plot Label	BF	BF (JUV)	BF (MET)	GF	GF (JUV)	GF (MET)	PF	PF (ADT)	PF (JUV)	PF (MET)
7	g	f2	0.30	0.20	0.10	1.60	0.00	1.60	0.10	0.00	0.00	0.17
7	g	f4	0.12	0.08	0.00	1.36	0.00	1.28	0.28	0.00	0.08	0.37
7	g	f6	0.19	0.09	0.09	1.04	0.00	1.04	0.09	0.00	0.00	0.17
8	fc	b2	0.19	0.00	0.19	1.54	0.00	1.54	0.29	0.00	0.10	0.37
8	fc	d6	0.39	0.00	0.29	0.87	0.19	0.68	0.19	0.00	0.00	0.37
8	fc	e5	0.81	0.40	0.40	0.61	0.00	0.50	0.20	0.00	0.10	0.18
8	fc	g6	0.49	0.10	0.39	1.56	0.10	1.37	0.10	0.00	0.00	0.19
8	g	b8	1.02	0.11	0.91	1.64	0.00	1.64	0.40	0.00	0.00	0.73
8	g	c1	0.40	0.00	0.40	1.39	0.20	1.19	0.33	1.00	0.00	0.46
8	g	c2	1.18	0.30	0.89	1.57	0.20	1.38	0.49	0.00	0.10	0.75
8	g	d3	0.44	0.00	0.44	2.93	0.44	2.49	3.81	0.00	0.15	5.71
8	g	d4	0.00	0.00	0.00	2.92	0.00	2.83	1.42	0.00	0.00	2.17
8	g	d5	0.54	0.12	0.42	1.26	0.00	1.26	0.90	0.00	0.12	1.39
8	g	e3	0.87	0.00	0.87	1.55	0.10	1.46	1.26	0.00	0.19	2.03
8	g	e6	0.09	0.00	0.09	0.38	0.09	0.28	0.47	0.00	0.09	0.71
9	fc	az8	1.10	0.92	0.18	6.32	0.18	6.14	0.09	0.00	0.00	0.17
9	fc	f5	1.10	0.73	0.37	6.94	0.00	6.94	0.09	0.00	0.09	0.00
9	fc	y4	0.72	0.63	0.09	4.62	0.00	4.62	0.00	0.00	0.00	0.00
9	fc	y7	0.65	0.56	0.09	4.35	0.09	4.26	0.09	0.00	0.00	0.17
9	g	a8	0.94	0.88	0.06	4.25	0.00	4.25	0.17	0.00	0.06	0.10
9	g	b8	0.28	0.22	0.06	4.63	0.00	4.54	0.09	0.00	0.00	0.17
9	g	c4	0.56	0.56	0.00	4.64	0.00	4.55	0.28	0.00	0.09	0.33
9	g	c6	0.68	0.55	0.12	3.33	0.00	3.23	0.03	0.00	0.00	0.06
9	g	e4	0.57	0.48	0.10	4.78	0.00	4.78	0.10	0.00	0.00	0.18
9	g	z5	0.66	0.37	0.28	3.37	0.00	3.37	0.19	0.00	0.09	0.17
9	g	z8	0.56	0.37	0.19	4.37	0.00	4.37	0.03	0.00	0.00	0.06

[1] BF = bullfrog, GF = green frog, PF = pickerel frog
[2] JUV = juveniles, MET = metamorphs, ADT = adults
[3] g = gap, cc = closed-canopy

Table E4. Continued.

Location			Species[1] (age-class) [2]				
RA	Plot Type[3]	Plot Label	LF	MF	WF	WF (JAD)	WF (MET)
1	fc	f2	0.00	0.00	0.82	0.09	1.27
1	fc	h4	0.00	0.00	1.01	0.09	1.59
1	fc	i5	0.00	0.00	0.90	0.00	1.54
1	fc	j3	0.00	0.18	1.17	0.27	1.54
1	g	e3	0.00	0.00	0.65	0.00	1.14
1	g	g2	0.00	0.00	0.46	0.00	0.79
1	g	g5	0.00	0.03	0.83	0.12	1.21
1	g	h7	0.03	0.00	0.46	0.06	0.69
1	g	i3	0.00	0.03	0.25	0.00	0.43
1	g	j2	0.00	0.00	0.46	0.09	0.64
1	g	j4	0.03	0.00	0.58	0.03	0.94
1	g	j5	0.09	0.00	0.27	0.00	0.46
2	fc	c3	0.00	0.00	0.73	0.18	0.98
2	fc	d3	0.00	0.00	0.55	0.00	0.99
2	fc	i4	0.00	0.00	0.28	0.00	0.51
2	fc	j5	0.00	0.00	0.46	0.09	0.67
2	g	c4	0.00	0.00	0.68	0.09	1.05
2	g	d2	0.00	0.06	0.28	0.11	0.31
2	g	f3	0.00	0.00	0.00	0.00	0.00
2	g	f4	0.00	0.00	0.19	0.09	0.17
2	g	g4	0.00	0.00	0.38	0.11	0.50
2	g	k3	0.00	0.00	0.27	0.00	0.49
2	g	k4	0.00	0.09	0.55	0.09	0.82
3	fc	a2	0.00	0.00	0.55	0.00	0.98
3	fc	d5	0.00	0.00	0.09	0.00	0.17
3	fc	e2	0.09	0.00	0.75	0.19	0.99
3	fc	g4	0.00	0.00	0.56	0.19	0.68
3	g	a3	0.00	0.00	0.47	0.12	0.63
3	g	c4	0.00	0.00	0.27	0.18	0.16
3	g	d4	0.00	0.00	0.55	0.18	0.67
3	g	e3	0.00	0.00	0.55	0.09	0.82
3	g	e4	0.00	0.00	0.73	0.37	0.66
3	g	j2	0.00	0.00	0.33	0.06	0.50
3	g	j4	0.00	0.00	0.55	0.00	0.99

[1] LF = northern leopard frog, MF = mink frog, WF = wood frog
[2] JAD = juveniles and adults, MET = metamorphs
[3] g = gap, cc = closed-canopy

Table E4. Continued.

Location			Species[1] (age-class)[2]				
RA	Plot Type[3]	Plot Label	LF	MF	WF	WF (JAD)	WF (MET)
4	fc	a5	0.00	0.09	0.65	0.00	1.20
4	fc	b4	0.00	0.09	1.40	0.00	2.52
4	fc	b7	0.00	0.67	1.34	0.00	2.40
4	fc	c3	0.00	0.00	1.37	0.18	2.15
4	g	a7	0.00	0.28	0.46	0.09	0.67
4	g	c8	0.09	0.19	0.65	0.19	0.84
4	g	d4	0.00	0.19	0.65	0.09	1.03
4	g	d5	0.00	0.36	0.46	0.09	0.66
5	fc	b4	0.00	0.00	0.64	0.18	0.84
5	fc	d4	0.18	0.00	0.54	0.09	0.83
5	fc	e5	0.00	0.09	0.45	0.00	0.83
5	fc	ef3	0.09	0.00	1.00	0.36	1.16
5	g	a8	0.00	0.19	0.28	0.09	0.34
5	g	b2	0.08	0.00	0.98	0.20	1.43
5	g	b5	0.08	0.20	0.82	0.27	1.00
5	g	c2	0.04	0.00	0.46	0.09	0.68
5	g	d7	0.18	0.09	1.04	0.09	1.65
5	g	e3	0.06	0.00	0.98	0.23	1.33
5	g	e4	0.00	0.00	0.58	0.00	0.92
6	fc	a6	0.10	0.10	1.09	0.30	1.37
6	fc	c1	0.00	0.00	0.75	0.09	1.24
6	fc	c7	0.18	0.18	0.91	0.36	0.99
6	fc	d5	0.09	0.09	0.46	0.09	0.67
6	g	a3	0.00	0.09	0.00	0.00	0.00
6	g	b4	0.00	0.00	0.19	0.10	0.17
6	g	b7	0.00	0.15	0.37	0.22	0.28
6	g	c2	0.00	0.00	0.27	0.17	0.19
6	g	c6	0.00	0.00	0.09	0.00	0.17
6	g	d6	0.00	0.02	0.32	0.08	0.43
6	g	e4	0.03	0.00	0.41	0.18	0.42
7	fc	b3	0.00	0.09	1.10	0.09	1.85
7	fc	b5	0.00	0.09	1.40	0.00	2.57
7	fc	d5	0.09	0.09	1.48	0.28	2.21
7	fc	f3	0.09	0.00	1.29	0.09	2.19
7	g	b2	0.00	0.00	3.02	0.39	4.26
7	g	b4	0.06	0.00	1.61	0.12	2.68
7	g	b7	0.10	0.00	0.40	0.00	0.70
7	g	c7	0.00	0.13	1.64	0.13	2.70
7	g	d7	0.10	0.19	0.97	0.19	1.43

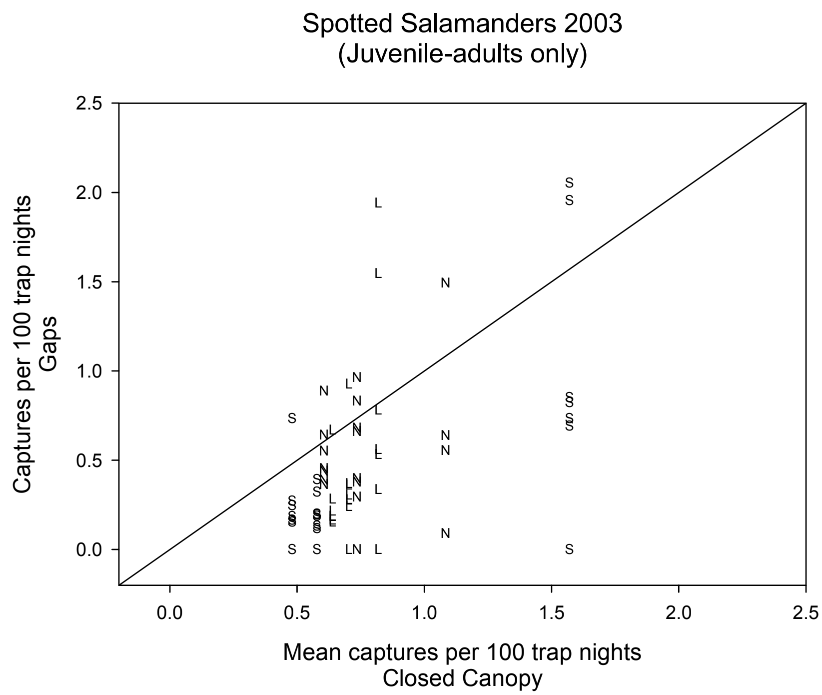
[1] LF = northern leopard frog, MF = mink frog, WF = wood frog
[2] JAD = juveniles and adults, MET = metamorphs
[3] g = gap, cc = closed-canopy

Table E4. Continued.

Location			Species[1] (age-class)[2]				
RA	Plot Type[3]	Plot Label	LF	MF	WF	WF (JAD)	WF (MET)
7	g	f2	0.00	0.10	2.81	0.80	3.47
7	g	f4	0.12	0.12	2.33	0.32	3.67
7	g	f6	0.00	0.00	1.23	0.09	2.07
8	fc	b2	0.00	0.19	0.00	0.00	0.00
8	fc	d6	0.00	0.00	0.00	0.00	0.00
8	fc	e5	0.00	0.00	0.10	0.00	0.18
8	fc	g6	0.00	0.00	0.10	0.00	0.19
8	g	b8	0.06	0.00	0.40	0.23	0.31
8	g	c1	0.13	0.13	0.07	0.00	0.12
8	g	c2	0.00	0.30	0.00	0.00	0.00
8	g	d3	0.29	0.00	0.15	0.15	0.00
8	g	d4	0.17	0.00	0.42	0.08	0.51
8	g	d5	0.06	0.00	0.30	0.12	0.32
8	g	e3	0.10	0.00	0.10	0.00	0.18
8	g	e6	0.00	0.09	0.09	0.00	0.18
9	fc	az8	1.56	0.00	0.64	0.09	1.00
9	fc	f5	1.92	0.00	0.73	0.18	1.00
9	fc	y4	0.91	0.00	0.27	0.09	0.33
9	fc	y7	2.04	0.00	0.19	0.00	0.34
9	g	a8	1.77	0.00	0.39	0.11	0.50
9	g	b8	0.81	0.00	0.09	0.03	0.12
9	g	c4	0.56	0.00	0.28	0.09	0.33
9	g	c6	0.80	0.00	0.12	0.06	0.11
9	g	e4	1.24	0.00	0.29	0.10	0.36
9	g	z5	1.12	0.00	0.09	0.00	0.17
9	g	z8	1.70	0.00	0.22	0.12	0.17

[1] LF = northern leopard frog, MF = mink frog, WF = wood frog
[2] JAD = juveniles and adults, MET = metamorphs
[3] g = gap, cc = closed-canopy

Figure E1. Capture rates (captures/100 TN) of each gap (L = large gap, S = small gap, N = natural gap) plotted against mean capture rates of closed-canopy plots for each research area.



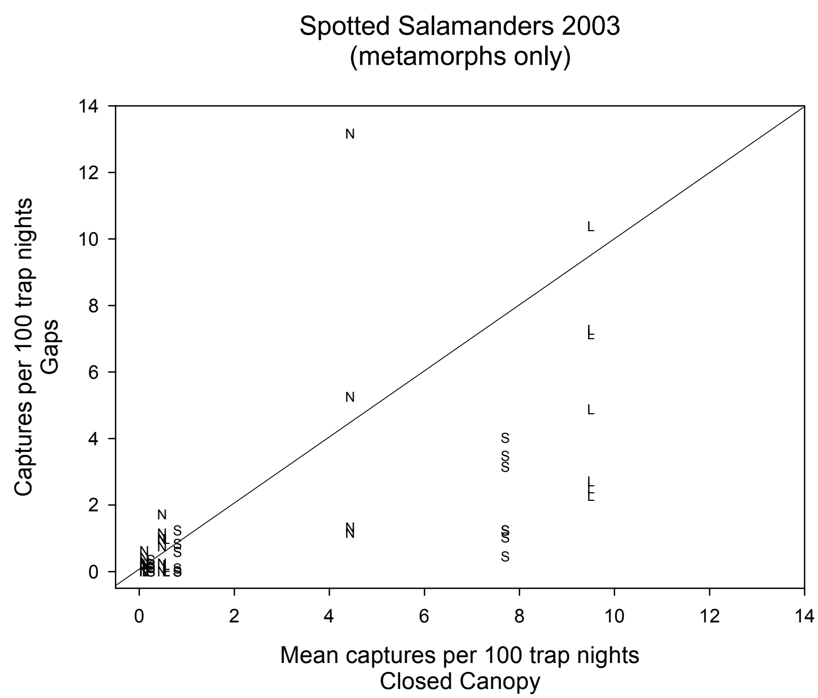
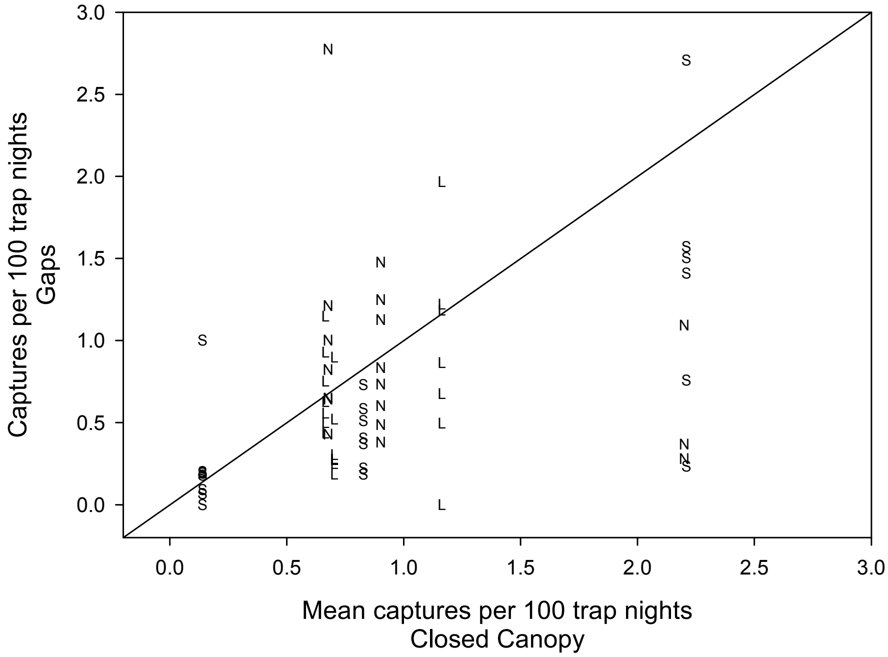


Figure E1 continued.

Eastern Newts 2003
(red eft stage)



Northern Redback Salamanders 2003
(adults)

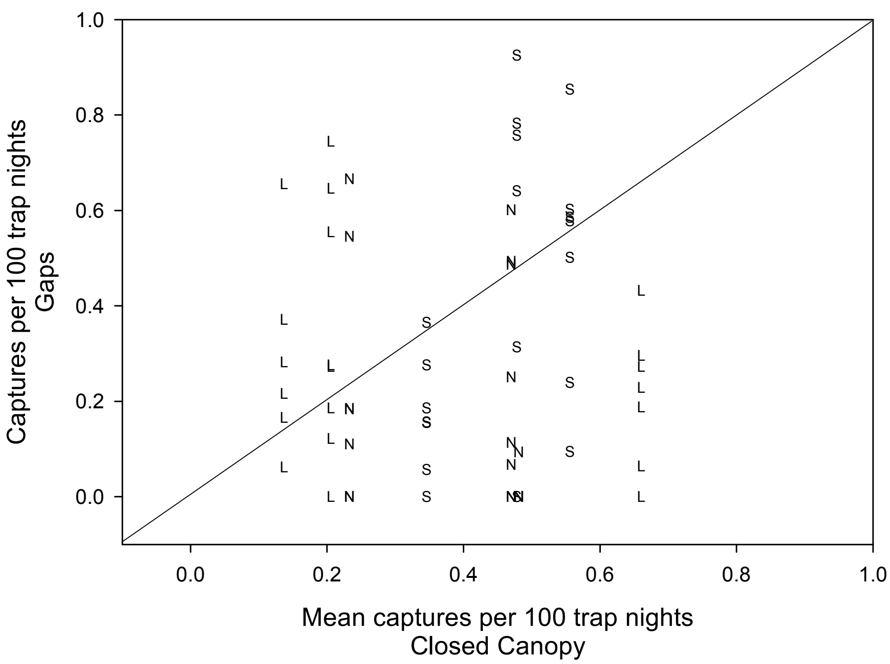
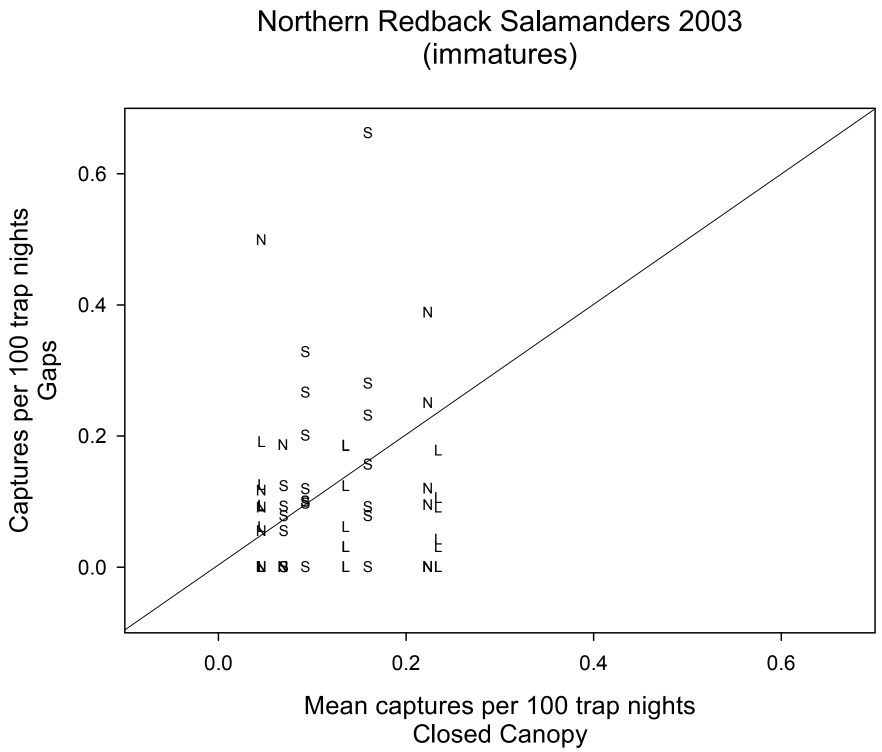


Figure E1 continued.



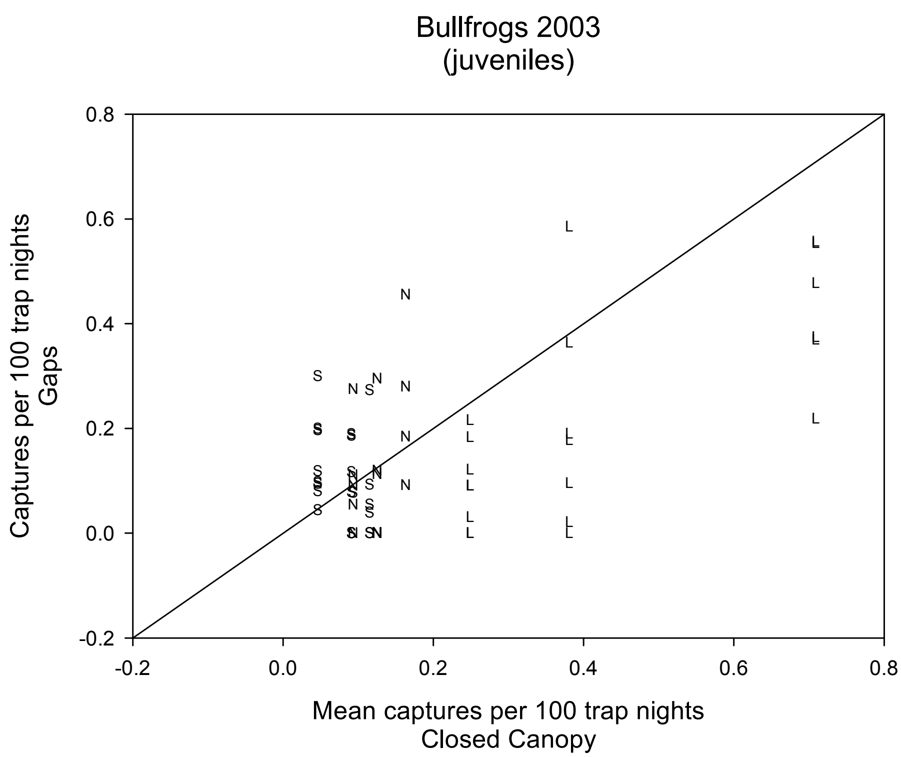
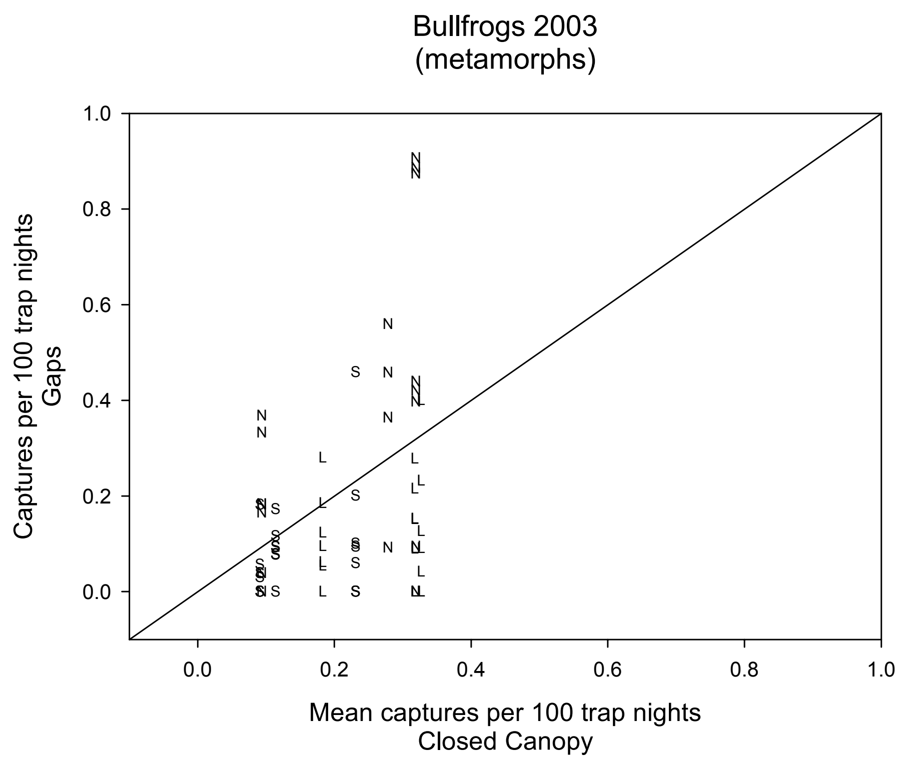


Figure E1 continued.



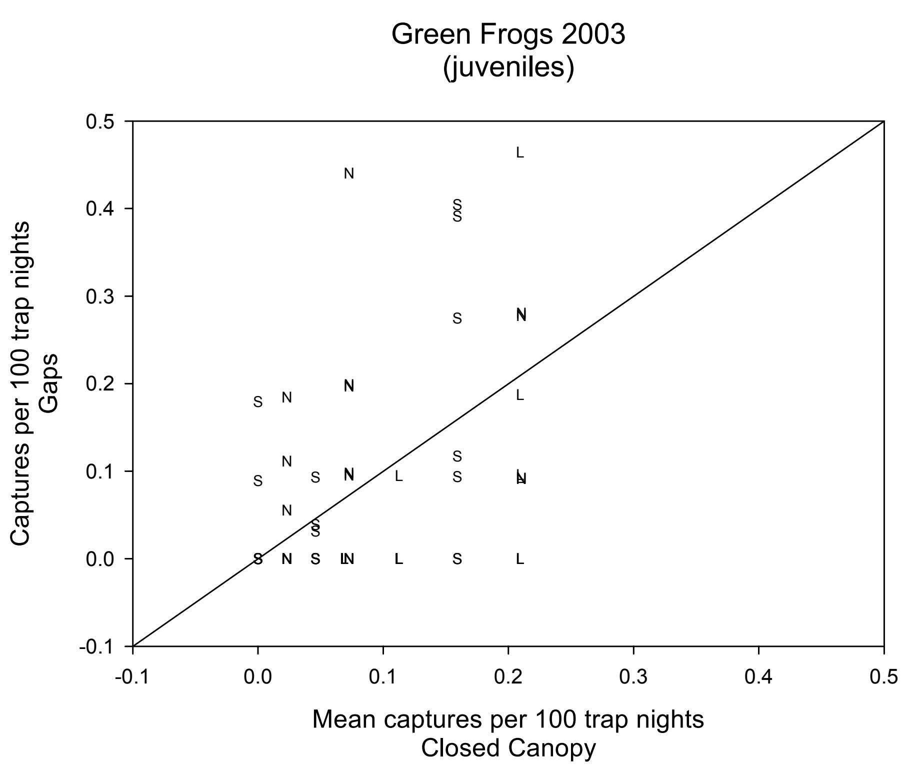
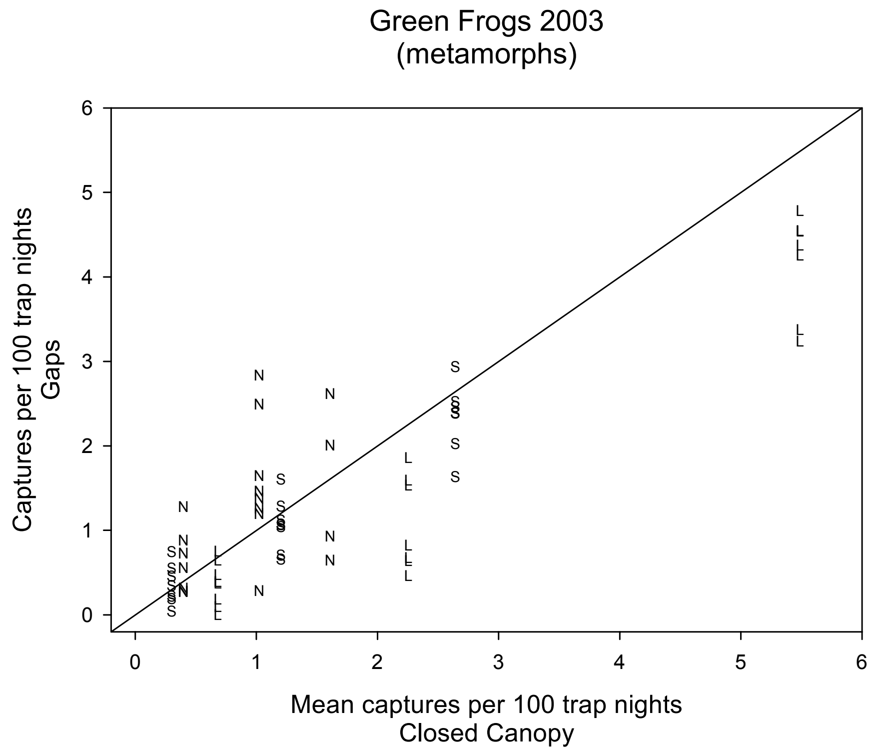


Figure E1 continued.



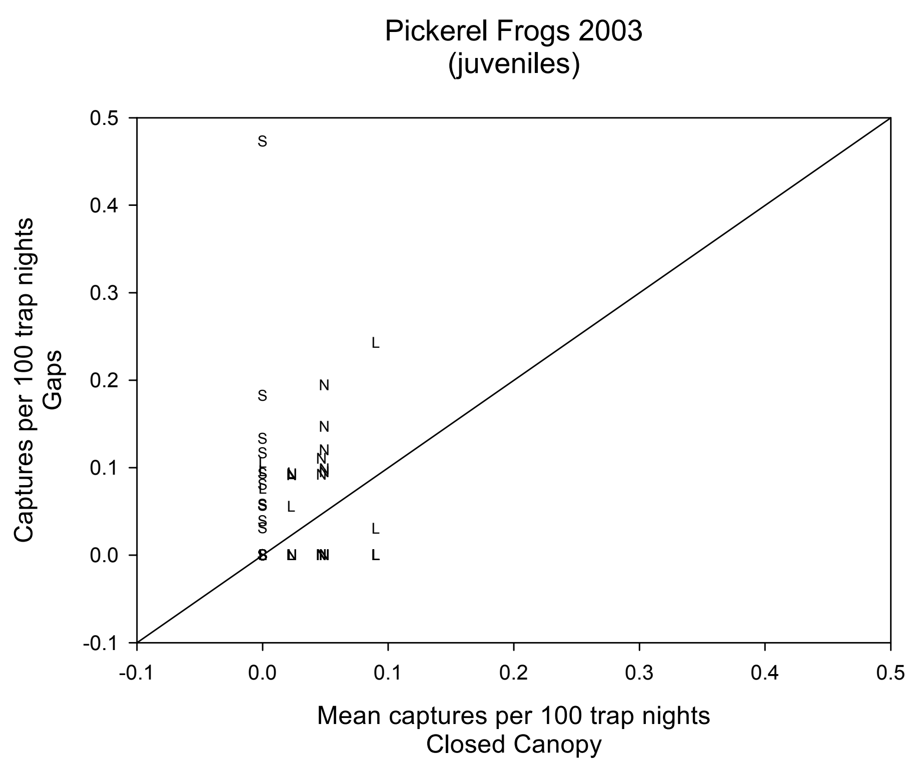
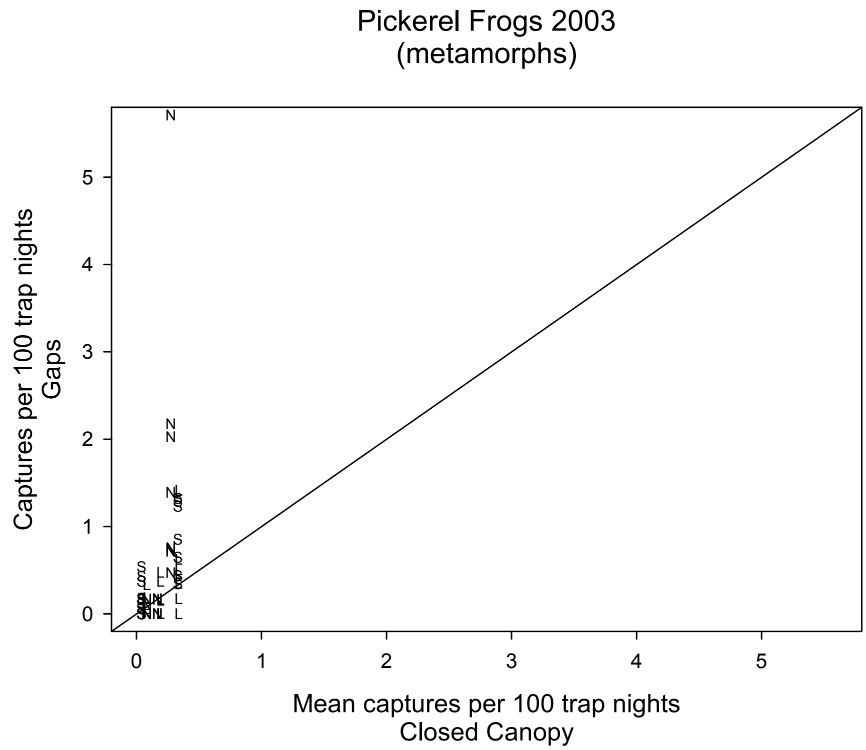


Figure E1 continued.



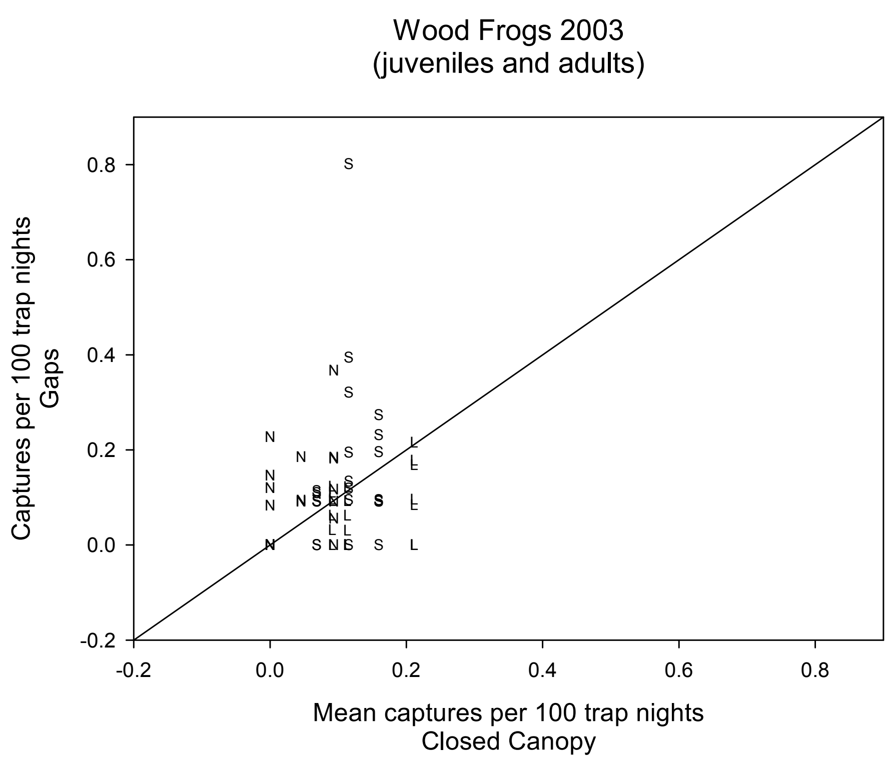
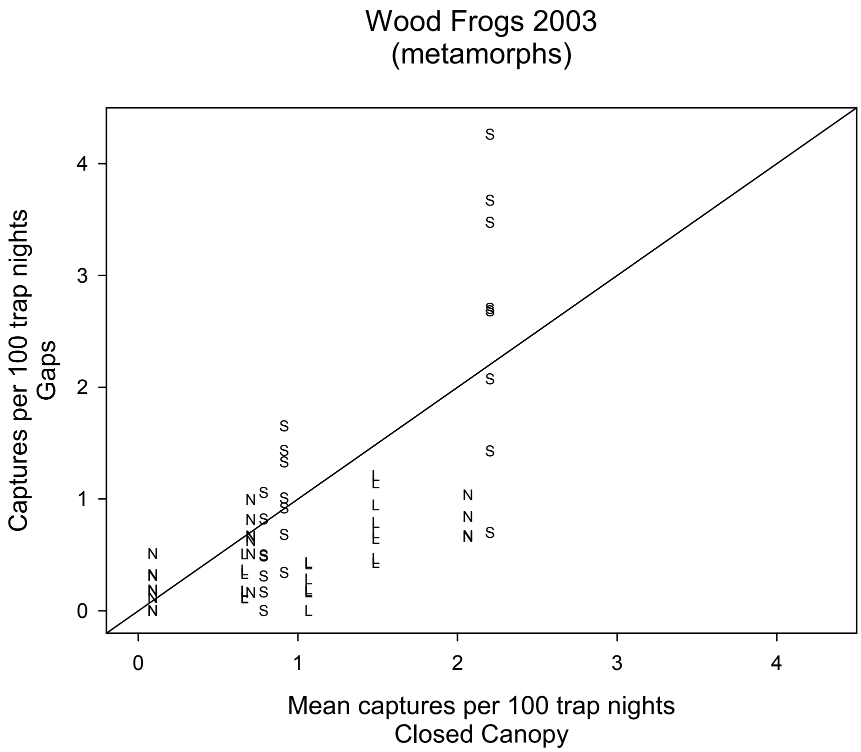


Figure E1 continued.



APPENDIX F: Seasonal (spring, summer, and fall) patterns of amphibian capture rates for each treatment.

Figure F1. Cumulative distribution plot of precipitation over time during the 2003 field season. Placements of vertical dotted lines are at June 17th and September 2nd, dividing the sampling period into 'spring', 'summer', and 'fall'.

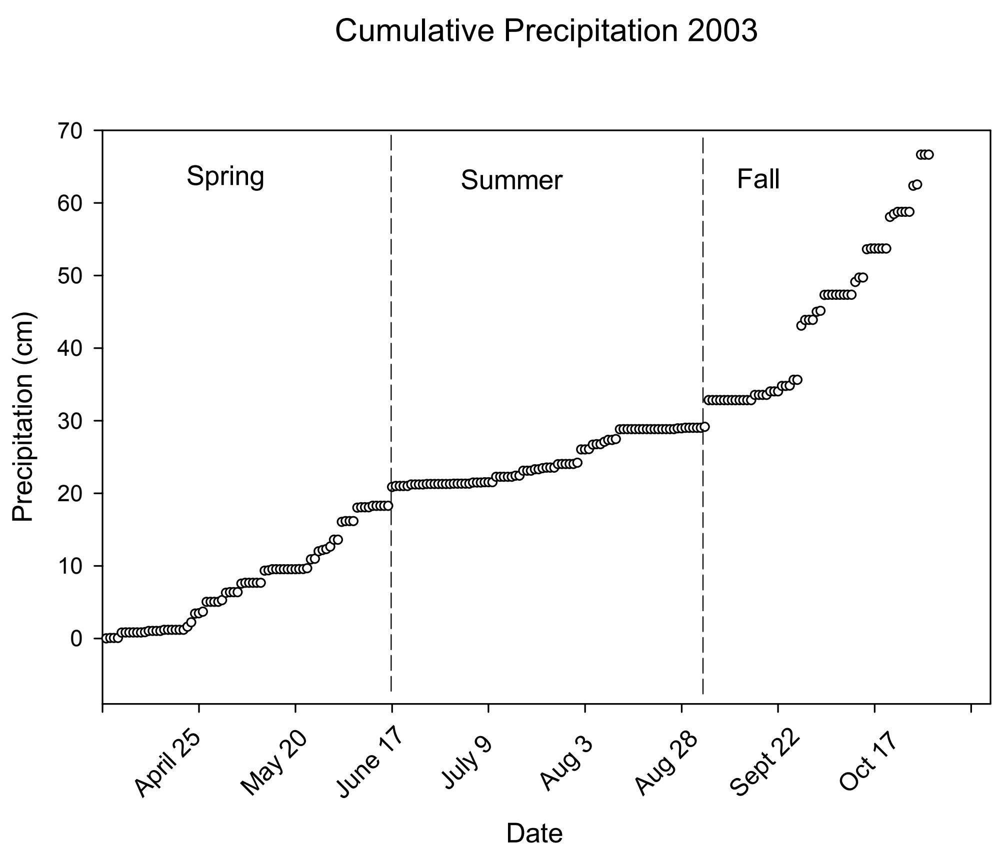


Figure F2. Mean difference values with 90% confidence intervals for age classes of amphibians captured in the Penobscot Experimental Forest, 2003 in spring, summer, and fall. Difference values were calculated by subtracting the mean of closed-canopy plot rates from gap rates for their respective research areas. The x-axis shows treatment type: large harvest gap (n=22), small harvest gap (n=22), and natural gap (n=19).

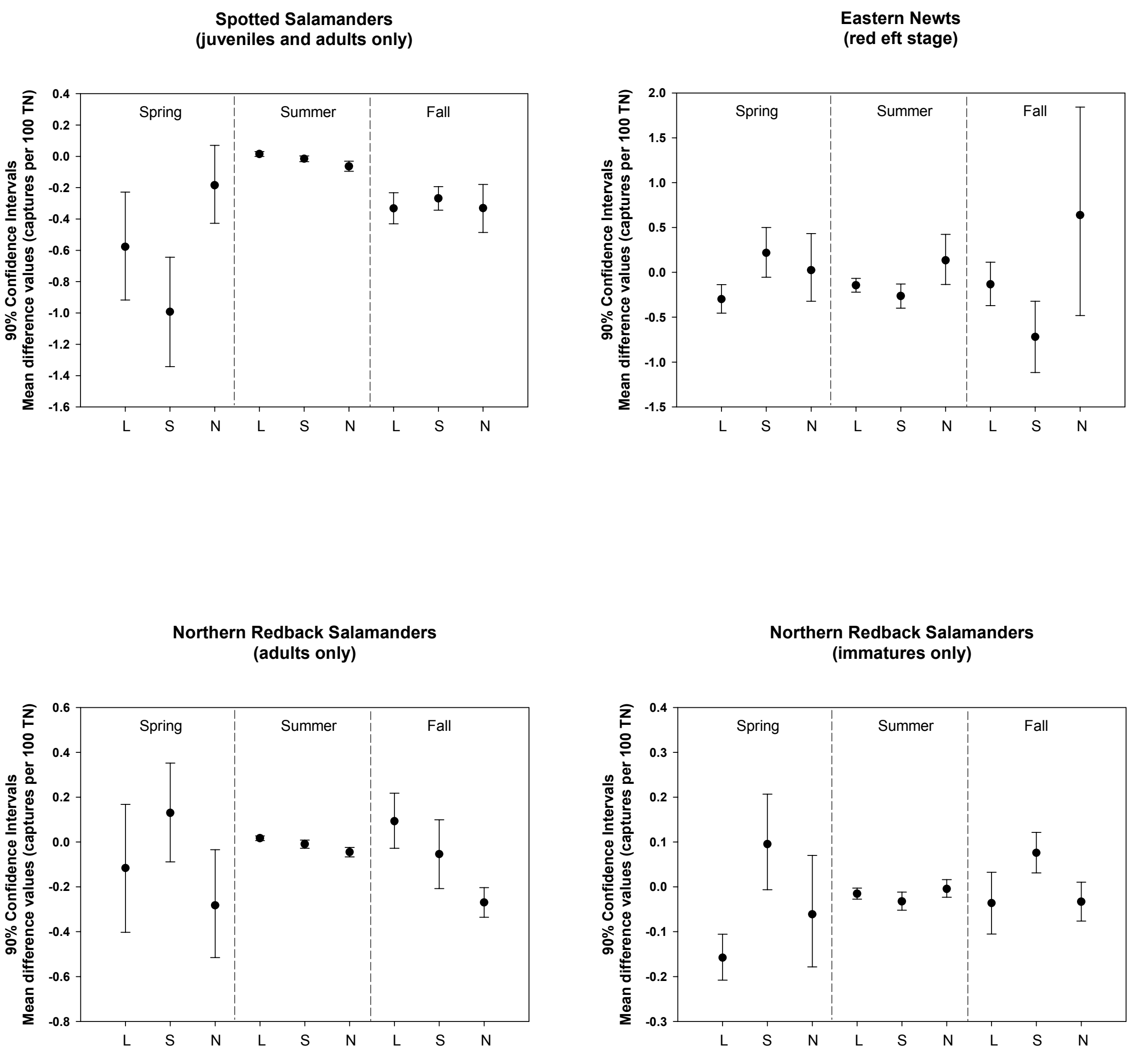
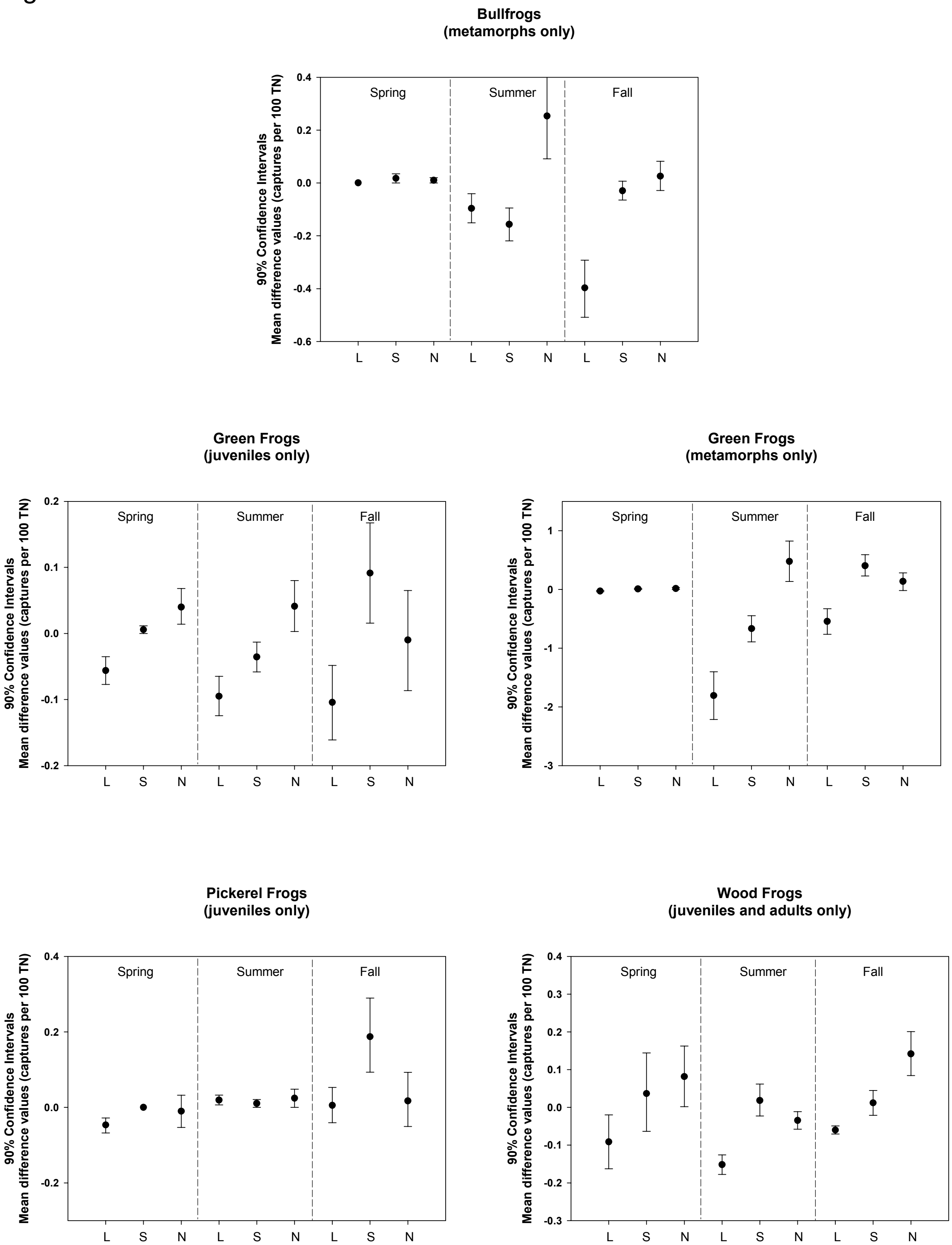


Figure F2 continued.



APPENDIX G: Estimated locations of gap and closed-canopy sampling areas in the Penobscot Experimental Forest.

Table G1. Universal Transverse Mercator coordinates for pitfall arrays (center array only). Datum 83 Zone 19.

RA	Plot Type[1]	Plot Label	UTM coordinates North	UTM coordinates East	Error (m)
1	cc	f2	4964018.092	531055.524	0.5
1	cc	h4	4963996.249	531196.331	0.6
1	cc	i5	4963976.780	531284.400	1.4
1	cc	j3	4964100.253	531305.565	2.1
1	g	e3	4963941.170	531084.449	0.5
1	g	g2	4964014.499	531138.306	0.4
1	g	g5	4963922.270	531190.419	0.7
1	g	h7	4963880.676	531260.175	1.4
1	g	i3	4964046.283	531203.135	0.4
1	g	j2	4964143.563	531259.451	1.0
1	g	j4	4964049.025	531326.198	2.0
1	g	j5	4963974.637	531310.033	1.3
2	cc	c3	4964108.902	530883.002	1.8
2	cc	d3	4964121.514	530944.261	1.4
2	cc	i4	4964204.494	531137.949	1.0
2	cc	j5	4964173.982	531180.064	1.0
2	g	c4	4964055.369	530906.359	0.5
2	g	d2	4964186.339	530904.912	1.1
2	g	f3	4964202.995	531003.245	0.8
2	g	f4	4964139.996	530991.281	0.9
2	g	g4	4964152.253	531087.050	1.0
2	g	k3	4964295.256	531195.714	0.9
2	g	k4	4964254.483	531261.216	1.1
3	cc	a2	4964258.029	530643.825	1.5
3	cc	d5	4964240.407	530857.329	1.6
3	cc	e2	4964372.024	530800.252	1.5
3	cc	g4	4964334.674	530946.188	1.5
3	g	a3	4964219.792	530669.872	1.3
3	g	c4	4964239.490	530768.741	1.2
3	g	d4	4964242.258	530812.372	1.5
3	g	e3	4964357.418	530840.853	1.1

[1] g = gap, cc = closed-canopy

[2] UTM coordinates are for trap location 5m south of center

[3] information not available

Table G1. continued.

RA	Plot Type[1]	Plot Label	UTM coordinates North	East	Error (m)
3	g	e4	4964327.187	530831.854	1.7
3	g	j2	4964507.049	531039.433	1.0
3	g	j4	4964420.472	531113.307	1.0
4	cc	a5	4963631.774	531574.959	0.6
4	cc	b4	4963557.836	531526.645	0.6
4	cc	b7	4963542.854	531673.662	0.8
4	cc	c3	4963497.024	531493.573	0.6
4	g	a7	4963600.801	531705.719	0.6
4	g	c8	4963494.093	531738.721	0.9
4	g	d4	4963446.404	531504.272	0.6
4	g	d5	4963443.334	531580.084	0.6
5	cc	b4	4962450.339	531372.901	1.9
5	cc	d4	4962499.192	531319.343	1.7
5	cc	e5	4962590.655	531296.362	1.7
5	cc	ef3	4962527.409	531229.347	1.8
5	g	a8	4962616.319	531504.131	1.3
5	g	b2	4962400.035	531366.817	1.7
5	g	b5	4962504.665	531432.450	1.3
5	g	c2	4962406.089	531277.936	1.0
5	g	d7	4962606.605	531370.466	1.6
5	g	e3	4962485.058	531248.808	1.4
5	g	e4	4962529.776	531271.938	1.6
6	cc	a6	4962678.836	531190.133	1.2
6	cc	c1	4962582.968	530938.184	1.5
6	cc	c7	4962830.476	531098.647	1.2
6	cc	d5	4962770.569	531047.648	1.1
6	g	a3	4962623.469	531085.132	1.3
6	g	b4	4962692.401	531056.499	1.0
6	g	b7	4962816.542	531150.022	1.5
6	g	c2	4962596.002	530981.632	0.9
6	g	c6	4962765.496	531084.494	1.1
6	g	d6	4962753.935	530960.319	0.9
6	g	e4	4962710.394	530907.144	1.0
7	cc	b3	4962483.881	533185.055	0.8
7	cc	b5	4962535.864	533105.511	1.2
7	cc	d5	4962430.603	533015.497	0.9
7	cc	f3	4962321.317	533082.150	0.5
7	g	b2	4962423.168	533231.620	0.6
7	g	b4	4962475.676	533142.056	1.4
7	g	b7	4962567.323	533015.710	0.5

[1] g = gap, cc = closed-canopy

[2] UTM coordinates are for trap location 5m south of center

[3] information not available

Table G1. continued.

RA	Plot Type[1]	Plot Label	UTM coordinates North	East	Error (m)
7	g	c7	4962497.461	532979.727	0.6
7	g	d7	4962487.339	532913.313	0.5
7	g	f2	4962230.328	533121.682	0.5
7	g	f4	4962333.150	533037.064	0.5
7	g	f6	4962357.495	532949.660	0.4
8	cc	b2	4964889.434	531986.482	1.0
8	cc	d6	4964791.561	531803.533	0.5
8	cc	e5	4964735.981	531834.405	0.5
8	cc	g6	4964671.927	531784.496	0.4
8	g	b8	4964899.928	531683.611	0.6
8	g	c1	4964841.503	532028.799	0.6
8	g	c2	4964836.809	531993.623	0.6
8	g	d3	4964773.959	531907.852	1.7
8	g	d4	4964807.125	531897.349	0.6
8	g	d5	4964780.299	531847.024	1.8
8	g	e3	4964743.136	531912.079	2.9
8	g	e6	4964757.845	531746.518	0.4
9	cc	az8	4968233.096	528312.976	0.6
9	cc	f5	4967973.629	528192.737	1.5
9	cc	y4	4968135.340	528508.205	0.6
9	cc	y7	4968249.431	528392.229	0.6
9	g	a8	4968181.432	528316.891	0.5
9	g	b8	4968157.018	528259.093	0.5
9	g	c4[2]	4967979.714	528374.701	0.6
9	g	c6	4968071.775	528287.452	0.7
9	g	e4	4967973.938	528289.543	0.5
9	g	z5[3]	-	-	-
9	g	z8	4968288.370	528345.075	0.6

[1] g = gap, cc = closed-canopy

[2] UTM coordinates are for trap location 5m south of center

[3] information not available

APPENDIX H: Mean capture rates for each plot type in each research area in the Penobscot Experimental Forest.

Table H1. Capture rates (captures / 100TN) delineated for each species and age-group by treatment type, research area (RA), and plot type for amphibians captured in the Penobscot Experimental Forest, 2003.

			Mean (± 1 SE) for species[1] (age-class)[2]												
Treatment	RA	Plot type[3] (n)	SS (JAD)	SS (MET)	EN	RB (ADT)	RB (IMM)	BF (JUV)	BF (MET)	GF (JUV)	GF (MET)	PF (JUV)	PF (MET)	WF (JAD)	WF (MET)
Large Gap	1	cc (4)	0.70 (0.09)	0.56 (0.30)	0.70 (0.11)	0.21 (0.12)	0.14 (0.08)	0.25 (0.13)	0.32 (0.06)	0.11 (0.09)	0.68 (0.14)	0.09 (0.09)	0.19 (0.15)	0.11 (0.06)	1.49 (0.07)
		g (8)	0.35 (0.09)	0.16 (0.12)	0.37 (0.08)	0.35 (0.09)	0.08 (0.03)	0.09 (0.03)	0.12 (0.03)	0.01 (0.01)	0.36 (0.09)	0.03 (0.03)	0.14 (0.07)	0.04 (0.02)	0.79 (0.10)
	6	cc (4)	0.82 (0.22)	9.51 (1.04)	1.16 (0.31)	0.66 (0.29)	0.23 (0.12)	0.38 (0.17)	0.33 (0.04)	0.21 (0.06)	2.25 (0.23)	0.00 (0.00)	0.34 (0.12)	0.21 (0.07)	1.07 (0.15)
		g (7)	0.81 (0.26)	5.30 (1.16)	0.91 (0.24)	0.21 (0.05)	0.06 (0.02)	0.20 (0.08)	0.13 (0.05)	0.12 (0.06)	1.08 (0.21)	0.04 (0.02)	0.50 (0.17)	0.11 (0.03)	0.24 (0.06)
	9	cc (4)	0.64 (0.14)	0.14 (0.09)	0.66 (0.31)	0.14 (0.06)	0.05 (0.03)	0.71 (0.08)	0.18 (0.06)	0.07 (0.04)	5.49 (0.63)	0.02 (0.02)	0.08 (0.05)	0.09 (0.04)	0.67 (0.19)
		g (7)	0.27 (0.07)	0.04 (0.03)	0.70 (0.10)	0.41 (0.14)	0.08 (0.03)	0.49 (0.08)	0.11 (0.04)	0.00 (0.00)	4.16 (0.23)	0.03 (0.02)	0.15 (0.04)	0.07 (0.02)	0.25 (0.06)
Small Gap	2	cc (4)	0.48 (0.14)	0.81 (0.30)	0.83 (0.12)	0.35 (0.17)	0.07 (0.07)	0.12 (0.04)	0.09 (0.09)	0.05 (0.03)	0.30 (0.12)	0.00 (0.00)	0.04 (0.04)	0.07 (0.04)	0.79 (0.12)
		g (7)	0.25 (0.09)	0.39 (0.19)	0.43 (0.07)	0.17 (0.05)	0.05 (0.02)	0.07 (0.04)	0.04 (0.02)	0.02 (0.01)	0.36 (0.09)	0.04 (0.03)	0.05 (0.03)	0.07 (0.02)	0.48 (0.14)
	5	cc (4)	1.57 (0.20)	7.70 (1.94)	2.21 (0.49)	0.48 (0.16)	0.16 (0.07)	0.09 (0.06)	0.11 (0.09)	0.16 (0.09)	2.64 (0.41)	0.00 (0.00)	0.33 (0.18)	0.16 (0.08)	0.91 (0.08)
		g (7)	1.02 (0.28)	2.08 (0.54)	1.68 (0.43)	0.63 (0.14)	0.21 (0.08)	0.08 (0.03)	0.09 (0.02)	0.18 (0.07)	2.33 (0.15)	0.11 (0.06)	0.87 (0.16)	0.14 (0.04)	1.05 (0.17)

[1] SS = spotted salamander, EN = eastern newt, RB = eastern red-backed salamander, BF = American bullfrog, GF = green frog, PF = pickerel frog, WF = wood frog

[2] JAD = juveniles and adults, MET = metamorphs, ADT = adults, IMM = immatures

[3] g = gap, cc = closed-canopy

Table H1 continued.

Treatment	RA	Plot type[3] (n)	Mean (± 1 SE) for species[1] (age-class)[2]												
			SS (JAD)	SS (MET)	EN	RB (ADT)	RB (IMM)	BF (JUV)	BF (MET)	GF (JUV)	GF (MET)	PF (JUV)	PF (MET)	WF (JAD)	WF (MET)
Small Gap	7	cc (4)	0.58	0.24	0.14	0.56	0.09	0.05	0.23	0.00	1.20	0.00	0.04	0.12	2.20
			(0.12)	(0.05)	(0.06)	(0.09)	(0.04)	(0.03)	(0.09)	(0.00)	(0.16)	(0.00)	(0.04)	(0.06)	(0.15)
		g (8)	0.19	0.14	0.24	0.57	0.15	0.14	0.11	0.03	1.07	0.03	0.23	0.26	2.62
			(0.04)	(0.04)	(0.11)	(0.11)	(0.04)	(0.03)	(0.05)	(0.02)	(0.11)	(0.02)	(0.07)	(0.09)	(0.42)
Natural Gap	3	cc (4)	0.61	0.48	0.68	0.23	0.05	0.09	0.09	0.02	0.40	0.05	0.08	0.09	0.71
			(0.27)	(0.29)	(0.20)	(0.06)	(0.05)	(0.00)	(0.04)	(0.02)	(0.12)	(0.03)	(0.05)	(0.05)	(0.19)
		g (7)	0.53	0.82	1.07	0.24	0.11	0.11	0.18	0.05	0.61	0.03	0.06	0.14	0.63
			(0.07)	(0.22)	(0.30)	(0.10)	(0.07)	(0.03)	(0.05)	(0.03)	(0.14)	(0.02)	(0.03)	(0.04)	(0.10)
	4	cc (4)	1.08	4.44	2.20	0.48	0.07	0.16	0.28	0.21	1.61	0.02	0.17	0.05	2.06
			(0.49)	(3.03)	(1.47)	(0.33)	(0.04)	(0.04)	(0.06)	(0.10)	(0.20)	(0.02)	(0.07)	(0.05)	(0.30)
		g (4)	0.69	5.21	2.56	0.02	0.05	0.25	0.37	0.19	1.55	0.05	0.08	0.12	0.80
			(0.29)	(2.81)	(1.99)	(0.02)	(0.05)	(0.08)	(0.10)	(0.05)	(0.46)	(0.03)	(0.05)	(0.02)	(0.09)
	8	cc (4)	0.74	0.11	0.90	0.47	0.22	0.13	0.32	0.07	1.02	0.05	0.27	0.00	0.09
			(0.17)	(0.06)	(0.22)	(0.17)	(0.11)	(0.10)	(0.05)	(0.05)	(0.25)	(0.03)	(0.05)	(0.00)	(0.05)
		g (8)	0.53	0.21	0.86	0.25	0.11	0.07	0.50	0.13	1.57	0.08	1.74	0.07	0.20
			(0.11)	(0.08)	(0.14)	(0.09)	(0.05)	(0.04)	(0.13)	(0.05)	(0.28)	(0.03)	(0.61)	(0.03)	(0.06)

[1] SS = spotted salamander, EN = eastern newt, RB = eastern red-backed salamander, BF = American bullfrog, GF = green frog, PF = pickerel frog, WF = wood frog

[2] JAD = juveniles and adults, MET = metamorphs, ADT = adults, IMM = immatures

[3] g = gap, cc = closed-canopy