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ORIGINAL ARTICLE

Evaluation of the United States Department of Agriculture Northeast Area-Wide Tick Control Project by Meta-Analysis

Brandon Brei,[1] John S. Brownstein,[2] John E. George,[3] J. Mathews Pound,[3] J. Allen Miller,[3] Thomas J. Daniels,[4] Richard C. Falco,[4] Kirby C. Stafford, III,[5] Terry L. Schulze,[6] Thomas N. Mather,[7] John F. Carroll,[8] and Durland Fish[1]

Abstract

As part of the Northeast Area-wide Tick Control Project (NEATCP), meta-analyses were performed using pooled data on the extent of tick-vector control achieved through seven concurrent studies, conducted within five states, using U.S. Department of Agriculture "4-Poster" devices to deliver targeted-acaricide to white-tailed deer. Although reductions in the abundance of all life-stages of *Ixodes scapularis* were the measured outcomes, this study focused on metrics associated with *I. scapularis* nymphal tick densities as this measure has consistently proven to directly correlate with human risk of acquiring Lyme disease. Since independent tick sampling schemes were undertaken at each of the five environmentally distinct study locations, a meta-analytic approach permitted estimation of a single true control-effect size for each treatment year of the NEATCP. The control-effect is expressed as the annual percent *I. scapularis* nymphal control most consistent with meta-analysis data for each treatment year. Our meta-analyses indicate that by the sixth treatment year, the NEATCP effectively reduced the relative density of *I. scapularis* nymphs by 71% on the 5.14 km^2 treatment sites, corresponding to a 71% lower relative entomologic risk index for acquiring Lyme disease.

Key Words: Acaricide—4-Poster—Entomologic risk index—*Ixodes scapularis*—Meta-analysis—Seasonal adjustment—Tick control—White-tailed deer.

Introduction

As part of the United States Department of Agriculture (USDA) Northeast Area-wide Tick Control Project (NEATCP), five concurrent studies were conducted from 1997 to 2004 in Rhode Island, Connecticut, New York, New Jersey, and Maryland, to evaluate the effectiveness of the USDA "4-Poster" acaricide-dispensing device for reducing tick abundance by targeted control of ticks feeding on white-tailed deer (Pound et al. 2009; Pound 2000; Pound et al 1994). All studies used a 2% amitraz formulation (PointGuard®, Hoechst Roussel Vet, Warren, NJ). The ultimate goal of reducing the number of adult *Ixodes scapularis* ticks, which preferentially feed on white-tailed deer (Wilson et al. 1990), was to reduce the numbers of questing nymphal ticks and, hence, reduce the risk of humans acquiring tick-borne diseases in endemic communities of the northeastern United States. The meta-analytic analysis estimated an overall control level of nymphal *I. scapularis* densities from each of the seven 5.14 km^2 treatment sites (three sites in Maryland), relative to control sites. The preceding research articles (this issue) describe the NEATCP and the individual studies in detail.

Materials and Methods

Comparisons

At most study locations, the 4-Poster devices were operational in 1997, and the meta-analysis compared data based

[1]Department of Epidemiology and Public Health, Yale School of Medicine, New Haven, Connecticut.
[2]Department Pediatrics, Division of Emergency Medicine, Harvard Medical School, Children's Hospital Boston, Boston, Massachusetts.
[3]Knipling-Bushland U.S. Livestock Insects Research Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Kerrville, Texas.
[4]Fordham University, Louis Calder Ecology Center, Armonk, New York.
[5]Connecticut Agricultural Experiment Station, New Haven, Connecticut.
[6]Terry L. Schulze, Ph.D., Inc., Perrineville, New Jersey.
[7]Department of Plant Sciences, University of Rhode Island, Kingston, Rhode Island.
[8]Livestock and Poultry Sciences Institute, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland.

Table 1. Seasonal Adjustment for Tick Samples Obtained from Rhode Island and New York

Dates	*Days*	*Equation*
May 7–May 25	0–18	%Activity = 0.42(Day) + 0.83
May 26–Jun 23	0–28	%Activity = 0.04(Day) + 8.12
Jun 24–Aug 19	0–56	%Activity = −0.13(Day) + 8.96
Aug 20–Sep 1	0–12	%Activity = −0.03(Day) + 1.68

on 7 years of monitoring *I. scapularis* nymphal densities at treatment and control sites. However, treatment in Maryland began in 1998, after a baseline nymphal collection period, and consequently, the data from this study consisted of 5 treatment years and 1 posttreatment year.

The baseline collection period revealed that the future Maryland treatment site started with 27% fewer *I. scapularis* nymphs than the control site (Carroll et al.). To adjust for this initial difference, we multiplied the control data for each treatment year by a factor of 0.73. Although all the studies attempted to sample ticks during periods of high nymphal activity (Fish 1993), some variation in sampling occurred. Comparisons from the Connecticut, New Jersey, and Maryland studies were based on tick density estimates obtained during the same week, while sampling dates from Rhode Island and New York varied in duration, and data from these sites were adjusted to account for seasonal tick activity.

Seasonal adjustment

Seasonal adjustment equations were developed to standardize estimates of tick density obtained at specific, but different, calendar dates of sampling at the Rhode Island and New York sites. The actual numbers of nymphs collected on specific sampling dates were divided by the percent of total seasonal nymphal activity associated with that specific date (Table 1), as determined from detailed, multiyear longitudinal studies conducted Westchester County, New York (Fish 1993).

Table 2. Treatment Year 1 (1998 with the Exception of Maryland, 1999)

			Treatment		*Control*			
Comparison	*Site*	*Date*	*Samples*	*Nymphs (SD)*	*Samples*	*Nymphs (SD)*	*Weight*	*Effect size*
1	RI	5/26–6/5/98	15	19.2 (0.6)	15	30.3 (1.9)	7.3	−0.52
2	RI	6/9–6/26/98	15	22.6 (0.9)	15	30.4 (1.9)	7.4	−0.34
3	RI	7/3–7/14/98	15	27.9 (1.2)	15	30.6 (1.6)	7.5	−0.13
4	RI	7/16–7/24/98	15	20.1 (1.2)	15	29.7 (1.6)	7.3	−0.45
5	CT	5/11–5/15/98	13	31 (3)	6	10 (2)	4.1	0.28
6	CT	5/25–6/3/98	16	160 (6)	8	41 (5)	5.0	0.81
7	CT	6/8–6/11/98	16	343 (34)	8	67 (5)	5.2	0.45
8	CT	6/22–6/29/98	16	330 (46)	8	47 (7)	5.3	0.38
9	CT	7/6–7/7/98	16	136 (6)	8	58 (4)	5.3	0.23
10	CT	7/20–7/24/98	16	51 (3)	9	23 (3)	5.7	0.21
11	CT	8/3–8/6/98	16	40 (3)	9	43 (7)	5.6	−0.46
12	NY	6/4–6/11/98	9	5.1 (0.5)	15	19.1 (2.4)	5.5	−0.35
13	NY	6/18–7/27/98	17	17.1 (0.6)	23	12.1 (0.5)	8.9	0.90
14	NY	7/23–9/1/98	18	29.0 (1.9)	16	16.0 (1.2)	8.3	0.38
15	NJ	5/19/98	25	28 (2)	20	55 (4)	10.7	−0.56
16	NJ	5/26/98	25	86 (3)	20	141 (6)	10.4	−0.73
17	NJ	6/1/98	25	75 (2)	20	412 (69)	10.9	−0.38
18	NJ	6/8/98	25	49 (2)	20	122 (8)	10.4	−0.72
19	MD	6/1/99	15	142 (10)	15	297.1 (11.0)	6.7	−0.98
20	MD	6/8/99	15	240 (16)	15	410.3 (21.3)	7.2	−0.58
21	MD	6/16/99	15	306 (19)	15	396.4 (20.0)	7.4	−0.30
22	MD	6/22/99	15	153 (10)	15	287.6 (10.7)	6.9	−0.85

SD, standard deviation.

Sampling methods

Although tick sampling methods varied among studies, these data could be combined for meta-analysis. In the Connecticut and New Jersey studies, tick sampling was conducted by 100 m^2 drag samples. Tick sampling in New York study was conducted by 200 to 400 m^2 drag samples that were converted to standard 200 m^2 drag samples; additional precision in these estimates may be reflected in smaller standard deviations. Sampling efforts in the Rhode Island and Maryland studies were 5-min flag samples. The tick collection data for most treatment-control comparisons satisfied the assumption of normality (by Kolmogorov-Smirnov tests), so no further transformation of data was required.

Meta-analysis model

We chose a fixed-effect meta-analysis model to maximize interpretation of the results with respect to the NEATCP studies (as opposed to a hypothetical population of future studies; Bailey 1987). Following the inverse variance-weighted method of Hedges and Olkin (1985), we standardized differences between treatment and control means (nymphs per sampling effort) using a pooled standard deviation, and then combined differences using a continuous outcome scale. To compensate for bias due to sample size (number of sampling efforts), we included a bias correction term (Hedges and Olkin 1985). We evaluated between-comparison heterogeneity using Cochran's Q statistic (Cochran 1954).

Percent nymphal control

In addition to assessing an effect size for each treatment year of the NEATCP, we desired an overall measure of nymphal control for each year of the project. We therefore determined the percent nymphal control that was most consistent with meta-analysis data for each study year. To do this, we multiplied the control-site nymphs in each comparison by an efficacy factor (such as 0.75 for a potential 25% nymphal control efficacy). We systematically tested efficacy factors in a meta-analysis spreadsheet to determine the percent nymphal control (and associated 95% confidence interval [CI]) most consistent with an overall effect size of zero.

Results

As anticipated, the effect of tick control experienced during the first treatment year was highly variable with evidence of nymphal tick control reported from sites in Rhode Island, New Jersey, and Maryland (negative effect values), while sites in Connecticut and New York showed no, or sporadic, evidence of any nymphal control (Table 2). Meta-analytic analyses indicated an overall control effect of 22% in

Table 3. Treatment Year 2 (1999 with the Exception of Maryland, 2000)

			Treatment		*Control*			
Comparison	*Site*	*Date*	*Samples*	*Nymphs (SD)*	*Samples*	*Nymphs (SD)*	*Weight*	*Effect size*
1	RI	5/26–6/1/99	15	18.9 (0.9)	15	22.1 (1.5)	7.5	−0.17
2	RI	6/3–6/8/99	15	14.4 (0.9)	15	24.4 (1.6)	7.3	−0.49
3	RI	6/14–6/21/99	15	13.7 (0.7)	15	12.3 (0.7)	7.5	0.12
4	RI	6/24–6/30/99	15	5.7 (0.3)	15	20.2 (1.3)	6.7	−1.00
5	CT	5/17–5/20/99	16	36 (3)	12	45 (3)	6.7	−0.48
6	CT	6/2–6/3/99	16	60 (4)	12	74 (5)	6.6	−0.53
7	CT	6/14/99	16	83 (5)	12	35 (3)	6.7	0.50
8	CT	6/28/99	16	48 (2)	12	54 (4)	6.7	−0.50
9	CT	7/12/99	16	8 (1)	12	24 (2)	6.0	−1.09
10	CT	7/26/99	16	22 (1)	12	14 (2)	6.8	0.13
11	NY	5/12–6/25/99	26	75.0 (2.9)	35	65.1 (1.6)	14.6	0.45
12	NY	7/7–8/18/99	24	42.9 (1.3)	24	28.0 (1.3)	11.7	0.48
13	NJ	5/26/99	25	41 (2)	20	120 (8)	10.3	−0.78
14	NJ	6/1/99	25	43 (3)	20	110 (6)	10.3	−0.81
15	NJ	6/8/99	25	73 (3)	20	67 (4)	11.1	−0.10
16	NJ	6/15/99	25	80 (4)	20	174 (9)	10.4	−0.77
17	MD	6/9/00	15	108 (5)	15	365.0 (21.1)	6.5	−1.08
18	MD	6/20/00	15	102 (6)	15	232.1 (9.3)	6.5	−1.08
19	MD	6/27/00	15	40 (3)	15	196.4 (7.8)	5.5	−1.71
20	MD	6/30/00	15	34 (2)	15	160.6 (6.4)	5.4	−1.75

SD, standard deviation.

Table 4. Treatment Year 3 (2000 with the Exception of Maryland, 2001)

			Treatment		*Control*			
Comparison	*Site*	*Date*	*Samples*	*Nymphs (SD)*	*Samples*	*Nymphs (SD)*	*Weight*	*Effect size*
1	RI	5/30–6/15/00	15	31.9 (0.8)	15	58.3 (3.0)	7.0	−0.77
2	RI	6/21–7/6/00	15	33.7 (1.0)	15	45.4 (2.3)	7.3	−0.43
3	RI	7/17–7/24/00	15	30.5 (1.1)	15	41.2 (2.1)	7.3	−0.41
4	RI	8/6–8/23/00	15	46.2 (2.5)	15	57.2 (2.9)	7.4	−0.27
5	CT	5/22/00	15	48 (3)	12	74 (6)	6.4	−0.63
6	CT	6/5/00	15	122 (8)	12	47 (3)	6.4	0.62
7	CT	6/19–6/22/00	15	76 (4)	12	94 (6)	6.4	−0.55
8	CT	7/3/00	15	48 (3)	12	80 (5)	6.1	−0.83
9	CT	7/17/00	15	39 (2)	12	88 (6)	5.8	−1.07
10	CT	7/31–8/1/00	13	19 (2)	12	18 (2)	6.2	−0.02
11	NY	5/25–6/2/00	13	30.1 (1.5)	11	35.1 (1.8)	5.8	−0.51
12	NY	6/20–6/28/00	21	18.5 (0.8)	13	14.1 (0.8)	8.0	−0.26
13	NJ	5/24/00	25	28 (1)	20	102 (6)	9.9	−1.02
14	NJ	5/30/00	25	46 (2)	20	74 (4)	10.6	−0.64
15	NJ	6/8/00	25	35 (2)	20	114 (6)	9.9	−1.00
16	NJ	6/15/00	25	59 (2)	20	91 (4)	10.6	−0.65
17	MD	6/4/01	15	126 (8)	15	262.1 (12.4)	6.9	−0.85
18	MD	6/11/01	15	109 (8)	15	406.6 (16.9)	5.9	−1.45
19	MD	6/18/01	15	101 (6)	15	357.0 (18.2)	6.3	−1.23
20	MD	6/26/01	15	61 (3)	15	341.6 (17.7)	6.0	−1.44

SD, standard deviation.

Table 5. Treatment Year 4 (2001 with the Exception of Maryland, 2002)

			Treatment		*Control*			
Comparison	*Site*	*Date*	*Samples*	*Nymphs (SD)*	*Samples*	*Nymphs (SD)*	*Weight*	*Effect size*
1	RI	6/1–7/2/01	15	25.3 (0.9)	15	52.3 (3.2)	7.0	−0.75
2	RI	7/3–7/25/01	15	19.6 (1.0)	15	44.2 (2.0)	6.7	−1.00
3	RI	7/31–8/3/01	15	14.4 (1.0)	15	27.6 (1.5)	7.1	−0.66
4	CT	5/28/01	16	45 (4)	13	72 (7)	7.0	−0.49
5	CT	6/18/01	16	74 (5)	14	98 (6)	7.3	−0.42
6	CT	7/9/01	16	35 (4)	14	58 (2)	7.1	−0.65
7	CT	7/23/01	16	4 (1)	14	38 (3)	6.5	−1.07
8	CT	8/6/01	16	7 (1)	14	18 (1)	6.6	−1.01
9	NY	5/8–8/23/01	197	164.1 (1.0)	173	398.6 (2.1)	83.4	−0.92
10	NJ	5/24–5/25/01	25	80 (3)	20	95 (4)	10.9	−0.43
11	NJ	5/28–5/30/01	25	82 (3)	20	174 (9)	10.3	−0.79
12	NJ	6/1–6/3/01	25	48 (3)	20	121 (5)	9.8	−1.02
13	NJ	6/5–6/8/01	25	47 (3)	20	150 (9)	10.1	−0.89
14	MD	6/4/02	15	43 (3)	15	175.2 (7.2)	5.8	−1.54
15	MD	6/11/02	15	71 (5)	15	146.0 (6.9)	6.9	−0.81
16	MD	6/13/02	15	60 (5)	15	154.0 (9.1)	6.9	−0.84
17	MD	6/18/02	15	37 (2)	15	195.6 (9.2)	5.8	−1.53

SD, standard deviation.

Table 6. Treatment Year 5 (2002 with the Exception of Maryland, 2003)

			Treatment		Control			
Comparison	*Site*	*Date*	*Samples*	*Nymphs (SD)*	*Samples*	*Nymphs (SD)*	*Weight*	*Effect size*
1	RI	6/6–6/21/02	15	15.6 (0.8)	15	36.9 (1.8)	6.7	−0.98
2	RI	6/25–7/1/02	15	16.2 (0.7)	15	39.2 (2.1)	6.7	−0.95
3	RI	7/8–7/12/02	15	11.3 (0.5)	15	35.3 (2.0)	6.6	−1.05
4	RI	7/19–7/26/02	15	8.4 (0.4)	15	21.3 (1.1)	6.6	−1.04
5	CT	5/20/02	16	45 (5)	14	53 (3)	7.4	−0.22
6	CT	6/3/02	16	29 (2)	14	59 (3)	6.7	−0.93
7	CT	6/17/02	16	13 (1)	14	75 (5)	6.2	−1.28
8	CT	7/1/02	16	22 (1)	14	26 (2)	7.4	−0.28
9	CT	7/15/02	16	16 (1)	14	20 (3)	7.4	−0.21
10	NY	5/16–7/25/02	29	9.1 (0.4)	30	25.0 (1.1)	14.0	−0.63
11	NJ	5/19–5/26/02	25	20 (1)	20	79 (5)	14.0 10.2	−0.84
12	NJ	5/29–5/31/02	25	40 (2)	20	139 (8)	10.0	−0.93
13	NJ	6/1–6/5/02	25	40 (2)	20	147 (11)	10.3	−0.78
14	NJ	6/7–6/11/02	25	53 (3)	20	165 (8)	9.8	−1.05
15	MD	6/9/2003	15	89 (7)	15	215.4 (11.4)	6.9	−0.87
16	MD	6/12/2003	15	85 (4)	15	192.0 (10.5)	6.9	−0.87
17	MD	6/17/2003	15	113 (6)	15	218.3 (11.8)	7.0	−0.74
18	MD	6/23/2004	15	90 (5)	15	178.9 (9.4)	7.0	−0.78

SD, standard deviation.

Table 7. Treatment Year 6 (2003)

			Treatment		Control			
Comparison	*Site*	*Date*	*Samples*	*Nymphs (SD)*	*Samples*	*Nymphs (SD)*	*Weight*	*Effect size*
1	RI	6/8–6/21/03	15	10.9 (0.42)	15	25.2 (1.1)	6.5	−1.14
2	RI	6/24–7/1/03	15	10.5 (0.4)	15	26.4 (1.4)	6.6	−1.02
3	RI	7/9–7/17/03	15	9.5 (0.3)	15	26.6 (1.2)	6.3	−1.23
4	RI	7/19–7/26/03	15	8.3 (0.4)	15	18.5 (0.9)	6.7	−0.95
5	CT	5/12/03	16	6 (1)	13	9 (1)	7.1	−0.31
6	CT	6/2/03	16	35 (2)	13	51 (3)	6.8	−0.66
7	CT	6/23/03	16	17 (1)	13	50 (5)	6.7	−0.74
8	CT	7/7/03	16	13 (1)	13	24 (4)	7.1	−0.35
9	CT	7/21/03	16	4 (1)	13	17 (1)	6.4	−0.98
10	CT	8/11/03	16	6 (1)	13	13 (1)	6.9	−0.57
11	NY	5/13–8/28/02	76	23.5 (0.4)	67	107.3 (2.3)	33.0	−0.80
12	NJ	5/13–5/20/03	25	3 (0.3)	20	51 (2)	8.8	−1.47
13	NJ	5/30–6/3/03	25	42 (2)	20	140 (7)	9.7	−1.10
14	NJ	6/7–6/10/03	25	30 (2)	20	103 (4)	8.9	−1.44
15	NJ	6/11–6/12/03	25	38 (2)	20	133 (8)	10.0	−0.95

SD, standard deviation.

Table 8. Nontreatment Year 7 (2004)

Comparison	Site	Date	Treatment Samples	Treatment Nymphs (SD)	Control Samples	Control Nymphs (SD)	Weight	Effect size
1	RI	6/8–6/20/04	15	15.5 (0.5)	15	27.4 (1.6)	7.1	−0.65
2	RI	6/23–7/6/04	15	5.7 (0.1)	15	17.9 (0.9)	6.3	−1.22
3	RI	7/15–7/27/04	15	11.1 (0.4)	15	13.5 (0.5)	7.4	−0.34
4	CT	5/17/04	16	19 (2)	13	6 (0.9)	6.4	0.43
5	CT	6/7/04	16	61 (4)	11	18 (3)	6.2	0.65
6	CT	6/21/04	16	21 (2)	11	11 (2)	6.5	0.16
7	CT	7/12/04	15	20 (1)	11	9 (1)	6.2	0.38
8	CT	7/26/04	15	18 (2)	11	13 (2)	6.4	0.01
9	CT	8/9/04	15	6 (0.6)	11	4 (0.6)	6.3	0.06
10	NY	6/8–8/10/04	33	26.1 (1.0)	30	15.7 (0.5)	15.5	0.32
11	NJ	5/13–5/19/04	25	62 (3)	20	99 (4)	10.4	−0.74
12	NJ	5/21–5/25/04	25	79 (4)	20	213 (14)	10.4	−0.77
13	NJ	5/25–5/27/04	25	105 (6)	20	155 (10)	10.9	−0.57
14	NJ	6/2–6/3/04	25	92 (4)	20	143 (8)	10.7	−0.57
15	MD	6/9/04	15	77 (4)	15	85.4 (7.5)	7.5	−0.09
16	MD	6/17/04	15	99 (6)	15	89.8 (8.9)	7.5	0.08
17	MD	6/23/04	15	76 (4)	15	148/2 (22.8)	7.4	−0.29
18	MD	6/28/04	15	123 (6)	15	78.8 (4.5)	7.3	0.53

SD, standard deviation.

treatment year 1 (Table 9). Although there was significant heterogeneity among control effects reported from sites, the 95% CI did not include 0.

In subsequent treatment years, evidence of nymphal tick control became increasingly apparent at all sites, although control effects achieved at the New York and Connecticut sites lagged behind other states (Tables 3–8). Overall estimates of the control effect increased in a near-monotonic manner, reaching 71% by the final treatment year (Table 9 and Fig. 1).

Variability in residual control effects achieved during the posttreatment year was apparent, with evidence of continued nymphal tick suppression in sites in Rhode Island and New Jersey, mixed effects in Maryland, and no control at sites in Connecticut and New York (Table 8). Although the overall residual control effect at the five sites was 18%, the high heterogeneity among sites precludes making any definitive statement regarding accrued benefit following acaricide removal.

Discussion

The meta-analyses indicated that the NEATCP effectively reduced the relative density of nymphs on 5.14 km^2 treatment sites, resulting in an increasing control effect, culminating at 71% nymphal control by the sixth treatment year (Table 9 and

Table 9. Meta-Analysis Results

Year	Effect size (95% CI)	Heterogeneity (Q)	Percent control (95% CI)
1	−0.23 (−0.38, −0.07)	43*	22 (7, 37)
2	−0.43 (−0.59, −0.28)	66*	39 (26, 52)
3	−0.67 (−0.83, −0.51)	30	48 (37, 59)
4	−0.87 (−1.01, −0.74)	12	62 (53, 71)
5	−0.79 (−0.96, −0.63)	11	61 (49, 73)
6	−0.91 (−1.07, −0.74)	13	71 (59, 83)
7	−0.16 (−0.33, −0.002)	36*	18 (0, 36)

CI, confidence interval.
*Significant between-comparison heterogeneity.

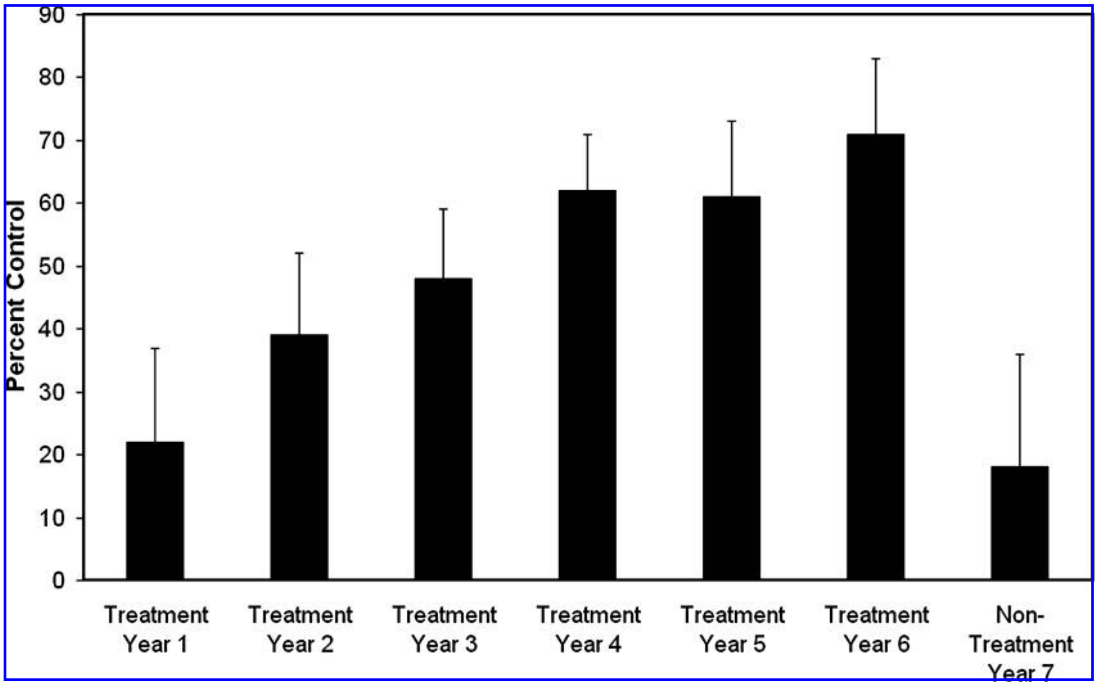

FIG. 1. Percent nymphal control for each of the 6 treatment years and the final nontreatment year 7. Means are shown with 95% confidence intervals.

Fig. 1). Our results compare favorably with the results of short-term, single-site studies reported previously (Carroll et al. 2002, Solberg et al. 2003). During the first 2 treatment years and final nontreatment year, the individual treatment-control comparisons exhibited significant effect-size heterogeneity (Table 9). Therefore, the overall nymphal control levels for the first 2 treatment years (Fig. 1) may not necessarily reflect the actual nymphal control experienced at each study location. However, the effect sizes were statistically homogeneous during treatment years 3 to 6 (Table 9). This suggests that all of the study locations attained an approximately 71% reduction in the density of nymphs sampled on treatment and control sites (Fig. 1); however, the time needed to reach this nymphal control level appeared to differ among locations, with sites in Connecticut and New York lagging behind (most notably during the first 2 treatment years).

Unexpectedly, we observed a significant control effect size in the first year following treatment (Table 9). This may indicate that maintaining 4-Poster devices impacts immature ticks (in addition to adults) either directly by acaricide or indirectly by altering the vertebrate community structure. Alternatively, the adjacent treatment and control sites may not have started with equal tick densities in all study locations. However, in the Maryland study (in which a baseline density estimate was obtained and adjusted for), we also observed a large treatment effect in the first year following 4-Poster maintenance (Tables 1, 2; Carroll et al., 2009). Additionally, the overall nymphal control level estimated for the NEATCP continued to increase after the first year following treatment (Fig. 1).

It's not possible to determine if the difference between treatment and control nymphal densities would continue to increase beyond 6 years if treatment were continued (Fig. 1). The mean nymphal control level in year 6 may be an underestimate of the actual level attained (see 95% CI in Fig. 1). However, the studies may have also reached a maximum level of nymphal control for 5.14 km^2 treatment sites. Birds and mammals with large home range (raccoons, skunks, etc.) may import ticks from adjacent untreated areas, continuously introducing immature ticks into the created "sink" populations.

Regardless of whether the nymphal control level would continue to increase, the NEATCP has demonstrated that maintaining 4-Poster devices in endemic communities of the northeastern United States can reduce human risk for tick-borne diseases. The entomologic risk index (ERI) for tick-borne disease is defined as the product of nymphal abundance and the proportion of nymphs infected (Mather et al. 1996). The proportion of *I. scapularis* nymphs infected did not differ between treatment and control sites after 5 treatment years (Gatewood Hoen et al., 2009). Therefore, maintaining 4-Poster devices resulted in treatment sites with 71% lower ERI than the control sites overall.

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Disclosure Statement

No conflicts to declare.

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Address correspondence to:
Dr. John S. Brownstein
Department of Department of Pediatrics
Harvard Medical School
1 Autumn Street
Room 541
Boston MA 02215

E-mail: john_brownstein@harvard.edu