Report on the 2005-2007 Survey of Selected Arthropods from Assateague Island National Seashore

In Partial fulfillment of a National Park Service Research Project by the
RHODE ISLAND NATURAL HISTORY SURVEY (RINHS)
P.O. Box 1858
Kingston, RI 02881

Richard Orr
Principle Investigator and Project Leader
Mid-Atlantic Invertebrate Field Studies (MAIFS)
5215 Durham Rd East
Columbia, MD 21044
(410) 730-7290
odonata457@comcast.net
www.marylandinsects.com

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ABSTRACT

A three year survey of the dragonflies, damselflies, butterflies, grasshoppers, katydids, crickets, leaf beetles and bees of Assateague Island National Seashore (ASIS) occurred from 2005 through 2007. Additional arthropod surveys were undertaken of the lower salt marsh (terrestrial environment) and the island's freshwater ponds. Beyond these basic surveys all conspicuous arthropods when encountered were recorded and when possible photographed so that a "field guide" could be created for use by the general public. Information was organized in a detailed Project Database including those species that were photographed or kept as voucher specimens. A checklist of the dragonflies, damselflies and butterflies of the island was developed. The arthropods recorded from ASIS generally fell into three distinct categories. The first were the long-time resident species (barrier island specialists). These were the fewest in number but often had the highest numbers of individuals. The second were introduced mainland species that found suitable habitat on the island to maintain viable populations from a few years to a few decades or even longer. This category contained the most arthropod species found on the island. The final category were vagrants from either the adjacent mainland or north/south moving dispersals/migrants that did not establish a population, or succeeded in establishing a population for only a season or so.

ACKNOWLEGMENTS

I would like to thank Carl Zimmerman, Jack Kumer and the other Natural Resource staff at Assateague Island National Seashore for their support on this project. They graciously provided housing, an over-the-sand vehicle, lab equipment, access to their insect collection and freely shared their collective scientific expertise and knowledge of the island. Their active support greatly increased the quality of the project.

My extended thanks also go out to the fellow professionals that helped gather field and historical data and helped with the surveys on a regular basis. This includes ZoAnn Lapinsky (Wildlife Photographer), Joseph Cavey (Leaf Beetle Specialist), Sam Droege (Bee Specialist), and Allison Turner (NPS employee). Many others also helped with field work on specific field days and my appreciation also extends to them.

Without the help of a number of taxonomic specialists, the identification of many of the island's species could never have been made. Specifically, Sam Droege (Bees), Joe Cavey (Leaf Beetles/Stink Bugs), Jim McCann (Aquatic Beetles), Barry Knisley (Tiger Beetles), Daniel Kjar (Ants), Matthias Buck (Wasps) and the many others that helped the PI expand the study beyond his own specific areas of expertise.

I also would like to thank the staff at Chincoteague National Wildlife Refuge, Steve Roble (Virginia Department of Conservation and Recreation, Division of Natural Heritage) and Denise Gibbs (Chincoteague Monarch Monitoring Project) for freely sharing their records of known arthropods from Chincoteague National Wildlife Refuge.

Finally, I would like to thank those who helped with the organizational structure and editing of this report (especially Jerry Persall, Sara Stevens, Carl Zimmerman, Jack Kumer and Allison Turner), Project Database (especially Dennis Skidds), the checklist and the field guide (especially ZoAnn Lapinsky and Rachelle Daigneault).

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INTRODUCTION

It has been said that an entomologist can travel all summer and get half way across his front lawn. There is truth in this seemingly contradictory saying. The diversity of invertebrates even from the best studied landscapes far exceeds our current taxonomic knowledge. And to move beyond just naming what moves at or under our feet to an understanding of how they interact with each other and the environment they live in is an ecological goal that may never be completely known.

There is no doubt, that as small-sized as these arthropod players are, they are forever tied to the health of the ecosystems in which they occur. It has been realized for sometime that arthropods are the most species diverse organisms in terrestrial and fresh water ecosystems and as such provide an unlimited source of biological information which can be used for the conservation, planning, and management of ecosystems (Kremen et al. 1992).

Baseline surveys and subsequent monitoring of key arthropod groups in critical habitats can increase our understanding of ecosystem dynamics and aid conservation management efforts. Conversely, survey efforts may also uncover new life history information for the organisms being studied (Cavey 2004). And, in turn, this new information may reveal additional knowledge that will help in current and future conservation assessments and ultimately to the species and their associated habitat's protection.

The National Park Service's (NPS) Assateague Island National Seashore (ASIS) manages Assateague Island north of the Maryland/Virginia state line. ASIS contains the only stretch of barrier island in the state of Maryland that is largely natural and undeveloped (Furbish, Railey and Meininger 1994). ASIS was created in 1965 by Public Law 89-195. Subsequent legislation in 1976 (Public Law 94-578) directed the NPS to provide "*measures for the full protection and management of the natural resources and natural ecosystems of the seashore*." The natural resources covered are those of an undeveloped mid-Atlantic coastal barrier island.

The NPS recognizes that a thorough protection and understanding of the natural resources cannot be seriously undertaken without a basic understanding of what arthropods are present and what role they play in maintaining the various habitats that make up a barrier island. Before this study, Assateague Island National Seashore had assembled considerable baseline information on many of its natural resources. However the biotic components studied had largely included "mega fauna" and vascular plants. Very little inventory work had been done on terrestrial arthropods. Similarly, most research and monitoring of the island's ecological processes had focused on terrestrial vertebrates and estuarine environments. This study was intended to help fill that critical gap in terrestrial and freshwater arthropod knowledge.

Another benefit from this project was to make available new educational materials to help the general public appreciate and understand the importance of their natural heritage. Specifically, charismatic large insects such as odonates (dragonflies and damselflies) and butterflies are rapidly gaining popularity among amateur naturalists as a subject of interest. Many bird enthusiasts are turning to these groups as a relatively visible and interesting component of the natural world that can be enjoyed using many of the same skills they have developed for bird identification. Just as bird watching has prompted a public desire to protect their habitat, popular interest in these insect groups has initiated interest in their conservation. The project's development of a checklist to the butterflies and dragonflies and a photographic field guide to the most conspicuous arthropods of ASIS will aid in cultivating this understanding. There is no doubt that many people are first introduced to a new aspect of the natural world through their attempts to identify what they see outdoors. It is the hope that the checklist and field guide will help in some small way to spark a conservation ethic and an appreciation for Assateague Island from its many visitors.

The main objects of the project were to:

- Identify species and provide natural history information on the dragonflies and damselflies of ASIS
- Identify species and provide natural history information on the butterflies of ASIS
- Identify species and provide natural history information on the grasshoppers, katydids, and crickets of ASIS
- Identify species and provide natural history information on the leaf beetles of ASIS

- Identify species and provide natural history information on the bees of ASIS
- Identify the major terrestrial arthropod species of the lower salt marshes within the National Park
- Identify the major arthropod species of the freshwater ponds within the National Park
- Provide an Project Database which captures the data collected
- Provide a checklist of the dragonflies, damselflies, butterflies and skippers for the general public
- Provide a digital photographic field guide to the conspicuous arthropods of ASIS

It is important to recognize that this study did not attempt the identification of all arthropods that inhabit ASIS. Such an ambitious goal would require a full range of taxonomic specialists and field expertise and decades of time that were not available for this project. It is recognized that serious gaps still exist in the taxonomic arthropod coverage of the island. However, it is hoped that this study will inspire additional specific habitat or taxon level arthropod surveys and ecological studies to help fill the existing gaps.

It is unfortunate that when most people (including biologists) think of arthropods and Assateague Island, what comes to mind are the hordes of mosquitoes, biting flies and ticks. There is no doubt that even the most adamant “bug lover” can be tested when visiting sections of the island during a salt marsh mosquito outbreak. But those “nasty” arthropods that seek out our blood are but a small part of the mind-numbing variety of joint-legged creatures that inhabit and dominate the island. Often out of sight and mind, these creatures are necessary and irreplaceable components of the unique barrier island habitats that we all agree makes ASIS worth visiting and protecting.

METHODS

Preparation for the study started in 2004 with the collection of existing scientific literature and locating historical specimens in collections that were relevant to the project. In November 2004, a reconnaissance field trip to ASIS took place where a member of the ASIS resource management staff escorted the Principle Investigator (PI) around the island for the purpose of checking potential habitats and learning the logistics of gaining access to these sites.

The in-depth surveys continued for the next full three years (2005-2007) at ASIS. Field excursions were organized to provide maximum coverage of the diverse arthropod habitats at the Park for (1) different times of the year and (2) under various environmental conditions. Different years focus on different surveys but all surveys were addressed to some degree during each of the three years.

Field trips were conducted throughout the year. The months of May, June, September and October were the most productive months for conducting field work and thus more field days were devoted to this time period. The time spent in the laboratory for identification and organizing the information far exceeded the time spent in the field. The laboratory work also took place year round.

Relevant information gathered in the field was saved to a digital voice recorder. The saved information was transferred to standardized log sheets at the end of each visit to the island to ensure consistency in recording field data. Relevant species data was then later entered into a database (Microsoft Excel program) designed by the Principle Investigator.

Collecting was necessary for vouchering many of the arthropod records taken from ASIS during the study. In addition to vouchering, field collected specimens were taken if they had significant scientific value (a new distribution record, hybrids, variants, etc.) or in those situations where an identification had to be done in the laboratory. Voucher photographs of the common, easy to identify species, were sometimes used instead of a collected voucher specimen.

Odonata Survey: Survey information was mainly from the identification of imagoes (adults) and exuvia (the cast skin remains left by emerging adults). Some larval sampling was also conducted on a limited basis. With some exceptions, most mature adults were identified using binoculars or by capturing and releasing individuals using an insect net. The presence of cast skins provided the emergent times and larval distributions for many of the species. The cast skins were discarded after the identifications had been made.

All ponds numbered by the NPS were visited at least once. However specific ponds were targeted for repeated visits. These ponds were 14A, 16B, 20H, 29A, 29E, 29D- 2 (a complex of ponds), 33A and 36B. In addition, the salt marsh habitat was also routinely visited for dragonflies and damselflies.

The majority of the time devoted to this survey was in 2005.

Orthoptera Survey: Most of the Orthoptera survey was conducted by netting (sweep and aerial) while walking through the various habitats within the Park. However, katydid and cricket songs/calls were on occasion recorded in the field with a digital recording device (Olympus Digital Wave Player) and later down loaded to a computer for comparison with known species recordings (Rannels, Hershberger and Dillon 1998; Elliott and Hershberger, 2007; Walker and Moore 2007).

In addition, a portable computer was used to play pre-recorded cricket and katydid songs (Rannels, Hershberger and Dillon 1998) at night to attract specific species. This was often done while blacklighting which also proved productive in drawing in a number of orthopteran species.

The majority of the time devoted to this survey was in 2006.

Leaf Beetle Survey: The Leaf Beetle Survey was conducted primarily by sweep netting while walking through the various plant communities within the Park. To associate host plants with collected leaf beetles, individual plant species or small groups of plants were selectively swept whenever possible. The netted leaf beetles were extracted and preserved, and recorded notes taken on a digital audio recorder. Plants were observed for leaf beetles, or signs of leaf beetle damage, and if found were hand picked. When an unusual leaf beetle find was recognized or suspected a GPS reading was taken of where the specimen was collected. Unfortunately, rare species were not always recognized in the field, but only after lab examination due to their tiny size (< 5mm). Therefore, for many of the specimens only the general host plant community and only general location were recorded.

Other methods were significantly less effective than sweeping and hand picking specimens. A few leaf beetles were collected in bee traps (see Methods for Bee Survey). In addition, a few specimens were collected while blacklighting.

Joe Cavey (a leaf beetle specialist) conducted the majority of the survey. All leaf beetle specimens required identification in the laboratory because of the complexity of the taxonomy and all preliminary identifications made by the PI were double checked by Joe Cavey to ensure accuracy.

The majority of the time devoted to this survey was in 2007.

Butterfly Survey: Survey information was mainly derived from the identification of imagoes (adults) visually encountered during the field work. Some larval sampling was also conducted on a limited basis and, when encountered, caterpillars were kept for identification. With some exceptions, most mature adults were identified using binoculars or by capturing and releasing individuals using an insect net.

The majority of the time devoted to this survey was in 2005.

Bee Survey: Two methods were relied on; the first was netting using both a general sweep net and targeting bees visiting flowers with an aerial net. The second method was trapping. The traps consisted of fifteen 3.24 oz. Solo brand soufflé cups placed in transects. Five fluorescent yellow, fluorescent blue and non-fluorescent white bowls were alternated and spaced approximately 5 meters apart. The traps were filled with water that had been treated with a small amount of liquid soap. The traps were either set out in the early morning, before the other field work started and picked up at the end of the day (approximately 8 hours) or left over night and picked up the following evening (approximately 20 hours). The trap protocol used was fine tuned by Sam Droege for use on the island from that presented in the LeBuhn, Droege, and Carboni (2007) paper.

All specimens required identification in the laboratory and all preliminary identifications made by the PI were double checked by Sam Droege to ensure accuracy.

The majority of the time devoted to this survey was in 2006 and 2007.

Freshwater Pond Survey: A general sampling of the arthropods from a number of the freshwater ponds (14A, 16B, 20H, 29A, 29E and 33A) was undertaken using aquatic nets. A Maryland DNR survey conducted in 1997 for aquatic beetles along with the Odonata survey data were added to the Freshwater Pond Survey results. Coupled together these three surveys provide a good sampling of the invertebrate fauna of the ASIS ponds. Both permanent and temporary ponds were sampled.

The majority of the time devoted to this survey was in 2005.

Salt Marsh Survey: A general sampling of the arthropods was undertaken whenever a salt marsh was visited. The survey was restricted to the low marsh where *Spartina alterniflora* predominated, but with a few additional vascular plants mainly *Distichlis spicata* and *Salicornia*. The pannes and wrack when located within the lower marsh were also sampled for arthropods. Two salt marsh sites were picked for repeated sampling in 2006. These were the Duck Blind salt marsh near kilometer 10 and Valentine House salt marsh near kilometer 28. Because the salt marsh habitat basically runs the full length of the western side of the Park there was the concern that sampling just two locations might be misleading. Therefore, additional sampling of the salt marsh outside of the selected sites was done whenever the opportunity arose.

In decreasing order of reliance, the sampling methods used were: 1) sweep netting, 2) visual inspection of ground cover, 3) blacklighting, 4) bee bowls (same method used in the Bee Survey), 5) visual inspection of the wrack and 6) recording of katydid calls (same method used in the Orthoptera Survey).

In 1994, arthropods were collected from the salt marsh, in part, for a NPS study (Furbish, Railey and Meininger, 1994). Although few of the collected samples were keyed beyond family level, the specimens collected were examined by the taxonomic specialists involved in the current project. Identifications from the 1994 study were combined with the current study to provide as complete coverage as possible of the ASIS salt marsh arthropods.

The majority of the time devoted to this survey was in 2006.

Macro-Arthropod Survey: Throughout all the surveys conducted on the island, any conspicuous terrestrial or freshwater arthropod that was encountered was identified and, if possible, photographed. All the techniques and methods described for the other surveys provided material for this survey. Since the goal of this survey was to provide a photographic field guide for identifying arthropods that the general public would be interested in, a camera was always carried when in the field.

In addition, a wildlife photographer (ZoAnn Lapinsky from Trailscapes Photography) was also contracted to take photos of the island's arthropods. All photographs used for the field guide or as species voucher photographs were taken at ASIS.

The majority of the time devoted to this survey was in 2006 and 2007.

RESULTS

The arthropods recorded at ASIS, generally fell into three distinct establishment categories: long-time resident species (barrier island specialists)* who survive in dynamic island habitats that are basically unchanged over time (e.g. beach and salt marsh), these were the fewest in number, but often had the highest numbers of individuals; introduced mainland species that find temporary suitable habitat on the island to maintain their populations from a few years to a few decades, this category contained the most arthropod species found on the island; and those species that are vagrants from either the adjacent mainland or north/south moving dispersals/migrants that normally would not establish a population, or if they did succeed in establishing a population it was only for a season or so, but never succeed in maintaining a viable population on the island.

*For the purposes of this report the term *barrier island specialist* also includes those arthropod species that evolutionarily are adapted to specific plant communities (e.g. salt marsh) or to specific host plants (e.g. Seaside Goldenrod) that are long term residents of the island's ecosystem, even though these plants (and thus their associated arthropods) can be found in similar ocean side environments outside of barrier islands.

Odonata Survey: Twenty-seven species of dragonflies and damselflies were found on the island. These species are listed along with their abundance, flight-period and larval habitat in Table 1.

Table 1: The Dragonflies and Damselflies of Assateague Island National Seashore (Worcester County, Maryland, 2005-2007 Survey)

GENUS	SPECIES	ENGLISH NAME	ABUNDANCE	FLIGHT PERIOD	LARVAL HABITAT
Anax	*junius*	Common Green Darner	Abundant	5Apr to 9Nov	Freshwater
Aeshna	*umbrosa*	Shadow Darner	Rare	7Sep	Freshwater slow streams
Epiaeschna	*heros*	Swamp Darner	Uncommon	18Jul to 1Aug	Freshwater swamps
Brachymesia	*gravida*	Four-spotted Pennant	Uncommon	18Jul	Slightly Brackish Water
Erythemis	*simplicicollis*	Common Pond Hawk	Common	9Jun to 9Oct	Freshwater
Erythrodiplax	*berenice*	Seaside Dragonlet	Abundant	22May to 9Oct	Freshwater to Brackish Water
Libellula	*axilena*	Bar-winged Skimmer	Uncommon	1Aug	Freshwater
Libellula	*lydia*	Common Whitetail	Common	9Jun to 6Sep	Freshwater
Libellula	*needhami*	Needhami's Skimmer	Common	7Jul to 20Sep	Freshwater
Libellula	*pulchella*	Twelve-spotted Skimmer	Uncommon	9Jun to 7Sep	Temporary freshwater
Libellula	*semifasciata*	Painted Skimmer	Common	9May to 7Jul	Freshwater marshes
Libellula	*vibrans*	Great Blue Skimmer	Uncommon	9Jun to 11Sep	Freshwater
Pachydiplax	*longipennis*	Blue Dasher	Common	9May to 9Oct	Freshwater
Pantala	*flavescens*	Wandering Glider	Common	7Jul to 26Oct	Temporary freshwater
Pantala	*hymaenea*	Spot-winged Glider	Uncommon	9Jun to 9Oct	Temporary freshwater
Perithemis	*tenera*	Eastern Amberwing	Rare	11Sep	Freshwater
Sympetrum	*ambiguum*	Blue-faced Meadowhawk	Rare	9Nov	Temporary freshwater
Sympetrum	*vicinum*	Autumn Meadowhawk	Rare	9Oct	Permanent ponds
Tramea	*carolina*	Carolina Saddlebags	Common	9Jun to 9Oct	Freshwater sometimes temporary
Tramea	*lacerata*	Black Saddlebags	Common	10Jun to 12Sep	Freshwater sometimes temporary
Lestes	*australis*	Common Spreadwing	Uncommon	1Oct to 5Nov	Freshwater sometimes temporary
Lestes	*rectangularis*	Slender Spreadwing	Uncommon	9Jun	Freshwater
Enallagma	*civile*	Familiar Bluet	Abundant	22May to 9Nov	Freshwater & Slightly Brackish
Enallagma	*signatum*	Orange Bluet	Uncommon	18-Jul	Freshwater
Ischnura	*hastata*	Citrine Forktail	Abundant	17Apr to 9Nov	Freshwater & Slightly Brackish
Ischnura	*posita*	Fragile Forktail	Uncommon	9May to 19Jul	Freshwater
Ischnura	*ramburii*	Rambur's Forktail	Abundant	18Apr to 9Nov	Freshwater & Slightly Brackish

Over 80 separate freshwater ponds on the Island were visited during the three year survey. Eight ponds were selected in 2005 for regular monitoring for odonates based on their representation of wetland characteristics found on the island. Two sites from salt marshes were also added to the survey selection. These selected ponds are listed in Table 2.

Not all of the species listed in Table 1 are true residents of ASIS. Table 2 lists those species that completed full life cycles on the island. Table 2 lists the targeted ponds (and salt marsh pannes) and the type of information used to determine those species that were completing their life cycle.

Table 2: Odonates by Pond with proof of larval development (primary targeted ponds only)
(Worcester County, Maryland, 2005-2007 Survey)
[L=larvae, CS=cast skins, A=adults which are either ovipositing, on territory, or freshly emerged adults]

14A	*Anax junius* (A)	*Epiaeschna heros* (A)	*Brachymesia gravida* (A)
	Libellula vibrans or *axilena* (L)	*Libellula* sp. (L)	*Libellula needhami* (A)
	Libellula vibrans (A)	*Erythemis simplicicollis* (A)	*Erythrodiplax bernice* (A)
	Pachydiplax longipennis (A)	*Tramea carolina* (A)	*Tramea lacerata* (A)
	Enallagma civile (A)	*Enallagma signatum* (A)	*Ischnura ramburii* (A)
16B	*Anax junius* (L, CS)	*Tramea carolina* or *lacerata* (L)	*Libellula semifasciata* (A)
	Libellula needhami (A)	*Pachydiplax longipennis* (A)	*Erythrodiplax bernice* (A)
	Sympetrum ambiguum (A)	*Lestes australis* (A)	*Enallagma civile* (A)
	Ischnura hastata (A)	*Ischnura ramburii* (A)	*Ischnura* sp. (L)
20H	*Anax junius* (A, CS)	*Pachydiplax longipennis* (A, CS)	*Libellula semifasciata* (A)
	Libellula needhami (A)	*Erythemis simplicicollis* (A)	*Erythrodiplax bernice* (A)
	Tramea carolina (A)	*Tramea lacerata* (A)	*Ischnura hastata* (A)
	Ischnura ramburii (A)	*Ischnura* sp. (L)	
29A	*Anax junius* (L, CS, A)	*Epiaeschna heros* (A)	*Libellula needhami* (L, A)
	Libellula lydia (A)	*Libellula pulchella* (CS)	*Libellula axilena* (A)
	Libellula vibrans (A)	*Libellula semifasciata* (A)	*Erythemis simplicicollis* (L,CS,A)
	Erythrodiplax bernice (A)	*Pachydiplax longipennis* (L, CS, A)	*Tramea carolina* (L, CS, A)
	Enallagma civile (A)	*Ischnura ramburii* (A)	*Ischnura hastata* (A)
	Ischnura posita (A)	*Ischnura* sp. (L)	
29E	*Anax junius* (CS, A)	*Erythemis simplicicollis* (A)	*Erythrodiplax bernice* (A)
	Libellula needhami (A)	*Libellula pulchella* (A)	*Libellula lydia* (A)
	Libellula vibrans (A)	*Pachydiplax longipennis* (A, CS)	*Tramea carolina* (A, CS)
	Enallagma civile (A)	*Ischnura ramburii* (A)	*Ischnura hastata* (A)
	Ischnura posita (A)		
29D-2	*Erythemis simplicicollis* (A)	*Pachydiplax longipennis* (A)	*Libellula vibrans* (CS, A)
Complex	*Erythrodiplax bernice* (A)	*Enallagma civile* (A)	*Lestes rectangularis* (A)
	Ischnura hastata (A)	*Ischnura posita* (A)	*Ischnura ramburii* (A)
33A	*Anax junius* (A)	*Epiaeschna heros* (L)	*Pachydiplax longipennis* (L)
	Libellula semifasciata (A, L)	*Ischnura ramburii* (A)	*Ischnura* sp. (L)
36B	*Anax junius* (A)	*Libellula semifasciata* (A)	*Libellula needhami* (A)
	Pachydiplax longipennis (A)	*Tramea carolina* (A)	*Tramea lacerata* (A)
	Erythrodiplax bernice (A)	*Enallagma civile* (A)	*Ischnura hastata* (A)
	Ischnura ramburii (A)		
Salt-Marsh pannes at		*Ischnura hastata* (A)	*Ischnura ramburii* (A)
Valentine & Duck Blind marshes		*Erythrodiplax bernice* (A)	

The highest diversity of dragonfly and damselfly species was found in the deeper freshwater ponds that occurred at the interface of open grasslands/secondary dunes and forest/brush edges. Examples are ponds 14A, 29A and 29E. The reason for this is that these are more stable than the other freshwater ponds at ASIS and receive enough sun to enhance subsurface plants which supported a greater number of niches for odonate larvae.

However, it was the freshwater shallow marsh-like ponds located in full sun that produced the greatest number of individual freshwater odonates (more numbers but less diversity than the above mentioned deep water ponds) but their ability to do so was inconsistent. The production of odonates in these shallow ponds changed greatly from year to year and was related to the current season's pattern of rainfall. Odonate numbers would crash in these shallow ponds to zero, or near zero, either due to an influx of saltwater or from drying up. Examples of these ponds are 20H (susceptible to drying) and 29D-2 complex (susceptible to saltwater intrusion).

There were three main differences between the ASIS freshwater pond odonate species composition and the mainland odonate freshwater pond species composition. The first was that the species diversity was noticeably lower on the island (See Table 3); the second was that the relative abundance of the more common species found on similar mainland habitats was skewed noticeably on the barrier island (See Figures 1a & 1b); and the third difference was that unlike mainland ponds (both permanent and temporary) where differences in the Odonata species composition often demonstrates variation due to minute differences even among similar looking ponds (Orr, 1996), the various ponds located throughout the length of ASIS showed very little variation in species composition. In other words the species found at a pond at the northern end of the island were basically the same as found at a similar looking pond at the southern end of the island and anywhere in-between.

Table 3: Number of Odonate Species found at three locations on Maryland's Coastal Plain

LOCATION ON MARYLAND'S COASTAL PLAIN	NUMBER OF SPECIES
Assateague Island National Seashore	27
Jackson Lane (TNC property) (Orr, 2006)	61
Patuxent Research Refuge (Orr, 1996)	109

Figure 1a: Relative Abundance of the 5 most Common Odonates from Assateague Island National Seashore (Worcester County, Maryland, 2005-2007 Survey)

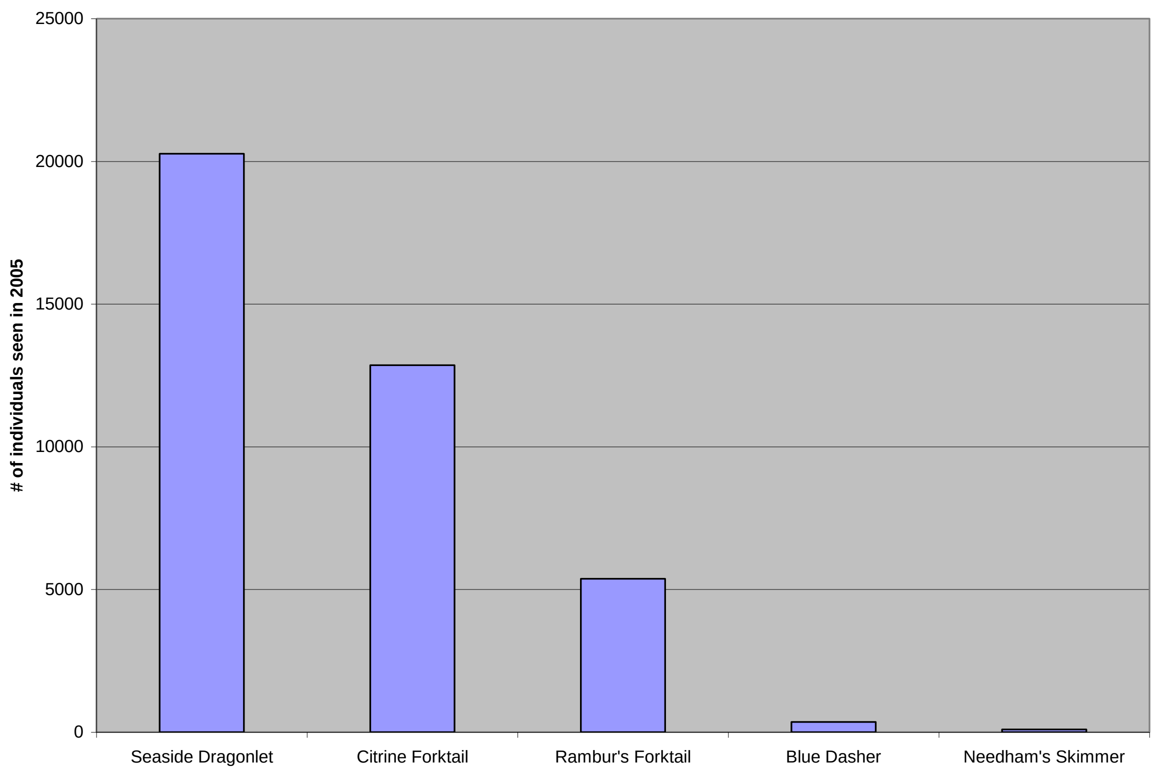
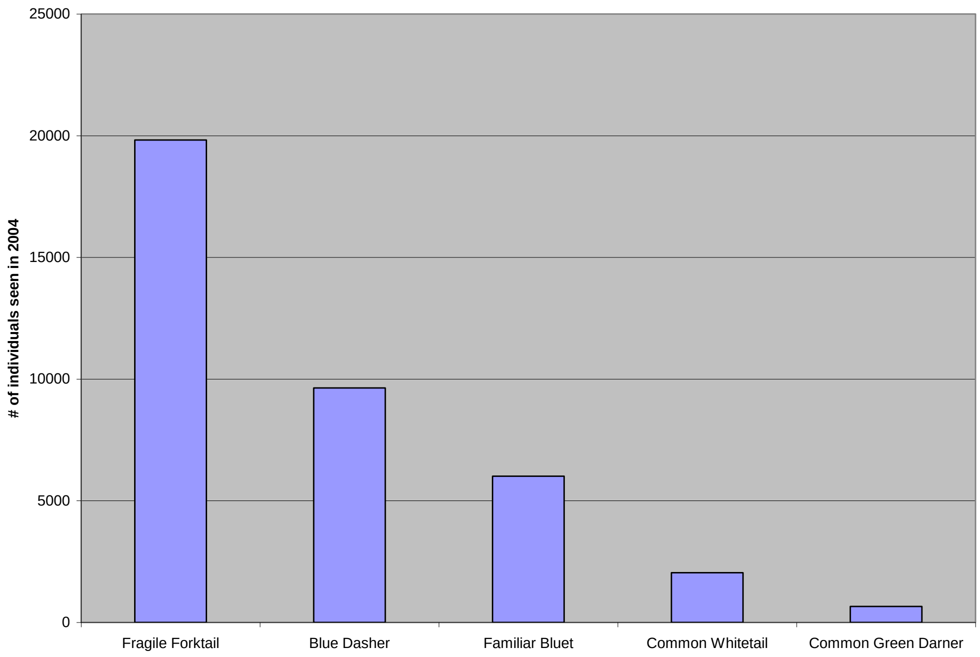


Figure 1b: Relative Abundance of the 5 most Common Odonates from Jackson Lane (a typical odonate eastern shore coastal plain mix) (Orr, 2004)



Figures 2 through 8 represent specific dragonfly and damselfly species that exhibited different seasonal patterns due to their biology. These seven species represent the range of seasonal patterns found among the various species on the island. See the discussion section for a detailed explanation.

Figure 2: Number of individual *Anax junius* adults observed over a season (Worcester County, Maryland, 2005-2007 Survey)

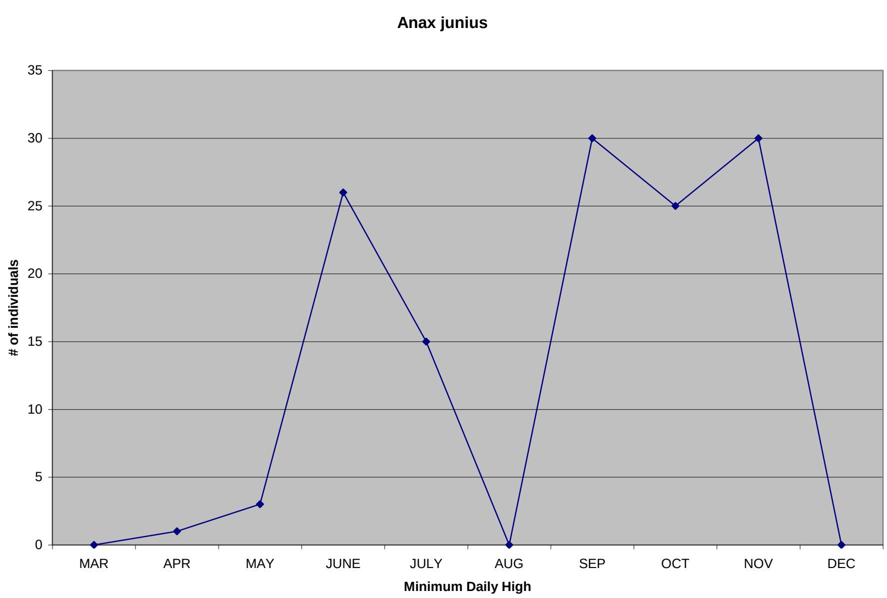


Figure 3: Number of individual *Pantala hymenaea* adults observed over a season (Worcester County, Maryland, 2005-2007 Survey)

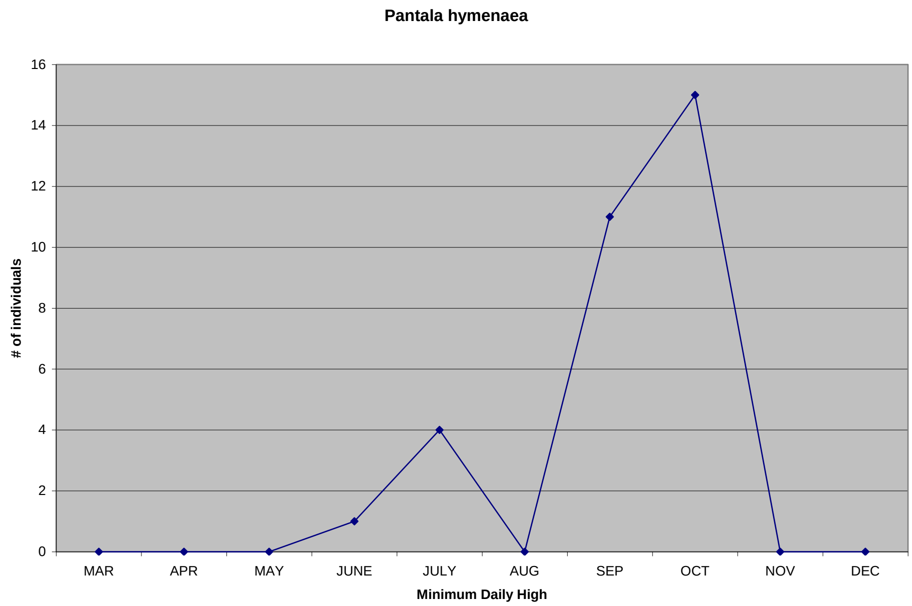


Figure 4: Number of individual *Tramea carolina* adults observed over a season (Worcester County, Maryland, 2005-2007 Survey)

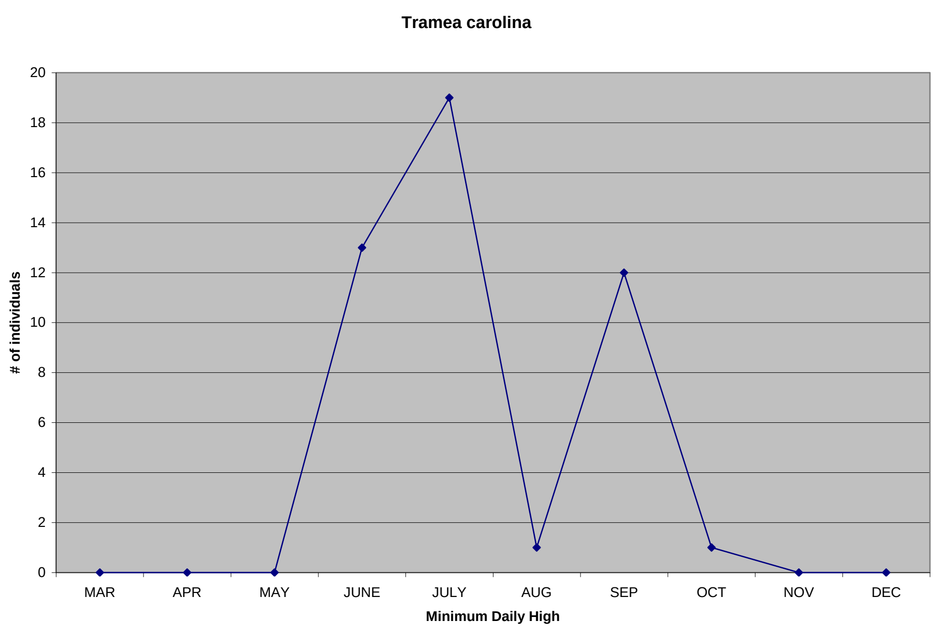


Figure 5: Number of individual *Ischura hastata* adults observed over a season (Worcester County, Maryland, 2005-2007 Survey)

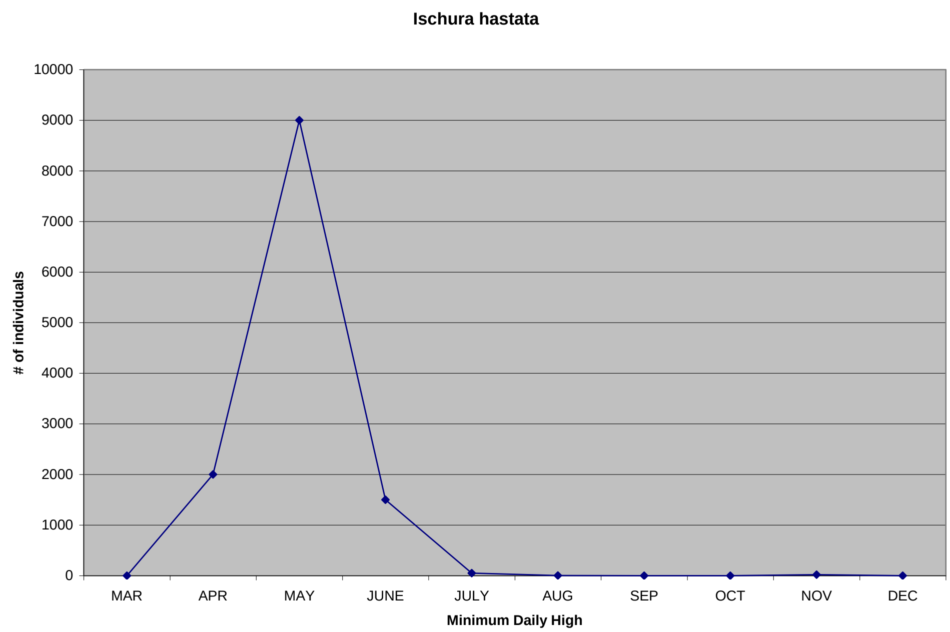


Figure 6: Number of individual *Ischnura ramburii* adults observed over a season (Worcester County, Maryland, 2005-2007 Survey)

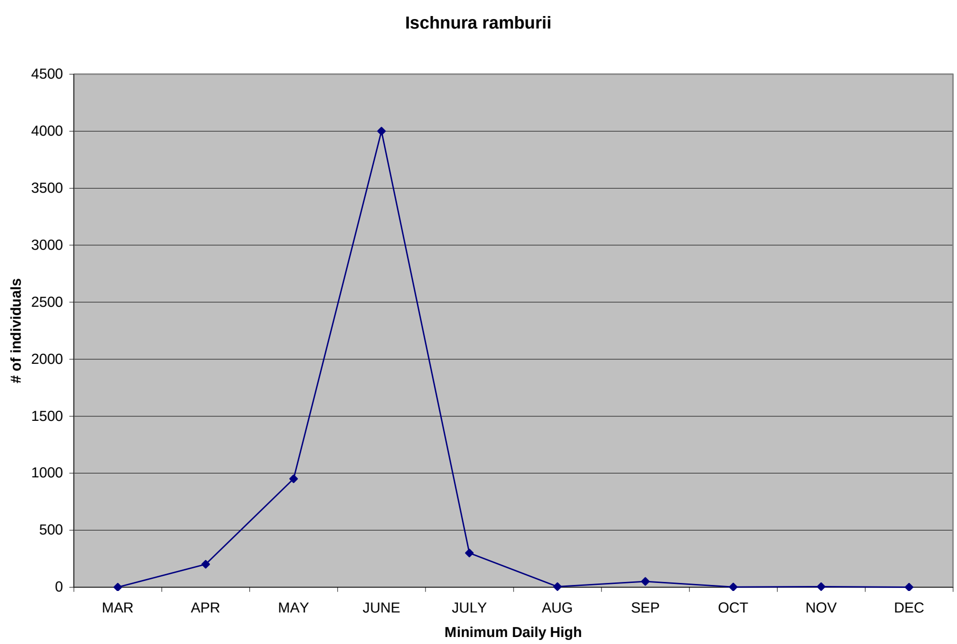


Figure 7: Number of individual *Enallagma civile* adults observed over a season (Worcester County, Maryland, 2005-2007 Survey)

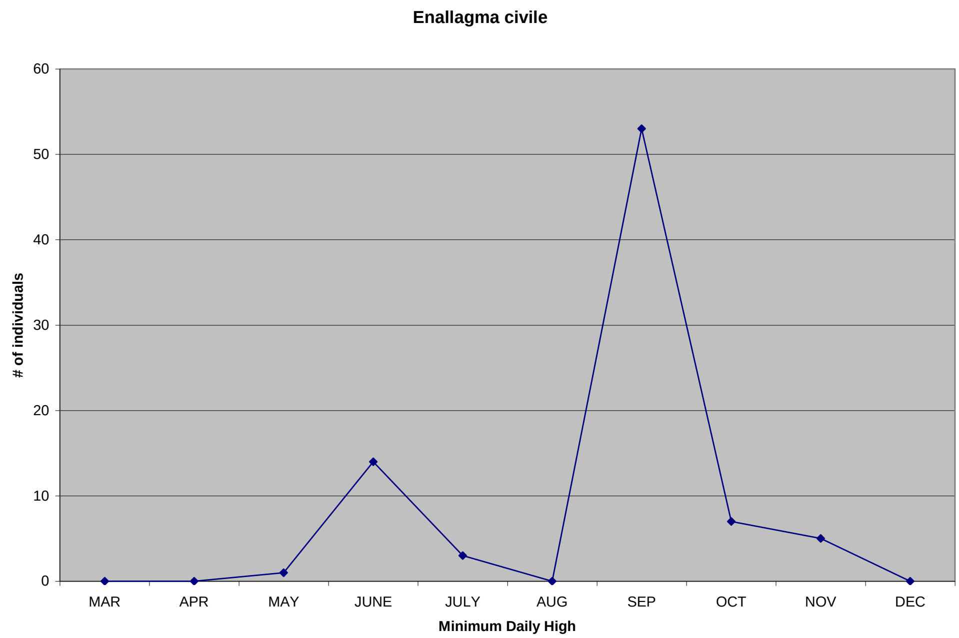
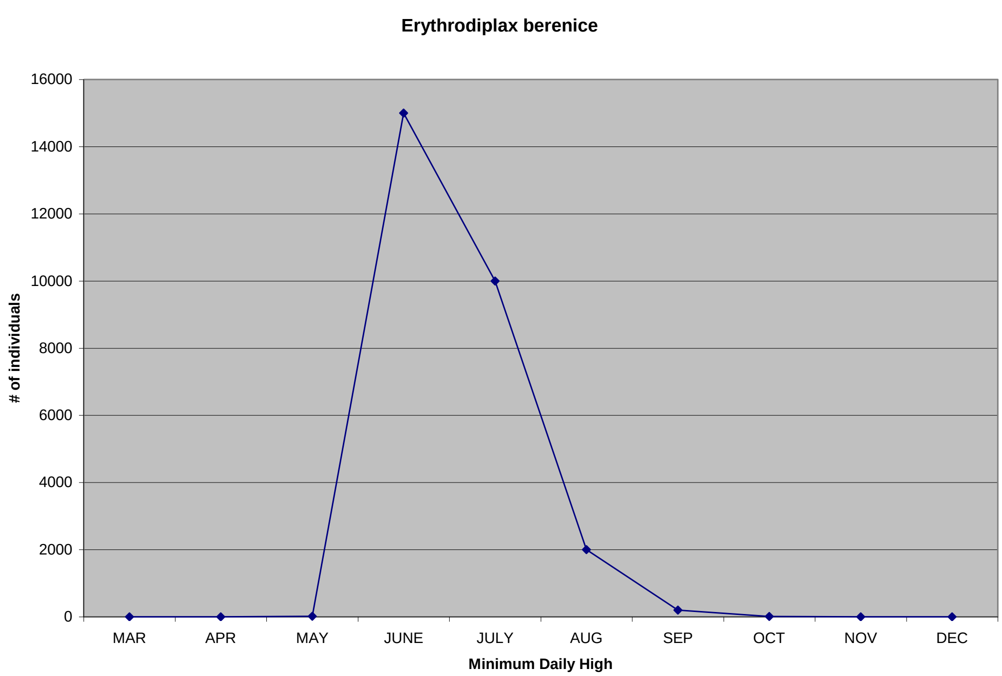


Figure 8: Number of individual *Erythrodiplax berenice* adults observed over a season (Worcester County, Maryland, 2005-2007 Survey)



On July 31, 2005 three full-length, ten-meter-wide island transects were walked at kilometers 10, 17 and 28. A gross estimation of the number of adult Seaside Dragonlets was recorded. Extrapolation from the transect numbers to the rest of ASIS gave the total number of Seaside Dragonlets on the wing that day on the Maryland side of the island as 1.8 million individuals. This was a minimum estimation since not all dragonlets present were seen while walking the transects and the transects did not include the most extensive salt marsh habitat present at ASIS. The true number of dragonlets was likely much higher, possibly many times this low-end estimate.

Orthoptera Survey: Forty-four species of grasshoppers, katydids and crickets were found at ASIS during the three year survey. These species are listed along with their abundance and preferred habitat in Table 4

Table 4: The Grasshoppers, Katydids and Crickets of Assateague Island National Seashore (Worcester County, Maryland, 2005-2007 Survey)

GENUS	SPECIES	ENGLISH NAME	ABUNDANCE	MAIN HABITAT
Arphia	*sulphurea*	Sulfur-winged Grasshopper	Common	Brushy areas & fields
Chortophaga	*viridifasciata*	Northern Green-striped Grasshopper	Uncommon	Wet areas with grass
Dichromorpha	*elegans*	Elegant Grasshopper	Common	Moist areas
Dichromorpha	*virdis*	Short-winged Green Grasshopper	Uncommon	Grassy areas
Dissosteira	*carolina*	Carolina Grasshopper	Common	Open areas and along roads
Melanophus	*differentialis*	Differential Grasshopper	Common	Grassland
Melanophus	*femurrubrum*	Red-legged Grasshopper	Abundant	Areas of thick vegetation
Melanophus	*sanquinipes*	Migratory Grasshopper	Uncommon	Disturbed weedy areas and grasslands
Orphulella	*pelidna*	Spotted-wing Grasshopper	Abundant	All habitats except deep shade & beach
Orphulella	*speciosa*	Pasture Grasshopper	Common	Dry areas with short to medium-height grass
Paroxya	*atlantica*	Atlantic Grasshopper	Rare	Wet areas including salt marshes
Psinidia	*fenestralis*	Longhorn Band-winged Grasshopper	Abundant	Open sand surrounded by grass
Schistocerca	*alutacea*	Rusty Bird-winged Grasshopper	Rare	Open woods
Schistocerca	*americana*	American Bird Grasshopper	Uncommon	Grassland forest interface
Schistocerca	*obscura*	Obscure Bird Grasshopper	Rare	Fields and open woodlands
Trimerotropis	*maritima*	Seaside Grasshopper	Abundant	Open sandy areas -- except beach
Nomotettix	*cristalus*	Creasted Pygmy Grasshopper	Rare	Freshwater wetlands
Paxilla	*obesca*	Obese Pygmy Grasshopper	Rare	Freshwater wetlands
Tettigidea	*lateralis*	Black-sided Pygmy Grasshopper	Uncommon	Edges of forested wetlands
Neocurtilla	*hexadactyla*	Northern Mole Cricket	Uncommon	Edges of wetlands and mucky ground
Comptonotus	*carolinenis*	Carolina Leaf-roller	Rare	Brushy areas
Conocephalus	*brevipennis*	Short-winged Meadow Katydid	Common	Grassy areas
Conocephalus	*fasciatus*	Slender Meadow Katydid	Abundant	Woodlands to grasslands
Conocephalus	*nigropleuroides*	Tidewater Meadow Katydid	??	Salt marshes
Conocephalus	*spartinae*	Saltmarsh Lesser Katydid	Common	Salt marshes
Microcentrum	*retinerve*	Lesser Angle-winged Katydid	Uncommon	Broadleaf trees and bushes
Neoconocephalus	*triops*	Broad-tipped Conehead	Rare	Nymphs inhabit grassy areas, adults in thickets or woods
Orchelimum	*agile*	Agile Meadow Katydid	Common	upper edges of salt marsh
Orchelimum	*concinnum*	Stripe-faced Meadow Katydid	Uncommon	Salt and freshwater marshes
Orchelimum	*vulgare*	Common Meadow Katydid	Uncommon	Freshwater marshes, fields, open areas
Scudderia	*furcata*	Fork-tailed Katydid	Uncommon	In tall grass-like plants near brackish pond
Allonemobius	*allardi*	Allard's Ground Cricket	??	Brushy areas
Allonemobius	*sparsalus*	Saltmarsh Ground Cricket	Common	Salt marshes
Allonemobius	*socius*	Southern Ground Cricket	Common	Open grassy areas
Allonemobius	*tinnulus*	Tinkling Ground Cricket	Rare	Dry edges of woodlands – oak litter
Gryllus	*firmus*	Sand Field Cricket	Abundant	Sandy Areas with vegetation

Gryllus	*rubens*	Southeastern Field Cricket	Common	Sandy Areas with vegetation
Hapithus	*agitator*	Restless Brush Cricket	Common	Brushy areas
Neonemobius	*variegates*	Variegated Ground Cricket	??	Brushy areas
Oecanthus	*celerinictus*	Fast-calling Tree Cricket	Uncommon	Brushy areas -- Arboreal
Oecanthus	*quadripunctatus*	Four-spotted Tree Cricket	Uncommon	Brushy areas -- Arboreal
Oecanthus	*nigicornis*	Black-horned Tree Cricket	Uncommon	Brushy areas -- Arboreal
Orocharis	*saltador*	Jumping Bush Cricket	Uncommon	Shrubs -- broadleaf
Phyllopalpus	*pulchellus*	Handsome Trig	Rare	Edges of wetlands

The status of *Conocephalus nigropleuroides*, Tidewater Meadow Katydid, occurrence at ASIS is in question. Morphologically and in song, it is very close to *Conocephalus spartinae* (Saltmarsh Lesser Katydid) which is a common inhabitant of the salt marshes at ASIS. Using a series of specimens and existing keys the majority keyed to *C. spartinae* but a couple did fit closer to *C. nigropleuroides*. Since the structural differences are so subtle (if real) between these two species, all specimens in the collection are labled as *Conocephalus spartinae/nigropleuroides*. The songs also are very close. Sound spectrograms reveal that *C. spartinae* sings at a higher pitch with a more staccato tempo than does *C. nigropleuroides* (Hershberger 2008). However hearing this difference is difficult since the songs are at the high frequency end of human hearing. Songs that were likely *C. nigropleuroides* individuals were on occasion heard within the chorus of *C. spartinae* but 100% confidence could not be made. If these two katydids are truly separate species (some specialists have doubts), then it is the author's impression that *C. nigropleuroides* is present in the ASIS salt marshes at a much lower number than *C. spartinae*.

Leaf Beetle Survey: Fifty species of Leaf Beetles have been found at ASIS. Table 5A contains a comprehensive list of 22 species compiled from specimens labeled from ASIS that were found in most of the major insect collections containing Maryland leaf beetles. Collections studied included the U. S. National Museum of Natural History (USNM), Washington, D.C.; the University of Maryland, College Park, Maryland; Towson State University, Towson, Maryland; USDA-APHIS-PPQ Port of Baltimore, Dundalk, Maryland; Maryland Department of Agriculture, Annapolis, Maryland; Academy of Natural Sciences in Philadelphia, Pennsylvania; University of Delaware, Newark, Delaware; and several private collections, including those of coleopterists Everett J. Ford, Charles Staines and Joseph Cavey (Cavey & Staines, 2007).

Table 5A. Leaf Beetles Recorded from Assateague Island, MD Prior to 2007
(Worcester County, Maryland, 2005-2007 Survey)
(22 species in five subfamilies)

Species	Subfamily	Species	Subfamily
Bassareus clathratus (Melsheimer)	Cryptocephalinae	*Trirhabda bacharidis* (Weber)	Galerucinae
Lexiphanes saponatus (Fabricius)	Cryptocephalinae	*Trirhabda canadensis* (Kirby)	Galerucinae
Pachybrachis spumarius Suffrian	Cryptocephalinae	*Acallepitrix nitens* Horn	Galerucinae
Paria aterrima (Olivier)	Eumolpinae	*Altica foliaceae* LeConte	Galerucinae
Leptinotarsa decemlineata (Say)	Chrysomelinae	*Chaetocnema denticulata* (Illiger)	Galerucinae
Acalymma vittatum (Fabricius)	Galerucinae	*Chaetocnema truncata* White	Galerucinae
Ceratoma trifurcata (Forster)	Galerucinae	*Disonycha collata collata* Fabricius	Galerucinae
Diabrotica undecimpunctata howardi Barber	Gallerucinae	*Disonycha triangularis* (Say)	Galerucinae
Erynephala maritima (LeConte)	Galerucinae	*Systena blanda* Melsheimer	Galerucinae
Ophraella americana (Fabricius)	Galerucinae	*Octotoma plicatula* (Fabricius)	Cassidinae
Ophraella notulata (Fabricius)	Galerucinae	*Odontota horni* Smith	Cassidinae

Table 5B lists all of the leaf beetles currently known from ASIS along with their adult plant host associations.

Table 5B. List of Leaf Beetles (Insecta: Coleoptera: Chrysomelidae), Exclusive of the Bruchinae, Recorded for Assateague Island, Maryland (Worcester County, Maryland, 2005-2007 Survey)		
Species	**English Name**	**Abbreviated List of Plant Host Associations for Adult Beetles**
Acallepitrix nitens	none	Solanaceae
Acalymma vittatum	striped cucumber beetle	cucurbits
Altica chalybea	grape flea beetle	grape*
Altica foliaceae	none	evening primrose and other herbaceous plants
Alticinae sp.	none	
Bassareus clathratus	none	woody plants
Bassareus lituratus	none	woody plants, mostly
Ceratoma trifurcata	bean leaf beetle	Fabaceae
Chaetocnema denticulata	toothed flea beetle	grasses mostly
Chaetocnema irregularis	none	rushes and sedges
Chrysochus auratus	dogbane leaf beetle	dogbane milkweed
Colaspis favosa	none	wax myrtle and other woody plants
Colaspis recurva	none	*Baccharis hamilifolia* and other woody plants
Cryptocephalus pumulus	none	willow oak*, *Baccharis* spp.
Cryptocephalus quadruplex	none	hardwood trees
Cryptocephalus incertus	none	Vacciniums, *Myrica cerifca*, *Prunus maritima*
Deloyala guttata	mottled tortoise beetle	morning glories
Diachus auratus	bronze leaf beetle	many hosts
Chaetocnema minuta	none	grasses, primarily
Chaetocnema truncata	none	none recorded
Diabrotica undecempunctata howardi	12 spotted cucumber beetle	cucurbits
Disonycha admirabilia	none	*Cassia* spp.
Disonycha collata collata	none	beet, lettuce, spinach
Disonycha glabrata		*Amaranthus* spp.
Disonycha pennsylvanica	none	*Polygonum* spp.
Disonycha triangularis	threespotted flea beetle	beet, spinach, *Chenopodium* spp.
Distigmoptera impennata	none	
Erynephala maritima	none	saltworts and seablite
Exema byersi	none	Compositae
Graphops curtipennis curtipennis	none	*Hypericum* spp.
Kuschelina fallax	none	*Agalinis fasciculata*
Lema trivittata trivittata	none	Solanaceae
Leptinotarsa decemlineata	Colorado potato beetle	Solanaceae
Lexiphanes saponatus	none	various hosts
Longitarsus	none	*Eupatorium capillifolium*
Microtheca ochroloma	yellowmargined leaf beetle	Brassicaceae
Neochlamisus gibbosus	none	blackberry, primarily
Octotoma plicatula	none	trumpet vine
Odontota horni	none	Fabaceae
Ophraella americana	none	goldenrod
Ophraella notulata	none	*Iva frutescens**
Paria aterrima	none	*Iva frutescens*
Paria fragariae fragariae	strawberry rootworm	many herbaceous plants
Paria sexnotata	none	red cedar
Pachybrachis spumarius	none	myrtle*, sumac, oak and other woody plants
Paria thoracica	none	goldenrod and other composites
Paria virginiae	none	*Avicennia* sp.

Systena blanda	palestriped flea beetle	*Baccharis* spp. and ragweed
Trirhabda bacharidis	none	*Baccharis* spp.
Trirhabda canadensis	none	goldenrod
* indicates the leaf beetle species was collected on the marked plant at ASIS		

Butterfly Survey: Thirty-nine species of butterflies and skippers were recorded during the three year survey. These species are listed along with their flight period and the larval host(s) in Table 6a and with their relative abundance and their establishment status in Table 6b. The presence of establishment was inferred by the presence of host plants on the island, presence of larvae found on the island, numbers and condition of adults encountered and previous information from the mainland on the dispersal and migration of adults.

Table 6a: The Butterflies of Assateague Island National Seashore with Flight Period and Larval Host (Worcester County, Maryland, 2005-2007 Survey)

GENUS	SPECIES	ENGLISH NAME	FLIGHT PERIOD	HOST OF LARVAE
Ancyloxypha	*numitor*	Least Skipper	9Jun to 21Sep	Various grasses
Atalopedes	*campestris*	Sachem	31Jul to 9Oct	Various grasses
Epargyreus	*clarus*	Silver-spotted Skipper	11Jun to 21Sep	Black Locust
Erynnis	*juvenalis*	Juvenal's Duskywing	4May	Oaks
Euphyes	*vestris*	Dun Skipper	6Sep	*Carex* sp.
Hylephila	*phyleus*	Fiery Skipper	8Oct to 9Oct	Bermuda grass
Poanes	*viator*	Broad Winged Skipper	31Jul to 11Sep	*Phragmites communis*
Poanes	*zabulon*	Zabulon Skipper	23May to 11-Jun	Various grasses
Polites	*themistocles*	Tawny-edged Skipper	17Jun to 11Sep	Various grasses
Pyrgus	*communis*	Common Checkered Skipper	8Oct to 14Oct	Mallows
Panoquina	*panoquin*	Salt Marsh Skipper	7Jul to 1Oct	*Distichlis spicata*
Papilio	*glaucus*	Eastern Tiger Swallowtail	22May to 6Sep	*Prunus serotina & Liriodendron tulipifera*
Papilo	*polyxenes*	Black Swallowtail	10June	Various Umbellifera
Colias	*eurytheme*	Orange Sulphur	2Apr to 27Oct	Various Legumes
Colias	*philodice*	Clouded Sulphur	2Apr to 27Oct	*Trifolium repens*
Eurema	*lisa*	Little Yellow	12Sep	*Cassia* spp.
Eurema	*nicippe*	Sleepy Orange	26Oct	*Cassia* spp.
Phoebis	*sennae*	Cloudless Sulpur	6Sep to 9Oct	*Cassia* spp.
Pieris	*rapae*	Cabbage White	2Apr to 27Oct	Various Cruciferae
Calycopis	*cecrops*	Red-banded Hairstreak	4May to 23May	Rotting leaves
Celastrina	*idella*	Holly Azure	17Apr to 19Apr	*Ilex* spp.
Celastrina	*neglecta*	Summer Azure	11 Jun to 12Jun	Many food plants
Everes	*comyntas*	Eastern Tailed Blue	4May to 9Oct	Members of the Pea family
Lycaena	*phlaeas*	American Copper	18Apr to A-12Sep	*Rumex acetosella*
Strymon	*melinus*	Gray Hairstreak	16Jun to 9Oct	Many hosts
Cercyonis	*pegala*	Common Wood Nymph	7Jul to 21Sep	Various grasses
Danaus	*plexippus*	Monarch	13Jun to 27Oct	*Asclepias* spp.
Euptoieta	*claudia*	Variegated Fritillary	22May to 27Oct	*Viola & Passiflora*
Junonia	*coenia*	Common Buckeye	17Apr to 15Nov	*Linaria canadensis* & *Agalinis purpura*
Limenitis	*archippus*	Viceroy	21Sep	Willows
Limenitis	*arthemis*	Red-spotted Purple	10May to 11Sep	*Prunus* & others
Megisto	*cymela*	Little Wood Satyr	13Jun to 18Jul	Various grasses
Nymphalis	*antiopa*	Mourning Cloak	26Oct	Many trees & shrubs
Phyciodes	*tharos*	Pearl Crescent	4May to 1Oct	*Aster spp.*

Polygonia	*comma*	Eastern Comma	21Sep	*Urtica* & Ulmaceae
Polygonia	*interrogationis*	Question Mark	7Sep	Many Hosts
Vanessa	*atalanta*	Red Admiral	19Apr to 27Oct	*Urtica spp.*
Vanessa	*virginiensis*	American Lady	8May to 9Oct	Many compositae
Vanessa	*cardui*	Painted Lady	6Apr to Oct27	Many hosts

Table 6b: The Butterflies of Assateague Island National Seashore with Abundance and Establishment Status (Worcester County, Maryland, 2005-2007 Survey)

ENGLISH NAME	ABUNDANCE	STATUS AT ASIS
Least Skipper	Common	Established
Sachem	Common	North moving late summer dispersals -- not established
Silver-spotted Skipper	Uncommon	Probably strays
Juvenal's Duskywing	Uncommon	Status on ASIS unknown
Dun Skipper	Rare	Probably not established
Fiery Skipper	Uncommon	North moving late summer dispersals -- not established
Broad Winged Skipper	Uncommon	Established
Zabulon Skipper	Uncommon	Status on ASIS unknown
Tawny-edged Skipper	Rare	Status on ASIS unknown
Common Checkered Skipper	Uncommon	Status on ASIS unknown
Salt Marsh Skipper	Common	Established
Eastern Tiger Swallowtail	Uncommon	Mostly dispersals and not a long term resident
Black Swallowtail	Rare	Mostly dispersals and not a long term resident
Orange Sulphur	Common	Established
Clouded Sulphur	Common	Probably dispersals and not established
Little Yellow	Rare	North moving late summer dispersals -- not established
Sleepy Orange	Uncommon	North moving late summer dispersals -- not established
Cloudless Sulphur	Common	North moving late summer dispersals -- not established
Cabbage White	Common	Tenuous establishment
Red-banded Hairstreak	Uncommon	Established
Holly Azure	Uncommon	Established
Summer Azure	Rare	Status on ASIS unknown
Eastern Tailed Blue	Common	Established
American Copper	Abundant	Established
Gray Hairstreak	Common	Established
Common Wood Nymph	Common	Established
Monarch	Common	Mostly migrants -- estabishment probably not continuous
Variegated Fritillary	Uncommon	North moving late summer dispersals -- not established
Common Buckeye	Abundant	Established
Viceroy	Rare	Probably dispersals and not established
Red-spotted Purple	Uncommon	Probably dispersals and not established
Little Wood Satyr	Common	Established
Mourning Cloak	Rare	Probably dispersals and not established
Pearl Crescent	Uncommon	Established
Eastern Comma	Uncommon	Probably dispersals and not established
Question Mark	Uncommon	Probably dispersals and not established
Red Admiral	Uncommon	North moving spring dispersals -- probably not established
American Lady	Common	North moving spring dispersals -- probably not established
Painted Lady	Uncommon	North moving spring dispersals -- probably not established

Bee Survey: Fifty-eight species of bees were recorded during the three year survey. These species are listed along with their English Name and known flight period on the island in Table 7.

Table 7: The Bees of Assateague Island National Seashore (Worcester County, Maryland, 2005-2007 Survey)

FAMILY	GENUS	SPECIES	ENGLISH NAME	FLIGHT PERIOD
Colletidae	*Colletes*	*americanus*	Plasterer Bee	19Sep to 20Sep
Colletidae	*Colletes*	*mitchelli*	Plasterer Bee	19Sep to 20Sep
Colletidae	*Colletes*	*simulans*	Plasterer Bee	19Sep to 20Sep
Colletidae	*Colletes*	*thoracicus*	Plasterer Bee	5May to 23May
Colletidae	*Colletes*	*validus*	Plasterer Bee	2Apr to 4May
Colletidae	*Hylaeus*	*modestus*	Yellow-faced Bee	2Jul
Halictidae	*Agapostemon*	*splendens*	Halictid Bee	11Jun to 20Sep
Halictidae	*Agapostemon*	*virescens*	Halictid Bee	20Sep
Halictidae	*Augochlora*	*pura*	Halictid Bee	2Apr to 20Sep
Halictidae	*Augochlorella*	*aurata*	Halictid Bee	2Apr to 20Sep
Halictidae	*Augochlorella*	*stricta*	Halictid Bee	19Sep
Halictidae	*Halictus*	*poeyi/ligatus*	Halictid Bee	22May to 8Oct
Halictidae	*Lasioglossum*	*admirandum*	Sweat Bee	19Sep to 20Sep
Halictidae	*Lasioglossum*	*bruneri*	Sweat Bee	2Apr to 23May
Halictidae	*Lasioglossum*	*coreopsis*	Sweat Bee	4May
Halictidae	*Lasioglossum*	*forbesii*	Sweat Bee	19Sep to 20Sep
Halictidae	*Lasioglossum*	*fuscipenne*	Sweat Bee	2Apr to 2Jul
Halictidae	*Lasioglossum*	*halophitum*	Sweat Bee	19Sep to 20Sep
Halictidae	*Lasioglossum*	*lustrans*	Sweat Bee	19Sep to 20Sep
Halictidae	*Lasioglossum*	*marinum*	Sweat Bee	4May to 20Sep
Halictidae	*Lasioglossum*	*nymphale*	Sweat Bee	4May to 20Sep
Halictidae	*Lasioglossum*	*oblongum*	Sweat Bee	4May to 2Jul
Halictidae	*Lasioglossum*	*pilosum*	Sweat Bee	4May to 20Sep
Halictidae	*Lasioglossum*	*rohweri*	Sweat Bee	22May to 20Sep
Halictidae	*Lasioglossum*	*truncatum*	Sweat Bee	17Jun
Halictidae	*Lasioglossum*	*versatum*	Sweat Bee	19Sep to 20Sep
Halictidae	*Lasioglossum*	*zephyrum*	Sweat Bee	19Sep to 20Sep
Halictidae	*Sphecodes*	sp.	Halictid Bee	22May to -2Jul
Andrenidae	*Andrena*	*bracatta*	Andrenid Bee	20Sep
Andrenidae	*Andrena*	*placata*	Andrenid Bee	A-20Sep
Andrenidae	*Andrena*	*simplex*	Andrenid Bee	20Sep
Andrenidae	*Andrena*	*violae*	Andrenid Bee	2Apr
Andrenidae	*Perdita*	*octomaculata*	Andrenid Bee	19Sep to 20Sep
Andrenidae	*Pseudopanurgus*	*compositarum*	Andrenid Bee	19Sep to 20Sep
Megachilidae	*Coelioxys*	*dolichos*	Leaf-cutter Bee	13Jun
Megachilidae	*Coelioxys*	*octodentata*	Leaf-cutter Bee	13Jun
Megachilidae	*Coelioxys*	*sayi*	Leaf-cutter Bee	2Jul
Megachilidae	*Heriades*	*leavitti*	Leaf-cutter Bee	19Sep to 20Sep
Megachilidae	*Heriades*	*variolosus*	Leaf-cutter Bee	2Jul
Megachilidae	*Hoplitis*	*pilosifrons*	Leaf-cutter Bee	22May to 23May
Megachilidae	*Megachile*	*inermis*	Leaf-cutter Bee	13Jun
Megachilidae	*Megachile*	*mendica*	Leaf-cutter Bee	11Jun to 2Jul

Megachilidae	*Megachile*	*sculpturalis*	Leaf-cutter Bee	11Jun
Megachilidae	*Megachile*	*xylocopoides*	Leaf-cutter Bee	13Jun to 2Jul
Megachilidae	*Osmia*	*pumila*	Leaf-cutter Bee	2Apr to 23May
Apidae	*Apis*	*mellifera*	Honey Bee	21Sep
Apidae	*Bombus*	*bimaculatus*	Bumble Bee	4May to 12-Jun
Apidae	*Bombus*	*griseocollis*	Bumble Bee	12-Jun to 13Jun
Apidae	*Bombus*	*pensylvanicus*	Bumble Bee	13Jun to 17Jul
Apidae	*Epeolus*	*pusillus*	Cuckoo Bee	19Sep-20Sep
Apidae	*Epeolus*	*scutellaris*	Cuckoo Bee	19Sep to 20Sep
Apidae	*Nomada*	*articulata*	Cuckoo Bee	22May to 23May
Apidae	*Nomada*	*maculata*	Cuckoo Bee	4May
Apidae	*Ceratina*	*calcarata*	Small Carpenter Bee	22May to 20Sep
Apidae	*Ceratina*	*dupla*	Small Carpenter Bee	2Apr to A-20Sep
Apidae	*Ceratina*	*strenua*	Small Carpenter Bee	2Apr to 20Sep
Apidae	*Melissodes*	*druriella*	Eucerine Bee	19Sep to 20Sep
Apidae	*Xylocopa*	*virginica*	Eastern Carpenter Bee	2Apr to 17Jun

Epeolus scutellaris and the few *Andrena* species were caught almost entirely while netting, but bowls caught many more *Lasioglossums.* Otherwise, the species captured were similar between the two methods.

There was an obvious seasonality to the diversity of species and flight periods of the island's bees. The most drastic change was between spring and fall, while inbetween there was a transition which was abrupt for some species, but slower for others. Figure 9 summarizes the results of spring bee records. Figure 10 summarizes the results of fall bee records.

Figure 9: Spring (April/May) Bee Captures from 2006-2007 [19 species, 298 individuals] (Assateague Island National Seashore, Worcester County, Maryland)

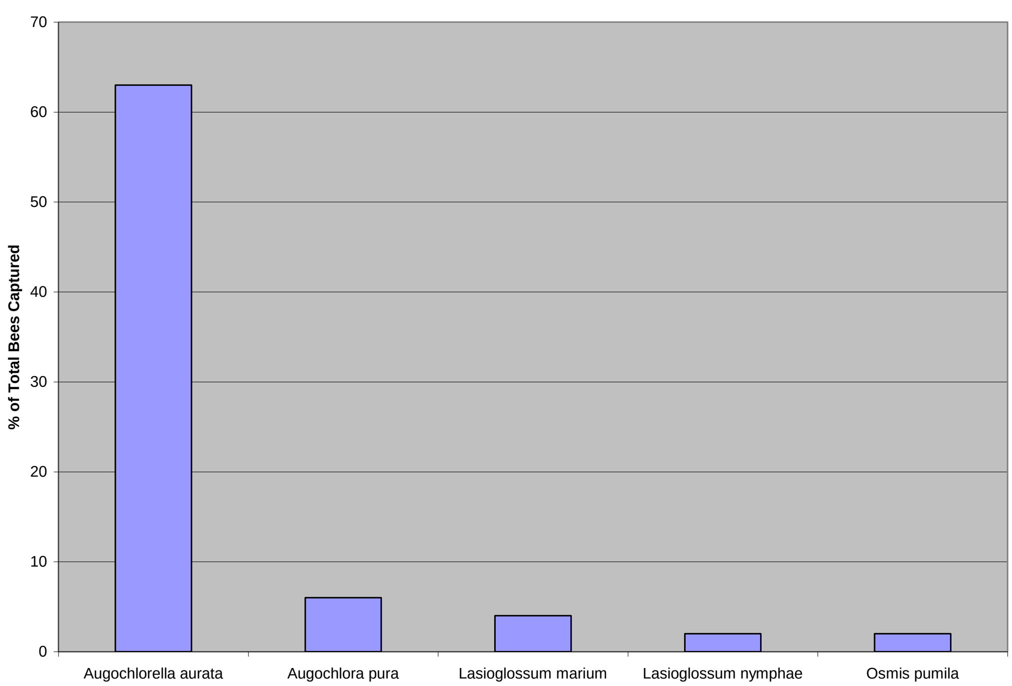
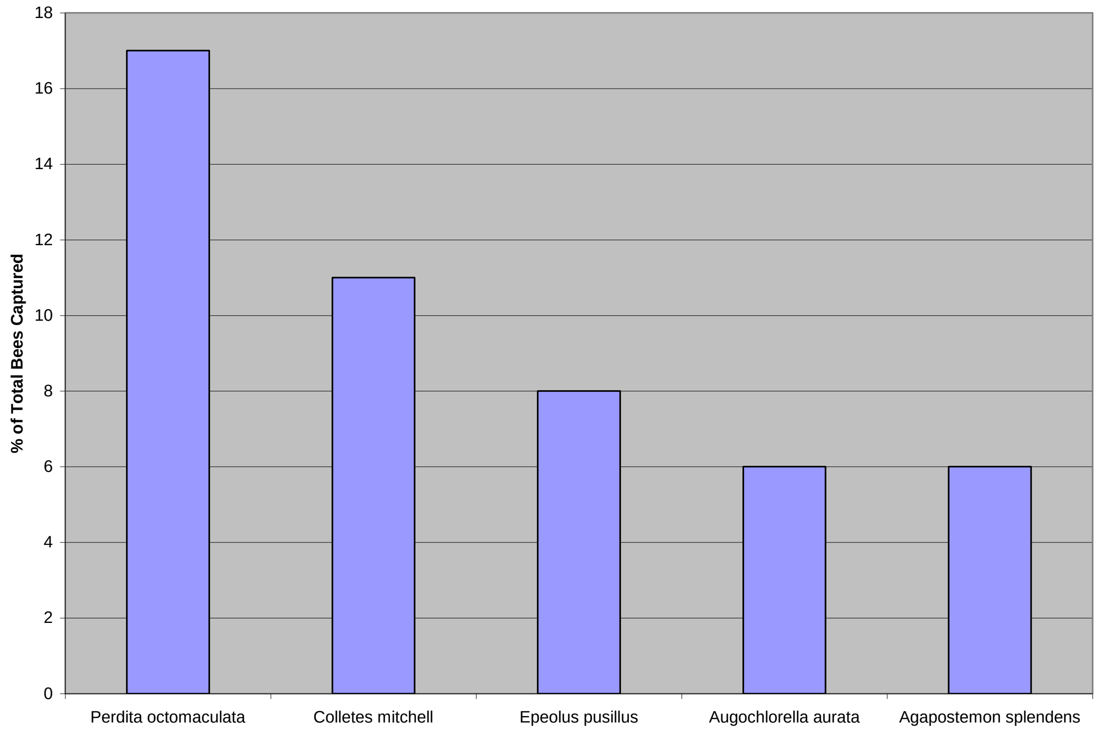


Figure 10: Fall (September) Bee Captures from 2006-2007 [30 species, 136 individuals] (Assateague Island National Seashore, Worcester County, Maryland, 2005-2007 Survey)



Freshwater Pond Survey: The species recorded from freshwater ponds along with their general feeding activities are presented in Table 8.

Table 8: The Freshwater Pond Arthropods of Assateague Island National Seashore (Worcester County, Maryland, 2005-2007 Survey)

ENGLISH NAME	GENUS	SPECIES	GENERAL FEEDING ACTIVITY
Freshwater Scuds			General Scavenger
Aquatic Sowbugs			General Scavenger
Long-jawed Orb Weavers	*Tetragnatha*	sp.	General Predator
Six-spotted Fishing Spider	*Dolomedes*	*triton*	General Predator
Springtail	Unknown A		Scavengers
Mayfly	*Callibaetis*	sp.	Feeds on filamentous algae as nymph
Common Green Darner	*Anax*	*junius*	General Predator
Shadow Darner	*Aeshna*	*umbrosa*	General Predator
Swamp Darner	*Epiaeschna*	*heros*	General Predator
Four-spotted Pennant	*Brachymesia*	*gravida*	General Predator
Common Pond Hawk	*Erythemis*	*simplicicollis*	General Predator
Seaside Dragonlet	*Erythrodiplax*	*berenice*	General Predator
Bar-winged Skimmer	*Libellula*	*axilena*	General Predator
Common Whitetail	*Libellula*	*lydia*	General Predator
Needhami's Skimmer	*Libellula*	*needhami*	General Predator
Twelve-spotted Skimmer	*Libellula*	*pulchella*	General Predator
Painted Skimmer	*Libellula*	*semifasciata*	General Predator

Great Blue Skimmer	*Libellula*	*vibrans*	General Predator
Blue Dasher	*Pachydiplax*	*longipennis*	General Predator
Wandering Glider	*Pantala*	*flavescens*	General Predator
Spot-winged Glider	*Pantala*	*hymaenea*	General Predator
Eastern Amberwing	*Perithemis*	*tenera*	General Predator
Blue-faced Meadowhawk	*Sympetrum*	*ambiguum*	General Predator
Autumn Meadowhawk	*Sympetrum*	*vicinum*	General Predator
Carolina Saddlebags	*Tramea*	*carolina*	General Predator
Black Saddlebags	*Tramea*	*lacerata*	General Predator
Common Spreadwing	*Lestes*	*australis*	General Predator
Slender Spreadwing	*Lestes*	*rectangularis*	General Predator
Familiar Bluet	*Enallagma*	*civile*	General Predator
Orange Bluet	*Enallagma*	*signatum*	General Predator
Citrine Forktail	*Ischnura*	*hastata*	General Predator
Fragile Forktail	*Ischnura*	*posita*	General Predator
Rambur's Forktail	*Ischnura*	*ramburii*	General Predator
Black-sided Pygmy Grasshopper	*Tettigidea*	*lateralis*	Feeds on leaf debris and algae associated with moist soil
Giant Water Bug	*Belostoma*	*testaceum*	General Predator
Giant Water Bug	*Lethocerus*	*americanus*	General Predator
Water Boatmen	*Hesperocorixa*	*interrupta*	Filter feeders
Water Measurers	*Hydrometra*	*martini*	Predators on small insects and ostracods
Water Strider	*Gerris*	sp.	Feeds on live and dead insects caught on surface film
Whirligig Beetle	Unknown A		Scavengers
Crawling Water Beetle	*Haliplus*	sp.	Feeds on algae and other plant material
Crawling Water Beetle	*Peltodytes*	sp.	Feeds on algae and other plant material
Burrowing Water Beetle	*Hydrocanthus*	*tricolor*	Feeds on algae
Predaceous Diving Beetle	*Agabius*	*disintegratus*	General Predator
Predaceous Diving Beetle	*Agabus*	spp.	General Predator
Predaceous Diving Beetle	Bidessine species of		General Predator
Predaceous Diving Beetle	*Copelatus*	*chevrolati*	General Predator
Predaceous Diving Beetle	*Copelatus*	sp.	General Predator
Predaceous Diving Beetle	*Desmopachria*	sp.	General Predator
Predaceous Diving Beetle	*Hydroporus*	*deflatus*	General Predator
Predaceous Diving Beetle	*Hydroporus*	spp.	General Predator
Predaceous Diving Beetle	*Hydrovatus*	*pustulatus*	General Predator
Predaceous Diving Beetle	*Laccophilus*	sp.	General Predator
Predaceous Diving Beetle	*Laccornis*	sp.	General Predator
Predaceous Diving Beetle	*Rhantus*	*calidus*	General Predator
Predaceous Diving Beetle	*Thermonetus*	*basillaris*	General Predator
Predaceous Diving Beetle	*Uvarus*	sp.	General Predator
Water Scavenger Beetle	*Berosus*	sp.	General Scavenger
Water Scavenger Beetle	*Cymbiodyta*	sp.	General Scavenger
Water Scavenger Beetle	*Enochrus*	spp.	General Scavenger
Water Scavenger Beetle	*Helochares*	sp.	General Scavenger
Water Scavenger Beetle	*Hydrochus*	sp.	General Scavenger
Water Scavenger Beetle	*Paracymus*	spp.	General Scavenger
Water Scavenger Beetle	*Tropisternus*	*lateralis*	General Scavenger

Water Scavenger Beetle	*Tropisternus*	*mexicanus*	General Scavenger
Water Scavenger Beetle	*Tropisternus*	spp.	General Scavenger
Fishfly	*Chauliodes*	sp. (larvae)	Predator
Fishfly	*Neohermes*	sp. (adult)	Predator
Chironomid Midges		spp.	larvae are aquatic, scavengers
Asian Tiger Mosquito	*Aedes*	*albopictus*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Aedes*	*atlanticus*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Aedes*	*canadensis*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Aedes*	*cantator*	larvae filter feeders, adult males nectar, females blood
Salt-marsh Mosquito	*Aedes*	*sollicitans*	larvae filter feeders, adult males nectar, females blood
Dark Salt-marsh Mosquito	*Aedes*	*taeniorhynchus*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Aedes*	possible *trivittatus*	larvae filter feeders, adult males nectar, females blood
Flood-water Aedes	*Aedes*	*vexans*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Anopheles*	*bradelyi*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Anopheles*	*crucians*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Anopheles*	*punctipennis*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Anopheles*	*quadrimaculatus*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Anopheles*	*walkeri*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Coquillettidia*	*perturbans*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Culex*	*salinarius*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Culisetta*	*melanura*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Psorophora*	*ciliata*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Psorophora*	*columbiae*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Psorophora*	*ferox*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Psorophora*	*howardii*	larvae filter feeders, adult males nectar, females blood
Mosquito	*Uranotaenia*	*sapphirina*	larvae filter feeders, adult males nectar, females blood
Horse Fly	*Tabanus*	sp. (larvae)	Larvae are predaceous

Salt Marsh Survey: The species recorded from lower salt marsh along with their general feeding activities are presented in Table 9.

Table 9: Terrestial Arthropods of Assateague Island National Seashore's Lower Salt Marshes (Worcester County, Maryland, 2005-2007 Survey)

ENGLISH NAME	FAMILY	GENUS	SPECIES	GENERAL FEEDING ACTIVITY
Marsh Crab	Grapsidae	*Sesarma*	*reticulatum*	General Scavenger
Fiddler Crab	Ocypodidae	*Uca*	*pugnax*	General Scavenger
Marine Scuds	Talitridae	*Orchestia*	*uhleri*	General Scavenger
Marine Scuds	Talitridae	*Orchestia*	sp.	General Scavenger
Isopod	Philosciidae	*Philoscia*	sp. prob. *vittata*	General Scavenger
Mite	Ascidae	Unknown A		Predator
Orb Weaver Spider	Araneidae	*Araneus*	*nordmanii*	General Predator
Orb Weaver Spider	Araneidae	*Eustala*	sp.	General Predator
Orb Weaver Spider	Araneidae	*Mangora*	*gibberosa*	General Predator
Dwarf Spider	Linyphiidae	Unknown A		General Predator
Wolf Spider	Lycosidae	*Pardosa*	*littoralis*	General Predator
Wolf Spider	Lycosidae	Unknown A		General Predator
Spider	Clubionidae	*Clubiona*	sp.	General Predator
Crab Spider	Philodromidae	*Tibellus*	*oblongus*	General Predator

Crab Spider	Thomisidae	Unknown A		General Predator
Jumping Spider	Salticidae	*Habronattus*	*agilis*	General Predator
Jumping Spider	Salticidae	*Habronattus*	*viridipes*	General Predator
Jumping Spider	Salticidae	*Marpissa*	*pikei*	General Predator
Jumping Spider	Salticidae	*Phidippus*	sp.	General Predator
Jumping Spider	Salticidae	Unknown A		General Predator
Spider		Unknown C		General Predator
Spider		Unknown G		General Predator
Springtail	Poduridae	*Podura*	*aquatica*	Scavengers
Seashore Springtail	Hypogastruidae	*Anurida*	*maritima*	Scavengers on dead invertebrates
Globular Springtail	Sminthuridae	*Neosminthurus*	sp.	Scavengers
Globular Springtail	Sminthuridae	*Sphyrotheca*	sp.	Scavengers
Seaside Dragonlet	Libellulidae	*Erythrodiplax*	*berenice*	General Predator
Familiar Bluet	Coenagrionidae	*Enallagma*	*civile*	General Predator
Citrine Forktail	Coenagrionidae	*Ischnura*	*hastata*	General Predator
Rambur's Forktail	Coenagrionidae	*Ischnura*	*ramburii*	General Predator
Elegant Grasshopper	Acrididae	*Dichromorpha*	*elegans*	Herbivore
Spotted-wing Grasshopper	Acrididae	*Orphulella*	*pelidna*	Feeds on grasses
Short-winged Meadow Katydid	Tettigoniidae	*Conocephalus*	*brevipennis*	Herbivore
Slender Meadow Katydid	Tettigoniidae	*Conocephalus*	*fasciatus*	Herbivore
Tidewater Meadow Katydid	Tettigoniidae	*Conocephalus*	*nigropleuroides*	Herbivore
Saltmarsh Lesser Katydid	Tettigoniidae	*Conocephalus*	*spartinae*	Herbivore
Stripe-faced Meadow Katydid	Tettigoniidae	*Orchelimum*	*concinnum*	Herbivore
Saltmarsh Ground Cricket	Gryllidae	*Allonemobius*	*sparsalus*	Omnivores-Scavengers
Sand Field Cricket	Gryllidae	*Gryllus*	*firmus*	Omnivores-Scavengers
Water Boatmen	Corixidae	*Trichocorixa*	*verticalis*	Filter feeders
Shore Bug	Saldidae	*Pentacora*	*hirta*	Predator
Plant Bug	Miridae	*Trigonotylus*	prob. *uhleri*	Sap of *Spartina*
Plant Bug	Miridae	*Tytthus*	*vagus*	Predator of Plant Hopper eggs
Damsel Bug	Nabidae	*Nabis*	possibly *capsiformis*	Predator
Assassin Bug	Reduviidae	species of Emesinae		Predator
Stink Bug	Pentatomidae	*Acrosternum*	*hilare*	Woody plant sap
Seed Bug	Lygaeidae	Unknown A	sp.	Seed Herbivore
Leafhopper	Cicadellidae	*Draeculacephala*	sp.	Plant sap
Leafhopper	Cicadellidae	Unknown A		Plant sap
Delphacid Planthopper	Delphacidae	*Prokelisia*	*marginata*	Sap of *Spartina*
Delphacid Planthopper	Delphacidae	Unknown A		Plant sap
Thrip	Thripidae	*Frankliniella*	sp.	Herbivore
Salt marsh Tiger Beetle	Carabidae	*Cicindela*	*marginata*	Predator
Hairy-necked Tiger Beetle	Carabidae	*Cicindela*	*hirticollis*	Predator
Scarb Beetle	Scarabaeidae	*Anomala*	spp.	Herbivore
Shining Flower Beetle	Phalachridae	*Stilbus*	sp.	Larvae feed on developing heads of flowers

Lady Bird Beetle	Coccinellidae	*Anatis*	sp.	Predator
Lady Bird Beetle	Coccinellidae	*Naemia*	*seriata*	Predator
Spotted Cucumber Beetle	Chrysomelidae	*Diabrotica*	*undecimpunctata*	General Herbivore
Leaf Beetle	Chrysomelidae	*Ophraella*	*notulata*	Herbivore
Leaf Beetle	Chrysomelidae	Alticinae species of		Herbivore
Seed Beetle	Chrysomelidae	Bruchinae sp. of		Seed Herbivore
Braconid	Braconidae	Aphidinae species of		Parasitoids of insects
Ichneumon	Ichneumonidae	Unknown A		Parasitoids of insects
Ichneumon	Ichneumonidae	Unknown B		Parasitoids of insects
Trichogrammatid Wasp	Trichogrammatidae	Unknown A		larvae parasites of insect eggs
Sphecid Wasp	Sphecidae	*Ammophilia*	*pictipennis*	Predator & nectar
Sweat Bee	Halicidae	*Lasioglossum*	*oblongum*	Feeds on nectar and pollen -- nest in ground burrows
Ant	Formicidae	*Lasius (Acanthomyops)*	*interjectus*	Omnivore
Ant	Formicidae	*Crematogaster*	*laeviuscula = clara*	Omnivore
Ant	Formicidae	*Monomorium*	*destructor*	Omnivore
Gracillarid Moth	Gracillaridae	Unknown A		Herbivore
Least Skipper	Hesperiidae	*Ancyloxypha*	*numitor*	Various grasses
Broad Winged Skipper	Hesperiidae	*Poanes*	*viator*	*Phragmites communis*
Salt Marsh Skipper	Hesperiidae	*Panoquina*	*panoquin*	*Distichlis spicata*
Noctuid Moth	Noctuidae	*Doryodes*	*grandipennis*	*Spartina patens*
Crane Fly	Tipulidae	*Erioptera*	*cana*	larvae as scavengers
Crane Fly	Tipulidae	Multiple Unknowns		larvae as scavengers
No-see-ums	Ceratopogonidae	*Culicoides*	*furens*	Adults preference for mammal bood, including humans
No-see-ums	Ceratopogonidae	*Culicoides*	*hollensis*	Adults feed on human blood
No-see-ums	Ceratopogonidae	*Dasyhelea*	sp. with round wings	Adults feed on insect fluids
No-see-ums	Ceratopogonidae	*Dasyhelea*	sp. with elongated wings	Adults feed on insect fluids
Midges	Chironomidae	Multiple Unknowns		larvae are aquatic, scavengers
Salt-marsh Mosquito	Culicidae	*Aedes*	*sollicitans*	larvae filter feeders, adult males nectar, females blood
Dark Salt-marsh Mosquito	Culicidae	*Aedes*	*taeniorhynchus*	larvae filter feeders, adult males nectar, females blood
Gall Midge	Cecidomyiidae	Unknown A		
Xylophagid Fly	Xylophagidae	Unknown A		Adults feed on sap or nectar
Green Headed Fly	Tabanidae	*Tabanus*	*nigrovittatus*	Males eat pollen and nactar, females feed on blood
Dance Fly	Empididae	Unknown adults A		adults predaceous
Long-Legged Fly	Dolichopodidae	*Condylostylus*	sp.	adults predaceous
Long-Legged Fly	Dolichopodidae	*Hydrophorus*	sp.	adults predaceous
Long-Legged Fly	Dolichopodidae	*Hypocharassus*	*sp.*	adults predaceous
Long-Legged Fly	Dolichopodidae	*Thrypticus*	sp.	Larva feed on Spartina
Long-Legged Fly	Dolichopodidae	Unknown A	M1 angled up	adults predaceous
Flower Fly	Syrphidae	*Eristalinus*	*aeneus*	adults on flowers, larvae predaceous
Flower Fly	Syrphidae	Unknown A		adults on flowers, larvae predaceous
Anthomyiid Fly	Anthomyiidae	*Lispe*	sp.	larvae feed on mosquitoes
Blow flies	Calliphoridae	*Phaenicia*	sp.	Carrion

Muscid Fly	Muscidae	Unknown adults A		
Skipper Fly	Piophidae	Unknown A		Scavengers
Picture-Winged Fly	Ulidiidae	*Chaetopsis*	*aenea*	Spartina sp.
Picture-Winged Fly	Ulidiidae	*Chaetopsis*	*apicalis*	Spartina sp.
Dryomyzid Fly	Dryomyzidae	Unknown A		larvae feed on decaying organic matter
Marsh Fly	Sciomyzidae	Unknown adults A	small species	larvae feed on snails, snail eggs and slugs
Marsh Fly	Sciomyzidae	Unknown adults B	large species	larvae feed on snails, snail eggs and slugs
Shore Fly	Ephydridae	Unknown adults A		larvae are aquatic
Shore Fly	Ephydridae	Unknown adults B		larvae are aquatic

Macro-Arthropod Survey: This survey was directed towards the creation of a field guide which is an independent document and separate from this report. Many of the arthropods found in the other surveys also qualify as macro-sized arthropods (butterflies, dragonflies, bumble bees, etc.). Therefore a complete list of macro-arthropods is not included in this report with the exception of the moths (Table 10) and wasps (Table 11). However, all species encountered on the island are presented in the Project Database (Orr, 2008) and those that were included in the macro-arthropod survey that were not included in the other surveys are so marked in the *Survey* column on the *General Information* spreadsheet.

Table 10 (list of the moths) and Table 11 (list of the wasps) recorded from the island are presented here since many of these species are new records, while others have significant ecological roles and thus will be of interest to the Park.

Table 10: Some Moths of Assateague Island National Seashore (Worcester County, Maryland, 2005-2007 Survey)

FAMILY	GENUS	SPECIES	FLIGHT PERIOD	GENERAL FEEDING ACTIVITIES
Acrolophidae	*Acrolophus*	*texanella*	24Jul	roots of grasses
Gracillaridae	*Chionodes*	*arenella*	5Aug	Herbivore
Gracillaridae	*Chionodes*	*fuscomaculella*	23Sep to 7Oct	Herbivore
Gracillaridae	Unknown A		5May	Herbivore
Limacodidae	*Euclea*	*delphinii*	16Jun	Various trees & shrubs
Limacodidae	*Lithacodes*	*fasciola*	9Aug	Various trees & shrubs
Limacodidae	*Parasa*	*chloris*	18Jul	Various trees & shrubs
Zygaenidae	*Harrisina*	*americana*	16Jun	Various vines
Tortricidae	*Choristoneura*	*rosaceana*	18Jul	Various trees
Tortricidae	*Donacaula*	*unipunctella*	??	Herbivore
Tortricidae	*Eucosma*	*dorisignatana*	8Oct	Herbivore
Tortricidae	*Hedya*	*separatana*	23Sep	Herbivore
Pyralidae	*Agriphila*	*ruricolella*	8Oct to 9Oct	Herbivore
Pyralidae	*Anania*	*funebris*	3Aug	*Solidago* spp.
Pyralidae	*Blepharomastix*	*ranalis*	16Jun	*Chenopodium* spp.
Pyralidae	*Coenochroa*	*bipunctella*	14Jul	Herbivore
Pyralidae	*Crambus*	*quinquareatus*	7Oct	Herbivore
Pyralidae	*Crambus*	sp.	8Oct	Herbivore
Pyralidae	*Desmia*	*funeralis*	16Jun	Evening-primrose & wild grapes
Pyralidae	*Diatraea*	*crambidoides*	??	Herbivore
Pyralidae	*Eustixia*	*pupula*	11Jun	Peppergrass
Pyralidae	*Helvibotys*	*helvialis*	14Jul	*Amaranthus* spp.
Pyralidae	*Homeoesoma*	*pedionnastes*	23Sep	Herbivore

Pyralidae	*Hulstia*	*undulatella*	23Sep	Herbivore
Pyralidae	*Melitara*	*prodenialis*	20Sep	Prickly Pear Cactus
Pyralidae	*Ostrinia*	*nubilalis*	14Sep	Many hosts
Pyralidae	*Peoria*	*gemmatella*	24Jul	Herbivore
Pyralidae	*Phaneta*	*ochrocephala*	23Sep	Herbivore
Pyralidae	*Prionapteryx*	*achatina*	14Jul	Herbivore
Pyralidae	Crambinae sp. of		16Jun	Herbivore
Drepanidae	*Oreta*	*rosea*	16Jun	Viburnums
Geometridae	*Dichorda*	*iridaria*	27Jun	Sumac
Geometridae	*Eusarea*	*confusaria*	8Oct	Composites
Geometridae	*Glena*	*cribrataria*	11Jun	*Vaccinium* sp.
Geometridae	*Nepytia*	sp.	18Jul	Pines
Geometridae	*Orthonama*	*centrostrigaria*	8Oct to 9Oct	Knotweeds
Geometridae	*Scopula*	*limboundata*	11Jun	Various plants
Lasiocampidae	*Artace*	*cribraria*	8Oct	Oaks and Prunus sp.
Lasiocampidae	*Malacosoma*	*americanum*	11Jun	Various trees & shrubs
Lasiocampidae	*Tolype*	*velleda*	18Jul to 15Oct	Various trees
Sphingidae	*Agrius*	*lineata*	20Sep to Oct11	Larvae eats Jimsonweed
Sphingidae	*Eumorpha*	*achemin*	??	Wild Grapes
Sphingidae	*Eumorpha*	*pandorus*	16Jun	Grapes and Virginia Creeper
Sphingidae	*Hyles*	*lineata*	20Sep	Nectar on Jimsonweed flowers
Sphingidae	*Xylophanes*	*tersa*	??	Herbivore
Noctuidae	*Acontia*	*delecta*	16Jun	Swamp rose-mallow
Noctuidae	*Acronicta*	*sp.*	16Jun	Herbivore
Noctuidae	*Agrapha*	*oxygramma*	20Sep	Goldenrods and Asters
Noctuidae	*Agrotis*	*vetusta*	late-Sep	Various plants
Noctuidae	*Alypia*	*octomaculara*	16Jun	Grapes and Virginia Creeper
Noctuidae	*Anomis*	*erosa*	23Sep to 6Oct	Hibiscus
Noctuidae	*Autographa*	*bimaculata*	18Jul	Dandelion
Noctuidae	*Autographa*	*precationis*	20Sep to 8Oct	Many herbaceous plants
Noctuidae	*Caenurgina*	*sp.*	??	Grasses
Noctuidae	*Discestra*	*trifolii*	24Jul	Many herbaceous plants
Noctuidae	*Doryodes*	*bistrialis*	20Jul	*Spartina patens*
Noctuidae	*Doryodes*	*grandipennis*	2Apr	*Spartina patens*
Noctuidae	*Drasteria*	*graphica*	18-Apr to 7Sep	*Vaccinium* sp.
Noctuidae	*Eucoptocnemis*	*fimbriaris*	8Oct to 9Oct	Herbivore
Noctuidae	*Eudryas*	*grata*	11Jun to 16Jun	Various shrubs and vines
Noctuidae	*Euxoa*	*detersa*	8Oct	Saltwort & searocket
Noctuidae	*Feltia*	*subgothica*	7Oct	Various plants
Noctuidae	*Feltia*	sp.	20Sep to 8Oct	Herbivore
Noctuidae	*Helicoverpa*	*zea*	20Sep	Various plants
Noctuidae	*Iridopsis*	*vellivolata*	18Jul	Pines
Noctuidae	*Lascoria*	*ambigualis*	11Jun	Ragweed
Noctuidae	*Leucania*	*extincta*	24Jul	Probably wetland grasses
Noctuidae	*Leucanopsis*	*longa*	16Jun	Marsh grasses
Noctuidae	*Melipotis*	*jucunda*	14Jul	host plant unknown
Noctuidae	*Noctua*	*pronuba*	18Jul	Grasses and low herbs

Noctuidae	*Ommatostola*	*lintneri*	21Sep	feeds on beach grass roots
Noctuidae	*Papaipema*	*duovata*	5Oct to 27Oct	feeds on Seaside Goldenrod
Noctuidae	*Papaipema*	*furcata*	??	Ash
Noctuidae	*Polygrammate*	*hebraeicum*	18Jul	Black gum Trees
Noctuidae	*Schinia*	*spinosae*	21Sep to 7Oct	host plant unknown
Noctuidae	*Simyra*	*henrici*	9Jun	Many hosts
Noctuidae	*Spodoptera*	*ornithogalli*	8Oct	Various plants
Noctuidae	*Thioptera*	*nigrofimbra*	2Aug	*Ipomoea* spp. & Grasses
Noctuidae	*Trichoplusia*	*ni*	8Oct	Many hosts
Arctiidae	*Apantesis*	*vittata* or *phalerata*	13May to 20Sep	Many hosts
Arctiidae	*Cisseps*	*fulvicollis*	30Sep to 5Nov	Grasses & spike-rushes
Arctiidae	*Cisthene*	*packardii*	9Aug to 30Sep	Lichens
Arctiidae	*Estigmene*	*acrea*	??	Many hosts
Arctiidae	*Grammia*	*virgo*	7Aug	Bedstraw
Arctiidae	*Halysidota*	*tessellaris*	11Jun	Many broad-leaf trees
Arctiidae	*Haploa*	*colona*	11Jun	Various broad-leaf trees
Arctiidae	*Hypoprepia*	*fucosa*	11Jun to 26Jul	Lichens
Arctiidae	*Pyrrharctia*	*isabella*	??	Many hosts
Arctiidae	*Spilosoma*	*sp.*	18Jul	Herbivore
Arctiidae	*Utetheisa*	*bella*	15Nov	Legumes and *Prunus* spp.

Table 11: Some Wasps of Assateague Island National Seashore (Worcester County, Maryland, 2005-2007 Survey)

FAMILY	GENUS	SPECIES	ENGLISH NAME	FLIGHT PERIOD
Braconidae	Aphidinae species of		Braconid	5May
Ichneumonidae	*Enicospilus*	sp.	Ichneumon	27-Jun
Ichneumonidae	*Thyreodon*	sp.	Ichneumon	18Jul
Ichneumonidae	Unknown A		Ichneumon	5May
Ichneumonidae	Unknown B		Ichneumon	5May
Mymaridae	Unknown A		Fairyflies	5May
Trichogrammatidae	Unknown A		Trichogrammatid Wasp	13Jun
Chrysididae	Unknown A		Cuckoo Wasp	6Sep to 7Sep
Sphecidae	*Ammophilia*	*pictipennis*	Sphecid Wasp	13Jun
Sphecidae	*Bembix*	sp.	Sand Wasp	6Sep
Sphecidae	*Chlorion*	*aerarium*	Blue Mud Dauber	6Sep
Sphecidae	*Microbembex*	sp.	Sand Wasp	10Jun to 18Jul
Sphecidae	*Oxybelus*	sp.	Sand Wasp	18Jul
Sphecidae	*Prionyx*	sp. prob. *parkeri*	Sphecid Wasp	20Sep
Sphecidae	*Sceliphron*	*caementarium*	Black & Yellow Mud Dauber	16Jun to 9Oct
Sphecidae	*Tachysphex*	sp.	Sphecid Wasp	6Sep to 7Sep
Sphecidae	Philanthinae sp. of		Sphecid Wasp	16Jun
Sphecidae	Sphecinae sp. of		Sphecid Wasp	18Jul
Tiphiidae	*Myzinum*	sp.	Tiphiid Wasp	6Sep
Pompilidae	Larrinae sp. of		Spider Wasp	4May
Pompilidae	Pompilini sp. of		Spider Wasp	5Nov
Pompilidae	Unknown A	small sized	Spider Wasp	5May to A-13Jun

Pompilidae	Unknown B	medium sized	Spider Wasp	13Jun
Pompilidae	Unknown C	medium sized	Spider Wasp	13Jun
Pompilidae	Unknown D	medium sized	Spider Wasp	14Oct
Scoliidae	*Campsomerus*	sp.	Scoliid Wasp	5May to A-13Jun
Vespidae	*Ancistrocerus*	*unifasciatus*	Potter Wasp	13Jun
Vespidae	*Eumenes*	*fraternus*	Potter Wasp	13Jun
Vespidae	*Monobia*	*quadridens*	Mason Wasp	13Jun to 8Oct
Vespidae	*Parancistrocerus*	*histrio*	Potter Wasp	6Jun to 5Nov
Vespidae	*Polistes*	*bellicosus*	Paper Wasp	5May to 13Jun
Vespidae	*Polistes*	*exclamans*	Paper Wasp	12Jun
Vespidae	*Polistes*	*fuscatus*	Northern Paper Wasp	4May to 20Sep
Vespidae	*Polistes*	*metricus*	Paper Wasp	5Jun
Vespidae	*Stenodynerus*	*histrionalis*	Potter Wasp	5Nov
Vespidae	*Stictia*	*carolina*	Horse Guard Wasp	6Sep to 8Oct
Vespidae	Eumeninae sp. of		Potter Wasp	8Jun to 8Oct
Formicidae	*Aphaenogaster*	*rudis*	Ant	22May to 23May
Formicidae	*Lasius (Acanthomyops)*	*interjectus*	Ant	4May
Formicidae	*Lasius*	*umbratus*	Ant	2Apr
Formicidae	*Camponotus*	*discolor*	Carpenter Ant	27Jun
Formicidae	*Crematogaster*	*laeviuscula = clara*	Ant	2Apr to 26Oct
Formicidae	*Dolichoderus*	*mariae*	Ant	2Apr to 20Sep
Formicidae	*Dorymyrmex*	*bureni*	Ant	2Apr
Formicidae	*Monomorium*	*destructor*	Ant	13Jun
Formicidae	*Monomorium*	*minimum*	Ant	2Apr

DISCUSSION

Assateague Island is a mostly pristine barrier island which is experiencing littoral drift towards its south end (Higgin, et al. 1971). Currently the island runs uninterrupted from just south of Ocean City, Maryland to the sand hook at Tom's Cove in Virginia. In recent years this continuum has experienced intermittent ephemeral inundations due to storms and/or abnormally high tides, but the island still remains intact at the writing of this report.

Prior to 1933, Assateague Island was part of a larger barrier spit that extended northward into Delaware. In that year, a major hurricane opened an inlet just south of what is now Ocean City, Maryland. By 1935, the U.S. Army corps of Engineers stabilized the inlet with parallel stone jetties to keep the inlet open as a federal navigation channel. Since then, the jetties have disrupted the natural north to south movement of sand and northern Assateague has become sand-starved. The chronic lack of sand has resulted in unnaturally accelerated shoreline erosion and landward migration of the north end of the island (Sieling 1960; Furbish, Railey and Meininger 1994).

Another human induced impact to the island was the construction of an artificial "primary" dune system by developers after a major storm in 1962. The system remained essentially intact until storms in 1991 and 1992 eliminated around 75% of the dunes in the Maryland portion of the island. During the approximately thirty years that the artificial dunes existed they restricted storm overwash and the resulting cross-island movement of sand. The island had not yet recovered from its effects by 1994 (Furbish, Railey and Meininger 1994).

The distributions of many resident arthropods on Assateague Island are strongly influenced by the characteristic vegetational zonation which is typical not only Assateague Island but barrier islands world wide (Oosting 1954). Applying Egler's 1942 classification to ASIS, zones of similar vegetation occur (going from east to west) in roughly parallel north-south bands starting with the beach, changing into a salt-spray grassland (grassland) zone, then into a salt-spray scrub (shrub) zone, which merges into a pine (forest) zone and finally ends in the salt marsh. These vegetative zones were obvious at most locations on the island, but were highly fragmented at other locations due to a combination of topography, sand movement, salt spray pattern and/or past weather events. Pine forests only occur in the most protected locations on the northern end of the island and unlike Chincoteague never formed a true deciduous forest climax zone within ASIS.

The other major habitat type that influences arthropod distribution on ASIS is the presence of fresh water pools or ponds that are distributed within the grassland, shrub, forest, and salt marsh zones.

Stability of the various habitats (zones) on a barrier island can vary greatly. The most stable are the salt marshes, while dune and grasslands are less stable (change over time) but still far better able to handle the abiotic stresses that exit on a barrier island, than the woodlands or fresh water ponds (Godfrey & Godfrey 1976). Even the least stable of zones have been maintained over time on the island despite that they may be periodically removed from a specific section of the island following a major storm event. These localized disturbed sites are normally re-colonized over time from adjacent plant communities.

The plants and animals of Assateague Island, like all barrier islands, are subjected to extreme changes in weather, fresh water availability and topography. The ephemeral and dynamic nature of barrier islands places abiotic stresses on its inhabitants not mirrored on the adjacent mainland. Over time there is a non-periodic cyclic pattern to the number of resident species at ASIS. Strong century-level storm events will often remove or reduce the arthropod populations on the island (or part of the island) particularly in the grassland, scrub and pine habitats. Only a few arthropod species that are barrier island specialists can weather through major storm events with little impact to their populations. Especially vulnerable are the freshwater ponds and pools found within each of these zones.

Most of the island's arthropod inhabitants are not barrier island specialists but are transplants from the adjacent mainland. Many of these introduced mainland species set up a tenacious residence on the island for only a few decades or less before being extinguished either by extreme weather events or from newer introduced competitor(s) or predators. Other mainland species fare somewhat better on the island because they co-evolved with plants that become established, at least for a limited period of time, on the island

This pattern of extinction and re-colonization of mainland species coupled with the few barrier island specialists defines the arthropod populations found at ASIS. The beach and salt marsh zones have the highest percentage of barrier island arthropod specialists compared to mainland arthropod species while the pine and freshwater ponds have the least (close to no barrier island specialists in these habitats). The brush and grasslands are intermediate harboring a few barrier island specialists but even here the vast majority are still mostly temporary establishments of mainland species. Currently, ASIS is likely near its apex of species diversity; there has really not been a storm event for a number of years that has removed island-wide sections of the various terrestrial habitats. However, freshwater ponds which are the most vulnerable habitat on the island are frequently disturbed by salt water inflow.

When a century-level storm event does impact ASIS the island will lose many of its arthropod species that were mainland introductions. The barrier island arthropod specialists will likely survive intact. Freshwater ponds will be significantly compromised with saltwater overwash most likely removing all truly freshwater arthropods from the ponds, while the salt marsh, which may be temporarily damaged, should recover and will likely benefit from the storm in the long run. Terrestrial habitats, except for the beach, will experience significant impacts and may ultimately transition to a habitat different from the original. The result of removing a significant number of arthropod species from the island will create a vacuum for re-introduction from the mainland. Which species gets to the island first and which succeeds in establishing a population will be based on the dispersal characteristics of the incoming species and a good bit of luck. At first, the newly formed arthropod populations will wax and wane to fill vacant niches and respond to new species establishments. Each re-introduction sequence will be different from the last. Although this waxing and waning of mainland species populations on the island will lessen overtime in intensity, it will continue to some degree until the next major storm event starts the process over again. This dynamic pattern means that the current view of the arthropod assemblage in the terrestrial and freshwater habitats at ASIS is a snap shot in time that will change once the next century-level storm event occurs. The beach and salt marsh arthropod assemblages being more adapted to handle major storm events should recover quicker than the other zones and return to a similar arthropod assemblage.

The re-colonization of mainland arthropod species is easily done by those species that are long-distance dispersers (e.g. dragonflies, butterflies, macro-moths, wasps, freshwater species and some grasshoppers). However, for most arthropods the re-colonization event occurs by chance introductions to the island. This probability of introduction is most pronounced along the main road where there is access to the island by visitors and their conveyances. In addition, there are campground locations for recreation vehicles adjacent to the main road. Elsewhere on the island, vehicles and visitors are more restricted and these remain mostly on the beach, thus reducing the chance of introducing new arthropods (and other organisms) to the island. It is no surprise that the section of the island that contains the main road and campgrounds had a higher diversity of arthropod species than the other sections of the island.

The least sampled of the zones during the survey was the open beach. Clearly there were fewer arthropod species here than at the other zones on the island. The ghost crab was the most conspicuous arthropod in the beach zone where they specialize in hunting the even more numerous (but less conspicuous) beach fleas (Perry 1985). A number of small flies were often seen in the beach wrack during the study, but they were never sampled for identification.

Odonata Survey: The species of dragonflies and damselflies found at ASIS fit into the three establishment categories mentioned in the results section. These were the long-time resident species whose larvae live in salt marshes (see Table 2); the short-term resident species whose larvae utilize the freshwater ponds on the island (see Table 2), and finally those species encountered as adults from either the adjacent mainland or from north/south moving dispersals/migrants that did not utilize ASIS wetlands for larval development (those species listed in Table 1, but not included in Table 2).

A historical survey of odonates from Chincoteague National Wildlife Refuge (CNWR) was conducted prior to the ASIS survey (See Appendix II). The species list from CNWR is nearly identical with what was found at ASIS. The only differences were that *Enallagma geminatum* was found on the refuge survey and not recorded at ASIS and *Pantala flavescens*, *Aeshna umbrosa*, and *Brachymesia gravida* (Photo 21) were found at ASIS, but not listed in the CNWR survey. The similarity between the two lists hints that only a minimal number of new odonate species should be expected from future field work on the island.

The Seaside Dragonlet (photos 22, 23 & 24), Rambur's Forktail (photos 36 & 37), and Citrine Forktail (photos 34 & 35) individuals far out number the individuals of other species of odonates on the island. The Seaside Dragonlet is a true brackish water species (salt marshes) while Rambur's Forktail and Citrine Forktail do well at the zone where brackish and fresh water meet and mix either at the salt marsh/freshwater interface or in ponds where mixing with saltwater periodically occurs.

The three most abundant damselflies flight periods are shown in Figures 5, 6 and 7. Rambur's Forktail and the Citrine Forktail were dominant in the spring and early summer while the Familiar Bluet did not reach its peak until late summer and fall.

Some of the most abundant species found in adjacent mainland ponds were rare or absent from the ponds on the island. Notable was the rarity of *Ischnura posita* and complete absence of *Ischnura verticalis* from the island. There is no reason why these species would not do well in the freshwater ponds at ASIS. Most likely the reason for their rarity or absence is due to chance arrival and establishment events on the island.

Most of the fresh water ponds at ASIS proved to be extremely dynamic and very susceptible to drying. Assateague Island in 2006 experienced a dry spring and a wet summer and fall. This was different from 2005 when the spring was very wet and copious standing freshwater was present through the year. This seasonal difference in available freshwater changed the dynamics of all but the most stable of the freshwater ponds. Many of the most productive ponds in 2005 for odonates were either dry or had become predominately saltwater by the spring of 2006. Except for the deeper ponds and the salt marsh, productivity as measured by numbers of individual dragonflies and damselflies was considerably lower in 2006 than 2005. The year 2007 was an unseasonably dry year that resulted in most of the island's freshwater ponds completely drying up by mid-summer; this resulted in a collapse of the permanent water dragonfly species populations that had built up in ASIS ponds during the previous few years. In addition, many of the ponds on the western edge of the island (bay side) alternated between being fresh and brackish water during the drier year drastically changing their odonate species composition.

Only a couple of the ponds on the island were protected enough to produce a good number of individual freshwater pond dragonflies, most ponds contained only a few individuals of each species indicating much stress on their populations. It is reasonable to assume that extreme storms that occur every few decades or more often reset the island's freshwater dragonfly populations back to, or nearly to, zero.

Those fresh water ponds that did maintain their integrity over the three year study were more homogenous in their odonate species composition than expected. The dynamics of the ponds are such that they consist mainly of general pond species introduced from the mainland, migratory species that utilize temporary or shallow ponds for larval development and an influx of species which normally prefer brackish or semi-brackish water. The fresh water ponds would maintain populations of these three types in various concentrations depending upon their physical characteristics and isolation from salt water intrusion.

The salt marshes are much more stable; but only a single odonate species, the Seaside Dragonlet has truly adapted to survive in the salt marsh. Two other species often compete life cycles in the salt marsh pannes where enough rain water accumulates to dilute the saltwater content of the pool. These are Rambur's Forktail and Citrine Forktail. The Familiar Bluet (photos 32 & 33) and Needham's Skipper (photo 25) also seemed able to withstand a degree of brackish water contamination. Although adults of these two species were seen over the salt marsh, no cast skins were found to show that they actually completed their life cycles within the salt marsh or the salt marsh pannes.

The Seaside Dragonlet is likely the only species of odonate that truly is a long-term resident (can reliably survive century-level storm events) on the island. The Seaside Dragonlet *Erythrodiplax berenice* is unique in that it has adapted to the salt marsh environment. It is truly the only marine dragonfly species known in the world whose larvae can regulate its hemolymph osmotic pressure in salinities from fresh water to 260% salt of seawater (Dunson 1980). Although the Seaside Dragonlet does complete its life cycle in the fresh water ponds at ASIS, it would likely not survive as a population for any length of time if not for the influx of adults from the salt marsh.

Large healthy expanses of salt marsh adjacent to extensive areas of forest with intermittent open areas produces and maintains the highest number of Seaside Dragonlet adults. The pine forest is necessary to provide a location where the adults can mature and feed without being destroyed during adverse weather. The loss of one of these two habitats would drastically decrease the number of adults present. *Erythrodiplax berenice* feeds mostly on homoptera and nematocean flies that emerge from the salt marshes.

In 1995 and 1996 the emergence of the Seaside Dragonlet approximately coincided with a major emergence of the salt-marsh mosquito (*Aedes solicitans*) (photo 213). However, in 1997 the lack of rains kept the mosquitoes from emerging until much later than that of the dragonlet. There is a possibility that there might be a quasi-predator/prey relationship between the salt-marsh mosquito and the Seaside Dragonlet, but my observational data was not conclusive. It should be noted that it is not only the adult dragonlet that is taking the mosquitoes; but the larvae of the dragonlet are as well. Seaside Dragonlet larvae occur in the small isolated pools in the salt marsh and the larvae are climbers (Merritt, Cummins and Berg 2008); while most other members in the family Libellulidae are burrowers or sprawlers. It is possible that the dragonfly larvae may be linked to the salt-marsh mosquito as well.

The flight period of the Seaside Dragonlet on the island is shown in Figure 8. There is a synchronous emergence around early June and then limited emergence afterwards. There is one generation per year.

Carolina Saddlebags (photos 30 & 31), Black Saddlebags, Spot-winged Gliders (photo 28), Wandering Gliders and a population of the Common Green Darner (photos 18, 19 & 20) are migratory species throughout Maryland (Orr 1996). For this report, migratory means that a full life cycle occurs in Maryland but no life stage overwinters. The sexually mature adults arrive from the south in the spring or early summer, lay eggs which develop within a few months and the emerging adults fly south. The Common Green Darner has two distinct populations, a population that is migratory and one that is a resident (larvae overwinter). All these migratory species occur at ASIS and most utilize the island's ponds as larval habitat. I was not able to show that Spot-winged Gliders or Wandering Gliders completed a larval cycle on the island, but suspect that they do, but in numbers below what I was able to detect. Both resident (few) and migratory (most) populations of the Common Green Darner occur on the island based on larval samples.

The migratory population of the Common Green Darner did not show a distinctive spring movement on the island as occurred inland in Maryland. The early spring arrivals showed up inland long before they did at ASIS. The fall movement of the migratory population of the Common Green Darner was evident on the island but less than expected based on comparison observations from Cape May and along the inland hawk migratory pathways.

Most interesting was finding a very early cast skin of the Common Green Darner on April 5, 2005 from Pond 20H and fully mature instar larvae of the Carolina Saddlebag on April 4, 2005 from pond 29A. Both these findings indicate that at least one individual of the migratory population of the Common Green Darners and that a few migratory Carolina Saddlebags overwintered as larvae at ASIS. This is the first record in Maryland of the migratory Common Green Darner overwintering and the most northern record of over wintering Carolina Saddlebag found to date. These were exceptions to the rule and most of the other individuals of both these species followed the traditional pattern of not overwintering as larvae at ASIS.

The early arrivals of the migratory adults and the emergence of south moving late season individuals with a reduced number of adults in between is shown in Figures 2, 3 and 4.

Orthoptera Survey: The diversity of the orthopterans on ASIS was as high, if not higher, than the adjacent mainland. This is due to the large extent of grasslands that exist on the island. The grasslands are not managed so are relatively free from pesticides. Also, the grasslands are more stable (recover faster from storm damage) than brushlands or forests on a barrier island and their arthropod complements have had the chance to build up over time.

The diversity of the orthopterans (minus those katydids that inhabit broadleaf forests – a habitat missing from ASIS) was surprising. A number of orthopteran habitat specialists were identified. The major sand-loving (dune) grasshoppers were the Seaside Grasshopper (photo 46) and the Longhorn Band-winged grasshopper (photo 41). Black-sided Pygmy Grasshoppers dominate the freshwater temporary pools while the major salt marsh species were the Saltmarsh Meadow Katydid (photo 48), Stripe-faced Meadow Katydid and Saltmarsh Ground Cricket. Where *Scirpus americanus* occurred in the upper marsh the Agile Meadow Katydid ruled. But the real diversity of orthopterans are the generalists that were found within the patchy distribution of the grasslands, brush and woodlands that run the length of the Island.

Trimerotropis maritima (Seaside Grasshopper) was often seen resting on hot sand rising high up off the sand to avoid the heat. This good-sized grasshopper matches the sand so well that it appears to disappear when it lands. The nymphs (photo 47) of this species are superb sand-camouflage mimics that match up their irregular colored markings to the sand grains that they are resting on.

ASIS has a population of the American Bird Grasshopper (photo 43 & 44) which is the largest flying grasshopper in North America. These giants overwinter on the island as adults. Even in mid-winter, during warm spells, they could be seen when flushed from low lying grass/brush and flying high into the trees. They were uncommon (but conspicuous) in 2006 and 2007 but were not seen in 2005.

The katydids are the major chewing herbivores of the salt marsh and an important component in the health of the salt marsh (see discussion under Salt Marsh Survey).

Leaf Beetle Survey: The Chrysomelidae comprises one of the largest insect families containing more than 37,000 species worldwide, including some 1,700 North American species (Jolivet 1988; Riley et al. 2002). This herbivorous group includes some general feeders and many host-specific beetles that feed and develop on one or a few related plants. Certain characteristics of leaf beetles, including host specificity, varied feeding habits and occurrence across a wide geographical range and variety of habitats, suggest vulnerabilities to extinction and potential for use as environmental indicator species (Bossart and Carlton 2002; Cavey 2004). The case for this potential is not well documented however; characteristics of chrysomelids suggest that inventories of leaf beetles and subsequent monitoring efforts in protected habitats such as ASIS will provide important data for future conservation planning and management.

Because many Chrysomelidae are relatively host-specific feeders, habitat possessing high plant diversity usually will contain a diverse leaf beetle fauna. ASIS contains 25 vegetation types as defined by the National Vegetation Classification System including four forest types, one woodland type, eight shrubland types, 11 herbaceous types and one sparsely vegetated type (TNC 1995).

The leaf beetle survey significantly increased the number of species known from ASIS, from 22 to 51 species. Four of the newly recorded species are also new to the state of Maryland. Each of these taxa is discussed below.

Paria virginiae Wilcox was formerly recorded from North Carolina south to Florida and Texas (Riley *et al*. 2003). Although in the past 51 years North American members of the genus *Paria* were revised (Wilcox 1957) and later reviewed (Balsbaugh 1972), the group still presents difficulties in recognizing species (Clark 2000; Riley *et al*. 2003). Consequently, this species may have been collected outside of the recorded distribution in the US. but not recognized or reported. Specimens of *P. virginiae* collected at ASIS in 2007 were the first recorded in Maryland. Wilcox (1957) reported collecting a series of this species in Florida from *Avicennia nitida* Jacq. (Verbenaceae), a southern evergreen shrub not known from Maryland (Brown & Brown 1972). No other host associations have been recorded (Clark *et al*. 2004). *Paria virginiae* was located at two different backdune locations on ASIS, one specimen at a time, and no host association could be matched with the specimens. One specimen was taken near Shell Road at N38°14.343' W075°08.242' on May 21, 2007 and another near the same location on June 18, 2007.

A South American native accidentally introduced into the United States in the 1940's (Ameen & Story 1997), is the yellow-margined leaf beetle *Microtheca ochroloma*. This species was previously recorded in the United States from Oklahoma, Texas, Louisiana, Mississippi, Alabama, Florida, and North Carolina (Riley *et al*. 2003). On ASIS, a single specimen was collected on April 29, 2007 by sweeping mixed herbaceous vegetation just east of Shell Road at N38°14.343' W075°08.242'. This record represents a northern extension of the known distribution for this species from North Carolina to Maryland. Adult and larval *M. ochroloma* feed on leaves of the Brassicaceae, including turnip, mustard, collard, cabbage, watercress and radish (Ameen & Story 1997; Clark *et al*. 2004). The ASIS specimen was swept from mixed, low herbaceous growth. The exact host plant was not identified. Although in Maryland *Microthea ochroloma* has been found only on ASIS, this affinity to the barrier island may have more to do with the more moderate winter climate of ASIS relative to most of the state than to dependency on ASIS habitats.

Cryptocephalus pumilus Haldeman was formerly reported from Louisiana, Alabama, Florida, Georgia, South Carolina, North Carolina, Virginia and New Jersey (Riley *et al*. 2003). Given its distribution, it is expected that this species occurs in Maryland and particularly on ASIS. The host(s) of *C. pumilus* has not been determined definitively. In Florida, Blatchley (1924) noted collections from "willow and dead vines along streams," and also sweeping open prairie. Clark *et al*. (2004) reported *Baccharis halimifolia* and *B. neglecta* as hosts. On ASIS, the specimens were taken from willow oak on the western loop of the Life of the Dunes Trail. Adults of common species in genus *Cryptocephalus* are often associated with numerous and unrelated host plants (personal observation, Clark *et al*. 2004). Associations with woody plants, like this one with *C. pumulis* on willow oak, are common.

Colaspis recurva Blake was formaerly recorded from coastal states ranging from Virginia to Louisiana (Riley et al. 2003). Virginia specimens include a series collected at Cape Charles on the coast. Thus, the ASIS collection represents a slight northern extension of the U.S. range for this species. Recorded plant associations for this species include five to six species in as many woody plant families, including *Baccharis hamilifolia*, *Camillia, Rosa, Rhododendron, Prunus Mexicana*, *Vitis rotundifolia* and possibly *Myrica* (Clark etal. 2004).

Host associations observed during the survey (marked *) are presented in Table 5B as are some of the previously recorded hosts of listed leaf beetles. Few observations were made as most beetles were collected one at a time in the sweep net. None of the observed host associations were unexpected. Regarding habitat preference, some of the species recorded for ASIS are restricted (*Bassareus clathratus*, *Erynephala maritima* and *Paria aterrima*) or mostly restricted (*Colaspis favosa*, *Odontota horni* and *Ophraella notulata*) to the Atlantic Coastal Plain, based on collection data in Maryland. None of the beetles identified to species have a known restrictive affiliation with barrier island habitat; however, two of the beetles are new to the state, *Paria virginiae* and *Colaspis recurva*, may be a coastal obligates.

The one known host for *Paria virginae* is a mangrove (Clark *et al*. 2004), and the distribution for this species is comprised entirely of coastal states (Riley *et al*. 2003). Although *P. virginiae* was first described over 50 years ago (Wilcox 1957), we know almost nothing about the life history and habits of this species. This species was taken on several occasions and at several different locations at ASIS in May and June 2007, notably near Shell Road and the Life of the Dunes Trail. Several specimens of *Colaspis recurva* were collected on the Life of the Dunes Trail, two near the South 3rd Street sign. Again, host associations were not apparent. Like *Paria virginae*, this species distribution excusively includes coastal states. Some of the host associations of *C. recurva* include plants common to the coastal habitat, ie. *Baccharis* and *Myrica*. And again, although this species was described over 30 years ago (Blake 1974), we know little of its biology. Given this experience, ASIS offers an opportunity to study the biology of these two beetles.

Butterfly Survey: The barrier island environment of ASIS proved inhospitable for most butterfly species which occur on the nearby mainland. ASIS also lacks the more extensive broad leaf forests found at Chincoteague National Wildlife Refuge which further reduced the number of species that are resident on the Maryland side of the island. Many of the butterfly species on ASIS were dispersals, strays, or migrants.

Of the ones that are likely established on the island many were in such low numbers that they likely require constant immigration from the outside in order to maintain their presences (Table 6b).

Chincoteague National Wildlife Refuge has been actively surveying butterflies since 1997 (Appendix IV). Their list is currently much longer than the ASIS list. Their additional species are mostly additional southern strays or resident butterfly species which require extensive broad leaf forests (present in CNWR but virtually absent at ASIS).

A few species like the Common Buckeye (photos 163, 164 & 165), American Copper (photo 156), Common Wood-Nymph (photo 159), Little Wood-Satyr (photo 166), Least Skipper (photo 146) and Broadwing Skipper (photo 148) were well established and maintained a healthy population on the island during the three year study. It is not known how well these healthy populations would survive during a major century-level storm event. The Least Skipper is associated with the fresh water wetlands which are susceptible to storm events. The increase in phragmites on the island in the past few years has provided the Broadwing Skipper with a healthy food source. Since phragmites is susceptible to drowning if inundated with salt water its numbers and thus the Broadwing Skipper population will likely be severely impacted immediately after major storm events.

The Salt Marsh Skippers (photo 147), are specialized for survival in the salt marsh environment. They may be the only species of butterfly that truly is a long-term resident (can reliably survive century-level storm events) on the island.

Clouded Sulphers, Orange Sulphers (photo 142) and Cabbage butterflies (photos 142 & 143) were in significantly higher numbers in the spring of 2006 compared to 2005. However, they were small in size when compared to individuals from the mainland indicating that the larval populations were under stress. These species probably overwintered in 2005-2006 on the island (it was a mild fall and winter), but may have failed to do so the year before (2004-2005 winter).

In addition to the current resident species of butterflies most often encountered at ASIS, are the north moving dispersals found on the island during late summer and fall (Table 6b).

Assateague Island National Seashore played less of a role in the survival of the Monarch Butterfly (photos 160 & 161) than expected. Although, milkweed host plants are present in fair numbers on the island they were rarely utilized by the Monarchs. North moving migratory Monarchs utilized ASIS less than the adjacent mainland. South moving late season Monarchs utilized the island more so than the north moving Monarchs did, utilizing the nectar from the golden rod and other plants; however, not more and even possibly less than the adjacent mainland. Considering that other natural areas along the eastern sea board are being utilized by Monarch butterflies it is easy to speculate that the Ocean-City, highly-developed, barrier island just to the north of ASIS may be diverting Monarchs inland due to lack of nectar plants or for some other reason.

Bee Survey: The interest in native pollinators has grown over the past few years ever since the honey bee (*Apis mellifera*) population has been declining. The importance of native bees cannot be over emphasized due to their importance in pollination and thus on the structure of plant communities. ASIS is not an exception.

The honey bee once was a common sight at flowers on ASIS (personal communication with NPS personnel) and there is no doubt that wild colonies use to exist on the island. While the honey bee was never a long-term resident on the island, it still could re-establish after major storm events. This is no longer the case due to the introduction into North America in the 1980s of the tracheal and virola mites. Wild honey bee colonies are not only gone from the island, but also from most of the adjacent mainland. A single honey bee was recorded from the island during the three year survey. It was a well-worn individual found at the far southern end of ASIS and most likely came from a distant managed bee colony.

Native bee surveys are being undertaken across the United States. The limiting factor has been the ability to obtain reliable identifications of the specimens. It was only due to Sam Droege (USGS) that this survey could have been undertaken. As a result, ASIS is the first barrier island in the Mid-Atlantic to have a bee survey completed.

There was quite a contrast between the native bees on the island and those from the mainland. The following sand specialists were found: *Agapostemon splendens*, *Lasioglossum halophitum*, *L. lustans*, *L. nymphale*, *Heriades variolosus*, *Colletes thoracicus* and *Perdita octomaculata*. Even more restrictive in habitat were the dune/beach specialists that included *Colletes mitchelli* and *Lasioglossum marinum*. In the spring *L. nymphale* and *L. marinum* were among the 5 most abundant bees found on the island (Figure 9), while in the fall (Figure 10), *A. splendens*, *P. octomaculata* and *C. mitchelli* were among the top five species (Figure 10). Most telling is that the abundant *Colletes mitchelli*, *Lasioglossum lustans* and *Lasioglossum nymphale* were not known from Maryland until this survey, despite a good number of mainland Maryland bee surveys. *Lasioglossum marinum*, one of the two dune/beach specialists mentioned above has previously been taken only along a few Chesapeake Bay beaches (Sam Droege, 2008). Additional research is warranted to determine the habitat requirements and potential human impact due to beach recreation on these bee specialists.

Lasioglossum (Hemihalictus) *lustrans* is an interesting bee in that it is a specialist on *Pyrrhopappus carolinianus* (false dandelion) where it appears restricted to the plants range (Sam Droege, personal communication). Higgins et al, 1971, lists the false dandelion as rare on the island. Based on the numbers of this species encountered on the island, either the plant his increased in numbers since 1971 or the bee is utilizing other plant species.

Two additional new Maryland bee records were added during the survey. These were *Lasioglossum truncatum* and *Coelioxys dolichos*. The former was known from Virginia and Pennsylvania so it was really not a surprise. The latter is a nest parasite of the leaf cutting bee *Megachile xylocopoides* (photo 110). *Coelioxys dolichos* had never been collected north of North Carolina before this survey.

The genus *Colletes* was more strongly represented on the island than the mainland. The common fall species *Epeolus scutellaris* and *Epeolus pusillus* on the island are nest parasites of *Colletes* species (Figure 10).

Assateague Island National Seashore was missing large groups of spring forest/shrub species in the *Osmia*, *Nomada*, and *Andrena* genera that are present on the mainland. Eucerines (a subgroup of Apidae) were in general also lacking, likely due to the lack of a large or a diverse assemblage of fall composites. Another oddity was the absence of *Megachile brevis* which is a relatively common bee in dry sand on the mainland. Other interesting bees that appear to be missing from ASIS are *Bombus impatiens* and *Halictus confusus*. *Bombus impatiens* is by far the most common bumblebee on the mainland and *Halictus confusus* is also very common on the mainland. Additional questions are why *Perdita octomaculata* occurs on the island and not additional species of *Perdita* or why only *Hylaeus modestus* and not other species in the genus were found?

Very little is known about the natural history of any of the bees that occur on ASIS. It is clear that the native bee assemblage on the island is unique to Maryland and possibly the whole Mid-Atlantic region and deserves additional study.

Freshwater Pond Survey: The freshwater ponds were the most ephemeral major habitat on the island. Annual storms impacted many of the freshwater habitats enough to severely reduce or eliminate freshwater arthropods. During the study, even the most sheltered freshwater ponds also contained populations of brackish water arthropod species which would likely not be able to sustain themselves if the freshwater ponds were reasonably stable over a long period of time.

The freshwater ponds and pools of ASIS were always in flux and were so dynamic that even naming and delineating the majority of them was a challenge. The ponds would expand and merge together in wet weather and shrink and fragment in drier weather. There was also a constant interplay between the brackish water and fresh water in many of the low-lying areas on the island.

The greatest arthropod diversity at ASIS in the freshwater ponds was where a reasonably deep pond occurred at the edge of a secondary dune and a bush/tree habitat. These ponds had the best balance of short term protection from storm damage and exposure to sunlight. More stable ponds did occur in maritime forest but these were heavily shaded and accumulated a bottom layer of pine needles which restricted arthropod diversity.

No barrier island freshwater arthropod specialist was identified from the ponds during the study and it is likely that none exist. Freshwater ponds on ASIS are just too ephemeral and dynamic. However, freshwater arthropods as a whole, are great night-time dispersers. When blacklighting, a good percentage of the insects that came to the sheet were from freshwater habitats. Any spring or summer freshwater pond or pool more than a week or so old will be filled with these insects emigrating from the mainland or from other ponds on the island. In addition, these insects were so effective in dispersing that little difference in species assemblages could be found in ponds of similar depth and shading throughout the island.

Also, see the discussion on freshwater ponds under the Odonata Survey.

Salt Marsh Survey: Although tidal salt marshes along the eastern United States are a fairly recent geologic occurance, existing only in the past 3000-4000 years (Niering and Warren 1980), the tidal salt marsh plant community is the most stable plant community on the island.

Spartina alterniflora (Saltmarsh Cordgrass) dominates the salt marshes throughout the eastern shores of North American from the Gulf of St. Lawrence to the Gulf of Mexico. Maryland has a little less than 2% of the total *Spartina alterniflora* habitat in North America (Teal 1986). Saltmarsh Cordgrass is the most conspicuous plant present in the lower marsh, but at ASIS large accumulations of algae also occurr on the surface of the sediments in between and at the bases of the Saltmarsh Cordgrass. In some salt marshes the biomass of the algae is even greater than that of the Saltmarsh Cordgrass itself (Teal 1986). This was likely the case in some sections of the salt marsh at ASIS.

Furbish, Railey and Meininger (1994) pointed out that there are three factors that currently influence the salt marsh flora and fauna at ASIS. The first is the amplitude and duration of the tidal regimes, the second is the impact due to landform manipulations (the former artificial dune system and the Ocean City Inlet jetties) that have altered the islands natural geomorphological processes and third the grazing pressure from feral horses in the salt marsh. Recent analyses indicate that horse grazing removes as much as 45% of the above ground vegetation in some locations in the salt marsh above what is otherwise consumed (Zimmerman 2008). Considering the vast numbers of herbaceous insects found throughout the lower salt marsh, it is likely that insects consume in total far more cordgrass than the horses do.

While conducting the current salt marsh survey, it was observed that trampling from horses adds to the damage to the lower marsh. Saltmarsh Cordgrass is very susceptible to trampling (Teal 1986) which crushes the stems allowing seawater to enter the plants resulting in their death. In addition, well-used horse trails in the lower marsh may increase the tidal flow rate through their narrow corridors which may contribute to increased erosion of the marsh.

The salt marsh at ASIS is eroding all along the bay and in many locations has an abnormal drop-off depth from the salt-marsh edge into the bay (Zimmerman 2005). This is likely the result of multiple stressors on the ASIS marsh. Godfrey and Godfrey (1976) paper demonstrated that the most productive salt marshes were those that develop over recent overwashed sand fans. The thirty years that ASIS' artificial primary dune existed significantly blocked the overwashes on the island and is likely a major contributor to the current condition of the ASIS' salt marsh environment. Currently the best intact salt marshes at ASIS are at kilometers 23, 26-27, 28-29, 31 and 33 kilometer (Kumer 2006).

For arthropods, the lower marsh extremes in oxygen, temperature and salinity puts limits on which species can survive (Teal 1986; Olmstead and Fell 1974). As a result the diversity of arthropod species is reduced compared to other plant zones found on ASIS, but those species that do succeed in finding the salt marsh home can be found in huge numbers due to the lack of competition. Some feed directly on the cordgrass and other vascular plants, but most find a living feeding on the algae, bacteria and decaying vegetable and animal material. Although the arthropod predators may be the most conspicuous of the arthropods at ASIS, their numbers are far below that of the herbivores and scavengers. It has been shown that in some salt marshes the insects were more abundant in those parts of the marsh that had a higher nitrogen content than in locations where the nitrogen levels were lower (Teal 1986). However, I saw little difference in the species, or their numbers, at the various salt marsh locations surveyed during the ASIS study.

The 1994 paper of Dunson and Travis summarizes the connection between the abiotic and the biotic components in the salt marsh environment: "*The common occurrence of salt-marsh endemics in a species-poor environment must be related to the unusual character of this habitat, in which the reduced importance of some biotic forces is paired with highly stressful abiotic factors. The salt marsh is probably not a refuge for competitievely inferior forms so much as it is a highly selective environment that admits only those specialized species that can muster the necessary physiological adaptations*." This is the reason that of all the vegetative zones at ASIS the salt marsh had the largest number of unique species.

A previous survey of the salt marsh arthropods was undertaken by the National Park Service (Furbish, Railey and Meininger 1994) and although extensive collecting was done within the salt marsh, most all of the identifications were taken to the family level only. However, the specimens were available for examination as part of this study. The 1994 study identified diptera and hemiptera (homoptera/heteroptera) as the most abundant organisms in the salt marsh. Comparison of the specimens with the sweep net material collected during the current study did not show any significant differences in the arthropod assemblages in the salt marshes from 1994 to 2006.

Sweep netting as a stand-alone method for determining the arthropod species composition of the salt marsh does have a bias. Therefore, the current survey used a variety of collection methods beyond sweep netting and each method used gave different catch results. Bee traps were best for collembella, thrips and flies. Black lighting was best for corixids, chironomids and aquatic beetles. Visual inspection of the wrack and ground cover added more scuds, mites, spiders and crabs. It is clear that a full understanding of the salt marsh inhabitants will require multiple sampling methods.

Probably the most effective and informative way to sample the salt marsh is to use emergent traps. Unfortunately, this was not possible during this study because of the limited time restraints. MacKenzies (2002) emergent trap study in southern Maine revealed that the vegetated marsh surface was more productive in numbers of insects than was the small salt marsh pannes and that the most abundant taxa of insects coming from the vegetated and brackish water pannes were species of Chironomidae (midges), while Tipulidae (crane flies) dominated the emergent traps from saltwater pannes. Emergent trap studies of salt marshes in Canada showed that 85% of the catch were of flies (Diptera) and two-thirds of these were nematoceran flies, with most belonging to the families Chironomidae, Ceratopogonidae and Culicidae (Giberson, Bilyj, and Burgess 2001). Although no actual counts of numbers or biomass was attempted during the ASIS survey, there is no doubt that nematoceran flies are also a major component of the salt marshes at ASIS.

It needs to be pointed out that a small number of the arthropod species found in the current survey of the low marsh, were not really full-time salt marsh specialists. These were likely present because: 1) they only utilize the marsh during low tide and escape to higher ground during high tide or 2) they were present from the other habitats that were adjacent to the marsh and were chance accidentals to the low marsh environment.

In June and July no matter where the blacklight was set up on the island, even far from the salt marsh, it attracted thousands of dispersing individuals of the Tidal Marsh Water Boatman, *Trichocorixa verticalis* (photographs 60, 61). Their actual numbers on the island must be staggering. These insects occur in the open pannes in the salt marsh where they are active predators of chironomid larvae and oligochaetes. Density studies of this species were determined in salt water pannes in New Hampshire; where maximum density of around 27,000/m^2 were reached (Kelts 1979). Similar densities likely occur at ASIS.

There are a number of salt marsh insect specialists associated directly with Saltmarsh Cordgrass. In the northeastern salt marshes the major chewing herbivore of cordgrass is the Katydid *Conocephalus spartinae*

(Vince 1979) while in Georgia's salt marsh it is the Katydid *Orchelimum fidicinum* (Smalley 1960). Both are restricted to salt marshes. At ASIS the Katydid *Conocephalus spartinae* was found in good numbers but *Orchelimum fidicinum* was never found, despite ASIS being well within its population range (Carpinera, Scott and Walker 2004). The reason for this unexcepted failure to find *O. fidicinum* at ASIS is not known; either it is not present or its population numbers were below the 2006 detection level when the samples were taken.

The saltmarsh ground crickets, *Allonemobius sparsalus*, were also present in the lower salt marsh, but were very inconspicuous and not easily collected by sweep netting. These herbivore grazers probably play a larger role in the salt marsh than this study's sample numbers suggest. The saltmarsh ground cricket is listed as an important herbivorous grazer in Connecticut (Olmstead and Fell 1974), a role they likely play at ASIS.

The major sucking herbivore of Salt Marsh Cordgrass at ASIS was shared between the plant bug *Trigonotylus* sp.and the delphacid plant hopper *Prokelisia marginata*. This was consistent with other studies conducted in northeastern salt marshes (Vince 1979; Olmstead and Fell 1974; Teal and Teal 1969). *Prokelisia marginata* can be, in some New England salt marshes the most numerically dominant herbivorous insect sometimes reaching 10 times the biomass of the next competitor (Teal 1986). Denno (1980) found nine sap-feeding insects on *Spartina patens*, four on *S. alterniflora*, and eight on *Distichlis* spp. in Mid-Atlantic salt marshes.

Two species of stem-boring Picture-winged flies, *Chaetopsis aenea* and *Chaetopsis apicalis*, were common in the salt marshes at ASIS. The larvae of these diptera live within the stems of the *Spartina alterniflora* where they seek out and eat the terminal bud. This results in the death of the stem nearly 100% of the time. Other studies have shown that in areas of high infestation, 50% of the plants are killed (Grevstad 2005). Competition within the stem between larvae will result in one of the larva stabbing and killing the others (Stiling and Strong 1983). The other *Spartina alterniflora* stem-boring fly at ASIS was *Thripticus violaceous*. This fly is unusual because all other members of the family it belongs to (Dolichopodidae) are predators and not plant feeders.

One of the more conspicuous insects of the salt marsh from about mid-summer on was the brightly colored Ladybug Beetle, *Naemia seriata* (photograph 98). Both the adult and larvae feed on the abundant aphids of shrubs at the edge of the high marsh (photo 74), but when flower heads form on the *Spartina alterniflora* the adult beetle flies to the lower marsh to feed on the pollen. They need the pollen to increase their fat content before overwintering (Olmstead and Fell 1974).

The most conspicuous ant of the lower marsh is *Crematogaster laeviuscula* (photograph 124). This black ant with a heart-shaped abdomen, when living in the salt marsh, lives in the stems of *Spartina alterniflora* where it retreats at high tide. A specialized worker-cast is designed with heads that block the entrance thus keeping the water out. During low tide the ants emerge to move throughout the salt marsh (Teal and Teal 1964).

Wolf spiders, especially *Pardosa littoralis*, were widespread in the salt marsh. Previous studies by the University of Maryland have shown that the planthopper *Prokelisia marginata* is often their main prey. The concentration of wolf spiders decreases from the high to the lower marsh and often the spiders will retreat to higher ground when the tides inundate the habitat. However, this is only partially true since some of the spiders seek refuge by climbing the Cordgrass stems (Lewis and Denno 2000).

Marsh and Fiddler Crabs are small crabs that were seen in large numbers (most are fiddler) moving over the ground within the lower salt marsh. They stay in burrows during high tide and emerge to run along the surface of the marsh once the water has retreated. The marsh crabs graze to a large extent on saltwater cordgrass while the Fiddler Crabs are more ominivorous feeding on algae and dead plant and animal material (Olmstead and Fell 1974).

The two major factors that limited the current salt marsh arthropod survey were 1) not using emergent traps and 2) lacking good taxonomic expertise for the diptera (true flies) and spiders.

Impact of Mosquito Control on the Salt Marsh: ASIS is regularly pressured by outside interests to allow treatment of the island to control nuisance biting insects. There is surprisingly little information to determine whether species of particular conservation concern may be present; or what the impact of treatment would have on the health of the salt marshes or other island habitats.

Aedes sollicitans (photo 213) is the main concern. It can occur in extremely high numbers on the island to the level of being a serious nuisance to humans and other mammals. In addition, the species has been identified as a vector for Eastern equine encephalitis (EEE) which has occurred at ASIS in the past (Kumer 2006).

Aedes sollicitans and the other salt marsh mosquitoes do not utilize the lower marsh for their life cycle. *Aedes sollicitans* lays its eggs on the surface of wet exposed mud in the higher marsh (King et al 1960). Any mosquito eggs that were deposited in the lower marsh would be subjected to high predation at each high tide (Teal 1986). The eggs of the salt marsh mosquitoes develop right to the point of hatching then enter a resting stage until inundated by either a heavy rain or an extra high tide. In warm weather they can become adults in about one week.

A number of predatory arthropods feed on salt marsh mosquitoes, some in huge numbers on the island. The millions of adult and larva Seaside Dragonlets (*Erythrodiplax berenice*) consume vast numbers of mosquitoes (see the Odonata Survey in the Results section). However, when compared to other arthropod predators, it likely pales in comparison in the numbers of mosquitoes consumed.

The webs of *Mangora gibberosa* (photos 9 & 10) often cover the upper layer of grass stems in incredible numbers in the upper salt marsh. In the early morning when dew identifies the extent of the webs they seem to fill the marsh with their gossamer. The small spiders may be found either below the web's center or above it. When disturbed the small spiders race away from the web's center to the adjacent grass stems. Their webs contain large numbers of the remaining husks of nematocerns of which Chironomidae (midges) and Culcidae (mosquitoes) make up a high percentage. These spiders and their kin likely consume far greater numbers of adult mosquitoes than the Seaside Dragonlets.

Equal to spiders in eating mosquitoes are the abundant insect predators that are found in the marsh. Many of them are general predators while a few (e.g. larvae of the Anthomyid fly *Lispe*) specialize in hunting mosquitoes. The degree in which these arthropods play in reducing the mosquito population is not known, but likely significant.

The negative impact of aerial spraying for adult mosquitoes on non-target arthropods needs to be considered. Although some advances in chemical formulations have reduced the impact to non-target animals, the insecticides used are still general insecticides and thus should be expected to impact non-target insects.

There is little doubt that the nematocera fly families of Tipulidae, Chironomidae and Ceratopogonidae are the most common insects of the lower salt marshes at ASIS. It is important to realize that many of these nematoceran flies are important components of the salt marsh. It has been demonstrated that a major benefit of marsh invertebrates is in raising the nutritional value of the *Spartina* detritus which is eventually exported into the estuaries (Olmstead and Fell 1974) and that the salt marshes' ability to maintain and increase its substrate is tied to the health of the biotic processes within the marsh (Cahoon, et. al. 2006).

The health of the salt marshes at ASIS, in turn contribute to the overall health of the Sinepuxent and Chincoteague bays. Since nematoceran flies are the most abundant arthropods in the salt marshes at ASIS their importance to the overall functioning of the salt marsh ecosystem and the bay should be recognized. Since these taxa are closely related to mosquitoes in morphology and evolutionary history it is a reasonable assumption that their reduction from general mosquito adulticid applications could have serious impacts on the salt marsh ecosystem.

In the early 1990s, ASIS was treated for mosquitoes with the insecticide Naled (Kumer 2008). Naled is a contact and stomach acting organophosphate that is effective against a wide range of insect pests. Although Naled has been shown to be highly to moderately toxic to birds, fish and aquatic invertebrate species, labeled ULV formulations/concentrations used for adult mosquito control reduce the likelihood of acute death in vertebrates and aquatic invertebrates. Naled is often used in adult mosquito control ULV formulations since it is non-persistent breaking down reasonably quickly in sunshine, soil, and water (EXTOXNET 2008). All adult nematocera flies (including mosquitoes & non-target species) coming in contact with the Naled ULV treatments will likely demonstrate high mortality rates.

It is often claimed that the larger an organism the less likely it is to receive a fatal dosage during spray treatments. The logic is sound in that the larger the body mass is in relationship to its exposed surface area, the less chemical amount per unit weight of the organism is received. When working the extremes such as a bird or mouse compared to a mosquito the argument is sound. However, I would advise caution applying this idea to arthropods larger than mosquitoes. Dragonflies and damselflies in general do not have large body mass in relationship to their surface size. If you examine a Seaside Dragonlet, the largest of the insect predators that take significant numbers of mosquitoes, you can see that it has a narrow body design and has a considerable body surface in relation to its overall mass. Of even more concern is that current toxicity studies on insects almost always use acute mortality data. A dragonfly could very well be mortally damaged, unable to reproduce, or sterile and it would never be reflected in the toxicity studies. Unlike birds and mammals which quickly change many of the ULV formulated organophosphates (e.g. Malathion) into a polar compound that is easily excreted from the body in a few days; insects do not have this ability and thus are more susceptible to long term chronic damage than warm-blooded animals.

The most likely spraying for mosquitoes would take place in the late summer or fall for control of EEE (Kumer 2006). The flight period for the dragonlet would mostly be over by then or on the downswing. If this is the case then ULV spraying would have little effect on the dragonfly population. But this can not be said for the other more abundant arthropod predators or for the nematoceran flies which are vital to the stability of the salt marsh ecosystem.

It is the author's opinion that spraying for adult mosquitoes should only occur in the most extreme situations where a real threat to human heath has been identified. The simple presence of EEE or WNV on the island does not constitute justification for spraying the salt marshes.

The creation of mosquito ditches has altered the hydrology and functionality of the existing salt marshes and its effects on mosquito control have been minimal to the point of being useless. This action was based on the premise that draining the *Spartina alterniflora* habitat would reduce the standing water used by salt marsh mosquitoes. However, the ditches rarely reached the areas of the marsh most intensively used by mosquitoes and their impacts on the salt marsh hydrology have been long-lasting.

Macro-Arthropod Survey: The goal of this survey was to develop a photographic macro-arthropod field guide to be used at the ASIS Visitor Center. The photographic field guide is a separate and independent product from this report. However, there were a couple of interesting finds while conducting this survey that warrant inclusion in this report.

A number of interesting macro-moth records were added to the island. Although no comprehensive moth survey was conducted, the larger species that came to the blacklight were photographed and identified. One of the most interesting events occurred when a pair of Long-streaked Tussock Moths (*Leucanopsis longa*) (photo 198) came to the blacklight on June 16, 2006. This was a first record for this species in Maryland and turned out to be the most northern known record in existence. Another interesting find was *Drasteria graphica* (photo 188). This species is considered a rare moth for Maryland, but on ASIS it is one of the most common moths encountered during the day, throughout the island, from spring through fall, where it is often flushed from the open ground on secondary dunes especially where the dunes edge up against a brush/forest habitat.

A review of historical records of moths from ASIS uncovered a number of rare moths that historically occurred on the island. These include *Eumorpha achemon*, *Xylophanes tersa*, *Ommatostola lintneri*, *Anomis erosa*, *Melipotis jucunda*, *Schinia spinosae* and *Papaipema duovata* (Glaser 2007; Glaser, Stevenson and Ferguson 2007). In addition, a detailed survey of the moths of Chinoteague National Wildlife Refuge (see Appendix V) completed in 1998 uncovered an impressive number of moth species.

The presence of 164 Pink-spotted Hawkmoths (photos 178 & 179) on the ranger station building and adjacent shed on October 8, 2007 generated the most interest of any arthropod phenomenon that occurred on the island during the study. This pheonomon was short lived and by October 11th the numbers at the ranger station had dropped to around a dozen. The outdoor lights at the ranger station were drawing the moths in where they stayed thoughout the daylight hours. The reason that birds were not taking the large moths is that their host plant both for the larvae and for providing nectar for adults (photo 180) is Jimsonweed which is a strong poison/hallucinogen and is toxic to most animals. Park Rangers were sure that this gathering of Pink-spotted Hawkmoths had not occurred in previous years. Since the moth population is tied to the host plant, a reasonable assumption is that the increase in numbers of these conspicuous moths reflects an increase in the host plant or that this species of moth just recently established on the island and this was the first year they became numerous enough around the lights to be noticed. These outdoor lights are on all night. There is little doubt that they greatly alter the normal behavior of the Pink-spotted Hawkmoth and other nocturnal arthropod species.

A number of noteworthy wasps were also found on the island. The paper wasp *Polistes exclamans* (photo 118) is a new Maryland state record and is the most northern record known for this species. Another paper wasp *Polistes bellicosus* (photos 237 & 238), when found in 2006 on the island, was a new Maryland state record. Additional Maryland records were taken of this species in 2007 from a couple of locations from the mainland.

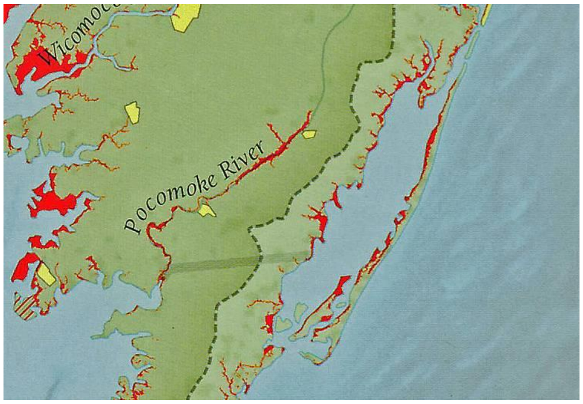
The potter wasp *Parancistrocerus histrio* (photo 117) from ASIS was the second record of this species taken from Maryland. The first record was from Port Republic. Its range is from Delaware southward and likely restricted to the coasts in Maryland and Delaware (Buck 2007). Another interesting potter wasp collected was *Stenodynerus histrionalis* that is known from southern NY to FL but is rarely collected (Buck 2007).

Strictia carolina (photos 121 & 122) is one of the most impressive wasps on the island and one that is often noticed since it is associated with the wild horses. This wasp which is known as the Horse Guard Wasp is often seen flying around the legs and under the bellies of the island's horses where it resembles the common mainland Cicada Killer Wasp. This species provisions its nests with horse flies including the giant *Tabanus atratus* (photos 216 & 217) that come in to feed on the horse's blood.

Throughout ASIS the most common trail seen in the sand away from the beach are the thin lines (photo 79) created by the ant lion larvae (Neuroptera:*Myrmeleon* sp.). The larva (photo 77) remains below the surface of the sand when it travels. Their sand traps (pits) are often placed in more protected areas in the sand (photo 78) and are less obvious than their trails. Adults (photos 80 & 81) are secretive and although common are rarely noticed.

Impact of Climate Change: Earlier studies of ASIS (summarized in Furbish, Railey and Meininger 1994 paper), identified two human-caused influences on the island's salt marshes; the first was landform manipulations (the artificial dune and the northern jetties) had altered the island's natural geomorphological processes and the second was the practice of maintaining a feral horse population that grazes predominantly on *Spartina*. There is little doubt that we can now, or will soon be able to, add climate change as a third man-made stressor which will have a negative impact on Assateague's salt marshes and probably the island's other vegetative zones as well.

The resource managers of the NPS have been tasked by the United States Government Accountability Office (GAO) to develop a strategy for addressing the effects of climate change (GAO 2007). It should be noted that at present we are in an interglacial period when sea level is rising and the coastline is subsiding (Vokes 1961). The rise of sea level is being compounded by climate change. The rates of salt marsh loss is accelerating on a global scale (Nicholls et al. 1999). Predictions of sea level rise specifically at ASIS shows that the western section of the barrier island (salt marshes) will be significantly impacted (Map 1).



MAP 1: Climate Change and Sea Level Rise. Red is expected inundation data based on a 2.5 foot (.76 meter) average rise in sea level by 2100 (CBF 2007)

The ability of the salt marsh to keep up with sea level rise and the landward movement of the island is tied to the topography at the upper edge of the salt marsh and the health of the biotic processes within the marsh (Cahoon et al. 2006). Sea level has been rising somewhere between 1 and 3 mm per century over the past few thousand years. At this rate sediment accumulation within the salt marshes has kept pace with seal level rise and the islands movement towards the mainland (Teal 1986; Gutierrez et al. 2007). At ASIS wind transportation of sand accounts for 1/3 of the sediment input into the salt marshes whereas water transport from washovers accounts for the remaining 2/3 (Furbish, Railey and Meininger 1994).

Major storms can and do impact barrier islands (Cahoon 2006). Current studies indicate that a warming of the world's oceans will increase the strength of hurricanes in the Atlantic. Concenses has not been reached if it would actually increase the number of hurricanes formed. Tenberth (2007) suggest that would not while Saunders and Lea (2008) believe that a 0.5^{o} C increase in sea surface temperature will increase both hurricane frequency and activity by 40%.

Stronger storms (both hurricanes and Northeasters) have the potential to increase the magnitude and frequency of significant overwash events on the island. This has the potential to increase rates of sedimentation within the salt marshes (a good thing). Unfortunately if roll-over events increase too much, the ability of the marshes to recruit the newly formed land may not be able to keep pace (Gutierrez et al. 2007).

An increase in atmospheric carbon dioxide has been shown to increase the damage done to plants by chewing and sucking insects. This occurs because under rising CO_2 concentrations 1) leaves increase sugar production, 2) the stomata close on herbaceous and broadleaf plants thus heating them up internally and 3) the plant's ability to trigger chemical defenses against plant feeding insects is diminished making the plants more digestible and thus more attractive to the insects (DeLucia 2008). The environmental conditions of barrier islands already put stress on many of the terrestrial plants that live there and stressed plants are already more susceptible to insect damage. Additional stress from increases in CO_2 concentrations will further increase the plant's susceptibility to feeding insects and may eventually contribute to subtle changes within the plant communities at ASIS.

A precise prediction of what will occur from the Earth's accelerated warming on ASIS over the next few decades is not possible. For ASIS salt marshes, climate change is likely to exacerbate the already existing stresses that are degrading this ecosystem. The ability of the salt marsh to adjust to a rising sea level and the increase speed that the island moves landward will be tied (in part due to the health of its arthropod inhabitants) to whether the marshes can accumulate sediment fast enough to keep pace. The impact on the rest of the island is even more speculative except that stronger major weather events should be expected.

SUMMARY OF MANAGEMENT SUGGESTIONS AND POSSIBLE FUTURE RESEARCH PROJECTS

GENERAL MANAGEMENT SUGGESTIONS:

Continue the ongoing sand-bypassing program at the north end of the island to help maintain the island's overall geologic integrity.

Continue the current practice of reducing the wild horse populations to a level that does not impact the sustainability of the salt marsh environment.

Keep the all night lighting at the island's campgrounds and office buildings at a minimum to reduce the impact to night flying insects.

Continue to discourage mosquito control on the island unless a real human risk is demonstrated.

Continue the policy of letting natural forces dictate the formation and evolution of dunes in all areas outside of the Park's development zone.

ARTHROPOD RESEARCH SUGGESTIONS:

Encourage future arthropod surveys specifically on taxa that were not focused on in this report. Examples are terrestrial beetles, salt marsh flies, moths, wasps, ants and spiders.

Encourage natural history and ecological studies of the unique bee fauna of ASIS especially the barrier island specialists and determine if their populations are impacted from human-recreational use of the island.

Encourage natural history and ecological studies of the likely coastal obligate leaf beetles *Paria virginiae* and *Colaspis recurva* to determine their biology at ASIS.

Encourage ecological studies and directed surveys in the salt marshes at ASIS specifically to determine the role of arthropods in maintaining the integrity of the marsh. Such information is vital before one can compare the risks with the benefits involved in adult mosquito control.

The National Park Service should partner with the Maryland Department of Natural Resources Wildlife and Heritage Division in reviewing the species identified in this study for possible Maryland listing as new threatened or endangered species. Encourage additional natural history studies on these arthropods.

Encourage a one-year repeat of this project every ten years, or one year after a century level storm event occurs in order to further increase our understand of the dynamics of the island's arthropod assemblages.

All parks within the NPS, that contain extensive salt marshes, should jointly develop and implement a nation wide monitoring program to measure the impact of climate change (rising sea levels) versus the marshes (including the arthropods) ability to maintain the habitat.

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APPENDIXES:

APPENDIX I: Data Dictionary for the Project Database (Microsoft Excel Spreadsheet)

The data from this project is organized in a Microsoft Excel database (*Arthropod Database for ASIS 2005-2007 Study*) that contains multiple spreadsheets. Additional data beyond what is presented in this report can be found in the database.

The first spread sheet within the file, ***General Information***, contains all the arthropods identified during the study and from historical searches. Data fields, from left to right, are *Excel Number*, *Class*, *Order*, *Family*, *Genus*, *Species*, *Subspecies*, *English Name*, *Survey*, *Locations*, *Abundance*, *Voucher Reference*, *Dates Observed* (A=adults, L=larvae), *General Habitat*, *Food or Host* and *Additional Notes*. The *Voucher Reference* data field identifies if a voucher specimen or photograph was taken. If no specimen or photograph was taken then this field records it as *Seen* (not collected/photographed), or *Heard* (not collected/photographed) or *Discarded* (collected but not kept or photographed).

The second spread sheet, ***Specimens***, contains specific information on the voucher specimens collected and kept. Data fields from left to right are *Excel Number, Class, Order, Family*, *Genus*, *Species*, *English Name*, *Location*, *Collection Method* (slide, pinned, or envelope), *Date Collected*, *Collector*, and *Identification* (who made the final determination). Each entry represents either a single specimen or a series of specimens of the same species taken at the same location and time.

The third spread sheet, ***Photographs***, contains specific information on the voucher photographs taken. Data fields from left to right are *Excel Number*, *Photo Number* (a reference number that matches a photograph provided on CDs), *Class*, *Order, Family*, *Genus*, *Species*, *Stage* (adult, larvae, etc.) *English Name*, *Location*, *Date*, *Photographer* and *Identification* (who made it).

The fourth spread sheet, ***Location***, contains specific information on the locations identified under the *General Information*, *Specimens* and *Photograph* spread sheets. Data fields from left to right are *Site #* (the abbreviation used in the other spread sheets as a record of location), *Latitude*, *Longitude*, *Location* (verbal), *Habitat* (type) and additional *Notes*. Latitude and longitude are provided either as a point source, or when more appropriate, as a range. Point locations should be viewed as marking the general area and usually not an actual pin point location where the arthropod was found. There are a number of reasons for this such as varying changes in the size and shape of seasonal ponds or that blacklight captures often drew in insects far from their actual habitat. However, the main reason was logistical, it just was not possible to record pin point GPS readings when reporting the huge number of species and individuals encountered throughout the field day nor did it make sense to use a pin point GPS reading for an individual flying dragonfly/butterfly or for species that were ubiquitous and common throughout the island (e.g. salt marsh mosquitoes).

The fifth spread sheet, ***Source of Records*** provides a brief description of the survey sources used in putting together the *Survey* column contained under the *General Information* spread sheet.

The *General Information*, *Specimens* and *Photograph* spread sheets all contain, as their first column, a data field labeled *Excel Number*. The *Excel Number* refers to the taxonomic hierarchy down to the family level of arthropods as presented in the 7th Edition of *Borror and Delong's Introduction to the Study of Insects by Triplehorn and Johnson* (2005). This hierarchy represents the basic layout of the rows within the spread sheets. The scientific names under each family are then listed in alphabetical order. Since it is expected that the spread sheets will often be rearranged to facilitate the finding of information, the *Excel Number* was included so that the spread sheets can quickly be returned to their original taxonomic-based organization.

APPENDIX II: Odonata of Chincoteague National Wildlife Refuge (Identifications by Anne C. Chazal and Steven M. Roble; nomenclature follows Garrison [1991]; English names are those adopted by the Dragonfly Society of the Americas [1996])

Suborder Zygoptera (damselflies)

Family Lestidae (spreadwings)

Lestes australis Walker	Common Spreadwing
Lestes rectangularis Say	Slender Spreadwing

Family Coenagrionidae (pond damsels)

Enallagma civile (Hagen)	Familiar Bluet
Enallagma geminatum Kellicott	Skimming Bluet
Ischnura hastata (Say)	Citrine Forktail
Ischnura posita posita (Hagen)	Fragile Forktail
Ischnura ramburii (Selys)	Rambur's Forktail

Suborder Anisoptera (dragonflies)

Family Aeshnidae (darners)

Anax junius (Drury)	Common Green Darner
Epiaeschna heros (Fabricius)	Swamp Darner

Family Libellulidae (skimmers)

Erythemis simplicicollis (Say)	Eastern Pondhawk
Erythrodiplax berenice (Drury)	Seaside Dragonlet
Libellula axilena Westwood	Bar-winged Skimmer
Libellula lydia Drury	Common Whitetail
Libellula needhami Westfall	Needham's Skimmer
Libellula pulchella Drury	Twelve-spotted Skimmer
Libellula semifasciata Burmeister	Painted Skimmer
Libellula vibrans Fabricius	Great Blue Skimmer
Pachydiplax longipennis (Burmeister)	Blue Dasher
Pantala hymenaea (Say)	Spot-winged Glider
Perithemis tenera (Say)	Eastern Amberwing
Sympetrum ambiguum (Rambur)	Blue-faced Meadowhawk
Tramea carolina (Linnaeus)	Carolina Saddlebags
Tramea lacerata Hagen	Black Saddlebags

APPENDEX III: Leaf Beetles Recorded from Chincoteague National Wildlife Refuge

(Nine species in five subfamilies)
(Reference: J.F. Cavey insect collection)

Species	Subfamily	Species	Subfamily
Pachybrachis spumarius Suffrian	Cryptocephalinae	*Kuschelina gibbitarsa* (Say)	Galerucinae
Calligrapha bidenticola Brown	Chrysomelinae	*Strabala rufa rufa* (Illiger)	Galerucinae
Paria aterrima (Olivier)	Eumolpinae	*Baliosus nervosus* (Panzer)	Cassidinae
Colaspis favosa (L.)	Eumolpinae	*Sumitrosis anchoroides* (Schaeffer)	Cassidinae
Trirhabda bacharidis (Weber)	Galerucinae		

APPENDEX IV: **Butterflies and Skippers of Chincoteague National Wildlife Refuge**

Family Papilionidae (swallowtails)	
Black Swallowtail (*Papilio polyxenes*)	
Spicebush Swallowtail (*Papilio troilus*)	
Palamedes Swallowtail (*Papilio palamedes*)	
Eastern Tiger Swallowtail (*Papilio glaucus*)	3
Family Pieridae (sulphurs)	
Cabbage White (*Pieris rapae*)	
Falcate Orangetip (*Anthocharis midea*)	1
Clouded Sulphur (*Colias philodice*)	
Orange Sulphur (*Colias eurytheme*)	
Cloudless Sulphur (*Phoebis sennae*)	
Little Yellow (*Eurema lisa*)	3
Sleepy Orange (*Eurema nicippe*)	
Family Lycaenidae (gossamer wings)	
American Copper (*Lycaena phlaeas*)	
Gray Hairstreak (*Strymon melinus*)	
Eastern Tailed-Blue (*Everes comyntas*)	
Spring Azure (*Celastrina ladon*)	
Family Libytheidae (snouts)	
American Snout (*Libytheana carinenta*)	3 (one occurrence in 2000)
Family Nymphalidae (brushfoots)	
Gulf Fritillary (*Agraulis vanillae*)	3 (one occurrence in 2000)
Variegated Fritillary (*Euptoieta claudia*)	
Pearl Crescent (*Phyciodes tharos*)	
Question Mark (*Polygonia interrogationis*)	
Mourning Cloak (*Nymphalis antiopa*)	1, 3
American Lady (*Vanessa virginiensis*)	
Painted Lady (*Vanessa cardui*)	3
Red Admiral (*Vanessa atalanta*)	
Common Buckeye (*Junonia coenia*)	
Red-spotted Purple (*Limenitis arthemis astyanax*)	1,3
Viceroy (*Limenitis archippus*)	
Little Wood-Satyr (*Megisto cymela*)	
Common Wood-Nymph (*Cercyonis pegala*)	
Monarch (*Danaus plexippus*)	
Family Hesperiidae (skippers)	
Silver-spotted Skipper (*Epargyreus clarus*)	3
Horace's Duskywing (*Erynnis horatius*)	3
Long-tailed Skipper (*Urbanus proteus*)	3 (one occurrence in 2000)
Common Checkered-Skipper (*Pyrgus communis*)	
Clouded Skipper (*Lerema accius*)	
Least Skipper (*Ancyloxypha numitor*)	
Fiery Skipper (*Hylephila phyleus*)	
Peck's Skipper (*Polites peckius*)	
Little Glassywing (*Pompeius verna*)	
Sachem (*Atalopedes campestris*)	3
Aaron’s Skipper (*Poanes aaroni*)	2
Salt-marsh Skipper (*Panoquina panoquin*)	

Species not numbered were recorded during 1998 survey by Virginia Department of Conservation and Recreation, Division of Natural Heritage by Anne C. Chazal and Steven M. Roble. Those not seen in the 1998 survey are: 1 = specimen in Refuge insect collection. 2 = reported by Clark and Clark (1951). 3 = observed during 1997-2007 by Denise Gibbs, Chincoteague Monarch Monitoring Project.

APPENDIX V: Moths Documented from Chinoteague National Wildlife Refuge

(Information from 1998 collections by Anne Chazal and Steve Roble; identifications by J. C. Ludwig, S. M. Roble, and D. F. Schweitzer except as noted. Unpublished information please do not use without authors permission)

Family Tineidae

Acrolophus plumifrontella (Clem.)
Acrolophus sp.

Family Yponomeutidae

Atteva punctella (Cram.)

Family Limacodidae

Parasa indetermina (Bdv.)

Family Zygaenidae

Harrisina americana (Guer.) -- Refuge collection

Family Megalopygidae

Megalopyge opercularis (J. E. Sm.)

Family Pyralidae

Clydonopteron tecomae Riley
Desmia funeralis (Hbn.)
Diacme elealis (Wlk.)
Pyrausta bicoloralis (Gn.)
Ostrinia nubilalis (Hbn.)
Urola nivalis (Drury)

Family Thyrididae

Thyris sepulchralis Guer.-- Refuge collection

Family Geometridae

Antepione thisoaria (Gn.)
Besma quercivoraria (Gn.)
Costaconvexa centrostrigaria (Woll.)
Cyclophora myrtaria (Gn.)
Cyclophora packardi (Prout)
Digrammia continuata (Wlk.)
Digrammia gnophosaria (Gn.)
Euchlaena amoenaria (Gn.)
Euchlaena johnsonaria (Fitch)
Euchlaena obtusaria (Hbn.)
Eulithis diversilineata (Hbn.)
Eupithecia miserulata Grt.
Eupithecia peckorum Heitzman & Enns
Eusarca confusaria Hbn.
Eusarca fundaria (Gn.)
Eutrapela clemataria (J.E.Sm.)
Exelis pyrolaria Gn.
Glenoides texanaria (Hulst)
Hypagyrtis esther (Barnes)
Hypagyrtis unipunctata (Haw.)
Idaea demissaria (Hbn.)
Iridopsis larvaria (Gn.)
Itame pustularia (Gn.)
Macaria aemulataria Wlk.
Macaria bicolorata (F.)
Macaria minorata Pack.
Macaria transitaria Wlk.
Metarranthis homuraria (Grt.& Rob.)
Metarranthis sp. 1 (undescribed)
Nemoria sp.
Nepytia sp. near *pellucidaria* (Pack.)
Orthonama centrostrigaria (Woll.)
Orthonama obstipata (F.)
Pero zalissaria (Wlk.)
Pleuroprucha insulsaria (Gn.)
Prochoerodes lineola (Goeze)
Prochoerodes transversata (Dru.)
Semiothisa aemulataria (Wlk.)
Semiothisa transitaria (Wlk.)
Semiothisa continuata (Wlk.)
Scopula cacuminaria (Morr.)
Tacparia zalissaria Wlk.
Thysanopyga intractata (Wlk.)
Xanthotype urticaria Swett

Family Lasiocampidae

Artace cribraria (Ljungh)
Malacosoma americanum (F.)
Tolype notialis Franc.
Tolype velleda (Stoll)

Family Saturniidae

Actias luna (L.) -- Refuge collection
Anisota stigma (F.)
Antheraea polyphemus (Cram.)
Automeris io (F.)
Citheronia regalis (F.) -- Refuge collection
Citheronia sepulcralis Grt.&Rob.
Dryocampa rubicunda (F.)
Eacles imperialis (Dru.)

Family Sphingidae

Agrius cingulata (F.)
Darapsa myron (Cram.)—Refuge collection
Dryocampa rubicunda (F.)
Hemaris diffinis (Bdv.)
Lapara coniferarum (J. E. Sm.)
Lapara bombycoides Wlk.
Manduca quinquemaculata (Haw.)
Manduca sexta (L.)
Paonias excaecatus (J.E. Sm.)
Xylophanes tersa (L.)

Family Notodontidae

Datana drexelii Hy. Edw.
Datana ministra (Drury)
Heterocampa biundata Wlk.
Heterocampa obliqua Pack.
Heterocampa sp.
Hyperaeschra georgica (H.-S.)
Lochmaeus manteo Doubleday
Macrurocampa marthesia (Cram.)
Nadata gibbosa (J. E. Sm.)
Oligocentria lignicolor (Wlk.)
Schizura unicornis (J.E.Sm.)
Symmerista albifrons (J.E.Sm.) complex

Family Arctiidae

Apantesis phalerata (Harr.)
Cisseps fulvicollis (Hbn.)
Cisthene packardii (Grt.)
Cisthene plumbea Stretch
Crambidia lithosioides Dyar
Cycnia oregonensis (Stretch)
Cycnia tenera Hbn.
Ecpantheria scribonia (Stoll)
Grammia virgo (L.)
Halysidota tessellaris (J.E.Sm.)
Haploa clymene (Brown)
Haploa colona (Hbn.)
Haploa reversa Stretch
Holomelina aurantiaca (Hbn.)
Holomelina laeta (Guer.-Meneville)
Holomelina opella (Grt.)
Hyphantria cunea (Dru.)
Hypoprepia fucosa Hbn.
Pyrrharctia isabella (J.E.Sm.)
Spilosoma congrua Wlk.
Spilosoma virginica (F.)

Family Lymantriidae

Dasychira tephra Hbn.
Dasychira manto (Stkr.)
Orgyia sp.
Lymantria dispar (L.)--Refuge collection

Family Noctuidae

Ablemma brimleyana (Dyar)
Acronicta afflicta Grt.
Abagrotis alternata (Grt.)
Acronicta clarescens Gn.
Acronicta hasta Gn.
Acronicta lithospila Grt.
Acronicta longa Gn
Acronicta subochrea Grt.
Acronicta tritona (Hbn.)
Agrochola bicolorago (Gn.)
Agrotis gladiaria Morr.
Agrotis ipsilon (Hufn.)
Agrotis subterranea (F.)
Agrotis venerabilis Wlk.
Agrotis vetusta (Wlk.)
Alypia octomaculata (F.)--Refuge collection
Amphipyra pyramidoides Gn.
Anagrapha falcifera (Kby.)
Anicla illapsa (Wlk.)
Anicla infecta (Ochs.)
Anticarsia gemmatalis Hbn.
Amolita fessa Grt.
Amphipoea velata (Wlk.)
Anorthodes tarda (Gn.)
Apamea vulgaris (Grt.& Rob.)
Arugisa latiorella (Wlk.)
Azenia obtusa (H.-S.)
Balsa labecula (Grt.)
Balsa malana (Fitch)
Bellura densa (Wlk.)
Caenurgina crassiuscula (Haw.)
Caenurgina erechtea (Cram.)
Callopistria mollissima (Gn.)
Catocala amatrix (Hbn.)

Catocala ilia (Cram.)
Catocala grynea (Cram.)
Catocala muliercula Gn.
Chaetaglaea sericea (Morr.)
Chytonix palliatricula (Gn.)
Condica sutor (Gn.)
Cucullia convexipennis Grt.& Rob.
Deltote bellicula (Hbn.)
Drasteria graphica atlantica B.& McD.
Euagrotis illapsa (Wlk.)
Eudryas grata (F.)
Euxoa detersa (Wlk.)
Faronta diffusa (Wlk.)
Feltia geniculata (Grt.&Rob.)
Feltia subterranea (F.)
Helicoverpa zea (Boddie)
Hypena baltimoralis Gn.
Hypena scabra (F.)
Idia aemula Hbn.
Idia julia (B.& McD.)
Lacinipolia laudabilis (Gn.)
Leucania adjuta (Grt.)
Lithacodia bellicula Hbn.
Loxagrotis acclivis (Morr.)
Meropleon cosmion Dyar
Metaxaglaea semitaria Franc.
Mocis latipes (Gn.)
Mythimna unipuncta (Haw.)
Nephelodes minians Gn.
Orthodes crenulata (Btlr.)
Paectes abrostoloides (Gn.)
Pangrapta decoralis Hbn.
Papaipema baptisiae (Bird)
Papaipema speciosissima (Grt.& Rob.)
Peridroma saucia (Hbn.)
Phosphila miselioides (Gn.)
Platypena scabra (F.)
Polygrammate hebraeicum Hbn.
Pseudaletia unipuncta (Haw.)
Renia fraternalis Sm.
Schinia arcigera (Gn.)
Schinia trifascia Hbn.
Spodoptera exigua (Hbn.)
Spodoptera ornithogalli (Gn.)
Sunira bicolorago (Gn.)
Tetanolita mynesalis (Wlk.)
Tricholita signata (Wlk.)
Xestia badicollis (Grt.)
Xestia dolosa Franc.
Xestia youngii (Sm.)
Zale helata (Sm.)
Zale sp. 2 (undescribed)
Catocala gracilis Edw.
Catocala marmorata Edw.
Cerma cerintha (Tr.)
Chaetaglaea tremula (Harv.)
Condica confederata (Grt.)
Condica videns (Gn.)
Chytolita petrealis Grt.
Doryodes spadaria Gn.
Elaphria grata Hbn.
Eucoptocnemis fimbriaris (Gn.)
Eurois occulta (L.)
Fagitana littera (Gn.)
Faronta rubripennis (Grt.& Rob.)
Feltia herilis (Grt.)
Galgula partita Gn.
Homophoberia apicosa (Haw.)
Hypena manalis Wlk.
Hypsoropha hormos Hbn.
Idia americalis (Gn.)
Iodopepla u-album (Gn.)
Lesmone detrahens (Wlk.)
Leucania extincta flabilis (Grt.)
Lithacodia muscosula (Gn.)
Macrochilo orciferalis (Wlk.)
Metallata absumens (Wlk.)
Metaxaglaea violacea Schweitzer
Mocis texana (Morr.)
Nedra ramosula (Gn.)
Noctua pronuba (L.)
Orthodes majuscula H.-S.
Palthis asopialis (Gn.)
Panthea sp. near *furcilla* (Pack.)
Papaipema duovata (Bird)
Papaipema stenocelis (Dyar)
Phalaenostola larentioides Grt.
Phyprosopus callitrichoides Grt.
Platysenta sutor (Gn.)
Protolampra brunneicollis (Grt.)
Pseudoplusia includens (Wlk.)
Renia nemoralis B.&McD.
Schinia nubila (Stkr.)
Simyra insularis (H.-S.)
Spodoptera frugiperda (J.E.Sm.)
Stiriodes obtusa (H.-S.)
Sutyna privata teltowa (Sm.)
Thioptera nigrofimbria (Gn.)
Trichordestra legitima (Grt.)
Xestia dilucida (Morr.)
Xestia elimata (Gn.)
Zale lunata (Dru.)
Zale obliqua (Gn.)

APPENDIX VI: Summary of Bees collected from Chinoteague National Wildlife Refuge.
(June 30-July 2, 2006. Information taken from a report provided by Sam Droege, USGS Patuxent Wildlife Research Center.)

In Virginia, activities consisted of setting out sets of 5 florescent yellow, 5 florescent blue, and 5 white bowls 5 meters apart along the wildlife drive and the service road running north from the wildlife drive. At the terminus of the service road numerous bowls were placed in the dune and back dunes area. Two and one half hours of hand collecting occurred along the service road and the dune area on one day, where a lone patch of common milkweed, a large patch of a small yellow composite were particularly productive. Weather throughout was sunny and went into the low 90's.

Numbers of bees found in bowls were quite high, net collecting was brief and quite rich in Virginia wherever flowers could be found. When compared to John Ascher's list of published and unpublished records of Virginia bees 4 new state records were established (*Hylaeus ornatus*, *Lasioglossum creberrimum*, *Lasioglossum halophitum, Nomada vegana*). *H. ornatus, L. creberrimum, L. halophitum* are species associated with salt and brackish marshes. *L. nymphale* is a deep sand specialist. *Nomada. vegana* is very uncommon in the East and is at least partially associated with coastal barrier islands.

The summary of the results are listed in the Table below.

	Virginia		Virginia Total
Species	**Bowl**	**Net**	
*Agapostemon splendens**	315	9	324
Augochlora pura	3		3
Augochlorella aurata	129	86	215
Bombus bimaculatus	2		2
Bombus griseocollis	9	3	12
Bombus impatiens	2		2
Bombus unknown	1		1
Ceratina aurata		15	15
Ceratina calcarata	2	1	3
Ceratina calcarata/dupla		4	4
Ceratina dupla	1		1
Ceratina strenua	1	1	2
Coelioxys octodentata	1	9	10
*Epeolus lectoides**	3	1	4
Halictus poeyi/ligatus	63	29	92
*Heriades variolosus**		40	40
Hoplitis pilosifrons	1		1
Hylaeus modestus		1	1
Hylaeus ornatus		1	1[#]
Lasioglossum blue pilosum	1		1
Lasioglossum bruneri	24		24
Lasioglossum coreopsis	1		1
Lasioglossum creberrimum	26		26[#]
Lasioglossum fat *rohweri*	1		1
Lasioglossum fuscipenne	18		18
Lasioglossum halophitum	4		4[#]
Lasioglossum interesting	15		15
*Lasioglossum marinum**	127	4	131

Lasioglossum near *rohweri*	42		42
*Lasioglossum nymphale**	65		65
Lasioglossum oblongum	46	1	47
Lasioglossum obscurum	2		2
Lasioglossum pectorale		1	1
Lasioglossum pilosum	223	7	230
Lasioglossum rohweri	58		58
Lasioglossum tegulare	17	5	22
Lasioglossum unknown	7	1	8
Lasioglossum versatum	1		1
Lasioglossum zephyrum	1	1	2
Megachile brevis	2	1	3
Megachile mendica	7	6	13
*Megachile texana**	10	21	31
Megachile xylocopoides	3	3	6
Melissodes trinodus	1		1
*Nomada vegana**	1	1	2[#]
Osmia pumila	2		2
Sphecodes unknown	1	1	2
Nonbee Species			
Nonbee	140	15	155
Chrysidid wasp	1		1
*Oxybelus ermarginatum**	14		14
Grand Total	1394	228	1662

* Known or likely sand specialist
[#] New state record

Note that a number of these species are restricted to deep sandy soils and thus have very limited distributions in the East. With more regional collecting it will become clear as to what species are barrier island specialists (such as *L. marinum*) and what others occur in the scattered sand sites in these states.

Euodynerus "species G" an undescribed Vespidae was taken from Assateague Island on the Virginia side on May 25, 1983 by BJ & FC Thompson. This species is very rare in collections and occurs mostly in coastal areas from MA to FL (also WV) and west to east-central Texas (Buck, 2007)