

**FINAL REPORT ON PROJECT T-15-D: LAKE WALES RIDGE SCRUB  
ARTHROPODS**

***Project Number.***--T-15-D

***Project Title.***--General Cycle Projects 2007: Conservation Status and Management of Lake Wales Ridge Arthropods Restricted to Scrub Habitat.

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## **ABSTRACT**

Project designed to survey specialized Florida scrub arthropods on protected lands (state, federal, private) on the Lake Wales Ridge (LWR).

### **Major goals:**

1. To accumulate information on potentially endangered species.
2. To demonstrate effectiveness of habitat acquisition for proactive protection of non-target species.
3. To compile an account of the conservation status of each scrub-restricted arthropod on the LWR.
4. To present information on these species in a way that is convenient for land managers and others concerned with maintaining wildlife diversity.

**Methods:** 1. Flight traps (Townes traps, i.e., modified Malaise traps). 2. Bowl traps. 3. Targeted searching for individual species. 4. Soil sifting and soil extraction.

**Results:** 1. Out of thousands of species of arthropods living in scrub habitat on the LWR, 91 were identified as dependent on scrub habitat. 2. These species were sought on 23 LWR preserves. 3. Recorded 19952 site occurrences of scrub-restricted arthropods. 4. Produced searchable ACCESS file with site characteristics for each occurrence, natural history characteristics for each species (CD of ACCESS file included). 5. Prepared and recorded in a data base museum specimens representative of each species, to date 993 specimens total, specimens accessible in Archbold Biological Station (ABS) invertebrate collection (CD of ACCESS file of archived specimens included). 6. Archived remaining specimens in samples at ABS, or sent to specialists for future study. 7. Produced list of scrub specialist arthropods known from each preserve studied. 8. Provided preliminary information on which species apparently adequately protected, and which are apparently of conservation concern. 9. Presented species accounts that cover identification, natural history, conservation and management (including survey methods). 10. Provided a descriptive summary of project with analyses based on final data. 11. Presented 2 workshops on Florida Scrub Arthropods for land managers on LWR.

## **ACKNOWLEDGEMENTS**

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## INTRODUCTION

### Florida Scrub Arthropods on the Lake Wales Ridge

**Florida scrub is a threatened habitat on the LWR.**--This project addresses the near-absence of useful information on arthropod animals (insects, spiders, etc.) that are of potential conservation concern because they are restricted to Florida scrub habitat. Florida scrub, which is readily converted to some kinds of agricultural use and to residential, commercial and industrial development, is rapidly disappearing. The most biologically diverse examples of Florida scrub are on the Lake Wales Ridge, which has the only major concentration of scrub plants and animals not found on scrub sites elsewhere in Florida (Deyrup 1990). Over 85% of xeric upland habitat (including scrub, yellow sand scrub and sandhill) on the LWR has been eradicated since European settlement, much of this destruction within the last few decades (Weekly et al. 2008).

**Florida scrub as a habitat for arthropods.**—Florida scrub is a habitat found on rapidly-draining, sterile, sandy soils. The vegetation consists primarily of drought-tolerant shrubs, interspersed with patches of open sand that supports low-growing perennials and a few annuals. Some species of scrub-restricted arthropods, such as burrowing wolf spiders (*Geolycosa* species) and pygmy mole crickets (species of *Neotridactylus* and *Ellipes*) are confined to these open patches. In some types of scrub there are widely dispersed slash pines (*Pinus elliotii*) or a denser canopy of sand pines (*Pinus clausa*). Florida scrub habitat evolved with periodic fires that prevent the habitat from becoming a dense, dry forest with a heavily shaded understory, no open patches, and a layer of leaf litter several inches thick. Few species of scrub-restricted arthropods persist in this dense habitat from which fire has been excluded. For a more detailed description of scrub, see Myers (1990).

**General biogeography of Florida scrub.**--Florida scrub habitat is related to ancient habitats of the Madrotertiary. During the Pliocene (beginning about 5 million years ago) and through the mid-Pleistocene a band of dry savannah extended across North America. This allowed elements of an older dryland ecosystem to move eastward, eventually entering Florida. A number of characteristic Florida scrub arthropods appear to be species derived from this eastern migration, for example, the Florida sand roach (*Arenivaga floridensis*), the little black scrub scarab (*Haroldiataenius saramari*) and the orange-banded scrub bee-fly (*Hemipenthes bigradata*). During this time the Mississippi River remained as a barrier, and the present dryland arthropod fauna of the Southeast is much less diverse in most groups than that of the Southwest, for example, the extensive southwestern fauna of scorpions and sun-scorpions is represented by only two native species in the Southeast (Deyrup 1990). Other scrub specialist arthropods may be derived from eastern lineages endemic to the Southeastern Coastal Plain, including the ancient Fall-line Sandhills. The scrub pygmy mole crickets probably have such a derivation. For more details on the biogeography of Florida, see Webb, 1990.

**Yellow sand scrub on the LWR.**—A distinctive feature of the LWR is a habitat that is somewhat intermediate between Florida scrub and sandhill habitat. Sandhill

habitat is characterized by a dense ground cover of perennial forbes, scattered, fire-resistant pines, well-separated turkey oaks (*Quercus laevis*) and occasional clumps of scrub oaks. Sandhill occurs on sites where fires are frequent, usually 1-5 years apart. For a detailed description of sandhill habitat, see Myers (1990d). On the LWR, soils on the higher elevations consist of yellow sand that was not reworked during higher stands of the sea during the late Pleistocene, e.g., about 135,000 years B.P. Some of these sites, especially in the northern half of the LWR, were occupied (before European settlement) by sandhill habitat, almost none of which remains. In the southern half of the LWR and along the eastern edge of the LWR many of the higher, yellow sand sites were occupied by yellow sand scrub, mentioned frequently in the species accounts below. This habitat varies from dense scrub with abundant scrub oaks and hickories, to more open scrub, often patches of open sand and scattered turkey oaks, and to a habitat resembling sandhill, but with more shrubs, palmettos, and barren open areas. An increase in fire frequency can apparently, over time, convert yellow sand scrub to sandhill, and a decrease in fire frequency can reverse this process (Myers 1990). Some scrub arthropods seem to be found primarily in yellow sand scrub, such as the Highlands tiger beetle (*Cicindela highlandensis*), the elegant cone-ant (*Dorymyrmex elegans*), an undescribed species of pygmy mole cricket (*Ellipes* sp.), and species associated with scrub hickory (*Carya floridana*) or turkey oak. Some sites on the much younger Atlantic Coastal Ridge have a similar-appearing yellow sand scrub, but may have some different species of scrub-endemic arthropods.

**Biogeography of LWR arthropods.**—There is a series of ridges and uplands in Peninsular Florida that have scrub habitat. Some of these have their own species of arthropods, of which the *Melanoplus* scrub grasshoppers are the best known (Deyrup 1996). The LWR has, by a considerable margin, the largest concentration of rare Florida scrub fauna and flora. These include 29 species of plants, 5 vertebrates (Turner et al. 2006) and many arthropods. The last published study on the subject (Deyrup 1990) listed 35 species of scrub-restricted arthropods on the LWR. In preparation for the present study, Deyrup and Carrel updated the list to incorporate discoveries during the 19 years since 1990. The updated list, which can be found in the proposal for this project, included over 70 species. As the project continued over the last two years, more species were found, and the current list of scrub-restricted arthropods on the LWR now consists of 91 species. All of these can be found in the annotated species list below in the “Results” section.

This remarkable concentration of scrub-restricted arthropods on the LWR can be best attributed to a combination of four factors:

**Age of the LWR.**--The LWR is old, well over 1 million years, perhaps as much as 2 million years. This extensive period of time has allowed scrub species to accumulate from elsewhere, or to evolve on the ridge itself, or to persist when many other uplands were inundated during the late Pleistocene. In contrast, the Atlantic Coastal Ridge is probably a little more than 100,000 years old.

**Size of the LWR.**--The LWR is large, about 100 miles long. When considered as an island of upland habitat, there comes into play the well-known phenomenon that larger islands have greater biodiversity than smaller islands (other things being equal) (MacArthur and Wilson 1967).

**Latitude of the LWR.**--The LWR extends further south than other old uplands, and may have been protected somewhat from much cooler temperatures that prevailed in northern Florida during parts of the late Pleistocene (Webb 1990). This is not to say that the LWR was unaffected by the biogeographically traumatic climatic events of the Pleistocene, but we have no way of documenting LWR arthropods that disappeared during that time.

**Topography of the LWR.**--The LWR has varied topography, including numerous sinkhole lakes and a complex ridge-and-swale topography along much of its eastern edge, representing a series of Pleistocene coastal dunes. This varied topography may well have served to protect scrub habitats from complete replacement by sandhill habitats by reducing the extent and frequency of fire. This effect seems much more noticeable on the southern half and eastern edge of the LWR, although it is difficult to be sure when so little natural habitat is left on the northern LWR.

**Sandhill habitat on the LWR**--Sandhill habitat is not a recently constituted habitat when viewed over the Southeast, but in Peninsular Florida it probably moved south in recent times when fire frequency on the Peninsula appears to have increased about 10,000 years ago. Sandhill habitat has, of course, its own species of arthropods, such as the various species associated with pocket gophers (*Geomys pinetis*). Some widely distributed sandhill arthropods also occur in scrub habitats on the LWR; examples are the scarabs *Pelotrupes profundus* and *Hypotrachia spissipes*. Even though some of these species are treated as species of conservation concern in volume 4 of the Rare and Endangered Biota of Florida (Deyrup and Franz 1994), we did not include them in the current study. The exception to this rule is the associates of the gopher tortoise; we did not feel that we could in good conscience ignore the arthropods dependent on a species that is of conservation concern throughout its range.

## **The Conservation Significance of Florida Scrub Arthropods**

From a conservation perspective arthropods are not, in general, "charismatic megafauna." They might more appropriately be called "forgettable microfauna." Nevertheless, endangered arthropod species are just as irreplaceable as endangered vertebrates and plants. Endangered arthropods, like endangered vertebrates and plants, often have interesting and potentially valuable adaptations, including chemical defenses against fungi and bacteria, or physiological innovations to deal with extreme environmental conditions. Within the Florida scrub ecosystem some scrub specialist arthropods may have important ecological roles in decomposition, pollination, predation, herbivory, and as prey for other scrub species. Before dismissing endangered scrub arthropods as unimportant or as uninteresting to conservationists and the general public, it is pertinent to remember that until quite recently hawks, owls and snakes were often considered useless and undesirable vermin. As the smallest wildlife in Florida scrub the arthropods are the next frontier in animal conservation.

## Goals of this Project

**Goal 1: to accumulate information on potentially endangered species of Florida and the United States**—Although this project on Florida scrub arthropods on the LWR seems narrowly focused, it fits neatly into the much larger goals of documenting and protecting America's native fauna. These are goals of the U.S Fish and Wildlife Service National Wildlife Legacy Program that supports the Florida's Wildlife Legacy Initiative through the Florida Fish and Wildlife Conservation Commission. It makes sense to focus on Florida because Florida is already known to be home to a large number of rare and endangered species of arthropods (Deyrup and Franz 1994). Many of these species are not only restricted to Florida, but also restricted to a small area within the state. This is somewhat surprising in view of the fact that Florida is the flattest state in the U.S. The deceptive topographic blandness of Florida may help explain why documenting and protecting Florida's arthropod diversity has proceeded so slowly. If one wanted to get a large amount of new information on a large number of potentially endangered species, Florida scrub habitat would be a good place to start because Florida scrub is a patchily distributed and locally threatened habitat that is already known to have many habitat specialists among its fauna and flora. Finally, the LWR seems to have a disproportionate number of these specialized organisms, for the reasons discussed above under "Biogeography of LWR arthropods." If one sought the most effective way to get the greatest amount of original information on the largest number of poorly known potentially endangered species at the state or national level, a study of Florida scrub arthropods on the LWR would be an excellent place to start.

**Goal 2: to demonstrate the effectiveness of habitat acquisition for proactive protection of non-target species**—It need hardly be said that no scrub preserves have been established specifically to protect such animals as spiders, beetles and grasshoppers. Nevertheless, it may be optimistically assumed that protection of natural habitat will incidentally protect habitat-specific arthropods. This, however, has not been demonstrated using a large number of diverse species and an array of habitat islands that vary in size, configuration and management. Theoretically, there could be so many idiosyncratic factors required to support populations of some species, and some species could be so narrowly distributed, that there would be little overlap in scrub specialist species among many of the sites. As we began the study, none of the 70+ targeted scrub arthropods were known from more than a few protected sites. Some of them were known from only a single site, the Archbold Biol. Sta., where scrub fauna and flora have been studied for more than 50 years. In spite of this, it seemed probable that the project would succeed in the sense that it would expand the list of known protected populations of many species. This would go beyond an academic demonstration of the effectiveness of habitat protection to inadvertently and incidentally protect potentially endangered species. Given the expense and regulatory burden associated with listing endangered species, every additional population found has positive implications for management and regulation. It would be money in the bank and red tape in the trash to show that even a few species were adequately protected when they were previously known from only one or two protected sites.

**Goal 3: to compile an account of the conservation status of each species of scrub-restricted arthropod on the LWR**—The data storage mechanism for this project is an ACCESS data base of species occurrences and associated information derived from two years of field survey work and lab identification work. Technically, most information on the species could be compiled directly from this data set. In actuality, this information would be difficult to use unless it were compiled and interpreted for each species by the researchers who had done the field and laboratory work. Much of this final report consists of species accounts, including not only data, but also interpretation. Literature references are appended to most species as resources for additional information and to assist in identification of species. Included in these species accounts should be enough information on the effectiveness of survey methods to allow additional or follow-up studies. The reader should remember, however, that the details in the “Methods” section, the information on date, habitat, trapping or observation method, the numbers of individuals, and GPS site occurrences in the data set would also be useful for any further work on any of these species.

**Goal 4: to present information on these species in a way that is convenient for land managers and others concerned with maintaining wildlife diversity**—Workshops are a useful way to present information and demonstrate techniques. Two workshops and two additional presentations were incorporated into this work. The final workshop included a Power Point presentation that can be distributed to anybody interested in scrub arthropods and their conservation. The value of workshops, however, fades over time as the participants move on to other activities. The best way to make a durable contribution is to provide an accessible report with a coherent narrative that is not excessively technical. This should be combined with specific information that is conveniently presented. For example, land managers or researchers could find out which of the scrub arthropods had been found at a particular preserve by calling up the data set or by going through the annotated species accounts. It is much more convenient, however, to get this information from a list of sites with the species known from each one. We have provided this in the final report. Likewise, there is information in the data set about which individual arthropods were seen or collected in particular habitats or situations. It is more useful for management and conservation, however, to be provided with information compiled to show a few of the most important patterns. For this project we discuss gopher tortoise associates, scrub rosemary associates, the effects of roads and, briefly, some effects of fire. Again, the reader is reminded that there are undoubtedly additional useful patterns to be derived from the data set. Anybody using this report is urged to read the section (under “Results”) discussing the data found in the ACCESS file to better understand the information that is available for analysis.

## **METHODS**

The methods involved are simple, but require considerable labor and expertise. Effective methods for finding or capturing the 90+ species vary by species. Sampling

methods are discussed in the individual species accounts and summarized below under each method.

## **How to Survey for Multiple Species**

An obvious methodological feature inherent in this project is the need to be able to recognize all the species. At first glance, it may seem that recognizing 90+ species should not be a major challenge; most bird watchers, for example, master this easily. In the arthropod world, however, the situation is made more difficult by the massive diversity of the group. Moreover, there are many sets of similar-appearing species, analogous to the winter sandpipers or fall warblers. In the scarab genus *Onthophagus*, for example, there are five similar-appearing small black species found in scrub habitats, of which only two (which are not the most abundant) are on the list of scrub specialists. According to faunistic studies done at the Archbold Biological Station, there are several thousand species of arthropods found in Florida scrub on the Station. The difficulty in surveying for scrub specialists lies in distinguishing them from similar species that occur in a much wider range of habitats. The species accounts attempt to briefly do so under the heading of "notes." The accounts also list references used for identification, when such references exist.

Any attempt to repeat this survey would still require some preliminary taxonomic training with actual specimens. A good place to start would be the arthropod collection of the Archbold Biological Station, where there are prepared specimens of all the scrub specialists found in the current survey. If this study were to be repeated at sites off the LWR one should be prepared for additional species not found on the LWR (Deyrup 1989, 1990). Finally, the current study was restricted by the limited taxonomic abilities and training of the principal investigators. Survey work by biologists with expertise in groups less familiar to the current principal investigators, for example leafhoppers or chalcidoid wasps, might well produce additional species that should be considered scrub specialists.

Multi-species survey efforts are never completely replicable. The success, however, of such programs as the Christmas bird counts shows that even those surveys most sensitive to differing environmental conditions and variable abilities of participants can have great scientific value.

## **Flight Traps**

The most important method for simultaneous sampling of multiple species of flying insects is the Malaise trap, now usually used in some modified form. The flight trap used in this survey is the Townes flight intercept trap, a barrier trap with a tent-like upper portion that funnels flying insects into a bottle of alcohol. These traps are available from a number of sources, for example, Bioquip. The advantage of these traps is that they operate day and night, also preserving the catch to be picked up at a convenient time. Normally, this should be every 2-3 days; longer delays risk having the collection bottle fill up with insects, which then begin to decay due to the dilution of preservative. In Florida the bottle of insects also heats up during the day in summer, further degrading the specimens when they are left out too long. Townes traps collect

enormous numbers of insects, especially Lepidoptera, Diptera, and Hymenoptera. Townes traps are the source of many of the records in our data set of scrub arthropods, as can be seen from the ACCESS files, in which trapping method and the length of time the trap was employed are listed for each species occurrence. Even some flightless arthropods, such as worker ants, flightless grasshoppers, and spiders sooner or later appear in Townes trap samples.

Townes traps and similar flight traps have three disadvantages. **1.** They collect so many specimens that a researcher can quickly become overwhelmed by samples from just a few traps. Processing, which involves looking at all the specimens and counting the individuals of the target species, takes so much time that in the current study the use of the traps was effectively limited to 2-3 preserves at a time, and even this led to a large backlog of samples. **2.** The numbers of specimens of a particular species are seldom useful for statistical analyses, tempting though it may be to do such analyses. This is because flight traps are extremely sensitive to positional effects. Even traps that have the same orientation and that are set up within a few meters of each other often show striking differences in numbers and species of insects caught during the same trapping period. Flight traps running at different times often show big differences in catch because of differences in weather and season. Even simple presence/absence studies are affected: the absence of a species from flight traps set up at a site does not mean much, unless that species is generally abundant in flight traps running at the same time elsewhere. **3.** These traps are expensive, currently costing about \$200, and generally only last for one season of continuous use. They are also subject to damage by animals, especially if the traps have been set up across a game trail; such trails are easily detected in sandy scrub and should be avoided. When setting up a trap across a trail with dense vegetation on each side it may pay to leave a gap on one side to allow passage of raccoons or deer. When a bear takes a dislike to a trap, as happened a few times in this study, the trap cannot be salvaged.

In spite of these limitations, flight traps provide some useful numerical information. A trap set up in one place for a long time provides useful numbers on seasonal activity of many species. When flight traps are run continuously in a region, even though they are at different sites they adequately show seasonal activity of flying insect species that occur through that region. Here again, the numbers are not suitable for quantitative analysis. For determining the presence or absence of a particular species at a particular site, even a single record from a flight trap is highly significant. The air space occupied by a flight trap is relatively tiny, and many flying insects that hit the net barrier do not go up into the tent trap, so there is little chance of picking up a single stray from outside the study area. While Townes traps often capture enormous numbers of insects, they are basically inefficient, for the reasons just mentioned. Therefore, a species that occurs in large numbers in these traps at a particular site can safely be considered abundant on that site. This is the case, for example, with *Odontomachus relictus*, a cryptic, nocturnally active ant whose males are often captured in flight traps. Information on which species were captured in Townes traps is in the ACCESS data base. This information also appears under "survey methods" for each species.

There are several ways to increase the efficiency of Townes traps. Setting one up across an open path through dense scrub can take advantage of the concentrated

flight traffic along such a corridor. (This also increases the chance that it will be damaged by large animals using the path). Townes traps can be baited with substances that are attractive to certain insects. We attempted to bait for scrub longhorn beetles by placing freshly cut branches beside the trap, but this did not seem effective. A simple way to greatly increase the effectiveness of Townes traps is to pile up sand and leaf litter along the lower edges of the trap so that there is no gap between the trap and the ground. We did this throughout the study.

The best way to increase the number and diversity of arthropods captured by Townes traps is to place a trough or set of shallow pans along the lower edge of the trap so that low-flying insects that hit the netting barrier fall into the trough. This was done in 2009 but not 2010. The trough can be filled with a preservative such as low-toxicity antifreeze. Rather than using antifreeze, we used water to which we added a few drops of biodegradable, phosphorus-free, unscented dishwashing detergent. Scrub soil is nutrient-deprived and subject to long-term retention of chemicals carried deep into the soil column, so we avoided antifreeze, which might wash out of the troughs during heavy rains. The problem with detergent is that the traps must be checked daily or specimens begin to rot. A trough combined with a Townes trap or other flight intercept trap is an excellent way to sample for low-flying insects, such as beetles associated with gopher tortoises, the surface-active flies *Asyndetus archboldi* and *Townsendia arenicola*, and even flightless arthropods such as spiders and pygmy mole crickets. Information on which species were captured in pan traps associated with Townes traps is in the ACCESS data base. This information also appears under “survey methods” for each species.

To one viewing bottles filled with hundreds or thousands of insects captured by Townes traps it might appear that these traps could significantly affect populations of rare species. As mentioned above, however, these traps sample such a small area that they are unlikely to alter the population of any species. An exception might be a trap baited with a substance that is almost irresistible to some species, such as carrion, dung, or a specific pheromone. This kind of baiting was not done in our study. One might also worry about the effect of a trap across an important flight corridor in a very small, insular habitat. If, for example, a species of tiger beetle were confined to a small patch of habitat within a preserve, it would be inadvisable to erect a Townes trap in that patch.

After each sample was sorted and the numbers of each target species recorded in the ACCESS data base, the samples were preserved in fresh alcohol and archived at the Archbold Biological Station.

## **Bowl Traps**

Pitfall traps, which are deep, open cylindrical containers buried to their brims in soil are a classic method for sampling for arthropods, especially beetles, spiders and ants. On the LWR, however, these traps are inappropriate, as they regularly capture endangered sand skinks (*Plestiodon reynoldsi*) and, much less frequently, endangered blue-tailed mole skinks (*Plestiodon egregius lividus*). Pitfall traps are frequently used in field studies of these fossorial lizards. In place of pitfall traps we used bowl traps, shallow plastic dessert bowls either 6” or 7” in diameter, manufactured by Solo Cup

Company. At the Archbold Biological Station yellow bowls seem to capture more beetles and wasps, blue or white bowls capture more bees and thrips, dark bowls capture a greater percentage of aquatic insects. The primary reason for bowl traps was to obtain spiders, which are probably not affected by bowl color. For this study we used yellow bowls. Bowl traps were buried up to their rims in sand. The slightly raised rims probably deterred some arthropods such as velvet ants (Mutillidae), but they evidently prevented the capture of sand skinks or blue-tailed mole skinks. Sand skink trails were frequently seen near the bowl traps. The bowls were filled with water containing a little detergent. Arthropods were strained out daily to prevent them from decomposing and preserved in alcohol. Bowls were spaced 1-3 m apart in trap lines of 25 bowls associated with each Townes trap. They were given the same site designation as the accompanying Townes trap. As in the case of the pan traps set out below Townes traps, a water-detergent mix was used rather than a preservative that might pollute the sites.

Bowl traps were especially useful for capturing ground-dwelling spiders, pygmy mole crickets (Tridactylidae), ants, the ground-active flies *Asyndetus* (Dolichopodidae) and *Townsendia* (Asilidae) and grasshoppers in the genus *Melanoplus* (Acrididae) and the millipede *Floridobolus penneri*. The vast majority of arthropods trapped by the bowl traps were non-target species, as in the case of the Townes traps. Some of these might be unrecognized Florida scrub specialists. Information on which species were captured in bowl traps is in the ACCESS data file. This information also appears under “survey methods” for each species.

Bowl trap data are subject to the same limitations as those from Townes traps. Their catch is strongly affected by position, seasonality and weather. Heavy rains may flush specimens out of the bowls. They are frequently disturbed by raccoons, which sometimes bite and puncture the bowls, or flip over a whole array one by one, or partially fill them with sand. It is easy to imagine that this vandalism reflects frustration, as the traps would provide both drinking water and edible arthropods if these resources were not contaminated by detergent.

We used bowl traps in 2009 but not 2010. The backlog of samples from 2009 was so great that we decided to confine trapping to Townes traps, which provide a greater diversity of species targeted in this study. Bowl traps are also more labor-intensive, taking more time to set out and collect, and requiring that the site be visited every day. If managers at some sites wish to follow up on this survey in the future, they might find it more efficient to deploy bowl traps strategically, especially if full-time field assistance is unavailable. For maximum efficiency, we would recommend setting out bowl traps in May just before the rainy season, and again in June after the first few soaking rains. These seem to be peak times for terrestrial arthropod activity, judging by the gross quantities of arthropods in our jars of samples.

It is unlikely that the number of bowl traps that we used would affect the populations of any arthropod species restricted to Florida scrub. There is no reason to believe that yellow bowl traps are attractive to these species, although they are known to be attractive to some insects, such as scelionid wasps. They should probably not be deployed in sites where species of ground-active arthropods such as scrub tiger beetles or scrub wolf spiders are confined to a very small patch within the preserve.

## Light Traps

We originally intended to use light traps to attract nocturnal scrub insects, especially June beetles (*Phyllophaga* species) and longhorn beetles (Cerambycidae) such as *Liopinus* sp. and *Enaphalodes archboldi*. This plan was abandoned after several attempts because the traps filled up with enormous numbers of moths and midges, such that sorting would have taken time needed for more productive activities.

## Specialized Collections or Observations of Scrub Arthropods

Townes traps and bowl traps survey in a haphazard way, and their virtue is that they operate continuously, gathering nocturnal species and species that are evasive or seldom seen. It is often more efficient, however, to search for species directly, using knowledge of their ecology to guide the search. A good example of the effectiveness of this approach is provided by the scrub spikemoss moth, *Chionodes latro*. This species was never collected as adults in flight traps, but could be easily observed and recorded from many (16) sites by searching for conspicuous and characteristic feeding tubes on its host, *Selaginella arenicola*.

Other species were found by sweeping an insect net repeatedly through the host plant. Several scrub-restricted plants have specialized associated herbivores; such plants include *Ceratiola ericoides*, *Polygonella myriophylla* and *Calamintha ashei*. The sought-after insects are usually small, and often evasive, even after they have been captured in an insect net. It is usually most productive to dump the contents of the sweep net, including all bits of vegetation, into a plastic bag, which is then sealed, taken back to the lab, and put in a freezer. After a few hours the bag is removed from the freezer, allowed to reach room temperature while sealed (otherwise, moisture may condense on cold specimens), and examined in small batches under the microscope.

*Geolycosa* spiders can be identified by their burrows in the sand. Actual specimens of *Geolycosa xera*, for example, were not excavated at all 21 sites from which this species is recorded.

Flightless scrub grasshoppers, of which there are several species on the list, are best found by walking slowly through low scrub while listening for the sound of jumping grasshoppers landing on dead leaves of shrubs. There is no good way of summarizing these techniques. They are included in the "survey methods" sections of the species accounts.

Subterranean beetles, especially *Geopsammadius* species and *Haroldiataenius saramari*, are collected by sifting. In the field, sand is sifted in a strainer with the approximate mesh size of window screen; this removes the sand. The siftate is placed in a plastic bag and brought back to the lab. It is then placed in a 1/8 inch mesh sifter (the sooner the better after returning), which is shaken to remove the larger material. The larger material on the screen is checked for sand roaches and large beetles. The sifted material is placed in a Tulgren funnel to extract small insects into containers of alcohol. A layer of sifted material about 1 cm thick takes about 2 hours for extraction.

A GPS notation is included in the ACCESS account for each observation or specialized collection.

## Storage and Use of Specimens

The specialized collecting mentioned above can produce a good number of specimens, especially the vegetation sweeping technique. The vast majority of specimens, however, were collected in flight traps (including those with a pan) and yellow bowl traps. These traps produced huge numbers of specimens, preserved in alcohol in individual sample jars. Specimens collected for this project should be considered part of the data set associated with each preserve, and there should be some accounting for this resource. Moreover, when large numbers of native arthropods are killed in natural habitats, even though this may have a negligible effect on populations (see discussion above), it is ethically proper to make sure that these arthropods are utilized as fully as possible. It may seem that the discussions below place an inordinate emphasis on arthropod specimens. In a large-scale arthropod survey, however, both long-term and short-term verification of species identification depends on the availability of specimens, and retention of specimens is one way to greatly increase and prolong the investment made in the project.

## Project Voucher Specimens

Voucher specimens are used in entomology to securely attach a research or literature record. This is useful, often even necessary, because the taxonomy and nomenclature of arthropods is not yet completely stable. For example, when *Geopsammodius relictillus*, one of the species studied in this project, was first described (Deyrup and Woodruff 1991), it was assumed that specimens found on the Atlantic Coastal Ridge were the same species, making it a fairly widespread species in peninsular scrub habitats. Later examination of specimens from both areas showed that there were actually two scrub species involved, one confined to the Lake Wales Ridge, the other found on the Atlantic Coastal Ridge. We already know that some scrub-specialist species on the Lake Wales Ridge seem to be undescribed species, and without specimens collected for this project there would be no way to eventually attach names to records from the preserves where these species were found. Moreover, the names applied to the specimens found in this survey are only as accurate as the knowledge of the entomologist who did the identification; there are no infallible entomologists.

We have prepared voucher specimens of the scrub-restricted species collected in this survey, attempting to get representative vouchers from each site. Pinned specimens were given catalog numbers, as well as the usual labels, entered into the ACCESS data base and incorporated into the ABS invertebrate collection. Spiders and millipedes are in separate vials of alcohol in the ABS collection.

## Additional Specimens

Many additional specimens were pinned, labeled and placed in the ABS collection. These are not necessarily scrub-restricted species, but are unusual, or possibly undescribed species. These include, for example, a long series of unidentified leafhoppers collected only by sweeping scrub rosemary (*Ceratiola ericoides*). The

additional specimens include many specimens that belong to poorly known groups that are likely to have undescribed local species, some of which may be restricted to scrub habitat. We have prepared, for example, hundreds of specimens of parasitic wasps in the family Braconidae. Within this family, to take an instance of taxonomic uncertainty, there are two genera of black-and-red wasps, *Digonogastra* and *Cyanopterus*, with species that are common on recently killed scrub oaks or pines, where they parasitize beetle larvae in the bark or wood; none of these species are identifiable at present. Eventually these specimens will find their way into the hands of specialists who are reviewing species in various genera of Braconidae, and new or unusual species will then be recorded from a series of protected sites. Such specimens are not currently part of the project data base, but it is our hope that when preserve managers get requests for permits to survey and collect a particular group of arthropods on their preserve these managers will remember that the study may be supplemented by some useful prepared material in the ABS collection. One example of how this may work is provided by a recent study of the fly family Curtonotidae. A graduate student working on this family found several old specimens collected in scrub at the ABS that appeared to be an undescribed species known from no other sites. When contacted, we were able to send about two dozen additional specimens from Tiger Creek; this series will now provide the primary basis for describing the new species. This fly, in its own little way, emphasizes the unique nature of Florida scrub and the concept that more has been protected than we are aware of.

An efficient way to project the effects of this grant into the future is to send sorted specimens to specialists, in the hope that these specialists, their students, or their colleagues will find time to study these specimens. The groups set aside to be sent to various specialists include Neuroptera, velvet ants (Mutillidae), vespid wasps, including Eumeninae (Vespidae), robber flies (Asilidae), and small dung flies (Sphaeroceridae). Remaining specimens are stored in alcohol at the ABS, and are available for study by anybody who is interested in seeing arthropods from a particular scrub preserve.

At the first workshop for this project land managers requested a guide or manual for the scrub-restricted arthropods found on Lake Wales Ridge preserves. This manual, discussed below, has species accounts that have brief diagnostic notes. Sometimes, however, it helps to see an actual specimen. The project voucher specimens can also be used as reference specimens for identification. In the ABS collection, these voucher or reference specimens are arranged in small trays, one species per tray, with related local species (if any) in nearby trays. This allows easy comparison between scrub-restricted species and other local species in the same genus.

## RESULTS

### Summary of Numerical Results

***19952 site occurrences of Florida scrub specialist arthropods***

***23 Florida scrub preserves visited (Private, State, National)***

***1598 pages of "field notes in ACCESS program***

***3000+ “trap days” in Florida scrub preserves***

***9 undescribed species of Florida scrub insects to date***

***91 species of arthropods now identified as Florida scrub specialists***

***25 species of Florida scrub arthropods identified as apparently not of conservation concern: known from 10 or more protected populations***

***66 species of Florida scrub arthropods remain as species of conservation concern: known from fewer than 10 protected populations OR dependent on a listed plant or animal.***

### **Status of Lake Wales Ridge Arthropods Restricted to Florida Scrub**

The alphabetical, annotated list of species is placed in a separate section, Appendix I, to separate it from more general discussions of the purpose, methodology and results of this study.

### **Scrub Arthropods Found at each Scrub Preserve**

A list of the species found on each preserve appears in Appendix 2.

### **ACCESS Data Base**

The written field data associated with this project are in the form of an ACCESS data base, as suggested by the grant provider. This is the principal product of this project that can be used for data analysis by the grant provider and others. A simple list of numbers of individuals of each of the species found on each preserve is only one of the many applications of this data set. Other ways that the data set might be used are suggested below in the list of occurrence data associated with each record. Species attributes at this point are confined to the species name, as it is not clear how the data base will be used. One could, for example, add “gopher tortoise burrow inquiline” to species attributes and sort for those records alone. If one were interested in the proportion of flightless to flying species in the data base, one could add these species attributes. One could make a separate category for species with flightless females and flying males (there are a number of these). It is not usually possible to infer species attributes from the ACCESS file itself. Many species attributes appear in the species accounts.

A disc with the ACCESS file is part of the final report. The ACCESS file will also be kept at Archbold Biological Station, and a copy has been requested by a representative of Florida Natural Areas Inventory. It seems probable that some of these data might be of interest to some preserve managers, for example, a preserve manager might wish to know exactly where and under what conditions a particular species was found on their preserve. For this reason, Archbold Biological Station might be willing to

host this data set on their web site. There seems to be little justification from the standpoint of conservation to restrict the availability of these data. Only one species, *Cicindela highlandensis*, is at all likely to be targeted by amateur collectors, and all the preserves included in this survey require collecting permits in any case.

Almost 20,000 occurrences have been entered to date into the data base. Each occurrence is associated with the following data.

**Observer.**--Initials of the person who made the observation or bulk sample collection, plus the person who made the identification. All identifications were made by MD (Mark Deyrup) or JC (James Carrel).

**Preserve.**--One of 23 preserves included in this study, e.g., Gould Road Preserve, or FWC Sunray Preserve. The list of species found on each preserve is both useful when considering conservation status of the species and of possible interest to preserve managers. As the project has proceeded, we have been extracting these records from the ACCESS files and sending them to preserve managers along with the quarterly reports. This list appears in this report, although it can also be extracted directly from the ACCESS data base.

**Trap site.**--Site where flight intercept traps or bowl arrays were located. Also used for observation sites, such as observations of *Geolycosa* spider burrows.

**Latitude and longitude.**--This provides a spatial position for each species occurrence. Readings were taken with a small, hand-held Garmin "etrex" GPS finder, with an accuracy of about 12 feet. Greater accuracy was considered meaningless, as all the species studied are relatively short-lived and have mobility greatly exceeding 12 feet. The data are expressed in decimal form, e.g. N27.18132. The positional data allow future return to an observation site, and can also be converted from the ACCESS file into distribution maps for any of the species. No records were added into the data set unless latitude and longitude were available. This excluded from the data set some historical records, but an attempt was made to replace these records with new records that had latitude and longitude.

**Habitat type.**--The Florida scrub habitats where observations were made fall into the following general categories: mature sand pine scrub; rosemary-oak scrub; mixed shrub scrub; scrubby flatwoods; yellow sand scrub; man-modified. One could use this information, for example, to find out how many times the scarab beetle *Geopsammadius relictillus* was found in each of these habitats. One could also compare the list of scrub-restricted species found in rosemary-oak scrub with the list of species found in another scrub habitat, such as scrubby flatwoods.

**Habitat density.**--Although one might expect that habitat density would correlate completely with time since fire (habitat stage, listed below), this is not always the case. Habitat density was roughly described as: open patches frequent, open patches few.

**Field methods.**—This information can be used to roughly quantify effective methods of surveying for a particular species. The methods listed are: Berlese extraction; flight trap; light trap; yellow bowls; blue bowls; sweeping (vegetation); observed; other. More detailed methods may also be included in the ACCESS files as “notes.” For example the plant bug *Keltonia rubrofemorata* might be listed as found by “sweeping,” and an additional note would list *Polygonella myriophylla* as the kind of plant that was swept with the insect net.

**Habitat stage.**--This information was included in recognition that the time since a fire has a huge effect on habitat structure in Florida scrub. The stages include: long unburned: more than 25 years; long unburned: about 25 years; intermediate burned: about 6 to 24 years; recently burned: about 1-5 years; unknown; n/a.

**Edge of road?**--This is a yes/no category. It is included in recognition that roadsides, especially in long-unburned Florida scrub habitat, may be refuges and dispersal corridors for open-site species. See discussion in this report.

**Number of traps and number of days.**--This allows an estimate of the number of “trap-days” required to collect certain species on a particular trap site. It can be expanded across sites to give a rough idea of the vulnerability to traps of various species. So, for example, all specimens of the longhorn beetle *Typocerus fulvocinctus* found during the two-year period were collected in flight traps, but only 6 specimens were collected over an enormous number of trap-days. This indicates one should not expect to find this species any time one set up a trap in the right habitat during the right season.

## DISCUSSION OF APPLICATIONS OF PROJECT

### Justification of proactive conservation

This project provides data-rich documentation that habitat protection may incidentally and inadvertently protect a wide range of potentially endangered species, even when the preserves vary widely in size, configuration, surrounding land uses, and management histories.

### Opportunities to build on the documented conservation success of scrub preserves

This project provides baseline data on the Florida scrub arthropods found on each site. Now that 91 species have been identified, it should be possible to increase the number of species known from each site. For some species this could be done by naturalist-volunteers supplied with a notebook and a standard GPS device. It would also be possible to get multiple site occurrences for many species on specific preserves.

Some easily-identified species could serve as habitat indicators for mapping out functional habitat types. For example, *Geolycosa xera*, whose burrows are easily found and counted, is a convenient indicator species for the community of gap-requiring arthropods and plants.

### **Access to results of the project**

Two workshops were presented during this project. The first was on 20 January 2010. At this workshop we presented the background and purpose of the study, reported on progress to date, and asked for feedback on what would be the most useful format for the next workshop and what would be the most useful types of information emerging from this project. The respondents (n=32), prioritizing various choices, showed the greatest interest in learning how to find and identify scrub arthropods, (score=109), then in learning about the distribution and natural history of scrub arthropods (score=66), then in learning how to manage for scrub arthropods (score=58), then in making visitors more aware and appreciative of rare scrub arthropods and arthropod diversity in general (score=27). These helped guide the contents of the final report.

The second workshop on 22 February 2011 consisted of a Power Point presentation that provided: an overview of project goals; a guide to the methodologies used; a numerical summary of results; examples of species accounts from the final report; a discussion, with examples, of the management implications of this project. Following this presentation there was a tour of the invertebrate ecology lab, showing archives of scrub arthropod specimens. Finally, there was a field demonstration of setting up traps in the scrub at the Archbold Biological Station. The Power Point presentation from this workshop is available on request and is included with materials associated with the final report.

As the project progressed, quarterly reports submitted to the granting agencies were also sent to the land managing agencies. Visits to sites began, at least initially, with meeting land managers on site.

The following projects results should be fully accessible:

***Power point presentation from the 22 February 2011 workshop***

***Final report on project***

***ACCESS data set***

***Shape files/maps of all species***

***Collections of specimens available for study at the Archbold Biol. Sta.***

***Residues of trap samples available for study at the Archbold Biol. Sta.***

### **Future scientific applications of the project**

**Formal scientific publications.**—These publications would include descriptions of new species of insects, such as the tough buckthorn bee (*Colletes* sp.), a new list of scrub-dependent arthropods, replacing the 1990 Deyrup publication, and analyses of the project as an example of conservation science.

**Expanded species accounts.**—Ideally, there should be a species account for each species that includes photographs or drawings, detailed diagnosis, and much more detailed information than was available for the present report. These species accounts would be on-line publications of the Archbold Biological Station.

## MANAGEMENT IMPLICATIONS OF THIS PROJECT

### General implications for scrub preserve managers

1. This project enhances the conservation value of all 23 preserves surveyed.
2. This project further justifies management practices that promote healthy Florida scrub communities.
3. This project should increase awareness of the biodiversity and complexity of Florida scrub habitat.
4. This project should provide opportunities for naturalist visitors to cooperate with preserve managers in obtaining additional useful information.

### Some specific implications for scrub preserve managers

**Gopher tortoises and their associates in LWR scrub.**—8 species of insects living on the LWR are known to be dependent on the gopher tortoise (*Gopherus polyphemus*). These species are: the gopher tortoise scarab (*Copris gopheri*), the little gopher tortoise scarab (*Blackburneus troglodytes*), the gopher tortoise Onthophagus (*Onthophagus polyphemi*), the tortoise burrow dance fly (*Drapetis* species), the gopher tortoise burrow fly (*Eutrichota gopheri*), the gopher tortoise shell moth (*Ceratophaga vicinella*), and the gopher tortoise burrow moth (*Idia gopheri*). It is possible that a ninth species, the hister beetle *Geomysaprinus florida*, found in entrances of tortoise burrows on the LWR, may also be dependent on the tortoise, but this species is poorly known and might not be exclusively dependent on tortoises.

**Special features of gopher tortoise ecology on the LWR.**—Gopher tortoises need a well-drained site for a burrow and abundant herbaceous vegetation for grazing. They are not adapted to some kinds of LWR scrub, such as scrubby flatwoods or mature sand pine scrub, neither of which have much ground vegetation. Gopher tortoises occur on at least half the sites studied for this project. They were observed in a variety of habitats. They may live in scrub that is burned frequently, so that it begins to have the structural characteristics of sandhill habitat. They may live near the edges of grassy, cultivated areas, or near the edges of roads that have herbaceous vegetation along their shoulders. Gopher tortoises on the LWR may also live in ecotones, for

example, between scrub and low grassy flatwoods, or they may even occupy scrub knolls at the edges of seasonally wet grassy areas. The varied burrow sites chosen by gopher tortoises on the LWR may present special difficulties for their insect associates because the limited and sometimes temporary nature of tortoise grazing areas may leave the host population unusually dispersed. The dispersal problems of flying insect associates of tortoises, however, are probably minor compared to the challenges faced by young tortoises seeking appropriate resources in scrub habitat. It is the uncertain demographics of their host that give these insect associates their conservation status in LWR scrub preserves.

**The gopher tortoise shell moth.**--One gopher tortoise associate on the LWR has a special vulnerability. This is the gopher shell moth, *Ceratophaga vicinella*. The larva of this remarkable species feeds on the keratin plates of recently deceased gopher tortoises. No other host is known; the natural history of this species is discussed by Deyrup et al. 2005. This moth faces a double threat. It requires a tortoise population that is large and stable enough to provide at least one dead tortoise each year. The shell of the tortoise must also remain undisturbed for a long period of time, as the caterpillars live in silken tunnels in the sand under the shell, extending these tunnels up onto the shell as feeding tubes. Within a few months, the shell appears to be rooted to the ground. Such shells may be disturbed by curious animals, but they are also often picked up by curious members of the public, who carry them off (in ignorance of regulations) or bring them to preserve managers who, they presume, would want this evidence of the death of a gopher tortoise.

**Conclusion.**--After observing many gopher tortoises in scrub habitat on the LWR, it is difficult to escape the conclusion that this species (with its associated fauna) cannot be managed in scrub habitat in a simple or formulaic way. Successful management probably requires assessing the resources used by each group of tortoises in the patch of habitat where they occur.

**Scrub rosemary: a keystone species on the LWR.**—Scrub rosemary (*Ceratiola ericoides*) is not an endangered species of plant, but at least some of its associates are species of conservation concern. Scrub rosemary is usually found on the driest sites, where it forms a distinctive vegetation type, called a rosemary bald, consisting of separated rosemary shrubs with intervening patches of bare sand. Scrub rosemary is slow to mature, and requires a long interval between fires, probably at least 20 years. After a fire, rosemary balds regenerate slowly from seeds buried in the sand, the previous generation having been killed by the fire.

**Arthropods directly and indirectly dependent on scrub rosemary on the LWR.**--There are at least 6 scrub rosemary specialist insects: the scrub rosemary grasshopper (*Schistocerca ceratiola*), the scrub rosemary emerald moth (*Nemouria outina*), the scrub rosemary plant bug (*Keltonia balli*), the slender scrub rosemary plant bug (*Parthenicus weemsi*), the scrub rosemary leaf beetle (*Pachybrachis* sp.), and the scrub rosemary tip weevil (*Auletobius* sp.). There may well be additional species of scrub rosemary specialists in poorly known groups such as gall flies, microlepidoptera, and leafhoppers. Some protected LWR sites have little or no scrub rosemary, but those that have this plant probably have all of its specialist insects, although some of these insects are difficult to find and some are only detectable at certain times of year. There

is no evidence that the scrub rosemary insect fauna differs biogeographically from one end of the LWR to the other.

The open sand patches in rosemary balds are colonized by low-growing plants, several of which are species of conservation concern. Four species of rosemary bald plants have their own species of specialized insects. There are 7 such insect species: the scrub wireweed plant bug (*Keltonia rubrofemorata*) and the scrub wireweed leaf beetle (*Pachybrachis* sp.) on *Polygonella myriophylla*, the calamintha plant bug (*Keltonia clinopodii*) and the blue calamintha bee (*Osmia* sp.) on *Calamintha ashei*, the scrub spikemoss moth (*Chionodes latro*) on *Selaginella arenicola*, and the scrub pygmy bee fly (*Pieza rhea*) on *Polygonella basiramia*.

The patches of bare sand in scrub rosemary balds are long-term gaps that are used by at least 15 species of arthropods that require open sand habitat. Some of these species also colonize short-term gaps following fires, or disturbed sites with bare sand. Scrub rosemary balds, however, provide the long-term and historical natural habitat for these species.

**Factors that have made scrub rosemary a keystone species.**--There appear to be two reasons why so many species are associated with scrub rosemary and the habitat that it creates. The first is the unusual nature of the plant itself. It is an extremely aberrant member of the family Ericaceae, with no other species in its genus. It has peculiar needle-like leaves, wind-pollinated flowers (required by the plant bug *Keltonia balli*), an unusual growth form more like that of a conifer than that of a member of the Ericaceae, and probably has unusual chemical defenses. Unique suites of characteristics in a species of plant tend to lead to the evolution of specializations among phytophagous insects. The second factor that may help explain the number of plants and animals adapted to scrub rosemary balds is the former dominance of this species under earlier and drier climatic conditions that ended about 7,000 to 10,000 years ago (Myers 1990).

**Scrub rosemary management on the LWR.**--Long-term management of this keystone species on the LWR has not been completely worked out. Part of the problem is that the species itself operates on a long cycle. Some 50 year old scrub rosemary balds are occupied by plants that are still vigorous and probably should not be burned. Few managers stay on a site long enough to see the full cycle of a scrub rosemary bald. Scrub rosemary regeneration from seeds is not yet predictable: after some fires there are many seedlings, after others there are almost none. On some sites it appears that scrub rosemary is being crowded out by sand pines (*Pinus clausa*), but if the sand pine is burned it may regenerate from seeds faster than scrub rosemary, necessitating a secondary cut of young sand pines. Sometimes scrub rosemary balds regenerate in response to scraping on abandoned housing lots, but this is not a consistent phenomenon, and the mechanism by which disturbance can cause rosemary bald regeneration is unknown. In the current study we never saw linear patches of scrub rosemary along road shoulders.

While scrub rosemary can persist for 50 years or more without a burn, it could be extirpated from a site by a few fires less than ten years apart. The 6 species of insects that feed exclusively on scrub rosemary are able to fly from one bald to another, but could be extirpated by a single burn of an isolated rosemary scrub, even if their host eventually grows back from seeds.

**Conclusion.**--At this point the most important goal should be to foster a general recognition that scrub rosemary is a remarkably important keystone species. Scrub rosemary balds should receive special attention and thoughtful adaptive management.

**Sand roads in Florida scrub habitat on the LWR.**—an aerial view of many scrub preserves, for example, the Archbold Biological Station, shows a significant amount of surface area occupied by sand roads. At the Archbold Biological Station these roads are used for fire management and research access, at other LWR sites they may have additional uses for public access and recreation. Roads through scrub habitats are convenient and often necessary, but their utility should not prevent examination of their dramatic ecological effects.

**Habitat provided by sand roads in scrub.**--The shoulders and sometimes the median of sand roads often provide open sand habitat akin to that of scrub rosemary balds. A number of arthropods that require extensive areas with patches of bare sand readily colonize the bare sand and suppressed vegetation of roadsides. These species include the two species of scrub burrowing wolf spiders (*Geolycosa xera* and *G. hubbelli*), the tequesta grasshopper (*Melanoplus tequestae*), the scrub pygmy mole cricket (*Neotridactylus archboldi*), two species of scrub tiger beetles (*Cicindela highlandensis* and *C. scabrosa*), the ghostly crazy ant (*Nylanderia phantasma*), the elegant cone ant (*Dorymyrmex elegans*), the Florida sand roach (*Arenivaga floridensis*) and others.

Some scrub-restricted plants with associated insects also take advantage of the open shoulders and median provided by sand roads through scrub habitat. These plants include *Polygonella basiramia*, *Paronychia chartacea*, *Selaginella arenicola*, and occasionally *Polygonella myriophylla* and *Calamintha ashei*.

Some scrub sites go unburned for so long that they lose the species of arthropods and plants that require open scrub or scrub with patches of bare sand. On such sites sand roads may be important refuges for these species. This was a familiar phenomenon before widespread implementation of fire management, and can still be seen on some LWR sites.

These effects amount to unintentional management that favors some potentially endangered species. Considering that sand roads through scrub habitat are here to stay on most LWR scrub preserves, it is fortunate that they sometimes benefit rare fauna and flora. Nevertheless, these effects should be recognized as unnatural perturbations of natural scrub habitats. It would be preferable if intelligent management of scrub made entirely superfluous this supplemental augmentation of the populations of open sand species.

**Sand roads as corridors for scrub arthropods.**—The corridor effect is most conspicuous as it applies to quadrupeds, whose tracks are left in the sand. It is obvious that the utilization of scrub habitat by terrestrial vertebrates is partially controlled by the establishment of sand roads. This same kind of influence can be seen in many arthropods, which can be observed running or flying along sand roads. One can show this by setting up a flight intercept trap along the edge of a wide sand road, leaving the other side open for mammalian traffic. Such a trap often catches an

astounding number and variety of insects that had been flying along the edge of the shrubs on the margin of the road.

It is difficult to believe that this wholesale channeling of animal movement has no ecological effects. It is also difficult to measure these effects, and it is even challenging to envision what these effects might be. As a general hypothesis, one would expect that animals that require resources with patchy distribution might miss many of the less exploited patches if these animals stay on flight corridors: they would be like people who eat out at restaurants but never venture off Main Street. On the other hand, sand roads also link patches of habitat. Also as a general hypothesis, any factor that makes the movements of animals more predictable and their movement past a point more frequent should favor predators of those species. One might also hypothesize that roadside plants might be more heavily used by insects than interior plants, although an increase in predation might counteract this. One might expect that sand road corridors would also increase the diversity of ecological relationships as more species should come into contact with each other. These topics might be more easily addressed by considering economic models rather than ecological models.

In the past the corridor effect of roads was probably accentuated by the fact that management-burn backfires that were lighted from the edges of roads often left a strip of higher vegetation along the roadside. This should increase the channeling of insects and make them less likely to move into nearby open sites. The recent practice of mowing edges before a burn should help prevent the most extreme corridor effects in fire-managed scrub.

The corridor effects of sand roads on arthropod populations are more difficult to assess than the effects of roads as strips of open habitat, but the same conclusion holds: sand roads should be recognized as a perturbation of a natural scrub ecosystem.

**Sand roads through scrub as barriers.**—Roads through scrub habitat must be barriers for some species, for example, species of arthropods that seldom leave the shelter of leaf litter. Arthropods that must cross sand roads on foot are especially exposed to predation when they do so. Scrub grasshoppers in the genera *Melanoplus* and *Aptenopedes* instinctively avoid moving into open roads. Surveys for these grasshoppers often involve walking through low ground vegetation along the edge of a sand road. When alarmed, these grasshoppers leap into the more dense vegetation away from the road, not out onto the sand road. For some species deep ruts in sand roads can be traps where arthropods die of exposure, if they are not captured by predators. This is mentioned with respect to the passalid beetle *Odontotaenius floridanus*. Scrub millipedes (*Floridobolus penneri*) also get trapped in ruts at night and their tracks can be seen the next day, showing that they travelled significant distances while exposed to enemies such as parasitic sarcophagid flies.

**Sand roads as access routes for invasive plants.**—The disturbed sand along road shoulders sometimes becomes occupied by invasive exotic plants such as natal grass (*Rhynchelytrum repens*). If soil in adjacent open scrub is disturbed these plants may move into open scrub, affecting the arthropod fauna that require sparse vegetation composed of native plant species.

**Sand roads and scrub arthropods: conclusion.**—The overall conclusion from consideration of these possible effects is that it is wise to think carefully before installing a road through a scrub ecosystem because this road will inevitably

change the ecosystem. Likewise, it often makes ecological sense to allow unnecessary roads to revert to a less open condition. These principles are already recognized in another management practice, that of filling in fire ditches.

**Scrub arthropods and fire on the LWR.**—All scrub-dependent arthropods require fire for maintenance of their habitat. There is little that needs to be added to this obvious fact. Fire management that maintains a diversity of scrub habitats (including scrub rosemary balds) will benefit scrub specialist arthropods.

**Open-site scrub arthropods on the LWR.**—Most of the 91 species of arthropods that have been identified as scrub specialists in this report require open scrub or scrub with gaps in the vegetation. It is probable that these species evolved under an older and drier climatic regime that produced more barren habitat (Myers 1990). These species survive under modern conditions only because fire reproduces this open vegetation structure. In the case of rosemary balds, scrub rosemary itself creates the open structure, assisted by very infrequent fires.

**Other scrub arthropods on the LWR.**—There are some scrub arthropods that may not require open scrub habitat, although precise ecological requirements are not known for these species. Such species include, among others, the 6 species of scrub longhorn beetles, the erotylid beetle *Ischyrus dunedinensis*, the treehopper *Telamona archboldi*, and the scarab *Trigonopeltastes floridana*. Considering that detailed ecological requirements are not known for these scrub arthropods, it would seem sensible to avoid burning simultaneously all of a particular type of scrub habitat within a preserve, especially if the preserve is isolated from other scrub habitats.

**Conclusion.**— We found no scrub-restricted species that are dependent entirely on scrub that has been burned in the last 1-2 years. Such species, we hypothesized, might be associated with recently killed trees and shrubs or with heavy blooming of scrub plants. It is possible that there are no species that move exclusively from one recently burned area to another because fires in scrub are too sporadic, and either too large or too isolated to allow evolution of a fire-following group of species. There are species that move into recently burned areas, but they are not scrub specialists. We also failed to find species of scrub specialists dependent entirely on long-unburned scrub that has become dry hammock forest. There are many species of arthropods found in long-unburned scrub hammock, but these tend to be species also found in other more mesic habitats. It is, of course, possible that future studies will reveal species of scrub specialists that depend on very recent fires or on scrub that has turned into dry hammock.

There is no evidence that any LWR scrub arthropods require any customized fire management. There are a number of already listed species of plants and animals that require thoughtful fire management of their habitats, including scrub rosemary balds.

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## APPENDIX I

### Status of Lake Wales Ridge Arthropods Restricted to Florida Scrub

**Introduction--.**This annotated list of species is placed in a separate section to separate it from more general discussions of the purpose, methodology and results of this study. This separation should be more convenient for those who are interested in specific arthropods and their occurrence on various preserves. These species accounts were prepared in response to a survey of preserve managers during the first workshop associated with this project. They generally follow the format used by Florida Natural Areas Inventory in the Field Guide to the Rare Animals of Florida. As a general rule, the scrub arthropod species accounts are more tentative than the accounts in FNAI, as most of the scrub arthropods remain poorly understood. For example, information on population dynamics is known for only three species, all of them spiders. The species accounts not only provide information, they also attempt to draw attention to deficiencies in our knowledge of these species. They are preliminary reports and the first of their kind for most of the species.

There are some species-by-species notes on the methods employed in this survey, but a much more thorough discussion of methods and their limitations is in the main body of the report.

A preliminary conservation status assessment is provided for each species. With only a few exceptions, this survey has increased the number of protected sites where these scrub arthropods are known to occur, so the results of this survey are overwhelmingly positive from a conservation standpoint. In some cases, species that were known from only a single protected site are now known to occur on many protected sites.

The preliminary conservation status of each species is based primarily on where that species was found, not on where that species might be expected to occur. In some cases there is good reason to believe that the survey methods involved were somewhat ineffective or inappropriate for a particular species. This is mentioned among the notes on the relevant species, but does not change the preliminary conservation status applied to the species.

Only two kinds of conservation assessments are made: based on current data, a species "appears to be a species of conservation concern," or "it does not appear to be a species of conservation concern." This is not linked to any of the conservation ratings of any government agency or conservation organization. As a general rule, species that were found on 10 or more preserves are not listed as a species of conservation concern.

One purpose of this survey was to explore how effectively the system of scrub preserves on the Lake Wales Ridge (hereafter LWR) protects scrub-restricted arthropods. This is discussed in the main body of the report. No consideration is given at this point to whether the species surveyed have a wide distribution off the LWR, or whether they are confined to the LWR.

### ***Annotated List of Species***

#### **Order Spirobolida (Spiral Millipedes)**

***Floridobolus penneri*** Florida Scrub Millipede (Spirobolida: Spirobolidae)

Sites: 8: Archbold Biol. Sta., Henscratch 27, Highland Pk. Estates, Arbuckle State For., McJunkin, Saddleblanket Lk., FWC Sunray, TNC Sunray.

Months found: May, Jun, Jul, Aug.

Habitat: Open Florida scrub with patches of bare sand.

Sampling methods: Bowl traps, also occasionally found by sifting sand. This species is active at night, its many legs leaving a pair of curving parallel grooves in the sand, but this is not a diagnostic trace, as these tracks are similar to those of another LWR burrowing millipede, *Narceus gordanus*.

Notes: In captivity individuals eat partially decomposed scrub oak leaves and small rotten twigs. Large millipedes are believed to take years to mature and to live a long time, perhaps 10-20 years. *Floridobolus penneri* could be confused with *N. gordanus*, as both are large, burrowing scrub millipedes. *Floridobolus penneri* is a uniform slate gray, and its body tapers slightly at each end. *Narceus gordanus* is gray with a lighter band on each segment, and is uniformly cylindrical. There might be competitive interactions between *F. penneri* and the more widespread *N. gordanus*. Species description: Causey 1957.

Conservation status: 35 individuals found, from 8 protected LWR sites. This species has been found on less than 10 protected LWR sites, is dependent on open scrub, and probably matures slowly. It should be considered a species of conservation concern on the LWR.

#### **Order Araneae (Spiders)**

***Geolycosa hubbelli*** Hubbell's Burrowing Wolf Spider (Araneae: Lycosidae)

Sites: 17: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highlands Hammock State Pk., Holmes Ave., Jack Ck., Lk. June State Pk., Lk. Placid Scrub, Arbuckle State For., Royce Ranch, Silver Lk., FWC Sunray, Tiger Ck.

Months found: Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov.

Habitat: Open Florida scrub with some leaf litter. Burrows are often partially hidden under edge of shrubs. This species is highly sensitive to microhabitat and does not occur either in bare sand or in long-unburned shaded sites. Adult females establish burrows in open gaps about 1-2 square feet in size. The ecology of this species has been described by Carrel (2003a, 2003b).

Sampling method: Searching for distinctive burrows, which are open vertical shafts with a rim of bits of vegetation constructed from leaf litter held in place with silk. Burrows can be difficult to find because they are often partially concealed from above by vegetation. Wandering individuals occasionally fall into bowl traps.

Notes: *Geolycosa xera*, discussed below, is a similar species that is found in bare sand patches rather than in patches with leaf litter.

Conservation status: 83 individuals found, from 17 protected LWR sites. This species is best found by directed searching; once it was found on a site search efforts became less intense, so many individuals were probably overlooked. There were, however, sites where this species appeared to be rare or absent. *Geolycosa hubbelli* does not appear to be a species of conservation concern on the LWR.

***Geolycosa xera***                      Scrub Burrowing Wolf Spider                      (Araneae: Lycosidae)

Note on the name of this species: There are two named subspecies of the scrub burrowing wolf spider: *Geolycosa xera archboldi*, Archbold's burrowing wolf spider, and *Geolycosa xera xera*, McCrone's burrowing wolf spider. Both subspecies appeared on our original list of target species. McCrone's burrowing wolf spider, which should have been found in the northern part of the LWR, proved difficult to separate from Archbold's burrowing wolf spider, and the validity of the subspecies needs some further research. All our records are referred to the species name, *Geolycosa xera*.

Sites: 21: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highlands Hammock State Pk., Holmes Ave., Jack Ck., Lk. June Scrub, Arbuckle State For., Lk. Louisa State Pk., Lk. Placid Scrub, McJunkin, Royce Ranch, Saddleblanket Lk., Silver Lk., FWC Sunray, Tiger Ck., Walk-in-Water State For.

Months found: Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov., Dec.

Habitat: Patches of bare sand in open scrub; sometimes on bare sand edges or medians of sand roads. The ecology of this species has been studied by Carrel (2003a, 2003b).

Sampling methods: Burrows of this species are in open sand and consist of an open vertical shaft with a very slight silk, sand-covered rim. During burrow excavation sand is flicked out in all directions, so there is no mound or fan of excavated sand. This is the easiest of all scrub arthropods to sample, thanks to its conspicuous and distinctive burrow in bare sand habitat. Males and immatures are sometimes found in bowl traps.

Notes: *Geolycosa hubbelli*, discussed above, is a similar species that is found in scrub patches with leaf litter rather than in patches of bare sand.

Conservation status: 288 individuals found, from 21 protected LWR sites. It would have been possible to add hundreds of records from some sites that had extensive areas of bare sand. This species was difficult to find at some sites, such as Saddleblanket Lk. The species *Geolycosa xera* as a whole is not a species of conservation concern on the LWR, but the identification, validity and conservation status of its two subspecies are still unresolved. Adult females of this species require undisturbed bare gaps of sand greater than one square yard in area, so appropriate habitat management, especially the management of *Ceratiola* habitat, is important for persistence of this species.

### ***Hogna ceratiola***

Ceratiola Wolf Spider

(Araneae: Lycosidae)

Sites: 20: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highlands Hammock State Pk., Holmes Ave., Jack Ck., Lk. June State Pk., Lk. Placid Scrub, Arbuckle State For., Royce Ranch, Saddleblanket Lk., Silver Lk., FWC Sunray, TNC Sunray, Tiger Ck., Walk-in-Water State For.

Months found: Mar, Apr, May, Jun, Jul, Aug, Sep, Oct.

Habitat: Open Florida scrub, including yellow sand scrub. Often found on bare sand at edges of sand roads through open scrub.

Sampling methods: Bowl traps, pan traps at base of Townes flight intercept traps. A more effective way to sample for *Hogna* wolf spiders in Florida scrub is to conduct nocturnal searches on warm nights; this was not done for this project. A flashlight is held at about forehead level, illuminating the open sand ahead. Reflective layers in the large, forward-facing eyes of wolf spiders produce brilliant blue-green pinpoints that can easily be traced to the spider. The spiders usually do not try to escape as the researcher approaches.

Notes: This species makes a burrow, leaving the burrow to forage for prey on open sand at night. The burrow, which is shallow and simple, has a collapsible silk entrance and is invisible during the day, unlike the open burrows of *Geolycosa* wolf spiders. There are several similar species on the LWR. Older references on species of *Hogna* use the genus name *Lycosa*. Species of *Hogna* are generally difficult to identify.

Conservation status: 114 individuals found, from 20 protected LWR sites. Bearing in mind the inefficiency of the survey method, this appears to be an abundant and widespread species on the LWR. *Hogna ceratiola* does not appear to be a species of conservation concern on the LWR.

***Hogna osceola***                      Osceola Wolf Spider                      (Araneae: Lycosidae)

Sites: 9: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Gould Rd., Holmes Ave., Arbuckle State For., Saddleblanket Lk., Tiger Ck.

Months found: Mar, Apr, May, Jun, Jul, Aug, Sep.

Habitat: Florida scrub, including yellow sand scrub. This species is often found on bare sand, on low shrubs, or on tree trunks at night, at most a few yards from its burrow. Burrows are always constructed beneath shrubs.

Sampling methods: Bowl traps and pan below Townes flight intercept trap. A more effective way to sample for *Hogna* wolf spiders in Florida scrub is to conduct nocturnal searches on warm nights; this was not done for this project. A flashlight is held at about forehead level, illuminating the open sand ahead. Reflective layers in the large, forward-facing eyes of wolf spiders produce brilliant blue-green pinpoints that can easily be traced to the spider. The spiders usually do not try to escape as the researcher approaches.

Notes: This is one of the largest spiders in Peninsular Florida. Accordingly, it makes a large, "gravy-boat-shaped" burrow in the sand, leaving the burrow to forage for prey on the sand at night. The burrow has a collapsible entrance made of silk-tied leaf litter, and is invisible during the day, unlike the open burrows of *Geolycosa* species. There are several similar species on the LWR. Older references on species of *Hogna* use the genus name *Lycosa*. Species of *Hogna* are generally difficult to identify.

Conservation status: 20 individuals found, from 9 protected LWR sites. Night collecting probably would have added many more individuals and some additional sites. Based on current information, however, *Hogna osceola* should be considered a species of conservation concern on the LWR.

***Latrodectus bishopi***                      Red Widow Spider                      (Araneae: Theridiidae)

Sites: 7: Archbold Biol. Sta., Jack Ck., Lk. June State Pk., Arbuckle State For., McJunkin, Royce Ranch, Tiger Ck.

Months found: Apr, May, Jun, Sep, Oct.

Habitat: Florida scrub and nearby palmetto flatwoods.

Sampling method: Directed searches, concentrating on scrub palmetto (*Sabal etonia*) and saw palmetto (*Serenoa repens*). Webs are usually down in the shelter a single, large, folded leaf about 1-2 feet above the ground. Characteristic strands of fine, tangled webbing serve to intercept flying insects are often attached to the tips of the palmetto leaves. These strands can be used to help locate webs on foggy mornings.

Notes: Other spiders, especially the funnel-web weaver *Baronopsis*, may occur in the same situation. At the Archbold Biol. Sta. the red widow undergoes large population fluctuations; this could affect surveys for this species and could also make its conservation status more precarious (Carrel 2001). Moreover, red widows strongly prefer palmetto leaves that extend 3-5 feet above the ground, the height normally present in recently burned scrub. This species appears to have venom similar to that of other members of its genus, but there appear to be no records of humans having been bitten. Photographs and natural history information on Florida *Latrodectus* species can be found in McCrone and Stone, 1965.

Conservation status: 10 individuals found, from 7 protected LWR sites. There is no efficient method for finding this species, especially in conjunction with more general arthropod surveys. Innumerable palmettos were searched to produce the 10 spiders found in this study, and it appears to be a rare species even where it is known to occur. *Latrodectus bishop* appears to be a species of conservation concern on the LWR.

***Phidippus workmani***      Workman's Jumping Spider      (Araneae: Salticidae)

Sites: 4: Archbold Biol. Sta., Flamingo Villas, Highlands Hammock State Pk., Saddleblanket Lk.

Months found: May, Jul, Aug, Oct.

Habitat: Florida scrub habitat.

Sampling methods: There is no known way to efficiently survey for this species. It does not normally appear in traps. It is not easily swept from vegetation, probably because it seems to spend much of its time in a silken retreat down in the foliage of a plant. When this jumping spider is out and moving about, however, it is conspicuous because of its bright markings (differing between male and female) and rapid movement.

Notes: There are several similar LWR species. There is a recent excellent illustrated revision of the genus *Phidippus* (Edwards 2004) that provides range and records of this species.

Conservation status: 5 individuals found, from 4 protected LWR sites. *Phidippus workmani* appears to be a species of conservation concern on the LWR.

***Sosippus placidus***                      Lake Placid Funnel Wolf Spider    (Araneae: Lycosidae)

Sites: 10: Archbold Biol. Sta., Carter Ck. N., Gould Rd., Highland Pk. Estates, Holmes Ave., Lk. Placid Scrub, McJunkin, Royce Ranch, Saddleblanket Lk., Silver Lk.

Months found: Apr, May, Jun, Jul, Aug, Sep, Oct, Nov.

Habitat: Open Florida scrub habitat with some bare sand and low vegetation. This species does not occur in closed-canopy, long unburned scrub, and is generally difficult to find in yellow sand scrub.

Sampling method: Best found by searching for the distinctive web, consisting of a sparse tangle of threads above a large sheet of silk with a funnel-like hole at one end that leads to an underground burrow. Once its web is found, the spider can be lured out far enough to reveal its distinctive coloration. The underground retreat is often in an abandoned mouse burrow or under a log, but at some sites webs and burrows can be found in thick clumps of prickly pear cactus (*Opuntia humifusa*) and at the base of palmetto leaves. Lab and field studies showed that this spider will readily occupy artificial burrows (e.g. PVC pipe sections), but in tests spiders never themselves initiated burrow construction in sand.

Notes: there is at least one similar LWR species (*S. floridanus*), although it is probable that this other species is seldom found in scrub. *Sosippus placidus* has a pale orange patch on each side of its fangs, and is orange underneath. This species shows extended maternal care, the young staying in the maternal web until about half grown, feeding on prey caught by the mother spider. This species was described and discussed by Brady (1972). A photograph appears in Deyrup and Eisner 1993.

Conservation status: 31 individuals found, from 10 protected LWR sites. Populations at most sites seemed relatively low, but this may be a reflection of the difficulty of finding webs, which are only visible when one is close to them. With 10 protected sites, *Sossipus placidus* does not appear to be a species of conservation concern on the LWR.

***Zelotes florodes***                      Florida Zelotes Spider                      (Araneae: Gnaphosidae)

Sites: 11: Archbold Biol. Sta., Henscratch 27, Highlands Hammock State Pk., Jack Ck., Lk. June State Pk., Lk. Placid Scrub, Arbuckle State For., Saddleblanket Lk., Silver Lk., FWC Sunray, Tiger Ck.

Months: Apr, May, Jun, Jul, Aug.

Habitat: Florida scrub.

Sampling methods: Bowl traps, pan traps at base of Townes flight intercept traps.

Notes: This species is very fast and elusive. It lives in leaf litter, but was seldom captured by sifting for other scrub arthropods, probably because it escaped as the leaf litter was being collected, assuming it was present to begin with. Gnaphosid spiders do not build elaborate webs, but make tubular silken “retreats,” often in a curled leaf. There is at least one similar LWR species (*Z. ocala*). This species was described and the genus reviewed by Platnick and Shadab (1983).

Conservation status: 12 individuals, from eleven protected LWR sites. This species appears to be relatively widespread on the LWR, but its abundance, according to trapping data, is very low: one individual from each of 10 sites, 2 from one site. In view of the lack of general natural history information on this species, and the extreme rarity of specimens, *Zelotes florodes* is probably best considered a species of conservation concern on the LWR.

***Zelotes ocala***                      Ocala *Zelotes* Spider                      (Araneae: Gnaphosidae)

Site: 1: Archbold Biol. Sta.

Months found: Sep.

Habitat: Low scrubby flatwoods with *Quercus inopina*, burned 9 years previously.

Sampling method: Sifting large amounts of surface leaf litter through 1/8 inch screen. Extensive sifting was done at all sites, to obtain, for example, sand roaches and small scarabs. The differences in the technique that produced these spiders were that large amounts of loose surface litter was sifted, without the finer material underneath, and the sifting was done with a coarser screen that was set on a shallow pan. These spiders were obtained at the end of the study when it was too late to attempt the technique at several sites.

Notes: This species was found once, in a very small area. The more commonly encountered LWR species *Z. florodes* is similar. This species was described and its genus reviewed by Platnick and Shadab (1983).

Conservation status: 5 individuals found, from 1 protected LWR site. According to current information, *Zelotes ocala* appears to be a species of conservation concern on the LWR.

## Order Blattaria (Cockroaches)

***Arenivaga floridensis***                      Florida Sand Cockroach                      (Blattaria: Polyphagidae)

Sites: 20: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highland Pk. Estates, Holmes Ave., Jack Ck., Lk. Louisa State Pk., Lk. Placid Scrub, Arbuckle State For., Royce Ranch, Saddleblanket Lk., Silver Lk., Snell Ck., FWC Sunray, Tiger Ck., Walk-in-Water State For.

Months found: Mar, Apr, May, Jun, Jul, Oct, Nov

Habitat: Open scrub, with patches of bare sand, including yellow sand scrub.

Sampling methods: Males, which are good fliers, are caught in Townes flight intercept traps, immatures and females (females lack wings) are found by sifting sand in open areas near the bases of scrub plants.

Notes: The diet of *A. floridensis* is unknown. Males might be confused with winged adults of the imported Surinam cockroach, *Pycnoscelus surinamensis*, a burrowing species sometimes found in disturbed scrub habitat. The Surinam cockroach has a narrower body shape and a strongly shining blackish pronotum. Drawing of male: Deyrup 1990, Deyrup and Franz 1994. Biogeography: Lamb and Justice 2005.

Conservation status: 77 individuals found, from 20 protected LWR sites. This species occurs on almost all the scrub preserves studied. Although its diet is unknown, scrub management that provides some open sand habitat should be sufficient. *Arenivaga floridensis* does not appear to be a species of conservation concern on the LWR.

## Order Orthoptera (Grasshoppers, Crickets)

***Aptenopedes nigropicta*** Wingless Scrub Grasshopper (Orthoptera: Acrididae)

Sites: 7: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Highland Pk. Estates, Royce Ranch, Snell Ck., Tiger Ck.

Months found: Feb, Mar, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec. While adults of this species occur through much of the year, they are most common in fall through early winter.

Habitat: Florida scrub, including yellow sand scrub.

Sampling methods: Yellow bowl traps, but targeted searching by experienced field researcher is more effective. This grasshopper is often up in small, dense scrub oaks, and not easily seen, but it can be heard jumping when alarmed.

Notes: In captivity this species feeds on young oak leaves. At the Archbold Biol. Sta. this species is parasitized by a fly, *Anisia serotina*, (Diptera: Tachinidae); this fly has other host species as well, and is not dependent on *A. nigropicta*. Two individual *A. nigropicta* were found dead in webs of *Argiope aurantia* (Araneae: Araneida) at separate sites. There are four species of LWR *Aptenopedes*. Females and immature individuals are difficult to identify. Adult male *A. nigropicta* are identified by their blue hind tibiae, combined with the absence of a median pale stripe on the abdomen. Reference: Hebard 1916.

Conservation status: 21 specimens were found, from 7 protected LWR sites. It is difficult to survey for this species because these grasshoppers spend most of their time up in thick scrub vegetation and are highly evasive. *Aptenopedes nigropicta* is widely distributed on the LWR, and probably occurs on additional LWR preserves, but targeted searches at the right season sometimes failed to produce any specimens. According to our current information, *Aptenopedes nigropicta* should be considered a species of conservation concern on the LWR.

***Aptenopedes robusta*** Robust Scrub Grasshopper (Orthoptera: Acrididae)

Sites: 1: Archbold Biol. Sta.

Months found: Jun, Aug, Sep.

Habitat: Oak scrub

Sampling method: Searches targeting *Aptenopedes* species.

Notes: An individual in captivity ate young oak leaves. Only adult males can be easily identified. They have the combination of pink hind tibiae and the absence of a pale, median abdominal stripe. Reference: Hebard 1916.

Conservation status: 3 individuals found, from 1 protected LWR site. This species appears to be the rarest by far of the four LWR species of *Aptenopedes*. This appears to be a species of conservation concern on the LWR.

***Ellipes, undescribed species*** Broussard Pygmy Mole Cricket  
(Orthoptera: Tridactylidae)

Sites: 2: Catfish Ck. State Pk., Tiger Ck.

Months found: Jun, Jul

Habitat: Bare sand patches in yellow sand scrub.

Sampling method: Yellow bowl traps, which catch pygmy mole crickets following rain. This species probably emerges from the sand at night.

Notes: This species appears to be closely related to *Ellipes eisneri*, from the rather distant Southern Brooksville Ridge, but differs in coloration and is slightly larger. For a discussion and illustration of *E. eisneri*, see Deyrup 2005. The new species will probably be described during the next 2-3 years.

Conservation status: 83 individuals found, from 2 protected LWR sites. These two sites are on the east side of the north-central LWR, where there is also a species of *Geopsammodius* scarab that is not known from farther south on the LWR. It is unlikely that this pygmy mole cricket has been overlooked in the southern part of the LWR. It could, however, occur in some of the few remaining examples of sandhill habitat on the more northern part of the LWR. The highly restricted geographic range of this species, and its need for open patches of yellow sand scrub, which develops a closed canopy quickly, makes this pygmy mole cricket a species of conservation concern on the LWR.

***Melanoplus forcipatus*** Broad-Tailed Scrub Grasshopper (Orthoptera: Acrididae)

Sites: 9: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Flamingo Villas, Gould Rd., Highland Pk. Estates, Saddleblanket Lk., FWC Sunray, Tiger Ck.

Months found: Jun, Jul, Aug, Sep, Oct, Nov, Dec.

Habitat: Open scrub with low scrub oaks.

Sampling methods: Yellow bowl traps. Specialized searching by experienced field researchers is the most efficient way to find flightless species of *Melanoplus*.

Notes: There are three similar species of flightless *Melanoplus* on the LWR. This species is best identified by the enlarged cerci (easily seen with a hand lens) of adult males, but females and immature individuals are very difficult to identify. In the laboratory this species will eat leaves of scrub legumes, such as species of milk pea (*Galactia*) and young scrub oak leaves, including those of sand live oak (*Quercus geminata*). Individuals of this species were found as prey of the orb-weaving spiders *Argiope florida* and *A. aurantia* (Aranae: Araneida), which build webs that capture insects moving through the canopy of low scrub oaks and palmettos. This species belongs to a small group of grasshoppers within the huge genus *Melanoplus* that have evolved into separate species on isolated sand ridges in Florida. This group of grasshoppers is of particular interest in revealing the evolutionary history of Florida scrub. The taxonomy and biogeography of these grasshoppers is discussed by Hubbell (1932) and Deyrup (1996).

Conservation status: 45 individuals found, from 9 protected LWR sites. It is difficult to survey for this species because it is evasive and often hides in thickets of low scrub oaks. It probably occurs on several additional protected sites. A conservative interpretation of current data however, suggests that *Melanoplus forcipatus* is a species of conservation concern on the LWR.

***Melanoplus tequestae*** Tequesta Grasshopper (Orthoptera: Acrididae)

Sites: 20: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highland Pk. Estates, Highlands Hammock State Pk., Holmes Ave., Jack Ck., Lk. June State Pk., Lk. Placid Scrub, Arbuckle State For., Royce Ranch, Saddleblanket Lk., Silver Lk., Snell Ck., FWC Sunray, Tiger Ck.

Months found: Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec. Adults of this species may be found through much of the year, but they are most abundant in September and October.

Habitat: Open Florida scrub with patches of bare sand. This species may also occur along bare edges of sand roads in low oak scrub.

Sampling methods: Yellow bowl traps; specialized searching by experienced field researchers is the most efficient way to find this species.

Notes: There are three similar species of flightless *Melanoplus* on the Lake Wales Ridge. Female and immature individuals are difficult to identify. Adult male tequesta grasshoppers have a white stripe on the hind femur (also found in the broad-tailed scrub grasshopper), but their cerci are narrow and pointed, unlike those of the broad-tailed scrub grasshopper. In captivity this species feeds on young scrub oak leaves, the catkins of scrub oaks, and scrub legumes, such as species of milk pea (*Galactia*). The wasp *Tachytes guatemalensis* (Sphecidae) is a predator of this species. This species belongs to a small group of species within the huge genus *Melanoplus* that have evolved into separate species on isolated sand ridges in Florida. This group is important for our understanding of evolutionary patterns in Florida scrub. The taxonomy and biogeography of this series of grasshoppers is discussed by Hubbell (1932) and Deyrup (1996).

Conservation status: 111 individuals found, from 20 protected LWR sites. *Melanoplus tequestae* does not appear to be a species of conservation concern on the LWR.

***Neotridactylus archboldi*** Scrub Pygmy Mole Cricket (Orthoptera: Tridactylidae)

Sites: 20: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highland Pk. Estates, Highlands Hammock

State Pk., Holmes Ave., Jack Ck., Lk. June State Pk., Lk. Placid Scrub, Arbuckle State For., Royce Ranch, Saddleblanket Lk., Silver Lk., FWC Sunray, TNC Sunray, Tiger Ck.

Months found: Mar, Apr, May, Jun, Jul, Aug.

Habitat: Florida scrub with patches of bare sand. Also found on bare sand road shoulders in low scrub habitat.

Sampling methods: Yellow bowl traps and pans at the base of Townes flight intercept traps. This species is active on the surface of sand after a rain.

Notes: This species feeds on cyanobacteria, also known as blue-green algae, that form a layer a few millimeters under the surface of the sand. This food resource depends on light passing through the sand surface, and does not tolerate leaf litter or shading by plants. The scrub pygmy mole cricket is flightless but is evidently able to find and colonize patches of bare sand within an area of scrub. Males are equipped with stridulatory organs, but the chirps that they make are probably transmitted through the substrate of sand rather than through the air, as females lack ears of the types that are found on aerially broadcasting Orthoptera. This species has two species of specialized predators among the digger wasps: *Tachytes mergus* and *T. intermedius* (Sphecidae). These wasps also prey on other species of pygmy mole crickets. The pygmy mole crickets (Tridactylidae) are a primitive group of Orthoptera that is not at all related to the much larger mole crickets that dig in lawns and pastures. Description and natural history of this species: Deyrup and Eisner 1996.

Conservation status: 2208 individuals were found, from 20 protected LWR sites. *Neotridactylus archboldi* is not a species of conservation concern on the LWR.

***Schistocerca ceratiola*** Scrub Rosemary Grasshopper (Orthoptera: Acrididae)

Sites: 9: Archbold Biol. Sta., Carter Ck. N., Flamingo Villas, Gould Rd., Henscratch 27, Highland Pk. Estates, Holmes Ave., Jack Ck., Royce Ranch.

Months found: May, Jun, Aug, Sep, Oct.

Habitat: Florida scrub with large scrub rosemary bushes (*Ceratiola ericoides*).

Sampling method: Sweeping scrub rosemary. This species is primarily nocturnal, taking refuge in the interior of scrub rosemary bushes during the day, but it can be forced to jump and fly during the day by sweeping the bushes with vigor.

Notes: Host specificity in grasshoppers is rare, and this may well be the only host-specific species in the large genus *Schistocerca*. There are several additional LWR species of *Schistocerca*, but they are much larger than the scrub rosemary

grasshopper, and they do not occur on scrub rosemary. Immature individuals of this species are lime green, like other local species of *Schistocerca*, but can be identified by their yellow markings, and by their host plant. An individual was found dead in a web of the orb spider *Argiope florida*.

Conservation status: 30 individuals found, from 9 protected LWR sites. This species occurs only on sites that have long-term populations of scrub rosemary, a keystone species whose management is not completely worked out. Because of this fact, and because *Schistocerca ceratiola* was found on only 9 protected LWR sites, this species remains a species of conservation concern on the LWR.

### Order Heteroptera (True Bugs)

***Keltonia balli***                      Scrub Rosemary Plant Bug                      (Heteroptera: Miridae)

Sites: 5: Archbold Biol. Sta., Flamingo Villas, Gould Rd., Jack Ck., Lk. Placid Scrub.

Months found: Oct, Nov.

Habitat: Open Florida scrub with abundant scrub rosemary (*Ceratiola ericoides*).

Sampling method: Sweeping scrub rosemary during its blooming and fruiting period, primarily October and November.

Notes: This species requires male scrub rosemary flowers for its development. There are similar LWR species, including one (*Parthenicus weemsi*) on scrub rosemary. Natural history reference: Wheeler 2009a. Taxonomy reference: Knight 1966, Kelton 1966.

Conservation status: 44 individuals found, from 5 protected LWR sites. This is a late-season species that would not have been found at sites that were not visited in October or November. It probably occurs on additional LWR preserves that have large populations of *Ceratiola*. Some sites, however, have little or no *Ceratiola*, including Tiger Ck., Silver Lk., Lk. Louisa State Pk., and Carter Ck. S. There is, as well, some uncertainty about long-term management of this keystone plant species. Based on current information, *Keltonia balli* is a species of conservation concern on the LWR.

***Keltonia clinopodii***                      Calamintha Plant Bug                      (Heteroptera: Miridae)

Sites: 5: Archbold Biol. Sta., Gould Rd., Holmes Ave., Jack Ck., McJunkin.

Months found: Apr, Sep, Oct.

Habitat: Open scrub with woody scrub mint (*Calamintha ashei*), a species most commonly associated with scrub rosemary, *Ceratiola ericoides*.

Sampling method: Sweeping the host plant in spring and fall.

Notes: A similar species (*K. robusta*) occurs on the scrub mint *Conradina brevifolia*. Taxonomic key: Kelton 1966.

Conservation status: 71 individuals found, from 5 protected LWR sites. This species might occur on a few additional sites that have *Calamintha ashei*. This plant bug depends on a host plant that is rare and whose management is not well understood. *Keltonia clinopodii* appears to be a species of conservation concern on the LWR.

***Keltonia robusta***                      Conradina Plant Bug                      (Heteroptera: Miridae)

Sites: 2: Saddleblanket Lk., FWC Sunray

Months found: May.

Habitat: Open Florida scrub with the scrub mint *Conradina brevifolia*.

Sampling method: Sweeping *Conradina brevifolia*.

Notes: This species seems extremely similar to *K. clinopodii*. Specimens were determined for this study by referring to the host plant. Natural history: Wheeler 2009b, taxonomy: Henry 1991.

Conservation status: 7 individuals found, from 2 protected LWR sites. This species might also occur at Arbuckle State For., where there is a population of *C. brevifolia*. *Keltonia robusta* appears to be a species of conservation concern on the LWR.

***Keltonia rubrofemorata***      Scrub Wireweed Plant Bug              (Heteroptera: Miridae)

Sites: 11: Carter Ck. N., Flamingo Villas, Gould Rd., Henscratch 27, Highland Pk. Estates, Highlands Hammock State Pk., Holmes Ave., Jack Ck., Arbuckle State For., Saddleblanket Lk., FWC Sunray.

Months found: Apr, May, Jun, Jul, Sep, Oct.

Habitat: Open Florida scrub with the host plant, scrub wireweed (*Polygonella myriophylla*).

Sampling method: Sweeping the host plant, *Polygonella myriophylla*.

Notes: There are similar LWR species, but the red legs, combined with the host plant, make this species relatively easy to identify. This species is not found on the other species of *Polygonella* that are often found together with *P. myriophylla*. Natural history: Wheeler 2004.

Conservation status: 229 individuals found, from 11 protected LWR sites. This species appears to be host-specific on a species of endangered plant, so it is a species of conservation concern on the LWR.

***Parthenicus weemsi*** Slender Scrub Rosemary Plant Bug (Heteroptera: Miridae)

Sites: 11: Archbold Biol. Sta., Carter Ck. N., Flamingo Villas, Gould Rd., Henscratch 27, Highland Pk. Estates, Jack Ck., Lk. Placid Scrub, Royce Ranch, Saddleblanket Lk., FWC Sunray.

Months found: Jan, Feb, Mar, Apr, May, Jun, Sep, Oct, Nov.

Habitat: Florida scrub with scrub rosemary (*Ceratiola ericoides*).

Sampling method: Sweeping scrub rosemary.

Notes: This species is similar to *Keltonia balli* in color, but is slightly smaller and more slender. It has a much longer season of adult activity than *K. balli*. *Parthenicus* is a large genus, and the great majority of the species are southwestern. The relatively small number of eastern species have been reviewed by Henry (1982), but problems with identification of *P. weemsi* are minimal, as virtually all specimens are likely to be obtained by sweeping scrub rosemary.

Conservation status: 89 specimens found, from 11 protected LWR sites. This is the most easily found of all the *Ceratiola*-dependent insects, and there are probably very large populations of this species on all sites with abundant *Ceratiola*. Long-term management of its host plant, however, is not completely understood. *Parthenicus weemsi* does not appear to be a species of conservation concern on the LWR.

## Order Homoptera (Leafhoppers, Treehoppers, Aphids, etc.)

***Telamona archboldi*** Archbold's Treehopper (Homoptera: Membracidae)

Sites: 2: Archbold Biol. Sta., Walk-in-Water State For.

Months found: Apr, May, Jul.

Habitat: Florida scrub habitat, including yellow sand scrub.

Sampling methods: Townes flight intercept traps; has also been found at U.V. lights in spring.

Notes: The host plant of this rare species is unknown; based on the habits of relatives elsewhere it is likely to be some species of scrub oak. There are no similar LWR species. This species was described by Froeschner (1968).

Conservation status: 6 individuals found, from 2 protected LWR sites. It appears that only 16 specimens have ever been found, all but one of them from the Archbold Biol. Sta. *Telamona archboldi* appears to be a species of conservation concern on the LWR.

### **Order Coleoptera (Beetles)**

***Aethecerinus hornii*** Horn's Chevron Longhorn Beetle (Coleoptera: Cerambycidae)

Sites: 5: Archbold Biol. Sta., Carter Ck. N., Flamingo Villas, Arbuckle State For., FWC Sunray.

Months found: Mar, Apr, May, Aug, Sep, Nov

Habitat: Florida scrub, including yellow sand scrub.

Sampling method: Townes flight intercept trap.

Notes: Known hosts are small stems of scrub oaks. This species was reared from *Quercus inopina* at the Archbold Biol. Sta. Somewhat similar to a few other LWR longhorn beetles. Identification reference: Lingafelter 2007.

Conservation status: 15 individuals found, from 5 protected LWR sites. This species is either rare or difficult to sample. Considering its known hosts and the variety of habitats in which it has been found, this species probably occurs on additional LWR scrub preserves. Specifics of management are unknown. The presently available information, including the small number of individuals found, the small number of sites, and the lack of any idea of a management regime, suggest that this should be considered a species of conservation concern.

***Aneflomorpha delongi*** Delong's Longhorn Beetle (Coleoptera: Cerambycidae)

Sites: 2: Archbold Biol. Sta., Highland Pk. Estates

Months found: Jun, Sep, Oct

Habitat: Florida scrub, including yellow sand scrub.

Sampling methods: Townes flight intercept traps, has also often been captured at U.V. lights.

Notes: The only known host is turkey oak (*Quercus laevis*). This species closely resembles another longhorn beetle, *Pyrassa pertenuis*. The species can be distinguished by reference to Lingafelter's manual of longhorn beetles (Lingafelter 2007).

Conservation status: 11 individuals found, at 2 protected LWR sites. There is no known reason why this species should be so rare, especially if one of its hosts is turkey oak, a common tree in yellow sand scrub. It appears to be a species of conservation concern on the LWR.

***Anomala eximia*** Scrub Anomala Scarab (Coleoptera: Scarabaeidae)

Sites: 7: Archbold Biol. Sta., Flamingo Villas, Gould Rd., Highlands Hammock State Pk., Lk. June State Pk., Royce Ranch, FWC Sunray.

Months found: May, Jun. Most records from late May.

Habitat: Florida scrub, including yellow sand scrub.

Sampling method: Townes flight intercept trap with pan trap below.

Notes: The larval host is unknown; larvae probably feed on roots of certain scrub plants. There are several similar LWR species. This species is best identified by the absence of a subapical external tooth on the front tibiae. Reference: Potts 1976.

Conservation status: 87 individuals were found, from 7 protected LWR sites. Prior to this survey, *A. eximia* was apparently known only from the Archbold Biol. Sta. The collecting data suggest that this species may have synchronized emergences, perhaps with some additional strays. This would mean that traps would need to be in just the right place and at the right time to get site records for this species, implying that it could be on additional sites. Alternatively, this species might be abundant at a few sites at the south end of the LWR, rare elsewhere. This ambiguity, combined with a lack of information on host and microhabitat requirements, suggests that *Anomala eximia* should be considered a species of conservation concern on the LWR.

***Auletobius* species near *A. cassandrae*** (Scrub Rosemary Tip Weevil)  
(Coleoptera: Attelabidae)

Sites: 5: Archbold Biol. Sta., Henscratch 27, Flamingo Villas, Holmes Ave., Jack Ck.

Months found: Feb, Mar, Apr, May, Jun, Sep, Oct, Dec.

Sampling method: Sweeping scrub rosemary (*Ceratiola ericoides*).

Notes: Larvae develop in growing tips of scrub rosemary. Adults are very similar to those of a species found in growing tips of wax myrtle (*Myrica cerifera*), but the differences between these two hosts in morphology, chemistry, phylogeny and phenology make it unlikely that the same weevil attacks these two hosts. The larvae are attacked by small chalcidoid wasps.

Conservation status: 22 individuals found, from 5 protected LWR sites. About 10 scrub preserves have no extensive areas of scrub rosemary, reducing the sites for scrub rosemary specialists by almost a half. This species of *Auletobius* may well occur on at least 12 protected LWR sites, but at this point it should conservatively be considered a species of conservation concern on the LWR.

***Blackburneus troglodytes*** Little Gopher Tortoise Scarab (Coleoptera: Scarabaeidae)

Sites: 10: Archbold Biol. Sta., Carter Ck. N., Flamingo Villas, Henscratch 27, Highlands Hammock State Pk., Lake Louisa State Pk., Arbuckle State For., Silver Lk, FWC Sunray, Tiger Ck.

Months found: Mar, Apr, May, Jun, Jul, Oct, Nov, Dec

Habitat: This species occurs in burrows of the gopher tortoise (*Gopherus polyphemus*).

Sampling methods: Pan trap at base of Townes flight intercept trap, sifting sand at entrance of burrow of gopher tortoises.

Notes: This species was formerly placed in the genus *Aphodius*. There are several other species, especially the common species *Blackburneus aegrotus*, that can be confused with *B. troglodytes*. The gopher tortoise species has longer hind tarsi and lacks hair on the postero-lateral region of the elytra, a feature of *B. aegrotus*. Identification reference: Woodruff 1973.

Conservation status: 16 individuals found, from 10 protected LWR sites. This species probably occurs wherever gopher tortoises are abundant. Its dependence on the gopher tortoise automatically makes it a species of conservation concern on the LWR.

***Blapstinus, undescribed species*** Scrub Subterranean Darkling Beetle  
(Coleoptera: Tenebrionidae)

Sites: 5: Archbold Biol. Sta., Arbuckle State For., Royce Ranch, FWC Sunray.

Months found: Mar, May, Jul, Oct.

Habitat: Open scrub with patches of bare sand.

Sampling methods: sifting sand in open areas or at edge of vegetation. There is no known way to predict which patch of sand is likely to produce one of these beetles.

Notes: The diet of this species is unknown. It is flightless and probably has poor dispersal ability. Its small size and lack of hind wings distinguish this species from other LWR *Blapstinus* species. No reference on this genus currently available.

Conservation status: 7 specimens found, from 4 protected LWR sites. It is much more difficult to find this species than to find the small flightless scarab *Geopsammadius relictillus*. It is possible that larvae of this *Blapstinus* are associated with some unknown subterranean resource or microhabitat. It may well occur on several additional scrub preserves, but it should be listed at this point as a species of conservation concern on the LWR.

***Chelyoxenus xerobatis*** Gopher Tortoise Hister Beetle (Coleoptera: Histeridae)

Sites: 10: Archbold Biol. Sta., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Henscratch 27, Highland Pk. Estates, Highlands Hammock State Pk., Jack Ck., Arbuckle State For., Royce Ranch.

Months found: Mar, Apr, May, Jun, Aug, Sep

Habitat: Florida scrub habitat with gopher tortoises (*Gopherus polyphemus*).

Sampling methods: Townes flight intercept trap with pan trap at base; this species does not fly up into the trap; yellow bowls; sifting at entrance of tortoise burrows.

Notes: This species probably feeds on fly larvae (especially *Eutrichota gopher*) in gopher tortoise burrows. There are numerous similar species of Histeridae on the LWR. This species is distinguished by the claws of the hind tarsi: the outer claw is minute, the inner claw greatly elongated, so it appears that there is one very long tarsal claw.

Description of species: Hubbard 1894.

Conservation status: 27 individuals found, from 10 protected LWR sites. *Chelyoxenus xerobatis* shares the conservation status of its host tortoise, and is a species of conservation concern on the LWR.

***Cicindela highlandensis*** Highlands Tiger Beetle (Coleoptera: Carabidae)

Sites: 10: Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Henscratch 27, Highlands Hammock State Pk., Jack Ck., Arbuckle State For., Tiger Ck., Walk-in-Water State For.

Months found: May, Jun, Jul. Adult activity of *C. highlandensis* has a shorter season than that of *C. scabrosa*.

Habitat: Florida scrub with numerous open patches and bare sand, often in yellow sand scrub.

Sampling methods: Observation of live individuals in the field; Townes flight intercept trap with pan at base to catch flying insects; yellow bowl traps. Trapping was curtailed when this species was present, as it is a candidate for federal listing as an endangered species.

Notes: This species is similar to *C. scabrosa*, but the two species can usually be distinguished in the field without catching specimens. *Cicindela highlandensis* is conspicuously metallic when seen in sunlight, and lacks the small white patches on the tips of the elytra found in *C. scabrosa*. Populations may vary markedly in size from year to year. This species does not occur in suitable sites on the Archbold Biol. Sta.; it was found only on sites north of Josephine Ck. Description of this species, and features distinguishing between *C. highlandensis* and *C. scabrosa*: Choate 1984.

Conservation status: 95 individuals were found, from 10 protected LWR sites. While this is an encouraging number of sites, populations were sometimes restricted to one or a few small areas on a site. Tiger beetles in general occur in semi-aggregations and do not occupy all apparently suitable sites. This makes them vulnerable to local extirpation. We were surprised to find this species so frequently and on so many sites. These beetles are easily caught, and this may be the only species in this survey that might possibly face a threat from over-collecting on some sites. This species is of conservation concern on the LWR.

***Cicindela scabrosa***                      Florida Scrub Tiger Beetle                      (Coleoptera: Carabidae)

Sites: 3: Archbold Biol. Sta., Highlands Hammock State Pk., Arbuckle State For.

Months found: May, Jun, Jul, Aug, Sep.

Habitat: Open Florida scrub with patches of bare sand. There is some indication that this species may tolerate a slightly higher water table than *C. highlandensis*.

Notes: This species is similar to *C. highlandensis*, but the two species can usually be distinguished in the field without catching specimens. This species has small white markings on the tips of the elytra, and lacks the metallic sheen of *C. highlandensis*. For

discussion of features distinguishing between *C. highlandensis* and *C. scabrosa*, see Choate 1984.

Conservation status: 7 individuals found, on 3 protected LWR sites. On the LWR this species was rarer than *C. highlandensis*, which is restricted to the LWR. *Cicindela scabrosa* appears to be a species of conservation concern on the LWR.

***Colaspis*, undescribed species** Scrub Oak Colaspis (Coleoptera: Chrysomelidae)

Sites: 2: Archbold Biol. Sta., Flamingo Villas.

Months found: Apr, May, Jun

Habitat: Yellow sand scrub with myrtle oak (*Quercus myrtifolia*); on the LWR myrtle oak tends to be replaced by *Quercus inopina* on most white sand sites.

Sampling methods: Sweeping scrub oaks at night, Townes flight intercept trap in oak scrub.

Notes: This species is similar to another LWR species of *Colaspis* (*C. pseudofavosa*), but can be distinguished by its reddish pronotum. Florida species of this genus have not been reviewed.

Conservation status: 12 individuals found, from 2 protected LWR sites. The sampling done during this study involved little night work, and was inadequate to sample for this species. It rarely appears in flight traps, but a visiting researcher at the Archbold Biol. Sta. found several specimens by sweeping *Quercus myrtifolia* at night. Based on current information this undescribed *Colaspis* is a species of conservation concern on the LWR.

***Diplotaxis rufa*** Red Diplotaxis Scarab (Coleoptera: Scarabaeidae)

Sites: 6: Archbold Biol. Sta., Carter Ck. S., Flamingo Villas, Gould Rd., Henscratch 27, FWC Sunray.

Months found: Mar, Apr, May

Habitat: Florida scrub, including yellow sand scrub. Individuals were found in both recently burned and long-unburned sites.

Sampling methods: Townes flight intercept traps with pan trap at base of trap.

Notes: Larvae of *Diplotaxis* species feed on roots, but specific hosts of this species are not known. This species strongly resembles the red form of the much commoner LWR

species *Diplotaxis bidentata* and specimens must be examined under the microscope for identification. As *Diplotaxis* go, this species is not particularly difficult to identify, as its clypeal punctures are conspicuously coarse and irregular compared with those of *D. bidentata*.

Conservation status: 19 individuals found, from 6 protected LWR sites. *Diplotaxis rufa* appears to be a species of conservation concern on the LWR.

***Enaphalodes archboldi*** Archbold Scrub Oak Longhorn Beetle (Coleoptera: Cerambycidae)

Sites: 1: Archbold Biol. Sta.

Months found: Sep.

Habitat: Florida scrub.

Sampling method: Found at light.

Notes: The larval host of this rare species is unknown, but based on the habits of related species it probably breeds in oak or hickory. Rare species of longhorn beetles often breed in common host plants and the reason for their scarcity remains a mystery. There are similar species of *Enaphalodes* on the LWR. For a description and illustrations of this species, and a key to the species of the genus see Lingafelter and Chemsak 2002.

Conservation status: 2 individuals found, at 1 protected LWR site. This species also occurs in Florida scrub sites off the LWR, so there is a good chance that it is widespread on the LWR and is not restricted to the Archbold Biol. Sta. *Enaphalodes archboldi* should be considered a species of conservation concern on the LWR.

***Geopsammadius morrissi*** Morris' Blind Scarab (Coleoptera: Scarabaeidae)

Sites: 1: Catfish Ck. State Pk.

Months found: Jun

Habitat: Along edge of sand road through recently burned yellow sand scrub.

Sampling method: Sifting sand, putting residue in Berlese funnel to extract the beetles. See sampling account for *G. relictillus*.

Notes: A similar species, *G. relictillus*, is more widespread on the LWR. The two species can be distinguished by differences in the sculpture of the pronotum; description and photographs in Skelley 2006.

Conservation status: 23 individuals were found at 1 protected LWR site, Catfish Ck. State Pk. The nearest other protected sites, Tiger Ck. Snell Ck. and Walk-in-Water State For., are inhabited by *G. relictillus*. Assuming that the two species do not occur together (a general rule within the genus *Geopsammodius*), Catfish Ck. State Pk. is the only protected site for *G. morrisoni*. *Geopsammodius morrisoni* is a species of conservation concern on the LWR.

***Geopsammodius relictillus***

(Coleoptera: Scarabaeidae)

Lake Wales Ridge Blind Scarab

Sites: 13: Archbold Biol. Sta., Carter Ck. S., Flamingo Villas, Holmes Ave., Jack Ck., Lk. Placid Scrub, Arbuckle State For., McJunkin, Silver Lk., Snell Ck., FWC Sunray, Tiger Ck., Walk-in-Water State For.

Months found: Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec

Habitat: Open Florida scrub with patches of bare sand.

Sampling methods: This species is found by sifting sand: the sand is eliminated with a window screen gauge strainer, the resulting detritus is extracted with a Berlese funnel, as these beetles are small and play dead in the sifter. This species is probably associated with some special microhabitat, or with a buried resource such as organic accumulations or fungal hyphae. Sometimes specimens are found by sifting around the mounds of harvester ants, but frequently this technique fails. Currently, hunting for this species is almost completely haphazard.

Notes: This species is blind and flightless; as far as we know, it never comes to the surface. A similar species, *G. morrisoni*, occurs at Catfish Ck. State Pk. The two species can be distinguished by differences in the sculpture of the pronotum; taxonomic key and photographs in Skelley 2006.

Conservation status: 134 individuals found, from 13 protected LWR sites. This species probably occurs in gigantic numbers at many sites, considering that the sampling method is cumbersome and could only be used on a tiny scale relative to the available habitat. On the other hand, this species must have very poor dispersal ability, and might be eliminated from an area if the scrub canopy became closed. *Geopsammodius relictillus* does not appear to be a species of conservation concern on the LWR.

***Haroldiataenius saramari*** Little Black Scrub Scarab (Coleoptera: Scarabaeidae)

Sites: 17: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Flamingo Villas, Henscratch 27, Highland Pk. Estates, Holmes Ave., Jack Ck., Lk. Louisa State Pk., Lk. Placid Scrub, Arbuckle State For., McJunkin, Royce Ranch, Snell Ck., FWC Sunray, Tiger Ck., Walk-in-Water State Pk.

Months found: Jan, Mar, Apr, May, Jul, Aug, Sep, Oct, Dec.

Habitat: Florida scrub, including yellow sand scrub. Often found at edges of clumps of scrub oaks, not usually found in areas of bare sand. This species seems to be associated with roots or leaf litter of scrub oaks, but cannot be found predictably by sifting sand from around scrub oaks

Sampling method: This scarab has wings, but is not known to fly, does not appear in traps, and there is no known way to attract the adults. It is found by sifting sand: the sand is eliminated with a window screen gauge strainer, the resulting detritus is extracted with a Berlese funnel, as these beetles are small and play dead in the sifter.

Notes: the diet of this species is unknown, but it might feed on organic matter or fungi. There appears to be some aggregation of adults, as many samples produce none of these beetles, while some produce several. There are several similar species of small black scarabs on the LWR. *Haroldiataenius saramari* can be distinguished from other species by using the key to the genus *Ataenius* in Woodruff 1973. *Haroldiataenius* was revised by Stebnicka and Skelley (2009). There are no additional Florida species in this genus, but there are several from southwestern North America; the Florida species might be an example of a western lineage with an isolated species in Florida scrub.

Conservation status: 128 individuals found, from 17 protected LWR sites. Taking into account the regularity with which this species was found by using small-scale, haphazard methods, it must be an abundant species on many of the 17 sites where it was found. It does not appear to be a species of conservation concern on the LWR.

***Ischyrus dunedinensis*** Scrub Pleasing Fungus Beetle (Coleoptera: Erotylidae)

Sites: 10: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Highlands Hammock State Pk., McJunkin, Tiger Ck., Walk-in-Water State For.

Months found: Apr, May, Jun, Jul, Aug, Sep, Nov.

Habitat: Florida scrub, primarily yellow sand scrub that has not burned recently.

Sampling method: Townes flight intercept traps with pan traps at base.

Notes: Like related species, this species probably feeds on fungi growing on dead trees or branches. There is a similar LWR species (*I. quadripunctatus*) that may be confined

to swamp forest on the LWR. A remarkably detailed drawing of this species can be found in Skelley and Goodrich (1989).

Conservation status: 39 individuals found, from 10 protected LWR sites. This species does not seem to be abundant, its host fungus is unknown, and it has not been associated with any scrub management regime. *Ischyryus dunedinensis* is, however, widely distributed among the sites surveyed, and there is no good reason to consider it a species of conservation concern at this time.

***Leiopsammodius deyrupi***                      Scrub Little Mole Scarab    (Coleoptera:  
Scarabaeidae)

Sites: 4: Archbold Biol. Sta., Catfish Ck. State Pk., TNC Sunray, Tiger Ck.

Months found: Mar, Jun, Aug.

Habitat: Florida scrub, including yellow sand scrub.

Sampling method: Pan traps at base of Townes flight intercept trap, or sifting.

Notes: This species is extremely similar to a much more common species *Leiopsammodius malkini*. Like other very small scarabs that can be sifted from sand, this species probably feeds on some kind of buried organic matter. Unlike *L. malkini*, *L. deyrupi* is seldom attracted to lights. Southeastern North America has four endemic species in this genus, all associated with sandy soil. One species that occurs on beach was collected primarily by sifting, but several specimens were found dead in beer cans; perhaps half-buried beer cans should be tested in scrub habitat for the LWR species. Natural history and key to species: Harpootlian et al. 2000.

Conservation status: 6 specimens found, from 4 protected LWR sites. This species is much more difficult to find than the other small scarabs that can be found by sifting or in flight intercept traps. It might have a more specialized diet, although there are no records of aggregations of this species. In the absence of any data that would suggest that this species is sometimes abundant or that it occurs on additional sites, *Leiopsammodius deyrupi* appears to be a species of conservation concern on the LWR.

***Liopinus, undescribed species***                      Scrub Hickory Longhorn Beetle  
(Coleoptera: Cerambycidae)

Sites: 2: Archbold Biol. Sta., Flamingo Villas.

Months found: May.

Habitat: Yellow sand scrub, the usual habitat for scrub hickory (*Carya floridana*).

Sampling methods: U.V. light trap, beating dead branches and twigs of scrub hickory.

Notes: this species probably breeds in dead branches and twigs. There are several similar LWR species. This species is distinguished by its uniform pale gray color, with a narrow black chevron on the elytra.

Conservation status: 2 individuals found, from 2 protected LWR sites. This species is known from only a few specimens, and seems to be rare. This *Liopinus* appears to be a species of conservation concern on the LWR.

***Lucidota luteicollis***                      Diurnal Scrub Firefly                      (Coleoptera: Lampyridae)

Sites: 19: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highland Pk. Estates, Highlands Hammock State Pk., Holmes Ave., Jack Ck., Lk. June State Pk., Lk. Placid Scrub, Arbuckle State For., McJunkin, Royce Ranch, Silver Lk., Tiger Ck., Walk-in-Water State For.

Months found: Apr, May, Jun, Jul, Aug.

Habitat: Open Florida scrub, including yellow sand scrub.

Sampling method: Townes flight intercept trap.

Notes: Females of this species are flightless and remain buried in the sand; they have only been seen a few times. The larvae are almost certainly predatory, but the specific larval diet is unknown. Males fly during the day, moving low over the sand, probably seeking the buried females by scent. Males are not known to use flash signals when seeking females, but when males are disturbed or threatened at night they display a pair of glowing spots on the abdomen. This is a distinctive species unlikely to be confused with any others, with the possible exception of *Plateros scutellatus* (Coleoptera: Lycidae).

Conservation status: 1730 individuals found, from 19 protected LWR sites. *Lucidota luteicollis* is not a species of conservation concern on the LWR.

***Neoptochus, undescribed species***                      Nocturnal Scrub Oak Weevil                      (Coleoptera: Curculionidae)

Sites: 2: Archbold Biol. Sta., Flamingo Villas.

Months found: Aug, Oct.

Habitat: Oak scrub.

Sampling method: Sweeping myrtle oak (*Quercus myrtifolia*) at night.

Notes: This species is flightless. Like many weevils that feed on leaves as adults, this species is probably hidden in leaf litter during the day. The larval plant host is unknown. While not wanting to characterize this species as nondescript, I know of no simple diagnostic features that would distinguish it from a large number of other brownish-gray weevils that occur on the LWR. It belongs to a group of weevils that have a short snout, not a long, beaklike snout.

Conservation status: 4 individuals found, from 2 protected LWR sites. This species is unlikely to appear in flight traps or bowl traps, and is unavailable during the day. There was no targeted effort to find this species by sweeping scrub oaks at night. Based on current information, however, this is a species of conservation concern on the LWR.

***Odontotaenius floridanus*** Florida Scrub Bess Beetle (Coleoptera: Passalidae)

Sites: 4: Archbold Biol. Sta., Carter Ck. N., Flamingo Villas, FWC Sunray.

Months found: Jan, Mar, Apr, May, Jun, Aug, Sep, Nov.

Habitat: Open Florida scrub.

Sampling methods: Occasionally found in yellow bowl traps or in pan traps at the base of Townes flight intercept traps. Dead individuals are sometimes found dead in ruts in dry sand roads. This species is not attracted to lights.

Notes: This species breeds in dead wood, including partially buried wood and roots. There is no record of this species flying. A similar LWR species (*O. disjunctus*) occurs in rotten logs in swamp forest. *Odontotaenius floridanus* was described by Schuster (1994).

Conservation status: 14 individuals found, from 4 sites. This species is relatively rare and frequently disperses by walking, when it is subject to predation and to getting stuck in vehicle ruts on sand roads, a threat observed during this study on the Archbold Biol. Sta., also documented by Arnaud and Arnaud (2008). This is one of the few Florida scrub arthropods obviously adversely affected by unpaved roads through sand. *Odontotaenius floridana* appears to be a species of conservation concern on the LWR.

***Onthophagus aciculatulus***  
(Coleoptera: Scarabaeidae)

Florida Scrub Onthophagus

Sites: 14: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highlands Hammock State Pk., Jack Ck., Lk. June State Pk., Lk. Placid Scrub, Arbuckle State For., Silver Lk., FWC Sunray.

Months found: Jan, Mar, Apr, May, Jun, Jul, Aug, Oct, Nov, Dec. Most of the old records from the Archbold Biol. Sta. are from the winter months.

Sampling method: Pan traps at base of Townes flight intercept traps. This species is not attracted to light traps, nor does it go up into the collecting bottles of flight traps. It probably flies low over the sand at night.

Notes: The larval food of this scarab is unknown. This species is probably a specialist associated with some kind of fungus or the dung of some animal found in Florida scrub. It has not been found on carrion or on large animal dung (bobcat, dog) at the Archbold Biol. Sta., and it seems too common to be associated with some rare species of animal. It does not appear to feed on mushrooms at the Archbold Biological Station. Perhaps the larvae feed on the underground truffles that occur in scrub. There are several very similar species of *Onthophagus* on the LWR. For identification see Woodruff 1973.

Conservation status: 135 individuals were found, from 14 protected LWR sites. Although the larval resources required by this species remain unknown, there is no reason to believe that *Onthophagus aciculatulus* is a species of conservation concern on the LWR.

***Onthophagus polyphemi*** Gopher Tortoise *Onthophagus* (Coleoptera: Scarabaeidae)

Sites: 15: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highlands Hammock State Pk., Holmes Ave., Jack Ck., Arbuckle State For., Royce Ranch, Saddleblanket Lk., FWC Sunray, Tiger Ck.

Months found: Apr, May, Jun, Jul, Aug, Sep.

Habitat: Florida scrub with gopher tortoises (*Gopherus polyphemus*).

Sampling methods: Yellow bowl traps, pan traps at base of Townes flight intercept traps. This species does not fly up into the collecting bottle of flight traps. Specimens also found at the entrance of gopher tortoise burrows.

Notes: Larvae of this species feed on gopher tortoise dung in the burrow. The shininess of this species, especially that of the pronotum, distinguishes it from other LWR species of *Onthophagus*, except for *O. striatulus*. For species identification see Woodruff 1973.

Conservation status: 95 individuals found, from 15 protected LWR sites. This species demonstrates how a species that seems relatively abundant and well protected on the LWR could actually be revealed as a species of conservation concern once its specialized ecology is known. *Onthophagus polyphemi* is a species of conservation concern on the LWR, sharing the conservation status of its host, the gopher tortoise.

***Onychomira floridensis*** Archbold Comb-Clawed Beetle (Coleoptera: Tenebrionidae)

Sites: 3: Archbold Biol. Sta., Flamingo Villas, Royce Ranch.

Months found: Mar, Apr.

Habitat: Florida scrub habitat.

Sampling methods: Townes flight intercept traps, also found at U.V. lights.

Notes: The yellowish color of this species is distinctive among comb-clawed beetles on the LWR. It also has only a few basal comb-like teeth on the tarsal claws, unlike the fully toothed claws characteristic of its group of tenebrionids. The larval diet is unknown. Most records of this species are from the Archbold Biol. Sta., the only known site for this species before this survey. Campbell (1984) provides an illustrated description of this species, as well as a key to the genera of the Alleculinae (formerly a separate family, the Alleculidae). Since the genus *Onychomira* includes a single species, the genus key can also be used to identify this species.

Conservation status: 5 individuals found, from 3 protected LWR sites. *Onychomira floridensis* appears to be a species of conservation concern on the LWR.

***Pachybrachis*, probable undescribed species** Scrub Rosemary Leaf Beetle  
(Coleoptera: Chrysomelidae)

Sites: 7: Archbold Biol. Sta., Carter Ck. N., Flamingo Villas, Gould Rd., Highland Pk. Estates, McJunkin, Royce Ranch.

Habitat: Florida scrub with scrub rosemary (*Ceratiola ericoides*).

Sampling method: Sweeping *Ceratiola ericoides*.

Notes: This species is probably undescribed, but its status will be unclear until the genus *Pachybrachis* receives some additional attention. Members of the family Chrysomelidae are often restricted to a single genus of host plant. Scrub rosemary, a highly aberrant member of the family Ericaceae, is not closely related to any other species of plant, and is the only host plant for several species of insects.

Conservation status: 32 individuals found, from 7 protected LWR sites. This beetle is known from only 7 protected sites, and its only known host is a species whose long-term management is not completely understood. This *Pachybrachis* is a species of conservation concern on the LWR.

***Pachybrachis*, probable undescribed species** Woody Wireweed Leaf Beetle (Coleoptera: Chrysomelidae)

Sites: 9: Carter Ck. N., Flamingo Villas, Henscratch27, Highland Pk. Estates, Jack Ck., Lk. June State Pk., Arbuckle State For., Saddleblanket Lk., FWC Sunray.

Months found: Apr, May, Jun, Aug, Sep.

Habitat: Open Florida scrub with woody wireweed (*Polygonella myriophylla*).

Notes: This distinctive species was found only on *P. myriophylla*, not on the three other species of scrub *Polygonella* often found on the same sites, or on other plants. This plant host also has a host-specific species of plant bug, *Keltonia rubrofemorata*. The taxonomic status of this species will remain unclear until there has been additional work on the genus *Pachybrachis*.

Conservation status: 29 individuals found, from 9 protected LWR sites. The host plant is an endangered scrub species and this beetle is known from only 9 sites. Current information suggests that this species of *Pachybrachis* is a species of conservation concern on the LWR.

***Pachybrachis*, probable undescribed species** Dalea Leaf Beetle (Coleoptera: Chrysomelidae)

Sites: 5: Archbold Biol. Sta., Carter Ck. N., Flamingo Villas, Highland Pk. Estates, Tiger Ck.

Months found: Apr, May, Jun.

Habitat: Florida scrub, including yellow sand scrub, with Feay's Prairie Clover (*Dalea feayi*). This host plant also occurs on open sandy road shoulders.

Sampling method: Sweeping *Dalea feayi*.

Notes: This species appears to be host-specific on *Dalea feayi*, a species that grows in scrub on the Lake Wales Ridge. Elsewhere in Florida this plant occurs in both scrub and sandhill habitats, and there are additional species of *Dalea* in other habitats. The

taxonomic status of this species will remain unclear until there has been additional work on the genus *Pachybrachis*.

Conservation status: 21 individuals found, from 5 protected LWR sites. This is the most dubious of the species studied, as its taxonomic status, host range and geographic range are all unknown. It was included in this survey because it appears to be host specific on a scrub plant on the LWR. Based on current information, this species of *Pachybrachis* is a species of conservation concern on the LWR.

***Phyllophaga elizoria***      Elizoria June Beetle      (Coleoptera: Scarabaeidae)

Sites: 4: Archbold Biol. Sta., Gould Rd., Henscratch 27, Holmes Ave.

Months found: Mar, Apr.

Habitat: Florida scrub.

Sampling method: Townes flight intercept trap. This species is also attracted to U.V. lights.

Notes: Larvae feed on roots of some scrub plant, but the host plant is unknown. Adults are nocturnal. This is a dark reddish-brown species that is noticeably furry; another furry species is *P. okeechobea*, discussed below. There are several generally similar LWR species, which are best identified by structures of the male genitalia. Fortunately, the great majority of specimens caught in traps are males. A good reference for identifying Florida June beetles is Woodruff and Beck 1989.

Conservation status: 73 individuals found, from 4 protected LWR sites. Not all sites were surveyed in March and early April when adults of this species are active. According to current information, *Phyllophaga elizoria* is a species of conservation concern on the LWR.

***Phyllophaga elongata***      Elongate June Beetle      (Coleoptera: Scarabaeidae)

Sites: 16: Archbold Biol. Sta., Carter Ck. N., Flamingo Villas, Gould Rd., Henscratch 27, Highland Pk. Estates, Highlands Hammock State Pk., Holmes Ave., Jack Ck., Lk. June State Pk., Arbuckle State For., McJunkin, Royce Ranch, Saddleblanket Lk., FWC Sunray, Tiger Ck.

Months found: Apr, May, Jun, Jul, Aug, Oct. This is an unusually long flight period for a June beetle.

Habitat: Florida scrub.

Sampling method: Townes flight intercept trap. This species is also attracted to U.V. lights.

Notes: Larvae feed on roots of some scrub plant, but the host plant is unknown. Adults are nocturnal. This species is yellowish brown, and its elytra are not noticeably covered with fine pale hairs. There are several similar LWR species, which are best identified by structures of the male genitalia. Fortunately, the great majority of specimens caught in traps are males. For identification, see Woodruff and Beck, 1989.

Conservation status: 251 individuals found, from 16 protected LWR sites. *Phyllophaga elongata* does not appear to be a species of conservation concern on the LWR.

***Phyllophaga okeechobea*** Diurnal Scrub June Beetle (Coleoptera: Scarabaeidae)

Sites found: 2: Archbold Biol. Sta., Gould Rd.

Months found: Mar, Apr, May.

Habitat: Florida scrub.

Sampling methods: There appears to be no effective way to survey for this species, although one would expect that a Townes flight intercept trap with a pan trap at its base would be effective if it happened to be in the right place at the right time.

Notes: This species, unlike other LWR June beetles, is active during the day. It appears to be one of the rarest of Florida endemic June beetles. This species is dark brown and noticeably furry, somewhat like *P. elizoria*. There are several similar LWR species of *Phyllophaga*, and best identification is by male genitalic structures, shown in the manual of Florida June beetles by Woodruff and Beck (1989).

Conservation status: 2 individuals found, from 2 protected LWR sites. *Phyllophaga okeechobea* appears to be a species of conservation concern on the LWR.

***Phyllophaga panorpa*** South Lake Wales Ridge June Beetle (Coleoptera: Scarabaeidae)

Site: 1: Archbold Biol. Sta.

Months found: Sep.

Habitat: Florida scrub.

Sampling method: one individual was found on a building at the Archbold Biol. Sta. This species, like *P. elongata*, should be readily caught by Townes flight intercept traps.

Notes: This rare species is extremely similar to the much commoner *P. elongata*, even when the two species are compared side-by-side. They differ in small details of male genitalia and a few other subtle ways. For identification, see Woodruff and Beck 1989.

Conservation status: 1 individual found, from 1 protected LWR site. *Phyllophaga panorpa* appears to be a species of conservation concern on the LWR.

***Pleotomodes needhami*** Ant-Loving Scrub Firefly (Coleoptera: Lampyridae)

Sites: 8: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Gould Rd., Henscratch 27, Jack Ck., Lk. Placid Scrub, Royce Ranch, Arbuckle State For.

Months found: Apr, May.

Habitat: Florida scrub, including yellow sand scrub.

Sampling method: Townes flight intercept traps.

Notes: This species is conspicuously variable in size. Larvae of this species have been found in ant nests, but their diet is unknown. In the laboratory they have not been seen to eat ant larvae. Females of this species are unable to fly, and hang out at the entrance of ant nests at night, apparently attracting males by their luminescence (Sivinski et al. 1998). Small species in the genus *Photinus* are similar in appearance, but have much longer antennae. There are two similar Florida species in the genus *Pleotomodes*, but only *P. needhami* is known from the LWR. The species are differentiated by Geisthardt (1986).

Conservation status: 64 individuals found, from 8 protected LWR sites. Prior to this survey, this species was known only from the Archbold Biol. Sta. *Pleotomodes needhami* is still only known from 8 protected sites, and appears to be a species of conservation concern on the LWR.

***Plesioclytus relictus*** Dimorphic Scrub Longhorn Beetle (Coleoptera: Cerambycidae)

Sites: 3: Archbold Biol. Sta., Flamingo Villas, Arbuckle State For.

Months found: Apr, Jun, Jul.

Habitat: Florida scrub.

Sampling methods: No effective sampling methods were found for this species. It sometimes visits flowers during the day, and was collected once in a Townes flight intercept trap.

Notes: *Plesioclytus relictus* probably breeds in dead wood of some tree, shrub or vine found in Florida scrub. Considering the sites where it has been found, it is unlikely to require some rare scrub plant as a host. This species is eagerly sought by collectors of longhorn beetles, but remains extremely rare in collections. In flight this species appears to be a wasp mimic, especially the female, which has short, thick antennae like those of vespid wasps. Identification reference (taxonomic key, photos): Lingafelter 2007; description of species, differentiation between males and females: Giesbert 1993.

Conservation status: 4 individuals found, from 3 protected LWR sites. *Plesioclytus relictus* appears to be a species of conservation concern on the LWR.

***Romulus globosus***      Round-Necked Scrub Longhorn Beetle    (Coleoptera: Cerambycidae)

Sites: 2: Archbold Biol. Sta., Tiger Ck.

Months found: Jul.

Sampling methods: There is no known way to efficiently survey for this species. Adults are occasionally seen crawling over sand in open scrub. One was captured in a yellow bowl trap. A few specimens were collected in a very large array of pitfall traps and drift fence used in a study of sand skinks (*Plestiodon reynoldsi*) at the Archbold Biol. Sta.

Notes: *Romulus globosus* is generally considered a rare scrub endemic, and only a small number of specimens are in collections. The larval diet is unknown, possibly oak, based on the hosts of some apparently related species. Many longhorn beetles in Florida and elsewhere appear to be rare, even though their host plants are common. Identification reference: Lingafelter 2007.

Conservation status: 2 individuals found, from 2 protected LWR sites. *Romulus globosus* appears to be a species of conservation concern on the LWR.

***Selonodon archboldi***      Archbold Cebrionine Beetle    (Coleoptera: Elateridae: Cebrioninae)

Sites: 5: Archbold Biol. Sta., Catfish Ck. State Pk., Lk. Placid Scrub, Tiger Ck., Walk-in-Water State For.

Months found: May, Jun. Adults fly during heavy rains at the beginning of the rainy season, so the flight period at any one site may occur over a very short time span.

Habitat: Florida scrub, including yellow sand scrub.

Sampling method: Townes flight intercept traps; this species is also attracted to U.V. light traps.

Notes: The larvae of this species probably feed on roots, but no hosts are known. Females are flightless and have never been observed. There is another much commoner LWR species of *Selonodon*, but it is conspicuously smaller and paler than *S. archboldi*. A third species has been found in the Clermont area. *Selonodon archboldi* was described and its genus revised by Galley (1999). Several southeastern species in this genus appear to have extremely restricted distributions.

Conservation status: 15 individuals found, from 5 protected LWR sites. Surveys for this species may be hindered by its short flight period. According to current data, *Selonodon archboldi* appears to be a species of conservation concern on the LWR.

***Serica frosti*** Frost's Silky June Beetle (Coleoptera: Scarabaeidae)

Sites: 9: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Flamingo Villas, Henscratch 27, Holmes Ave., Lk. Louisa St. Pk., Lk. Placid Scrub, Arbuckle State For.

Months found: Mar, Apr, May.

Habitat: Florida scrub.

Sampling method: Townes flight intercept traps with pan trap at base; this species is also attracted to lights and often appears in large numbers on lighted windows at the Archbold Biol. Sta.

Notes: Larvae of *Serica* species feed on plant roots. This is a large genus, with over 100 North American species. It is surprising that there is only one species known from the LWR, and that this species is known from nowhere else. Description of species: Dawson 1967.

Conservation status: 76 individuals found, from 9 protected LWR sites. This species has an extensive LWR range, from Archbold Biol. Sta. to Lk. Louisa State Pk. It is known, however, from only 9 protected sites, and its host requirements are unknown; for these reasons *Serica frosti* remains a species of conservation concern on the LWR.

***Trigonopeltastes floridana*** Scrub Palmetto Scarab (Coleoptera: Scarabaeidae)

Sites: 16: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highlands Hammock State Pk., Jack Ck.,

Lk. June State Pk., Lk. Placid Scrub, Arbuckle State For., McJunkin, Royce Ranch, FWC Sunray, Tiger Ck., Walk-in-Water State For.

Months found: May, Jun.

Habitat: Open Florida scrub.

Sampling methods: Townes flight intercept traps. Also found by searching flowers, especially those of scrub palmetto (*Sabal etonia*), a highly predictable flower host for this species.

Notes: The larval diet of this species is unknown. Members of other genera in its group of scarabs (Trichiinae) breed in rotten wood. There is a similar LWR species of *Trigonopeltastes*; this species has a yellow triangle outlined on its pronotum, rather than the V found on *T. floridana*.

Conservation status: 140 individuals found, from 16 protected LWR sites. The larval host for this species is unknown and might potentially be associated with a particular fire frequency; this is always a potential issue for scrub species that may breed in dead wood. Currently, *Trigonopeltastes floridana* does not appear to be a species of conservation concern on the LWR.

***Typocerus fulvocinctus*** Gold-Banded Longhorn Beetle (Coleoptera: Cerambycidae)

Sites: 7: Archbold Biol. Sta., Henscratch 27, Highlands Hammock State Pk., Lk. Louisa State Pk., Arbuckle State For., FWC Sunray, Walk-in-Water State For.

Months found: Apr, May.

Habitat: Florida scrub, including yellow sand scrub.

Sampling methods: Townes flight intercept traps. This species is also found on flowers, including saw palmetto (*Serenoa repens*) and gallberry (*Ilex glabra*).

Notes: The larval host of this species is unknown. The larval hosts of *Typocerus* species are varied, but most species feed in dead wood. Although this species is rare, that does not mean that its larval host is a rare scrub plant, as there are many rare longhorn beetles with common host plants. The coloration of *T. fulvocinctus*, black with a bright yellow band, distinguishes it from other LWR longhorn beetles. It appears to mimic the coloration of several LWR wasps, especially the sphecid digger wasp *Cerceris fumipennis*. A photograph of this species appears in Lingafelter 2007.

Conservation status: 9 individuals found, from 7 protected LWR sites. *Typocerus fulvocinctus* appears to be a species of conservation concern on the LWR.

## Order Diptera (Two-Winged Flies)

***Asaphomyia floridensis*** Scrub Non-Biting Horsefly (Diptera: Tabanidae)

Sites: 2: Archbold Biol. Sta., Lk. Placid Scrub.

Months found: May, Jun, Jul

Habitat: Open Florida scrub.

Sampling methods: Townes flight intercept traps; occasionally found on flowers or vegetation.

Notes: *Asaphomyia floridensis* lacks the biting mouthparts usually associated with horseflies. Larval habits are unknown, but larvae are probably in sand. At the Archbold Biol. Sta. an adult was found visiting flowers of *Sideroxylon tenax*. A related species occurs in southern Texas. Description of species: Pechuman 1974.

Conservation status: 20 individuals found, from 2 protected LWR sites near the south end of the LWR. 19 of these specimens are from Archbold Biol. Sta. This species never seems to be common. It appears to be a species of conservation concern on the LWR.

***Asyndetus archboldi*** Scrub Long-Legged Fly (Diptera: Dolichopodidae)

Sites: 20: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highland Pk. Estates, Highlands Hammock State Pk., Holmes Ave., Jack Ck., Lk. June State Pk., Arbuckle State For., Royce Ranch, Saddleblanket Lk., Silver Lk., FWC Sunray, TNC Sunray, Tiger Ck., Walk-in-Water State For

Months found: Apr, May, Jun, Jul, Aug. The principal period of adult activity appears to be in May and June.

Habitat: Open patches of bare sand in open scrub; may also be found along bare sandy edges of sand roads.

Sampling method: Yellow bowls are highly effective traps for this species. It is also captured in pan traps at the base of Townes flight intercept traps.

Notes: The larval diet is unknown. This species flies just above the surface of the sand in late afternoon. Adults are probably micro-predators. It was previously known only from the Archbold Biol. Sta. This species is identified by its small size and the

conspicuous discontinuous vein in the front half of the wing. Description of species: Robinson and Deyrup 1997.

Conservation status: 3718 individuals (this number correct) found, from 20 protected LWR sites. *Asyndetus archboldi* is not a species of conservation concern on the LWR.

***Drapetis*, undescribed species**    Tortoise Burrow Dance Fly    (Diptera: Empididae)

Sites: 4: Archbold Biol. Sta., Carter Ck. S., Flamingo Villas, Henscratch 27.

Months found: Jan, Mar, Apr, Sep, Oct, Nov.

Habitat: This species occurs in the burrows of gopher tortoises (*Gopherus polyphemus*).

Sampling methods: Examining burrow entrances of gopher tortoises. The gopher tortoise dance fly is not difficult to observe, but is difficult to collect because of its tiny size, evasiveness, and strong tendency to retreat down the burrow. Specimens are obtained by lying down in front of the burrow, very slowly moving a vial until it is over the target fly, then quickly lowering the vial. This species could be confused with dark-winged fungus gnats (Diptera: Sciaridae) that are sometimes found in the entrances of gopher tortoise burrows.

Notes: The tortoise dance fly belongs to a very large genus that includes a daunting number of undescribed species. It is unlikely that this species will be formally described in the near future because modern species descriptions require indications of how to separate the species being described from all other species in the same genus.

Conservation status: 31 individuals found, from 4 protected LWR sites. Sampling may have been inadequate as this species is best found in fall, winter and early spring, while most of the sampling for this survey was done in late spring through summer. No gopher tortoise burrows were seen on some sites, such as Gould Rd., Holmes Ave., Lake Placid Scrub, and Silver Lk. There is a good chance that this species occurs on most of the LWR sites that have gopher tortoises. Like the gopher tortoise, the tortoise burrow dance fly is a species of conservation concern on the LWR.

***Eutrichota gopheri***    Gopher Tortoise Burrow Fly    (Diptera: Anthomyiidae)

Sites: 8: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Flamingo Villas, Henscratch 27, Jack Ck., Lake Louisa State Pk., FWC Sunray.

Months found: Jan, Feb, Mar, Apr, May, Jun, Aug, Sep, Oct. This species is more difficult to find in June and July than at other times of year.

Habitat: This species occurs in burrows of gopher tortoises (*Gopherus polyphemus*).

Sampling methods: Easily flushed from the burrow entrance by flicking a little sand down the burrow.

Notes: This fly, as well as the beetle inquilines of the gopher tortoise, might be a valuable resource for gopher frogs (*Rana (=Lithobates) capito aesopus*). There are several similar flies on the LWR, but they are not found in tortoise burrows. For a description of this species, see Griffiths 1984.

Conservation status: 44 individuals found, from 8 protected LWR sites. Its dependence on the gopher tortoise automatically makes this a species of conservation concern on the LWR.

***Gymnoprosope*, undescribed species**  
(Diptera: Sarcophagidae)

Black-Palp Little Satellite Fly

Sites: 1: Archbold Biol. Sta.

Months found: Jan, Oct, Nov.

Habitat: Open Florida scrub with scrub rosemary (*Ceratiola ericoides*).

Sampling method: On flowers of papery nailwort (*Paronychia chartacea*), in Townes flight intercept trap.

Notes: This species is difficult to identify, resembling several other small Sarcophagidae of the subfamily Miltogramminae (Satellite flies) on the LWR, and even some small Tachinidae. This species is probably a parasitoid of late season bees or wasps. General review of group: Allen 1926.

Conservation status: 2 individuals found, from one protected LWR site. This species flies late in the year, at a time when little sampling was done for the current study. It may well be relatively abundant and widespread in the appropriate habitat on the LWR, but according to current information this species of *Gymnoprosope* is a species of conservation concern on the LWR.

***Gymnoprosope*, undescribed species**  
(Diptera: Sarcophagidae)

Big-Palp Little Satellite Fly

Sites: 5: Archbold Biol. Sta., Carter Ck. S., Flamingo Villas, Holmes Ave., Jack Ck.

Months found: Sep, Oct

Habitat: Open Florida scrub with species of nailwort (*Paronychia*). Often found along bare edges or medians of sand roads.

Sampling method: May be captured with an insect net snapped down over a clump of nailwort where a fly has just landed. These flies move rapidly from plant to plant, so they are relatively easy to see, in spite of their small size. This species is very active and easily lost in the folds of a net.

Notes: This species is difficult to identify, resembling several other small Sarcophagidae of the subfamily Miltogramminae (satellite flies) on the LWR, and even some small Tachinidae. This species is probably a parasitoid of late season bees or wasps. It is probably the primary pollinator of papery nailwort (*Paronychia chartacea*), which is one of the endangered plants of the LWR. General review of group: Allen 1926.

Conservation status: 69 individuals found, from 5 protected sites. Sampling for this species was incomplete and inefficient, due to its late flight period, and the difficulty in capturing and preparing specimens. It might well be abundant at most or all sites where papery nailwort is common. Based on current information, this is a species of conservation concern on the LWR.

***Hemipenthes bigradata* (or undescribed species near *H. bigradata*)**

Orange-Banded Scrub Bee Fly (Diptera: Bombyliidae)

Sites: 6: Archbold Biol. Sta., Catfish Ck. State Pk., Henscratch 27, Jack Ck., Lk. Placid Scrub, Gould Rd.

Months found: Mar, Apr, May, Jun, Aug, Sep.

Habitat: Open scrub with patches of bare sand, especially scrub rosemary (*Ceratiola ericoides*) habitat.

Sampling method: Searching on low-growing flowers in open areas, often rests on bare sand. May also be found on bare sand edges of sand roads in open scrub, especially where the tiny spring annual *Stipulicida setacea* occurs.

Notes: The larval host is unknown; the larva is probably a predator of some sand-inhabiting insect larva. Flowers visited by adults include *Stipulicida setacea*, *Polanisia tenuifolia*, *Polygonella myriophylla*, *Paronychia chartacea*, *P. americana*, *Syngonanthus flavidulus*. A different form of *H. bigradata* occurs in Texas, assuming Florida specimens are the same species. This is apparently the first report of a *H. bigradata*-like species from Florida. This species may be confused in the field with small LWR bee flies in the genus *Anthrax*.

Conservation status: 40 individuals found, from 6 protected LWR sites. This species is usually found in the most open sites, especially those with scrub rosemary. Based on

the small number of sites where it was found and its restricted habitat, *Hemipenthes bigradata* should be considered a species of conservation concern on the LWR.

***Nemomydas melanopogon***      Black-Bearded Mydas Fly      (Diptera: Mydidae)

Sites: 14: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Henscratch 27, Highland Pk. Estates, Highlands Hammock State Pk., Jack Ck., Lk. June State Pk., Arbuckle State For., Royce Ranch, Saddleblanket Lk., FWC Sunray, Tiger Ck.

Months found: May, Jun, Jul. The flight period of *N. melanopogon* is concentrated in June.

Habitat: Open Florida scrub with patches of bare sand.

Sampling method: Townes flight intercept traps with pan traps at base; individuals found in both pan and bottle of traps.

Notes: The larval host or prey is not known. Mydas flies are sometimes specialized predators as larvae. Adults of this species apparently do not feed. Females are heavy-bodied and seldom seen in traps. There are several species of mydas flies on the LWR, but this is the only one with narrow, whitish dorsal stripes on the thorax and without a conspicuous blackish or brownish tint to the wings.

Conservation status: 42 individuals found, from 14 protected LWR sites. Larval resources required by this species are unknown, but are apparently generally available in open Florida scrub habitat. *Nemomydas melanopogon* does not appear to be a species of conservation concern on the LWR.

***Pieza rhea***      Scrub Pygmy Bee Fly      (Diptera: Mythicomyiidae)

Sites: 7: Archbold Biol. Sta., Carter Ck. S., Flamingo Villas, Henscratch 27, Jack Ck., Lk. Placid Scrub, Royce Ranch

Months found: Apr, Oct, Nov.

Habitat: Open Florida scrub with patches of bare sand; also found along bare sand edges through open scrub.

Sampling methods: Although this species sometimes appears in Townes flight intercept traps, the most efficient way to find it is by sweeping blooming plants of hairy jointweed (*Polygonella basiramia*), a common gap and roadside species primarily restricted to scrub habitat on the LWR.

Notes: The biology of pygmy bee flies (Mythicomyiidae) is poorly known. It is possible that their larvae occur in the nests of ants or bees. Flies in the genus *Pieza* are similar to species in the commoner genus *Glabellula* but differ in details of wing venation. The name *Pieza rhea* has a legitimate Greek derivation, but the specialist who named the species also designed the name to be pronounced "Pizzaria." Another species is named *Pieza pi*. The genus *Pieza* is widely distributed in the New World, but only one species is known from Florida. The genus was described and reviewed by Evenhuis (2002).

Conservation status: 116 individuals found, from 7 protected LWR sites. It turns out that the key to finding this species is by sweeping blooming *Polygonella basiramia* in October and November. This was not done on several sites where this plant occurs, so the survey for this species is obviously incomplete. Based on current survey data, as well as the association of this species with an endangered plant species, *Pieza rhea* should be considered a species of conservation concern on the LWR.

***Townsendia arenicola***                      Pygmy Scrub Robber Fly                      (Diptera: Asilidae)

Sites: 11: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Henscratch 27, Holmes Ave., Jack Ck., Arbuckle State For., FWC Sunray, Tiger Ck., Walk-in-Water State For.

Months found: Jun, Jul, Aug.

Habitat: open Florida scrub with patches of bare sand.

Sampling methods: Yellow bowl traps and pan traps at base of Townes flight intercept traps. This species seldom goes up into the bottle at the top of a Townes trap. It can also be found by close inspection of patches of bare sand.

Notes: All robber flies are predatory, but the prey of this species has not been discovered. This tiny species might feed on the even smaller scrub long-legged fly, (*Asyndetus archboldi*) which is usually common in the same habitat. Females have been seen entering the burrows of small bees, but it is not known whether bee larvae are the larval food of this species. There are no similar LWR species. For species description and comments on natural history of this species see Scarbrough et al. 1995.

Conservation status: 87 individuals found, from 11 protected LWR sites. *Townsendia arenicola* does not appear to be a species of conservation concern on the LWR.

***Villa, undescribed species***                      Scrub Rosemary Bee Fly (Diptera: Bombyliidae)

Sites: 4: Archbold Biol. Sta., McJunkin, Royce Ranch, Lk. Placid Scrub.

Months: Apr, May, Jun.

Habitat: Open Florida scrub, especially scrub rosemary (*Ceratiola ericoides*) habitat.

Sampling methods: Searching small flowers in open scrub. This species is also often found resting on bare sand.

Notes: The larval hosts are unknown; larvae are probably predators of some sand-dwelling insect larvae. Flowers visited by adults include *Polanisia tenuifolia*, *Eryngium cuneifolium*, *Stipulicida setacea*, *Sabal etonia*, *Sideroxylon tenax* and *Polygonella basiramia*. There are several similar LWR species. Florida species of *Villa* have never been reviewed.

Conservation status: 23 individuals found, from 4 protected LWR sites. This species apparently requires open *Ceratiola* habitat. Surveys for this species were not comprehensive, as it is best found by directed searching and it is easily confused with other LWR species of *Villa*. According to current data, this species of *Villa* appears to be a species of conservation concern on the LWR.

## Lepidoptera (Butterflies, Moths)

***Ceratophaga vicinella*** Gopher Tortoise Shell Moth (Lepidoptera: Tineidae)

Sites: 1: Archbold Biol. Sta., Highlands Hammock State Park

Months found: Feb, May, Jul.

Habitat: Florida scrub inhabited by gopher tortoises (*Gopherus polyphemus*)

Sampling: Larvae are found on shells of recently deceased gopher tortoises.

Notes: Large numbers of larvae can be found on a single shell, feeding on the keratin plates. Picking up or moving the shell may separate the larvae, which spend much of their time in silk tubes under the shell, from their food resource. Species of the genus *Ceratophaga* are the only insects known to be able to subsist on a diet of solid, dry keratin. The other members of this genus occur in the Old World tropics, where they consume other sources of keratin, such as the horns of deceased Cape buffalo. Photographs of moth, caterpillar, feeding tubes on shells, natural history, conservation: Deyrup et al. 2005.

Conservation status: This is probably one of the most endangered of the gopher tortoise associates, as it relies on a population of tortoises large enough to provide at least one dead individual per year. *Ceratophaga vicinella* is a species of conservation concern on the LWR.

***Chionodes latro***                      Sand Spikemoss Moth                      (Lepidoptera: Gelechiidae)

Sites: 16: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Gould Rd., Henscratch 27, Highland Pk. Estates, Highlands Hammock State Pk., Holmes Ave., Jack Ck., Lk. Louisa State Pk., Lk. Placid Scrub, Arbuckle State For., McJunkin, Royce Ranch, Saddleblanket Lk., Silver Lk.

Months found: Seasonality is not known, all records are based on finding feeding indications on the host plant. There is probably one generation each year and the larvae appear to grow slowly compared with most caterpillars, perhaps a reflection of poor nutritive value of sand spikemoss.

Habitat: Open Florida scrub with patches of bare sand and sand spikemoss (*Selaginella arenicola*), sometimes on sand road edges or medians.

Sampling method: Look for conspicuous feeding tubes on sand spikemoss; one of the easiest scrub invertebrates to survey. Adult moths were not found in Townes flight intercept traps.

Notes: Larvae have silk-lined burrows extending into sand amid the spikemoss roots. Feeding tubes of silk covered with plant bits are on the upper part of the spikemoss. *Chionodes* is a very large genus, with species that consume a great variety of plants, including a few species that consume lichens. Description of species, photograph of adult: Hodges 1999.

Conservation status: 69 individuals found, from 16 protected LWR sites. At some sites with a large population of *Selaginella arenicola* it would have been easy to add hundreds of additional records. This moth and its host are regularly found in open habitats with *Ceratiola ericoides*, but other open sites, including sand road shoulders are also used, unless there is a ground cover of exotic grasses. *Chionodes latro* does not appear to be a species of conservation concern on the LWR.

***Idia gopheri***                      Gopher Tortoise Burrow Moth                      (Lepidoptera: Noctuidae)

Site: 1: Archbold Biol. Sta.

Month found: Apr.

Habitat: This species lives in burrows of the gopher tortoise (*Gopherus polyphemus*).

Sampling method: We found no good way to survey for this species. Bowl traps outside tortoise burrows were not effective. No moths were found inside burrow entrances where the gopher tortoise flies were found. An attempt to lure moths out with U.V. lights

was unsuccessful. The Archbold Biol. Sta. specimen was obtained by placing a screen funnel over a burrow.

Notes: Caterpillars of this moth probably feed on dead leaves and dry gopher tortoise droppings in the burrows. There is at least one similar LWR species of *Idia*. A photograph of this species can be found on the Internet.

Conservation status: One individual found, from one protected LWR site. *Idia gopheri* is a species of conservation concern on the LWR, as it shares the conservation status of the gopher tortoise. It is also possible that this moth is less widely distributed or has fewer protected populations than the gopher tortoise.

***Nemouria outina*** Scrub Rosemary Emerald (Lepidoptera: Geometridae)

Sites: 3: Archbold Biol. Sta., Highland Pk. Estates, Holmes Ave.

Habitat: Open scrub rosemary (*Ceratiola ericoides*) habitat.

Sampling methods: Sweeping scrub rosemary for caterpillars; in the past U.V. lights have been used; Townes flight intercept traps in *Ceratiola* areas were generally unsuccessful.

Notes: *Nemouria outina* is host-specific on *Ceratiola*. There are several similar species of green geometrid moths, including species that appeared in flight traps during this study. Larvae, which are small inchworms, occur in two forms: a tuberculate gray winter form that mimics a scrub rosemary twig, and a green, smoother form that matches young scrub rosemary needles. Photographs of these forms appear in Deyrup and Eisner 1993. There are several green geometrid moths that resemble this species on the LWR. Photographs of all of these can be found on the Internet, but without a key for identification of species. A taxonomic key was published by Ferguson (1969).

Conservation status: 8 individuals found, from 3 protected LWR sites. During the last few years at the Archbold Biol. Sta. this species was much more difficult to find than it was when it was being studied in the late 1980's. The significance of this is unknown. Long-term management of *Ceratiola* scrub also remains somewhat problematic. At present, *Nemouria outina* appears to be a species of conservation concern on the LWR.

## Order Hymenoptera (Ants, Bees, Wasps)

***Aleiodes pardalotus*** Leopard-Spotted Mummy Wasp (Hymenoptera: Braconidae)

Sites: 2: Archbold Biol. Sta., Arbuckle State For.

Months found: May

Habitat: Florida scrub, not recently burned

Sampling method: Townes flight intercept trap

Notes: The host, like that of other species of *Aleiodes*, is some species of caterpillar. Larval wasps of this genus pupate within the dried up, "mummified" skin of the host caterpillar. This species is easily distinguished from other members of its genus by the conspicuous black spots along the side of the body. Identification reference: Marsh and Shaw 1998.

Conservation status: 2 individuals found, from 2 protected LWR sites. The genus *Aleiodes* is well represented in collections, and if this highly distinctive species occurred elsewhere with any regularity, one would expect specimens to have been found in the Florida State Collection of Arthropods, the National Museum of Natural History, or elsewhere. It is not known whether the host insect of this species is a rare or common insect. Based on current information, *Aleiodes pardalotus* should be considered a species of conservation concern on the LWR.

***Caupolicana floridana*** Scrub Giant Plasterer Bee (Hymenoptera: Colletidae)

Sites: 2: Archbold Biol. Sta., Highlands Hammock State Pk.

Months found: Jul, Sep, Oct.

Habitat: Open Florida scrub.

Sampling methods: Searching flower host plants in morning or late afternoon (*Dicerandra*, *Trichostema*, and *Chamaecrista*), occasionally captured in Townes flight intercept traps.

Notes: This is a large, conspicuous bee, not easily overlooked. The first observation of a pollen host for this rare bee was made during this survey: the pollen host is *Chamaecrista fasciculata*. In the field it slightly resembles two species of long-horned bees (Apidae, Eucerini). Description of species, photographs, discussion of biogeography: Michener and Deyrup 2004.

Conservation status: 3 individuals found, from 2 protected LWR sites. *Caupolicana floridana* appears to be an extremely rare species, and is a species of conservation concern on the LWR.

***Colletes*, undescribed species** Tough Buckthorn Bee (Hymenoptera: Colletidae)

Sites: 5: Archbold Biol. Sta., Gould Rd., Catfish Ck. State Pk., Arbuckle State For., Walk-in-Water State For.

Months found: May, Jun

Habitat: Open Florida scrub with tough buckthorn (*Sideroxylon tenax*).

Sampling method: Netting individuals around blooming host plant; Townes flight intercept traps near blooming host.

Notes: This species appears to be a specialized visitor to flowers of tough buckthorn. Flowers of this scrub plant are visited by many other species of bees, wasps, and flies; the host plant is not dependent on this species of *Colletes*. There are several similar species of *Colletes* on the LWR. A description of this species is in preparation.

Conservation status: 24 individuals found, from 5 protected LWR sites. It is difficult to survey for this species with an insect net because the bees constantly dodge among the thorny branches of their host. The flight season is relatively short, and flowering host plants were not available at every study site during the time of sampling. The north-south range of this species on the LWR is from Gould Rd. to Catfish Ck. State Pk., so it seems probable that this species is found on additional sites that have populations of tough buckthorn, for example, McJunkin, Royce Ranch, and Flamingo Villas. Currently, however, this species of *Colletes* is known from only 5 sites, and should be considered a species of conservation concern on the LWR.

***Colletes*, undescribed species**    Scrub Plasterer Bee    (Hymenoptera: Colletidae)

Sites: 15: Archbold Biol. Sta., Carter Ck. N., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highlands Hammock State Pk., Jack Ck., Lake Placid Scrub, Arbuckle State For., McJunkin, Saddleblanket Lk., FWC Sunray, Tiger Ck., Walk-in-Water State For.

Months found: Apr, May, Jun

Habitat: Open Florida scrub habitat, also along edges of unburned scrub.

Sampling methods: Townes flight intercept traps. This species is also found on flowers of several species of scrub plants, including *Serenoa repens*, *Eryngium cuneifolium*, *Lyonia fruticosa*, *Licania michauxii*, and *Hypericum reductum*.

Notes: There are several very similar LWR species.

Conservation status: 428 individuals found, from 15 protected LWR sites. This undescribed species of *Colletes* does not appear to be a species of conservation concern on the LWR.

***Dasymutilla archboldi*** Lake Wales Ridge Velvet Ant (Hymenoptera: Mutillidae)

Sites: 18: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highland Pk. Estates, Highlands Hammock State Pk., Holmes Ave., Jack Ck., Lake June State Pk., Lake Placid Scrub, Arbuckle State For., Saddleblanket Lk., FWC Sunray, Tiger Ck., Walk-in-Water State Pk.

Months found: Mar, Apr, May, Jun, Jul, Aug, Sep, Aug

Habitat: All types of open Florida scrub habitat with open patches of bare sand.

Sampling methods: Males captured in Townes flight intercept traps. Females are active diurnally and one of the most frequently seen velvet ants in open sites on the LWR.

Notes: Larval hosts are unknown, but undoubtedly consist of a variety of small bees or wasps that dig nests in open sand. Identification of females is by microscopic examination, as there are several similar LWR species. For identification of females, see Schmidt and Mickel 1979. Males of this species have only recently been recognized; the earlier association between males and females of this species was erroneous. Males are small and slender, with abundant silvery pubescence. A description of the male is in preparation. Both males and females are included in the data set from this survey.

Conservation status: 143 individuals found, from 18 protected LWR sites. Despite the restricted geographic range of this species, and the uncertainty about the host resources required by its larvae, *Dasymutilla archboldi* does not appear to be a species of conservation concern on the LWR.

***Dorymyrmex elegans*** Elegant Cone Ant (Hymenoptera: Formicidae)

Sites: 12: Archbold Biol. Sta., Carter Ck. N., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highland Pk. Estates, Holmes Ave., Lk. June State Pk., Lake Placid Scrub, Royce Ranch, Tiger Ck.

Months found: Jan, Mar, Apr, Jun, Jul, Sep, Aug, Oct, Nov, Dec. Ant colonies have adults present throughout the year, although activity may vary seasonally.

Habitat: open Florida scrub, with patches of bare sand; usually but not always found in yellow sand scrub; may occur along bare sand edges of sand roads. This species is not

found on heavily disturbed or weedy sites, where it is replaced by the common species *D. bureni*.

Sampling methods: Yellow bowl traps; this species, like other species of *Dorymyrmex*, makes volcano-like nest entrances, from which a few individuals can often be dug up, even during the day.

Notes: This species is easily confused with the yellow scrub form of *Dorymyrmex bureni*, a species with relatively shorter legs and antennae. *Dorymyrmex elegans* is active primarily during the night and on cloudy days, while *D. bureni* is often active during much of the day, as well as on warm nights.

Conservation status: 325 individuals found, from 12 protected LWR sites. The number of individual worker ants found is not a good indicator of conservation status because accidental placement of a bowl trap near a nest entrance can result in large numbers of individuals in a single bowl. Colonies of this species seem to be aggregated in relatively small areas at some sites. The occurrence of this species on 12 protected sites suggests that *Dorymyrmex elegans* should not be considered a species of conservation concern on the LWR.

***Dorymyrmex flavopectus*** Bicolored Scrub Cone Ant (Hymenoptera: Formicidae)

Sites: 10: Archbold Biol. Sta., Carter Ck. N., Flamingo Villas, Henscratch 27, Highlands Hammock State Pk., Jack Ck., Lk. Placid Scrub, Arbuckle State For., McJunkin, Royce Ranch.

Months found: Jan, Feb, Mar, Apr, May, Jun, Jul, Aug. Ant colonies have adults present throughout the year, although activity may vary seasonally.

Habitat: Open Florida scrub with large areas of bare sand. Often in scrub rosemary (*Ceratiola ericoides*) habitat.

Sampling methods: Yellow bowls and looking for workers and nests. This species lives in large extended colonies and is active during the day, so it is usually easily found where present.

Conservation status: 2,950 individuals found, from 10 protected LWR sites. Large numbers of individuals were found at a few sites where bowl traps were near nests. This species has extended colonies with many nest entrances. A single colony with thousands of individuals may dominate a patch of scrub. If, however, single colonies are considered units of conservation, *D. flavopectus* is a rare species. Although *Dorymyrmex flavopectus* was found on 10 sites, it seems reasonable at this point to consider it a species of conservation concern on the LWR.

***Eusapyga nordenae*** Florida Leaf-Cutter Bee Parasite (Hymenoptera: Sapygidae)

Sites: 2: Archbold Biol. Sta., Flamingo Villas.

Months found: May, Nov

Habitat: Florida scrub habitat.

Sampling method: Townes flight intercept trap; occasionally seen on flowers.

Notes: In general appearance this species closely resembles several unrelated LWR wasps in the family Vespidae, subfamily Eumeninae. Its hosts are unknown, but might be species of bees in the genera *Anthidium* or *Dianthidium*. There is no obvious reason why this species should be so rare, or why it should have been found only in Florida scrub habitat. For a description of this species, see Krombein 1999.

Conservation status: 3 individuals found, from 2 protected LWR sites. Currently *Eusapyga nordenae* should be considered a species of conservation concern on the LWR.

***Leptochilus krombeini*** Scrub Pygmy Twig Wasp (Hymenoptera: Vespidae)

Sites: 16: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highland Pk. Estates, Highlands Hammock State Pk., Jack Ck., Arbuckle State Pk., Royce Ranch, Saddleblanket Lk., TNC Sunray, FWC Sunray, Tiger Ck.

Months found: Apr, May, Jun, Jul, Aug, Sep.

Habitat: Open Florida scrub with patches of bare sand and some ground vegetation with small flowers.

Sampling methods: Observing visitors on small flowers, pan traps below Townes intercept traps, yellow bowl traps.

Notes: Females probably catch tiny caterpillars and nest in small hollow twigs. Adults feed on nectar; they have been found on flowers of *Stipulicida setacea*, *Polygonella myriophylla*, *Paronychia chartacea*, *P. americana*, and *Polanisia tenuifolia*. With a length of about 5 mm, *L. krombeini* is the smallest of the local wasps in the family Vespidae. There are three species of similar, but slightly larger wasps: *Microdynerus monolobus*, *Leptochilus alcolhuus*, and *L. ornatus*. *Leptochilus krombeini* may be distinguished from these by its flat-surfaced mesopleuron with well-separated punctures, densely covered with silvery hairs, and by its evenly concave propodeum with areas that are smooth and free of punctures. Taxonomy of genus: Parker 1966.

Conservation status: 58 individuals found, from 16 protected LWR sites. This species is not especially abundant, but it can be found predictably at many open scrub sites. Some of the flowers visited by this species also grow along bare sand edges of sand roads through open scrub. Since nests are probably in hollowed out dead twigs, populations might be set back by fire. *Leptochilus krombeini* does not appear to be a species of conservation concern on the LWR.

***Nylanderia phantasma*** Ghostly Crazy Ant (Hymenoptera: Formicidae)

Sites: 12: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Flamingo Villas, Gould Rd., Henscratch 27, Holmes Ave., Arbuckle State For., McJunkin, Royce Ranch, Snell Ck., Tiger Ck.

Months found: Mar, Jul, Aug, Sep, Oct, Dec. Ant colonies have adults present throughout the year, although activity may vary seasonally.

Habitat: Florida scrub with extensive patches of bare sand, especially scrub rosemary (*Ceratiola ericoides*) habitat.

Sampling methods: Yellow bowl traps. This species is also found by digging at nest entrances in open sand areas.

Notes: This species is nocturnal, but can sometimes be found during the day by digging down a few inches at a nest entrance and spreading the sand in a tray. Nests are diffuse, with many small entrances, only some of which seem to be in use at any one time. At the Archbold Biol. Sta. this species is a frequent prey of the narrow-mouthed toad, *Gastrophryne carolinensis*. There are several LWR species of *Nylanderia*, one of which, *N. arenivaga*, is common in scrub sites and is easily confused with *N. phantasma*. The latter species is very pale in color, almost white, and the large bristles on the body have whitish tips. The taxonomy of Florida species is provided by Trager (1984).

Conservation status: 502 individuals found, from 12 protected LWR sites. The number of individuals captured in bowls is not very informative when surveying for ants because this number depends on the proximity of traps to a nest of ants. *Nylanderia phantasma* does not appear to be a species of conservation concern on the LWR.

***Nylanderia*, undescribed species** Parasitic Scrub Crazy Ant (Hymenoptera: Formicidae)

Sites: 3: Archbold Biol. Sta., Carter Ck. N., Flamingo Villas.

Months found: Sep, Oct.

Habitat: Open Florida scrub habitat; this may be low inopina oak (*Quercus inopina*) oak scrub, or the edges of unburned yellow sand scrub.

Sampling methods: Townes flight intercept traps may collect dispersing flying queens. Otherwise, found by looking through nests of its host species.

Notes: This species is a rare parasite living in the nest of the related ant *Nylanderia wojciki*. Males are flightless and resemble workers of the host ant. The queen parasite apparently produces eggs and larvae that are cared for by the host species. Species of parasitic ants are often both rare within their range and restricted in distribution. A description of this species is in preparation.

Conservation status: 20 individuals were found, from 3 protected LWR sites. This species of *Nylanderia* appears to be a species of conservation concern on the LWR.

***Odontomachus relictus*** Florida Scrub Snapping Ant (Hymenoptera: Formicidae)

Sites: 15: Archbold Biol. Sta., Carter Ck. N., Carter Ck. S., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Highland Pk. Estates, Holmes Ave., Lk. June State Pk., Lk. Placid Scrub, Arbuckle State For., McJunkin, Royce Ranch, Saddleblanket Lk., Tiger Ck.

Months found: Mar, Apr, May, Jun, Jul, Aug, Sep, Oct. These records include both workers in bowl traps and males in flight traps.

Habitat: Florida scrub habitat, including both open scrub and dense, long-unburned scrub.

Sampling methods: Bowl traps capture workers, while Townes flight intercept traps capture large numbers of dispersing males in late summer and fall. Nests are not easily found, their entrances often concealed in leaf litter or under logs, never in open sand.

Notes: both workers and winged males and queens are nocturnal. There are two similar LWR species. One of these, *Odontomachus brunneus*, is found in wet areas on the LWR, although it also lives in dry areas off the LWR where *O. relictus* does not occur. The other, *O. ruginodis*, is an exotic Caribbean species that has begun to appear in LWR scrub habitats in recent years. It is possible that this species might affect populations of *O. relictus* in the future, although at this time *O. ruginodis* is found primarily in disturbed areas and is not common in Florida scrub habitat. At the Archbold Biol. Sta. *O. relictus* is sometimes eaten by the Florida scrub lizard, *Sceloporus woodi*. *Odontomachus relictus* was described and the U.S. species reviewed by Deyrup and Cover (2004).

Conservation status: 4156 individuals found, from 15 protected LWR sites. Most of these records are for males, not workers, and do not reflect chance placement of bowl traps near nests. *Odontomachus relictus* does not appear to be a species of conservation concern on the LWR.

***Osmia*, undescribed species**      Blue Calamintha Bee      (Hymenoptera: Megachilidae)

Sites: 3: Archbold Biol. Sta., Gould Rd., Holmes Ave.

Months found: Mar, Apr.

Habitat: Open Florida scrub with woody scrub mint (*Calamintha ashei*), usually in habitats with scrub rosemary (*Ceratiola ericoides*).

Sampling methods: Searches of blooming *Calamintha ashei*. May also be collected in blue or white bowl traps and Townes flight intercept traps located near blooming woody scrub mint.

Notes: This species appears to be host-specific on *Calamintha ashei*. It has a pollen-collecting structure that seems adapted to the placement of anthers on this host. It is possible that *Conradina brevifolia*, another rare scrub mint with similar anthers, might also be a host. Several similar-appearing bees visit the flowers of *C. ashei*. A description of this species is in preparation.

Conservation status: 9 individuals found, from 3 protected LWR sites. The majority of additional specimens known are from unprotected platted lots in Placid Lakes Development south of the Archbold Biol. Sta. The only known host for this species of *Osmia* is a scrub plant that is itself rare and whose management is not well understood. The blue Calamintha bee is a species of conservation concern on the LWR.

***Photomorphus archboldi***      Nocturnal Scrub Velvet Ant  
(Hymenoptera: Mutillidae)

Sites: 18: Archbold Biol. Sta., Carter Ck. N., Catfish Ck. State Pk., Flamingo Villas, Gould Rd., Henscratch 27, Highland Pk. Estates, Highlands Hammock State Pk., Jack Ck., Lk. June State Pk., Arbuckle State For., Royce Ranch, Saddleblanket Lk., Silver Lk., FWC Sunray, TNC Sunray, Tiger Ck., Walk-in-Water State For.

Months found: Apr, May, Jun, Jul, Aug, Sep, Oct.

Habitat: Florida scrub.

Sampling method: Townes flight intercept traps.

Notes: *Photomorphus archboldi* is nocturnal and seldom seen alive. Males are readily captured in flight traps, but females, which are flightless, are rarely encountered. Females may be trapped in pitfall traps, but these traps were not used during this study because of the probability that the traps would capture sand skinks. Larvae of this species feed on larvae of sand-dwelling bees or wasps, but specific hosts are unknown. There are two similar LWR species. Male *P. archboldi* were described by Manley and Deyrup (1987); the female was described by Brabant et al. (2010).

Conservation status: 159 individuals found, from 18 protected LWR sites.  
*Photomorphus archboldi* does not appear to be a species of conservation concern on the LWR.

## APPENDIX 2

### Scrub Arthropods Found at Each Scrub Preserve

An asterisk (\*) denotes a species that remains a species of conservation concern, based on the number of protected sites (usually less than 10) or some ecological feature. The reason for establishing a preliminary conservation status is mentioned for each species in Appendix 1.

Species_Order_by_Preserve		
preserve_designation	order_	species
Archbold Biological Station	Arachnida	<i>Geolycosa hubbelli</i>
Archbold Biological Station	Arachnida	<i>Geolycosa xera archboldi</i>
Archbold Biological Station	Arachnida	<i>Hogna ceratiola</i>
Archbold Biological Station	Arachnida	* <i>Hogna osceola</i>
Archbold Biological Station	Arachnida	* <i>Latrodectus bishopi</i>
Archbold Biological Station	Arachnida	* <i>Phidippus workmani</i>
Archbold Biological Station	Arachnida	<i>Sosippus placidus</i>
Archbold Biological Station	Arachnida	* <i>Zelotes florodes</i>
Archbold Biological Station	Arachnida	* <i>Zelotes ocala</i>
Archbold Biological Station	Blattaria	<i>Arenivaga floridensis</i>
Archbold Biological Station	Coleoptera	* <i>Aethecerinus hornii</i>
Archbold Biological Station	Coleoptera	* <i>Aneflomorpha delongi</i>
Archbold Biological Station	Coleoptera	* <i>Anomala eximia</i>
Archbold Biological Station	Coleoptera	* <i>Aphodius troglodytes</i>
Archbold Biological Station	Coleoptera	* <i>Auletobius nr. Cassandreae</i>
Archbold Biological Station	Coleoptera	* <i>Blapstinus sp.</i>
Archbold Biological Station	Coleoptera	* <i>Chelyoxenus xerobatis</i>
Archbold Biological Station	Coleoptera	* <i>Cicindela scabrosa</i>
Archbold Biological Station	Coleoptera	* <i>Colaspis n sp.</i>
Archbold Biological Station	Coleoptera	* <i>Diplotaxis rufa</i>
Archbold Biological Station	Coleoptera	* <i>Enaphalodes archboldi</i>
Archbold Biological Station	Coleoptera	<i>Geopsammodius relictillus</i>
Archbold Biological Station	Coleoptera	<i>Haroldiataenius saramari</i>
Archbold Biological Station	Coleoptera	<i>Ischyrus dunedinensis</i>
Archbold Biological Station	Coleoptera	* <i>Leiopsammodius deyrupei</i>
Archbold Biological Station	Coleoptera	* <i>Liopinus sp</i>
Archbold Biological Station	Coleoptera	<i>Lucidota luteicollis</i>
Archbold Biological Station	Coleoptera	* <i>Neoptochus sp.</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Archbold Biological Station	Coleoptera	* <i>Odontotaenius floridana</i>
Archbold Biological Station	Coleoptera	<i>Onthophagus aciculatulus</i>
Archbold Biological Station	Coleoptera	* <i>Onthophagus polyphemi</i>
Archbold Biological Station	Coleoptera	* <i>Onychomira floridensis</i>
Archbold Biological Station	Coleoptera	* <i>Pachybrachis sp. 3</i>
Archbold Biological Station	Coleoptera	* <i>Pachybrachis sp. 1</i>
Archbold Biological Station	Coleoptera	* <i>Phyllophaga elizoria</i>
Archbold Biological Station	Coleoptera	<i>Phyllophaga elongata</i>
Archbold Biological Station	Coleoptera	* <i>Phyllophaga okeechobea</i>
Archbold Biological Station	Coleoptera	* <i>Phyllophaga panorpa</i>
Archbold Biological Station	Coleoptera	* <i>Pleotomodes needhami</i>
Archbold Biological Station	Coleoptera	* <i>Plesioclytus relictus</i>
Archbold Biological Station	Coleoptera	* <i>Romulus globosus</i>
Archbold Biological Station	Coleoptera	* <i>Selonodon archboldi</i>
Archbold Biological Station	Coleoptera	* <i>Serica frosti</i>
Archbold Biological Station	Coleoptera	<i>Trigonopeltastes floridana</i>
Archbold Biological Station	Coleoptera	* <i>Typocerus fulvocinctus</i>
Archbold Biological Station	Diplopoda	* <i>Floridobolus penneri</i>
Archbold Biological Station	Diptera	* <i>Asaphomyia floridensis</i>
Archbold Biological Station	Diptera	<i>Asyndetus archboldi</i>
Archbold Biological Station	Diptera	* <i>Drapetis sp.</i>
Archbold Biological Station	Diptera	* <i>Eutrichota gopheri</i>
Archbold Biological Station	Diptera	* <i>Gymnoprosope sp. 1</i>
Archbold Biological Station	Diptera	* <i>Gymnoprosope sp. 2</i>
Archbold Biological Station	Diptera	* <i>Hemipenthes bigradata</i>
Archbold Biological Station	Diptera	<i>Nemomydas melanopogon</i>
Archbold Biological Station	Diptera	* <i>Pieza rhea</i>
Archbold Biological Station	Diptera	<i>Townsendia arenicola</i>
Archbold Biological Station	Diptera	* <i>Villa sp.</i>
Archbold Biological Station	Heteroptera	* <i>Keltonia balli</i>
Archbold Biological Station	Heteroptera	* <i>Keltonia clinopodii</i>
Archbold Biological Station	Heteroptera	<i>Parthenicus weemsi</i>
Archbold Biological Station	Homoptera	* <i>Telamona archboldi</i>
Archbold Biological Station	Hymenoptera	* <i>Aleiodes pardalotus</i>
Archbold Biological Station	Hymenoptera	* <i>Caupolicana floridana</i>
Archbold Biological Station	Hymenoptera	* <i>Colletes sp. 1</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Archbold Biological Station	Hymenoptera	<i>Colletes sp. 2</i>
Archbold Biological Station	Hymenoptera	<i>Dasymutilla archboldi</i>
Archbold Biological Station	Hymenoptera	<i>Dorymyrmex elegans</i>
Archbold Biological Station	Hymenoptera	* <i>Dorymyrmex flavopectus</i>
Archbold Biological Station	Hymenoptera	* <i>Eusapyga nordenae</i>
Archbold Biological Station	Hymenoptera	<i>Leptochilus krombeini</i>
Archbold Biological Station	Hymenoptera	<i>Nylanderia phantasma</i>
Archbold Biological Station	Hymenoptera	* <i>Nylanderia sp.</i>
Archbold Biological Station	Hymenoptera	<i>Odontomachus relictus</i>
Archbold Biological Station	Hymenoptera	* <i>Osmia sp.</i>
Archbold Biological Station	Hymenoptera	<i>Photomorphus archboldi</i>
Archbold Biological Station	Lepidoptera	* <i>Ceratophaga vicinella</i>
Archbold Biological Station	Lepidoptera	<i>Chionodes latro</i>
Archbold Biological Station	Lepidoptera	* <i>Idia gopheri</i>
Archbold Biological Station	Lepidoptera	* <i>Nemouria outina</i>
Archbold Biological Station	Orthoptera	* <i>Aptenopedes nigropicta</i>
Archbold Biological Station	Orthoptera	* <i>Aptenopedes robusta</i>
Archbold Biological Station	Orthoptera	* <i>Melanoplus forcipatus</i>
Archbold Biological Station	Orthoptera	<i>Melanoplus tequestae</i>
Archbold Biological Station	Orthoptera	<i>Neotridactylus archboldi</i>
Archbold Biological Station	Orthoptera	* <i>Schistocerca ceratiola</i>
Carter Creek North	Arachnida	<i>Geolycosa hubbelli</i>
Carter Creek North	Arachnida	<i>Geolycosa xera archboldi</i>
Carter Creek North	Arachnida	<i>Hogna ceratiola</i>
Carter Creek North	Arachnida	* <i>Hogna osceola</i>
Carter Creek North	Arachnida	<i>Sosippus placidus</i>
Carter Creek North	Blattaria	<i>Arenivaga floridensis</i>
Carter Creek North	Coleoptera	* <i>Aethecerinus hornii</i>
Carter Creek North	Coleoptera	* <i>Aphodius troglodytes</i>
Carter Creek North	Coleoptera	* <i>Cicindela highlandensis</i>
Carter Creek North	Coleoptera	<i>Haroldiataenius saramari</i>
Carter Creek North	Coleoptera	<i>Ischyrus dunedinensis</i>
Carter Creek North	Coleoptera	<i>Lucidota luteicollis</i>
Carter Creek North	Coleoptera	* <i>Odontotaenius floridana</i>
Carter Creek North	Coleoptera	<i>Onthophagus aciculatulus</i>
Carter Creek North	Coleoptera	* <i>Onthophagus polyphemi</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Carter Creek North	Coleoptera	* <i>Pachybrachis sp. 2</i>
Carter Creek North	Coleoptera	* <i>Pachybrachis sp. 3</i>
Carter Creek North	Coleoptera	* <i>Pachybrachis sp. 1</i>
Carter Creek North	Coleoptera	<i>Phyllophaga elongata</i>
Carter Creek North	Coleoptera	* <i>Pleotomodes needhami</i>
Carter Creek North	Coleoptera	* <i>Serica frosti</i>
Carter Creek North	Diptera	<i>Asyndetus archboldi</i>
Carter Creek North	Diptera	* <i>Eutrichota gopheri</i>
Carter Creek North	Diptera	<i>Nemomydas melanopogon</i>
Carter Creek North	Diptera	<i>Townsendia arenicola</i>
Carter Creek North	Heteroptera	* <i>Keltonia rubrofemorata</i>
Carter Creek North	Heteroptera	<i>Parthenicus weemsi</i>
Carter Creek North	Hymenoptera	* <i>Colletes sp. 1</i>
Carter Creek North	Hymenoptera	<i>Dasymutilla archboldi</i>
Carter Creek North	Hymenoptera	<i>Dorymyrmex elegans</i>
Carter Creek North	Hymenoptera	* <i>Dorymyrmex flavopectus</i>
Carter Creek North	Hymenoptera	<i>Leptochilus krombeini</i>
Carter Creek North	Hymenoptera	<i>Nylanderia phantasma</i>
Carter Creek North	Hymenoptera	* <i>Nylanderia sp.</i>
Carter Creek North	Hymenoptera	<i>Odontomachus relictus</i>
Carter Creek North	Hymenoptera	<i>Photomorphus archboldi</i>
Carter Creek North	Lepidoptera	<i>Chionodes latro</i>
Carter Creek North	Orthoptera	* <i>Aptenopedes nigropicta</i>
Carter Creek North	Orthoptera	* <i>Melanoplus forcipatus</i>
Carter Creek North	Orthoptera	<i>Melanoplus tequestae</i>
Carter Creek North	Orthoptera	<i>Neotridactylus archboldi</i>
Carter Creek North	Orthoptera	* <i>Schistocerca ceratiola</i>
Carter Creek South	Arachnida	<i>Geolycosa hubbelli</i>
Carter Creek South	Arachnida	<i>Geolycosa xera archboldi</i>
Carter Creek South	Arachnida	<i>Hogna ceratiola</i>
Carter Creek South	Arachnida	* <i>Hogna osceola</i>
Carter Creek South	Blattaria	<i>Arenivaga floridensis</i>
Carter Creek South	Coleoptera	* <i>Chelyoxenus xerobatis</i>
Carter Creek South	Coleoptera	* <i>Cicindela highlandensis</i>
Carter Creek South	Coleoptera	* <i>Diplotaxis rufa</i>
Carter Creek South	Coleoptera	<i>Geopsammodius relictillus</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Carter Creek South	Coleoptera	<i>Haroldiataenius saramari</i>
Carter Creek South	Coleoptera	<i>Ischyrus dunedinensis</i>
Carter Creek South	Coleoptera	<i>Lucidota luteicollis</i>
Carter Creek South	Coleoptera	<i>Onthophagus aciculatulus</i>
Carter Creek South	Coleoptera	* <i>Onthophagus polyphemi</i>
Carter Creek South	Coleoptera	* <i>Pleotomodes needhami</i>
Carter Creek South	Coleoptera	* <i>Serica frosti</i>
Carter Creek South	Coleoptera	<i>Trigonopeltastes floridana</i>
Carter Creek South	Diptera	<i>Asyndetus archboldi</i>
Carter Creek South	Diptera	* <i>Drapetis sp.</i>
Carter Creek South	Diptera	* <i>Eutrichota gopheri</i>
Carter Creek South	Diptera	* <i>Gymnoprosope sp. 2</i>
Carter Creek South	Diptera	<i>Nemomydas melanopogon</i>
Carter Creek South	Diptera	* <i>Piezia rhea</i>
Carter Creek South	Diptera	<i>Townsendia arenicola</i>
Carter Creek South	Hymenoptera	<i>Dasymutilla archboldi</i>
Carter Creek South	Hymenoptera	<i>Leptochilus krombeini</i>
Carter Creek South	Hymenoptera	<i>Nylanderia phantasma</i>
Carter Creek South	Hymenoptera	<i>Odontomachus relictus</i>
Carter Creek South	Lepidoptera	<i>Chionodes latro</i>
Carter Creek South	Orthoptera	* <i>Aptenopedes nigropicta</i>
Carter Creek South	Orthoptera	* <i>Melanoplus forcipatus</i>
Carter Creek South	Orthoptera	<i>Melanoplus tequestae</i>
Carter Creek South	Orthoptera	<i>Neotridactylus archboldi</i>
Catfish Creek Preserve	Arachnida	<i>Geolycosa hubbelli</i>
Catfish Creek Preserve	Arachnida	<i>Geolycosa xera archboldi</i>
Catfish Creek Preserve	Arachnida	<i>Hogna ceratiola</i>
Catfish Creek Preserve	Arachnida	* <i>Hogna osceola</i>
Catfish Creek Preserve	Blattaria	<i>Arenivaga floridensis</i>
Catfish Creek Preserve	Coleoptera	* <i>Chelyoxenus xerobatis</i>
Catfish Creek Preserve	Coleoptera	* <i>Cicindela highlandensis</i>
Catfish Creek Preserve	Coleoptera	* <i>Geopsammodius morrisoni</i>
Catfish Creek Preserve	Coleoptera	<i>Ischyrus dunedinensis</i>
Catfish Creek Preserve	Coleoptera	* <i>Leiopsammodius deyrupi</i>
Catfish Creek Preserve	Coleoptera	<i>Lucidota luteicollis</i>
Catfish Creek Preserve	Coleoptera	<i>Onthophagus aciculatulus</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Catfish Creek Preserve	Coleoptera	* <i>Onthophagus polyphemi</i>
Catfish Creek Preserve	Coleoptera	* <i>Selonodon archboldi</i>
Catfish Creek Preserve	Coleoptera	<i>Trigonopeltastes floridana</i>
Catfish Creek Preserve	Diptera	<i>Asyndetus archboldi</i>
Catfish Creek Preserve	Diptera	* <i>Hemipenthes bigradata</i>
Catfish Creek Preserve	Diptera	<i>Nemomydas melanopogon</i>
Catfish Creek Preserve	Diptera	<i>Townsendia arenicola</i>
Catfish Creek Preserve	Hymenoptera	* <i>Colletes sp. 1</i>
Catfish Creek Preserve	Hymenoptera	<i>Colletes sp. 2</i>
Catfish Creek Preserve	Hymenoptera	<i>Dasymutilla archboldi</i>
Catfish Creek Preserve	Hymenoptera	<i>Dorymyrmex elegans</i>
Catfish Creek Preserve	Hymenoptera	<i>Leptochilus krombeini</i>
Catfish Creek Preserve	Hymenoptera	<i>Odontomachus relictus</i>
Catfish Creek Preserve	Hymenoptera	<i>Photomorphus archboldi</i>
Catfish Creek Preserve	Orthoptera	* <i>Ellipes n. sp. nr. eisneri</i>
Catfish Creek Preserve	Orthoptera	<i>Melanoplus tequestae</i>
Catfish Creek Preserve	Orthoptera	<i>Neotridactylus archboldi</i>
Flamingo Villas	Arachnida	<i>Geolycosa hubbelli</i>
Flamingo Villas	Arachnida	<i>Geolycosa xera archboldi</i>
Flamingo Villas	Arachnida	<i>Hogna ceratiola</i>
Flamingo Villas	Arachnida	* <i>Phidippus workmani</i>
Flamingo Villas	Arachnida	* <i>Zelotes sp.</i>
Flamingo Villas	Blattaria	<i>Arenivaga floridensis</i>
Flamingo Villas	Coleoptera	* <i>Aethecerinus hornii</i>
Flamingo Villas	Coleoptera	* <i>Anomala eximia</i>
Flamingo Villas	Coleoptera	* <i>Aphodius troglodytes</i>
Flamingo Villas	Coleoptera	* <i>Auletobius nr. Cassandrae</i>
Flamingo Villas	Coleoptera	* <i>Chelyoxenus xerobatis</i>
Flamingo Villas	Coleoptera	* <i>Cicindela highlandensis</i>
Flamingo Villas	Coleoptera	* <i>Colaspis n sp.</i>
Flamingo Villas	Coleoptera	* <i>Diplotaxis rufa</i>
Flamingo Villas	Coleoptera	<i>Geopsammodius relictillus</i>
Flamingo Villas	Coleoptera	<i>Haroldiataenius saramari</i>
Flamingo Villas	Coleoptera	<i>Ischyrus dunedinensis</i>
Flamingo Villas	Coleoptera	* <i>Liopinus sp</i>
Flamingo Villas	Coleoptera	<i>Lucidota luteicollis</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Flamingo Villas	Coleoptera	* <i>Neoptochus sp.</i>
Flamingo Villas	Coleoptera	* <i>Odontotaenius floridana</i>
Flamingo Villas	Coleoptera	<i>Onthophagus aciculatulus</i>
Flamingo Villas	Coleoptera	* <i>Onthophagus polyphemi</i>
Flamingo Villas	Coleoptera	* <i>Onychomira floridensis</i>
Flamingo Villas	Coleoptera	* <i>Pachybrachis sp. 2</i>
Flamingo Villas	Coleoptera	* <i>Pachybrachis sp. 3</i>
Flamingo Villas	Coleoptera	* <i>Pachybrachis sp. 1</i>
Flamingo Villas	Coleoptera	<i>Phyllophaga elongata</i>
Flamingo Villas	Coleoptera	* <i>Plesioclytus relictus</i>
Flamingo Villas	Coleoptera	* <i>Serica frosti</i>
Flamingo Villas	Coleoptera	<i>Trigonopeltastes floridana</i>
Flamingo Villas	Diptera	<i>Asyndetus archboldi</i>
Flamingo Villas	Diptera	* <i>Drapetis sp.</i>
Flamingo Villas	Diptera	* <i>Eutrichota gopheri</i>
Flamingo Villas	Diptera	* <i>Gymnoprosope sp. 2</i>
Flamingo Villas	Diptera	* <i>Pieza rhea</i>
Flamingo Villas	Heteroptera	* <i>Keltonia balli</i>
Flamingo Villas	Heteroptera	* <i>Keltonia rubofemorata</i>
Flamingo Villas	Heteroptera	<i>Parthenicus weemsi</i>
Flamingo Villas	Hymenoptera	* <i>Colletes sp. 1</i>
Flamingo Villas	Hymenoptera	<i>Dasymutilla archboldi</i>
Flamingo Villas	Hymenoptera	<i>Dorymyrmex elegans</i>
Flamingo Villas	Hymenoptera	* <i>Dorymyrmex flavopectus</i>
Flamingo Villas	Hymenoptera	* <i>Eusapyga nordenae</i>
Flamingo Villas	Hymenoptera	<i>Leptochilus krombeini</i>
Flamingo Villas	Hymenoptera	<i>Nylanderia phantasma</i>
Flamingo Villas	Hymenoptera	* <i>Nylanderia sp.</i>
Flamingo Villas	Hymenoptera	<i>Odontomachus relictus</i>
Flamingo Villas	Hymenoptera	<i>Photomorphus archboldi</i>
Flamingo Villas	Orthoptera	* <i>Melanoplus forcipatus</i>
Flamingo Villas	Orthoptera	<i>Melanoplus tequestae</i>
Flamingo Villas	Orthoptera	<i>Neotridactylus archboldi</i>
Flamingo Villas	Orthoptera	* <i>Schistocerca ceratiola</i>
Gould Road	Arachnida	<i>Geolycosa hubbelli</i>
Gould Road	Arachnida	<i>Geolycosa xera archboldi</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Gould Road	Arachnida	<i>Hogna ceratiola</i>
Gould Road	Arachnida	* <i>Hogna osceola</i>
Gould Road	Arachnida	<i>Sosippus placidus</i>
Gould Road	Blattaria	<i>Arenivaga floridensis</i>
Gould Road	Coleoptera	* <i>Anomala eximia</i>
Gould Road	Coleoptera	* <i>Diplotaxis rufa</i>
Gould Road	Coleoptera	<i>Ischyrus dunedinensis</i>
Gould Road	Coleoptera	<i>Lucidota luteicollis</i>
Gould Road	Coleoptera	<i>Onthophagus aciculatulus</i>
Gould Road	Coleoptera	* <i>Onthophagus polyphemi</i>
Gould Road	Coleoptera	* <i>Pachybrachis sp. 1</i>
Gould Road	Coleoptera	* <i>Phyllophaga elizoria</i>
Gould Road	Coleoptera	<i>Phyllophaga elongata</i>
Gould Road	Coleoptera	* <i>Phyllophaga okeechobea</i>
Gould Road	Coleoptera	* <i>Pleotomodes needhami</i>
Gould Road	Coleoptera	<i>Trigonopeltastes floridana</i>
Gould Road	Diptera	<i>Asyndetus archboldi</i>
Gould Road	Diptera	* <i>Hemipenthes bigradata</i>
Gould Road	Heteroptera	* <i>Keltonia balli</i>
Gould Road	Heteroptera	* <i>Keltonia clinopodii</i>
Gould Road	Heteroptera	* <i>Keltonia rubrofemorata</i>
Gould Road	Heteroptera	* <i>Parthenicus weemsi</i>
Gould Road	Hymenoptera	* <i>Colletes sp. 1</i>
Gould Road	Hymenoptera	<i>Colletes sp. 2</i>
Gould Road	Hymenoptera	<i>Dasymutilla archboldi</i>
Gould Road	Hymenoptera	<i>Dorymyrmex elegans</i>
Gould Road	Hymenoptera	<i>Leptochilus krombeini</i>
Gould Road	Hymenoptera	<i>Nylanderia phantasma</i>
Gould Road	Hymenoptera	<i>Odontomachus relictus</i>
Gould Road	Hymenoptera	* <i>Osmia sp.</i>
Gould Road	Hymenoptera	<i>Photomorphus archboldi</i>
Gould Road	Lepidoptera	<i>Chionodes latro</i>
Gould Road	Orthoptera	* <i>Melanoplus forcipatus</i>
Gould Road	Orthoptera	<i>Melanoplus tequestae</i>
Gould Road	Orthoptera	<i>Neotridactylus archboldi</i>
Gould Road	Orthoptera	* <i>Schistocerca ceratiola</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Henscratch 27	Arachnida	<i>Geolycosa hubbelli</i>
Henscratch 27	Arachnida	<i>Geolycosa xera archboldi</i>
Henscratch 27	Arachnida	<i>Hogna ceratiola</i>
Henscratch 27	Arachnida	* <i>Zelotes florodes</i>
Henscratch 27	Arachnida	* <i>Zelotes sp.</i>
Henscratch 27	Blattaria	<i>Arenivaga floridensis</i>
Henscratch 27	Coleoptera	* <i>Aphodius troglodytes</i>
Henscratch 27	Coleoptera	* <i>Auletobius nr. Cassandrae</i>
Henscratch 27	Coleoptera	* <i>Chelyoxenus xerobatis</i>
Henscratch 27	Coleoptera	* <i>Cicindela highlandensis</i>
Henscratch 27	Coleoptera	* <i>Diplotaxis rufa</i>
Henscratch 27	Coleoptera	<i>Haroldiataenius saramari</i>
Henscratch 27	Coleoptera	<i>Lucidota luteicollis</i>
Henscratch 27	Coleoptera	<i>Onthophagus aciculatulus</i>
Henscratch 27	Coleoptera	* <i>Onthophagus polyphemi</i>
Henscratch 27	Coleoptera	* <i>Pachybrachis sp. 2</i>
Henscratch 27	Coleoptera	* <i>Phyllophaga elizoria</i>
Henscratch 27	Coleoptera	<i>Phyllophaga elongata</i>
Henscratch 27	Coleoptera	* <i>Pleotomodes needhami</i>
Henscratch 27	Coleoptera	* <i>Serica frosti</i>
Henscratch 27	Coleoptera	<i>Trigonopeltastes floridana</i>
Henscratch 27	Coleoptera	* <i>Typocerus fulvocinctus</i>
Henscratch 27	Diplopoda	* <i>Floridobolus penneri</i>
Henscratch 27	Diptera	<i>Asyndetus archboldi</i>
Henscratch 27	Diptera	* <i>Drapetis sp.</i>
Henscratch 27	Diptera	* <i>Eutrichota gopheri</i>
Henscratch 27	Diptera	* <i>Hemipenthes bigradata</i>
Henscratch 27	Diptera	<i>Nemomydas melanopogon</i>
Henscratch 27	Diptera	* <i>Pieza rhea</i>
Henscratch 27	Diptera	<i>Townsendia arenicola</i>
Henscratch 27	Heteroptera	* <i>Keltonia rubofemorata</i>
Henscratch 27	Heteroptera	<i>Parthenicus weemsi</i>
Henscratch 27	Hymenoptera	* <i>Colletes sp. 1</i>
Henscratch 27	Hymenoptera	<i>Dasymutilla archboldi</i>
Henscratch 27	Hymenoptera	<i>Dorymyrmex elegans</i>
Henscratch 27	Hymenoptera	* <i>Dorymyrmex flavopectus</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Henscratch 27	Hymenoptera	<i>Leptochilus krombeini</i>
Henscratch 27	Hymenoptera	<i>Nylanderia phantasma</i>
Henscratch 27	Hymenoptera	<i>Photomorphus archboldi</i>
Henscratch 27	Lepidoptera	<i>Chionodes latro</i>
Henscratch 27	Orthoptera	<i>Melanoplus tequestae</i>
Henscratch 27	Orthoptera	<i>Neotridactylus archboldi</i>
Henscratch 27	Orthoptera	* <i>Schistocerca ceratiola</i>
Highland Park Estates	Blattaria	<i>Arenivaga floridensis</i>
Highland Park Estates	Coleoptera	* <i>Aneflomorpha delongi</i>
Highland Park Estates	Coleoptera	* <i>Chelyoxenus xerobatis</i>
Highland Park Estates	Coleoptera	<i>Haroldiataenius saramari</i>
Highland Park Estates	Coleoptera	<i>Lucidota luteicollis</i>
Highland Park Estates	Coleoptera	* <i>Pachybrachis sp. 2</i>
Highland Park Estates	Coleoptera	* <i>Pachybrachis sp. 3</i>
Highland Park Estates	Coleoptera	* <i>Pachybrachis sp. 1</i>
Highland Park Estates	Coleoptera	<i>Phyllophaga elongata</i>
Highland Park Estates	Diplopoda	* <i>Floridobolus penneri</i>
Highland Park Estates	Diptera	<i>Asyndetus archboldi</i>
Highland Park Estates	Diptera	<i>Nemomydas melanopogon</i>
Highland Park Estates	Heteroptera	* <i>Keltonia rubrofemorata</i>
Highland Park Estates	Heteroptera	<i>Parthenicus weemsi</i>
Highland Park Estates	Hymenoptera	<i>Dasymutilla archboldi</i>
Highland Park Estates	Hymenoptera	<i>Dorymyrmex elegans</i>
Highland Park Estates	Hymenoptera	<i>Leptochilus krombeini</i>
Highland Park Estates	Hymenoptera	<i>Odontomachus relictus</i>
Highland Park Estates	Hymenoptera	<i>Photomorphus archboldi</i>
Highland Park Estates	Lepidoptera	<i>Chionodes latro</i>
Highland Park Estates	Lepidoptera	* <i>Nemouria outina</i>
Highland Park Estates	Orthoptera	* <i>Aptenopedes nigropicta</i>
Highland Park Estates	Orthoptera	* <i>Melanoplus forcipatus</i>
Highland Park Estates	Orthoptera	<i>Melanoplus tequestae</i>
Highland Park Estates	Orthoptera	<i>Neotridactylus archboldi</i>
Highland Park Estates	Orthoptera	* <i>Schistocerca ceratiola</i>
Highlands Hammock State Park	Arachnida	<i>Geolycosa hubbelli</i>
Highlands Hammock State Park	Arachnida	<i>Geolycosa xera archboldi</i>
Highlands Hammock State Park	Arachnida	<i>Hogna ceratiola</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Highlands Hammock State Park	Arachnida	* <i>Phidippus workmani</i>
Highlands Hammock State Park	Arachnida	<i>Sosippus placidus</i>
Highlands Hammock State Park	Arachnida	* <i>Zelotes florodes</i>
Highlands Hammock State Park	Coleoptera	* <i>Anomala eximia</i>
Highlands Hammock State Park	Coleoptera	* <i>Aphodius troglodytes</i>
Highlands Hammock State Park	Coleoptera	* <i>Chelyoxenus xerobatis</i>
Highlands Hammock State Park	Coleoptera	* <i>Cicindela highlandensis</i>
Highlands Hammock State Park	Coleoptera	* <i>Cicindela scabrosa</i>
Highlands Hammock State Park	Coleoptera	<i>Ischyrus dunedinensis</i>
Highlands Hammock State Park	Coleoptera	<i>Lucidota luteicollis</i>
Highlands Hammock State Park	Coleoptera	<i>Onthophagus aciculatulus</i>
Highlands Hammock State Park	Coleoptera	* <i>Onthophagus polyphemi</i>
Highlands Hammock State Park	Coleoptera	<i>Phyllophaga elongata</i>
Highlands Hammock State Park	Coleoptera	<i>Trigonopeltastes floridana</i>
Highlands Hammock State Park	Coleoptera	* <i>Typocerus fulvocinctus</i>
Highlands Hammock State Park	Diptera	<i>Asyndetus archboldi</i>
Highlands Hammock State Park	Diptera	<i>Nemomydas melanopogon</i>
Highlands Hammock State Park	Heteroptera	* <i>Keltonia rubrofemorata</i>
Highlands Hammock State Park	Hymenoptera	* <i>Caupolicana floridana</i>
Highlands Hammock State Park	Hymenoptera	* <i>Colletes sp. 1</i>
Highlands Hammock State Park	Hymenoptera	<i>Dasymutilla archboldi</i>
Highlands Hammock State Park	Hymenoptera	* <i>Dorymyrmex flavopectus</i>
Highlands Hammock State Park	Hymenoptera	<i>Leptochilus krombeini</i>
Highlands Hammock State Park	Hymenoptera	<i>Photomorphus archboldi</i>
Highlands Hammock State Park	Lepidoptera	<i>Chionodes latro</i>
Highlands Hammock State Park	Orthoptera	<i>Melanoplus tequestae</i>
Highlands Hammock State Park	Orthoptera	<i>Neotridactylus archboldi</i>
Holmes Avenue	Arachnida	<i>Geolycosa hubbelli</i>
Holmes Avenue	Arachnida	<i>Geolycosa xera archboldi</i>
Holmes Avenue	Arachnida	<i>Hogna ceratiola</i>
Holmes Avenue	Arachnida	* <i>Hogna osceola</i>
Holmes Avenue	Arachnida	<i>Sosippus placidus</i>
Holmes Avenue	Blattaria	<i>Arenivaga floridensis</i>
Holmes Avenue	Coleoptera	* <i>Auletobius nr. Cassandreae</i>
Holmes Avenue	Coleoptera	<i>Geopsammodius relictillus</i>
Holmes Avenue	Coleoptera	<i>Haroldiataenius saramari</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Holmes Avenue	Coleoptera	<i>Lucidota luteicollis</i>
Holmes Avenue	Coleoptera	* <i>Onthophagus polyphemi</i>
Holmes Avenue	Coleoptera	* <i>Phyllophaga elizoria</i>
Holmes Avenue	Coleoptera	<i>Phyllophaga elongata</i>
Holmes Avenue	Coleoptera	* <i>Serica frosti</i>
Holmes Avenue	Diptera	<i>Asyndetus archboldi</i>
Holmes Avenue	Diptera	* <i>Gymnoprosope sp. 2</i>
Holmes Avenue	Diptera	<i>Townsendia arenicola</i>
Holmes Avenue	Heteroptera	* <i>Keltonia clinopodii</i>
Holmes Avenue	Heteroptera	* <i>Keltonia rubrofemorata</i>
Holmes Avenue	Hymenoptera	<i>Dasymutilla archboldi</i>
Holmes Avenue	Hymenoptera	<i>Dorymyrmex elegans</i>
Holmes Avenue	Hymenoptera	<i>Nylanderia phantasma</i>
Holmes Avenue	Hymenoptera	<i>Odontomachus relictus</i>
Holmes Avenue	Hymenoptera	* <i>Osmia sp.</i>
Holmes Avenue	Lepidoptera	<i>Chionodes latro</i>
Holmes Avenue	Lepidoptera	* <i>Nemouria outina</i>
Holmes Avenue	Orthoptera	<i>Melanoplus tequestae</i>
Holmes Avenue	Orthoptera	<i>Neotridactylus archboldi</i>
Holmes Avenue	Orthoptera	* <i>Schistocerca ceratiola</i>
Jack Creek	Arachnida	<i>Geolycosa hubbelli</i>
Jack Creek	Arachnida	<i>Geolycosa xera archboldi</i>
Jack Creek	Arachnida	<i>Hogna ceratiola</i>
Jack Creek	Arachnida	* <i>Latrodectus bishopi</i>
Jack Creek	Arachnida	* <i>Zelotes florodes</i>
Jack Creek	Blattaria	<i>Arenivaga floridensis</i>
Jack Creek	Coleoptera	* <i>Auletobius nr. Cassandrae</i>
Jack Creek	Coleoptera	* <i>Chelyoxenus xerobatis</i>
Jack Creek	Coleoptera	* <i>Cicindela highlandensis</i>
Jack Creek	Coleoptera	<i>Geopsammodius relictillus</i>
Jack Creek	Coleoptera	<i>Haroldiataenius saramari</i>
Jack Creek	Coleoptera	<i>Lucidota luteicollis</i>
Jack Creek	Coleoptera	<i>Onthophagus aciculatulus</i>
Jack Creek	Coleoptera	* <i>Onthophagus polyphemi</i>
Jack Creek	Coleoptera	* <i>Pachybrachis sp. 2</i>
Jack Creek	Coleoptera	<i>Phyllophaga elongata</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Jack Creek	Coleoptera	<i>*Pleotomodes needhami</i>
Jack Creek	Coleoptera	<i>Trigonopeltastes floridana</i>
Jack Creek	Diptera	<i>Asyndetus archboldi</i>
Jack Creek	Diptera	<i>*Eutrichota gopheri</i>
Jack Creek	Diptera	<i>*Gymnoprosope sp. 2</i>
Jack Creek	Diptera	<i>*Hemipenthes bigradata</i>
Jack Creek	Diptera	<i>Nemomydas melanopogon</i>
Jack Creek	Diptera	<i>*Pieza rhea</i>
Jack Creek	Diptera	<i>Townsendia arenicola</i>
Jack Creek	Heteroptera	<i>*Keltonia balli</i>
Jack Creek	Heteroptera	<i>*Keltonia clinopodii</i>
Jack Creek	Heteroptera	<i>*Keltonia rubrofemorata</i>
Jack Creek	Heteroptera	<i>Parthenicus weemsi</i>
Jack Creek	Hymenoptera	<i>*Colletes sp. 1</i>
Jack Creek	Hymenoptera	<i>Dasymutilla archboldi</i>
Jack Creek	Hymenoptera	<i>*Dorymyrmex flavopectus</i>
Jack Creek	Hymenoptera	<i>Leptochilus krombeini</i>
Jack Creek	Hymenoptera	<i>Photomorphus archboldi</i>
Jack Creek	Lepidoptera	<i>Chionodes latro</i>
Jack Creek	Orthoptera	<i>Melanoplus tequestae</i>
Jack Creek	Orthoptera	<i>Neotridactylus archboldi</i>
Jack Creek	Orthoptera	<i>*Schistocerca ceratiola</i>
Lake June State Park	Arachnida	<i>Geolycosa hubbelli</i>
Lake June State Park	Arachnida	<i>Geolycosa xera archboldi</i>
Lake June State Park	Arachnida	<i>Hogna ceratiola</i>
Lake June State Park	Arachnida	<i>*Latrodectus bishopi</i>
Lake June State Park	Arachnida	<i>*Zelotes florodes</i>
Lake June State Park	Coleoptera	<i>*Anomala eximia</i>
Lake June State Park	Coleoptera	<i>Lucidota luteicollis</i>
Lake June State Park	Coleoptera	<i>Onthophagus aciculatulus</i>
Lake June State Park	Coleoptera	<i>*Pachybrachis sp. 2</i>
Lake June State Park	Coleoptera	<i>Phyllophaga elongata</i>
Lake June State Park	Coleoptera	<i>Trigonopeltastes floridana</i>
Lake June State Park	Diptera	<i>Asyndetus archboldi</i>
Lake June State Park	Diptera	<i>Nemomydas melanopogon</i>
Lake June State Park	Hymenoptera	<i>Dasymutilla archboldi</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Lake June State Park	Hymenoptera	<i>Dorymyrmex elegans</i>
Lake June State Park	Hymenoptera	<i>Odontomachus relictus</i>
Lake June State Park	Hymenoptera	<i>Photomorphus archboldi</i>
Lake June State Park	Orthoptera	<i>Melanoplus tequestae</i>
Lake June State Park	Orthoptera	<i>Neotridactylus archboldi</i>
Lake Louisa State Park	Arachnida	<i>Geolycosa xera archboldi</i>
Lake Louisa State Park	Blattaria	<i>Arenivaga floridensis</i>
Lake Louisa State Park	Coleoptera	* <i>Aphodius troglodytes</i>
Lake Louisa State Park	Coleoptera	<i>Haroldiataenius saramari</i>
Lake Louisa State Park	Coleoptera	* <i>Serica frosti</i>
Lake Louisa State Park	Coleoptera	* <i>Typocerus fulvocinctus</i>
Lake Louisa State Park	Diptera	* <i>Eutrichota gopheri</i>
Lake Louisa State Park	Lepidoptera	<i>Chionodes latro</i>
Lake Placid Scrub Preserve	Arachnida	<i>Geolycosa hubbelli</i>
Lake Placid Scrub Preserve	Arachnida	<i>Geolycosa xera archboldi</i>
Lake Placid Scrub Preserve	Arachnida	<i>Hogna ceratiola</i>
Lake Placid Scrub Preserve	Arachnida	<i>Sosippus placidus</i>
Lake Placid Scrub Preserve	Arachnida	* <i>Zelotes florodes</i>
Lake Placid Scrub Preserve	Blattaria	<i>Arenivaga floridensis</i>
Lake Placid Scrub Preserve	Coleoptera	<i>Geopsammodius relictillus</i>
Lake Placid Scrub Preserve	Coleoptera	<i>Haroldiataenius saramari</i>
Lake Placid Scrub Preserve	Coleoptera	<i>Lucidota luteicollis</i>
Lake Placid Scrub Preserve	Coleoptera	<i>Onthophagus aciculatulus</i>
Lake Placid Scrub Preserve	Coleoptera	* <i>Pleotomodes needhami</i>
Lake Placid Scrub Preserve	Coleoptera	* <i>Selonodon archboldi</i>
Lake Placid Scrub Preserve	Coleoptera	* <i>Serica frosti</i>
Lake Placid Scrub Preserve	Coleoptera	<i>Trigonopeltastes floridana</i>
Lake Placid Scrub Preserve	Diptera	* <i>Asaphomyia floridensis</i>
Lake Placid Scrub Preserve	Diptera	* <i>Hemipenthes bigradata</i>
Lake Placid Scrub Preserve	Diptera	* <i>Pieza rhea</i>
Lake Placid Scrub Preserve	Heteroptera	* <i>Keltonia balli</i>
Lake Placid Scrub Preserve	Heteroptera	<i>Parthenicus weemsi</i>
Lake Placid Scrub Preserve	Hymenoptera	* <i>Colletes sp. 1</i>
Lake Placid Scrub Preserve	Hymenoptera	<i>Dasymutilla archboldi</i>
Lake Placid Scrub Preserve	Hymenoptera	<i>Dorymyrmex elegans</i>
Lake Placid Scrub Preserve	Hymenoptera	* <i>Dorymyrmex flavopectus</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Lake Placid Scrub Preserve	Hymenoptera	<i>Odontomachus relictus</i>
Lake Placid Scrub Preserve	Lepidoptera	<i>Chionodes latro</i>
Lake Placid Scrub Preserve	Orthoptera	<i>Melanoplus tequestae</i>
Lake Placid Scrub Preserve	Orthoptera	<i>Neotridactylus archboldi</i>
Lake Wales Ridge State Forest	Arachnida	<i>Geolycosa hubbelli</i>
Lake Wales Ridge State Forest	Arachnida	<i>Geolycosa xera archboldi</i>
Lake Wales Ridge State Forest	Arachnida	<i>Hogna ceratiola</i>
Lake Wales Ridge State Forest	Arachnida	* <i>Hogna osceola</i>
Lake Wales Ridge State Forest	Arachnida	* <i>Latrodectus bishopi</i>
Lake Wales Ridge State Forest	Arachnida	* <i>Zelotes florodes</i>
Lake Wales Ridge State Forest	Arachnida	* <i>Zelotes sp.</i>
Lake Wales Ridge State Forest	Blattaria	<i>Arenivaga floridensis</i>
Lake Wales Ridge State Forest	Coleoptera	* <i>Aethecerinus hornii</i>
Lake Wales Ridge State Forest	Coleoptera	* <i>Aphodius troglodytes</i>
Lake Wales Ridge State Forest	Coleoptera	* <i>Blapstinus sp.</i>
Lake Wales Ridge State Forest	Coleoptera	* <i>Chelyoxenus xerobatis</i>
Lake Wales Ridge State Forest	Coleoptera	* <i>Cicindela highlandensis</i>
Lake Wales Ridge State Forest	Coleoptera	* <i>Cicindela scabrosa</i>
Lake Wales Ridge State Forest	Coleoptera	<i>Geopsammodius relictillus</i>
Lake Wales Ridge State Forest	Coleoptera	<i>Haroldiataenius saramari</i>
Lake Wales Ridge State Forest	Coleoptera	<i>Lucidota luteicollis</i>
Lake Wales Ridge State Forest	Coleoptera	<i>Onthophagus aciculatulus</i>
Lake Wales Ridge State Forest	Coleoptera	* <i>Onthophagus polyphemi</i>
Lake Wales Ridge State Forest	Coleoptera	* <i>Pachybrachis sp. 2</i>
Lake Wales Ridge State Forest	Coleoptera	<i>Phyllophaga elongata</i>
Lake Wales Ridge State Forest	Coleoptera	* <i>Pleotomodes needhami</i>
Lake Wales Ridge State Forest	Coleoptera	* <i>Plesioclytus relictus</i>
Lake Wales Ridge State Forest	Coleoptera	* <i>Serica frosti</i>
Lake Wales Ridge State Forest	Coleoptera	<i>Trigonopeltastes floridana</i>
Lake Wales Ridge State Forest	Coleoptera	* <i>Typocerus fulvocinctus</i>
Lake Wales Ridge State Forest	Diplopoda	* <i>Floridobolus penneri</i>
Lake Wales Ridge State Forest	Diptera	<i>Asyndetus archboldi</i>
Lake Wales Ridge State Forest	Diptera	<i>Nemomydas melanopogon</i>
Lake Wales Ridge State Forest	Diptera	<i>Townsendia arenicola</i>
Lake Wales Ridge State Forest	Heteroptera	* <i>Keltonia rubrofemorata</i>
Lake Wales Ridge State Forest	Hymenoptera	* <i>Aleiodes pardalotus</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Lake Wales Ridge State Forest	Hymenoptera	* <i>Colletes sp. 1</i>
Lake Wales Ridge State Forest	Hymenoptera	<i>Colletes sp. 2</i>
Lake Wales Ridge State Forest	Hymenoptera	<i>Dasymutilla archboldi</i>
Lake Wales Ridge State Forest	Hymenoptera	* <i>Dorymyrmex flavopectus</i>
Lake Wales Ridge State Forest	Hymenoptera	<i>Leptochilus krombeini</i>
Lake Wales Ridge State Forest	Hymenoptera	<i>Nylanderia phantasma</i>
Lake Wales Ridge State Forest	Hymenoptera	<i>Odontomachus relictus</i>
Lake Wales Ridge State Forest	Hymenoptera	<i>Photomorphus archboldi</i>
Lake Wales Ridge State Forest	Lepidoptera	<i>Chionodes latro</i>
Lake Wales Ridge State Forest	Orthoptera	<i>Melanoplus tequestae</i>
Lake Wales Ridge State Forest	Orthoptera	<i>Neotridactylus archboldi</i>
McJunkin	Arachnida	<i>Geolycosa xera archboldi</i>
McJunkin	Arachnida	* <i>Latrodectus bishopi</i>
McJunkin	Arachnida	<i>Sosippus placidus</i>
McJunkin	Coleoptera	<i>Geopsammodius relictillus</i>
McJunkin	Coleoptera	<i>Haroldiataenius saramari</i>
McJunkin	Coleoptera	<i>Ischyrus dunedinensis</i>
McJunkin	Coleoptera	<i>Lucidota luteicollis</i>
McJunkin	Coleoptera	* <i>Pachybrachis sp. 1</i>
McJunkin	Coleoptera	<i>Phyllophaga elongata</i>
McJunkin	Coleoptera	<i>Trigonopeltastes floridana</i>
McJunkin	Diptera	* <i>Villa sp.</i>
McJunkin	Heteroptera	* <i>Keltonia clinopodii</i>
McJunkin	Hymenoptera	* <i>Colletes sp. 1</i>
McJunkin	Hymenoptera	* <i>Dorymyrmex flavopectus</i>
McJunkin	Hymenoptera	<i>Nylanderia phantasma</i>
McJunkin	Hymenoptera	<i>Odontomachus relictus</i>
McJunkin	Lepidoptera	<i>Chionodes latro</i>
Royce Ranch	Arachnida	<i>Geolycosa hubbelli</i>
Royce Ranch	Arachnida	<i>Geolycosa xera archboldi</i>
Royce Ranch	Arachnida	<i>Hogna ceratiola</i>
Royce Ranch	Arachnida	* <i>Latrodectus bishopi</i>
Royce Ranch	Arachnida	<i>Sosippus placidus</i>
Royce Ranch	Blattaria	<i>Arenivaga floridensis</i>
Royce Ranch	Coleoptera	* <i>Anomala eximia</i>
Royce Ranch	Coleoptera	* <i>Blapstinus sp.</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Royce Ranch	Coleoptera	* <i>Chelyoxenus xerobatis</i>
Royce Ranch	Coleoptera	<i>Haroldiataenius saramari</i>
Royce Ranch	Coleoptera	<i>Lucidota luteicollis</i>
Royce Ranch	Coleoptera	* <i>Onthophagus polyphemi</i>
Royce Ranch	Coleoptera	* <i>Onychomira floridensis</i>
Royce Ranch	Coleoptera	* <i>Pachybrachis sp. 1</i>
Royce Ranch	Coleoptera	<i>Phyllophaga elongata</i>
Royce Ranch	Coleoptera	<i>Trigonopeltastes floridana</i>
Royce Ranch	Diptera	<i>Asyndetus archboldi</i>
Royce Ranch	Diptera	<i>Nemomydas melanopogon</i>
Royce Ranch	Diptera	* <i>Pieza rhea</i>
Royce Ranch	Diptera	* <i>Villa sp.</i>
Royce Ranch	Heteroptera	<i>Parthenicus weemsi</i>
Royce Ranch	Hymenoptera	<i>Dorymyrmex elegans</i>
Royce Ranch	Hymenoptera	* <i>Dorymyrmex flavopectus</i>
Royce Ranch	Hymenoptera	<i>Leptochilus krombeini</i>
Royce Ranch	Hymenoptera	<i>Nylanderia phantasma</i>
Royce Ranch	Hymenoptera	<i>Odontomachus relictus</i>
Royce Ranch	Hymenoptera	<i>Photomorphus archboldi</i>
Royce Ranch	Lepidoptera	<i>Chionodes latro</i>
Royce Ranch	Orthoptera	* <i>Aptenopedes nigropicta</i>
Royce Ranch	Orthoptera	<i>Melanoplus tequestae</i>
Royce Ranch	Orthoptera	<i>Neotridactylus archboldi</i>
Royce Ranch	Orthoptera	* <i>Schistocerca ceratiola</i>
Saddleblanket Lake	Arachnida	<i>Geolycosa xera archboldi</i>
Saddleblanket Lake	Arachnida	<i>Hogna ceratiola</i>
Saddleblanket Lake	Arachnida	* <i>Hogna osceola</i>
Saddleblanket Lake	Arachnida	* <i>Phidippus workmani</i>
Saddleblanket Lake	Arachnida	<i>Sosippus placidus</i>
Saddleblanket Lake	Arachnida	* <i>Zelotes florodes</i>
Saddleblanket Lake	Arachnida	* <i>Zelotes sp.</i>
Saddleblanket Lake	Blattaria	<i>Arenivaga floridensis</i>
Saddleblanket Lake	Coleoptera	* <i>Onthophagus polyphemi</i>
Saddleblanket Lake	Coleoptera	<i>Pachybrachis sp. 2</i>
Saddleblanket Lake	Coleoptera	<i>Phyllophaga elongata</i>
Saddleblanket Lake	Diplopoda	* <i>Floridobolus penneri</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Saddleblanket Lake	Diptera	<i>Asyndetus archboldi</i>
Saddleblanket Lake	Diptera	<i>Nemomydas melanopogon</i>
Saddleblanket Lake	Heteroptera	* <i>Keltonia rubrofemorata</i>
Saddleblanket Lake	Heteroptera	<i>Parthenicus weemsi</i>
Saddleblanket Lake	Hymenoptera	* <i>Colletes sp. 1</i>
Saddleblanket Lake	Hymenoptera	<i>Dasymutilla archboldi</i>
Saddleblanket Lake	Hymenoptera	<i>Leptochilus krombeini</i>
Saddleblanket Lake	Hymenoptera	<i>Odontomachus relictus</i>
Saddleblanket Lake	Hymenoptera	<i>Photomorphus archboldi</i>
Saddleblanket Lake	Lepidoptera	<i>Chionodes latro</i>
Saddleblanket Lake	Orthoptera	* <i>Melanoplus forcipatus</i>
Saddleblanket Lake	Orthoptera	<i>Melanoplus tequestae</i>
Saddleblanket Lake	Orthoptera	<i>Neotridactylus archboldi</i>
Silver Lake	Arachnida	<i>Geolycosa hubbelli</i>
Silver Lake	Arachnida	<i>Geolycosa xera archboldi</i>
Silver Lake	Arachnida	<i>Hogna ceratiola</i>
Silver Lake	Arachnida	<i>Sosippus placidus</i>
Silver Lake	Arachnida	* <i>Zelotes florodes</i>
Silver Lake	Blattaria	<i>Arenivaga floridensis</i>
Silver Lake	Coleoptera	* <i>Aphodius troglodytes</i>
Silver Lake	Coleoptera	<i>Geopsammodius relictillus</i>
Silver Lake	Coleoptera	<i>Lucidota luteicollis</i>
Silver Lake	Coleoptera	<i>Onthophagus aciculatulus</i>
Silver Lake	Diptera	<i>Asyndetus archboldi</i>
Silver Lake	Hymenoptera	<i>Photomorphus archboldi</i>
Silver Lake	Lepidoptera	<i>Chionodes latro</i>
Silver Lake	Orthoptera	<i>Melanoplus tequestae</i>
Silver Lake	Orthoptera	<i>Neotridactylus archboldi</i>
Snell Creek	Blattaria	<i>Arenivaga floridensis</i>
Snell Creek	Coleoptera	<i>Geopsammodius relictillus</i>
Snell Creek	Coleoptera	<i>Haroldiataenius saramari</i>
Snell Creek	Hymenoptera	<i>Nylanderia phantasma</i>
Snell Creek	Orthoptera	* <i>Aptenopedes nigropicta</i>
Snell Creek	Orthoptera	<i>Melanoplus tequestae</i>
Sunray FWC	Arachnida	<i>Geolycosa hubbelli</i>
Sunray FWC	Arachnida	<i>Geolycosa xera archboldi</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Sunray FWC	Arachnida	<i>Hogna ceratiola</i>
Sunray FWC	Arachnida	* <i>Zelotes florodes</i>
Sunray FWC	Blattaria	<i>Arenivaga floridensis</i>
Sunray FWC	Coleoptera	* <i>Aethecerinus hornii</i>
Sunray FWC	Coleoptera	* <i>Anomala eximia</i>
Sunray FWC	Coleoptera	* <i>Aphodius troglodytes</i>
Sunray FWC	Coleoptera	* <i>Blapstinus sp.</i>
Sunray FWC	Coleoptera	* <i>Diplotaxis rufa</i>
Sunray FWC	Coleoptera	<i>Geopsammodius relictillus</i>
Sunray FWC	Coleoptera	<i>Haroldiataenius saramari</i>
Sunray FWC	Coleoptera	* <i>Odontotaenius floridana</i>
Sunray FWC	Coleoptera	<i>Onthophagus aciculatulus</i>
Sunray FWC	Coleoptera	* <i>Onthophagus polyphemi</i>
Sunray FWC	Coleoptera	* <i>Pachybrachis sp. 2</i>
Sunray FWC	Coleoptera	<i>Phyllophaga elongata</i>
Sunray FWC	Coleoptera	* <i>Pleotomodes needhami</i>
Sunray FWC	Coleoptera	<i>Trigonopeltastes floridana</i>
Sunray FWC	Coleoptera	* <i>Typocerus fulvocinctus</i>
Sunray FWC	Diplopoda	* <i>Floridobolus penneri</i>
Sunray FWC	Diptera	<i>Asyndetus archboldi</i>
Sunray FWC	Diptera	* <i>Eutrichota gopheri</i>
Sunray FWC	Diptera	<i>Nemomydas melanopogon</i>
Sunray FWC	Diptera	<i>Townsendia arenicola</i>
Sunray FWC	Heteroptera	* <i>Keltonia robusta</i>
Sunray FWC	Heteroptera	* <i>Keltonia rubrofemorata</i>
Sunray FWC	Heteroptera	<i>Parthenicus weemsi</i>
Sunray FWC	Hymenoptera	* <i>Colletes sp. 1</i>
Sunray FWC	Hymenoptera	<i>Dasymutilla archboldi</i>
Sunray FWC	Hymenoptera	<i>Leptochilus krombeini</i>
Sunray FWC	Hymenoptera	<i>Photomorphus archboldi</i>
Sunray FWC	Orthoptera	* <i>Melanoplus forcipatus</i>
Sunray FWC	Orthoptera	<i>Melanoplus tequestae</i>
Sunray FWC	Orthoptera	<i>Neotridactylus archboldi</i>
Sunray TNC	Arachnida	<i>Hogna ceratiola</i>
Sunray TNC	Coleoptera	* <i>Leiopsammodius deyrupei</i>
Sunray TNC	Diplopoda	* <i>Floridobolus penneri</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Sunray TNC	Diptera	<i>Asyndetus archboldi</i>
Sunray TNC	Hymenoptera	<i>Photomorphus archboldi</i>
Sunray TNC	Orthoptera	<i>Neotridactylus archboldi</i>
Tiger Creek Preserve	Arachnida	<i>Geolycosa hubbelli</i>
Tiger Creek Preserve	Arachnida	<i>Geolycosa xera archboldi</i>
Tiger Creek Preserve	Arachnida	<i>Hogna ceratiola</i>
Tiger Creek Preserve	Arachnida	* <i>Hogna osceola</i>
Tiger Creek Preserve	Arachnida	* <i>Latrodectus bishopi</i>
Tiger Creek Preserve	Arachnida	* <i>Zelotes florodes</i>
Tiger Creek Preserve	Arachnida	* <i>Zelotes sp.</i>
Tiger Creek Preserve	Blattaria	<i>Arenivaga floridensis</i>
Tiger Creek Preserve	Coleoptera	* <i>Aphodius troglodytes</i>
Tiger Creek Preserve	Coleoptera	* <i>Blapstinus sp.</i>
Tiger Creek Preserve	Coleoptera	* <i>Cicindela highlandensis</i>
Tiger Creek Preserve	Coleoptera	<i>Geopsammodius relictillus</i>
Tiger Creek Preserve	Coleoptera	<i>Haroldiataenius saramari</i>
Tiger Creek Preserve	Coleoptera	<i>Ischyrus dunedinensis</i>
Tiger Creek Preserve	Coleoptera	* <i>Leiopsammodius deyrupi</i>
Tiger Creek Preserve	Coleoptera	<i>Lucidota luteicollis</i>
Tiger Creek Preserve	Coleoptera	* <i>Onthophagus polyphemi</i>
Tiger Creek Preserve	Coleoptera	<i>Phyllophaga elongata</i>
Tiger Creek Preserve	Coleoptera	* <i>Romulus globosus</i>
Tiger Creek Preserve	Coleoptera	* <i>Selonodon archboldi</i>
Tiger Creek Preserve	Coleoptera	<i>Trigonopeltastes floridana</i>
Tiger Creek Preserve	Diptera	<i>Asyndetus archboldi</i>
Tiger Creek Preserve	Diptera	<i>Nemomydas melanopogon</i>
Tiger Creek Preserve	Diptera	<i>Townsendia arenicola</i>
Tiger Creek Preserve	Hymenoptera	* <i>Colletes sp. 1</i>
Tiger Creek Preserve	Hymenoptera	<i>Dasymutilla archboldi</i>
Tiger Creek Preserve	Hymenoptera	<i>Dorymyrmex elegans</i>
Tiger Creek Preserve	Hymenoptera	<i>Leptochilus krombeini</i>
Tiger Creek Preserve	Hymenoptera	<i>Nylanderia phantasma</i>
Tiger Creek Preserve	Hymenoptera	<i>Odontomachus relictus</i>
Tiger Creek Preserve	Hymenoptera	<i>Photomorphus archboldi</i>
Tiger Creek Preserve	Orthoptera	* <i>Aptenopedes nigropicta</i>
Tiger Creek Preserve	Orthoptera	* <i>Ellipes n. sp. nr. eisneri</i>

Species_Order_by_Preserve		
preserve_designation	order_	species
Tiger Creek Preserve	Orthoptera	* <i>Melanoplus forcipatus</i>
Tiger Creek Preserve	Orthoptera	<i>Melanoplus tequestae</i>
Tiger Creek Preserve	Orthoptera	<i>Neotridactylus archboldi</i>
Walk-in-water	Arachnida	<i>Geolycosa xera archboldi</i>
Walk-in-water	Arachnida	<i>Hogna ceratiola</i>
Walk-in-water	Blattaria	<i>Arenivaga floridensis</i>
Walk-in-water	Coleoptera	* <i>Cicindela highlandensis</i>
Walk-in-water	Coleoptera	<i>Geopsammodius relictillus</i>
Walk-in-water	Coleoptera	<i>Haroldiataenius saramari</i>
Walk-in-water	Coleoptera	<i>Ischyrus dunedinensis</i>
Walk-in-water	Coleoptera	<i>Lucidota luteicollis</i>
Walk-in-water	Coleoptera	* <i>Selonodon archboldi</i>
Walk-in-water	Coleoptera	<i>Trigonopeltastes floridana</i>
Walk-in-water	Coleoptera	* <i>Typocerus fulvocinctus</i>
Walk-in-water	Diptera	<i>Asyndetus archboldi</i>
Walk-in-water	Diptera	<i>Townsendia arenicola</i>
Walk-in-water	Homoptera	* <i>Telamona archboldi</i>
Walk-in-water	Hymenoptera	* <i>Colletes sp. 1</i>
Walk-in-water	Hymenoptera	<i>Colletes sp. 2</i>
Walk-in-water	Hymenoptera	<i>Dasymutilla archboldi</i>
Walk-in-water	Hymenoptera	<i>Photomorphus archboldi</i>