

***Peristenus relictus (stygicus)* (Hymenoptera: Braconidae)
A Possible Biological Control Agent
For Tarnished Plant Bug, *Lygus lineolaris*, (Hemiptera: Miridae)
In New Jersey**

**Annual Report
2014**



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INTRODUCTION

Tarnished plant bug, (TPB), *Lygus lineolaris*, (Hemiptera: Miridae) (Figure 1) is a piercing sucking insect native to North America that feeds on over 300 plant species and causes at least two billion dollars in losses and control costs each year (Day 2002). Adults over-winter under leaf litter and become active during the first warm days of spring. Mating and oviposition occur within days and females lay 30 to 120 eggs during their lifespan. Eggs hatch within 10 – 12 days with life cycle completion in 3 to 4 weeks. Generally, there are 3 generations per year in New Jersey (Chianese 2001).



Figure 1. Tarnished plant bugs in rearing box.

The tarnished plant bug is widely distributed, and is present in all states east of the Rocky Mountains where it is a pest of many agricultural crops including vegetables, fruits and seed crops (Schwartz and Footit 1998). Feeding damage to these crops frequently goes unnoticed because there are no visible signs of TPB feeding so crop damage is not obvious until weeks after feeding has occurred (Day 2002). The injury causes a reduction in yield due to a severe distortion of fruit or plant terminals. Growers routinely use broad-spectrum insecticides as a prophylactic treatment on high value crops however, these spray treatments may cause secondary pest problems by reducing beneficial insect populations that keep minor agricultural pests at tolerable levels.

In early spring, the majority of TPB damage occurs on tree fruit, due to the reservoir of TPB found in the blooming annual weeds. The TPB feeds on these weeds and as the weeds die or senesce, they move up onto the developing fruit buds, blossoms and young fruit. (PSU 2000). Damaged flower clusters appear dried and the leaves have a distorted appearance. The damage to the fruit is the major concern, because it can cause punctures or deep dimples to form as the fruit develops, resulting in deformities known as “cat facing” (Spangler et. al. 1991). In New Jersey, the TPB and other “cat facing” insects are the single largest cause for insect fruit damage in peaches statewide and over most varieties” according to Rutgers Cooperative Extension Fruit IPM coordinator Dean Polk (Chianese 2001).

The TPB has a number of natural enemies such as other true bugs (nabids, geocorids), ladybird beetles, spiders and parasitic wasps, but they are not able to effectively control the pest (Spangler et. al.1991). In an attempt to reduce indigenous TPB populations, the United States Department of Agriculture – Agricultural Research Service (USDA-ARS) introduced two species of European parasitoids, *Peristenus digoneutis* and *Peristenus relictus (stygicus)* (Hymenoptera: Braconidae) (Figure 2). These multivoltine species have been found to parasitize significant numbers of TPB nymphs in certain forage crops and strawberries (Day and Tatman 2005, unpublished data). In addition, *P. digoneutis* has also been shown to reduce “cat facing” damage to apples in New Hampshire by 63% (Day 2003).



Figure 2. *P. relictus* attacking tarnished plant bug nymph (L) and adult female (R).

Dr. William Day of USDA-ARS released *P. digoneutis*, a native of Northern Europe, in New Jersey in the early 1980's. The parasitoid became well established in Northwestern New Jersey by 1988 (Day, et. al. 1990), and had not been recovered south of Hunterdon County until the New Jersey Department of Agriculture recovered it in 2003 in Gloucester County. Researchers hypothesized that the Southern New Jersey climate was not as conducive to the establishment of *P. digoneutis*, which thrives in a more northerly European climates. Another parasitoid, *P. relictus* was imported from Southern Europe, where the climatic match is near that found in Central and Southern NJ; the regions where most of the high cash crops such as peaches, apples and strawberries are grown.

MATERIALS AND METHODS

In the fall of 2000, field staff from PABIL, using standard insect sweep nets, surveyed alfalfa, hay, and fallow fields for the presence of TPB. The sweep surveys resulted in a list of possible locations for initial parasitoid releases. Survey results, were also used to establish baseline TPB population data and native parasitoid occurrence.

The original 2001 Whig Lane and subsequent 2002-2003 Cedar Road release sites were in Gloucester County alfalfa fields surrounded by and in close proximity to both apple and peach orchards. These fields were minimally disturbed, seldom treated with insecticides and the growers' alfalfa management practice of harvesting in strips staggered throughout the growing season at the release sites was favorable for parasitoid development and establishment. This practice maintained some TPB in the field, providing a continuous reservoir of nymphs for parasitism by *P. relictus*.

The "uncut strips" in the release field were sampled weekly using standard insect sweep nets (Figure 3) with samples consisting of 100 sweeps/field. The collections were placed into a sleeve cage (Figure 4) and the number of TPB adults and nymphs were counted and recorded. If a minimum number of 100 TPB nymphs was not collected in the first 100-sweep sample then additional sweeps were taken until 100 nymphs were collected. The nymphs were packaged, kept cool overnight, and transported to the PABIL, where they were set to recover the parasites.



Figure 3. Sweeping for TPB



Figure 4. Sleeve cage

In 2004, two additional release sites were set up, one in Mantua Township, Gloucester County and the other at the Rutgers Research Farm in Upper Deerfield Township, Cumberland County. The same sampling procedures used for 2001-2003 was followed at both of the new sites. The new sites were on “set-aside” or fallow ground with high weed populations. Marestalk, *Conyza canadensis* (Asteraceae) was the prominent weed species at both sites. Preliminary field observations in 2000 found high TPB populations in weedy locations and weedy fields were less disturbed by normal harvesting and cultivating practices.

During the 2005 season, three new alfalfa fields were added to the program. The sites were in Vineland in Cumberland County and Mannington in Salem County. The 2004 Cumberland County site at Rutgers Centerton Farm was strip-planted with wild flowers to attract more TPB and provide a more diverse weed population. The Phillip Alampi Beneficial Insect Laboratory also implemented a new laboratory-rearing technique using an artificial diet in that gave the laboratory the ability to produce substantially more *P. relictus* than previous years shown in Table 1.

Table 1. *Peristenus relictus* Releases in New Jersey

Release Year	Number of Sites	Number Released
2001	1	250
2002	1	1,650
2003	1	930
2004	2	3,400
2005	10	18,625
2006	13	21,500
2007	23	40,000
2008	39	51,000
2009	20	15,800
2010	11	4,700
2011	16	28,750
2012	14	11,500
2013	8	11,750
2014	8	21,500
Total		231,355

In 2006, PABIL entered into a cooperative agreement with the USDA-ARS and Delaware State University to produce, release and monitor *P. relictus* in Delaware and New Jersey. Under the terms of the agreement, PABIL would provide parasitized *L. lineolaris* nymphs and adult *P. relictus* for New Jersey and Delaware release. There were six alfalfa study sites consisting of two *P. relictus* adult release sites, two parasitized TPB nymph release sites and two control sites in each state. Delaware cooperators were responsible for processing of weekly nymph collections from both states, as well as rearing and dissecting a portion of the collections.

RESULTS AND DISCUSSION

In 2014, field staff targeted sampling sites in areas that received high concentrations of releases in the past with the surveys beginning in June and continuing through September. The reason for this procedural change was that in theory, the areas that received large numbers of releases in successive years should have high numbers of parasites, and that the resulting collections would yield the best probability for parasite recovery. Between July 9 and October 2, field personnel made eight nymphal collections. The collections were transported to the laboratory, processed, and set up to recover the parasitoids. Only two species of Braconid were recovered in 2014, the native species *Leiophron uniformis*, and *P. digoneutis*. Table 2 shows the total number of *Peristenus* recovery locations by township and location from 2004-2014 which can also be viewed graphically in Figure 5. It was expected that *P. relictus* recoveries would increase over

time once the weather conditions are more conducive for an increase in the tarnished plant bug populations but 2010 was only year where substantial recoveries were made and all of those were *P. digoneutis*. The lack of *P. relictus* recoveries is concern although *P. digoneutis* was recovered almost a decade after the first releases (Day, et. al. 1990). If *P. relictus* is present, it should start to show up. Halloran and Tumlinson (2011) showed that *Lygus* spp. are attracted more to flowers and weeds so we might be looking for the parasites in the wrong locations, i.e. an alfalfa field versus wildflowers.

Figure 6 shows the location of the release fields and any parasitoid recoveries. *P. digoneutis* continues to be recovered by field staff in South Jersey, although not in high numbers. *P. digoneutis* was recovered by field personnel in Cape May in 2010 and that is the first recovery in South Jersey outside the initial survey area of Salem/Gloucester/Cumberland Counties.

Table 2. Location and Year of Recovery of Peristenus spp. (PD=*Peristenus digoneutis*/PR= *Peristenus relictus*)

County	Location/(Year established)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Gloucester	Elk, Whig Lane (2001)	(1) PD	(6) PD	(8) PD	(1) PD	(4) PD		(55) PD				
Gloucester	East Greenwich, Cedar Road (2003)	(1)PD	(6) PD			(9) PD	(1) PD		(2) PD			
Gloucester	Woolwich, Davidson Road (USDA) (2006)			(1) PD								
Cape May	Lower, Villas WMA (2009)							(1) PD				
Cumberland	Deerfield, Kenyon Ave (2008)							(1) PD				
Cumberland	Upper Deerfield, Polk Lane (2004)			(1) PR				(2) PD			(1) PD	
Cumberland	Upper Deerfield, Freisburg Road (2006)								(2) PD		(3) PD	
Salem	Upper Pittsgrove, Daretown Road (USDA) (2006)			(1) PD					(12) PD			
Salem	Mannington, Haines Neck Rd. (2007)							(3) PD				
Salem	Pittsgrove, Maple Grove (2008)							(2) PD				
Salem	Pilesgrove, Acton Station Rd. (2005)					(1) PD	(1) PD					
Salem	Pittsgrove, Pole Tavern (2008)						(1) PD					
Salem	Pittsgrove, Foote Ln. & Richwood Rd.(2007)						(3) PD					
Salem	Pittsgrove, Hughes Rd. (2008)						(2) PD					
Salem	Alloway,Holly Hills WMA, (2014)						(1) PD	(6) PD				
Mercer	Hopewell, Honeybrook Farm (2006)											(1) PD
Mercer	Hopewell, Rosedale Park (2014)											(1) PD
Total		2	12	10 (1)	1	14	9	70	16	0	4	2

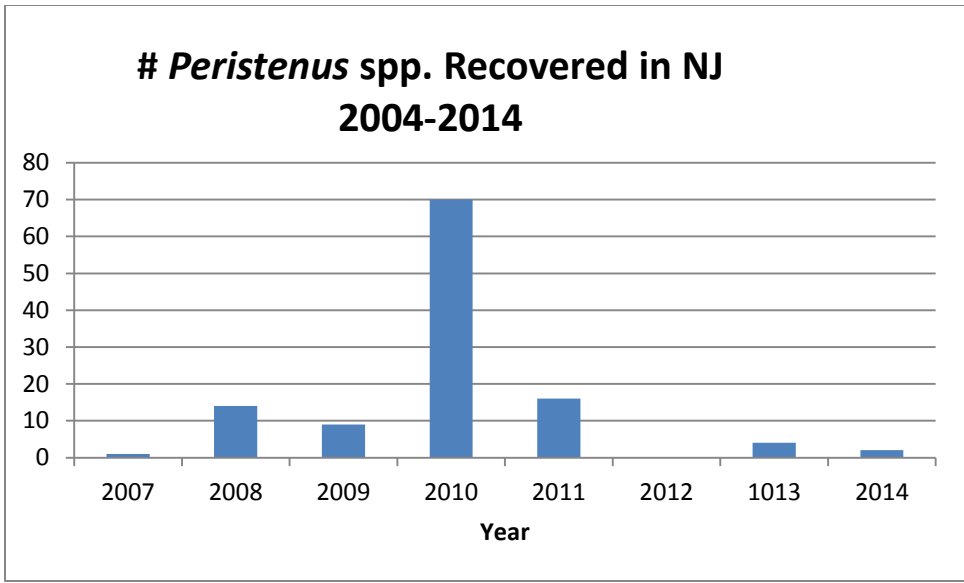
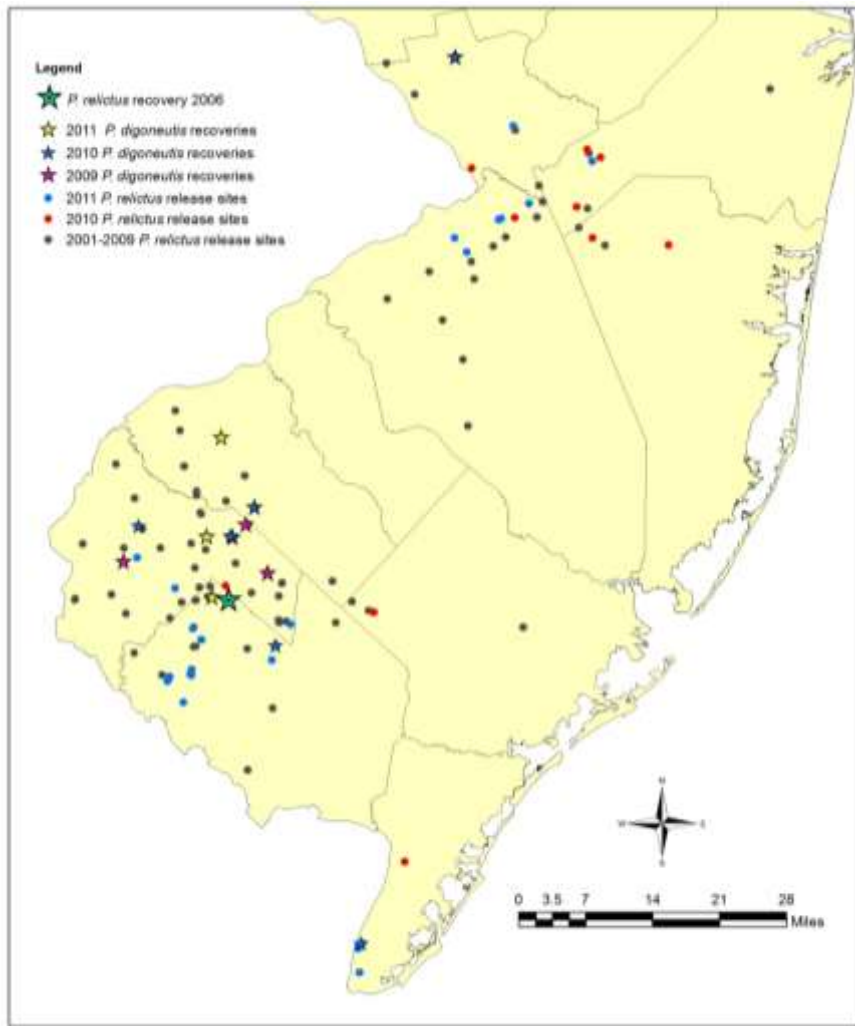


Figure 6. *Peristenus* spp. Release and Recovery Sites in NJ



Despite the 231,355 *P. relictus* that have been released in the state, only one recovery of that species has been made in South Jersey. As stated previously, Day, et. al. (1990) showed that another species, *P. digoneutis*, was not recovered until the late 80's after the initial releases so it might be too soon to expect to recover *P. relictus* but far more *P. relictus* than *P. digoneutis* were released in equivalent periods. The fact that we have not recovered *P. relictus* may possibly be due to other factors 1) *Lygus* spp. prefer weeds to alfalfa so we may have to concentrate on weedy fields versus crops; 2) *P. digoneutis* is in South Jersey and *P. relictus* may not be able to compete with it; 3) the two species may hybridize; 4) The climate may not match well for *P. relictus*; 5) the weather conditions during the survey season may not be conducive to the recovery of the parasites because of insufficient host material.

Conclusion

In 2014, the lack of a *P. digoneutis* being recovered is probably due to the fact that, field collections were down due to program and personnel constraints. In order for *P. relictus* to be recovered and this program to be successful, a significant *Lygus* host population is necessary which was not present during 2014. The recoveries of parasites will be difficult as long as host populations and field collections remain low. This could mean that a much longer period of time will be necessary for the parasites to build up their numbers to noticeable levels such as was the case with *P. digoneutis* (Day, et. al. 1990).

2015 Plans

The same 2014 protocol for surveys and collections will be used in hopes of increasing the chance for recovery but weedy field filled with wildflowers will also be extensively sampled. The 2004 release site where *P. relictus* was initially recovered in 2006 will continue to be highly surveyed. New release sites of *P. relictus* will be at least a ½-mile away from all previous release sites. Releases will begin at the first appearance of nymphs and will continue weekly or biweekly throughout the growing season. Release locations will continue to expand into Burlington, Mercer, Monmouth, and Cape May Counties. Surveys will be conducted in newer areas where there were releases made in the past but no surveys were previously made.

Photo credits: M. Mayer, NJDA, PABIL

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Appendix 1. *Peristenus relictus* Release Sites in New Jersey.

County	Location (Township & Road)	Release Year	Dates	Number Released	Total
Gloucester	Elk, Whig Lane *	2001	7/27-8/24	250	250
Gloucester	Elk, Whig Lane	2002	6/14-9/25	1,650	1,650
Gloucester	East Greenwich, Cedar Road *	2003	8/1-10/30	930	930
Gloucester	Mantua, Jackson Road	2004	7/2-9/30	1,750	
Cumberland	Upper Deerfield, Polk Lane *	2004	7/23-9/17	1,650	3,400
Cumberland	Vineland, Maple Avenue *	2005	6/21-8/23	4,750	
Salem	Mannington, Acton Station Road *	2005	6/24-8/29	5,125	
Salem	Mannington, Rt. 45 Acton Sta. Rd. *	2005	6/24-8/19	3,625	
Atlantic	Buena Vista, Brewster Road	2005	9/2-9/9	1,375	
Salem	Upper Pittsgrove, Burl.-Shirley Rd.	2005	9/9	500	
Salem	Pittsgrove, Daretown-Aldine Rd.	2005	9/23	750	
Salem	Oldmans, Pennsville-Pedricktown Rd.	2005	9/30	750	
Salem	Elsinboro, Mason Point Road	2005	10/7	500	
Cumberland	Stow Creek, Causeway Rd. & Stow Creek Rd.	2005	9/16	750	
Cumberland	Fairfield, Rahmah & Cedarville Road	2005	10/14	500	18,625
Gloucester	<i>USDA-Harrison, Bishop Rd. * PN</i>	2006	6/30-8/25	3000	
Gloucester	<i>USDA-Woolwich, Davidson Rd. * PN</i>	2006	6/30-9/22	5000	
Salem	<i>USDA-Lower Alloways Ck, Beasley Neck Rd.*</i>	2006	6/30-9/01	1750	
Salem	<i>USDA-Upper Pittsgrove, Daretown Lake *</i>	2006	6/30-9/22	2750	
Cumberland	Upper Deerfield, Friesburg Road 4 Fields	2006	6/8-10/13	3000	
Mercer	Hopewell, Honey Brook Organic	2006	5/25	500	
Salem	Upper Pittsgrove, Route 581	2006	7/5	500	
Cumberland	Downe, Route 734 and 637	2006	7/7	1000	
Cumberland	Upper Deerfield, Tice Lane	2006	11/1	1000	
Cumberland	Hopewell, Trench Road	2006	11/1	500	
Cumberland	Upper Deerfield, Griens Lane and Burlington Rd	2006	6/23	500	
Cumberland	Hopewell, Barretts Run	2006	6/16-10/20	1000	
Cumberland	Hopewell, Beals Mill Road	2006	6/20-10/13	1000	21,500
Gloucester	<i>USDA-Harrison, Bishop Rd. * PN</i>	2007	6/26-9/27	7,000	
Gloucester	<i>USDA-Woolwich, Davidson Rd. * PN</i>	2007	6/26-9/27	7,000	
Salem	<i>USDA-Lower Alloways Ck, Beasley Neck Rd.*</i>	2007	6/26-9/27	3,500	
Salem	<i>USDA-Upper Pittsgrove, Daretown Lake *</i>	2007	6/26-9/27	3,500	
Atlantic	Buena Vista, Brewster Road	2007	7/17	1,000	
Cumberland	Hopewell, Barretts Run and Trench Road	2007	6/26	1,000	
Cumberland	Hopewell, Bridgeton and Greenwich Road	2007	7/20	1,000	
Cumberland	Hopewell, Greenwich Rd. & Mosley Rd. field 1	2007	6/12	1,000	
Cumberland	Hopewell, Minches Corner Rd. & Mosley Rd.	2007	6/15	1,000	
Cumberland	Hopewell, Roadstown-Greenwich Rd.	2007	7/20-8/14	1,500	
Cumberland	Hopewell, Sewall Rd. & Beebe Run Rd.	2007	6/15	1,000	
Cumberland	Hopewell, Shoemaker Rd.	2007	6/12	1,000	
Cumberland	Greenwich, Springtown Rd.	2007	7/6	1,000	
Cumberland	Hopewell, Greenwich Rd. & Mosley Rd. field 2	2007	10/4	500	
Cumberland	Deerfield, Alvin Rd. & Route 56	2007	10/4	500	
Cumberland	Hopewell, Earnest Garton Road	2007	10/4	500	
Salem	Mannington, Haines Neck Road	2007	7/13	1000	
Salem	Pilesgrove, Layton Road	2007	6/29	1000	
Salem	Mannington, Money Island Road	2007	7/3	1000	
Salem	Pilesgrove, Pointers-Auburn Rd. & Featherbed Ln.	2007	6/29-8/16	1,500	
Salem	Pilesgrove, Whig Lane	2007	6/19	1,000	

Salem	Pennsville, Chestnut Ln. & Supawna Rd.	2007	10/11-10/18	2,000	
Salem	Pittsgrove, Foote Lane	2007	10/11	500	40,000
County	Location (Township & Road)	Release Year	Dates	Number Released	Total
Gloucester	<i>USDA-Harrison, Bishop Rd. * PN</i>	2008	6/24-9/18	6,500	
Gloucester	<i>USDA-Woolwich, Davidson Rd. * PN</i>	2008	6/24-9/18	6,500	
Salem	<i>USDA-Lower Alloways Ck, Beasley Neck Rd. *</i>	2008	6/24-9/18	3,250	
Salem	<i>USDA-Upper Pittsgrove, Daretown Lake *</i>	2008	6/24-9/18	3,250	
Atlantic	Buena Vista Twp. Route 655	2008	7/15	1,000	
Atlantic	Galloway Twp., Cologne Ave	2008	7/29, 8/12	1,250	
Burlington	Westampton Twp., Rt. 541, by MBB plot #44	2008	6/12	500	
Burlington	North Hanover Twp., Rt. 664 & Stewart Rd.	2008	6/12	500	
Burlington	Shamong Twp., Route 206 South	2008	8/12, 8/15	1,750	
Burlington	Hainesport Twp., Eayrestown road by the ship	2008	8/19	1,000	
Burlington	Hainesport Twp., Centerton road by the ship	2008	8/19	1,000	
Cumberland	Deerfield Twp. Carmel Road	2008	6/27, 8/22	1,000	
Cumberland	Hopewell Twp. Columbia Hwy. & Minches Corner Rd.	2008	6/24	500	
Cumberland	Hopewell Twp., Barretts Run Rd.	2008	6/24	500	
Cumberland	Deerfield Twp., Kenyon Ave.	2008	7/18-8/22	1,500	
Cumberland	Deerfield Twp., Central Ave.	2008	7/25, 8/26	1,000	
Cumberland	Deerfield Twp., Alvine Rd.	2008	7/25- 8/26	2,000	
Cumberland	Hopewell Twp. Earnest Garton Rd.	2008	8/15	1,000	
Gloucester	Harrison Twp. Harrisonville Rd.	2008	7/11	500	
Gloucester	Franklin Twp. Route 40 Malaga	2008	8/8, 8/22	1,250	
Gloucester	Harrison Twp. Harrisonville Way	2008	8/15	1,000	
Gloucester	Harrison Twp. Eldridge's Hill Rd. Harrisonville	2008	8/29	500	
Gloucester	Logan Twp. Mill Rd. & Stone Meeting House Rd.	2008	10/16	1,000	
Gloucester	Logan Twp. Rt. 130 and Floodgate Rd.	2008	10/16	1,000	
Salem	Pittsgrove Twp. Alvin Rd.	2008	7/1, 8/22	1,000	
Salem	Pittsgrove Twp. Crow Pond Rd.	2008	7/1	500	
Salem	Alloway Twp. Canhouse Rd.	2008	7/3	500	
Salem	Pittsgrove Twp. Hughes Rd.	2008	7/3, 8/22	1,000	
Salem	Pittsgrove Twp. Holdcraft Rd.	2008	7/3	500	
Salem	Pittsgrove Twp. Upper Neck Rd.	2008	7/18, 8/22	1,000	
Salem	Quinton Twp. Pecks Corner Rd.	2008	7/22	500	
Salem	Pilesgrove Twp. Haines Neck Rd.	2008	8/8	750	
Salem	Pittsgrove Twp. Pole Tavern Monroeville Rd.	2008	9/11	500	
Salem	Alloway Twp. Rt. 603 before Brickyard Rd.	2008	9/11	500	
Salem	Pittsgrove Twp. Rt. 553 past Christian Dr.	2008	10/9	1,000	
Mercer	Hopewell Twp. Honey Brook Organic Farm	2008	5/29, 6/5	2,000	
Monmouth	Colts Neck Twp. Dorbrook Rec. area off Rt. 537	2008	8/27	1,000	
Monmouth	Upper Freehold Twp. Assunpink WMA	2008	6/20	1,000	
					51,000
Atlantic	Buena Vista, Tuckahoe Road	2009	6/17	1,000	
Burlington	Spring Field, Juliustown Road	2009	6/17	1,000	
Burlington	Mansfield, Mount Pleasant Road	2009	6/24	1,000	
Burlington	Springfield, Jacksonville-Jobstown Road	2009	6/24	1,000	
Burlington	North Hanover, Route 664 and Stewart Road	2009	7/2	500	
Burlington	Mansfield, Route 68 West	2009	7/10	1,000	
Burlington	Southampton, Eayrestown Road	2009	10/8	200	
Burlington	Chesterfield, Ellisdale Rd. & Providence Line Rd.	2009	7/9	500	
Cape May	Lower, Higbee Beach WMA	2009	7/31	1,000	
Cape May	Lower, Villas WMA	2009	8/7 - 10/8	2,100	
Cape May	Dennis, Dennis Creek WMA	2009	7/17	500	
Mercer	Hamilton Twp., Extonville Rd. across from Russel Ln.	2009	7/24	500	
Mercer	Hopewell Twp., Route 579 at Route 637	2009	7/24	500	
Mercer	Hopewell Twp., Howell Living Farm	2009	7/24	500	
Mercer	West Windsor, Line Rd.	2009	7/24	500	
Monmouth	Upper Freehold, Route 539 & Schoolhouse Rd.	2009	7/9	500	
Monmouth	Upperfreehold, Holmes Rd.	2009	7/2	1,000	

Ocean	Plumstead, Route 537 & Highbridge Rd.	2009	6/25	1,000	
Ocean	Plumstead, West Colliers Mill Rd.	2009	6/25	1,000	
Ocean	Plumstead, Fischer Rd.	2009	9/24	500	
Total					15,800
County	Location (Township & Road)	Release Year	Dates	Number Released	Total
Atlantic	Buena Vista, Tuckahoe Rd. near Union Rd.	2010	8/19	200	
Burlington	Chesterfield, Honey Brook Organic Farm	2010	6/2 - 6/18	400	
Cape May	Lower, Dennis Creek WMA	2010	9/9	350	
Cape May	Lower, Higbee Beach WMA	2010	9-16 - 9/30	350	
Cumberland	Upper Deerfield, Griers Ln. and Burlington Rd.	2010	9/24	100	
Mercer	Hopewell, Honey Brook Organic Farm	2010	6/2 - 7/2	500	
Mercer	Hamilton, Duck Island	2010	7/21	400	
Monmouth	Upper Freehold, Assunpink WMA	2010	7/7 - 7/27	1,200	
Monmouth	Upper Freehold, Route 539 & Schoolhouse Rd.	2010	7/7	100	
Ocean	New Egypt, Good Tree Farm	2010	6/2 - 7/2	500	
Ocean	Plumstead, Fisher Rd.	2010	7/1	600	
Total					4,700
Burlington	Petticoat Bridge Road	2011	8/9	500	
Burlington	White Pine Road and Route 545	2011	8/9	250	
Burlington	Fernwood Farm, Georgetown	2011	8/16	1000	
Cape May	Villas WMA (Coxhall Creek WMA)	2011	6/14-10/7	8,500	
Cape May	Higbee Beach WMA, Lower	2011	7/15-7/22-7/29	3,000	
Cumberland	Greenwich Road and Mosley Road. Field #2	2011	6/28-9/16	500	
Cumberland	Columbia Highway, Hopewell TWP	2011	7/26	250	
Cumberland	Rt 56 Landis Avenue, Deerfield Twp	2011	7/29-9/23	500	
Cumberland	Shoemaker and Beebe Run Roads, Hopewell	2011	8/2	750	
Cumberland	Kenyon Road	2011	9/8	1500	
Cumberland	Greenwich Road and Mosley Road	2011	6/28-9/16	1,250	
Cumberland	Barretts Run Road and Trench Road, Hopewell	2011	9/16	750	
Cumberland	Morton Ave	2011	7/8-7/19-8/19	2,750	
Cumberland	Barretts Run Road, Hopewell	2011	7/15-9/2	2,000	
Cumberland	Back Neck Road	2011	10/7	750	
Mercer	Honey Brook Farm	2011	7/1	1000	
Mercer	Tindall Farm, Edinburg Road, West Windsor	2011	6/10	1000	
Monmouth	Assunpink WMA, East Branch Road	2011	8/26	500	
Ocean	Fisher Road, Plumsted	2011	8/26	750	
Salem	Alloway-Friesburg Road, Alloway Twp	2011	9/27	1250	
Total					28,750
Burlington	Route 537 and Route 635, North Hanover	2012	8/10	250	
Burlington	Honey Brook Organic Farm Harker and Ellisdale Rd.	2012	8/23	500	
Cape May	Cape May Villas WMA (Coxhall Creek WMA)	2012	8/14	500	
Cumberland	Freisburg Rd, Upper Deerfield	2012	6/22	750	
Cumberland	Barretts Run Rd & Trench Rd, Hopewell	2012	6/22	750	
Cumberland	Rutgers, Polk Lane, Upper Deerfield	2012	6/29,8/3,9/13	2000	
Cumberland	Route 56 Landis Ave, Deerfield	2012	7/10	750	
Cumberland	Hoover Rd, Upper Deerfield	2012	8/30, 9/6	750	
Gloucester	County Rd. 623, Elk	2012	6/22	1500	
Mercer	Saint Micheal's Preserve, DNR Greenway,	2012	9/20	1000	
Monmouth	Route 524, Upper Freehold	2012	7/10	750	
Salem	Layton Rd, Pilesgrove	2012	7/13	500	
Salem	Acton Station Rd, Mannington	2012	7/20, 8/7	1000	
Salem	Colson, Rd, Pittsgrove	2012	7/27	500	
Total					11,500
Cumberland	Sheppard's Mill Road, Greenwich	2013	7/11	1500	
Cumberland	Cohansey Golf Club, Fairfield	2013	7/26, 9/18	1000	
Gloucester	Route 40 near Main Rd, Newfield	2013	7/16	500	
Gloucester	Route 553 and Salina Rd, Deptford	2013	8/15	1000	
Mercer	Chickadee Creek Organic Farm	2013	8/13	500	
Salem	Newkirk Station Rd, Upper Pittsgrove	2013	7/19-8/2	2000	
Salem	Holly Hills WMA, Alloway	2013	8/7-9/4	4750	

County	Location (Township & Road)	Release Year	Dates	Number Released	Total
Salem	Acton Station Rd/Waldac Farm, Mannington	2013	7/26	500	
Total					11,750
Cumberland	Rutgers Polk Lane, Upper Deerfield	2014	6/27	1,500	
Cumberland	Freisburg Road, Upper Deerfield	2014	6/27	1,000	
Cumberland	Kenyon Road, Deerfield	2014	6/27	1,250	
Cumberland	Trench Road, Hopewell	2014	7/3	1,250	
Cumberland	Cohanzick WMA, Fairfield	2014	7/18, 10/18	2,500	
Salem	Richwood-Swedesboro Rd. , Upper Pittsgrove	2014	7/11, 8/13	1,250	
Salem	Pinyard Road, Upper Pittsgrove	2014	7/11	1,000	
Salem	East Lake WMA, Pilesgrove	2014	8/13-10/28	11,750	
Total					21,500