Bromeliad Weevils in Florida

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The slides should be self-explanatory, but some additional background information is provided here, given by slide. The program should be suitable for the general public or for more specific audiences. The following explanations can be used as a script or simply as a guide.

1.) This program will provide an overview of the effect of the Mexican bromeliad weevil (nicknamed the "evil weevil" by bromeliad lovers) on Florida's native bromeliads. It will show damage to bromeliad populations and how to spot damage in individual plants, plus explain management solutions and what everyone can do to become involved in stopping this highly destructive pest.

2.) Bromeliads are members of the pineapple family (Bromeliaceae). They are perennial herbs with reduced stems and stiff leaves. They are native to the New World tropics and are restricted in their range primarily by temperature. In Florida, bromeliads mainly grow epiphytically, attaching themselves to tree trunks and branches. Since they do not absorb nutrients from or harm the host tree, they are not parasitic.

3.) Bromeliads have several adaptations to the dry and exposed conditions of epiphytic life. Water accumulates between leaf axils in the larger tank bromeliads. Since their roots serve only to anchor the plant to the tree, epiphytic bromeliads absorb through their leaves the water and nutrients they need from the air and rain that falls through the canopy and becomes enriched with nutrients along the way (called throughfall). The tank water becomes further enriched with decayed material from fallen leaf litter and dead insects. Another adapatation is the presence of scales on bromeliad leaves that absorb moisture and dissolved organic matter. Leaves also have water-storage tissue and are covered with a thick cuticle to reduce water loss.

4.) Florida has 16 species of native bromeliads and 2 natural hybrids. Thirteen of those species are found in no other U.S. state, and one species (*Tillandsia simulata*) is found nowhere else but in Florida.

5.) The water-holding tanks of larger bromeliads provide a habitat for specialist invertebrates. There, many small animals live in what to them are like ponds. Several insect and worm species depend on bromeliads in Florida for their survival, and larger animals such as frogs, snakes and salamanders use these plants for protection and as a water source in drier months. There are at least 15 known species of insects and other invertebrates that would not survive in Florida without the bromeliads in whose tanks they live. Bromeliads also contribute to the diversity of plants found

in south Florida's unique ecosystems. Some of Florida's bromeliad species exhibit differences depending on where their populations are found, and some of Florida's bromeliads are distinct from the same species in other places.

6.) One of these specialists that depends on bromeliads in Florida is the Florida bromeliad weevil, whose scientific name is *Metamasius mosieri*. It is thought to be native to Florida, having evolved together with Florida's bromeliad populations. This weevil is not a significant pest and does not threaten native bromeliad populations. It tends to attack small plants. It is an occasional minor pest on ornamental bromeliads but is rarely found either in cultivated bromeliads or in natural areas of Florida. No other bromeliad weevils are native to Florida.

7.) In addition to their important ecological roles, Florida's bromeliads are an aesthetic addition to the state's many parks and natural areas. The unusual form and colorful flowers of Florida's bromeliads add to the beauty of the many parks in which they are found, and it is the natural features of the parks that attract millions of visitors each year. In addition, the state's native bromeliads provide a hands-on teaching tool for teachers and environmental educators. So Florida's native bromeliads are important to the health of the ecosystems in which they occur and also to the people and educators who visit the parks where they are found. The loss of our bromeliads would be a real tragedy for the state.

8.) Many of Florida's native bromeliad species have been on the state's list of threatened and endangered species for years because their populations have been so low. Development in south Florida continues to reduce the habitat available for bromeliads, and several species are now found only on state and federal protected lands. Even bromeliads on protected lands are not immune to illegal collection, another threat to their existence. But a new threat has appeared more recently, one which is much more dangerous because it does not distinguish park boundaries. The newer, deadlier threat is an invasive pest weevil that attacks bromeliads, *Metamasius callizona*. It has no official common name, although it has been called both the Mexican bromeliad weevil (because of its origin) and the “evil weevil” (because of the destruction it has caused to Florida’s bromeliads).

9.) Non-native species frequently enter Florida, and those that become established in the environment and spread are considered invasive. Invasive pests have become a serious problem in Florida, affecting both agriculture and natural areas. With ever-increasing transportation and commerce, there are more and more opportunities for non-native insects to enter the state. There are about 450 million ornamental plants shipped into the U.S. each year, and close to 85% of those arrive through the port of Miami. Inspectors from the U.S. Department of Agriculture/APHIS (Animal and Plant Health Inspection Service) intercept over 18,000 insects on imported plants each year, but they are able to inspect less than 2% of imported shipments. As a result, non-native insects are continually reported in Florida.

10) Between 1970 and 1990, there were 271 new reports of non-native insect species in Florida. That represents an average of 13 species immigrating per year, and that includes an average of one major pest per year. Florida receives many bromeliad imports each year, and those are just as susceptible. Between 1973 and 1987, USDA inspectors intercepted *Metamasius* species weevils on bromeliads entering the state 122 times. That included 14 interceptions of *Metamasius callizona*, the Mexican bromeliad weevil.

11.) All it takes is one un-inspected plant infested with weevils, and apparently the Mexican bromeliad weevil immigrated to Florida in that way. It is believed to have entered the state on a

shipment of Tillandsias from Veracruz, Mexico. The weevil was first discovered in 1989, in a nursery in Fort Lauderdale (Broward County).

12.) The nursery was treated, but by the time it was discovered, the weevil had become established in nearby natural areas. Once established in Broward County, it has moved throughout southern Florida both by natural dispersal and by the movement of infested plants.

13.) Since its first appearance, the weevil has been reported in 18 Florida counties, and as of the summer of 2002 it was found in 17 counties. It was present in Miami-Dade County before Hurricane Andrew, which destroyed the plants in which it was found, and it has not been seen in that county since then. From its appearance in Broward County it moved quickly to Palm Beach County. It was next detected in Lee County, probably the result of an infested plant being moved across the state. It has steadily moved up and down both coasts since then and is now moving inland. The sightings on the map represent only what is known about the weevil's spread. Extensive survey work has not been conducted, so the weevil may be in many more areas than is currently known.

14.) The weevil is infesting bromeliads in many important natural areas, including 6 state parks (Savannas Preserve, Myakka River, Highlands Hammock, Koreshan Historic Site, Lake Kissimmee, and most recently Fakahatchee Strand). It is destroying bromeliads in the Loxahatchee National Wildlife Refuge (Boynton Beach, Palm Beach County) and has recently been found in Audubon's Corkscrew Swamp Sanctuary. Its presence in the Fakahatchee Strand makes the situation even more critical, since the Fakahatchee contains populations of Florida's rarest bromeliad species. The Fakahatchee is home to 14 of Florida's 16 native bromeliad species, including one species found nowhere else in the U.S. It is only a matter of time before the weevil also reaches Big Cypress National Preserve and Everglades National Park, the other places where Florida’s rare bromeliads are found.

15.) The Mexican bromeliad weevil is easily distinguished from the Florida bromeliad weevil in the adult stage. It is black and has a single band across its back, which is usually yellow but may be reddish or orange. Rarely the band is not visible. Florida bromeliad weevil is smaller and is red and black with 2 black spots.
16.) The immature larvae (grubs) of the two look alike. When found in a bromeliad, it is best to keep the larva on a plant and wait until it reaches the adult stage to know which species it is.

17.) The weevil’s direct effect on native bromeliads in their natural setting has so far included 6 species. *Tillandsia utriculata* (giant airplant) and *Tillandsia fasciculata* (cardinal airplant) have been placed on the state’s list of endangered species as a direct result of their destruction due to weevil attack.

18.) The weevil has also attacked *Tillandsia flexuosa* (twisted airplant), which was already on the endangered list, and *Tillandsia paucifolia* (potbelly airplant).

19.) *Guzmania monostachia* (West Indian tufted airplant) has recently begun to be attacked by the weevil in the Fakahatchee Strand. Also listed as endangered, it is found in few places outside of the Fakahatchee Strand. *Tillandsia balbisiana* (northern needleleaf), was already considered threatened and now faces destruction from the weevil as well.

20.) There are several other native bromeliads in Florida that have not yet been attacked by the weevil because of their more isolated occurrence, but which will probably be susceptible once the

weevil reaches them. These include *Catopsis berteroniana* (powdery strap airplant), and *Catopsis floribunda* (Florida strap airplant), which are already state-listed as endangered.

21.) *Catopsis nutans* (nodding strap airplant), now listed as endangered, will probably also be susceptible, as will *Tillandsia variabilis* (leatherleaf airplant), which is now considered threatened.

22.) Finally, *Tillandsia pruinosa* (fuzzywuzzy airplant), which is also endangered, and *Tillandsia simulata* (broad needleleaf), which is not listed as threatened but is found nowhere else but in Florida, will probably also be susceptible to the weevil.

23.) The remainder of bromeliads native to Florida are not considered likely to be attacked by the weevil, which prefers larger plants that have enough material at the base for larvae to complete their development. *Tillandsia bartramii* (Bartram's airplant), and *Tillandsia recurvata* (ball moss), are among those that do not appear to be susceptible.

24.) The last of Florida's native bromeliads, *Tillandsia setacea* (southern needleleaf) and *Tillandsia usneoides* (Spanish moss), have also not been susceptible to the weevil. Although the adults may feed to some extent on these smaller plants in the absence of large host populations, they will not lay eggs in them, so the plants will not be killed.

25.) From greenhouse host range tests and grower observations, the weevil has been found to develop on ornamental bromeliads in 13 genera in Florida: Aechmea, Ananas, Canistrum, Cryptanthus, Dyckia, Guzmania, Hohenbergia, Neoregelia, Nidularium, Orthophytum, Quesnelia, Tillandsia, and Vriesia. Not all genera and species have been tested, so the weevil's range may prove to be much wider. Additional host range tests are planned.

26.) Adults feed mainly on leaves but they may also feed on the inflorescence or flower stalk. Females lay their eggs in slits they make in the leaves, close to where they feed. After hatching from the egg, the young larvae eat through the leaf tissue, making their way down to the stem, where they mine the meristematic tissue. As they grow, larvae tunnel deep into the base of the plant, forming large holes. When mature, the larva develops into the pupal stage (the resting stage before its final molt to the adult), surrounding itself with a cocoon it has constructed from shredded stem material. The cocoons can usually be found in the center of the plant or the base of the stem.

27.) All life stages, the egg, larva, pupa and adult, can be found on the same plant. In natural areas, the weevil appears to continually mate and reproduce all year long.

28.) The development of the weevil from egg to adult is completed in about 8 weeks under laboratory conditions, on a diet of pineapple stems. Each generation is estimated to take 13-17 weeks to complete, so there are probably 3-4 generations each year in south Florida. There are still many things that are unknown about this weevil, especially about how its populations develop and disperse in natural settings. The time between a female adult emerging and beginning to lay eggs, and the maximum number of eggs laid per female are also unknown.

29.) The weevils kill the plant by destroying the base of the stem with the tunnels produced by the larvae. Adult feeding also produces holes in the stem, but it is the larval damage that is most severe. The damaged stem base separates from the plant and falls to the ground. The most typical symptom of weevil damage is the decomposition of leaves at the base, with the middle of the plant becoming so loose it can easily be removed.

30.) Larvae may also tunnel up the inflorescence, and both adults and larvae may mine the flower stalk. Damage to flowering plants is especially harmful to the population. In addition to the tunnels made in the stem base, there are several other symptoms of weevil damage, including browning of the leaves as a result of the destruction of the leaf bases. In some species, stress on the leaves, including that from weevil attack, may cause the leaves to turn purplish.

31.) The adults' feeding marks can also be seen on the plant's leaves. Finally, when damaged, the plant often produces a clear or brownish gel that may serve as the plant's defense mechanism. The gel is produced when the plant is damaged in any way and is not specific to weevil attack.

32.) The weevil is as destructive to bromeliad populations as it is to individual plants. When the weevils move into an area, they infest the larger plants, which comprise the breeding population. Once the larger plants are gone, the weevil can remain in an area attacking smaller plants.

33.) The weevil has been most devastating to *Tillandsia utriculata* populations. In general, *Tillandsia fasciculata* populations have been somewhat more resistant to weevil attack, although they are still affected.

34.) In many county and state parks, bromeliads are disappearing at an alarming rate. For example, in the Savannas Preserve State Park in St. Lucie County, an area of terrestrially growing *Tillandsia utriculata* was reduced to debris within a matter of months, and the weevil continues to destroy the epiphytic bromeliads in the park.

35.) In Myakka River State Park, the weevil is currently decimating populations of *Tillandsia utriculata* and *Tillandsia fasciculata*. In a study at the park's Deer Prairie Slough, 18% of bromeliads along a study transect were killed in just 15 weeks, and 39% of those in a densely populated host tree were killed. Bromeliads at Myakka River State Park are being monitored as part of a study of where and when weevil populations most affect bromeliad populations.

36.) After being present in Highlands Hammock State Park since 1999, the weevil began to inflict more serious damage during 2001 and 2002.

37.) The weevil's presence in the Fakahatchee Strand Preserve State Park was confirmed in March of 2002, and it is already attacking both *Tillandsia utriculata* and *Guzmania monostachia* there.

38.) In Loxahatchee National Wildlife Refuge, the weevil is attacking *Tillandsia fasciculata* and *Tillandsia balbisiana* on the cypress swamp boardwalk and surrounding areas. Refuge volunteers have been monitoring bromeliads to keep track of the weevil's damage.

39.) The weevil is also spreading through the Sebastian, St. Lucie, Indian River, Loxahatchee, Peace, Caloosahatchee, Myakka, and Manatee River Systems. Along a stretch of the St. Lucie River, the once abundant *Tillandsia fasciculata* have all but been destroyed.

40.) The weevil is spreading throughout south Florida and is destroying populations of several species of bromeliads in its path. It is imperative that we stop it before it gets to Florida's rarest bromeliads in the Everglades region. One factor in managing the weevil is preventing inadvertent human contributions to its further spread. This is important both for management in natural areas

and for private collections and nurseries. Much of the county-to-county spread of the weevil has been aided by the movement of infested plants.

41.) Therefore, it is important to minimize movement of ornamental bromeliads whenever possible. In addition, plants should be inspected before being moved. It is particularly important to monitor newly acquired plants for weevil presence. Ideally, plants should be subjected to a pesticide dip (if barerooted) or spray before being moved off a property or upon being received.

42.) Another important management consideration is the prevention of the establishment of additional non-native bromeliad weevils in Florida. At the same time that plants are monitored for Mexican bromeliad weevil, they should be monitored for any other weevils that may have escaped detection at the port. Finding immigrant bromeliad weevils before they become established would avoid repeating the problems that have been caused by the Mexican bromeliad weevil. If unknown bromeliad weevils are found, a Plant Inspector from the Florida Department of Agriculture and Consumer Services (DOACS), Division of Plant Industry (DPI) should be notified. All imported bromeliads should also be treated with a chemical dip or spray. Finally, importing only seeds of bromeliads would also avoid the risk of further immigrations, since weevil eggs in bromeliads cannot be detected during inspections and are protected from pesticides. If you travel to Latin America, never bring back bromeliad plants, since they may be infested with bromeliad weevils not currently present in Florida.

43.) In the American tropics (Neotropics), at least 26 species of weevils live in bromeliads. Most (17 species) are in the genus *Metamasius*. In their native lands, these bromeliad weevils do not threaten the bromeliad populations in which they live. Any of the 23 bromeliad weevils not presently found in Florida could potentially immigrate in imported bromeliads, but some are more likely than others to enter. USDA/APHIS inspectors and growers importing plants to Florida have intercepted individuals of several species, including *Metamasius cincinnatus*.

44.) *Metamasius dimidiatipennis* has also been intercepted in imported plant shipments.

45.) *Metamasius flavopictus* has been found by a grower on imported bromeliads.

46.) *Metamasius sellatus* is another species intercepted by USDA/APHIS inspectors.

47.) *Metamasius nudiventris* is another potential immigrant.

48.) *Metamasius quadrilineatus* is another potential immigrant.

49.) *Metamasius rugipectus* could also potentially be found in imported bromeliads. If you find any weevil in bromeliads that is not the Mexican bromeliad weevil or the Florida bromeliad weevil, immediately notify a DPI Plant Inspector.

50.) In terms of managing the Mexican bromeliad weevil in Florida, we can't use chemical controls, because the epiphytic habit of the plants makes access from the ground difficult. More importantly, the weevil inhabits parks and other natural areas, where the use of chemical pesticides would be inappropriate because of the effects on the surrounding ecosystem. And finally, since pesticides would have to be applied by air, the economic cost of aerial sprayings over 18 counties would be extremely high.

51.) The weevil has been so destructive in part because it came into Florida without the natural enemies that keep it under control in its homeland. So the most appropriate course of action in this case is to use biological control. Biological control, also called biocontrol, involves the use of a living organism to keep a pest's population below a damaging level. There are several different ways in which biological control can be used, but the type most appropriate for this situation is classical biological control, in which natural enemies of the pest are imported from the region where the pest originated. Even though the related Florida bromeliad weevil is thought to be native to Florida, no other insects have been found in Florida that attack either weevil, so we have to import a natural enemy from the pest's homeland. Once it is determined that release of the natural enemy will have no detrimental effects except on the pest population, a release permit is issued. Releases are made where the pest population is highest and, if successful, the natural enemy, or biological control agent, becomes established. The goal is not to completely eradicate the pest population, but to maintain it at a very low level so that damage is minimized.

52.) The weevil's place of origin is Mexico and Central America, and therefore explorations have been made to Mexico, Panama, Honduras and Guatemala in search of a natural enemy. Natural enemies of the weevil have been very difficult to find on exploration trips. One natural enemy, a potential biological control agent, was found attacking a related weevil species in Honduras.

53.) This candidate biological control agent is a specialist fly parasitoid in the family Tachinidae. It is an undescribed species in the genus *Lixophaga*. It was formerly thought to be in the genus *Admontia*, so it is referred to as *Admontia* species in older articles. As a specialist, it only attacks bromeliad weevils, and it will probably only attack a few very closely related species of those.

54.) In Honduras, this fly attacks the larvae of the closely related weevil species *Metamasius quadrilineatus.* When it was imported to the quarantine facility in Florida, it was found to attack *Metamasius callizona* (Mexican bromeliad weevil) as well. Once the fly colony is established in quarantine, non-target testing must be carried out to determine if the fly will attack anything else. For the non-target testing, species most closely related to the target pest are tested first, by exposing them to the biological control agent to see if they would be parasitized as well. Besides the target pest *Metamasius callizona* (Mexican bromeliad weevil), there are only 2 other species of *Metamasius* weevils in Florida at this time: the native Florida bromeliad weevil, (*Metamasius mosieri)*, and the silky cane weevil (*Metamasius hemipterus)*, which is a non-native pest of sugarcane and ornamental palms in south Florida. If the biological control agent (the fly) does not attack these related species, it will not attack any other organisms in the environment. Once non-target testing shows that the fly will not harm other species, application will be made for a release permit. At that point, the fly could be removed from quarantine to rear it in high numbers and release it in areas of high weevil concentration. Its effect on weevil populations would then be evaluated to plan further releases.

55.) The fly had never been studied before, and there is still a lot of information lacking about its biology. There are many conditions that must be met for this fly to successfully parasitize the weevil and to become established in south Florida after it is released. Most insects lay eggs, but in this fly the eggs hatch while still inside the adult female. The fly deposits the newly hatched larvae, which are called maggots since they are flies, at the entrance to the weevil tunnel. Each fly maggot crawls down the tunnel looking for a weevil larva, and when it finds one and enters it, the maggot feeds from inside until it is fully developed. When a maggot is ready to pupate (change its form to the resting stage just before the adult stage), it comes out of the weevil larva, which dies at that point. The fly then creates a puparium, a hardened case, around itself. The weevil larva is also fully grown at that point, and may even have formed the cocoon around itself, in preparation

for its own transformation or molt. The fly pupates within the plant, at the base of the leaves, very close to where the weevil larva was found. A few weeks later, the adult fly emerges and comes out of the plant to mate, find more weevil tunnels, and lay its own maggots.

56.) Biological control is safe for both people and the environment. It is regulated by the state, and a permit to release the biological control agent from quarantine is only issued once studies have shown that the biological control agent will not affect anything but the targeted pest.

57.) For this project, once the *Lixophaga* species fly or another biological control agent has been issued a release permit, releases will be made in natural areas in south Florida, with state parks and other protected areas as priority, where weevil populations are highest. The long-term goal is not to eradicate the weevil completely but to reduce its damage enough that bromeliad populations in Florida are no longer threatened by its presence.

58.) After the weevil is under control, areas previously affected by the weevil need to be repopulated with the bromeliads that were there before. To this end, a seed collection project has been organized to collect seeds now of bromeliad species at risk from weevil attack. Volunteers associated with parks and with the Florida Council of Bromeliad Societies (FCBS) are collecting small amounts of bromeliad seeds (under permits to harvest endangered plants issued by the Florida Department of Agriculture's Division of Plant Industry when required). Collectors submit detailed collection records, which are maintained in a database at FCBS. Volunteer growers associated with FCBS and registered as nurseries with the Division of Plant Industry are growing out the seeds, all of which will eventually be reintroduced. Based on the collection records, seedlings grown from those seeds will be returned to their respective places of collection, once the weevil is no longer a threat to native bromeliads.

59.) We can all play a role in the important effort to save Florida's native bromeliads, by volunteering for the collecting project or to monitor bromeliads in natural areas, or by supporting the research into a solution through biological control. It is also important to continue to work to prevent the future immigration of other bromeliad-eating weevils and to continue to make everyone aware of the importance of maintaining Florida's native bromeliad populations.

60.) The Save Florida's Native Bromeliads project, a collaboration between the Florida Council of Bromeliad Societies, the University of Florida, and the Florida Department of Agriculture and Consumer Services, has received additional support from the U.S. Department of Agriculture, the Florida Park Service, the U.S. Environmental Protection Agency, the Florida Division of Forestry, the Bromeliad Society International, and Gulfstream Environmental and Recreational Trust program.