Insects, Other Arthropods & Other Macroinvertebrates Observed on Fort Eustis: Understanding the Significance of Invertebrate Taxa on Military Missions

UPDATE #2:

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Insects, Other Arthropods & Other Macroinvertebrates Observed on Fort Eustis, Update #2

Executive Summary

1. General. Arthropods (as defined in section 4) represent more than 80% of all animal life. Insects comprise the majority of all arthropods encompassing over 70%. Furthermore, insects themselves constitute approximately 50% of all living organisms, including plants, algae, fungi, and microorganisms. Over 1 million insect species have been described to science and various sources suggest the actual number may approach 30 million. No other group of organisms demonstrate this extensiveness of speciation. Collectively, arthropods are found on all Continents and virtually all habitats. Their roles in natural communities are vast. These roles include pollination, decomposition of organic matter, seed dispersal, soil continuity, herbivory, predation of other organisms while serving as food for other predators, parasites of vertebrate and other invertebrate forms, and vectors of disease in humans, domestic animals, and wildlife. Comprehensively, this group directly and indirectly influence the structure and function of ecosystems. Such influences can be complex and can impact execution of military missions. Natural Resources and Integrated Pest Management Branch staff recognize the significance of this and acts accordingly.

2. Purpose. This Update provides continuing information following the original document first prepared 27 Dec 2018. The original document and the subsequent Updates are used to support preparation and execution required plans. Specifically, data from the original document was incorporated into the Integrated Natural Resources Management Plan (INRMP) that was approved 5 June 2019. The data from the first Update was incorporated into the Integrated Pest Management Plan (IPMP) that was approved 20 May 2020. Changes in invertebrate fauna can be dynamic and challenging to monitor yet annual efforts to collect data become incorporated into respective annual reviews of both the INRMP and IPMP. In order to execute these plans, we must know what our invertebrate fauna (especially arthropods) consists of.

3. Goal. The goal is to continuously document data on invertebrate fauna and prepare annual reports (Updates) that can be incorporated into INRMPS, IPMPs, and annual reviews. These documents guide the Branch on managing natural resources and execution of via Integrated Pest Management (IPM) program. The data places significant emphasis on whether or not a given arthropod species can have a negative impact on military missions. In some cases a given arthropod has wide-ranging negative effects while in other cases only under certain conditions. Consequently, this data helps identify pest conditions as well as natural functioning.

4. Content of the document. The document should NOT be considered too technical. It offers a explanation of entomology and taxonomy as well as defining several key terms (see sections 4 and 5). Note that many arthropods lack common names and scientific names are used. However, groups have been identified with common names where feasible. This is NOT a decision document but rather serves as documentation of data as well as to help educate the chain of command.

1. General. Invertebrate fauna represent a highly significant group of organisms in relation to ecosystem management at Joint Base Langley-Eustis (Eustis), Fort Eustis, Virginia. Arthropods represent the largest number of invertebrates and are characterized by having body segmentation, paired jointed legs and a chitinous exoskeleton. Insects constitute the largest number of arthropods and are characterized by having three body segments and three pairs of jointed legs.

2. Purpose of this document. The original document *Insects, Other Arthropods & Other Macroinvertebrates Observed on Fort Eustis* (Christensen, 2018) was completed 27 Dec 2018 and included as an appendix to the revised Integrated Pest Management Plan (IPMP) and the Integrated Natural Resources Management Plan (INRMP). The objective is to review and update this document annually. The first update (Update # 1) was generated 25 June 2020. This document represents the second update (Update #2). This update includes observations since the previous Update and consolidates that data with the previous inventory of primarily insect taxa but includes to a lesser extent other arthropods and other invertebrates. It serves as an information source for continued inventories and surveys, and surveillance plans, and continues to be included in IPMP annual reviews and Annual Integrated Natural Resources Management (INRMP) Review Summaries.

3. Methods and Data sources. This Update was prepared based on field surveys performed by CEIE staff and contractors, and an examination of other data as noted below.

A. An Inventory of Insect and Medically Important Arthropod Taxa at Joint Base Langley-Eustis, Fort Eustis, Virginia (Christensen, February 2014).

B. Forest Insect Survey at Joint Base Langley-Eustis, Fort Eustis, Virginia (A. Evans, Parsons, December 2015). An insect collection was generated and included by-catch species. These specimens were examined and included in this update.

C. Tick & Tick-Borne Disease Threat Assessment (USA Public Health Command and the College of William & Mary, 2007-2019 which includes bird and mammalian host surveys).

D. 2017 Mosquito Species Inventory (Christensen, 2017).

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E. Planning Level Surveys for Amphibians and Reptiles, Mammals, Birds, and Fish, As Well As Pest Insects and Invasive Plants at FE, Virginia in 2004-2005 (Versar, August 2006).

F. Data from previous Integrated Natural Resources Management Plans, Integrated Pest Management Plans and respective annual reviews.

G. Annual records/observations. The Natural Resources Manager/Installation Pest Management Coordinator (IPMC) collects and identifies arthropods based on visual encounters, collections from wildlife, specimens brought to CEIE, photographs submitted to CEIE, and sampling/trapping programs.

H. Integrated pest management reports.

I. Historical collections and photographs.

J. Cooperative Agricultural Pest Survey (CAPS) data (Virginia Polytechnic & State University/Insect ID Lab). This program began at Fort Eustis in 2007 with continuation through 2020. Information on insects collected is reported to CEIE by Virginia Polytechnic & State University.

K. Spider Inventory. In January 2020, the IPMC began examining sticky traps used by the BOS contractor to document spiders.

L. Inquiries from installation community. Occasionally, members of the installation community provide photographs or specimens to the Natural Resources & IPM Branch.

M. Tick & Tick-borne Pathogen Species Inventory (Christensen, 2019).

N. 2018 Mosquito Management Report (Christensen, 2019).

O. 2021 mosquito surveys performed by MEDDAC Department of Environmental Health.

P. Goose Island Arthropod Survey (Christensen & Mooring, 2016).

Q. Scouting (CEIE staff examine selected areas for specific arthropods).

R. Opportunistic observations.

4. Terminology. The following terms are defined:

Annelida. Refers to annelids which are worms characterized by body segmentation. This group includes examples such as earthworms and leeches.

Arachnid. Arachnids are a group of arthropods that include spiders, mites, ticks, scorpions and a few others that have the arthropod characteristics but have 4 pairs of legs at some point in their life cycles, typically have two body regions, and lack wings and antennae.

Arthropod. Most arthropods are macroinvertebrate animals characterized by having paired, jointed appendages; a chitinous exoskeleton, and defined segmented body regions (however, arthropods also include very tiny microscopic mites). Examples include spiders, crayfish, crabs, mites, ticks, centipedes, millipedes, and insects.

Chitin (Chitinous). Chitin is a polysaccharide (essentially a sugar) that contributes to the durability of the arthropod exoskeleton.

Crustacea. Refers to crustaceans which include various aquatic and marine forms such as crabs, lobsters, crayfish as well as various terrestrial isopods such as woodlice, pillbugs and sowbugs.

Entomology. The study of insects.

Fauna. Refers to the animal life occurring in a given area such as Fort Eustis. It includes all vertebrate and invertebrate animals.

Hematophagous. An organism that consumes vertebrate blood.

Insect. Insects are the largest group of arthropods characterized by having 3 pairs of legs, 3 body regions, wings in most and antennae.

Invertebrate. Refers to animals lacking a vertebral column. Typical examples include insects, spiders, crayfish, crabs, mites, centipedes, clams, barnacles, and worms. Collectively these organisms can be called invertebrate fauna that encompass over 90% of all animal life.

Macroinvertebrate. Macroinvertebrates are invertebrate animals that can be seen with the naked eye.

Mollusca. Refers to molluscs (or mollusks) which include snails, clams, oysters, and others.

Parasite. Any organism that feeds on or utilizes another organism (a host) to its advantage while at the affected organism's detriment. Mosquitoes, ticks, bot flies, and chigger mites are representatives of parasitic arthropods.

Parasitoid. Parasitoids are arthropods but primarily insects in the orders Hymenoptera (more typically wasps in this case) and Diptera (some true flies such as tachanid flies). These insects lay eggs on or inject into the body of a host arthropod where the immature stages consumes the host eventually leading to the host's death.

Pest. An organism that adversely affects military readiness, damages equipment and supplies, damages real property or serves as a vector of disease. An organism may be a pest regionally or locally but may or may not be a pest specific to the installation.

Phoresy (Phoretic). An association between two organisms (in this case different arthropods) by which one travels on the body of another as a means of transport.

Taxon (taxa, pl). Refers to individual species or any taxonomic group of organisms such as any of the taxonomic hierarchy noted below in section 5 – kingdom, phylum, class, order, family, genus or species.

Taxonomy. Taxonomy is the system of classifying organisms.

5. Overview of taxonomic hierarchy. Organisms are classified using the following basic taxonomic hierarchy:

Kingdom
  Phylum
    Class
      Order
        Family
          Genus
            Species

The basic taxonomic hierarchy groups are defined below.

Kingdom. There are several Kingdoms including Animalia (animals), Plantae (plants), Fungi, Archaebacteria, Eubacteria, and Protista (though variations in the literature or forums may exist). Our discussion here focuses on insects and similar organisms that are within the animal kingdom. Animals are multicellular organisms that ingest food in some manner and lack a cell wall.

Phylum (or Phyla in the plural form). Phyla further divide kingdoms based on certain characteristics. One example is Chordata which includes those animals having a form of spinal cord. We could deviate slightly from the basics by including the Subphylum Vertebrata which includes animals with segmented backbones (such as mammals, birds, reptiles and amphibians). Our discussion focuses on the Phylum Arthropoda. Members of this phylum are animals (arthropods) that are characterized by having bilateral symmetry, segmented bodies, an external exoskeleton and paired jointed legs.

Succeeding hierarchical groups then follow Class, Order, Family, Genus (plural form is genera) and then Species. These groups focus on common characteristics in each group. The further down the hierarchy, the more closely related organisms are. The scientific name for an organism is written as the genus and species with the first letter of the genus capitalized while the species name does not reflect capitalization. Genus could be thought of as a "generic" group and species could be thought of as the specific organism. The two words are italicized. For example, the scientific name for humans is written as *Homo sapiens*.

The common yellow garden spider is used as an example:

Kingdom:	Animalia (Animals)
Phylum:	Arthropoda (Arthropods)
Class:	Arachnida (arachnids)
Order:	Araneae (true spiders)
Family:	Araneidae (orb-weaving spiders)
Genus:	*Argiope*
Species:	*aurantia* (*Argiope aurantia*)

6. Summary of macroinvertebrate taxa documented on JBLE-E and Goose Island to date. Arthropods constitute the predominant group of invertebrates documented at JBLE-E. Indeed, arthropods constitute approximately 85% of all animal life. Insects (Class Insecta) represent the majority of all arthropods (over 70% are insects). The larger insect orders Coleoptera (beetles), Hymenoptera (bees, wasps, ants, hornets, and sawflies), Lepidoptera (butterflies, moths, skippers), and Diptera (true flies) remain as the largest documented orders on the installation. Additional members of other insect orders have been identified including Hemiptera (true bugs, cicadas, hoppers, aphids, and allies), Blattodea (cockroaches and termites) and several others. Goose Island is a small land mass immediately adjacent to JBLE-E. It is currently managed by Virginia Department of Wildlife Resources.

7. Invertebrate inventories.

A. Consolidated Arthropod Inventory Categories as of 30 November 2021 (Phylum Arthropoda is represented in A(1) – (7).

(1) Class Insecta (Insects) at Fort Eustis.

Orders (18)	Families	Genera	Species
Blattodea (Cockroaches & Termites)	4	5	4
Coleoptera (Beetles)	72	313	365
Dermaptera (Earwigs)	2	2	2
Diptera (True Flies)	20	27	47
Ephemeroptera (Mayflies)	1		
Hemiptera (True Bugs, Cicadas, Hoppers, Aphids & Allies)	18	27	29
Hymenoptera (Bees, Wasps, Hornets, Sawflies & Ants)	25	39	38
Lepidoptera (Butterflies, Moths & Skippers)	19	84	93
Mantodea (Mantids)	1	1	1
Mecoptera (Scorpionflies, Hangingflies & Allies)	1		
Megaloptera (Alderflies, Dobsonflies & Fishflies)	2	1	0
Microcoryphia (Bristletails)	1		
Neuroptera (Antlions, Owlflies, Lacewings & Mantidflies)	5	2	1
Odonata (Dragonflies & Damselflies)	5	5	2
Orthoptera (Grasshoppers, Katydids & Crickets)	5	8	3
Phasmida (Stick Insects)	1		
Psocodea (Barklice, Booklice & Parasitic Lice)	1	1	1
Trichoptera (Caddisflies)			
	183	513	584

(2) Class Insecta (Insects) at Goose Island.

Orders (7)	Families	Genera	Species
Coleoptera	8	14	13
Diptera	3	4	3
Lepidoptera	4	7	5
Hemiptera	6	6	5
Hymenoptera	4	3	2
Orthoptera	3	6	5
Mantidae			
	28	40	33

(3) Class Arachnida (Arachnids) at Fort Eustis.

Orders (6)	Families	Genera	Species
Aranae (Spiders)	14	21	17
Mesostigmata (Mites)	2	2	2
Trombidiformes (Mites)	2	3	
Ixodida (Ticks)	1	4	8
Opiliones (Harvestmen, daddy longlegs)	1	1	
Pseudoscorpiones (Pseudoscorpions)			
	20	31	27

(4) Class Arachnida (Arachnids) at Goose Island.

Orders (4)	Families	Genera	Species
Araneae	3	4	3
Ixodida			
Opiliones			
Pseudoscorpiones			

(5) Subphylum Crustacea/Class Malacostraca at Fort Eustis.

Orders	Families	Genera	Species
2	4	5	6

(6) Class Diplopoda (Millipedes) at Fort Eustis.

Orders	Families	Genera	Species
2	2	2	2

(7) Class Chilopoda (Centipedes) at Fort Eustis.

Orders	Families	Genera	Species
2	1	1	1

B. Phylum Mollusca is represented in B(1) and Phyla Annelida & Platyhelminthes are represented in B(2) & B(3), respectively.

(1) Phylum: Mollusca/Class: Bivalvia (Molluscs) at Fort Eustis.

Orders	Families	Genera	Species
1	1	2	2

(2) Phylum Annelida/Class: Clitellata (Segmented worms) at Fort Eustis.

Orders	Families	Genera	Species
2	2	1	1

(3) Phylum: Platyhelminthes (Flatworms)/Class: Rhabditophora at Fort Eustis.

Orders	Families	Genera	Species
1	1	1	1

8. Numbers of insects and other arthropods species posing issues. Tables 1 & 2 identify the number of species per order that reflect some given issue. The following abbreviations and respective definitions are reflected in the Tables 1 & 2 and subsequent sections:

B = Beneficial. Natural enemy of a pest or potential pest (plant or animal) that might affect missions. Definition does not include pollinators, generalist predators, or decomposers.
NB = Nuisance Biting or Stinging. Insects/other arthropods that bite humans or sting in defense to include those considered medically significant.
DV = Disease Vector. Capable of transmitting pathogens to humans, domestic animals, & wildlife.
NN = Non-Native. Introduced into the United States at some point. May or may not be invasive.
I = Invasive. Proliferates to create serious conditions affecting native fauna or habitat.
FP = Forest Pest. May have the potential to cause significant damage to trees/forest stands. This includes species that may vector disease pathogens to trees or other plants. Could affect training area quality, promote erosion, promote invasive vegetation growth, impact aesthetics, and impact recreational hunting.
OP = Other Pest. Creates undesirable conditions by means other than biting, stinging or forestry impacts.
WP = Wildlife Pest. Adversely affects the health of a given wildlife groups or species. Usually parasitic.
NE = Native to the area; considered an ecological component of the installation's natural system.
LDR = Federally/State Listed, Rare or Declining.
GI = Refers to taxa observed on Goose Island.
FE = Observed at Fort Eustis.

A. Table 1: Insects.

ORDER	B	NB	DV	NN	I	FP	OP	WP	LRD	NE	GI
Blattodea				3			2			1	
Coleoptera	11			31	9	14	7	1		352	17
Dermaptera				2							
Diptera	1	39	16	6	4		3	26		46	6
Ephemeroptera										1	
Hemiptera		3		3	1	3	3	1		28	12
Hymenoptera		5		5	2		1	1	2	34	4
Lepidoptera	3	2		1		3	1		2	92	11
Mantodea				1	1?						1
Mecoptera										?	
Megaloptera										1	
Microcoryphia										1	
Neuroptera										5	2
Odonata										6	
Orthoptera										8	6
Phasmida											
Psocodea		1									
Trichoptera											

B. Table 2: Other arthropods.

ORDER	B	NB	DV	NN	I	FP	OP	WP	NE	GI	Comments
Araneae		1							25	7	NB - Black widows. See section 12.B(4)
Pseudoscorpiones									X		Need more data.
Opiliones									X		Need more data.
Ixodida		7	6					8	4	1	Hard ticks.
Mesostigmata		1						2			E. fowl mite, mites from bats (no common name).
Trombidiformes		1							1		Chigger mite.
Polydesmida (Diplopoda)											Need more data.
Spirobolida (Diplopoda)									1		
Decapoda									6		
Isopoda									X		Need more data.
Scutigeromorpha	1			1							

X = Refers to presumably native species occurring on the installation.

Since no agriculture out lease occurs at Fort Eustis, insects noted as pests are primarily nuisance biting/stinging or disease vectors to humans, pets, working military dogs or wildlife; urban pests, forests pests or landscape plant pests.

9. Class Insecta (Insects) genera/species organized by family. Orders are highlighted in yellow. Families are underlined. Genera and species are italicized. Note that "?" refers to uncertainty on identification or role in a designated category, and "??" refers to uncertainty as to whether a taxon is native or cosmopolitan. Common names are retained for order and family level for the most part. Many species have several common names or none at all. Consequently, scientific names are used for the most part.

Order Coleoptera (Beetles).

Aderidae (Ant-like Leaf Beetles)
Zonantes subfasciatus (NE)(FE)

Alleculidae? (Comb-clawed Beetles)(FE)

Anthicidae (Antlike Flower Beetles)
Notoxus murinipennis (NE)(FE)

Anthribidae (Fungus Weevils)
Euparius marmoreus (NE)(FE)
Euparius paganus (NE)(FE)
Ormiscus (No known non-native species in US)

Archeocrypticidae (Cryptic Fungus Beetles)
(Presumably *Enneboeus caseyi* - only species locally -uncertain on specimen, NE)(FE)

Attelabidae (Leaf Rolling Weevils)
Pterocolus ovatus (NE)(FE)

Bostrichidae (Horned Powder-post Beetles)
Amphicerus bicaudatus (NE)(FE)
Prostephanus punctatus (NE)(FE)
Xylobiops basilaris (NE)(FE)

Brachyceridae (No common name groupings)
Lissorhoptrus lacustris (NE)(FE)
Notiodes cribricollis (NE)(FE)
Tanysphyrus lemnae (NE)(FE)

Brentidae (Primitive Weevils)
Arrhenodes minutus (NE)(FE)

Buprestidae (Metallic Wood-boring Beetles)
Acmaeodera ornata (NE)(FE)
Acmaeodera tubulus (NE)(FE)
Agrilus celti (NE)(FE)
Agrilus ruficollis (NE)(FE)
Brachys aerosus (NE)(FE)
Brachys aeruginosus (NE)(FE)
Brachys floricola (NE) (FE)
Buprestis apricans (NE) (FE)
Buprestis lineata? (NE) (FE)
Buprestis maculipennis (NE) (FE)
Buprestis rufipes (NE) (FE)
Chalcophora virginiensis (FE) (NE)(FP?)
Chrysobothris femorata (NE) (FE)
Chrysobothris orono (NE) (FE)
Dicerca juncea (NE, new state record when observed in 2015) (FE)
Dicerca lepida (NE) (FE)
Dicerca lurida (NE) (FE)
Dicerca obscura (NE) (FE)(GI)
Pachyschelus laevigatus (NE) (FE)
Paragrilus tenuis (NE) (FE)
Spectralia gracilipes (NE) (FE)
Taphrocerus howardi (NE) (FE)

Callirhipidae (Callirhipid Cedar Beetles)
Zenoa picea (NE) (FE)

Cantharidae (Soldier Beetles)
Atalantycha bilineata (NE) (FE)
Chauliognathus pensylvanicus (NE) (FE)
Discodon planicolle (NE) (FE)

Carabidae (Ground Beetles)
Acupalpus(FE)
Acupalpus pauperculus (NE) (FE)
Amara(FE)
Amphasia interstitialis (NE) (FE)
Anisodactylus nigerrimus (NE) (FE)
Bradycellus(FE)
Bradycellus badipennis (NE) (FE)
Calosoma(FE)
Calosoma scrutator (NE)(FE)

Calosoma wilcoxi (NE) (FE)
Cicindela sexguttata (NE)(FE)
Cicindela hirticollis (NE)(GI)
Cymindis limbata (NE)(FE)(GI)
Cymindis platicollis (NE)(FE)
Plochionus timidus (NE)(FE)
Stenolophus ochropezus (NE)(FE)
Tachyta (NE)(FE)

Cerambycidae (Long-horned Beetles)
Acanthocinus nodosus (NE)(FE)
Acanthocinus obsoletus (NE)(FE)
Aegomorphus morrisii (NE)(FE)
Anelaphus parallelus (NE) (FE)
Anelaphus villosus NE)(FE)
Arhopalus rusticus (?, ??)(FE)
Asemum(FE)
Asemum striatum (NE)(FE)
Astylopsis arcuata (NE)(FE)
Astylopsis sexguttata (NE)(FE)
Ataxia crypta (NE)(FE)
Cyrtophorus verrucosus (NE)(FE)
Eburia quadrigeminata (NE)(FE)
Elaphidion mucronatum (NE)(FE)
Elytrimitatrix undata (NE) (FE)
Enaphalodes atomarius (NE) (FE)
Enaphalodes rufulus (NE, potential FP)(FE)
Euderces pini (NE) (FE)
Eupogonius tomentosus (NE)(FE)
Gaurotes cyanipennis (NE)(FE)
Graphisurus fasciatus (NE)(FE)
Leptostylus asperatus (?, NE)(FE)
Mallodon dasystomus (NE, potential FP)(FE)
Molorchus bimaculatus (NE)(FE)
Monochamus carolinensis (NE, potential FP) (FE)(GI)
Monochamus titillator (? NE)(FE)
Neandra brunnea (NE)(FE)
Neoalosterna capitata (NE)(FE)
Neoclytus acuminatus (NE)(FE)
Neoclytus scutellaris (NE)(FE)
Oberea tripunctata (NE)(FE)
Orthosoma brunneum (NE)(FE)
Parelaphidion incertum (NE)(FE)

Phymatodes amoenus (NE)(FE)
Prionus imbricornis (NE)(FE)
Prionus laticollis (NE)(FE)
Prionus pocularis (NE)(FE)
Psenocerus supernotatus (NE) (FE)
Rhagium inquisitor (NN, FP, I?) (FE)
Smodicum cucujiforme (NE) (FE)
Sphenostethus taslei (NE) (FE)
Strangalia famelica (NE) (FE)
Strangalia luteicornis (NE) (FE)
Styloleptus biustus (??)(FE)
Tessaropa tenuipes (NE) (FE)
Typocerus acuticauda (NE) (FE)
Typocerus zebra (NE) (FE)
Urographis fasciatus (NE) (FE)
Xylotrechus colonus (NE) (FE)
Xylotrechus convergens (NE) (FE)
Xylotrechus sagittatus (NE) (FE)(GI)
Xylotrechus schaefferi (NE) (FE)

Cerophytidae (Rare Click Beetles)
Cerophytum pulsator (NE) (FE)

Chelonariidae (Turtle Beetles)
Chelonarium lecontei (NE) (FE)

Chrysomelidae (Leaf Beetles)
Altica chalybea (NE) (FE)
*Bruchidius villosus (*NN) (FE)
Capraita obsidiana (NE) (FE)
Demotina modesta (NN) (FE)
Donacia (??)(FE)
Exema elliptica (NE) (FE)
Kuschelina gibbitarsa (NE) (FE)
Labidomera clivicollis (NE) (FE)
Paria (NE) (FE)
Rhabdopterus (NE) (FE)

Ciidae (Minute Tree-fungus Beetles)
Cis fuscipes (NE) (FE)

Cleridae (Checkered Beetles)
Cymatodera undulata (NE, B) (FE)
Enoclerus(FE)
Enoclerus ichneumoneus (NE, B) (FE)
Enoclerus nigripes (NE, B) (FE)
Phyllobaenus corticinus (?, possible error: range is south TX to Guatemala) (FE)
Thanasimus dubius (NE, B) (FE)(GI)

Coccinellidae (Lady Beetles)
Chilocorus stigma (NE, B) (FE)
Cycloneda (NE, B) (FE)
Diomus amabilis (NE, B) (FE)
Harmonia axyridis (NN, OP, I?) (FE)
Hyperaspis binotata (NE, B) (FE)

Corylophidae (Minute Hooded Beetles)
Holopsis marginicollis (NE) (FE)

Cucujidae (Flat Bark Beetles)
Cucujus clavipes (NE) (FE)

Curculionidae (Snout & Bark Beetles)
Ambrosiodmus (FE)
Ambrosiodmus rubricollis or *A. obliquus* (rubricollis is NN, I? & potential FP) (FE)
Ambrosiodmus obliquus (??)(FE)
Ambrosiophilus atratus (NN) (FE)
Ampeloglypter ampelopsis (NE) (FE)
Anthonomus signatus (NE) (FE)
Apteromechus pumilus (NE, FP?) (FE)
Apteromechus ferratus (NE) (FE)
Auleutes tenuipes (NE) (FE)
Carphoborus bicornus (NE)(FE)
Cnesinus strigicollis (NE) (FE)
Cnestus mutilatus (NN) (FE)
Conotrachelus anaglypticus (NE) (FE)
Conotrachelus juglandis (NE) (FE)
Conotrachelus naso (NE) (FE)
Conotrachelus posticatus (NE) (FE)
Cophes obtentus (NE) (FE)
Cossonus impressifrons (NE) (FE)
Curculio (NE) (FE)
Cyclorhipidion bodoanum (NN) (FE)
Cylindrocopturus nanulus (NE) (FE)

Cryptorhynchus fuscatus (NE) (FE)
Cyrtepistomus castaneus (NN, OP?) (FE)(GI)
Dendroctonus terebrans (NE potential FP) (FE)
Dryophthorus americanus (NE) (FE)
Dryoxylon onoharaensis (NN) (FE)
Eubulus bisignatus (NE) (FE)
Eubulus obliquefasciatus (NE)(FE)
Euplatypus compositus (NE)(FE)
Euwallacea validus (NN, I?, potential FP) (FE)
Geraeus picumnus (NE) (FE)
Glyptobaris lecontei (NE) (FE)
Gnathotrichus materiarius (NE) (FE)
Hylastes opacus (NN) (FE)
Hylastes porculus (NE) (FE)
Hylastes salebrosus (NE) (FE)
Hylastes tenuis (NE) (FE)
Hylesinus aculeatus (NE) (FE)
Hylesinus fasciatus (NE) (FE)
Hylobius pales (NE potential FP) (FE)(GI)
Hylocurus langstoni (NE) (FE)
Hylurgops pinifex (NE) (FE)
Hylurgops salebrosus (NE) (FE)
Hypothenemus (NN?) (FE)
Ips avulsus (NE, potential FP) (FE)
Ips grandicollis (NE, potential FP) (FE)
Lechriops oculatus (NE) (FE)
Listronotus sparsus (NE) (FE)
Madarellus undulates (NE) (FE)
Microhyus setiger (NE) (FE)
Monarthrum fasciatum (NE) (FE)
Myoplatypus flavicornis (NE) (FE)
Naupactus cervinus (NN) (FE)
Nicentrus lecontei (NE) (FE)
Odontocorynus calcarifer (NE) (FE)
Oedophrys hilleri (*Pseudoedophrys hilleri*)(NN) (FE)
Orchestomerus marionis (NE) (FE)
Orthotomicus caelatus (NE) (FE)
Otiorhynchus sulcatus (NN) (FE)
Oxoplatypus quadridentatus (NE) (FE)
Pachylobius picivorus (NE, potential FP) (FE)
Pandeleteius hilaris (NE) (FE)
Perigaster cretura (NE) (FE)
Perigaster obscura (NE) (FE)
Phloeosinus (NN?)

Phloeotribus (NE) (FE)
Phloeotribus frontalis (NE) (FE)
Pissodes (NE) (FE)
Pissodes nemorensis (NE, potential FP) (FE)
Pissodes strobi (NE, potential FP) (FE)
Pityogenes meridianus (?, NE)
Pityophthorus (?)(FE)
Pseudopityophthorus minutissimus (NE) (FE)
Pseudothysanoes lecontei (NE) (FE)
Rhynchus apiculatus (NE) (FE)
Rhyncolus discors (NE) (FE)
Stenoscelis andersoni (?)(FE)
Stenoscelis brevis (NE) (FE)
Tachygonus lecontei (NE) (FE)
Tychius meliloti (NN) (FE)
Thysanoes (NE) (FE)
Xyleborinus saxesenii (NN, potential FP, I?) (FE)
Xyleborus (FE)
Xyleborus celsus (NE) (FE)
Xyleborus ferrugineus (NE) (FE)
Xyleborus pfeili (NN)(I?)(FP?)
Xyleborus pubescens (NE) (FE)
Xylosandrus crassiusculus (NN) (FE)
Xylosandrus germanus (NN, potential FP, I?) (FE)
Xylosandrus crassiusculus (NN, potential FP?, I?) (FE)

Cryptophagidae (Silken Fungus Beetles)
Cryptophagus maybe (NN) (FE)

Dermestidae (Carpet Beetles)
Anthrenus pimpinellae (OP, Cosmopolitan) (FE)
Cryptorhopalum (NE) (FE)
Dermestes ater (NN) (FE)

Disteniidae (may now be a subfamily under Cerambycidae) (FE)

Dytiscidae (Predaceous Diving Beetles)
Copelatus glyphicus (NE) (FE)
Dytiscus (NE) (FE)

Elateridae (Click Beetles)
Alaus myops (B?, NE) (FE)
Alaus oculatus (B?, NE) (FE)
Ampedus areolatus (NE) (FE)

Ampedus collaris (NE) (FE)
Ampedus linteus (NE) (FE)
Ampedus nigricollis (NE) (FE)
Conoderus lividus (NE) (FE)
Dolerosomus silaceus (NE) (FE)
Lacon (NE) (FE)
Lacon discoideus (NE) (FE)
Limonius (*Gambrinus*) *griseus* (NE) (FE)
Orthostethus infuscatus (NE) (FE)(GI)

Elmidae (Riffle Beetles)
Stenelmis (NE) (FE)

Endomychidae (Handsome Fungus Beetles)
Mycetina perpulchra (NE) (FE)
Rhanidea unicolor (NE) (FE)

Erotylidae (Pleasing Fungus Beetles)
Ischyrus quadripunctatus (NE) (FE)
Toramus pulchellus (NE) (FE)
Triplax festiva (NE) (FE)
Triplax flavicollis (NE) (FE)
Triplax thoracica (NE) (FE)
Tritoma unicolor (NE) (FE)

Eucinetidae? (Plate-thigh Beetles) (NE) (FE)

Eucnemidae (False Click Beetles)
Isorhipis (NE) (FE)
Microrhagus (NE) (FE)

Geotrupidae (Earth-Boring Scarab Beetles)
Bolbocerosoma farctum (NE) (FE)

Haliplidae (Crawling Water Beetles)
Peltodytes (NE) (FE)

Heteroceridae (Variegated Mud-loving Beetles)
Tropicus pusillus (NE) (FE)

Histeridae (Clown Beetles)
Platysoma aurelianum (NE) (FE)
Platysoma leconti (NE) (FE)

Hybosoridae (Scavenger Scarab Beetles)
Hybosorus illigeri (NN) (FE)
Germarostes globosus (NE) (FE)

Hydraenidae (Minute Moss Beetles)
Hydraena (NE) (FE)

Hydrophilidae (Water Scavenger Beetles)
Enochrus ochraceus (NE) (FE)

Laemophloeidae (Lined Flat Bark Beetles)
Charaphloeus convexulus (NE) (FE)

Lampyridae (Fireflies)
Ellychnia corrusca (NE) (FE)
Photinus (NE) (FE)

Latridiidae (Minute Brown Scavenger Beetles)
Corticaria (??)(FE)
Corticarina cavicollis (NE) (FE)
Cortinicara gibbosa (NN) (FE)
Enicmus maculatus (NE) (FE)
Melanophthalma (NE) (FE)

Leiodidae (Round Fungus Beetles)
Agathidium (NE) (FE)
Catops basilaris (??)(FE)

Lucanidae (Stag Beetles)
Platycerus virescens (*Platycerus quercus*)(NE) (FE)

Lycidae (Net-winged Beetles)
Eropterus (NE) (FE)

Lymexylidae (Ship-timber Beetles)
Melittomma sericeum (NE) (FE)

Melandryidae (False Darkling Beetles)
Dircaea liturata (NE) (FE)
Melandrya striata (NE) (FE)

Melyridae (Soft-winged Flower Beetles)
Hypebaeus oblitus (??)(FE)

Meloidae (Blister Beetles)
Epicauta funebris (NE) (FE)
Epicauta vittata (NE) (FE)
Lytta aenea (NE) (FE)
Lytta polita (NE) (FE)
Meloe (NE) (FE)

Monotomidae (Root-eating Beetles)
Rhizophagus (??)(FE)

Mordellidae (Tumbling Flower Beetles)
Falsomordellistena hebraica (NE) (FE)
Mordellaria serval (NE) (FE)
Mordellina ancilla (NE) (FE)
Mordellistena liturata (NE) (FE)
Mordellistena testacea (NE) (FE)
Mordellistena trifasciata (NE) (FE)
Mordellochroa scapularis (NE) (FE)
Tomoxia lineella (??)(FE)

Nitidulidae (Sap-feeding Beetles)
Aethina tumida (NN, WP, I?) (FE)
Amphicrossus ciliatus (NE) (FE)
Carpophilus sayi (NE, potential FP) (FE)
Colopterus maculatus (NE) (FE)
Colopterus unicolor (NE) (FE)
Cryptarcha ampla (NE) (FE)
Cryptarcha strigatula (NE) (FE)
Epuraea peltoides (NE) (FE)
Glischrochilus obtusus (NE) (FE)
Lobiopa undulata (NE) (FE)
Prometopia sexmaculata (NE) (FE)
Stelidota (NE) (FE)

Oedemeridae (False Blister Beetles)
Oxycopis suturalis (NE) (FE)
Oxycopis thoracica (NE) (FE)

Passalidae (Bess Beetles)
Odontotaenius disjunctus (NE) (FE)

Phalacridae (Shining Flower Beetles)
Stilbus (NE) (FE)

Ptilodactylidae (Toe-winged Beetles)
Anchytarsus bicolor (NE) (FE)
Ptilodactyla (NE) (FE)

Ptinidae (Death-watch and Spider Beetles)
Caenocara (NE) (FE)
Ptinus bimaculatus (NE) (FE)
Ptinus ? *ruficornis*? (??)(FE)

Pyrochroidae (Fire-Colored Beetles)
Neopyrochroa femoralis (NE) (FE)

Rhysodidae (Wrinkled Bark Beetles)
Omoglymmius americanus (NE) (FE)

Scarabaeidae (Scarab Beetles)
Anomala binotata (FE) (NE)
Ataenius (NE) (FE)
Ataenius imbricatus (NE) (FE)
Ataenius spretulus (NE, OP) (FE)
Calamosternus granarius (*Aphodius granarius*) (NE, ?) (FE)
Callistethus marginatus (NE) (FE)
Canthon (NE) (FE)
Canthon pilularius (NE) (FE)
Copris minutus (NE) (FE)(GI)
Cotinus nitida (NE, potential OP) (FE)
Cyclocephala borealis (NE) (FE)
Deltochilum gibbosum (NE) (FE)
Dichotomius carolinus (NE) (FE)
Diplotaxis liberta (NE) (FE)
Dyscinetus morator (NE) (FE)
Dynastes tityus (NE) (FE)
Euetheola humilis (?, ??) (FE)
Euphoria herbacea (NE) (FE)
Euphoria sepulcralis (NE) (FE)
Gnorimella maculosa (NE) (FE)
Hoplia trivialis (NE) (FE)
Macrodactylus angustatus (NE)
Maladera castanea (NN) (FE)
Onthophagus hecate (NE) (FE)
Onthophagus pennsylvanicus (NE) (FE)
Onthophagus subaeneus (NE) (FE)
Pelidnota punctata (NE) (FE)

Phanaeus vindex (NE) (FE)
Phileurus truncatu (NE) (FE)
Phyllophaga (FE)(GI)
Phyllophaga anxia (NE) (FE)
Phyllophaga ephilida (NE, OP? = turfgrass?) (FE)
Phyllophaga fraterna (??)(FE)
Phyllophaga fusca (NE) (FE)
Phyllophaga hirsute (?, ??) (FE)
Phyllophaga marginalis (NE) (FE)
Phyllophaga micans (NE) (FE)
Phyllophaga quercus (NE) (FE)
Plectris aliena? (NN) (FE)
Popillia japonica (NN, OP, I) (FE)
Serica atracapilla (??)(FE)
Serica mystaca (NE) (FE)
Trigonopeltastes delta (NE) (FE)
Valgus (4 spp in US; 1 NN but uncertain for FE) (FE)(GI)
Valgus canaliculatus (NE) (FE)
Valgus seticollis (NE) (FE)
Xyloryctes jamaicensis (NE) (FE)

Scirtidae (Marsh Beetles)
Cyphon (*Cyphon* genus no longer used; genus changed to *Contacyphon*?) (??)(FE)

Silphidae (Carrion Beetles)
Necrodes surinamensis (NE) (FE)
Necrophila americana (NE) (FE)
Nicrophorus orbicollis (NE) (FE)
Nicrophorus tomentosus (NE) (FE)
Oiceoptoma inaequale (NE) (FE)
Oiceoptoma noveboracense (NE) (FE)

Sphindidae (Cryptic Slime Mold Beetles)
Sphindus americanus (NE) (FE)

Staphylinidae (Rove Beetles)
Arpedium (NE) (FE)
Asclera ruficollis (NE) (FE)
Creophilus maxillosus (??, 2 subspecies; 1 is NN) (FE)
Hesperus apicialis (?) NE) (FE)
Hesperus baltimorensis (GI)
Platydracus exulans (?), NE) (FE)
Sepedophilus (NE) (FE)

Sylvanidae (Silvanid Flat Bark Beetles)
Silvanus (?? 6 of 9 species are NN) (FE)

Synchroidae (Synchroa Bark Beetles)
Synchroa punctata (NE) (FE)

Tenebrionidae (Darkling Beetles)
Alobates pennsylvanica (*A. pensylvanicus*) (NE) (FE)
Centronopus calcaratus (NE) (FE)
Corticeus parallelus (NE) (FE)
Corticeus thoracicus (NE) (FE)
Helops aereus (*Nalassus aereus*) (NE) (FE)
Isomira pulla (NE) (FE)
Isomira sericea (NE) (FE)
Neomida bicornis (NE) (FE)
Pseudocistela amoena (*Chromatia amoena*) (NE) (FE)
Platydema excavatum (NE) (FE)
Platydema flavipes (NE) (FE)
Platydema ruficorne (NE) (FE)
Platydema subcostatum (NE) (FE)
Statira basalis (NE) (FE)
Statira gagatina (NE) (FE)
Tharsus seditiosus (*Metaclisa seditiosa*) (NE) (FE)
Uloma punctulata (NE) (FE)
Xylopinus saperdoides (NE) (FE)

Tetratomidae (Polypore Fungus Beetles)
Eustrophopsis bicolor (NE) (FE)
Eustrophus tomentosus (NE) (FE)
Penthe pimelia (NE) (FE)
Synstrophus repandus (NE) (FE)

Trogidae (Hide Beetles)
Trox (NE) (FE)

Trogossitidae (Bark-gnawing Beetles)
Corticotomus parallelus (NE) (FE)
Temnoscheila virescens (NE) (FE)(GI)
Tenebroides collaris (NE, B?) (FE)
Tenebroides corticalis (NE) (FE)
Tenebroides (FE)
Tenebroides laticollis (NE) (FE)

Zopheridae (Ironclad Beetles)
Aulonium parallelopipedum (NE) (FE)
Bitoma quadriguttata (NE) (FE)
Colydium lineola (NE) (FE)
Hyporhagus punctulatus (NE) (FE)
Microsicus parvulus (*Synchita parvula*) (NE) (FE)
Namunaria guttulata (NE) (FE)
Pycnomerus sulcicollis (NE) (FE)

Order Diptera (True flies).

Asilidae (Robber Flies)
Diogmites (NE) (FE)
Efferia (NE) (FE)
Promachus (NE) (FE)(GI)

Bibionidae (March Flies) (NE, species data lacking) (FE)

Bombyliidae (Bee Flies)
Bombylius major (NE) (FE)
Xenox tigrinus (B, NE) (FE)

Calliphoridae (Blow Flies).
Lucilia (NE) (FE)

Cecidomyiidae (Gall Midges and Wood Midges)
Polystepha pilulae (FE)
Taxodiomyia cupressi (GI)
Taxodiomyia cupressiananassa (GI)
Taxodiomyia taxodii (GI)

Ceratopogonidae (Biting Midges)
Culicoides (NE, NB, DV/WP) (FE)

Chironomidae (Midges) (NE) (FE)

Culicidae (Mosquitoes)
Aedes(FE)
Aedes albopictus (NN, I, NB, DV) (FE)
Aedes (*Ochlerotatus*) *c. canadensis* (??, NB, WP/parasitizes any vertebrate) (FE)
Aedes cinereus (NN?, NB, cosmopolitan) (FE)
Aedes hendersoni (*Ochlerotatus hendersoni*) (NE, NB, WP [mammals]) (FE)
Aedes infirmatus (NB, WP [general feeder] (FE)

Aedes j. japonicas (*Ochlerotatus japonicas*) (NN, I?, NB, DV, WP) (FE)
Aedes sollicitans (*Ochlerotatus sollicitans*) (NE, NB, DV) (FE)
Aedes taeniorhynchus (*Ochlerotatus taeniorhynchus*) (NE, NB, DV) (FE)
Aedes triseriatus (*Ochlerotatus triseriatus*) (NE, NB, DV, WP [squirrels]) (FE)
Aedes trivittatus? (*Ochlerotatus trivittatus*) (??, NB) (FE)
Aedes vexans (NB, DV, WP [mammalian hosts], cosmopolitan)(FE)
Anopheles (FE)
Anopheles quadrimaculatus (NE?, NB, DV) (FE)
Anopheles bradleyi? (member of *An. crucians* complex) (NE, NB) (FE)
Anopheles crucians (NB, NE?) (FE)
Anopheles punctipennis (NE?, NB, DV?) (FE)
Coquillettidia perturbans (Cosmopolitan, NB, DV) (FE)
Culex (FE)
Culex erraticus (NB, WP [birds]) (FE)
Culex nigripalpus (NB, DV, NN, I?) (FE)
Culex pipiens (NB, DV, WP [birds]) (FE)
Culex pipiens-quinquefasciatus (NB, DV, WP [birds], NN, I?) (FE)
Culex restuans (NE?, NB, DV) (FE)
Culex salinarius (NE?, NB, WP [birds and mammals]) (FE)
Culex territans (NE?, WP [amphibians and reptiles]) (FE)
Culiseta impatiens (??, NB) (FE)
Culiseta inornata (NE?, NB, DV?) (FE)
Orthopodomyia (FE)
Orthopodomyia signifera (NE?, NB, possible DV, WP [birds]) (FE)
Psorophora (FE)
Psorophora ciliata (NE?, NB, WP [mammals]) (FE)
Psorophora columbiae (NE?, NB, WP [mammals]) (FE)
Psorophora ferox (NE, NB, WP [mammals]) (FE)
Psorophora mathesoni? (NE?, NB) (FE)
Uranotaenia sapphirina (NE?, not a NB of humans, WP [amphibians and reptiles]) (FE)

Drosophilidae (Vinegar Flies)
Drosophila suzukii (NN) (FE)

Muscidae (House Flies & Kin)
Musca domestica (Cosmopolitan, DV, OP) (FE)

Mydidae (Mydas Flies)
Mydas clavatus? (Only species in eastern US?) (FE)

Oestridae (Bot Flies)
Cephenemyia phobifer (NE, WP [deer]) (FE)

Pyrgotidae (No common name grouping)
Pyrgota undata (NE) (FE)

Rhagionidae (Snipe Flies)
Chrysopilus thoracicus (NE) (FE)

Sarcophagidae (Flesh Flies) (NE) (FE)

Simuliidae (Black Flies) (NE, data source?) (FE)

Syrphidae (Syrphid Flies)
Mallota (NE) (FE)
Meromacrus (NE) (*M. acutus*?) (FE)

Tabanidae (Horse, Yellow and Deer Flies) (FE)
Chrysops (NE, NB, DV?, WP) (FE)
Chrysops dimmocki (NE, NB, DV?, WP) (FE)
Diachlorus ferrugatus (NE NB, WP) (FE)
Tabanus (NE, NB, WP) (FE)(GI)
Tabanus atratus? (NE, NB, DV, WP) (FE)
Tabanus fusciocostatus (NB? DV?) (FE)
Tabanus lineola (NE, NB, WP) (FE)
Tabanus nigrovittatus (NE, NB?, WP?) (FE)
Tabanus stygius (NE, NB?, WP?) (FE)
Tabanus sulcifrons (NE, NB?, WP?) (FE)

Tachinidae (Parasitic Flies)(NE, species data lacking) (FE)

Tipulidae (Large Crane Flies)(NE, species data lacking) (FE)
Tipula (GI)

Therevidae (Stiletto Flies)(NE, species data lacking) (FE)

Order Blattodea (Cockroaches and termites).

Blaberidae
Panchlora nivea (NN) (FE)

Blattidae
Eurycotis (??) (FE)
Parcoblatta (NE) (FE)
Periplaneta americana (NN, Cosmopolitan, OP) (FE)
Periplaneta fuliginosa (OP) (FE)

Ectobiidae
Blattella germanica (NN, Cosmopolitan, OP) (FE)

Rhinotermitidae (?, Subterranean Termites, Cosmopolitan) (FE)

Order Lepidoptera (moths, butterflies and skippers).

Attevidae (Tropical Ermine Moths)
Atteva aurea (NE) (FE)

Crambidae (Crambid Snout Moths)
Desmia funeralis (NE) (FE)

Erebidae
Apantesis (GI)
Caenurgina erechtea (NE) (FE)
Catocala ilia (NE) (FE)
Estigmene acrea (?, NE) (FE)
Hyphantria cunea (NE, potential FP) (FE)(GI)
Pyrrharctia isabella (NE [woolly bear caterpillar]) (FE)

Geometridae (Geometrid Moths)
Ematurga amitaria (??)(FE)
Erannis tiliaria (NE) (FE)

Hesperiidae (Skippers)
Achalarus lyciades (NE) (FE)
Amblyscirtes vialis (NE) (FE)
Anatrytone logan (NE) (FE)
Ancyloxypha numitor (NE) (FE)
Atalopedes campestris (NE) (FE)
Epargyreus clarus (NE) (FE)
Erynnis horatius (NE) (FE)
Euphyes dion (??)(FE)
Euphyes vestris (NE) (FE)
Hylephila phyleus (NE) (FE)
Lerema accius (NE) (FE)
Nastra lherminier (NE) (FE)
Panoquina panoquin (NE) (FE)
Poanes viator (NE, B?) (FE)
Poanes yehl (NE) (FE)
Poanes zabulon (NE) (FE)
Polites origenes (NE) (FE)
Polites themistocles (??) (FE)

Pompeius verna (NE) (FE)
Pyrgus communis (NE) (FE)
Thorybes pylades (NE) (FE)
Wallengrenia egeremet (NE) (FE)
Wallengrenia otho (NE) (FE)

Lasiocampidae (Tent Caterpillar and Lappet Moths)
Malacosoma americana (NE, potential FP depending on conditions) (FE)
Malacosoma disstria (NE, potential FP depending on conditions) (FE)

Lycaenidae (Blues, Coppers, Hairstreaks, Harvesters)
Atlides halesus (NE, B?) (FE)
Calycopis cecrops (?, NE) (FE)
Celastrina ladon (NE) (FE)
Cupido comyntas (NE) (FE)
Feniseca tarquinius (NE, B?) (FE)
Plebejus (FE)(GI)
Satyrium calanus (NE) (FE)
Satyrium favonius (NE) (FE)
Satyrium kingi (NE, rare in SE US) (FE)
Satyrium liparops (NE) (FE)
Strymon melinus (NE) (FE)

Megalopygidae (Flannel Moths)
Megalopyge opercularis (NE, NB) (FE)

Noctuidae (Owlet Moths)
Autographa (NE) (FE)
Choephora fungorum (FE)(NE)
Trichoplusia ni (NE) (FE)

Notodontidae (Prominent Moths)
Heterocampa umbrata (NE)(FE)
Nadata gibbosa (NE) (FE)

Nymphalidae (Brush-footed Butterflies)
Asterocampa celtis (NE) (FE)
Cercyonis pegala (NE) (FE)(GI)
Chlosyne nycteis (NE) (FE)
Cyllopsis gemma (NE) (FE)
Danaus plexippus (NE) (FE)
Enodia anthedon (NE, now *Lethe anthedon*) (FE)
Euptoieta claudia (NE) (FE)
Hermeuptychia sosybius (NE) (FE)

Junonia coenia (NE) (FE)
Libytheana carinenta (NE) (FE)
Limenitis archippus (NE) (FE)
Limenitis arthemis astyanax (NE) (FE)
Megisto cymela (NE) (FE)
Nymphalis antiopa (NE, NB) (FE)
Phyciodes tharos (NE) (FE)
Polygonia comma (NE) (FE)
Polygonia interrogationis (NE) (FE)
Satyrodes appalachia (NE) (FE)
Speyeria cybele (NE) (FE)
Vanessa atalanta (NE) (FE)
Vanessa virginiensis (NE) (FE)

Papilionidae (Swallowtails & Parnassians)
Eurytides marcellus (NE) (FE)(GI)
Papilio glaucus (NE) (FE)(GI)
Papilio palamedes (NE) (FE)
Papilio polyxenes (NE) (FE)
Papilio troilus (NE) (FE)(GI)

Pieridae (Whites, Sulphurs, Yellows [butterflies])
Abaeis nicippe (NE) (FE)
Colias eurytheme (NE) (FE)
Phoebis sennae (NE) (FE)
Pieris rapae (NN) (FE)
Pyristia lisa (NE) (FE)

Psychidae (Bagworm Moths) (Actual species not identified; family is cosmopolitan, OP) (FP/OP)(FE)

Saturniidae (Giant Silkworm and Royal Moths)
Actias luna (NE) (FE)
Antheraea imperialis (?, NE) (FE)
Antheraea polyphemus (NE) (FE)
Anisota virginiensis (NE) (FE)
Callosamia (NE) (FE)
Dryocampa rubicunda (NE) (FE)
Eacles imperialis (NE) (FE)
Hyalophora cecropia (NE) (FE)

Sesiidae (Clearwing Moths)
Hymenoclea (??)(FE)

Sphingidae (Sphinx Moths)
Darapsa myron (NE) (FE)
Eumorpha pandorus (NE) (FE)
Hemaris diffinis (NE) (FE)
Lapara coniferarum (NE)(FE)
Manduca sexta (NE) (FE)

Torticidae (Tortricid Moths)
Acleris subnivana (??)(FE)

Zygaenidae (Leaf Skeletonizer Moths)
Harrisina americana (NE) (FE)
Pyromorpha dimidiata (NE)(FE)

Order Hemiptera (True bugs, cicadas, hoppers, aphids and allies).

Aphalaridae (GI).
Pachypsylla celtidismamma (GI)

Aphididae (Aphids)
Cinara strobi (??, potential FP) (FE)
Grylloprociphilus imbricator (NE, potential FP, NB if handled) (FE)
Longistigma caryae (NE, potential FP) (FE)

Aleyrodidae (Whiteflies)
Pealius azaleae (??)(FE)

Aradidae (Flat Bugs)
Aradus (NE) (FE)

Belostomatidae (Giant Water Bugs)
Abedus (NE) (FE)

Cercopidae (Froghoppers)
Prosapia bicincta (NE) (FE)(GI)

Cicadidae (Cicadas)
Diceroprocta viridifascia (GI)
Neotibicen auletes - *Megatibicen auletes*? (NE) (FE)
Neotibicen canicularis (originally reported as *Tibicen canicularis*) (NE) (FE)
Neotibicen tibicen (NE) (FE)

Cimicidae (Bed Bugs)
Cimex adjunctus (NE, potential NB, WP [bats]) (FE)
Cimex lectularius (cosmopolitan, NB) (FE)

Coreidae (Leaf-footed Bugs)
Acanthocephala declivis (NE) (FE)
Leptoglossus(FE)
Leptoglossus corculus (NE)(fe)(FP?)
Leptoglossus oppositus (NE)(FE)
Leptoglossus fulvicornis (NE) (FE)
Leptoglossus phyllopus (NE) (FE)

Fulgoridae (Fulgorid Planthoppers)(NE species data lacking) (FE)

Gerridae (Water Striders)(NE)(FE)(GI)

Lygaeidae (Seed Bugs)
Lygaeus turcicus (NE)(FE)
Oncopeltus fasciatus (NE) (FE)

Membracidae (Treehoppers)(NE, species data lacking) (FE)

Notonectidae (Backswimmers)
Notonecta (NE) (FE)

Pentatomidae (Stink Bugs)(FE)(GI)
Euthyrhynchus floridanus (NE) (FE)
Halyomorpha halys (NN, OP) (FE)(GI)

Plataspidae (a single recently introduced species).
Megacopta cribraria (NN, OP, potential NB) (FE)

Reduviidae (Assassin Bugs)
Apiomerus crassipes (NE) (FE)
Arilus cristatus (NE) (FE)(GI)
Melanolestes picipes (NE) (FE)
Pselliopus cinctus (NE) (FE)
Sinea (GI)
Sinea diadema (NE)(FE)
Sirthenea carinata (NE) (FE)
Stenopoda spinulosa (NE) (FE)

Rhopalidae (Scentless Plant Bugs)
Boisea trivittata (NE, OP) (FE)

Tingidae (Lace Bugs)
Stephanitis pyrioides (NN) (FE)

Order Hymenoptera (Bees, wasps, hornets, ants and sawflies).

Ampulicidae (Cockroach Wasps)
Ampulex canaliculate (??)(FE)

Apidae (Cuckoo, Carpenter, Digger, Bumble, and Honey Bees)
Apis mellifera (NN) (FE)
Bombus pensylvanicus (NE, declining, potential NB) (FE)
Xylocopa virginica (NE, OP) (FE)(GI)

Aulacidae (No common name groupings)
Pristaulacus stigmaterus (??)(FE)

Ampulicidae (Cockroach Wasps)
Ampulex canaliculate (NE) (FE)

Bethylidae (No common name groupings)(NE but species information is lacking) (FE)

Braconidae (Braconid Wasps)(NE but species information is lacking) (FE)

Chrysididae (Cuckoo Wasps)(NE but species information is lacking) (FE)

Colletidae (Cellophane or Plasterer, Masked, and Fork-tongued Bees)
Colletes thoracicus (NE) (FE)

Crabronidae (Square-headed Wasps)
Microbembex (GI)
Trypoxylon politum (NE) (FE)

Evaniidae (Ensign Wasps)
Evania appendigaster (NN) (FE)
Hyptia thoracica (NE) (FE)

Formicidae (Ants)(species information is lacking)
Camponotus pennsylvanicus (NE) (FE)
Crematogaster (Cosmopolitan) (FE)
Formica exsectoides (NE) (FE)
Solenopsis invicta (NB, WP) (FE)

Ichneumonidae (Ichneumon Wasps)(Species information is lacking)
Megarhyssa macrurus (NE) (FE)

Megachilidae (Leafcutter, Mason, and Resin Bees, and allies)(??-several NN occur in North America, species information is lacking)
Megachile (FE)
Megachile xylocopoides (NE, B) (FE)

Mutillidae (Velvet Ants)
Dasymutilla occidentalis (NE Not a NB unless handled) (FE)
Sphaeropthalma (??)(FE)

Orussidae (Parasitic Wood Wasps)
Orussus (NE) (FE)
Orussus sayii (NE) (FE)

Pergidae (Pergid Sawflies) (*Acordulecera* is only genus in US, NE) (FE)

Pompilidae (Spider Wasps) (FE)(GI)
Entypus (NE) (FE)
Tachypompilus ferrugineus (NE) (FE)

Rhopalosomatidae (Rhopalosomatid Wasps)
Rhopalosoma nearcticum (NE) (FE)

Sapygidae (Sapygid Wasps)
Sapyga centrata (NE) (FE)

Scoliidae (Scoliid Wasps)
Scolia bicincta (NE)(FE)(B)
Scolia nobilitata (NE) (FE)

Siricidae (Horntails)
Sirex nigricornis (NE) (FE)

Sphecidae (Thread-waisted Wasps)
Ammophila (NE) (FE)
Chalybion californicum (NE) (FE)
Eremnophila aureonotata (NE) (FE)
Sceliphron caementarium (?, NE) (FE)
Sphecius speciosus (NE) (FE)

Tenthridinidae (Common Sawflies)
Empria maculata (NE) (FE)
Thrinax dubitata (*Hemitaxonus dubitatus*) (??) (FE)

Tiphiidae (Tiphiid Wasps) (NE but species information is lacking). (FE)

Vespidae (Yellowjackets and Hornets, Paper Wasps; Potter, Mason & Pollen Wasps)
Dolichovespula maculata (NE, NB) (FE)
Eumenes fraternus (NE, B) (FE)
Monobia quadridens (NE). (FE)
Polistes (NE, NB) (FE)
Polistes dorsalis (FE)
Polistes exclamans (?, NE) (FE)
Polistes metricus (FE)
Vespa crabro (NN, I?) (FE)(GI)
Vespula (FE)
Vespula germanica (NN, potential NB) (FE)
Vespula maculifrons (NE, potential NB) (FE)

.

Order Megaloptera (Alderflies, dobsonflies, and fishflies).

Corydalidae (Dobsonflies and Fishflies)
Neohermes (FE)

Sialidae (Alderflies). (NE, single genus: *Sailis*. Species information lacking) (FE)

Order Microcoryphia (Bristletails).

Meinertellidae (Rock Bristletails) (NE, species information lacking) (FE)

Order Neuroptera (Antlions, Owlflies, Lacewings, Mantidflies and Allies).

Ascalaphidae (Owlflies) (NE, species information lacking) (FE)

Chrysopidae (Green Lacewings)
Chrysopa (NE) (FE)
Chrysoperla rufilabris (FE)

Hemerobiidae (Brown Lacewings)(NE, species information lacking)

Mantispidae (Mantidflies)(NE, species information lacking)

Myrmeleontidae (Antlions)(NE, species information lacking)(FE)(GI)

Order Odonata (Dragonflies and damselflies). All NE but species lacking.

Aeshnidae (Darners).

Calopterygidae (Broad-winged Damselflies).
Calopteryx

Coenagrionidae (Narrow-winged Damselflies).

Gomphidae (Clubtails).

Libellulidae (Skimmers).
Erythemis
Libellula
Pachydiplax longipennis (FE)(NE)
Plathemis lydia (FE)(NE)

Order Orthoptera (Grasshoppers, katydids and crickets).

Acrididae (Short-horned Grasshoppers)(speciesinformation lacking).
Dissosteira (NE)(FE)
Leptysma marginicollis (NE)(FE)
Melanoplus femurrubrum (FE/GI)
Melanoplus sanguinipes (NE)(FE)
Metaleptea brevicornis (FE/GI)
Paroxya clavuliger (FE/GI)

Gryllidae (True Crickets) (NE but species lacking).
Gryllus (GI)
Hapithus agitator (GI)

Gryllotalpidae (Mole Crickets).
Neocurtilla hexadactyla (NE, OP).

Rhaphidophoridae (Camel Crickets).
Ceuthophilus (NE)

Tettigonidae (Katydids).
Atlanticus (NE)
Microcentrum (NE)
Neoconocephalus (NE)
Orcheliuum vulgare (GI)

Order Psocodea (Barklice, Booklice, and Parasitic Lice).

Trichodectidae
Trichodectes canis (NB of military working dogs & pets, WP)

Order Dermatoptera (Earwigs).

Carcinophoridae? / Anisolabididae
Euborellia annulipes (NN)

Forficulidae
Forficula auricularia (NN)

Order Phasmida (Stick Insects). NE, species infornation lacking.

Phasmatidae

Order Mecoptera (Scorpionflies, Hangingflies and Allies). Species information lacking.

Bittacidae (Hangingflies)

Order Mantodea (Mantids). Species information lacking.

Mantidae (FE)(GI)
Tenodera sinensis (NN, I?)

Order Ephemeroptera (Mayflies). Species information lacking.

Baetidae?

Order Trichoptera (Caddisflies). No definitive information or specimens support documentation of this order on the installation.

9. Class Arachnida.

Order Araneae (True spiders).

Agelenidae (Funnel Weavers)
Agelenopsis (NE)(FE)

Araneidae (Orb Weavers)
Argiope aurantia (NE)(FE/GI)
Araneus marmoreus (NE)(FE)
Gasteracantha cancriformis (NE)(FE)(GI)
Larinioides cornutus (NE)(FE)
Lariniodes sclopetarius (NE but found in box shipped from Pennsylvania though documented in VA.)(FE)
Neoscona domiciliorum (NE)(FE)

Ctenidae (Wandering Spiders)(NE)(FE)

Filistatidae (Crevice Weavers)
Kukulcania(FE)
Kukulcania hibernalis (NE)(FE)

Gnaphosidae (Ground Spiders)(NE, species information is lacking)(FE)

Lycosidae (Wolf Spiders)
Hogna? (NE)(FE)
Rabidosa (NE)(FE)

Philodromidae (Running Crab Spiders)
Philodromus vulgaris (NE)(FE)

Pholcidae (Cellar Spiders)(NE)(FE)

Pisauridae (Nursery Web & Fishing Spiders)
Dolomedes tenebrosus (NE)(FE)
Dolomedes triton (NE)(FE/GI)

Salticidae (Jumping Spiders)
Colonus sylvanus (GI)
Lyssomanes viridis (NE)(FE)
Phidippus (GI)
Phidippus audax (NE)(FE)
Platycryptus (NE)(FE)
Platycryptus undatus (NE)(FE)

Segestriidae (Tube Web Spiders)(?)
Ariadna bicolor (?, NE)(FE)

Tetragnathidae (Long-jawed Orb Weavers)
Leucauge venusta (NE)(FE)
Tetragnatha (NE)(FE)(GI)

Theridiidae (Cobweb Spiders)
Latrodectus mactans (NE, potential NB)(FE)
Steatoda grossa (NE)(FE)

Thomisidae (Crab Spiders) (NE, species information is lacking)

Order Pseudoscorpiones (Pseudoscorpions). Observed and identified only at order level. Species information is lacking.

Order Opiliones (Harvestmen, daddy-longlegs). Species information is lacking.

Sclerosomatidae
Leiobunum(?, ??)

Order Ixodida (Ticks).

Ixodidae (Hard Ticks).
Amblyomma americanum (NB, DV, WP)
Amblyomma maculatum (NB, DV, WP)
Dermacentor variabilis (NB, DV, WP)
Haemaphysalis leporispalustris (NB, DV?, WP)
Ixodes affinis (NB?, DV?, WP)
Ixodes rugosus? (NB?, DV?, WP?)
Ixodes scapularis (NB, DV, WP)

Order: Mesostigmata (mites).

Dermanyssidae
Steatonyssus ceratognathus (NE, WP)

Macronyssidae
Ornithonyssus sylviarum (NE, potential NB, WP)

Order: Trombidiformes (mites).

Tetranychidae (Spider Mites)
Bryobia praetiosa? (Clover mite?)

Erythraeidae
Balaustium? (Sidewalk mite?)

Trombidiidae (true velvet mites)
Trombidium (Chigger mite) (NE, NB)
(Phoretic mites observed on cerambycid beetles but taxonomy undetermined.)

10. Other arthropods.

Class Diplopoda (millipedes). Species inventory is limited.

Order: Polydesmida

Xystodesmidae
Apheloria virginiensis

Order Spirobolida.

Spirobolidae
Narceus americanus (NE)

Class Malacostraca.

Order Decapoda.

Ocypodidae (Fiddler Crabs and Ghost Crabs)
Uca pugnax (Atlantic Marsh Fiddler Crab) – family observed/species assumed.

Portunidae (Swimming Crabs)
Callinectes sapidus (Atlantic Blue Crab) – previously documented.

Grapsidae (Marsh Crabs, Shore Crabs, and Talon Crabs)
Sesarma reticulatum

Cambaridae (Crayfish). Existing inventory is old and needs new survey (FY 21)
Cambarus bartonii bartonii (NE)
Cambarus robustus (NE)
Orconectes immunis (NE)

Order Isopoda (Isopods). Sow bugs observed. Species inventory needed.

Class Chilopoda (Centipedes). Only one taxon is documented on the installation.

Order Scutigeromorpha (House Centipedes).

Scutigeridae
Scutigera coleoptrata (House Centipede) (NN, B?-indoor predator of roaches, etc but may bite if handled)
(other centipedes different from this order observed but not ID beyond class)

10. Other invertebrates.

Phylum Mollusca
Class Bivalvia
Order: Unionoida
Unionidae
Anodonta cataracta
Elliptio complanata

Phylum: Annelida
Class: Clitellata
Order: Haplotaxida
Lumbricidae
Earthworms

Subclass: Hirudinea
Leeches

Phylum: Platyhelminthes (Flatworms)
Class: Rhabditophora (All parasitic flatworms & most free-living species)
Order: Tricladida (Free-living flatworms)
Geoplanidae (Land planarians or land flatworms)
Bipalium kewense (NN, I?)

11. Habitat restoration and enhancements. The Natural Resources & IPM Branch has implemented various projects to restore natural areas or make enhancements to existing areas. This work contributes to the overall biodiversity to include arthropods. Some key examples where this relates to arthropods are as follows.

A. Management of invasive vegetation. The Branch has been combating several species of invasive vegetation. Golden bamboo once existed in many areas across the installation but has since been greatly reduced. Removal/elimination of bamboo may contribute to mosquito control by reducing breeding sites as some mosquito species use portions of the plant that retains rainwater. Tree of heaven is a significant invasive tree that impacts training areas because it grows very thick and outcompetes native trees making mobility through such areas difficult. This tree is a preferred host plant of the recently introduced spotted lanternfly. The lanternfly is currently found in two counties of Virginia though not yet in the Hampton Roads area. It is known to damage some 70 other native plants/trees. The removal of tree of heaven from the installation may help stem the establishment of the lanternfly. Johnson grass is an invasive herbaceous plant that also has a wide distribution across the installation. It too can impact mobility and aesthetics. Probably most importantly, deer may use these areas to bed down and thereby create refugia for ticks. The Branch as taken action to control Johnson grass in several areas.

B. Creation of early successional habitats. Several early successional habitats were created by removing undesirable vegetation and replanting selected areas with various wildflowers and to some extent Native Warm Season Grasses (NWSG). Pollinator mixes were planted at these sites. Some of the major flowering plants included:

Blanketflower *Guillardia* spp.
Tickseed Coreopsis spp.
Black/Brown Eyed Susan *Rudbeckia* spp.
Blue mistflower *Conoclinium coelestinum*
Bundleflower *Desmanthus* spp.
Partridge (Sensitive) Pea *Chamaecrista nictitans*
Perennial Sunflower *Helianthus tuberosus*
Wild Senna Senna hebecarpa
Joe Pye Weed *Eutrochium purpureum*
Sulphur Cosmo Cosmo sulphureus
Garden Cosmo Cosmo bipinatus
Canada Goldenrod *Solidago canadensis*
Showy Aster *Eurybia* spp.

Additionally, some patches of heavily used milkweed (common, swamp, and Indian hemp) were planted at the Mulberry Island Road site.

(1) Irwin Street Site (Figure 1). This site was originally planted with longleaf pine and has been maintained as such. It consists of 0.72 acres. In the spring of 2021, the area was enhanced by planting a pollinator mix followed by a flowering clover mix planted in the fall. Deer consumed the planted vegetation so it was not examined for arthropods. Regrowth will be monitored in 2022 before proceeding further. It will be managed as early successional, but may need to switch it to NWSG.

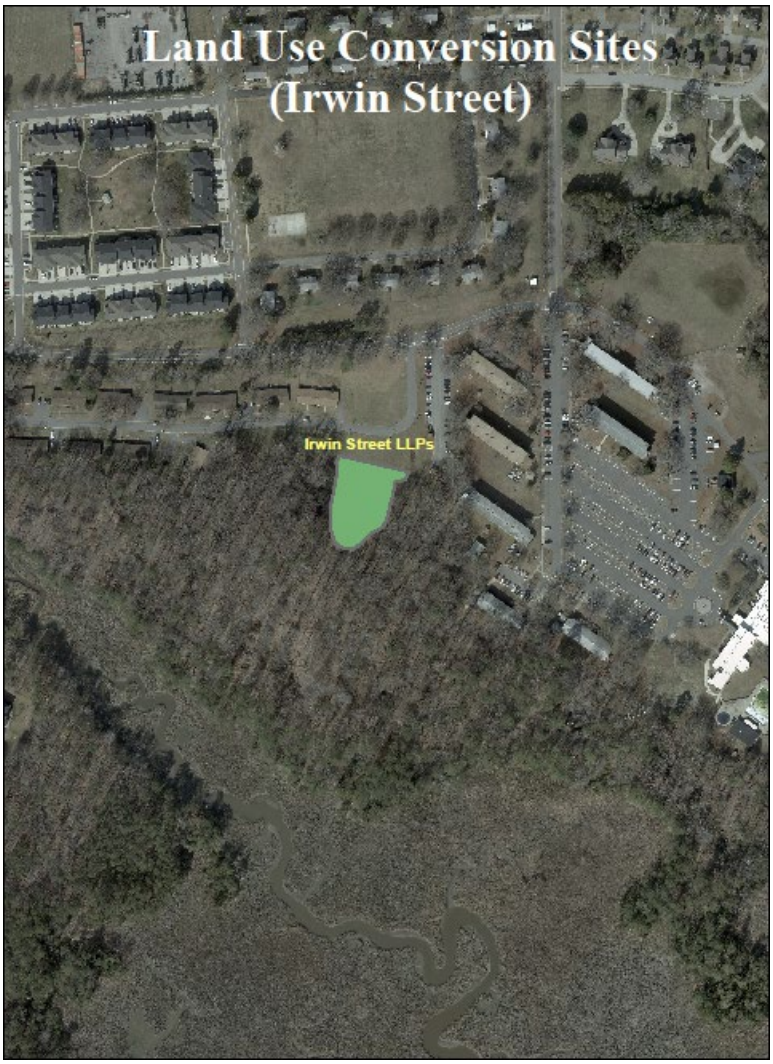

Figure 1: Irwin Street Site

(2) Mulberry Island Road Site (Figure 2). This site was originally 0.71 acres of unused land that was maintained by mowing. Several years ago it was converted into an early successional habitat with forbs. It was managed for two years before time and manpower constraints precluded effective maintenance. In spring 2020 the existing undesirable vegetation was removed, and the site replanted with a pollinator mix intermixed with sparse NWSG. Preliminary assessments in 2021 revealed considerable arthropod activity. Several hymenopterans, lepidopterans, dipterans and orthropterans were noted. Confirmed species included *Plebejus* sp., *Scolia bicincta*, *Monobia quadridens*, various bumble bee species (*Bombus* spp.), *Junonia coenia*, *Polistes metricus*, *Polistes dorsalis*, unidentified crickets, *Melanoplus sanguinipes*, *Eumernes fraternus*, and various flies and moths. Northern mole crickets (*Neocurtilla hexadactyla*) were heard calling from subsoil area in adjacent mowed area. Remenants of spider webs could be observed. An Isabella Tiger Moth caterpillar (*Pyrrharctia isabella*) was observed on the running/walking path adjacent to the site on 17 November.

(3) Building 1409 Site (Figure 2). The general area surrounding building 1409 was also once a mowed area comprising 0.36 acres. Previous habitat work involved planting several wax myrtle shrubs were planted but the area was not maintained due to other work priorities. Since the area was replanted with the pollinator mix in 2020 adjacent to the parking lot and then expanded around the building in 2021. Additional plants including verbena were also planted. It is the most diverse site established thus far. A preliminary assessment of arthropod use was also made. The following arthropods were observed using the site: monarch butterflies (*Danaus plexippus*), various bumble bee species (*Bombus* spp.), *Megachile* sp., *Chauliognathus pensylvanicus*, *Polites themistocles, Eumernes fraternus*, *Popillia japonica*, *Lygaeus turcicus*, *Phoebis sennae*, *Apis mellifera, Plathemis lydia*, *Polistes metricus*, *Scolia bicincta*, *Sinea diadema*, *Eremnophila aureonotata*, and *Vanessa virginiensis*.

Figure 2: Mulberry Island Road/B1409 Sites

(4) South Golf Course Site (Figure 3). These sites collectively comprise 17.45 acres. These sites were cleared of vegetation and woody competition in summer-winter of 2020 and planted in spring 2021. Results were mixed due to wet weather, planting depths, and potential golf course mowing. The Long Pond, and Golf Course V were planted in a pollinator and meadow mix and were mostly successful but will need to be augmented in the coming seasons. The Long Fairway (thin strip to the east) was planted in a roadside pollinator mix composed of mostly *Rudbeckia* and *Coreopsis* that did very well but is fairly short lived. The Archery Range was cleared of invasive species and woody competition in 2021 and will be planted in a upland bird/wildlife mix in spring 2022. Deer have eaten this patch to the ground because it was not large enough to withstand browsing. This site will be planted in a meadow mix and upland bird/wildlife mix in spring 2022. The 3 unlabeled patches on this map were largely unsuccessful and will likely be replanted in native grasses in 2023. Arthropod assessments will be considered beginning in 2022.

Figure 3: South Golf Course Site

(5) Quick Six Course and Back River Road Sites (Figure 4). Collectively these sites comprise 4.22 acres. The B2015 West patch was planted in 2020 in wildflower mix, but was destroyed by deer and groundhogs. It will be replanted in spring 2022. B2015 East was planted in fall 2021 in a flowering clover mix to relieve browse pressure on the pollinator patch and because it is still used as a lay down area for equipment and disposing of wildlife carcasses. It will still flower during spring and summer with 4 varieties of perennial clover. Back River Road Patch was planted in 2020 and then over-seeded again in 2021 with pollinator mix and with laudatory comments from the chain of command and installation community. The patch labeled Quick 6 is slated to be planted in a quail and meadow mix pending invasive species removal and once much of the woody debris has broken down. Arthropod assessments will be considered beginning in 2022.

Figure 4: Quick Six Course and Back River Road Sites.

(6) Mathew Jones House (MJH) and Lee Boulevard Site (Figure 5). Mathew Jones House often referred to informally as the Matthew Jones House Plantation (4.4 acres) is a reforestation site created following the dismantling of the former wastewater treatment plant. Currently, thinning and invasive vegetation control is taking place. Trees were pruned or thinned to allow enough sunlight to grow ground vegetation and to assist in eradication of Johnson grass. Some arthropods were noted particularly a Cantheridae beetle larva foraging for prey on a red oak sapling and *Polystepha pilulae* gall (a dipteran midge) found on a red oak leaf. Planting of a portion of the site with native meadow/wildlife mix is anticipated in summer 2022. The Lee Boulevard site (1.05 acres) consists of longleaf pine planted several years ago and a pollinator mix was planted between the rows twice in 2021. Deer have eaten this plot to the ground, but several species of pollinators in this mix were not browsed on particularly *Eutrochiu*m and *Asclepias*. Replanting is anticipated with NWSG in summer 2023.

Figure 5: Mathew Jones House (MJH) and Lee Boulevard Site.

12. Significance of the data. Macroinvertebrates include arthropods (such as insects, spiders, harvestmen, ticks, mites, crayfish, crabs, copepods, isopods, etc.), flatworms, snails, clams, and annelids (such as earthworms, leeches, etc.). These organisms are critical components of any ecosystem and are no less important in the installation ecosystem. Insects have the greatest diversity of any group of organisms and are often overlooked when one considers management of wildlife, other fauna, and habitats. Their species richness and high fecundity make this group substantial components of biomass. Collectively, macroinvertebrates as well as multicellular microscopic forms serve as food sources for other fauna, predators, parasitoids, disease vectors, soil constituents, pollinators, decomposers, seed dispersing, and plant consumption. Some arthropods vector disease pathogens to plants while others are disease vectors and biting nuisances of wildlife. Other arthropods are nuisance pests and disease vectors of humans. Comprehensively, these factors influence habitat structure through direct and indirect means thus potentially affecting habitat health/quality that in turn affects quality of training lands, soil quality, recreational hunting, and human health.

A. Beneficial arthropods (B).

(1) Beetles:

- The following checkered beetles (Coleoptera: Cleridae) are considered beneficial because they are native predators of Southern pine beetles and other bark beetles that may pose serious threats to forest health: *Cymatodera undulata*, *Enoclerus ichneumoneus*, *Enoclerus nigripes*, and *Thanasimus dubius*. *Thanasimus dubius* appears to be the more abundant species of this group and specifically preys upon Southern pine beetles.

- *Tenebroides collaris* (Coleoptera: Tenebrionidae, no common name). This species may be predators of *Ips* and other bark beetles and their presence may be indicative of damaging Southern pine beetles.

- The following lady beetles (Coleoptera: Coccinellidae) are considered beneficial because they are native predators of aphids, mealybugs and scale insects that can damage plants: *Chilocorus stigma*, *Cycloneda*, *Diomus amabilis*, and *Hyperaspis binotata*.

- Blind Click Beetle (*Alaus myops*) and Eyed Click Beetle (*Alaus oculatus*). Larvae of these beetles may feed on wood-boring beetles of pines. This may contribute to natural control to some extent.

(2) True flies: Tiger Bee Fly (Diptera: Bombyliidae: *Xenox tigrinus*) larvae are parasitoids of carpenter bees that can cause damage to wood structures.

(3) Moths & butterflies:

- Broad-winged Skipper (Lepidoptera: Hesperiidae: *Poanes viator*). Larvae may feed on the invasive grass Common Reed (*Phragmites australis*). No obvious effects have been observed on the installation; however, more information and research may yield useful insight.

- Great Purple Hairstreak (Lepidoptera: Lycaenidae: *Atlides halesus*). Larvae feed on mistletoe which is a parasitic plant of trees.

- *Feniseca tarquinius* (Lepidoptera: Lycaenidae, no common name) larvae feed on aphids.

(4) Bees, wasps, ants & sawflies (Hymenoptera). Many hymenopterans are important pollinators as are some true flies, some beetles and certain other insects. Several taxa documented at the family level may serve as parasitoids of pest insects; however, current data is insufficient.

B. Nuisance biting and stinging arthropods (NB).

(1) True flies. Nuisance biting arthropods occurring on the installation include mosquitoes (Diptera: Culicidae), tabanid flies (Diptera: Tabanidae that include deer flies, horse flies and yellow flies), and "no-see-ums" that encompass the genus *Culicoides* (Diptera: Ceratopogonidae). Approximately 28 mosquito species documented on the installation are nuisance biters of varying degrees. Deer flies (*Chrysops dimmocki* and likely other species within this genus) are frequent typical nuisance biters as are several species of horseflies (*Tabanus*). Yellow flies, more appropriately called the Yellow Fly of the Dismal Swamp (*Diachlorus ferrugatus*) has been observed on the installation though much less frequently than other tabanids. Their significance as a biting nuisance appears less so than deer flies and horse flies. "No-see-ums" can become annoyances beginning in March-April and continue at least into June. Deer flies tend to become annoyances in April-May through about July while horse flies become nuisances in about July through September-October. Mosquitoes usually begin in May but may remain an issue as late as November depending on species & weather conditions. Weather conditions in November 2021 was fairly mild with ambient daytime temperatures ranging from 50-75 degrees.

(2) True bugs (Hemiptera). Two species from the family Cimicidae are noted as nuisance biting true bugs. This included the Common Bed Bug (*Cimex lectularius*) and the Eastern Bat Bug (*Cimex adjunctus*). The Common Bed Bug is the primary biting nuisance of the two species because it is associated only with humans and has a cosmopolitan distribution. Infestations have occurred at installation lodging facilities in the past and will continue to occur. The Eastern Bat Bug has a parasitic association with bats and only poses a biting nuisance concern if infested bats reside within occupied structures. This

species has been documented on bats found inside the operational warehouse of building 1610. In 2021, the bat infestation of building 1610 was resolved with the identification of entry points and installation of exclusion devices.

(3) Stinging hymenopterans. Many hymenopterans are capable of inflicting painful stings; however, only a small number of those documented on the installation may aggressively do so. Foraging hymenopterans (i.e., bees and wasps observed on flowers and vegetation) are not typically aggressive if simply left alone. Many wasps and some bee species are solitary and do not defend nests. Adult female velvet ants (*Dasymutilla occidentalis*) are wingless and solitary but can inflict serious stings if handled. The following species pose stinging risks by aggressively defending their communal nests: Paper wasps (*Poliestes*, NE), American Bumble Bee (*Bombus pensylvanicus*)(NE), Bald-faced Hornet (*Dolichovespula maculata*)(NE), German Yellowjacket (*Vespula germanica*)(NN), and Eastern Yellowjacket (*Vespula maculifrons*)(NE). The American Bumble Bee is in decline across its range and measures should be taken to avoid encouraging them to nest near human activities. This was observed in the former Military Operations in an Urban Training site in Training Area 21 previously.

(4) Spiders. Spiders as a group are not considered nuisance biting arthropods in the same context as other biting arthropods. None aggressively attack humans and bites in general are rare. The only spider of medical significance on the installation is the Southern Black Widow (*Latrodectus mactans*)(NE), and represents the only potential nuisance biting spider. It has been observed in several buildings and in outdoor playgrounds on the installation. No bites have been documented or reported to the IPMC to date. The Northern black widow (*Latrodectus variolus*) may occur on the installation but none have been documented. Many lay people believe Brown Recluse Spiders (*Loxosceles reclusa*) exist on the installation or in the local area. This is inaccurate as the spider is not native to Virginia, and none have ever been documented on Fort Eustis. Females of *Kukulcania hibernalis* (NE) are often mistaken for tarantulas while males look remarkably similar to and thus mistaken for brown recluses. Wolf spiders (family Lycosidae) are also mistaken for brown recluses though they bear no true similarities. This family is probably the most abundant group in forested areas of Fort Eustis but some may enter structures. This group does not pose a health risk to people.

(5) Caterpillars with stinging/venomous spines. The immature stage of several moth and butterfly species native to eastern North America have venomous spines that can cause irritation (and potentially allergic reactions). Two species have been documented on the installation to date though others may exist:

- Puss caterpillar (*Megalopyge opercularis*). The caterpillar of this species has venomous spines though it exhibits a soft, benign appearance. Adults are referred to as flannel moths.
- Mourning Cloak butterfly (*Nymphalis antiopa*). The caterpillar of this species has venomous spines.

(6) Ticks (Arachnida: Ixodida). Hard ticks (family Ixodidae) are biting nuisances and all species documented are either vectors of human disease or contribute to maintaining pathogesns in the environment. All may be pests of wildlife. Heavy infestations can adversely impact wildlife health with the consequential impacts on habitat conditions and the quality of the hunting program.

C. Disease vectors (DV). Several arthropods are competent vectors of pathogens that cause disease in animals and humans. The arthropod disease vectors (and potential disease vectors) occurring on the installation include members of the insect order Diptera (true flies) and the ticks (Arachnida: Ixodida).

(1) True flies (Diptera). Disease and potential disease vectors include 14 mosquito species. Diseases potentially vectored by mosquitoes include West Nile Virus Disease (WNV), Eastern Equine Encepahlitis (EEE), LaCross Encephalitis (LAC), and St. Louis Encephalitis (SLE) in humans, and dog heartworm in dogs and wild canids. "No-see-ums" (*Culicoides*) have the potential to vector the Epizootic Hemorrhagic Disease (EHD) virus that causes Hemorrhagic Disease in whitetail deer in the southeastern US including Virginia. The cosmopolitan house fly (*Musca domestica*) has potential to mechanically transmit pathogens. Some species of *Chrysops* (deer flies) may be capable of mechanically transmitting the pathogen that causes tularemia. No viable pathogen testing of true flies has occurred on the installation in recent years.

(2) Ticks. Ticks represent the most important disease vectoring arthropods in the United States and includes Fort Eustis. Currently, six species have been documented. Pathogens have also been monitored and include those that cause ehrlichiosis, tidewater spotted fever, Lyme disease, human babesiosis, canine babesiosis, anaplasmosis, and Borrelia miyamotoi disease. A separate comprehensive report was prepared for tick and tick-borne diseases at Fort Eustis (Christensen, *Tick & Tick-borne Pathogen Species Inventory*, March 14, 2019). This report represents the most recent data on ticks occurring on the installation; however, some tick analysis was performed in August 2019. A total of 3,364 ticks were collected from various locations on the installation August 12-13. These specimens consisted of immature stages and adults of the species Lone Star Ticks (*Ambylomma americanum*), American Dog Tick (*Dermacentor variabilis*) and *Ixodes affinis* (no common name). These 3 species were documented on the installation previously. *Ambylomma americanum* and *Dermacentor variabilis* are important disease vectors of humans though they do not vector the pathogen that causes Lyme disease. Existing literature and knowledge suggests that *Ixodes affinis* does not bite humans but it is known to contribute to maintaining the Lyme disease pathogen in the environment. The ticks will be tested for pathogens when the facility (US Army Public Health Command laboratory at Fort Meade, MD) reopens following the COVID-19 situation.

(3) Cockroaches (Blatodea). Cockroaches occurring inside structures have potential to be mechanical disease vectors.

D. Invasive species (I), Forest Pests (FP), Wildlife Pests (WP) and Other Pests (OP). It is difficult to determine whether any arthropods are truly invasive with regards to the installation. Several species have been documented on the installation that may have the potential to become invasive. Some nonnative and native species can be forest pests or become pests in other ways.

- *Aedes albopictus*, *Ochlerotatus japonicas*, *Culex nigripalpus*, *Culex pipiens-quinquefasciatus* (I, DV, WP, NB)(non-native mosquitoes). Invasive mosquitoes that are biting nuisances and potential disease vectors of humans and wildlife.
- European Hornet (*Vespa crabro*)(I?, WP?, NB?). Competes with and preys upon native insects. Capable of inflicting painful sting but no nesting sites have been documented on the installation to date.
- Red imported fire ant (*Solenopsis invicta*)(I, NB, WP). Establishment would pose serious health & safety risks to personnel and destructive of vertebrate wildlife and other native invertebrates. Two colonies were documented (and eliminated) to date.
- Chinese mantis (*Tenodera sinensis*)(I?, WP?). Competes with native mantids and preys upon native insects. May prey on small native vertebrates.
- Japanese beetle (*Popillia japonica*)(I, OP). Well established on the installation and is destructive of many herbaceous plants. Larvae may be pests of turfgrass and lawns. Specific example was their impact on native wetland plant regeneration following control of Common Reed (adults feeding on marsh mallow flowers).
- Ribbed Pine Borer (*Rhagium inquisitor*)(I?, FP). This nonnative beetle is a potential forest pest that can spread certain fungus spores from infected to healthy trees, thus indirectly causing the blue-staining of the wood.
- Asian Lady Beetle (*Harmonia axyridis*)(I, OP). Well established on the installation. Can become a pest in winter by entering structures. It is predatory on and competes with native coccinellids and dramatically can reduces their populations. Aggressively bites when handled.
- *Ambrosiodmus rubricollis* (no common name)(I?, FP). This nonnative bark beetle may be damaging to forest resources because of a variety of host plants; however, more information is needed.
- *Euwallacea validus* (no common name)(I?, FP). This nonnative bark beetle may be damaging to forest resources because of a variety of host plants; however, more information is needed.
- Fruit-tree Pinhole Borer (*Xyleborinus saxesenii*)(I?, FP). Almost all conifers and hardwoods are susceptible to this nonnative bark beetle; however, the extent of its effects on installation forest resources requires more information.
- Alnus Ambrosia Beetle (*Xylosandrus germanus*)(I?, FP). This nonnative bark beetle may be damaging to forest resources because of a variety of host plants; however, more information is needed.
- Asian Ambrosia Beetle (*Xylosandrus crassiusculus*)(I?, FP). This nonnative bark beetle may be damaging to forest resources because of a variety of host plants; however, more information is needed.

- Small Hive Beetle (*Aethina tumida*)(I?, OP). This non-native beetle is a pest of beehives. It is uncertain whether it impacts honeybee colonies or other hymenopteran pollinators on the installation.
- Northern Mole Cricket (*Neocurtilla hexadactyla*)(NE, OP). This native cricket can cause damage to golf course landscapes. It was heard calling in other areas such as the B2015 compound where it would not be a pest.
- White Pine Aphid (*Cinara strobi*)(??, FP). Potential pest of white pine.
- Dog Biting Louse (*Trichodectes canis*) (OP, WP). This species was observed on a coyote in 2018. It may be a pest of other wild canids and domestic dogs including military working dogs.
- Deer Bot Fly (*Cephenemyia phobifer*)(NE, WP). Larval stages are endoparasites of whitetail deer that may affect deer health.
- Asiatic Oak Weevil (*Cyrtepistomus castaneus*)(NN, OP?). May enter structures during fall.
- Black Turpentine Beetle (*Dendroctonus terebrans*)(NE potential FP). This beetle attacks several pine species including loblolly pine which is the most common pine on the installation. Affected trees may survive; however, mortality can occur from accumulated attacks over multiple beetle generations or period of years.
- Small Southern Pine Engraver (*Ips avulsus*)(NE, potential FP). Attacks may occur in young trees and the tops of large living trees, which may be killed. However, when large living trees are attacked, the infestation is usually limited to the upper crown, and the mid- and lower boles of the same tree are often colonized by other species of *Ips* (*Ips calligraphus* Germar, *Ips grandicollis* Eichhoff), or the southern pine beetle (*Dendroctonus frontalis* Zimmermann). Any tree cutting or accidental injury that creates a pitch flow can induce attack by this species.
- Eastern Five-Spined Engraver (*Ips grandicollis*)(NE, potential FP). May attack weakened or dying pine species (or infest felled timber) which can lead to tree mortality or timber damage and may transmit fungi (*Ceratocystis pini* and other fungi) that are often fatal to pines.
- Pitch-eating Weevil (*Pachylobius picivorus*)(potential FP, NE). Can be damaging to pine seedlings/young trees.
- Eastern Pine Weevil (*Pissodes nemorensis*)(NE, potential forest pest). Both adults and larvae can kill terminal and lateral branches of pine species, girdle the stems of small trees and vector the pitch canker fungus pathogen to trees.
- White Pine Weevil (*Pissodes strobi*)(NE, potential FP). May damage Eastern white pine, various spruces, and sometimes other pine species.
- Black Turfgrass Ataenius (*Ataenius spretulus*)(NE, OP). Potential pest of turfgrass such as the golf course.
- American Cockroach (*Periplaneta americana*)(NN, Cosmopolitan, OP, potential DV). Pests of food handling facilities, lodging and other occupied structures.
- Smoky Brown Cockroach (*Periplaneta fuliginosa*)(OP, Cosmopolitan?). Pests of food handling facilities, lodging and other occupied structures.

- German Cockroach (*Blattella germanica*)(NN, Cosmopolitan, OP). Pests of food handling facilities.
- *Carpophilus sayi* (no common name)(NE, potential FP). Potential vector of the oak wilt fungus, *Ceratocystis fagacearum*.
- Beech Blight Aphid (G*rylloprociphilus imbricator*)(NE, potential FP, NB). Can be a pest of beech trees based on conditions. Can bite if handled.
- Giant Bark Aphid (*Longistigma caryae*)(NE, potential FP). Potential pest of several tree species. Only documented once in 2004.
- Bird Nest Carpet Beetle (*Anthrenus pimpinellae*)(Cosmopolitan, OP). May damage woolens or animal materials when indoors.
- Green June Beetle (*Cotinus nitida*)(NE, potential OP). Can be a pest of turfgrass.
- Bagworm Moths (family Psychidae). Actual species have not been identified. Uncertain if native since family is cosmopolitan. May be OP as a pest of ornamental conifers.
- Marmorated Stink Bug (*Halyomorpha halys*)(NN, OP when invading structures during winter).
- Kudzu Bug (*Megacopta cribraria*)(NN, OP, NB). May invade structures during fall and may bite if handled.
- Boxelder Bug (*Boisea trivittata*)(NE, OP). May invade structures during winter. This issue has been observed at Fort Eustis requiring pest control.

E. Listed, rare and declining species. Several species falling into these categories have been documented on the installation with the exception of actually listed species.

- The following federally listed insects may occur in Virginia but have not been documented on the installation at this time based on this Update: Rusty patched bumble bee (*Bombus affinis*)-endangered, American burying beetle (*Nicrophorus americanus*)-endangered, Mitchell's satyr butterfly (*Neonympha mitchellii*)-endangered (and state endangered), and Northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*)-threatened (state threatened).
- Monarch butterfly (*Danaus plexippus*). This species has been documented on the installation and several adult individuals were observed in 2021 particularly in early successional habitats constructed 2020-2021 foraging on various wildflowers. Adults were observe at JBLE-E as late as mid-November 2021. This species was under consideration by the US Fish & Wildlife Service (USFWS) for listing under the Endangered Species Act. A decision was made by USFWS to not list the monarch butterfly in December 2020. It remains as a candidate species however, for future considerations.
- The following federally listed arachnids may occur in Virginia but have not been documented on the installation at this time:

  - Spruce-fir moss spider (*Microhexura montivaga*) - endangered.

- The following state listed insects may occur in Virginia but have not been documented on the installation at this time based on this Update: Appalachian grizzled skipper (*Pyrgus wyandot* [=*Pyrgus centaureae wyandot*])-threatened, Buffalo Mountain mealybug (*Puto kosztarabi*)-endangered, Thomas' cave beetle (*Pseudanophthalmus thomasiand*)-endangered, Virginia Piedmont water boatman (*Sigara depressa*)-endangered, and Holsinger's cave beetle (*Pseudanophthalmus holsingeri*)-endangered.
- Linden Looper (*Erannis tiliaria*) has been documented on the installation and is native to the eastern US but appears to be declining in its range.
- American bumblebee (*Bombus pensylvanicus*) has been documented on the installation and is native to our area. It serves as an important pollinator. However, it is declining across its range. It actively defends nests and may pose as stinging nuisances at times.
- Of particular interest were two specimens of a rarely encountered parasitoid wasp, *Orussus sayii* (Orrusidae) as observed during the 2015 survey. Orussids are known or suspected to parasitize buprestids, cerambycids, siricids, and xyphidrids.

13. Arthropod inventory, surveillance, and management. This report represents a consolidation of all arthropods (and to a lesser extent other invertebrates) identified on the installation as of 30 November, 2021. A continuous perpetual inventory of all arthropods remains as a valid task as it provides data by which to assess ecosystem health. Surveillance programs for certain taxa were considered in the previous Update and remain valid due to their potential impacts that could affect missions, Specific surveillance and management programs are articulated in the IPMP.

A. Several taxa suggest a need for surveillance. These could include the following:

(1) Red Oak Borer (*Enaphalodes rufulus*)(potential FP). The larvae of this taxon have the potential to affect healthy, living oak tree species if numbers become high enough. This may be important given the objective of planting mixed oak species as part of habitat management. More information regarding numbers is needed as well as review of the new forest inventory completed in November 2021 in order to design a surveillance plan.

(2) Hardwood Stump Borer (*Mallodon dasystomus*)(potential FP). Larvae infest the heartwood of several deciduous trees such as oaks, elm, willow, pecan, maple, and sycamore. More information regarding numbers is needed as well as the new forest inventory in order to design a surveillance plan.

(3) Carolina pine sawyer (*Monochamus carolinensis*)(potential FP). This species has been observed with some degree of frequency and may be relatively common on the installation. It has the potential to transmit the *Bursaphelenchus xylophilus* nematode that can affect the health of several pine species. Given its apparent common occurrence and no apparent compromising of pine tree health on the installation, it may be of limited risk. Nonetheless, various abiotic and biotic factors could change the conditions. Surveillance could be included as part of a general forest pest surveillance program.

(4) Ribbed Pine Borer (*Rhagium inquisitor*)(NN, FP). This non-native beetle can cause significant damage to various pine species as well as some deciduous trees including birch, oak and poplar. It more typically attacks weakened or stressed trees. Its frequency on the installation is unknown. Surveillance should include this in a general forest pest surveillance program.

(5) *Euwallacea validus* (No common name)(NN, I?, potential FP). This beetle has the potential to be beneficial but also detrimental depending on the conditions. It transmits the fungus *Verticillium nonalfalfae* that causes lethal Verticillium wilt in the invasive Tree of Heaven (*Ailanthus altissima*) in Virginia and other states. However, large portions of Tree of Heaven have been removed from the installation and no obvious effects of this beetle on that tree has been confirmed. Additionally, it may impact a large number of deciduous and conifer trees. More information is needed about its effects on forests is needed.

(6) Pales weevil (*Hylobius pales*)(potential FP). This species is native to our area and was frequently collected in lingren funnel traps using various baits during surveys in 2011 and 2015. Its potential for impact on pine trees requires further review. Control using the lingren traps might help maintain numbers. However, this trapping method tends to target a variety of insect taxa including beneficial species such as Dubious Checkered Beetle (*Thanasimus dubius*). This weevil is a potential pest of pine seedlings. Consequently, monitoring of damage to planted pine represents the primary surveillance.

(7) Eastern Five-Spined Engraver (*Ips grandicollis*)(potential FP). By itself, this beetle is probably not a major forest pest concern because it more typically attacks stressed, dying or dead trees including slash or felled trees. Its presence likely suggests activity of other forest pests.

(8) Pitch-eating Weevil (*Pachylobius picivorus*)(potential FP). Similar to pales weevil but not nearly as frequently observed at JBLE-E. This taxon has potential to damage pines including seedlings and branches on older trees. It tends to be attracted to conditions created by fire and timber clearing. This species would be considered for surveillance in pine stands adjacent to tree clearing or fires. No surveillance plan has been developed.

(9) Fruit-tree Pinhole Borer (*Xyleborinus saxesenii*)(NN, potential FP). This non-native beetle apparently has a wide host range that includes ornamental trees and trees bearing fruits. However, the literature suggests that nearly all conifers and deciduous trees may be susceptible. More information is needed about its effects on forests is needed. No surveillance plan has been developed.

(10) Alnus Ambrosia Beetle (*Xylosandrus germanus*)(NN, I?, potential FP). This non-native beetle is well established in the United States to include Virginia. The extent of its distribution on the installation is unknown and information about native host trees needs further research. No surveillance plan has been developed.

(11) Japanese beetle (*Popillia japonica*)(NN, OP). This beetle is well established and is common everywhere locally including the installation. Adults feed on foliage of many plants while larvae feed on roots in the soil. Excluding landscaped plants, it tends to pose issues on certain habitat management such as converting herbaceous invasive vegetation to native vegetation in wetlands. Surveillance is probably not feasible or appropriate in general but should be considered for specific habitat management. Several individuals were observed in 2021.

(12) White Pine Aphid (*Cinara strobi*)(potential FP of white pine). This taxon has the potential to be an important pest of white pine with heavy infestations. Distribution of white pine on the installation is limited though a new forest inventory was completed in November 2021. This inventory was due in 2017 and overdue by nearly 5 years. A surveillance plan shall be considered following a review of the new forest inventory report. None were documented between June 2020 and November 2021.

(13) Beech Blight Aphid (*Grylloprociphilus imbricator*)(potential FP of beech). This native taxon is easily identified by their colonies on beech limbs. Two separate locations (well segregated) were observed. General perspectives as to their damage to beech remains uncertain. Large infestations may possibly affect tree health. Surveillance would involve spot checks of forest stands containing beech trees. None were documented between June 2020 and October 2021.

(14) Giant Bark Aphid (*Longistigma caryae*)(potential FP - several tree species). This species may have been identified once in 2004 and consequently, little information about its distribution or potential impact on the installation exists. It has not been identified since 2004. It does have a large range of tree hosts including American elm, pin oak, live oak, post oak, blackjack oak, pecan, hickory, sycamore, maple, basswood, birch, beech, walnut, chestnut, and willow. More information is needed. None were documented between June 2020 and October 2021.

(15) Red Imported Fire Ant (*Solenopsis invicta*)(NN, I). A colony was discovered near the new Shoppette (BLDG 321) along outbound Washington Blvd and eliminated in 2015. IPMC confirmed specimens with the York County Extension Office at the time. No new colonies had been documented until December 2020 when natural resources staff accidentally found a colony in the Slingload and Landing Zone (STALZ) training site in Training Area 28. This colony was treated with bait and appears to have been eliminated. This second colony may have been brought onto the installation in soil used for construction projects. CEIE staff had planned to conduct more intensive surveillance of open areas on Mulberry Island; however, heavy workload precluded this action. More surveillance will be attempted in 2022.

(16) European hornet (*Vespa crabro*)(NN, I?). This species is well established across its range. Issues pertain to predation on other insects and possibly competition with other insect taxa. Several individuals were documented previously and several were observed in 2021. No nests have been documented. Those individuals observed were competing with other hymenopterans and lepidopterans for access to tree sap. Likely no specific surveillance plan is feasible or needed at this time.

(17) Chinese mantis (*Tenodera sinensis*)(NN, I?). This species is likely well established in the eastern United States. Only a few individuals were observed at the installation. Its impact would be related to predation on native insects and competition with native mantids. Surveillance and evaluation of impacts would be difficult in terms of time and resources. None were documented between June 2020 and November 2021.

B. Other taxa for consideration. Several potential invasive taxa were not identified in the surveys/inventories and other documentation cited in this report. Some of these taxa currently occur in portions of Virginia while others have not yet been found in Virginia but could expand into the Commonwealth in the future. This report suggests that current conditions represent low risk to forest habitats while biting nuisance and disease vector taxa remain important concerning human health and mission accomplishment. Based on potential future impacts and what has been documented thus far, surveillance for the following taxa is should be considered:

(1) Mosquitoes. Knowledge of the various mosquito species contributes to determining the best control techniques and reduces overuse of pesticides. Currently, mosquito-borne pathogens probably represent a lower risk at JBLE-E with West Nile Virus (WNV) being the one of significance. Species surveillance was conducted in 2009 and then a more comprehensive inventory was accomplished in 2017. Department of Public Health (MEDDAC) performed species surveillance in 2021 and the data was incorporated into a consolidated list of mosquito species documented in 2009, 2017 and 2021. Species identification was performed by US Army Public Health Command. Consolidated list is found in section 8. *Aedes infirmatus* was documented in 2021 and had not been observed on the installation previously. It is a nuisance biter and may bite during the day. It appears to breed in low-lying areas that collect precipitation in forested areas and open fields. This species is not known to be a vector of pathogens that cause disease in humans.

(2) Hard ticks. Tick and tick-borne pathogen surveillance has been on-going at least as far back as 1998. Department of Public Health (MEDDAC) has disseminated tick specimens to US Army Public Health Command (and its preceding organizational names) from 1998 through the current time. These tick specimens are brought to that office by personnel who find a given tick. In 2007, CEIE began executing a Tick & Tick-borne Disease Threat Assessment that acquired ticks from the environment as well as biological samples from mammalian and avian wildlife. Collectively, these two surveillance programs provide

current information to support tick risk assessments and management. However, changes in tick species and vectored pathogens and other conditions have been observed since 2007. Some tick species were not identified until after the 2007 program began, several pathogens were documented only recently, and new information on host species has been noted. Additionally, a new invasive tick species was only recently found in the United States. The Asian long-horn tick (*Haemaphysalis longicornis*) was first documented in 2017 and has since been found in several states including Virginia by 2018. JBLE-E participated in a 2018 surveillance program with US Army Public Health Command with 24 whitetail deer examined and subsequent ticks sent for identification. In August 2019, US Army Public Health Command assisted CES and DPH in collecting ticks. A number of specimens were obtained and CES received tick data but no pathogen analyses. No funding was available for further tick and vectored pathogens with FY 20 or 21. CEIE collected several tick specimens and blood card samples in April, May and June 2020 as well as 2021 but unable to forward testing. Ticks will be identified by the IPMC and blood card samples retained in the event analytical resources become available.

(3) Red swamp crayfish (*Procambarus clarkii*) and Rusty crayfish (*Orconectes rusticus*). Both species are invasive in aquatic systems to include areas where water retention is not constant. The author documented the Red swamp crayfish at a York County location in 2015. These two taxa were included in an ACES project for FY 2021 (HERT215331); however, AFCEC did not fund the project.

(4) Asian long-horned beetle (*Anoplophora glabripennis*). This taxon has been found in certain parts of North America and may not be established in the United States and is thus not likely in Virginia as yet. However, it could be devastating to the installation forest resources should this condition change. Monitoring in advance of possible spread reduces risks of potential impacts. It attacks healthy trees and has a wide range of deciduous host species. Surveillance could be included with Alnus Ambrosia Beetle (*Xylosandrus germanus*), Fruit-tree Pinhole Borer (*Xyleborinus saxesenii*), *Euwallacea validus*, Ribbed Pine Borer (*Rhagium inquisitor*), and Carolina pine sawyer (*Monochamus carolinensis*).

(5) European gypsy moth (*Lymantria dispar*). This species is established in the United States and does occur in Virginia. The Base Operating Services contract includes surveillance for this pest; however, none have been documented on the installation. CEIE is considering taking over this task and possibly focusing on areas where hardwood trees are dominant such as Training Areas 1 and 2.

(6) Sirex woodwasp (*Sirex noctilio*). This species is established in portions of the northeast and upper Midwest but is not yet documented in Virginia. The survey performed in 2015 included monitoring for this wasp but none were found. Nonetheless, surveillance should be designed and implemented in advance as with the Asian longhorned beetle.

(7) Spotted lanternfly (*Lycorma delicatula*). This hemipteran is established in portions of the United States and was confirmed in one county in Virginia in 2017. It has not been documented thus far in the Hampton Roads area nor at JBLE-E. Specific host plants at the installation are uncertain; however, damage to at least some herbaceous plants from feeding and deposition of honeydew that contributes to black sooty mold could be of concern. The current Integrated Pest Management Plan (signed in 2020) contains a management program for this species.

(8) Redbay ambrosia beetle (*Xyleborus glabratus*). This beetle is established in the United States and caused major damage to redbay trees in Florida and other areas. It is known to occur in North Carolina and is probably not yet found in Virginia. It vectors a fungal pathogen (*Raffaelea*) that causes lethal laurel wilt. Some redbay stands exist on JBLE-E but their distribution on the installation needs clarification. A new forest inventory received in November 2021 is being reviewed to help identify redbay stand locations. This taxon was included in the 2015 inventory, but none were found. Surveillance could be included with the Alnus Ambrosia Beetle, Fruit-tree Pinhole Borer, *Euwallacea validus*, Ribbed Pine Borer, Carolina pine sawyer and Asian longhorn beetle.

(9) Beech scale (*Cryptococcus fagisuga*). This scale insect causes beech bark disease in healthy beech trees. It is established in portions of the United States and occurs in portions of central and western Virginia. A surveillance plan should be developed.

(10) Southern pine beetle (*Dendroctonus frontalis*). This tiny beetle is native to the United States including Virginia, yet it can be one of the most destructive pests of southern pine forests. Monitoring took place between 2011-2013 and again in 2015; however, none were identified. Purely based on speculation, this taxon may be absent or in low numbers due to various artificial and natural barriers (James & Warwick Rivers, large open areas on the installation, and the predominant deciduous forests in Training Areas 1 & 2), and/or adequate predators particularly the Dubious Checkered Beetle (*Thanasimus dubius*) which was collected in large numbers during the 2011-2013 survey. The current Integrated Pest Management Plan (signed in 2020) contains a management program for this species. Preventive measures are the primary management tool and the Integrated Pest Management Plan includes an assessment of pine forest basal area and working towards achieving basal areas of approximately 80 where feasible based on resources and military training needs. This might be partially met by funding HERT215337. Additionally, interspersed planting of longleaf pine represents another potential preventive measure. Surveillance remains necessary based on its destructive impacts on pines. If FY 21 projects are funded, HERT215331 (Macroinvertebrate and Flora Survey) will include a survey for Southern pine beetle.

(11) Cockroaches. The species discussed above have potential to be mechanical disease vectors and are important pests in food handling facilities (such as dining facilities) as well as lodging facilities. Elimination of clutter and maintaining good routine sanitary conditions represents effective preventive measures.

14. Data shortfalls. The following data shortfalls remain:

A. Order Odonata (dragonflies, damselflies). A small number of species have been identified. However, this group is an important component of freshwater habitats and should be further evaluated.

B. Order Orthoptera (grasshoppers, crickets and katydids). A taxa have been identified to genus and species. No taxa have been identified below family for Gryllidae and only a few tettiogonids are noted. Additional taxa are noted from Goose Island

C. The order Megaloptera (alderflies, dobsonflies & fishflies) also requires more attention. A few specimens were observed at BLDG 1409. This group are important in freshwater aquatic systems.

D. Only one individual mayfly (Order Ephemeroptera) had been observed in 2012 and was only identified to family level. This group may not be common because much of the surface water habitats are brackish. This group is extremely important in freshwater habitats.

E. One source suggested the presence of caddisflies (order Trichoptera) but no individuals were collected or identified below the order. This is another group important to freshwater habitat.

F. Plecoptera (stoneflies) remains undocumented.

G. The classes Protura (coneheads), Collembola (springtails) and Diplura (two-pronged bristletails) are insect-like arthropods and remain undocumented.

H. Other shortfalls. Data on the orders Decapoda (crabs, crayfish, etc.), other crustaceans, Chilopoda (centipedes), and Diplopoda (millipedes) as well as Opiliones (harvestmen, daddy longlegs) remains limited and still requires considerable review. Inventories of other invertebrates particularly molluscs and annelids (segmented worms) exist but remain extremely limited in scope.

15. Continued inventory of macroinvertebrates and supporting actions.

A. HERT215331 (Macroinvertebrate and Flora Survey). A scope of work for this project was submitted AFCEC for inclusion in ACES; however, it was not funded at the end of FY 21. The ISS/AFCEC indicated it would attempt to reverse this. As of the time of this Update, this had not been accomplished and is not likely to be executed. If it is executed or if the project can get reinstated in another FY, the following groups will be examined:

- Hydrachnidia Water Mites:
  Class Arachnida, Subclass Acari, Superorder Acariformes, Order Trombidiformes, Suborder Prostigmata, Infraorder Anystina:
  - Parasitengona
  - Trombidiina
  - Hydrachnidia - Water Mites (or referred to as Hydracarina or Hydrachnidiae)

- Identify remaining unidentified (by-catch) specimens in existing 2015 collection.

- Perform Southern Pine Beetle (*Dendroctonus frontalis*) survey.

- Spiders, Millipedes & Centipedes.

- Crayfish, Aquatic Amphipods, Aquatic Isopods.

- Tidewater interstitial amphipod (*Stygobromus araeus*).

B. CY/FY 2021-2022 inventory and surveillance. Natural resources staff continue to document macroinvertebrates by various means pending availability of resources, primarily time.

(1) Participation with the Cooperative Agricultural Pest Survey (CAPS) through Virginia Polytechnic & State University/Insect ID Lab continued in CY 2021.

(2) The CEIE spider inventory remains a perpetual task though the spider groups are limited to those that enter buildings.

(3) Pending time availability and the effects of the COVID-19 situation natural resources & IPM staff will implement a limited insect trapping and collection, and visual encounter surveys.

(4) Forest inventory. The installation is required to have a forest inventory completed every 10 years. The last inventory was completed in 2007. Originally, a survey was funded and scheduled for 2017; however, errors beyond the control of the installation precluded this task. This task was initiated in September 2020 and finished in November 2021. This inventory will be reviewed and analyzed for issues pertaining to arthropod diversity and potential for forest pest issues.

(5) Surveillance for Eastern Blood-sucking Conenose (*Triatoma sanguisuga*). This hematophagous hemipteran is a member of the family Reduviidae: Triatominae that parasitizes vertebrate wildlife. It is native to and has been documented in Virginia. In the southwestern United States and possibly Florida this species and other related species are competent vectors of protozoan parasite *Tryponosoma cruzi* that causes Chagas disease in humans. Only limited information exists for Virginia, and the insect has not been documented on the installation or Goose Island. Consideration is being given for surveillance work in 2022-2023.

(6) Survey in Training Area (TA) 30. TA 30 is located on the north side of Skiffes Creek across from 3d Port. Only limited wildlife survey data exists and no data exists for botanical or arthropod taxa. Consideration is being given to work this in 2022-2023.

Appendix A:

Goose Island Arthropod Survey

Supporting information related to Goose Island. The author performed an arthropod survey of Goose Island following approval by Virginia Department of Game and Inland Fisheries between 2014 and 2015 (Christensen, TP and W Mooring. 2016. *An Insect and Flora Inventory of Goose Island Wildlife Management Area Newport News, Virginia*, unpublished). This task was executed based on the close proximity of the Fort Eustis and a separate report exists for this effort. Goose Island is a land mass adjacent to Fort Eustis created from dredge material from Skiffes Creek that was deposited originally offshore in the 1940s and 1950s. Though not connected directly to Fort Eustis property, the island is separated from that landmass by only a few meters. A long vegetated spit reaches to within approximately 4-5 meters on the southeast and the remainder of the island is separated by a narrow channel on the northeast. Ownership was once held by the federal government (US Army) but the property had been transferred to the Commonwealth of Virginia. Currently, it serves as an informal Wildlife Management Area. No additional survey work has been conducted at Goose Island since 2015.

(1) Habitats. Goose Island contains no structures nor is used beyond an area for wildlife management. It consists of several habitat types: a brackish open water cove, low marsh, upland forest, a vegetated spit, open beach and a small pond.

(2) Results. Seven insect orders, 33 families. A total of 42 insect taxa were identified to genus or species level. 4 arachnid orders and 5 families. A total of 6 arachnids were identified to genus or species level. Actual taxa are noted in Tables 3 through 11.

Table 3: Insect Orders and Families Observed at Goose Island.

Coleoptera	**Family:**
	Buprestidae Carabidae Cerambycidae Cleridae Curculionidae Elateridae Scarabaeidae Staphylinidae Trogossitidae
Diptera	**Family:**
	Asilidae Cecidomyiidae Tabanidae Tipulidae
Hemiptera	**Family:**
	Aphalaridae Cercoidae Cicadidae Gerridae

	Pentatomidae Reduviidae
Hymenoptera	**Family:**
	Apidae Crabronidae Pompilidae Vespidae
Lepidoptera	**Family:**
	Erebidae Hesperiidae Lycaenidae Papilionidae Nymphalidae
Neuroptera	**Family:**
	Myrmeleontidae Chrysopidae
Orthoptera	**Family:**
	Acrididae Gryllidae Tettigoniidae

Table 4: Insect Subfamily/Genus/Species by Family (Coleoptera).

Family:	Subfamily/Genus/Species:
Buprestidae	*Dicerca obscura*
Carabidae	*Cicindela hirticollis*
	Cymindis limbata
Cerambycidae	*Xylotrechus sagittatus*
Cleridae	*Thanasimus dubius*
Curculionidae	*Hylobius pales*
	Platypodinae
	Cyrtepistomus castaneus?
	Scolytiniae
Elateridae	*Orthostethus infuscatus*
	Monchamus carolinensis
Scarabaeidae	*Phyllophaga*
	Copris minutus
	Valgus?

Staphylinidae	*Hesperus baltimorensis*
	Other unidentified staphylinids
Trogossitidae	*Temnoscheila virescens*

Table 5: Insect Genus/Species by Family (Diptera).

Family:	Genus/Species:
Asilidae	*Promachus*
Cecidomyiidae	*Taxodiomyia cupressiananassa*?
	Taxodiomyia taxodii?
	Taxodiomyia cupressi?
Tabanidae	*Tabanus*
Tipulidae	*Tipula*

Table 6: Insect Genus/Species by Family (Hemiptera).

Family:	Genus/Species:
Pentatomidae	*Halyomorpha halys*
Reduviidae	*Arilus cristatus*
	Sinea
Cicadidae	*Diceroprocta viridifascia*
Aphalaridae	*Pachypsylla celtidismamma*
Gerridae	
Cercoidae	*Prosapia bicincta*

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Table 7: Insect Subfamily/Genus/Species by Family (Hymenoptera).

Family:	Genus/Species:
Vespidae	*Vespa crabro*
	Monobia quadridens
Apidae	*Xylocopa virginica*
Pompilidae	
Crabronidae	*Microbembex*

Table 8: Insect Genus/Species by Family (Lepidoptera).

Family:	Genus/Species:
Papilionidae	*Papilio troilus*
	Papilio glaucus
	Eurytides marcellus
Erebidae	*Hyphantria cunea*
	Apantesis
Hesperiidae	
Nymphalidae	*Cercyonis pegala*
Lycaenidae	*Plebejus saepiolus*?

Table 9: Orders Mantodea, Neuroptera & Odonata.

Order:	Suborder:	Family:
Mantodea		
Neuroptera		Myrmeleontidae
		Chrysopidae
Odonata	Anisoptera	
	Zygoptera	

Table 10: Insect Genus/Species by Family (Orthoptera).

Family:	Genus/Species:
Gryllidae	*Gryllus*
	Hapithus agitator
Tettigoniidae	*Orchelimum vulgare*
Acrididae	*Paroxya clavuliger*
	Melanoplus femurrubrum
	Metaleptea brevicornis

Table 11: Arachnid Orders, Families & Genus/Species Observed at Goose Island.

Araneae	Family
	Araneidae Pisauridae Salticidae Tetragnathidae
Ixodida	Ixodidae (specimen lost)
Opiliones	
Pseudoscorpiones	

Table 3: Araneae Genera and Species

Araneidae	*Argiope aurantia* *Gasteracantha cancriformis*
Pisauridae	*Dolomedes triton*
Salticidae	*Colonus sylvanus*? *Phidippus*?
Tetragnathidae	*Tetragnatha*

(3) Applicability to JBLE-E. The following information about Goose Island and arthropods observed there during the 2014-2015 time frame can be applied to the installation.

- Tabanid flies. Goose Island contains suitable breeding sites for tabanid flies. As discussed at least one genus (*Tabanus*) was documented. This genus is a nuisance biting fly also observed on the installation. Portions of such breeding areas are close proximity to Third Port, Magnolia Park, and Harrison Road picnic areas allowing for emerging adults to impact the installation.

- Mosquitoes. No survey of mosquitoes was conducted by the author at Goose Island; however, they were obvious biting nuisances during the Goose Island insect survey. Areas of the adjacent salt marsh and the pond represent sufficient breeding sites for mosquitoes which could fly to the installation and become biting nuisances or disease vectors at Third Port, Magnolia Park and other areas of the installation.
- European Hornet (*Vespa crabro*). This large nonnative hornet was found at Goose Island. As discussed above, it may be invasive.
- Additional insect species. Several insect species were observed on Goose Island though none of these have been documented on Fort Eustis. It's likely these taxa may also occur on the installation. All taxa are considered native and none are considered to be pests.

  - Salt Marsh Cicada (Hemiptera: Cicadidae: *Diceroprocta viridifascia*).
  - Cypress Gall Midge (Diptera: Cecidomyiidae: *Taxodiomyia cupressiananassa*?).
  - Cypress Leaf Gall Midge (Diptera: Cecidomyiidae: *Taxodiomyia taxodii*?).
  - *Taxodiomyia cupressi*? (Diptera: Cecidomyiidae).
  - *Cymindis limbata* (Coleoptera: Carabidae, no common name).
  - *Hesperus baltimorensis* (Coleoptera: Staphylinidae, no common name).
  - *Sinea* (Hemiptera: Reduviidae, no common name).
  - Hackberry Nipplegall Maker (Hemiptera: Aphalaridae: *Pachypsylla celtidismamma*).
  - *Microbembex* (Hymenoptera: Crabronidae, no common name).
  - *Apantesis* (Lepidoptera: Erebidae, no common name).
  - *Plebejus saepiolus* (Lepidoptera: Lycaenidae, no common name).
  - *Gryllus* (Orthoptera: Gryllidae).
  - Restless Bush Cricket (Orthoptera: Gryllidae: *Hapithus agitator*).
  - Common Meadow Katydid (Orthoptera: Tettigonidae: *Orchelimum vulgare*).
  - Olive-green Swamp Grasshopper (Orthoptera: Acrididae: *Paroxya clavuliger*).
  - Red-legged Grasshopper (Orthoptera: Acrididae: *Melanoplus femurrubrum*).
  - Clip-wing Grasshopper (Orthoptera: Acrididae: *Metaleptea brevicornis*).

Appendix B:

Mosquitoes Species & Counts as of CY 2021

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Gneral. Mosquitoes represent an important group that adversely impact missions at JBLE-E. Most of the documented species bite humans. When populations attain sufficient numbers, nuisance biting can make outdoor activities difficult or even unbearable. This can affect the quality of military outdoor training, affect maintenance or field work by Range Operations and natural resources staff as well as contracted construction. Disease transmission is also a possibility with West Nile Virus being the more significant risk though Eastern Equine Encephalitis and Saint Louis Encephalitis are also possible though more rare. Knowledge of the species present offers insight on their respective biologies to include peak periods and locations of nuisance biters as well as disease risks.

Species Surveillance in 2021. It is the objective of this Branch to perform mosquito species surveys annually with resources permitting. Concurrently, the MAHC Department of Public Health also performs surveys with both organizations providing mutual assistance and sharing of resources. The Natural Resources and IPM Branch was unable to perform this task in 2021. Fortunately, the Department of Public Health (DPH) was able to collect data during June and July using BG Sentinels traps provided by the Branch. DPH identified the following species in 2021:

Aedes sp
Aedes albopictus
Aedes infirmatus
Aedes triseriatus
Aedes vexans
Anopheles crucians
Anopheles punctipennis
Anopheles quadrimaculatus
Coquillettidia perturbans
Culex sp
Culex erraticus
Orthopodomyia signifera
Psorophora ciliata
Psorophora columbiae
Psorophora ferox

All of the above genera and species had been previously documented with the exception of *Aedes infirmatus*. *Aedes infirmatus* was documented on the installation for the first time in 2021. According to MAHC DPH, US Army Public Health Command would not be performing any testing for mosquito-borne pathogens of specimens submitted by JBLE-E.

The combined mosquito species inventory as of November 2021 comprises 8 genera and 32 species:

Aedes sp.
Aedes albopictus
Aedes (Ochlerotatus) c. canadensis
Aedes cinereus
Aedes hendersoni (Ochlerotatus hendersoni)
Aedes infirmatus
Aedes j. japonicas (Ochlerotatus japonicas)
Aedes sollicitans (Ochlerotatus sollicitans)
Aedes taeniorhynchus (Ochlerotatus taeniorhynchus)
Aedes triseriatus (Ochlerotatus triseriatus)
Aedes trivittatus (Ochlerotatus trivittatus)
Aedes vexans
Anopheles sp.
Anopheles quadrimaculatus
Anopheles bradleyi?
Anopheles crucians
Anopheles punctipennis
Coquillettidia perturbans)
Culex sp.
Culex erraticus
Culex nigripalpus
Culex pipiens
Culex pipiens-quinquefasciatus
Culex restuans
Culex salinarius
Culex territans
Culiseta impatiens
Culiseta inornata
Orthopodomyia
Orthopodomyia signifera
Psorophora sp.
Psorophora ciliata
Psorophora columbiae
Psorophora ferox
Psorophora mathesoni
Uranotaenia sapphirina

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Mosquito Biology Simplified.

I. Mosquito species documented at Fort Eustis:

Aedes albopictus
Aedes (Ochlerotatus) c. canadensis
Aedes cinereus
Aedes hendersoni (Ochlerotatus hendersoni)
Aedes infirmatus
Aedes j. japonicas (Ochlerotatus japonicas)
Aedes sollicitans (Ochlerotatus sollicitans)
Aedes taeniorhynchus (Ochlerotatus taeniorhynchus)
Aedes triseriatus (Ochlerotatus triseriatus)
Aedes trivittatus (Ochlerotatus trivittatus)
Aedes vexans
Anopheles quadrimaculatus
Anopheles bradleyi?
Anopheles crucians
Anopheles punctipennis
Coquillettidia perturbans)
Culex erraticus
Culex nigripalpus
Culex pipiens
Culex pipiens-quinquefasciatus
Culex restuans
Culex salinarius
Culex territans
Culiseta impatiens
Culiseta inornata
Orthopodomyia
Orthopodomyia signifera
Psorophora ciliata
Psorophora columbiae
Psorophora ferox
Psorophora mathesoni
Uranotaenia sapphirina

II. Basic biology of genera & species as derived from various sources. Variations in respective biologies may vary to include here at JBLE-E.

III. Overwintering stages in temperate areas:

1. *Culex* and *Anopheles* overwinter as adult females.
2. Most species of *Aedes*, *Ochlerotatus*, *Psorophora* overwinter as eggs.
3. *Coquillettidia*, *Culiseta* and *Orthopodomyia* overwinter as larvae.

IV. Important points.

1. *Culex* spp.

- Breeds in artificial sites including but limited to open containers containing precipitation such as cans, barrels, tires and storm drains, with preferences for high organic matter content, and also street drains and culverts.
- Usually active dusk to dawn.
- Usually remain within 0.5 miles of emergence sites but can fly several miles.
- Under ideal conditions, development egg to adult is 1-14 days but usually a month of longer.
- *Culex territans* breeds in semi-permanent and permanent pools of streams, swamps, and ponds. Larvae had been found in roadside ditches and forested wetlands and collected from low areas of a tarp covering an ATV contained rainwater at JBLE-E. Larvae can be collected during spring, summer or fall. Sources suggest females prefer to feed on herpetofauna especially frogs but may bite humans. Females overwinter as adults in hibernation in colder areas. Has a short flight range less than 0.5 miles.
- *Culex salinarius* breed in either fresh or foul water such as grassy pools, ditches, ponds, occasionally in barrels, bilge water in boats, and sometimes in stump holes. Larvae collected from abandoned containers holding rainwater as well as the black gum swamp in Training Area 23 at JBLE-E. Larval development early in the season and continues at uniform rate during summer and early fall. Adults rest during the day in outbuildings and other similar shelters. Adult females overwinter in hibernation. Readily bite humans outdoors. Flight range variable - 1/4 to 5 miles.
- *Culex pipiens* breed in foul water in barrels, catch basins, faulty cesspools, ditches, and other similar habitats. Enter houses and bite at night. Adult females overwinter hibernating in cellars, basements, outbuildings, caves and other places that provide protection from cold. Short flight range of 1/2 mile or less. Can transmit organisms causing bird malaria, dog heartworm, Western Equine Encephalitis, West Nile Virus and St. Louis Encephalitis.

2. *Aedes* spp.

- May be brightly marked.
- Day-active (often biting in early morning and late evening) though *Aedes vexans* bites after dark.
- Breed in relatively clean water in small containers.
- Weak flyers = remain near emergence sites.
- Eggs can remain dormant for months if not wet.
- Adults live ~ 24 hours.
- Warmer temps usually needed for hatching/development.

3. *Anopholes* spp.

- Most have spotted wings (most other mosquitoes do not).
- Most do not have abdominal scales.
- Development egg to adult = ~ 8-10 days.
- Females live ~ 21 days, males ~ 7 days.
- One-time insemination is needed for a female to produce eggs throughout her life.
- Some feeding during day but rapidly increased after hours of darkness.
- Oviposition occurs at night.
- *Anopheles crucians* breeds in ponds, swamps, semi-permanent and permanent pools & are associated with aquatic vegetation usually under partly shaded conditions; seems to prefer acid water (reaches its greatest abundance in the acid water of cypress swamps). Overwinter as aquatic stages. Primarily outside and night biters.
- *Anopheles quadrimaculatus* overwinter as inseminated females in hibernation, flight range is one mile or less and can have 7 to 10 generations in a single season.
- *Anopheles punctinpennis* breeds in ponds, temporary pools, springs, borrow pits, roadside puddles, wheel ruts, stream eddies, barrels and other artificial containers – preference for cool and clear water. Females usually bite after dusk but will attack during daytime in wooded areas or in their resting places. They rest during day in hollow trees, culverts, underneath overhanging banks of streams or similar dark moist shelters. Most abundant early spring and late fall (less abundant in midsummer). Overwinter as adult females in buildings, cellars, hollow trees and other protected shelters. Short flight range typically up to 0.25 mile.

4. *Coquillettidia perturbans* eggs deposited on the surface of water containing heavy emergent vegetation as larvae attach to the vegetation with modified siphon (roots or submerged stems) remaining throughout development until ready to emerge as adults. Overwinter as larvae with adults emerging in spring and summer. Bite during night but will bite in shade if disturbed. Strong fliers (1 to 5 miles). Important pest near shallow water containing emergent aquatic vegetation. Attracted to light traps. It is a competent vector of Eastern Equine Encephalitis.

5. *Psorophora ciliata* overwinter as an egg. Eggs deposited in small depressions or cracks in the soil. Larvae are found in temporary rain-filled pools where they develop rapidly - usually 4 to 6 days while pupal stage is about 2 days. Larvae predaceous consuming other mosquito larvae. Larvae can be found from March to October but are seldom abundant. Females are persistent biters any time during day. Flight range 1 to 2 miles.

6. *Psorophora columbiae* females deposit eggs on damp soil subject to flooding by rainfall or overflow from streams. Overwinter in egg stage. Rank low-growing vegetation is ideal oviposition site. Attracted to light and flight range = 1 to 5 miles. Persistent biters day or night and even in direct sunlight.

7. *Psorophora ferox* breed in temporary rain-filled pools esp. in or near thickets, in overflow pools of streams, and occasionally in potholes in stream beds after summer rains. Larvae occur March to November developing rapidly. The females are persistent and painful biters, even in the open on cloudy days. Flight range is 1 to 2 miles.

8. *Uranotaenia sapphirina* breed in permanent pools and ponds, lakes and swamps containing emergent or floating vegetation exposed to sunlight. Larvae may be found throughout most of year. Most believe *U. sapphirina* feeds on reptiles and frogs as opposed to biting humans. Rest during the day in culverts, hollow trees and vegetation. Overwinter as adult females in shelters such as hollow trees. Attracted to light.

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Mosquito Counts for 2021.

1. CES performs mosquito counts at from 1 April through 31 October annually. In 2021, light traps with CO2 were deployed at 5 locations and adult mosquitos collected three times per week. The number of adult females (not identified below family) were counted and recorded.

2. Traps were deployed at the following locations:

Trap 1: Magnolia Park (vicinity of the TRADOC Band Concert Site). This was originally identified because public events occur there in the evenings at various times throughout the summer months, and potential breeding sites exist nearby. Potential mosquito breeding areas include the Memorial Park pond, tree hole cavities in the adjacent forested area, ravine adjacent to Magnolia Park and the pond located at Goose Island.

Trap 2: Child Development Center (CDC) at building 1140. This site was identified because children and CDC staff utilize an outdoor playground that is part of the facility. Potential breeding areas exist in the marsh habitat east of the facility.

Trap 3: Combined Club outdoor pool (vicinity of building 2123). This site was identified for surveillance because the pool serves as outdoor events during the summer months. Potential breeding areas include marsh and swamp habitats (as well as tree hole cavites) south of the building. The pool underwent extensive repair during 2021 and was virtually unused this year as a result.

Trap 4: Range 3. This location is near the south end of Mulberry Island before reaching the impact area. Soldiers conduct small arms live fire training from this site. Various potential breeding sites exist around the general area including swamp and marsh habitats, tree hole cavities, ditches and potential containerized breeding materials.

Trap 5: Golf Course Maintenance. The Pines Golf Course is the primary outdoor recreational facility at JBLE-E located towards the center of Mulberry Island. Collectively, it is a large area consisting of approximately 480 acres. It virtually surrounded by large areas containing various types of mosquito breeding habitats including roadside ditches, low-lying areas, forested wetlands, marsh habitats, ponds, tree hole cavities in adjacent forests and potential containerized breeding materials.

3. Data extracted from 2021 mosquito count reports.

   A. Overall counts were too low across the entire season to warrant aerial applications for adult mosquito control.

B. Overall average numbers per trap site based on 58 trap nights:

- Trap 1: 0.91
- Trap 2: 8.4
- Trap 3: 8.5
- Trap 4: 3.6
- Trap 5: 13.7

C. The golf course had the highest number of female mosquitoes per trap per night over the course of the season. The highest trap night recorded 39 females on 1 September. These higher numbers at this site are expected based on the large area and the extensive and diverse breeding habitats as well as resting areas being available.