



TOWNSHIP OF BERNARDS

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June 29, 2011

Kiersten Kugeler
Epidemiologist – Bacterial Diseases Branch
Division of Vector-Borne Diseases
CDC, Foothills Campus, Rampart Road
Fort Collins, CO 80521

Re: Contract 200-2010-37561

Kiersten,

Attached is our Final report of the Aerial Deer Density Survey, conducted within Bernards Township on March 19-20, 2011, by Davis Aviation, Kent, Ohio.

This report includes an historical comparison of the deer population in Bernards Township; the impact of the deer reduction program on the frequency of deer vs. motor vehicles; historical comparisons of the deer population and confirmed incidents of Lyme Disease within Bernards Township. We also included a brief report comparison of the current population of Black-legged tick (*Ixodes scapularis*) survey conducted by Dr. Robert Jordan, Ph.D. vs his initial survey when the deer reduction program began.

Please feel free to contact me (908-204-3063 – email: joconnell@bernards.org) if you have any questions or need additional information.

Judy O'Connell
Bernards Township
Deer Management Committee Secretary

Deer Management Program in Bernards Township

Final Report to the CDC
Submitted on June 28, 2011

Introduction: The formal deer management program in Bernards Township began in 2001. A full aerial census was made in 2002, but none thereafter until March of this year. The Centers for Disease Control and Prevention (CDC) funded the current survey. This final report is submitted as one of the deliverables in the CDC contract.

A preliminary report was submitted on April 21, 2011.

The Setting: Bernards Township is a 24.5 square mile municipality in Somerset County in central New Jersey. It lies midway between Morristown to the north, the county seat of Morris County, and Somerville to the south, the county seat of Somerset County.

Bordering it and running clockwise from the top are Harding and Longhill Townships in Morris County and Warren Township, Bridgewater Township, Bedminster Township, Far Hills Boro, and Bernardsville Boro in Somerset County. Bernards, the northern part of Bridgewater that borders Bernards, and the other towns may be classified as suburban or exurban.

Interstate I287 cuts across the northwest part of the township, angling from southwest to northeast, and I78 runs east-west across the south end.

Bernards topography is a mix of flat and rolling land and moderately steep hills.

Land use varies. Data below is from the township master plan.

Pct of Land	Land Use
39.4	Single family homes, most on 1/2 to 1-acre lots.
5.0	Multifamily homes.
7.2	Business, mostly small retail districts and large office campuses.
27.6	Farms and large residential tracts.
17.2	Parks and open space owned by township or county.
3.6	Schools, hospitals, golf.
100.0	All township land, 24.5 square miles.

The landscape includes lawns, open fields, shrubbery, hedgerows, and woodland. Almost all is excellent habitat for deer. Only a fraction is suitable for hunting.

Deer Management Program: Bernards is governed by a five-person Township Committee. In the 90s concerns grew in the community and in the committee for problems related to white tail deer (*Odocoileus Virginianus*). These included deer-vehicle accidents, Lyme Disease, deer feces in play areas, and loss of shrubbery and woodland understory.

The committee appointed a task force in the summer of 1999 to review the problems and make recommendations. Writing for the task force, Chairman William R. Darrow, MD, PhD, submitted a report to the Township Committee in November 2000. The report included a recommendation for a culling program to reduce the township deer population to 20 per square mile.

After several months of community dialog the Township Committee decided in 2001 to initiate a formal deer management program. The informal deer task force became the official Deer Management Advisory Committee (DMAC). This currently has seven regular members, two alternates, an administrative assistant, and a representative from the township police department. A culling program was authorized for the 2001-2002 hunting season.

We define a Deer Biological Year or DBY as the period from April 1 through March 31. One DBY ends after a full hunting season and a new DBY begins before fawning. DBY 2001 ended on March 31, 2001 and is the base year for our culling program. DBY 2002 ended on March 31, 2002 and included our first culling season. DBY 2011 ended this year and was the tenth year of the program.

In New Jersey the Division of Fish and Wildlife (NJF&W) has the authority to write regulations and issue permits for fishing and hunting throughout the state. By 2001 many other New Jersey municipalities had deer problems similar to Bernards. In an effort to cope with these, the state had enacted legislation that gave NJF&W authority to receive and approve Community Based Deer Management Plans (CBDMP). A CBDMP is prepared within a municipality, approved by its governing body, and submitted to NJF&W. The purpose is to reduce the deer population by more intense activity than regular sport hunting, and a plan may relax some hunting regulations. It applies only to hunting on the public lands that are approved for hunting by the governing body for these lands.

Bernards submitted and received approval for a CBDMP in each of the ten years of its program. The principle benefit for us has been to extend the hunting season on designated public lands from mid February to March 31.

In DBY 2002, the first culling season, Bernards hired a small group of professional hunters who used shotguns. Their results were limited, but expensive, and we never used them again.

We also used a private organization of volunteer archery hunters during our first year. They were more successful and have been part of the program for ten years. This

organization currently has 15 members. A second private organization of volunteers joined the program in 2003 and currently has 39 members. They use archery equipment, shotguns, and muzzle loaders.

Members of these two organization are proficient and committed hunters. They assign great importance to safety and respect the wishes and concerns of the general public. They are qualified every two years for proficiency with tests administered by township police.

Except for the extended season on public lands, members of these organization are bound by and observe all sport-hunting regulations.

There have been no reported incidents in which a member of the public or a domestic animal was injured.

Aerial Surveys: Bernards has commissioned six aerial surveys for deer, but only two of these were considered reliable and covered the whole township. They were made at night and used IR photography.

Hot/Shot Infrared Inspections, Inc. of Lakewood, CO, made a survey on the nights of April 4 and 5 in 2002. This included the whole township and produced a prefawning estimate of 2,170 deer, 89 per square mile. This has been our reference population estimate. Note, however, that this survey was made after our first culling season in DBY 2002.

Larry Davis, principal in Davis Aviation of Kent, OH, made a survey during the nights of March 19 and 20 of this year. The total deer count was 1,137. (See the Davis report of 27 March 2011 that was submitted with our preliminary report.) This produces a prefawning estimate for the whole township of 46 deer per square mile, a reduction of 48% from 2002.

Enclosed is a large map entitled "Deer Locations 2011". It is a township street map with an overlay of the locations of observed deer.

For analysis we have divided the township into 400-foot squares, assigned each deer to a square, counted the deer in each square, and then aggregated the squares into ten districts defined by the township boundary and major internal roads. This analysis is in Attachment 1 entitled "Bernards Deer Census 2011". The densities vary from a low of 24.5 deer per square mile in District A at the north end of the township (top of map) to 60.4 per square mile in District H in the southeast.

There is no clear geographic pattern of density, and we don't have explanations for the different densities. A computer simulation indicates that the probability, that the variations in density shown on the map could be caused by chance alone, is 28%.

I287 is the southeast boundary of Districts A and B, and I78 separates Districts F and G. These may serve as barriers and impede movement of deer across the district boundaries. Deer probably move freely across the other district boundaries and across the township boundary with neighboring municipalities.

Recent Hunting Results: The table below contains the results for the 2010-2011 hunting season.

Hunting Harvest in DBY 2011	Count	Pct of Total
By two private organizations on public lands	334	76.6
By two private organizations on private lands	73	16.7
By other hunters on private lands	29	6.7
Total for year from NJF&W	436	100.0

Our two private organizations provide the data for the first and second rows above. Over half of these kills are with archery equipment. All lawful kills are reported to NJF&W and it notifies us of the total for the season. The third row is the net of the last row less the first two.

Note that the total harvest is equal to 38% of the total population estimated in March. [436 / 1137 = 38%] Without hunting this past season, the deer population would be 38% higher than it is now.

Deer-Vehicle Collisions: Some deer are injured or killed in deer-vehicle collisions on public roads. Our local police report all those that are found dead on roads in the township, except for I78 and I287. We have kept careful records of these "roadkills" since DBY 2001. Attachment 2 contains the population and roadkill data and a chart.

Roadkill data includes the base year and the ten years of the program. In order to show the relationship between deer population and roadkills, the data has been normalized to the population reference year of 2002, and the chart shows this normalized data.

Over nine years (from 2002 to 2011) the deer population dropped to 52% of its reference value, and roadkills dropped to 50% of their reference value over the same period. This suggests that roadkills, for which data is available each year, may serve as a rough proxy for the deer population in those years when survey data is not available.

Using this reasoning, population declined steadily from 2001 to 2007 and then leveled off. Over the ten years of the program, roadkills declined from 289 to 129, a change of 55%. It is reasonable to conclude that the deer population declined by about the same amount over the ten years of the program.

NJF&W estimates that 15 roadkills should be added for each 100 reported roadkills to account for those that are hit and go off the road to die, and for collisions on I78 and I278. This leads to an estimated reduction in roadkills of 184 per year by our tenth year.

A rough estimate of the average cost to repair a car after a collision in which a deer is killed is \$2,500. This leads to an estimate for avoided costs of \$460,000 per year.

There are many deer-vehicle collisions that do not result in a dead deer and are not reported, and there may be vehicle damage.

There have been serious human injuries and deaths from deer collisions in nearby towns. Fortunately, Bernards has not had these, but there are risks. We believe that our deer program has reduced these risks substantially.

Note that the reported roadkills this past year are equal to 11% of the surveyed population.

If we add the totals reported for harvest and roadkills we get 565 deer. This is 50% of the current population estimate. If we note that the population for four years is near the current level, and if we define fertility in terms of new fawns that survive to the next DBY, then we may conclude that this fertility averaged over both males and females is 50%. There are also unreported deaths and these are offset by an additional fertility increment that we have no way to estimate.

Deer Ticks: The tick with the official names of "black legged tick" and "*Ixodes scapularis*" is called "deer tick" in our region, and it is common. The white tail deer is the primary host for this tick in its adult stage. The DMAC has made no independent study of these ticks.

Dr. Robert A. Jordan and Dr. Terry L. Schulze have surveyed these ticks during six of the years of our program: calendar 2002, 2003, 2004, 2005, 2009, and 2010. They collected tick nymphs at ten "culling" sites in Bernards Township and ten "remote" sites outside the township. We understand that this work will be described in a report to be submitted to the CDC in June.

Dr. Jordan has forwarded summary data to us for inclusion in our report. This and a chart appear in Attachment 3.

We hope that lower deer density in Bernards will eventually lead to lower tick density. The survey data don't yet show any downward trend in nymph density. Deer are probably not a limiting factor for ticks at the current density of 46 deer per square mile.

Lyme Disease: This disease is caused by the spirochete *Borrelia burgdorferi*. The deer tick is the major vector for this spirochete and that's why we are interested in these ticks. With no apparent change in tick density we did not expect to see a change in the cases of Lyme Disease. However, the data for Bernards do show a decline in Lyme cases during our program.

Attachment 4 is the same as Attachment 2, but with the addition of reported Lyme Disease cases. Note that Lyme cases are shown in the DBY that overlaps the calendar

year in which the cases were reported. This is done to align these cases better with the population and roadkill data.

The pattern for Lyme cases in the chart is not as clear as that for roadkills. Except for the high-case year of 2007, there does appear to be a decline from DBY 2002 to 2011. To better evaluate this trend we analyzed Lyme cases in neighboring municipalities. Dr. Jordan sent us data for the calendar years 2001-2009 for our neighbors Harding, Warren, Bridgewater, Bedminster, Far Hills, and Bernardsville. Longhill was not included.

This additional data and analysis are in Attachment 5. Chart 1 is a column chart with the case rates for Bernards and for the aggregate rates for the six other towns for the calendar years 2001-2009. Rates are cases for each 10,000 in population. Both Bernards and the neighboring towns show declines.

Chart 2 is a trendline analysis for Bernards, and Chart 3 is the same for the neighboring towns. Both lines show downward slopes, but the Bernards slope is twice as steep, starting with a higher case rate (11 vs 8 cases) and ending slightly lower (4 vs 5 cases).

Some of our neighbors encourage deer hunting, but none has as vigorous a program as Bernards. We can't say with certainty that the Bernards deer management program has reduced Lyme Disease in the township, but the data does point in this direction.

Richard Ostfield, in his 2010 book *Lyme Disease: The Ecology of a Complex System*, presents data and analysis that suggest a path by which Lyme Disease can decline without a decline in deer ticks.

- Lower deer density will lead to greater biodiversity, starting with regrowth of native plants and understory and followed by small animals that thrive in these habitats.
- Greater diversity will present questing larva and nymphs with a greater variety of hosts, some of which are less efficient reservoirs and transmitters of the Lyme spirochete than is the white footed mouse. The latter is the principal host for ticks in the larva and nymph stages in low diversity environments and is a very efficient transmitter.
- Fewer questing ticks will become infected with the Lyme spirochete.
- Humans bitten by ticks will have lower risk of infection.

This thesis is speculative at this time. But it does suggest some avenues of research by others. Example: It would be interesting to learn how the fraction of infected ticks varies with location and over time.

Other Benefits of Program: With fewer deer roaming about there should be less deer feces where children play. We have made no attempt to measure this.

- Very high on the list of concerns at the start of the program was loss of woodland understory. Catherine Schrein, Manager of the Department of Environmental Science, Somerset County Park Commission, reports improvements at the Environmental

Education Center. This is a 425-acre, mostly wooded tract near our east boundary and part of The Great Swamp Basin. (It is in District D in Attachment 1.) She notes the appearance of early spring flowers and oak and maple saplings as tall as two feet. A few years ago all seedlings were regularly browsed to the ground.

This might be a good place to monitor tick infection rates over time and then compare them with rates in locations where there is no understory regrowth.

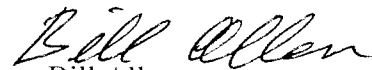
- Some residents have reported less shrubbery damage from deer browse.
- Many of the harvested deer are butchered at township expense (currently \$66 each) and donated to food banks designated by NJF&W.

Looking Ahead: The roadkill chart in Attachment 2 suggests that the methods and strategies employed so far have achieved substantial success, but that more will be needed to drive the deer population below the current 46 per square mile. Some considerations follow.

- In 2010 the state enacted legislation that will allow archery hunting within 150 feet of an occupied building. The minimum distance used to be 450 feet and this continues in force for guns. Our hunting organizations took advantage of this change in some locations this past season and found it helpful. We will look for more tracts where this rule will provide better access or access for the first time.
- We do not have hunting access to some large private tracts, such as two golf courses. We will continue to try to get access to these tracts.
- Some of our residents set up feeding stations for deer during the winter. These draw deer away from bait sites set up for the deer culling program. We will consider a local ordinance to ban this private feeding.
- We will consider very intensive hunting in a limited area to determine if this will drive the population down and keep it down in that area. If we try this strategy we may ask CDC for funds for a limited aerial survey to monitor progress.



Dan Snyder
Deer Management Wildlife Administrator
and Vice Chair of the DMAC



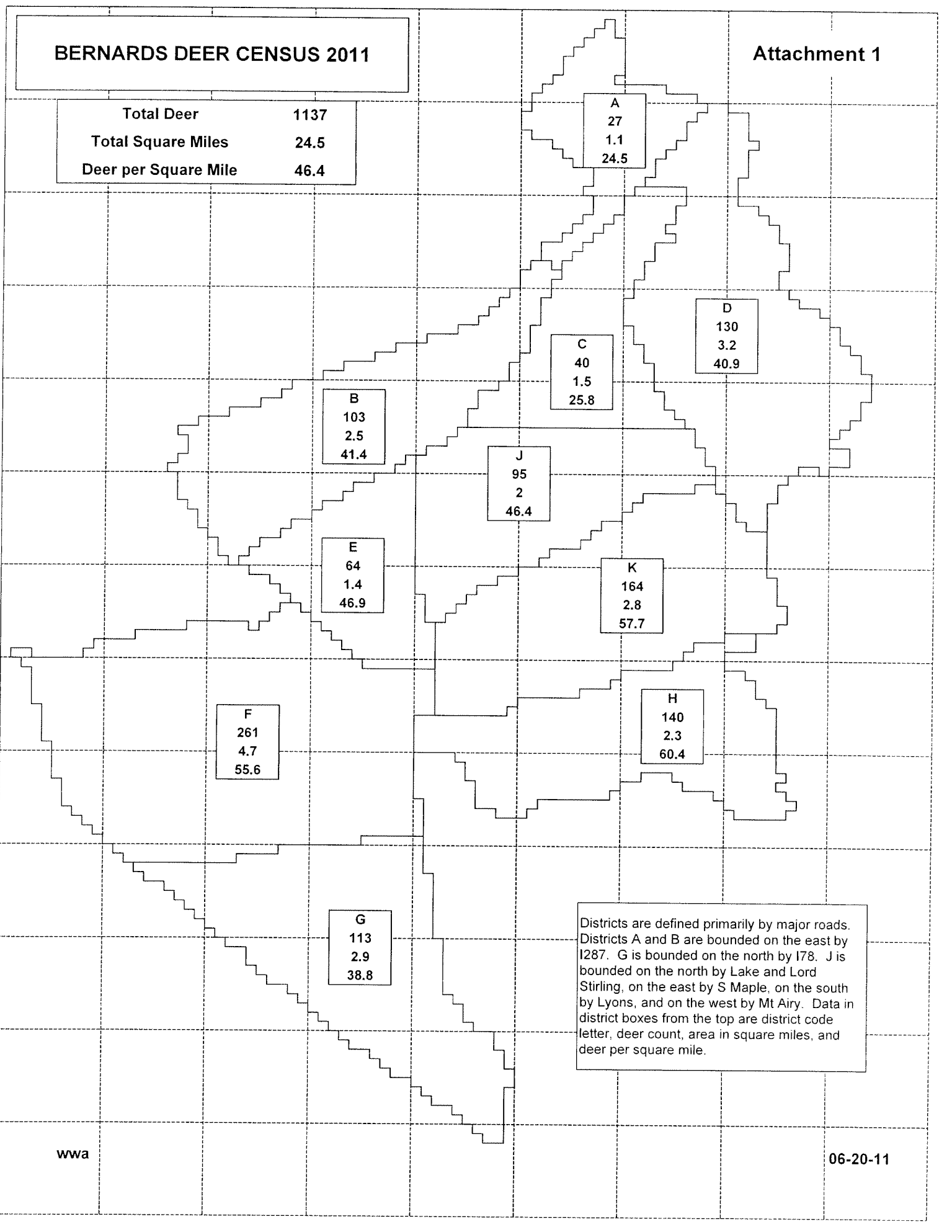
Bill Allen
Chair of the DMAC

enc: Attachments 1 thru 5.
Map of township streets with overlay of deer found in aerial survey.

BERNARDS DEER CENSUS 2011

Attachment 1

Total Deer	1137
Total Square Miles	24.5
Deer per Square Mile	46.4



Districts are defined primarily by major roads. Districts A and B are bounded on the east by I287. G is bounded on the north by I78. J is bounded on the north by Lake and Lord Stirling, on the east by S Maple, on the south by Lyons, and on the west by Mt Airy. Data in district boxes from the top are district code letter, deer count, area in square miles, and deer per square mile.

DEER POPULATION AND ROADKILLS TO 2011

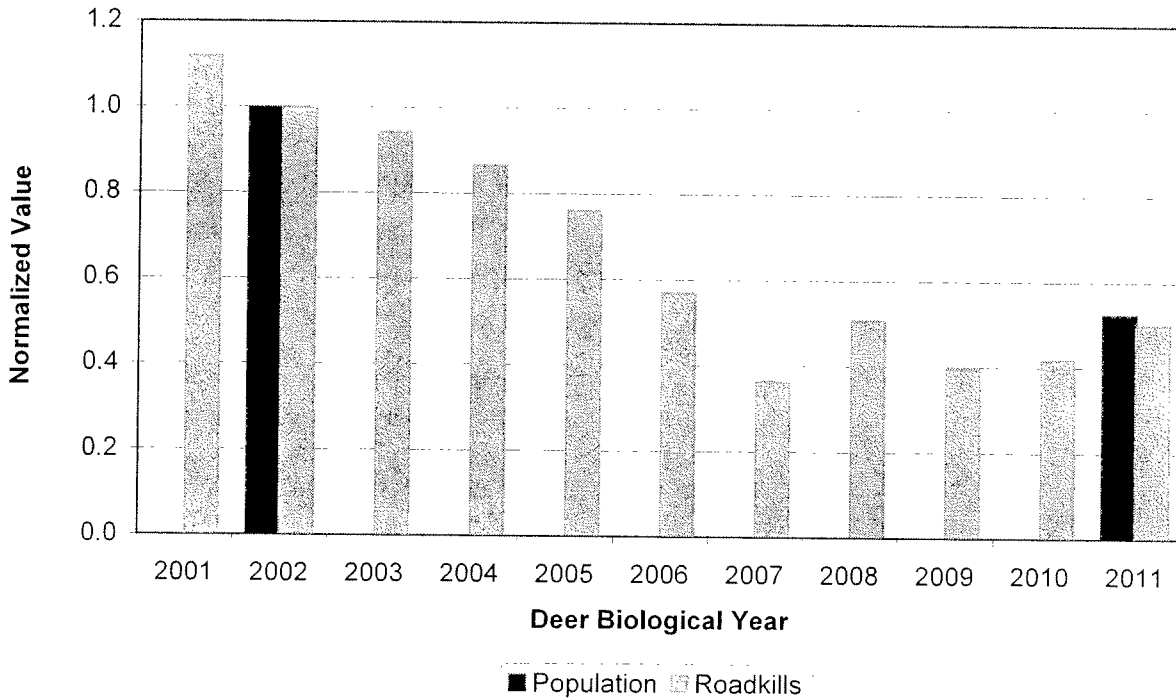
Attachment 2

<> Population estimates are from IR aerial surveys in April 2002 and March 2011. The official estimate for 2011 is 1,137 and does not include 34 "possible" deer.
 <> Roadkills are reported by township police for roads inside township, but not on I78 and I287. Totals are for Deer Biological Year that runs thru March 31.

Deer Biological Year	Data as reported		Data normalized by dividing by values for 2002	
	Population	Roadkills	Population	Roadkills
2001		289		1.12
2002	2170	258	1.00	1.00
2003		243		0.94
2004		223		0.86
2005		196		0.76
2006		147		0.57
2007		94		0.36
2008		131		0.51
2009		102		0.40
2010		108		0.42
2011	1137	129	0.52	0.50

Deer Population and Roadkills

Plotted values are normalized to 2002



DEER TICK NYMPHAL ABUNDANCE

Attachment 3

Tick is black legged tick (*Ixodes scapularis*).

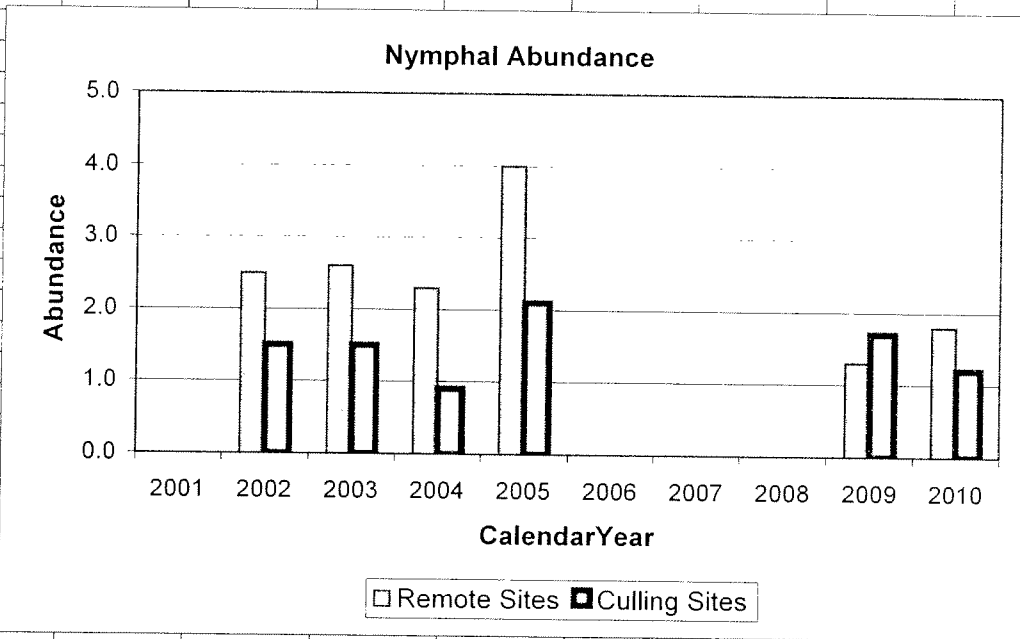
Data from Bob Jordan Table 2 in msg on 04-27-11.

Culling sites are in Bernards Township.

Remote sites are outside Bernards Township.

Abundance numbers are ticks found in a transect 100 meters long and 1 meter wide and are the averages over ten sites.

Nymph Abundance		
Calendar Year	Remote Sites	Culling Sites
2001		
2002	2.5	1.5
2003	2.6	1.5
2004	2.3	0.9
2005	4.0	2.1
2006		
2007		
2008		
2009	1.3	1.7
2010	1.8	1.2



06-21-11

rev

DEER POPULATION, ROADKILLS, AND LYME CASES

Attachment 4

<> Population estimates are from IR aerial surveys in April 2002 and March 2011. The official estimate for 2011 is 1,137 and does not include 34 "possible" deer.

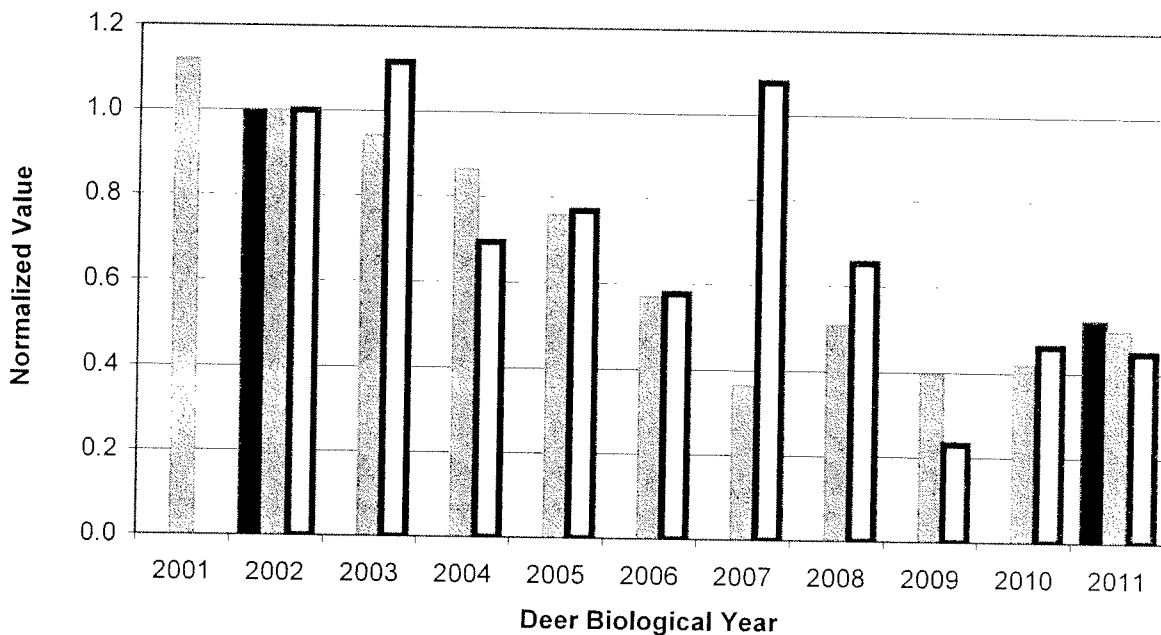
<> Roadkills are reported by township police for roads inside township, but not on I78 and I287. Totals are for Deer Biological Year that runs thru March 31.

<> Lyme Disease cases are those reported for Bernards Township residents in state health records. Most Lyme cases are reported in April or later in the year and the state aggregates them for a calendar year. Therefore cases reported for calendar 2001 are shown below in DBY 2002, and the same for all other years.

Deer Biological Year	Data as reported			Data normalized by dividing by values for 2002		
	Population	Roadkills	Lyme Cases	Population	Roadkills	Lyme Cases
2001		289			1.12	
2002	2170	258	26	1.00	1.00	1.00
2003		243	29		0.94	1.12
2004		223	18		0.86	0.69
2005		196	20		0.76	0.77
2006		147	15		0.57	0.58
2007		94	28		0.36	1.08
2008		131	17		0.51	0.65
2009		102	6		0.40	0.23
2010		108	12		0.42	0.46
2011	1137	129	13	0.52	0.50	0.45

Deer Population, Roadkills, and Lyme Cases

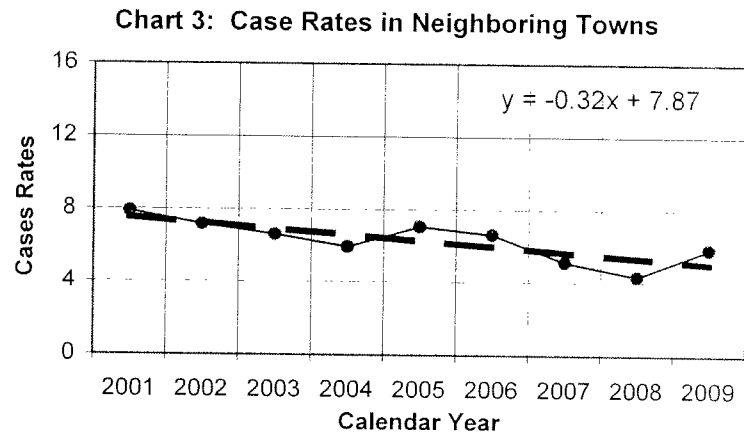
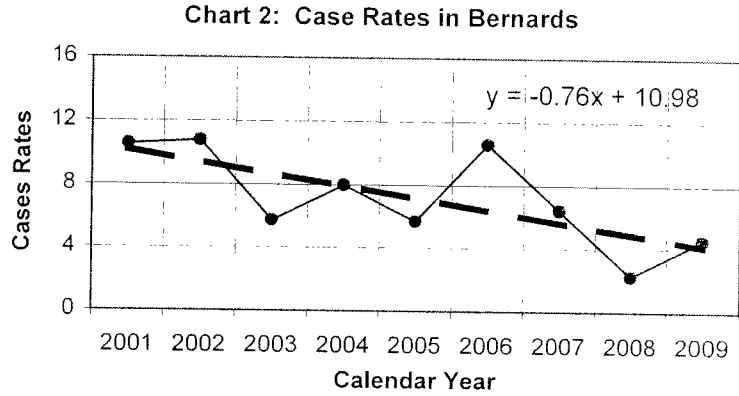
Plotted values are normalized to 2002



LYME CASES IN BERNARDS AND NEIGHBORING TOWNS

Attachment 5

Town	Year	Cases	Pop	Case Rate
Bernards	2001	27	25,621	10.5
Bernards	2002	28	25,955	10.8
Bernards	2003	15	26,072	5.8
Bernards	2004	21	26,261	8.0
Bernards	2005	15	26,333	5.7
Bernards	2006	28	26,425	10.6
Bernards	2007	17	26,445	6.4
Bernards	2008	6	26,542	2.3
Bernards	2009	12	26,542	4.5
Neighbors	2001	61	77,353	7.9
Neighbors	2002	56	78,167	7.2
Neighbors	2003	52	78,606	6.6
Neighbors	2004	47	78,914	6.0
Neighbors	2005	56	79,273	7.1
Neighbors	2006	53	79,672	6.7
Neighbors	2007	41	80,179	5.1
Neighbors	2008	35	80,591	4.3
Neighbors	2009	47	80,591	5.8



Case rates are cases reported for each 10,000 in population.

