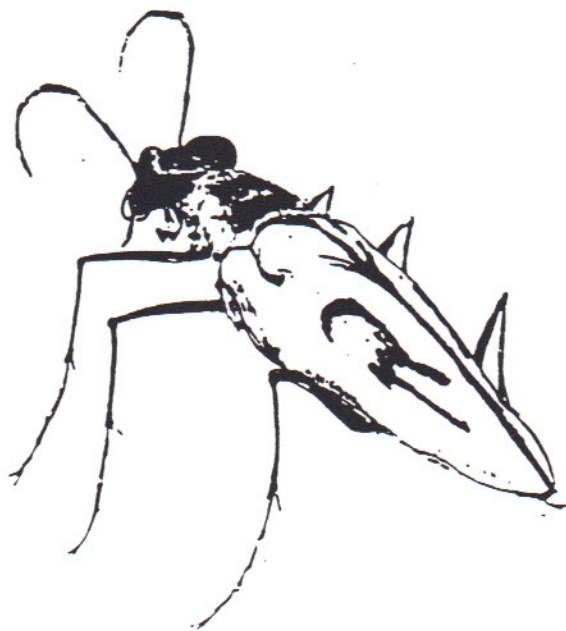


**DISTRIBUTION AND ABUNDANCE OF ADULTS AND  
LARVAE OF THE NORTHEASTERN BEACH TIGER  
BEETLE, *CICINDELA DORSALIS DORSALIS*, AT COVE  
POINT, MARYLAND, 1996-1997**

**FINAL REPORT**

**August 22, 1997**



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## INTRODUCTION

The Northeastern Beach Tiger Beetle, *Cicindela dorsalis dorsalis*, was listed as a Threatened species by the U. S. Fish and Wildlife Service in 1990 because of the extirpation of nearly all populations in the northeast and the lack of protection for populations in the Chesapeake Bay area. This species occurs at nearly 60 sites in Virginia but most are small in size and with very small populations. In Maryland, there are currently five known populations. The Calvert County populations at Western Shores Estates, Flag Ponds Nature Park, and Scientists Cliffs and the Eastern Shore populations at Janes Island and Cedar Island are all large, with over 500 adults in peak season. Small populations have been found sporadically over the past 10 years at Parker Creek and Drum Point, but few or no beetles have been found at these two sites in the last three years. In some years small numbers of beetles have been found at several other sites along the Calvert County shoreline, but these sites are not believed to support breeding populations..

The Cove Point population of *C. d. dorsalis* has been little studied except for annual surveys of adult numbers which I have done since 1988 along with surveys of other Calvert County sites. The adult population at Cove Point was much larger prior to 1992, with over 400 counted in 1988 (427), 1990 (707) and 1991 (406) (see Fig. 4). Since 1991 numbers have declined, with a low count of 194 in 1995. It is not certain if these low numbers in recent years represented a decline in habitat quality at the site or were a result of other factors of the population dynamics of this species. Like many other tiger beetles, *C. d. dorsalis* exhibits considerable year-to-year variation in abundance (2-3 fold variations in abundance are not uncommon), due to climatic factors or other abiotic and biotic factors which affect recruitment and survival.

Surveys of larvae can provide a good measure of habitat quality of a site and may also indicate future adult population trends. Little is known about the Cove Point larval population. The only larval surveys were conducted in fall 1991 as part of a study to assess possible impacts of *Phragmites* control on *C.*



*d. dorsalis* (Knisley and Hill, unpublished report). In that survey larvae were very restricted in distribution and abundance. Most of the two meter wide belt transects across the beach had only 2-4 larvae, and the maximum total larval count for four dates was 24. This compares with maximum densities of 50 to over 100 per transect found at large populations such as Flag Ponds. At Cove Point larvae were scattered over a rather wide area, from north of the pier to about 1000 meters south of it. Because of the low larval numbers it was suggested in the report that the Cove Point site may not provide a good habitat for larval recruitment and development. These low larval numbers relative to adult numbers might also lend support to the possibility that many of the adults moved in from other Calvert County sites rather than having developed and emerged at Cove Point. *C. d. dorsalis* is known to commonly disperse to new sites, possibly in response to high population densities. Mark-recapture studies in Calvert County indicated dispersal distances of 10-15 miles (Knisley and Hill, unpublished studies). However, the importance of immigration on the Cove Point population is not known, nor are the other factors which might influence abundance at this site.

The objectives of this study were to: 1. accurately determine adult population size and other parameters using census and mark-recapture procedures; 2. determine larval distribution, abundance, and habitat suitability; and 3. determine development pattern, survivorship and life cycle. Because larval numbers were found to be so low, objectives 2 and 3 could not be completed fully. Consequently, it was decided, with Board approval, that additional adult surveys would be done in summer 1997 as a substitute objective.

## METHODS

Prior to the adult and larval surveys in June 1996, the shoreline was divided into 200 meter sections, using stakes placed on the back beach or other shoreline landmarks (see Fig. 7). Adult and larval surveys and measurements of several beach parameters were determined within these separate sections. Photographs of representative sections of the shoreline were also taken and are included in this report (see photos 1-8). Both visual index counts and mark-recapture were used to determine adult population size in summer 1996. Only



the visual index count was used in 1997. The index count was done by walking slowly along the water edge and counting all beetles that were present. Counts were made when the weather was sunny and warm because under such conditions a high percent of the population will be active in the intertidal beach zone and visible. Care and experience are necessary to avoid missing individuals or counting beetles twice. This is accomplished by walking slowly, looking ahead 15-20 feet on the ground close to the water edge so that the beetles will fly up or run to the back beach as they are approached. On each sample date two counts were made, one while going down the beach (north to south) and another on the return from south to north. The highest of the two counts was used as the index count value.

For the mark-recapture method adult beetles were captured, marked, and released on seven dates, from late June to mid August. Six of the dates (June 25 to July 30) were the peak abundance period for *C. d. dorsalis*. The August 13 date was at a time when the population declined from peak numbers. On each date I moved slowly north to south along the beach, caught all beetles that were seen and placed them in individual vials. The vials were immediately transferred to a cooler and held until collecting was completed for the day. Two to three passes through the habitat were made so that a high percentage of the beetles present could be collected. The vials of beetles within each 200 m section of beach were kept together in separate plastic bags in the cooler, then released at the mid-point of the section within which they were collected. Before release the beetles were given a specific mark to indicate the date and section where they were collected. The marks were made by using a dissecting needle to scratch off a small patch of setae at specific locations along either the right or left side of the beetles body (see Fig. 1). Patches removed from the right side indicated date of capture and those on the left side indicated location of capture. The numbers of captures and recaptures on each date were recorded and later entered in a computer program to calculate the Jolly-Seber population estimate for each date.

In addition to population size other population parameters were determined from the mark-recapture study. Dispersal or movement of adults within the Cove Point site was determined by comparing mark and recapture locations of all recaptured beetles. The seasonal abundance of males and females was determined by keeping track of the sexes of all marked and recaptured beetles.



Longevity of adults was determined from the elapsed time between the mark and recapture dates. This method did not give a true measure of longevity but it did provide an indication of how long adults survive in the field.

Surveys of larval distribution and abundance were conducted by walking slowly along the intertidal zone of the beach and looking for the characteristic burrows of active larvae. These surveys were done on four dates from mid-September through October, 1996, and on three dates in March-April 1997. These surveys were done in early mornings or early evening when the sand surface was cool or moist since such conditions are necessary to insure a high level of larval activity. When the soil surface is warm or dry, larvae plug their burrows and cannot be seen and counted.

In fall 1996 and summer, 1997, beach width was determined at 100 meter intervals along the shoreline by measuring the distance between the most recent high tide and the vegetation line on the back beach. While this distance changes over time due to changes in tidal levels, it does give a comparative measure of beach width at different locations at Cove Point. In September 1996, beach slope and sand particle size distribution were also determined at 100 meter intervals. Beach slope was measured using a Topcon surveyor transit. Sand particle size distribution was determined from core (2 cm diameter x 20 cm long) samples taken by pressing a plastic tube into the sand at an area about 10-20 cms above the most recent high tide zone (in the wrack line). The core samples were brought to the laboratory, emptied into finger bowls, and dried at 100 C for 10 hours, then placed into a Keck Sand Shaker (Forestry Suppliers, Jackson, MS). The shaker included a set of graded sieves which separated the sand into five fractions: shells and coarse gravel (size 8), fine gravel (size 14), coarse sand (24), medium sand (30), fine sand (60). Samples from each sieve were placed into a graduated cylinder to determine volume of each fraction and from these, percents of each of the five fractions calculated.

## RESULTS

**Adult Population Estimates, 1996 and 1997.** The results of the visual index counts for the adults are shown in Figure 2. These results indicate adult numbers in 1996 were low and rather consistent (61-70) for the three dates from June 25 through July 5, then increased about three fold to over 200 on July 16 and July 30. The low count on July 20 was a result of weather conditions being unfavorable (cloudy and cool). On August 13, numbers decreased to 36, indicating the typical seasonal decline of the *C. dorsalis* population. Adult index counts in the summer of 1997 during peak season were very low: 26 on July 9, 32 on July 17, and 28 on July 25.

The Jolly-Seber mark-recapture method provided more complete information on the population size and dynamics of the Cove Point population. The numbers of new adults caught, marked and released ranged from 18 to 92 per date with a cumulative total of 301 (Fig. 3). The numbers of beetles recaptured (total of 103) were quite consistent during peak season, ranging from 16 to 24 per date, then declining to 8 recaptures on Aug. 13 (Table 1). The percent of recaptures was very high, ranging from 24 to 67%. Thirteen of these recaptured beetles had more than one mark, indicating they were recaptured more than once. Of these, nine had two marks and four had three marks.

The Jolly-Seber calculation of population size (Table 1) gave higher estimates of adult numbers on most dates and a higher maximum than the index counts. With this method, numbers during the peak season ranged from 165 (on July 30) to 357 (on July 16). The 95% confidence interval during this time (dates 1-6) ranged from a low of 113 (July 30) to 458 (July 16).



Table 1. Mark and recapture parameters for the adult *C. dorsalis* population at Cove Point, 1996. Population estimates for both index counts and mark-recapture (Jolly Seber values) are given in column three.

Date#	Date	Popul. Estim. Indx Mk-Re		No. Marked	No. Recap.(%)	Recaptures per Mark Date				
						1	2	3	4	5
1	6/25	70		52						
2	6/30	61	184	44	16 (36%)	16				
3	7/5	67	202	41	24 (59%)	5*	19*			
4	7/16	211	357	92	22 (24%)	1*	6*	15*		
5	7/20	30	165	24	16 (67%)				16	
6	7/30	217	165	30	17 (57%)		5*	3*	9*	4*
7	8/13	28	86	18	8 (44%)	1*	2*	3*	4*	

\* indicates some individuals had multiple marks, thus numbers in individual columns may exceed the recapture total

Estimates of the annual adult population size at Cove Point from 1988 to 1997 are given in Fig. 4. These annual counts are based on the visual census method since this was the only method used most years. This figure shows the significant year-to-year fluctuation of adult numbers. From 1988 to 1992, the population had greater numbers of adults with a maximum of 707 in 1990, then declined (195-278) from 1993 to 1996, and then dropped very significantly to 32 in 1997.

**Adult Distribution, Dispersal, and Other Parameters.** The adult *C. d. dorsalis* at Cove Point exhibited a highly clumped distribution throughout the course of this study (Fig. 5). Eighty percent (572 of 704) of all beetles were captured in the section of straight, moderately wide sandy beach just south of the washover (gut) area, about 400-600 m south of the pier (see Photo 6, Fig. 7). Most of the other adults captured were in the bordering sections, 44 in the 200-400 m section to the north, and 48 in the 600-800 m section to the south. There was relatively little movement of beetles along the shoreline. Of the 103



recaptures, 95 were recaptured within the same 200 meter section of beach where they were marked. Of the 18 beetles that moved within the site, 6 moved south 150 m, 6 moved north 150 m, 2 moved north 300 m, 3 moved south 300 m, and 1 moved north 450 m.

The per date and cumulative numbers of males and females captured and marked indicate that early in the season, more males than females were captured, by mid-July more females were captured, and by the last two sample dates (late July to August) the cumulative proportion of the sexes was nearly equal (Fig. 6). The sex ratio was similar for recaptures with more males recaptured during the first three recapture dates and more females the last three dates. This pattern is typical for most tiger beetle species because males usually emerge earlier and are shorter-lived than females.

The mark-recapture data also gave information on the survival time or longevity of adults in the population. An examination of the recapture data indicates that on most recapture dates, the majority of marked beetles caught were those marked on the previous date (Table 1). However, for the last recapture date (August 13), one of the recaptured beetles was marked on June 25 (49 day longevity), two were marked on June 30 (44 day longevity) and one was marked on July 5 (39 day longevity). Four recaptures on July 30 survived 30 days since the date they were marked. However, the mean survival time for 91 recaptured beetles was only 9.7 days.

**Larval Distribution and Abundance.** The total numbers of larvae counted on the seven survey dates along the whole Cove Point beach were very low despite thorough searches along the whole shoreline. The area where adults were most abundant was the most thoroughly searched area since past experience with *C. d. dorsalis* indicated that larvae are most likely to be found where adults are most common. Specific counts were: two larvae (both second instars) on September 15, 11 (7 seconds, 4 thirds) on September 25, 5 (2 seconds, 3 thirds) on October 13, and 8 (4 seconds, 4 thirds) on October 30. In 1997, the counts were 6 (2 seconds, 4 thirds) on March 25, 3 (all thirds) on April 13, and 6 (2 seconds, 4 thirds) on April 28. All larvae were found within a narrow, two meter wide band of the upper intertidal zone, at or just above the most recent high tide mark and in the beach section 500 to 600 meters south of the pier. This is the same area where adults were most abundant throughout



the summer (see above). I did observe relatively large numbers of *C. hirticollis* larvae (about 5-15 per two meter wide transect) along most sections of the Cove Point shoreline.

**Beach Characteristics.** The beach parameters that were determined are given in Table 2. Beach width varied considerably but the 400 meter northern section just south of the pier was the most narrow and the far south portion the widest. Width measurements were narrower in October 1996 than in August 1997. Beach slope was very consistent along the whole shoreline, ranging from 70 to 80 degrees. All but four of the sections had slopes between 78 and 80 degrees. Results of the soil particle size distribution were most variable in the proportion of medium and fine sand. Three of the sections had a much higher proportion of shells and large fragments. No patterns of sand distribution along the beach were evident.

## DISCUSSION

**What is the Size of the Cove Point Adult Population?** While this study could not accomplish some of the proposed objectives, good population estimates in 1996 and 1997 were obtained along with much additional information on the population ecology of *C. d. dorsalis*. The visual count index gave a much lower peak population size for adults (217) than the mark-recapture method (457). Visual counts typically underestimate population size, since all beetles in the population are not likely to be active or present on the beach and thus counted on the survey date. Previous studies I have done with various tiger beetle species indicated that often the adult population size will be 2-3 times the visual index count. On that basis, the Cove population would probably have over 400 adults. The Jolly-Seber estimate of 357 adults on July 16 (with a 95% confidence interval of 255-456) is probably the most reliable estimate for the 1996 Cove Point population. This method typically provides a good measure of population size if a high proportion of the population is captured and the recapture percentages are high as they were in this study. One other indicator of adult numbers is the total number of beetles (different) marked on all dates. This number (301) is, however, really an indicator of total numbers of adults present throughout the length of the study rather than the peak number present at any one time. In summary, I believe the



adult population size for 1996 was probably within the 255-456 confidence limit range. It is also clear from this study that the population declined dramatically in 1997 to probably 50-100 adults (or two-three times the maximum index count of 32 (see discussion below). The three index counts were very consistent and done under ideal conditions, so they probably included a very high percent of the adults present.

**Was Immigration Involved in 1996?** The cause of the dramatic increase in adult numbers between July 5 and July 16 is unknown. It could be a result of an increased emergence of new adults at the Cove Point site or due to immigration of adults from another Calvert County population, possibly Flag Ponds or Western Shores. In several other population studies with this species in Maryland and Virginia, I have found adult numbers usually peak by early July and increase only slightly or even decrease from early to mid-July. If new emergence accounts for the large increase seen in early July 1996, it would have been due to a delayed emergence of adults. New adults could have emerged between July 6 and July 16 surveys. This is possible but somewhat atypical of what I know of this species. Also, very few of the adults caught and examined on July 16 were teneral (newly emerged adults). Teneral can be recognized by their characteristic gray, soft elytra (wing covers).

The immigration of adults into the Cove Point population from elsewhere seems a more likely hypothesis, since previous studies indicated many adults may emigrate from large populations in early to mid-July, apparently in response to high densities. The Western Shores or Flag Ponds populations are the possible source of immigrants, although both of these populations were low in 1996, 1380 and 810 adults, respectively. Additional studies with surveys at 2-4 day intervals during the first two weeks in July would have been necessary to determine which of these factors accounted for the dramatic increase in adult numbers. In such surveys, adult beetles would be captured and examined so the actual numbers of teneral in the population could be determined.

**What Accounts for the Low Larval and Adult Numbers in 1997?** The extremely low numbers of larvae at Cove Point in fall 1996 and spring 1997 were unexpected. An adult population of several hundred beetles could be expected to produce several hundred to over 1000 larvae. Two causative factors may be involved. The major storm events in the late summer and early



fall of 1996 almost certainly contributed greatly to the reduced larval numbers and ultimately could have contributed to the low adult numbers in summer 1997. These major storm events occurred from mid-July to early October and included a hurricane (Bertha) and two storms with high winds, each of which caused significant beach erosion in Maryland and Virginia. These storms were at a critical time for larval recruitment and early development. Most of the larvae are in the first instar stage at this time, and with their shallow burrows (4-7"), would be very susceptible to the erosive effects of storms. Many second and third instars could also have been lost during these times. Other fall 1996 surveys of larvae at several Virginia sites indicated numbers decreased 2-4 fold from the previous two years.

Another factor that may have contributed to the low larval numbers is a limited amount of suitable larval habitat at Cove Point, perhaps only enough to support a small population. The quantity or quality of larval habitat may have declined in recent years, thus explaining the progressive decline in adult numbers. The adults which have developed and emerged at the site along with others which may have immigrated into the site may have yielded little recruitment of larvae because of reduced oviposition or reduced early instar larval survival. If this is true, it is not clear what aspect of habitat decline is involved. Narrow beaches are a known cause of decline of *C. dorsalis* numbers, and there are areas at Cove Point, such as the northern portion of the shoreline which have experienced significant erosion. Beaches less than 2-3 meters above high tide are not wide enough to sustain development and survival of larvae. However, much of the shoreline, from 600-1400 meters south of the pier is wide and seemingly suitable for *C. dorsalis*, but few adults or larvae have ever been found in the shoreline south of about 900 meters. There is no obvious difference in this southern portion of the site to explain the lack of beetles. There was also no measured difference in the other beach parameters (slope and particle size distribution) to explain this. It does appear that the sections immediately north and south of the pier were probably too narrow to be suitable. Observations during this study did indicate that larvae of *C. hirticollis* were widely distributed along most of the Cove Point shoreline. This species is less habitat specific than *C. dorsalis*, and also completes its larval development rapidly between April and July. Thus, it is less susceptible than *C. dorsalis* to late summer, fall and winter storms.

Table 2. Beach parameters and adult numbers at 100 meter intervals along the Cove Point shoreline.

Site #	Location (meters s of pier)	Beach Width in meters*		Slope	% of Soil Particle Size Distribution					Total No. of Adults
		a	b		Shells	Gravel	Coarse Sand	Medium Sand	Fine Sand	
0.5	50			71						
1	100	3.5	1.5	76	4	9	1	70	24	26
2	200	4.0	2.0	79	6	8	8	48	46	
3	300	2.5	0.4	70						44
4	400	3.5	1.1	72	2	1	1	41	55	
5	500	7.5	5.0	80	12	7	7	25	49	572
6	600	7.5	5.4	78	11	5	5	48	31	
7	700	8.5	4.8	78	4	1	1	57	39	48
8	800	5.2	5.1	79	4	1	1	64	31	
9	900	5.0	6.1	79	14	6	6	20	54	11
10	1000	5.2	5.0	79	2	3	9	49	38	
11	1100	5.3	5.8	79	1	1	1	64	35	3
12	1200	5.0			4	1	1	59	35	
13	1300	10.0	9.8	79	6	1	3	58	33	
14	1400	9.0	8.0		3	1	1	30	66	
15	1500	14.0		80						

\*Beach width is measured as the distance between the most recent high tide mark and the vegetation line on the back beach. a indicates measurements in August 1997 and b. are for October 1996.



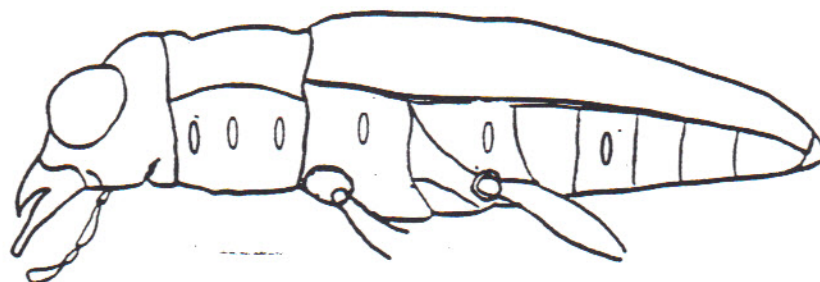
In conclusion, the results of this study give good evidence that the Cove Point population of *C. d. dorsalis* has declined in recent years and also experienced a very significant decline from 1996 to 1997. It will be important to continue monitoring the adult and population closely in the next few years to see if the population rebounds, at least to 1996 levels. *C. dorsalis* populations with less than 100 adults are highly susceptible to extinction, and this is a possibility for the Cove Point population.

## ACKNOWLEDGMENTS

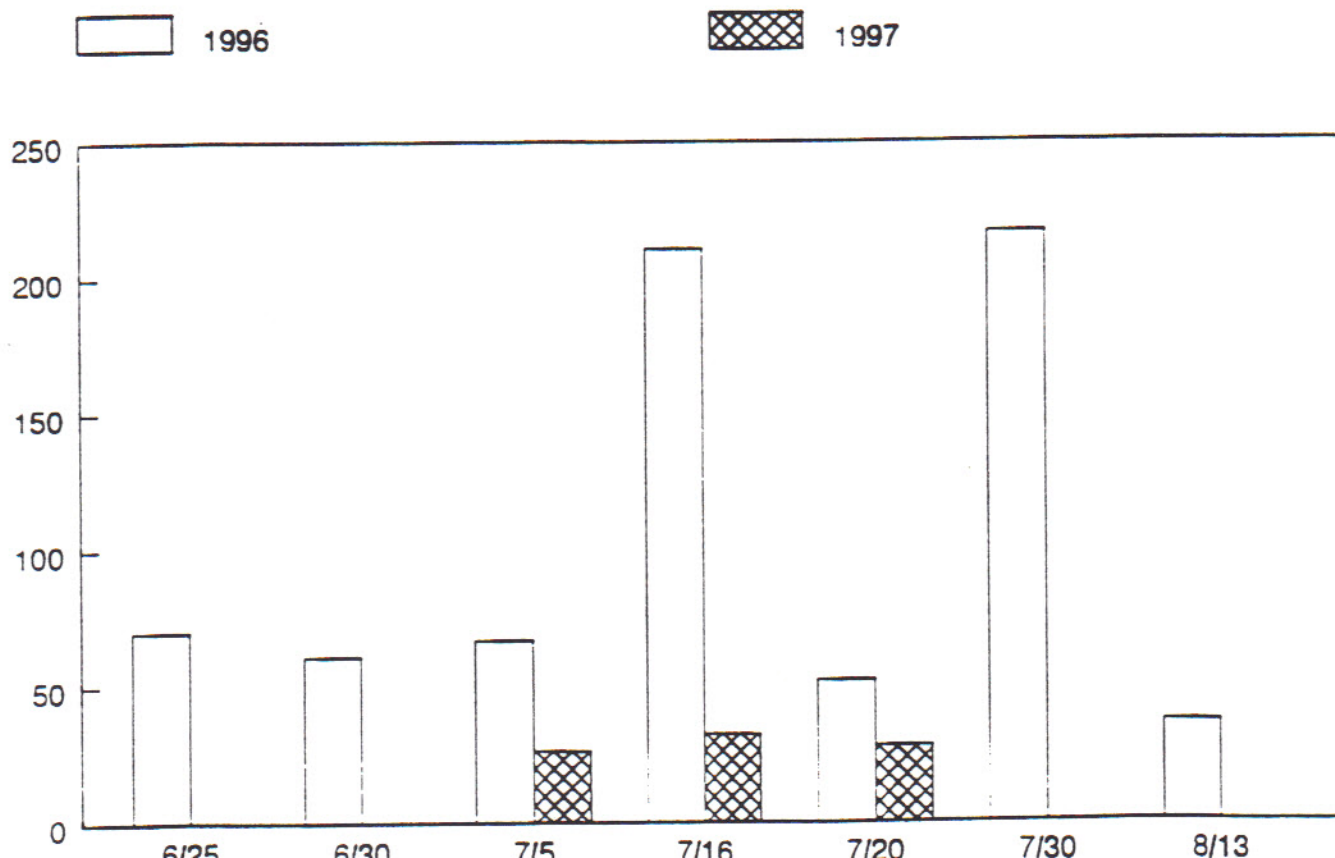
I gratefully acknowledge the Cove Point Natural Heritage Trust for providing funding for this study and Columbia LNG Company for permission to use the Cove Point site.



**Fig. 1. Diagram showing areas on adult beetles where setal patches were removed for mark an recapture studies.**

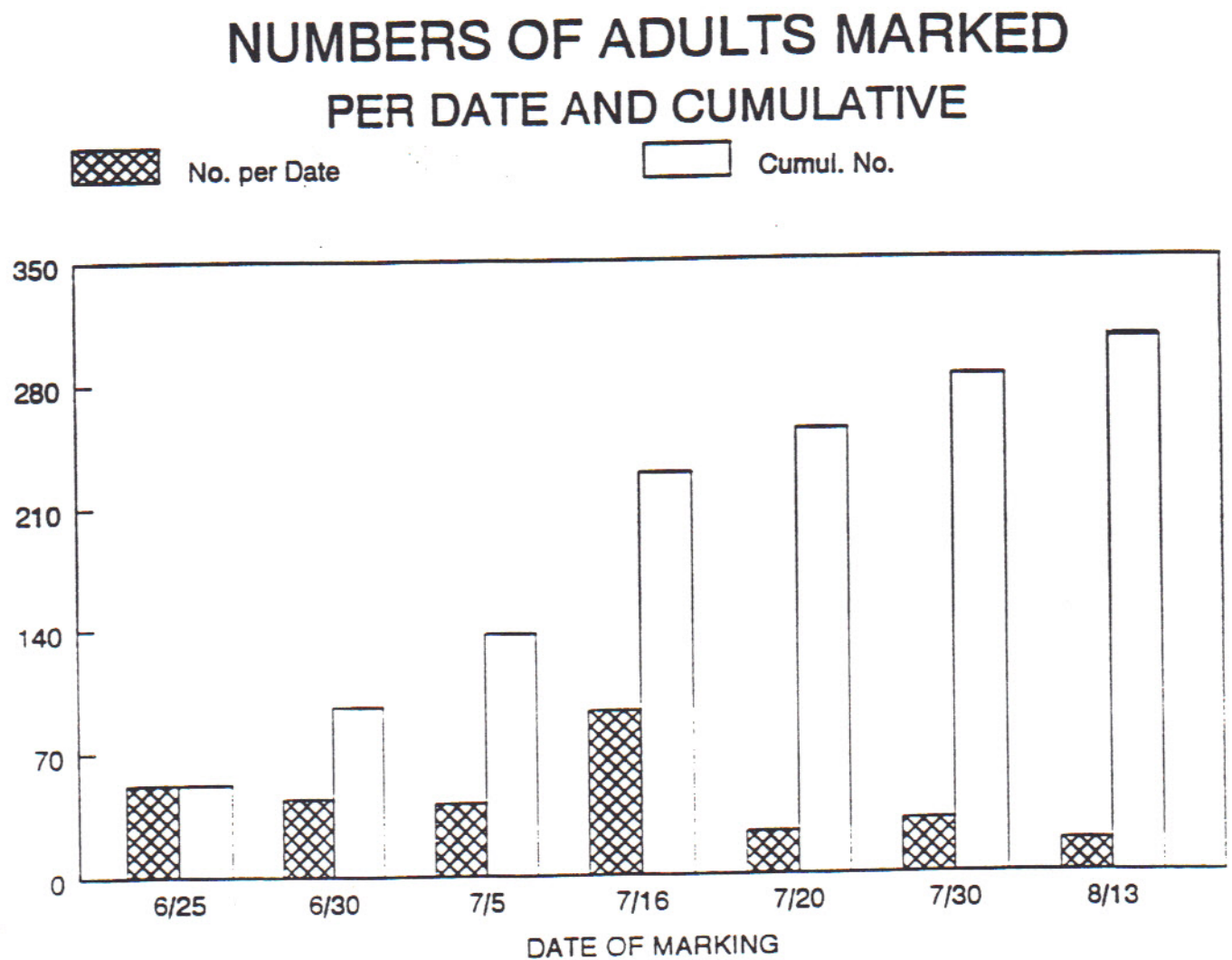


**Fig. 2. Numbers of adult *C. dorsalis* counted along the Cove Point shoreline 1996 and 1997. Based on visual index count method.**



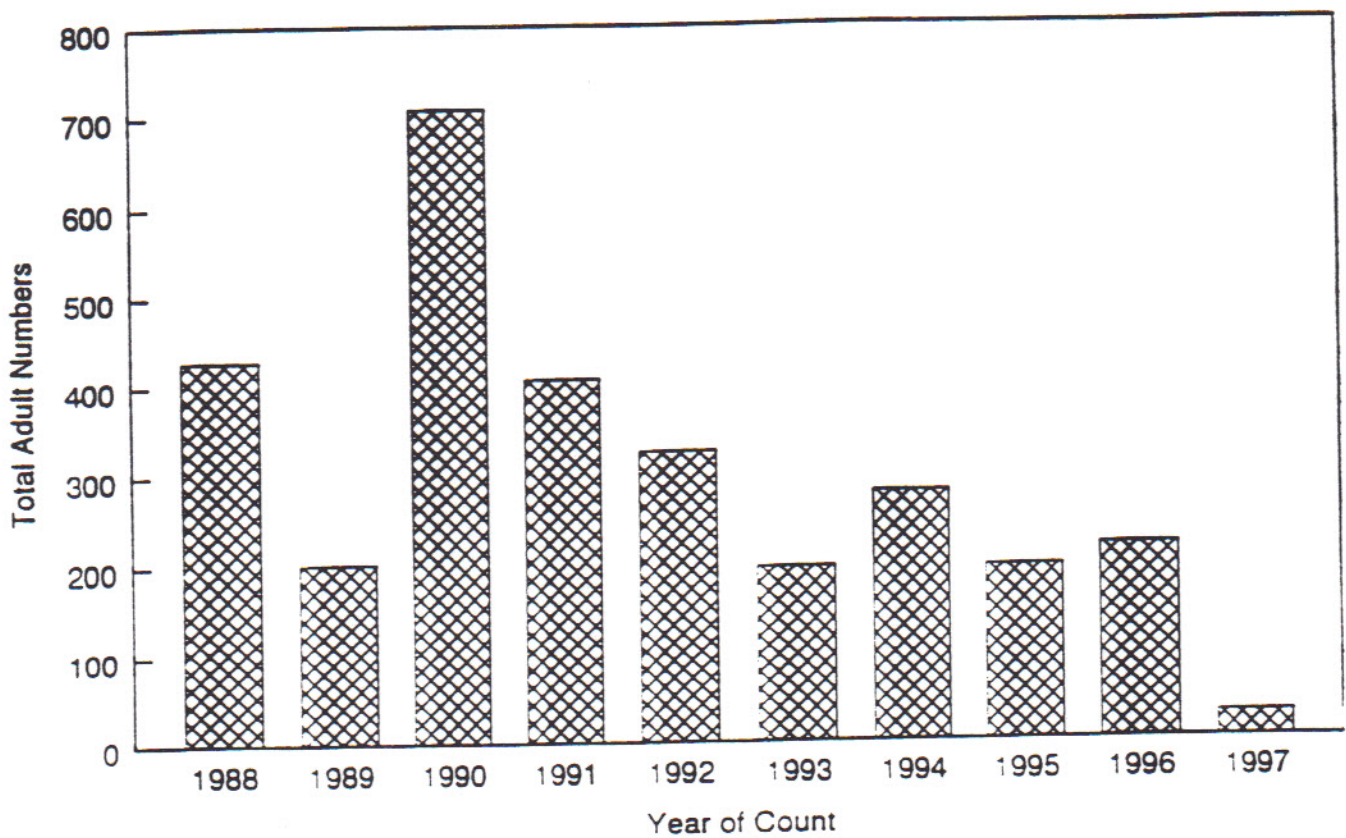


**Fig. 3. Numbers of adult *C. dorsalis* marked and released and cumulative total at Cove Point, 1996.**



**Fig. 4. Annual adult population estimates of *C. dorsalis* at Cove Point, 1988-1997. Based on visual index counts.**

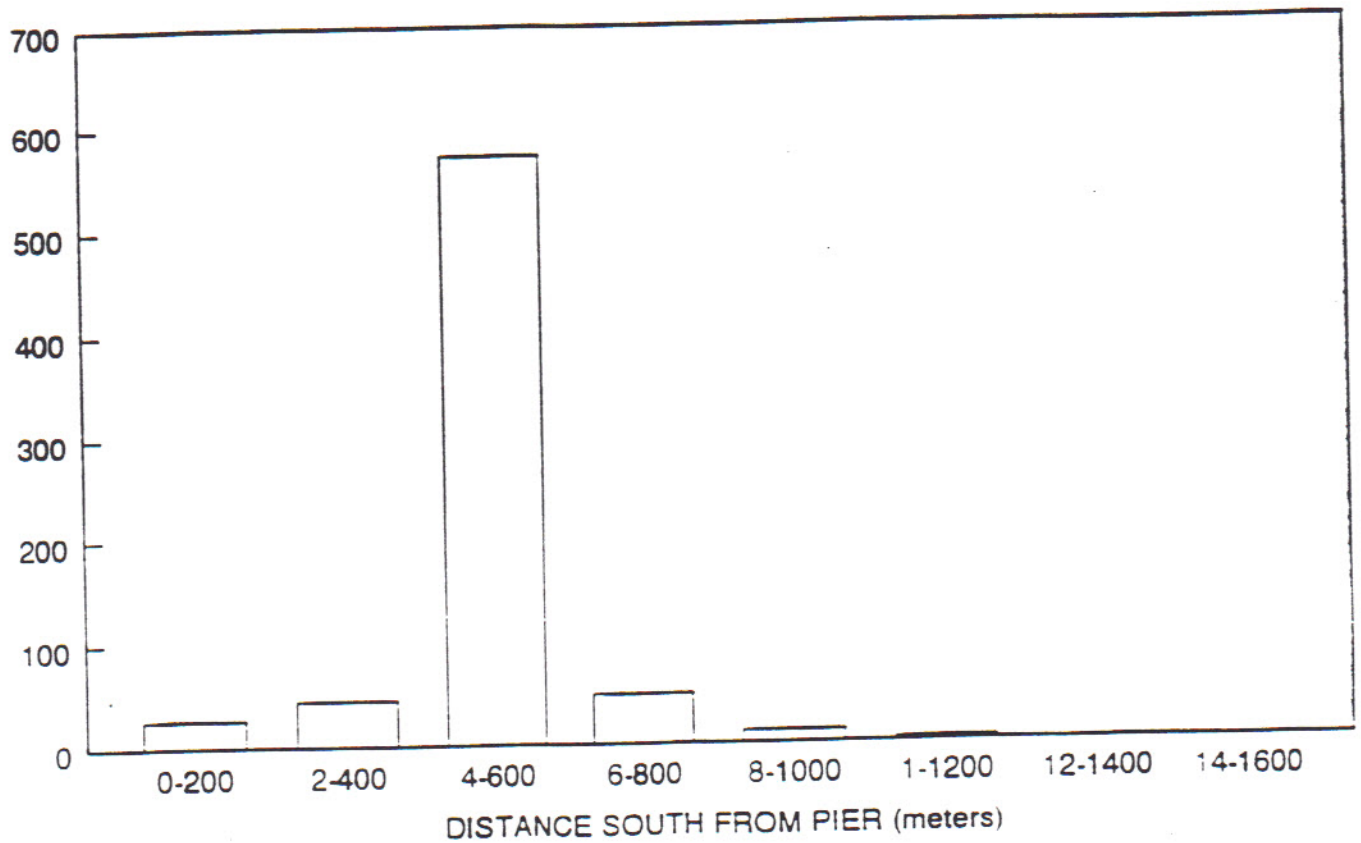
## ADULT CICINDELA DORSALIS COUNTS 1988 TO 1997



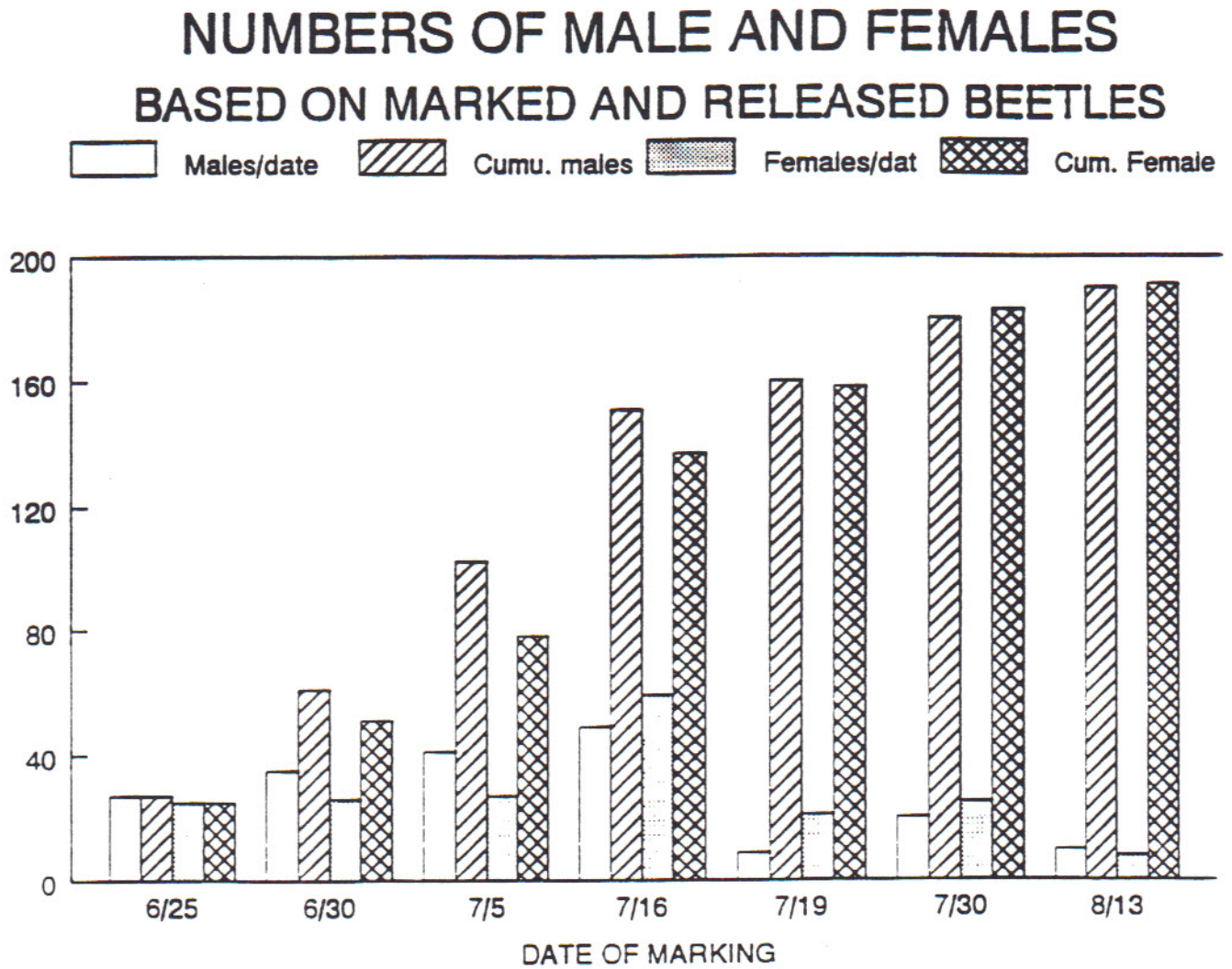


**Fig. 5. Total numbers of marked beetles per 200 m section of beach at Cove Point. The 200 m sections are from north to south starting at the pier.**

### ADULT DISTRIBUTION ALONG BEACH BASED ON NUMBERS CAPTURED



**Fig. 6. Numbers of male and female adult *C. dorsalis* marked and released at Cove Point.**







**PHOTO 7.** 900 meters south at end of *C. dorsalis* area (just north of GPS maker), looking south to continuing wide beach.



**PHOTO 8.** 1200 meters south, north of Cove Pt. sign, looking south, showing wide beach narrowing.





**PHOTO 5.** 350 meters south, looking south to beach area just north of gut or washover area



**PHOTO 6.** 450 meters south, looking south to best *C. dorsalis* area with wide beach habitat





**PHOTO 3. 150 meters south of pier, looking south to where Phragmites encroaches and beach narrows**



**PHOTO 4. 225 meters south, looking south where Phragmites encroaches**





**PHOTO 1.** 300 meters north of pier, near north end of Cove Point, looking south to pier



**PHOTO 2.** 0 meters, at pier looking south at arc beach just south of pier



**Fig 7. Map of the Cove Point shoreline showing beach sections where *C. d. dorsalis* studies were conducted.**

