

**DISTRIBUTION AND ABUNDANCE OF TWO RARE TIGER
BEETLES, *CICINDELA DORSALIS MEDIA* AND *C.
LEPIDA*, AT ASSATEAGUE ISLAND NATIONAL
SEASHORE IN 2012**

FINAL REPORT

Submitted to:

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ABSTRACT

The objective of this study was to continue monitoring the distribution and abundance of two rare tiger beetles (*Cicindela dorsalis media*, *Cicindela lepida*) at AINS, to compare the results with previous surveys and to use this information to inform management strategies. This year's survey was conducted on July 15-17, 2012. Methods were identical to those used in the annual surveys conducted in previous years (2001-2011). Determinations of adult numbers of each species were based on a visual search method where the surveyors moved slowly throughout the areas of probable habitat and counted all adults seen. The survey area for *C. d. media* included the whole length of shoreline from the north inlet to the Virginia line. This included the ocean shoreline of the North End, the State Park, the NPS Developed Zone and the extensive ORV zone including plover closure areas. Surveys for *C. lepida* were conducted along the whole length of the ORV zone and concentrated in and behind the primary dune line where this species has been most common. A summary of the results of these studies were:

1. The **total count of *C. d. media* in 2012 was 123 adults**, but for the first time all were in the ORV zone and none along the North end shoreline. These adults were distributed from the VA state line north to km 23 with the largest concentration (80 individuals) between km 23 to km 25. This northward and extended distribution in this and the past few years was apparently a result of the plover closure being extended further north compared to earlier years when beetles and the closure was restricted to the southern few kms.
2. Results of the *C. d. media* surveys further document the high year-to-year variation in population size. Factors causing the loss of adults from the north end in 2012 are unknown, but likely due to either natural shoreline changes which impacted habitat or possibly negative effects of vehicle patrols on larval burrows.
3. The **total number of *C. lepida* counted in 2013 was 41** which along with the 128 in 2011 were the lowest counts since two less complete surveys in the 1990s. These two years are significant declines from 976 in 2010 and other significantly higher counts in recent years. Although tiger beetle numbers can fluctuate significantly from year to year, it is likely this significant decline is a result of habitat deterioration. Observations from our surveys suggest the primary dune areas where the *C. lepida* are found has become more stabilized and vegetated, probably because storm events in recent years have not maintained the overwashes and cut throughs that were created by significant storms in the mid- to late 1990s.
4. Management and survey recommendations suggested previously are still appropriate. Continued high numbers in the closed area of the south ORV zone indicate this area might be suitable habitat if vehicle disturbance is eliminated. Permanent protection of this area might improve the overall viability of *C. dorsalis* at AINS. Reduction of plover patrols or other vehicle use in the North end would help to determine if this activity might be impacting the population there.

OBJECTIVES

The 2012 study had the same objectives as in previous years:

1. Determine the distribution and abundance of adult populations of *C. d. media* and *C. lepida* at AINS in 2012
2. Evaluate population trends and distribution patterns for *C. d. media* and *C. lepida* in 2012 compared to previous years.

3. Interpret the current population status of these two species and attempt to determine any changes in conditions at AINS that might explain trends in distribution and abundance.

BACKGROUND

***C. d. media*.** This tiger beetle is restricted to extensive, dynamic sandy coastal beaches without significant human disturbance (e.g. shoreline erosion control structures, resort development, ORV's, high pedestrian use) (Boyd 1978, Glaser 1984, Knisley and Schultz 1997). It occurs in the beach zone at the water edge, not island interiors, because adults and larvae are dependent on regular tidal wave action to create suitable microhabitat conditions. Like the Federally listed nominate subspecies (*C. d. dorsalis*), its presence is generally considered an indicator of pristine or "natural" beach habitat (Knisley 1986).

Historically, *C. d. media* occurred at scattered localities along the Atlantic coast, from southern New Jersey to south Florida (Knisley and Schultz 1997, Pearson et al. 1997). Most records are from barrier islands but it also has been found along mainland coastal beaches directly exposed to ocean waves. It has been extirpated from many of these areas, probably as a result of intense human recreational use, beach erosion control and shoreline development. Today, it is considered rare to uncommon in much of its remaining range. The only extant populations north of Maryland are located at Cape Henlopen, DE and on a small island north of Atlantic City, NJ. To the south, it occurs in a few areas on the Virginia portion of Assateague Island and is locally common at several other Virginia barrier islands (Knisley and Hill 1992). Scattered, highly localized populations are also present in the Carolinas, Georgia, and Florida (Yarborough and Knisley 1994, Ciegler 1997, Knisley and Schultz 1997).

In Maryland, *C. d. media* probably occurred historically along most of the ocean shoreline of Fenwick and Assateague Islands (Glaser 1984; Knisley and Hill 1990). It was last collected from Fenwick Island during 1926 and has since been extirpated from there (Knisley and Hill 1990). On Assateague Island, surveys since 1985 indicated that initially this species was largely confined to the northern 6 km of the island and absent from the other shoreline of the island. High intensity beach use by pedestrians and ORV's had apparently eliminated it from all areas between the State Park and Maryland-Virginia state line. More recent surveys we have conducted indicated an additional concentration at the far south end of the Maryland section adjacent to the State Line. The presence of beetles here is a result of this section of shoreline being closed to vehicle activity during the plover season. During 1986-1991, annual counts of adults were relatively high ranging from approximately 120 to 400 individuals (Knisley 1986; Knisley and Hill 1990; Knisley and Hill 1992). Adult numbers dropped consistently thereafter to a low of 14 adults in 1998 (Knisley 1996; Hill and McCann unpublished data). The population rebounded dramatically to 698 adults in 2001 (Knisley et al. 2002) and then declined (220 in 2002 and 190 in 2003, 60 in 2004), and then increased to 455 in 2005. Since then numbers have fluctuated with higher numbers in even years: 2006 (57), 2007 (88), 2008 (169), 2009 (184) and 2010 (245).

Cicindela dorsalis media, like the closely-related Federally Threatened taxon, *C. d. dorsalis*, is known to be impacted by a variety of natural and human-induced factors. The cause of the apparent severe decline at Assateague in the late 1990's is uncertain. However, several major

coastal storms struck this region in the mid-late 1990's resulting in severe shoreline erosion at Assateague Island and dramatic changes in the shoreline configuration, elevation and overall habitat conditions on much of the island, especially on the North End. A 1998 storm event was particularly severe. The long-term sand starvation effects resulting from stabilization of the Ocean City Inlet on natural barrier island beach processes also may have contributed to the apparent decline. Use of ORV's on the North End during routine patrols and piping plover research activities also may have contributed to the decline.

The potential effects (either positive or negative) of the shoreline modification projects at AINS are not well known. One of these projects, the Assateague Island Emergency Storm Berm project was constructed in August through September of 1998 to compensate for the impacts of Nor'easters in January and February of 1998. Approximately 134,000 cubic yards of sand were placed on northern Assateague along an 8,400 ft. long reach of the island located from 3.2 to 4.8 miles south of the inlet and shaped to construct a trapezoidal berm 100 ft in base width, and with 1:10 side slopes in this section of the island. It is important to note that this is the area where most of the beetles were found in the 2001 survey suggesting a possible beneficial effect on the species by providing additional or improved habitat. During 1999-2000, some beetles were incidentally collected at the North End during piping plover food and habitat studies (Jack Kumer, pers. comm.), confirming the beetle's continued presence at AINS. It is expected that the distribution of *C. d. media* and that of *C. lepida* (see below) will identify the critical habitat areas for these species and thus allow for the delineation of "no-spray" areas in the event that mosquito control occurs at AINS.

C. lepida. This species is typically found in sparsely vegetated dunes or extensive sand blows with dry, loose sand (Larochelle 1974; Boyd 1978; Knisley 1979; Glaser 1984; Knisley and Schultz 1997; Leonard and Bell 1999). It occurs in widespread, scattered localities throughout central and eastern North America (Knisley and Schultz 1997; Pearson et al. 1997; Leonard and Bell 1999). In most parts of the eastern U.S. it is uncommon to rare especially along the Atlantic coast where it is nearly restricted to coastal dunes (Boyd 1978; Knisley and Schultz 1997). North of Maryland, the closest extant population is located at Cape Henlopen, Delaware. A few populations still occur in New Jersey, but the species apparently has been extirpated from much of the remaining northeastern U. S., including Massachusetts, Long Island and Pennsylvania. South of Maryland, the species is known from only two areas, the Virginia portion of Assateague Island and Nags Head, North Carolina. In Maryland, it has been extirpated from Fenwick Island (Glaser 1984), and the state's only remaining population has been found to be restricted to the southern part of AINS. Beach stabilization, coastal development, ORV's and other sources of dune disturbance (e.g. high levels of pedestrian use) have probably contributed to the decline and extirpation of this species from many coastal areas in the eastern U.S. (Knisley and Schultz 1997; Leonard and Bell 1999).

C. lepida was first reported in Maryland by Glaser (1984) and Knisley (1986). Before our recent studies (2001-present) the only attempts to systematically survey for *C. lepida* at AINS occurred in 1990 (Knisley and Hill 1990) and 1998 (Hill and McCann, unpublished data). In 1990, a total of 127 adults were found at 5 sites on the southern end of the Maryland portion of the island. Approximately half of the individuals occurred at a single site. In 1998, a similar number (84 adults) was detected in three areas although there appeared to be some changes in distribution.

Storm-related changes in habitat availability apparently resulted in lower numbers of beetles in some interdunal areas that were occupied in 1990. However, more beetles were found in newly formed habitat in nearby, primary dune blowouts. In addition, *C. lepida* was found for the first time in and along recently closed sections of the Off-road Vehicle Route. Higher numbers have been found in recent years (892 in 2003, 582 in 2004, 514 in 2005, 388 in 2006, 465 in 2008, and 976 in 2010), probably a result of increased suitable habitat caused by storm-induced increases in cut-throughs and washovers in the primary dunes. Most adults and larvae in these recent years have been found in these habitats. Another factor is our more thorough and systematic searches along the whole length of the primary dunes in these recent surveys.

METHODS

We conducted surveys for adult tiger beetles during July 13-16, 2012. Three observers participated, each with extensive experience in conducting surveys for tiger beetles. Our surveys focused on those areas known to support *C. d. media* and *C. lepida* and have been essentially the same areas surveyed since 2001 and using the same methods. The method was a direct visual index count that involved recording the numbers of all adults seen while observers walked slowly through potential habitat. We used hand-held GPS units to record adult beetle locations and also to regularly record reference waypoints to indicate the area covered in our survey. Using the GIS program ArcMap, these point locations were overlaid onto aerial photos and/or U.S.G.S. 7.5' topographic maps to depict distribution of both tiger beetle species throughout the island.

Surveys for *C. d. media* were conducted by walking along the wet intertidal zone of the beach during mid-day (1100h to 1700h) when adult beetles are concentrated in this microhabitat. Shoreline areas covered by walking surveys included the ocean sides of the whole North End, the State Park and Developed Zone, and the southern ORV zone including shoreline sections that were closed for piping plovers. Since 2008 we surveyed the long ORV section by walking along the shoreline; in some earlier years we surveyed by making counts from a slow moving vehicle. The reason for the change in recent years was to avoid driving in the expanded closure area and because more beetles were found in this area, unlike earlier years.

Monitoring for *C. lepida* has been less frequent in earlier years than for *C. d. media*. However, in most years since 2002, we completed comprehensive, standardized surveys along the entire length of the ORV zone, from km 16 to the Virginia state line. These surveys involved thorough searches of primary dune and interdunal habitats, including the back beach, the front of the fore dune, open areas behind the foredune, and associated washovers and cut throughs. These areas were searched by two observers (sometimes 3) positioned about 10 m apart walking slowly in a zig-zag pattern through potential habitat. We also spot checked potential areas further inland (e.g., Fox Hills area, along the old ORV road). Areas with clearly unsuitable habitat (e.g., wet swales, vegetated patches and dense scrub) were bypassed. Weather conditions during the *C. lepida* surveys in 2012 were ideal (sunny, warm). In 2012 we did not survey for larval burrows as had been done in some earlier years.

RESULTS AND DISCUSSION

***C. d. media*.** We observed a **total of 123 adults in 2012**, a count significantly lower than the 235 in 2011 and 245 in 2010. Other recent counts were significantly higher in these two counts from previous recent counts (88 in 2007, 169 in 2008, and 84 in 2009) (Table 1). Most notable was that all adults in 2012 were in the ORV zone and none along the North end. The distribution of *C. d. media* has varied significantly over the years, specifically the numbers in the north end versus those in the south ORV zone. North end numbers have been low, 96 or less since 2006 with previous lows of 5 in 2008, 6 in 2004 and 14 in 2011. The count in 2010 was 96, the highest since 2005. Although tiger beetle numbers fluctuate significantly over the years, these recent low counts indicate a very marginal population and a high chance of the population becoming extirpated. The cause of these low numbers is uncertain but it is likely a result of a decline in the suitability of the habitat, possibly due to progressive natural shoreline changes or impacts on larval burrows from the frequent vehicle patrols. Larval recruitment and development in their burrows along the upper intertidal zone are susceptible to both of these factors. Evidence for the latter cause would be increased patrols or vehicle use in recent years.

Another interesting aspect of the distribution of *C. d. media* adults was the increase in numbers in the ORV zone and an expansion of their distribution to further north since 2008 (Table 1). In most earlier years of our surveys, the adults in the ORV zone were restricted to the south most 1-2 km which were roped off for plovers. This protection area was expanded to the north of km 24-25 in 2010, 2011 and 2012, and coincidentally adult numbers expanded into this area. Most of the 123 adults in 2012 and the 189 in 2011 were widely distributed throughout the area from km 23 to the Virginia state line, and numbers in this area in 2010-2012 higher than any previous years. In 2011 most adults (80) were between km 23 and 25. As we suggested in previous reports, the presence of high numbers of adults here indicate the distinct association of adults with a shoreline free of heavy vehicle use. It seems apparent that adults are moving into this area, probably from VA and finding this area suitable, and surviving there. These recent surveys indicated they expand throughout the shoreline where there is no or very limited ORV use. It is unlikely that these adults developed from larvae in this area because the intense vehicle use before and after the closure is removed would disrupt the larvae and prevent their survival.

Table 1. Numbers of adult *C. dorsalis media* counted within specific sections at AINS, 1985-2012.

North End (kms from Jetty)	1985	1986	1987	1988	1990	1991	1992	1996	1998	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	10	19	11		23	52	7	6	0	0	11	0	0	0	0	0	1	0	1	0	0
0.5	20	8	28		64	140	57	2	0	0	3	0	0	1	0	0	2	1	6	1	0
1	41	5	36		108	109	10	7	0	1	0	0	0	5	0	2	0	1	6	0	0
1.5	25	12	3		26	40	4	5	0	5	3	0	1	3	4	2	0	1	3	0	0
2	1	38	0		14	23	2	3	5	6	0	4	0	21	1	11	0	2	1	0	0
2.5	4	49	0		0	4	0	3	5	2	2	0	0	8	0	11	0	0	13	0	0
3	27	59	0		17	3	1	2	4	2	4	1	0	5	10	9	0	4	30	0	0
3.5	42	42	11		67	12	5	18	0	66	15	8	3	37	3	6	1	0	28	0	0
4	7	12	24		27	0	1	13	0	112	18	14	1	25	2	0	1	0	9	0	0
4.5	8	9	4		2	0	0	10	0	106	0	18	0	75	4	4	0	6	0	0	0
5	2	3	5		0	0	1	2	0	34	1	11	1	34	1	9	0	0	0	0	0
5.5	2	1	0		0	0	0	0	0	10	2	13	0	5	0	0	0	0	0	1	0
6	1	0	0		0	0	0	3	0	54	11	10	0	12	0	0	0	0	0	0	0
6.5	2	0	0		0	0	0	0	0	62	3	38	0	4	0	1	0	0	0	0	0
7	3	2	0		0	0	0	0	0	83	2	14	0	11	0	2	0	0	0	0	0
7.5	0	0	0		0	0	0	0	0	17	0	9	0	12	0	0	0	1	0	2	0
8	0	0	0		0	0	0	0	0	22	0	0	0	15	0	0	0	1	0	4	0
8.5	0	0	0		0	0	0	0	0	27	0	3	0	7	0	0	0	3	0	2	0
9	0	0	0		0	0	0	0	0	1	0	3	0	7	0	0	0	1	0	4	0
9.5	0	0	0		0	0	0	0	0	1	0	2	0	1	0	0	0	0	0	0	0
Total North end																					
Shoreline	195	259	122	200	346	383	88	74	14	611	75	148	6	265	25	57	5	21	96	14	0
North end Bayside										15	15		8		0	0	8	0	0	0	0
State Park and Dev. Zone	0	0	0	0		0	0	0	0	0	0	21	8	12		0	0	0	0	0	0
ORV Zone, N of closure										0	18	12	18	7	11	5	57*	31	31**	32	0
ORV Closure Zone					13					72	97	9	20	145	21	16	99	32	118	189#	123#
Grand AINS total	195	259	122	220	359	383	88	74	14	698	220	190	60	429	57	88	169	84	245	235	123
*Most in new plover closure: km24, 26 individuals; km26, 4; km28, 1; km30, 3; 31, 2; 32, 1 = 57																					
**4 in km 29, 6 in km 30, 5 in km 32, 6 in km 33																					
# In 2011 and 2012 the shoreline section closed for plover nesting extended from north of km 24 to the Va line																					

Factors Affecting Population Dynamics. The factors producing the considerable year-to-year fluctuations in population size of *Cicindela dorsalis media* cannot be accurately determined without the simultaneous detailed monitoring of a wide array of factors (beetle development patterns, weather, erosion, shoreline changes, human impacts) that are likely to directly or indirectly affect distribution and abundance. The range of annual fluctuations that we have found at AINS during the survey years between 1985 and 2012 is not significantly different than what we have seen for the related taxon, *C. d. dorsalis* in Maryland over a similar period. Our experience with various tiger beetle species, including *C. dorsalis*, suggest that the population trends are largely driven by climatic factors, especially coastal storm events, or by severe perturbations to their habitat. Storm events cause direct larval mortality and habitat loss through beach erosion where active or overwintering larvae occur. Over the long term, however, storms are an essential element in maintaining and redistributing suitable habitat. Storm impacts of Hurricane Isabel in 1993 were seen in the results of my survey of adults of *C. d. dorsalis* at over 60 sites along the western shoreline in Virginia during the summer of 2004. Total numbers at these sites declined about 70% from the numbers in 2001 and 1998. Many individual sites declined by 80-90% and some sites with several hundred adults in previous surveys had none in

2004. Interestingly, however, is that a smaller number of survey sites along the southern part of the eastern shore of the Bay in Virginia did not decline. The observed condition of the beach sites on the western and eastern shorelines and available information indicated that the hurricane which struck in September 2003 had, in Virginia, a much greater impact on the western shore. The severe beach erosion apparently washed out large sections of shoreline with larvae, thus reducing the numbers of maturing and emerging adults in summer 2004. Surveys at Janes and Cedar Islands on Maryland's upper Eastern Shore also declined dramatically in 2004 compared to the several previous several years.

Our past surveys at Assateague also provide some evidence of storm effects on tiger beetle numbers, and here we provide a brief chronology of these events. During 1985-1991, a period characterized by a general lack of major storms (Army Corps of Engineers 1998), adult numbers gradually increased, from 195 to 383 individuals. However, during October 1991 through January 1992, three severe storms struck the island. These three storms included the familiar "perfect storm" (October 31, 1991) and an even more severe storm (the third most severe on record for coastal Maryland) on January 4, 1992 (Army Corps of Engineers 1998). During the following summer of 1992, beetle numbers dropped to a then low of 88. No surveys were conducted the following three years (1993-95) but major storms occurred on March 2, 1994 and January 7, 1996 and numbers again appeared to remain low during surveys in 1996 with a count of just 74 individuals. Also, the lowest count ever in 1998 was preceded by two major nor'easters in January-February 1998.

In addition to annual fluctuations in population size, substantial shifts in distribution occurred during 1985-2005 (Table 1). During 1985-86, the population was centered around km 1 to 5 then shifted northward to km 0 to 2 during 1990-1991. In 1998, it was confined to km 2 to 3. During 2001-2004, the population shifted again and was centered at km 3.5 to 7.0. Supporting data are lacking but these distributional changes were probably related to shifts in the extent and suitability of larval habitat resulting from storm events, other beach sand transport processes (e.g., long shore sand transport, normal tidal action) and perhaps human effects (e.g., Emergency Storm Berm). Interestingly, during 2001-2007, the population was centered in the Emergency Storm Berm area which may have led to increases in larval habitat. The presence of a large number of adults within the area of the North End Restoration Project in 2003 is in part a result of the very high adult numbers in 2001 which should have produced a large cohort of offspring which became adults in 2003. Apparently significant numbers of these larvae survived and successfully emerged to produce the larger 2003, 2005 adult populations there. Correspondingly, the low numbers in 2004, 2006, and 2008 may have been in part a result of the low numbers of adults in 2002 and 2003, respectively. Fewer adults would have produced fewer larvae and thus fewer emerging new adults in these two years. However, if beach/ habitat conditions were suitable, recruitment should have been greater and resulted in a build up in the population in all years. Numbers in more recent years have been too low to determine much about distributional changes.

The potential impacts of human activity, including heavy pedestrian foot traffic and ORV activity, have been previously documented as a cause of extirpation of *C. d. media* from portions of AINS (Glaser 1977, 1984; Knisley and Hill 1992). Our surveys over the past few years provide further evidence of these effects. However, we do not know what effects, if any, may be

caused by beach vehicle use from park patrols and plover survey work on the North End. Any increase in this activity in recent years might indicate this as a cause of the very low counts in the past several years.

C. lepida. The total count for *C. lepida* in 2012 was 41, the lowest ever count since the beginning of survey work in 1990. Other recent counts were 128 in 2011, this the previous low count. The counts were much higher in 2010 (976) and in 2008 (465). The two year progressive and significant decline in counts from 2010 to 2012 does not appear to be due to survey conditions since these were similar and ideal in both years. Numbers do fluctuate greatly for all tiger beetle species that have been studied and for *C. lepida*, but counts have been over 400 in all years since 2003, except for the 386 in 2006. Our best explanation for this significant decline in the past two years is due to the progressive natural stabilization of the many areas of new habitat (see below) created by the series of storms in the late 1990s (see above). The distribution of adults in 2011 and 2012 was similar to most other recent years (Table 2, Appendix). In general, during these surveys some adults have been widely distributed in the south ORV zone (km 17 to 34). (No adults have been found in the northern half of the site, kms 1-16.) Frequently, some sections between km 17-35 had few or no adults. The highest numbers of adults during all years occurred between km 23 and 32 and especially between 25 and 31. The most notable shift in distribution during 2002-2008 compared to the 1990's surveys was a shift to the area along the primary dune ridge. The highest concentration in the 1990's was in the more inland dunes near Fox Hills. That area is now more vegetated and thus less suitable, resulting in few or no adults there in the past few years. The highest counts per transect in 2011 and 2012 were in km 19 and 25-29 although numbers were much lower than most other years. Counts in other km sections were very low or 0.

We believe that our surveys for *C. lepida* since 2002 provide a reasonably accurate representation of their relative abundance and distribution at AINS. The higher numbers and the change in distribution of this species since the 1990's are apparently a result of the effects of storm activity causing habitat changes along most of the length of the southern shoreline. In these recent surveys we have found increasing numbers of adults present in the primary dune area, and a more eastward movement from earlier surveys. A series of storms in the mid- and late 1990's caused significant breaks in the primary dunes and resulted in washovers with the deposition of many patches of new sand behind the foredunes. These dynamic events have also resulted in progressive wind-driven sand movement since that time, creating new habitat for *C. lepida* in the cuts, breaks, and overwashes in the primary dune. Our observations of many adults and large numbers of larvae in these overwash pans indicate ideal habitat for adult foraging and oviposition and larval development. *Cicindela lepida*, like many tiger beetles, is a colonizer of newly opened bare ground, and unable to persist in habitats that are more stabilized or with reduced sand movement. No research has fully determined the cause of this preference for newly created habitats typical of many species, but it could be their need for more open habitat (where plant density is reduced) for feeding and other activities or fewer natural enemies or pathogens that may build up in stabilized habitats. It is quite likely that the 2011 and 2012 counts indicate that natural succession and stabilization has been progressing to the point of impacting the population. Surveys in the next year or two should confirm this hypothesis unless the storms in the past year have created new habitat and a rebound in abundance.

Table 2. Numbers of adult *C. lepida* counted along whole length of Assateague Island National Seashore, 1990-2012, and numbers of larvae in 2006 and 2008.

Location (km)	Numbers of Adults			2003	2004	2005	2006	2008	Larvae		2010	2011	2012
	1990*	1998*	2002						2006	2008			
0 -10			0	0	0	0	0	0	0	0	0	0	0
11-16			0	0	0	0	0	0	0	0	0	0	0
16-17			0	24	9	0	2	0	0	0	0	0	0
17-18			2	40	1	1	13	6	93	27	59	0	0
18-19			0	65	5	1	18	27	109	124	53	3	0
19-20			0	67	13	12	6	75	212	48	208	19	6
20-21			3	46	8	22	3	18	100	0	69	1	0
21-22			3	11	4	15	0	0	330	0	18	9	0
22-23			8	12	6	6	0	2	11	8	3	0	5
23-24			19	73	2	4	0	4	0	5	1	0	0
24-25			22	34	34	15	5	7	56	38	7	0	0
25-26			22	66	93	10	18	27	131	35	14	13	0
26-27			9	68	52	17	72	66	720	106	35	29	0
27-28			27	76	64	30	42	53	1535	77	170	21	15
28-29			19	52	42	31	33	38	837	5	128	0	17
29-30			19	82	79	100	16	31	1282	0	56	3	4
30-31			25	75	72	71	67	29	2826	95	26	4	0
31-32			15	22	27	89	36	11	1653	35	22	11	0
32-33			8	51	20	60	36	19	715	18	43	7	4
33-34			7	20	35	0	12	47	212	50	35	6	1
34-35			5	6	14	27	5	5	156	15	28	2	0
35-VA line			1	2	2	3	2	0	55	0	1	0	0
Totals	127	84	214	892	582	514	386	465	11033	686	976	128	41

* No data collected for individual segments in 1990 and 1998

Our surveys in recent years suggest that the elimination of ORV's on the inland road has not increased beetle numbers or apparent habitat. This seems to be a result of these areas now being too stabilized and lacking dynamic sand movement. Also many sections of the road are low in elevation with the water table close to the surface, thus increasing vegetation growth and eliminating open areas needed by *C. lepida*. It also suggests the old inland road probably did not have a negative effect on beetle populations. Future storm events could increase sand movement or deposition and create favorable habitat on and adjacent to the road.

MANAGEMENT RECOMMENDATIONS AND RESEARCH NEEDS

Long-term monitoring data for *C. d. media* and *C. lepida* are an essential tool for evaluating potential impacts and providing adequate protection of these species and their requisite habitats. Monitoring also provides both intended and unexpected insights into their biology and ecological requirements. Continued monitoring will provide additional assessment of the effects of plover closures as a cause of the northern extension of beetles and if the North end population can recover and become re-established. Maintaining this species at Assateague will be more likely if there are at least two sections of protected or partially protected habitat areas to sustain populations.

Remarkably, some basic features of the two species' biology remain poorly known. Of particular importance, is that it is still uncertain if *C. d. media* has a one or two-year life cycle.

As mentioned earlier, this information is essential for understanding the species' population dynamics. Dispersal ability and the seasonal timing of dispersal are also poorly understood. Such information will play an obvious role in determining the degree to which there is exchange between different population segments on the island or even, in the case of *media*, if the North End and state line beetles represent discrete populations or a single metapopulation. Finally, it would be very helpful if future inventory and monitoring efforts for these species occurred throughout the island (i.e., Chincoteague NWR) and that these activities be coordinated between refuge and park staff.

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APPENDIX

**Aerial Photographs of the AINS Shoreline showing
Distribution and Abundance of *C. d. media* and *C.
lepida* (Figs 1a-8a)**

Figure 4. AINS Tiger Beetle Survey 2012

Blue numbers indicate tally of *C. lepida* adults

● -Kilometer post

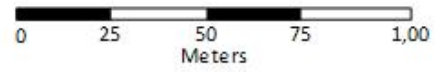


Fig. 5. Blue numbers are *C. lepidus*; Red numbers are *C. d. media*

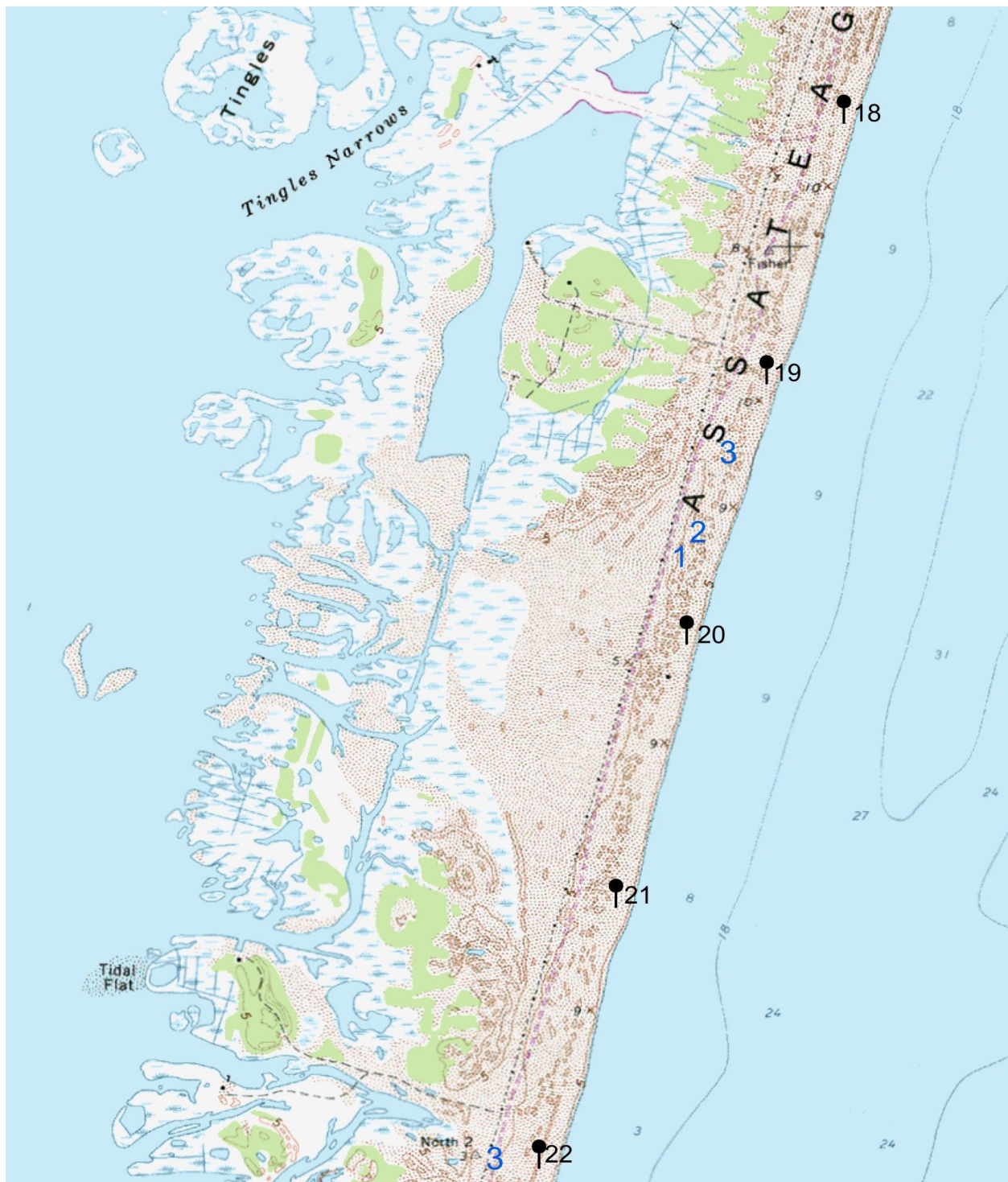
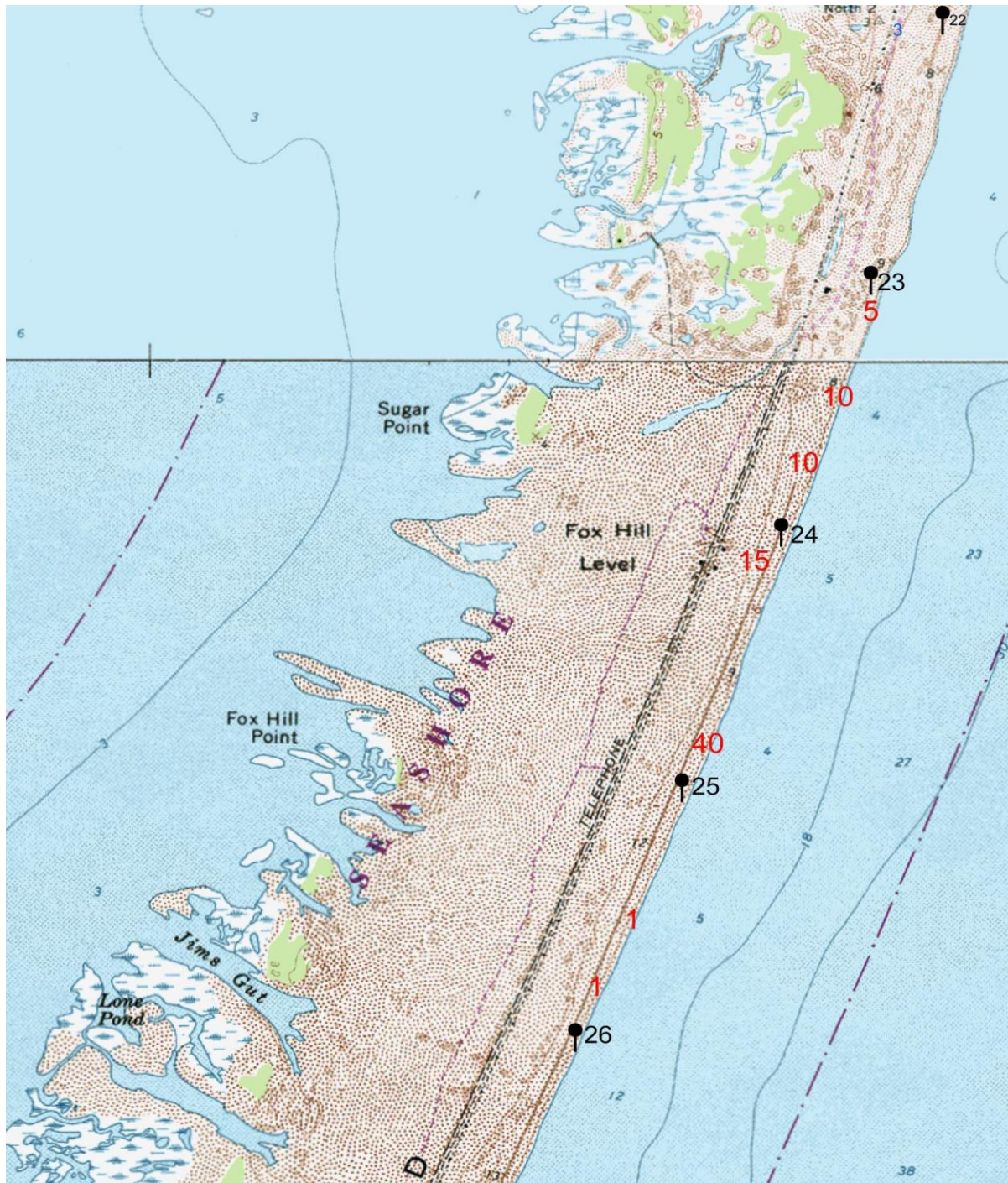


Fig. 6. Blue numbers are *C. lepida*; Red numbers are *C. d. media*



Map of Green Run Bay, Alaska, showing the coastline, islands, and various numbered points of interest. The map includes labels for Turnagain, Scotts Point, Scotts Landing, and Freeman. A dashed line labeled "TELEPHONE" runs along the coast. Numerous numbered points (1-31) are marked along the shoreline, with some points having additional numbers (e.g., 1, 2, 3, 4, 7, 12, 13, 27, 28, 29, 30, 31). The map also shows bathymetric contours and a dashed line labeled "GREEN RUN".

Fig. 8. Blue numbers are *C. lepida*, Red numbers are *C. d. media*

