

**DISTRIBUTION AND ABUNDANCE OF TWO RARE TIGER
BEETLES, *CICINDELA DORSALIS MEDIA* AND *C.
LEPIDA*, AT ASSATEAGUE ISLAND NATIONAL
SEASHORE IN 2011**

FINAL REPORT

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Berlin, MD 21811**

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by

**C. Barry Knisley
1510 Beaverdam Ck. Rd.
Crozier, VA 23039**

(Department of Biology, Randolph-Macon College, Ashland, VA 23005)

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, 2011. Methods were identical to those used in the annual surveys conducted from 2001-2010. 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 2011 was 235 adults**, including only 14 along the North End ocean shoreline (none counted on the western bay side) and 221 in the ORV zone in the southern half of the site. Of the 221 in the ORV zone, 32 were in the temporary plover closure section from km 24 to the VA State Line south of km 35; the other 32 were from 19 to km 24. The 2011 count was very similar to the 245 adults in 2010 and compares with 429 in 2005, 57 in 2006, 88 in 2007 169 in 2008, and 84 in 2009. This year's results are an exception to the pattern of significantly lower numbers in even years.
2. Results of the *C. d. media* surveys further document the high year-to-year variation in population size. The low even year counts may have been triggered by hurricane Isabel or perhaps north end restoration work, but exact causes are unknown. Favorable habitat and other conditions should have resulted in a build-up of both cohorts by 2007 or 2008, but it seems that certain habitat conditions have not allowed this to occur and numbers remain low especially in the north end where extensive shoreline habitat is present.
3. The **total number of *C. lepida* counted in 2011 was 128**, compared to counts of 976 in 2010, 465 in 2008, 386 in 2006, 514 in 2005, and 582 in 2004. The explanation for this low count is uncertain but was not a result of survey conditions which seemed ideal. Most adults in 2011 were in the km 25-28 section. As in previous years all adults were within the ORV zone and along the edges, flats and slopes of breaks, washovers, and pans that were cut through the primary dunes.
4. The low numbers of *C. lepida* adults in 2011 are a significant departure from the much higher counts in other recent years. Prior to this the numbers of adults and larvae indicated a relatively stable population with favorable recruitment and survival. These high numbers indicated that in the past 10 years there was increasing colonization of areas of primary dune habitat that were created by intense storm and erosion activity.
5. The results of the 2011 survey, even though numbers of *C. lepida* were much lower than in other recent years, do not significantly change our conclusions and management recommendations from earlier reports. It is apparent from this year's survey that the population of *C. d. media* continues to occupy the North End restoration project area, but is now at significant risk of extinction there, as suggested recent low and erratic counts. 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.

OBJECTIVES

The study objectives for 2011 are as in previous surveys:

1. Determine the distribution and abundance of adult populations of *C. d. media* and *C. lepida* at AINS in 2011
2. Evaluate population trends and distribution patterns for *C. d. media* and *C. lepida* at AINS for all survey years.
3. If possible, evaluate any effects that the 2002 North End Beach Restoration Project might have had on *Cicindela dorsalis media* and determine if *C. lepida* has become established along the former Off-road Vehicle Route or in new areas that may have been impacted by coastal storms.

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 with dry, loose sand (Laroche 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 may 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 appears to be restricted to the southern part of AINS (Hill and McCann, unpublished data). 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), increased believed to be 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 15-17, 2011. 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. The method we used was a direct visual index count which 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 when adult beetles are concentrated in this habitat. 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 when we surveyed by making counts from a slow moving vehicle. The reason for this was that the extended plover closure areas and more adults within this extended section.

Monitoring over the years 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. lepidus* surveys in 2011 were ideal (sunny, warm). In 2010 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 235 adults during the 2011 survey, a count very similar to the 245 in 2010 and a significant increase in these two counts from previous recent counts (57 in 2006, 88 in 2007 and 169 in 2008) (Table 1, Fig. 1). 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. In 2011, only 14 adults were found along the north end shoreline, a significant decline from the 96 in 2010 and more similar to the 21 in 2009 and 5 in 2008. Overall, the north end numbers have varied but have been consistently low most years (with very low densities) since 1992, indicating that progressive recruitment and population buildup has not occurred along this long section of shoreline. The reason for this is not known since impacts are limited and habitat would appear to be suitable. It is possible the frequent vehicle patrols are having a negative effect. Interestingly, in 2011 we again saw relatively large numbers in the south ORV zone, with 221 adults counted. This is the highest count ever in this section. Most of those counted (189) were within the extended plover closure section which went from near km 24 south to the Virginia line; 116 of these were found from km 24 to 26 with the other high density section (51 adults) at km 34. 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 consistent vehicle use. It seems apparent that adults are moving into this area, probably from VA and finding this area suitable, and surviving there. 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, 1985-2011.

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
0	10	19	11		23	52	7	6	0	0	11	0	0	0	0	0	1	0	1	0
0.5	20	8	28		64	140	57	2	0	0	3	0	0	1	0	0	2	1	6	1
1	41	5	36		108	109	10	7	0	1	0	0	0	5	0	2	0	1	6	0
1.5	25	12	3		26	40	4	5	0	5	3	0	1	3	4	2	0	1	3	0
2	1	38	0		14	23	2	3	5	6	0	4	0	21	1	11	0	2	1	0
2.5	4	49	0		0	4	0	3	5	2	2	0	0	8	0	11	0	0	13	0
3	27	59	0		17	3	1	2	4	2	4	1	0	5	10	9	0	4	30	0
3.5	42	42	11		67	12	5	18	0	66	15	8	3	37	3	6	1	0	28	0
4	7	12	24		27	0	1	13	0	112	18	14	1	25	2	0	1	0	9	0
4.5	8	9	4		2	0	0	10	0	106	0	18	0	75	4	4	0	6	0	0
5	2	3	5		0	0	1	2	0	34	1	11	1	34	1	9	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
6	1	0	0		0	0	0	3	0	54	11	10	0	12	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
7	3	2	0		0	0	0	0	0	83	2	14	0	11	0	2	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
8	0	0	0		0	0	0	0	0	22	0	0	0	15	0	0	0	1	0	4
8.5	0	0	0		0	0	0	0	0	27	0	3	0	7	0	0	0	3	0	2
9	0	0	0		0	0	0	0	0	1	0	3	0	7	0	0	0	1	0	4
9.5	0	0	0		0	0	0	0	0	1	0	2	0	1	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
North end Bayside										15	15		8		0	0	8	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
ORV Zone, N of closure										0	18	12	18	7	11	5	57*	31	31**	32
ORV Closure Zone					13					72	97	9	20	145	21	16	99	32	118	189#
Grand AINS total	195	259	122	220	359	383	88	74	14	698	220	190	60	429	57	88	169	84	245	235
*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 the shoreline section closed for plover nesting extended from near 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) which 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 2011 is not significantly different than what we have seen for the related taxon, *C. d. dorsalis* in Maryland. 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. Relevant and recent evidence of storm impact (Hurricane Isabel, in this case) 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

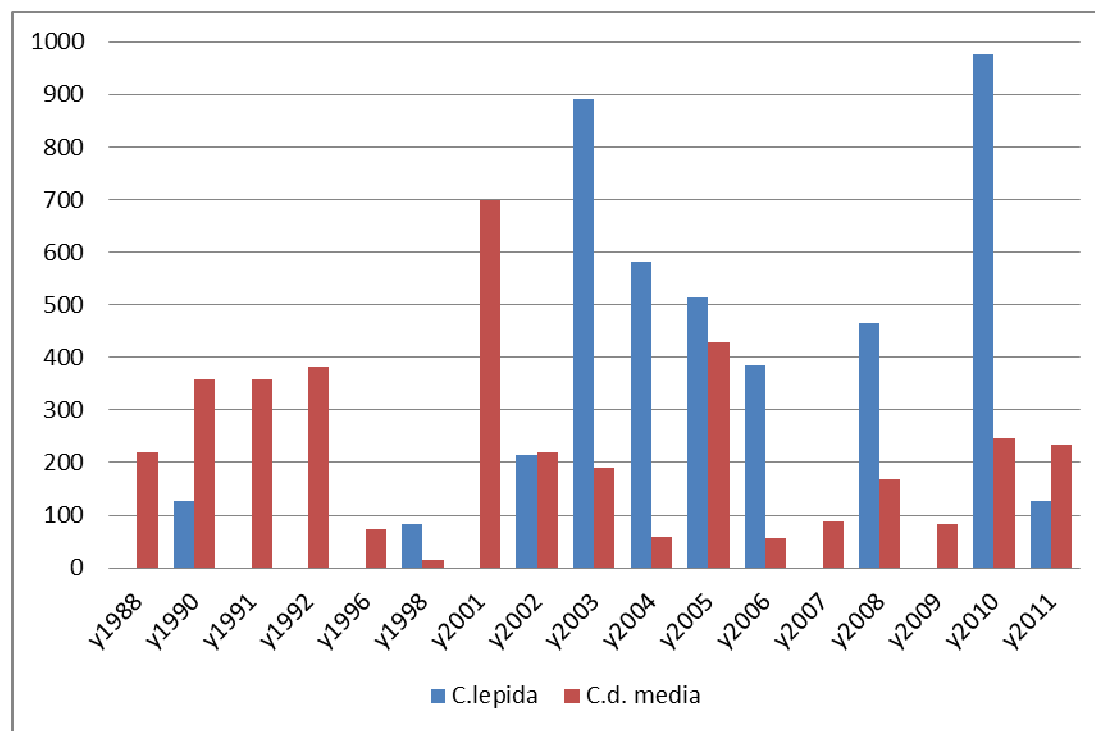
2004. Surveys at Janes and Cedar Islands on Maryland's upper Eastern Shore also declined dramatically in 2004 compared to the several previous several years. Effects from Hurricane Isabel may also explain this decline.

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, Fig. 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 around 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 were too low to determine much about distributional changes.

The potential impacts of human activity, including heavy pedestrian foot traffic and ORV activity, has 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 be a possible cause of the very low counts in the past several years.

Fig. 1. Total numbers of adult *C. d. media* and *C. lepida* at AINS, 1985-2011.



C. lepida. The total count for *C. lepida* in 2011 was 128, the lowest number counted since 1998 when the count was 84. Previous lows were 127 in 1990 and more recently, 386 in 2006. No surveys for *C. lepida* were conducted in 2007 and 2009. The significant decline in 2011 is unusual and not fully understood, especially since survey conditions were suitable and cannot explain the low count. 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. The lower count in 2006 was due to less favorable weather conditions during the survey (cooler and partly cloudy) which resulted in reduced activity and fewer adults counted. Conditions were ideal for larvae that year, producing high larval counts. Larvae are more active during cloudy, cooler conditions. A possible explanation for the low count in 2011 could have been 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 was similar to most other recent years. 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 now seems 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 were in km 19 and 25-27, although numbers were much lower than most other years. Counts in other km sections were very low.

In most years 2002-present, we found a very high proportion of the adults (over 70% in all years) and most patches of larvae in overwash and cut through areas where the primary dune had been breached. Active adults, patches of larvae, and adult burrows were especially common along the sides and flat in the area of these cuts. Increased efforts to count larvae in 2006 and 2008 indicated most were also in these same microhabitats.

Table 2. Numbers of adult *C. lepida* counted along whole length of Assateague Island National Seashore, 1990-2011, and numbers of larvae in 2006 and 2008.

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

* No data collected for individual segments in 1990 and 1998

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 the past few years 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 possible that the 2011 count may indicate natural succession and stabilization is now occurring in the south ORV zone. Surveys in 2012 and subsequent years may indicate whether the 2011 count is an indication of a progressive trend or a “normal” population fluctuation.

Our surveys in recent years suggest that the elimination of ORV's on the inland road has 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 and the water table is close to the surface, thus increasing vegetation growth and eliminating open areas needed by *C. lepida*. It also suggests the 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

Additional research and monitoring 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 in the immediate future will provide much needed information on the short-term effects of the North End Beach Restoration Project and, if implemented, the northward extension of the state line Piping Plover restricted area. The very low numbers of *C. d. media* in recent years provide additional justification for the expansion and permanent restrictions of the Piping Plover protection area. Maintaining a viable population of beetles at Assateague will be more likely if there are at least two sections of protected or partially protected habitat areas.

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 1a. AINS Tiger Beetle Survey 2011
Blue numbers indicate tally of *C. lepida* adults
Red numbers indicate tally of *C. media* adults

⌚ - Kilometer Post

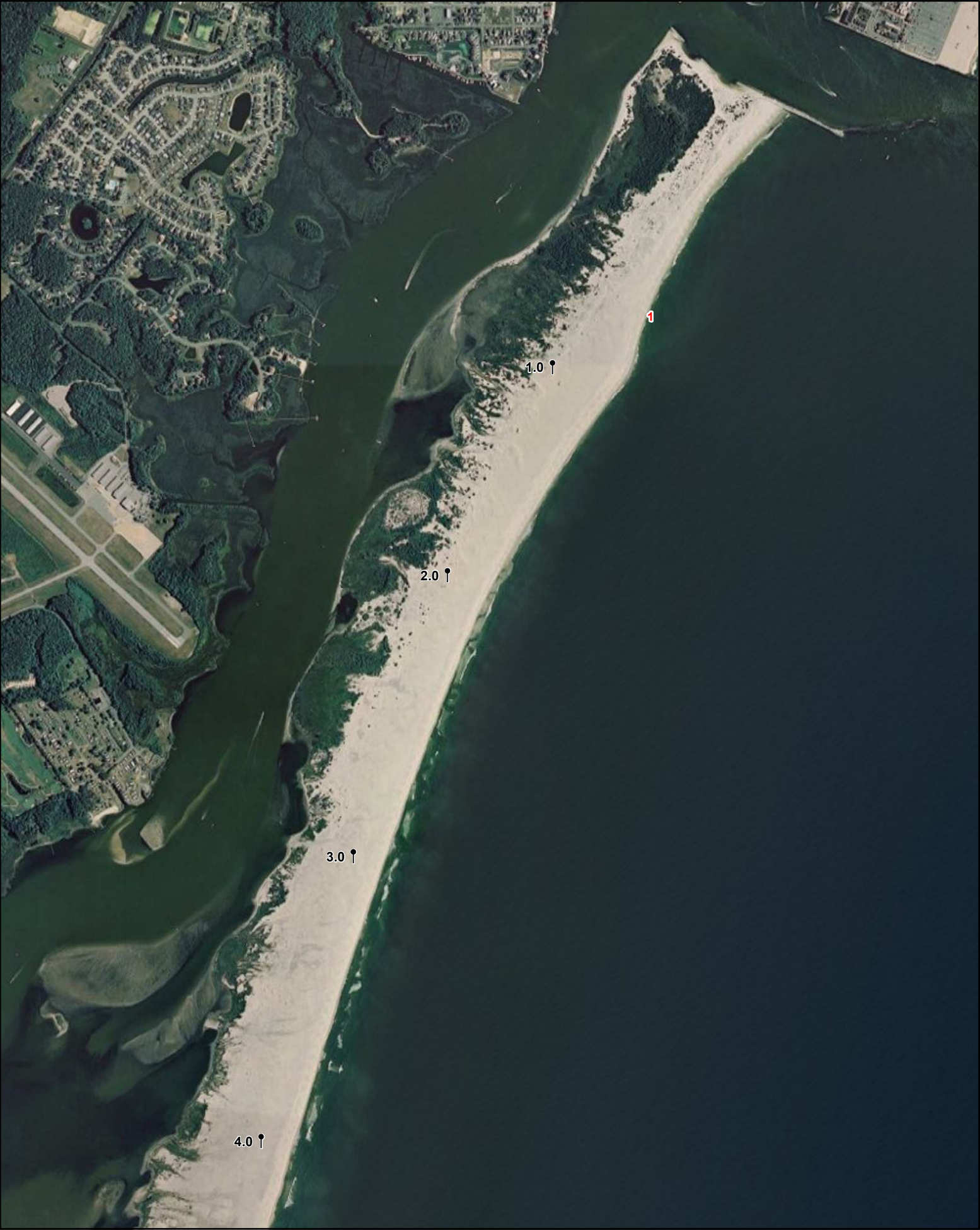


Figure 2a. AINS Tiger Beetle Survey 2011
Blue numbers indicate tally of *C. lepida* adults
Red numbers indicate tally of *C. media* adults

📍 - Kilometer Post

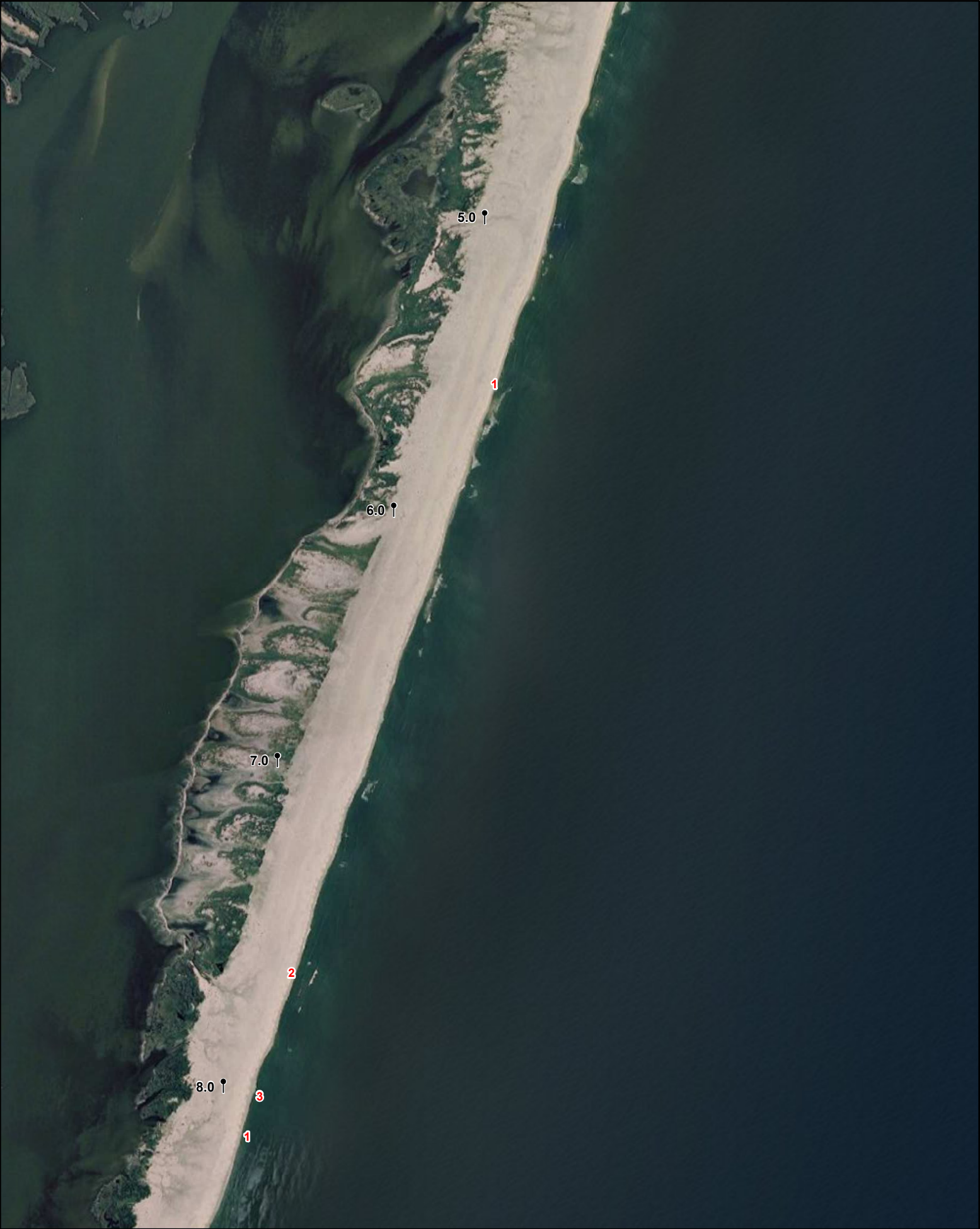


Figure 3a. AINS Tiger Beetle Survey 2011
Blue numbers indicate tally of *C. lepida* adults
Red numbers indicate tally of *C. media* adults

● - Kilometer Post

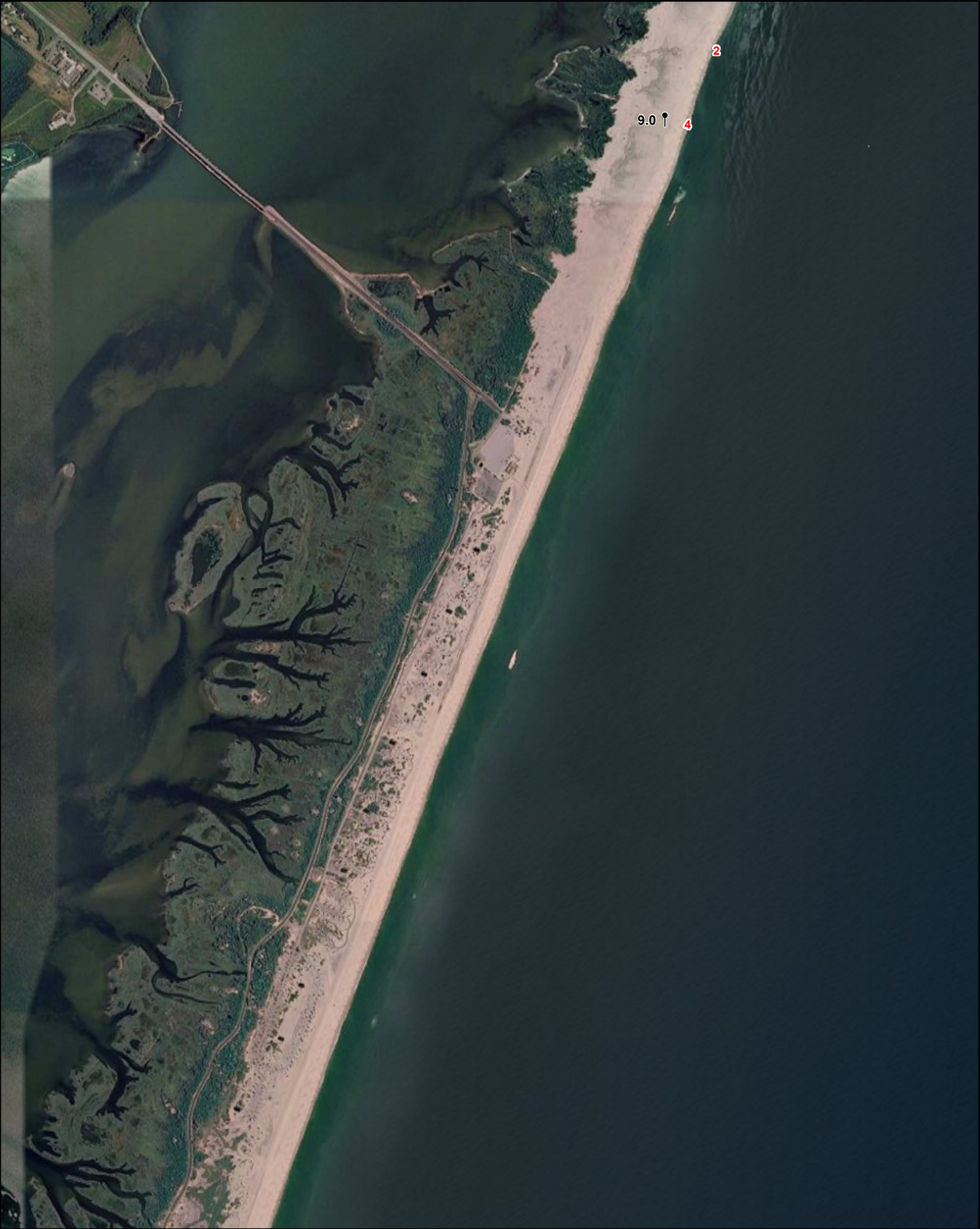
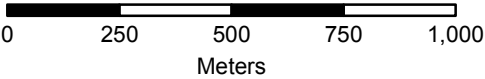


Figure 4a. AINS Tiger Beetle Survey 2011
Blue numbers indicate tally of *C. lepida* adults
Red numbers indicate tally of *C. media* adults

📍 - Kilometer Post

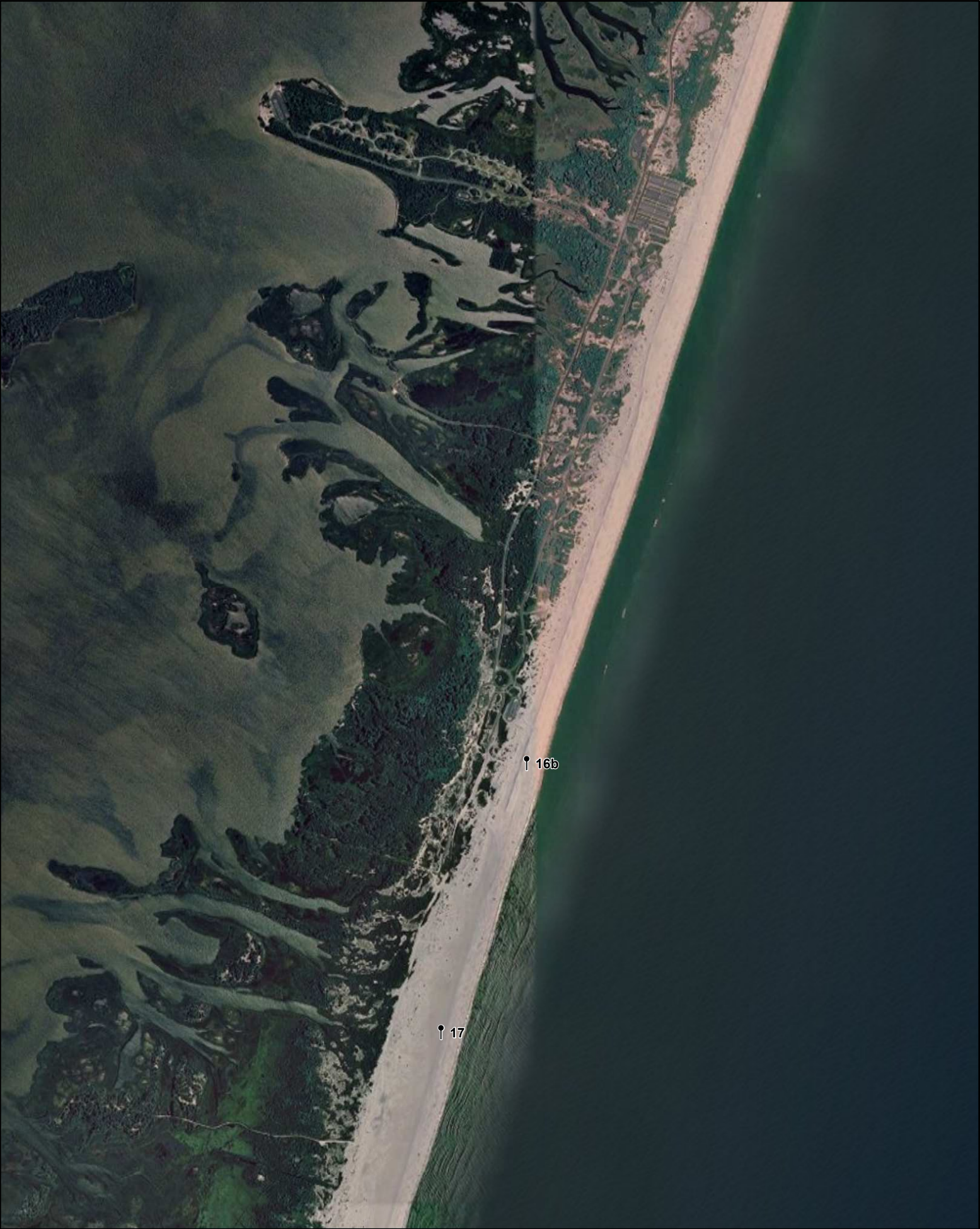
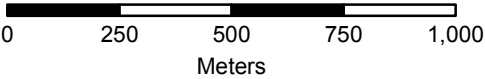
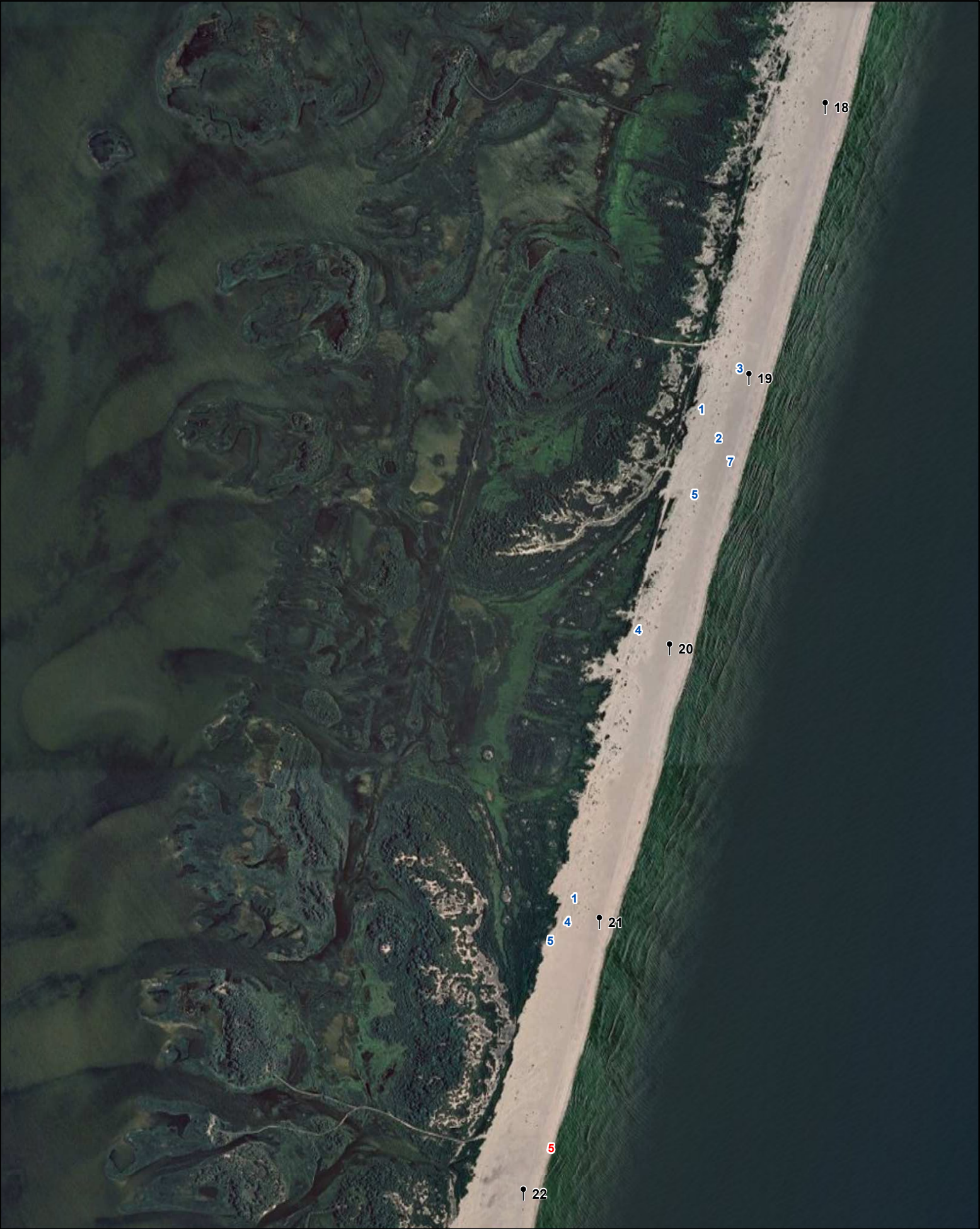
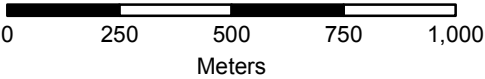


Figure 5a. AINS Tiger Beetle Survey 2011
Blue numbers indicate tally of *C. lepida* adults
Red numbers indicate tally of *C. media* adults

⌋ - Kilometer Post



● - Kilometer Post



Figure 7a. AINS Tiger Beetle Survey 2011
Blue numbers indicate tally of *C. lepida* adults
Red numbers indicate tally of *C. media* adults

⌚ - Kilometer Post

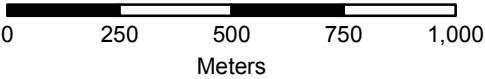


Figure 8a. AINS Tiger Beetle Survey 2011
Blue numbers indicate tally of *C. lepida* adults
Red numbers indicate tally of *C. media* adults

⌚ - Kilometer Post

