A Species Action Plan for the
Lake Eustis Pupfish
Cyprinodon variegatus hubbsi

Final Draft
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EXECUTIVE SUMMARY

This plan establishes a framework for monitoring the Lake Eustis pupfish as it is proposed to be removed from the list of species of special concern in Florida (Rule 68A-27.005, (F.A.C.). The goal of the plan is to ensure that the population does not fall to a level that requires relisting. The Lake Eustis pupfish has been listed as a state Species of Special Concern since 1979. A panel of species experts constituting the Biological Review Group team determined that Lake Eustis pupfish are relatively abundant and the population is stable within the 8 lakes in central Florida they are known to occupy, and based on this review, Florida Fish and Wildlife Conservation Commission (FWC) staff recommended delisting for this species.

The review team identified the most likely threats to the Lake Eustis pupfish population are from water quality declines leading to habitat loss, alteration of important habitat from aquatic plants, and the potential introduction of a new fish predator to the ecosystem. These risks are substantially addressed by existing programs within the FWC as well as other state agencies, such as the Florida Department of Environmental Protection and the St. Johns River Water Management District. Programs covering water quality, aquatic habitat, and general fish population monitoring within the occupied lakes are in place and adequately funded.

Strategies and specific actions are given to accomplish three objectives to achieve the goal of not relisting the species: 1) document the current distribution and abundance of the species with an efficient and scientifically valid sample program to use as a benchmark for management decisions, 2) investigate and document the aquatic habitat important to maintaining the species, and 3) establish a mechanism for communicating important findings to the public and other aquatic resource mangers having authority over lakes occupied by the Lake Eustis pupfish. This species is adequately protected under existing FWC rules. No new rules or protections are proposed at this time. Any significant changes to this plan will be made with the continued involvement of stakeholders.

This plan details the actions necessary to improve the conservation status of the Lake Eustis pupfish (*Cyprinodon variegatus hubbsi*). A summary of this plan will be included in the Imperiled Species Management Plan (ISMP), in satisfaction of the management plan requirements in Chapter 68A-27, Florida Administrative Code (F.A.C.), Rules Relating to Endangered or Threatened Species. The ISMP will address comprehensive management needs for 60 of Florida’s imperiled species and will include an implementation plan; rule recommendations; permitting standards and exempt activities; anticipated economic, ecological, and social impacts; projected costs of implementation and identification of funding sources; and a revision schedule. The imperiled species management planning process relies heavily on stakeholder input and partner support. This level of involvement and support is also critical to the successful implementation of the ISMP.

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GLOSSARY OF TERMS AND ACRONYMS

BMAP: Basin Management Action Plan, the plan developed by the Department of Environmental Protection to implement the total maximum daily load for nutrients for a waterbody.

BRG: Biological review group, a group of taxa experts convened to assess the biological status of species using criteria specified in Rule 68A-27.001, Florida Administrative Code, and following the protocols in the Guidelines for Application of the International Union of Conservation of Nature (IUCN) Red List Criteria at Regional Levels (Version 3.0) and Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1).

BSR: Biological status review report, the summary of the biological review group's findings. Includes a Florida Fish and Wildlife Conservation Commission (FWC) staff recommendation on whether or not the species status meets the listing criteria in Rule 68A-27-001, Florida Administrative Code. These criteria, based on the IUCN criteria and IUCN guidelines, are used to help decide if a species should be added or removed from the Florida Endangered or Threatened Species List. In addition, FWC staff may provide within the report a biologically justified opinion that differs from the criteria-based finding.

DEP: Florida Department of Environmental Protection

F.A.C.: Florida Administrative Code. The Department of State's Administrative Code, Register and Laws Section is the filing point for rules promulgated by state regulatory agencies. Agency rulemaking is governed by Chapter 120, Florida Statutes, the Administrative Procedures Act. Rules are published in the Florida Administrative Code.

FWC: Florida Fish and Wildlife Conservation Commission, the state agency constitutionally mandated to protect and manage Florida's native fish and wildlife species.

F.S.: Florida Statutes

GIS: Geographic Information System

Habitat: The area used for any part of the life cycle of a species (including foraging, breeding, and sheltering).

ISMP: Imperiled Species Management Plan

IUCN: International Union for Conservation of Nature, a professional global conservation network.

IUCN Red List: (IUCN Red List of Threatened Species) An objective, global approach for evaluating the conservation status of plant and animal species, the goals of which are to: Identify and document those species most in need of conservation attention if global

extinction rates are to be reduced; and provide a global index of the state of change of biodiversity.

MFL: Minimum Flows and Levels, the minimum water flows and/or levels adopted by the St. Johns River Water Management District's Governing Board as necessary to prevent significant harm to the water resources or ecology of an area resulting from permitted water withdrawals. MFLs define how often and for how long high, average and low water levels and/or flows should occur to prevent significant harm. When use of water resources alters the water levels below the defined MFLs, significant ecological harm can occur.

SJRWMD: St. Johns River Water Management District

Species of Special Concern. Protected under Chapter 68A-27, F.A.C., which declares that "no person shall take, possess, transport, or sell any species of special concern included in this subsection or parts thereof or their nests or eggs except as authorized by permit from the executive director, permits being issued upon reasonable conclusion that the permitted activity will not be detrimental to the survival potential of the species. For purposes of this section, the definition of the word take in Rule 68A-1004, F.A.C., applies."

TMDL: Total Maximum Daily Load. A scientific determination of the maximum amount of a given pollutant that a surface water can absorb and still meet the water quality standards that protect human health and aquatic life.

INTRODUCTION

Biological Background

The Lake Eustis pupfish (*Cyprinodon variegatus hubbsi*) is a small (ranging from 16 to 56 mm [0.5 to 2.2 inches] in length) and cryptic fish. The Florida National Areas Inventory field guide (2012) described the species as a "stout, deep bodied fish with clear dorsal and caudal fins. The general body color is beige to olive, with dark, irregular stripes; dorsal surface is white, except in breeding males, when it is iridescent blue." The Lake Eustis pupfish is considered a subspecies of the common sheepshead minnow (*Cyprinodon variegatus*). This fish is found in only 8 central Florida lakes (Figure 1), compared to the sheepshead minnow, which is found in estuarine areas from Massachusetts to northern Mexico and in islands of the Caribbean (Haney et al. 2007). The Lake Eustis pupfish was considered a separate species (Carr 1936) until work by Johnson (1974) classified it as a subspecies. Electrophoretic investigation conducted by Duggins et al. (1983) supported the classification of the Lake Eustis pupfish as a subspecies of *C. variegatus*. Further research may confirm or disprove that conclusion. No specific research on systematics is proposed as part of this plan.

The life history and specific habitat requirements of the Lake Eustis pupfish are poorly understood, but fish in this genus are extraordinarily hardy and adaptable to environmental change. The Lake Eustis pupfish has been shown to tolerate salinities from nearly pure water to hypersaline environments (Jordan et al. 1993), and the sheepshead minnow has been shown to have one of the widest temperature tolerances for a vertebrate species. The species' upper thermal limit was listed as 44.2^0 C (111.2° F) and the lower as 0.6^0 C (33° F), given proper acclimation (Bennett and Beitinger 1997). A similar ability would likely extend to the Lake Eustis pupfish as well. Lake Eustis pupfish have typically been captured in shallow areas characterized by a sandy substrate and sparse vegetation (Gilbert et al. 1992). They have occasionally been collected in the open-water area of lakes Eustis and Harris by bottom trawl (Hellman 1953; Cheree Steward, Florida Fish and Wildlife Conservation Commission [FWC], personal communication). Guillory and Johnson (1986) performed an extensive seine survey of the species in October of 1977 and 1978, and found them to be locally abundant in the 8 occupied lakes. Bass et al. (2004) performed 10 standard seine samples in the 8 occupied lakes in 2003 and classified them as "readily collected." Periodic general surveys of the fish community in shallow water in occupied lakes have continued to collect the species, although no true quantitative samples have been taken recently that specifically target Lake Eustis pupfish. The range of Lake Eustis pupfish occupation has neither expanded nor contracted over the period of observations. The subspecies has no known importance to anglers or commercial fishing interests.

Conservation History

The Lake Eustis pupfish has been a listed species in Florida since 1977, first as an Endangered Species, and then classified as a Species of Special Concern in 1979. Bass et al. (2004) recommended delisting the species in their final report. The FWC requested a complete review of all listed species in 2010, resulting in a recommendation to delist the Lake Eustis pupfish by the Biological Review Group (BRG) of species experts convened to evaluate the species' status. No species-specific rules or protections have been implemented since this fish was listed.

Threats and Recommended Listing Status

In 2010, the FWC staff conducted a literature review and solicited information from the public on the status of the Lake Eustis pupfish. The FWC convened a biological review group (BRG) of experts on the Lake Eustis pupfish to assess the biological status of the species using criteria specified in Rule 68A-27.001, Florida Administrative Code (F.A.C.). This rule includes a requirement for BRGs to follow the Guidelines for Application of the International Union for Conservation of Nature (IUCN) Red List Criteria at Regional Levels (Version 3.0) and Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1). FWC staff developed an initial draft of a Biological Status Review Report, which included the BRG's findings and a preliminary listing recommendation from staff. The draft was circulated for peer review, and the reviewers' input was incorporated into a final Biological Status Review Report (BSR). The panel identified habitat loss due to overgrowth of aquatic plants, water contamination, and the potential introduction of a new fish predator into occupied lakes as potential threats to the species stability. The final staff recommendation, based on the BRG findings, was for delisting the Lake Eustis pupfish as a Species of Special Concern.

The species is likely to have benefitted from broad initiatives that have produced improving trends in water quality within occupied lakes. For example, the St. Johns River Water Management District (SJRWMD) coordinated purchases of large tracts of agricultural lands adjacent to occupied lakes that were major sources of nutrients to the aquatic system. The Florida Department of Environmental Protection (DEP) initiated the Total Maximum Daily Load (TMDL) program, which identified pollutant sources and produced coordinated actions with state and local governments to reduce nutrient loading to upper Ocklawaha basin lakes. DEP, local government, and FWC have minimized the threat of aquatic plants overwhelming important Lake Eustis pupfish habitat through coordinated surveillance and treatment of invasive aquatic plants, such as hydrilla (*Hydrilla verticillata*).

Figure 1. A handful of the invasive aquatic plant *Hydrilla verticillata.* Photograph by John Benton, FWC.

This plan charts a course for documenting the current population across its range, establishing a cost-effective and scientifically valid monitoring program for the fish and the habitat that is important to maintaining the species, and establishing a communication and outreach plan to ensure the Lake Eustis pupfish population is not reduced to the point where it requires relisting under Rule 68A-27.0012, F.A.C.

CONSERVATION GOALS AND OBJECTIVES

Goal

Conservation status of the Lake Eustis pupfish is maintained or improved so that the species will not again need to be listed on the Florida Endangered and Threatened Species List.

Objectives

I. Determine current distribution and abundance of Lake Eustis pupfish.

Rationale

Lake Eustis pupfish have been collected on multiple occasions in most lakes of the upper Ocklawaha chain in central Florida (e.g., lakes Eustis, Dora, Harris, Beauclair, Carlton, Griffin, Yale, and Weir) by various methods and persons, most often as part of a general survey of fish inhabiting the shallow-water areas of the lakes. The last targeted collection specifically for the Lake Eustis pupfish was made by FWC personnel in 2003 (Bass et al. 2004) using a seine (Figure 2). Other lakes of the upper Ocklawaha chain may contain Lake Eustis pupfish (e.g., lakes Denham, Trout, Horseshoe, or Ola). A practical and efficient method of determining abundance in various habitats will require research.

II. Determine habitat requirements and estimate important habitat coverage within occupied lakes.

Rationale

Lake Eustis pupfish are typically collected only within a narrow depth profile (<1 m [3.3 ft]deep) in barren or sparsely vegetated, sand-bottom areas. It is important to know if the fish are using other areas of the littoral zone (e.g., deeper zones or zones with vegetation and different substrates) for feeding, reproduction, or other life stages. There is evidence that the species uses deep-water habitats occasionally. Once important life-stage areas and habitats are identified, the next step is to incorporate those findings into the existing FWC aquatic habitat monitoring program to ensure that important habitat is maintained or improved for the species and to guide aquatic plant management planning. There may be some aspects of life history (e.g., food habits, life stage habitat requirements) that require additional research to achieve the objective.

III. Establish a system of information development, storage, and exchange regarding the Lake Eustis pupfish to support the conservation goal of keeping the Lake Eustis pupfish from being relisted.

Rationale

Persons who manage lakes and aquatic habitat, both riparian property owners and lake/aquatic habitat managers in governmental positions in a city, a county, DEP, FWC, SJRWMD, and Lake County Water Authority, should be aware of and have current information regarding the Lake Eustis pupfish. Information would include this plan, periodic research updates, and publications covering species life history and habitat requirements that guide decisions affecting the Lake Eustis pupfish. John Benton (fishery biologist with FWC in the Eustis office) conducted an informal survey of local lake managers in June of 2011 and found limited or no awareness of the Lake Eustis pupfish among local government aquatic resource managers. Florida law requires

coordination of governmental consideration under the Comprehensive Growth Management planning process. Detailed actions are presented in the Coordination with Other Entities section of this plan. Data collected by FWC should be incorporated into the long-term monitoring database for storage and retrieval.

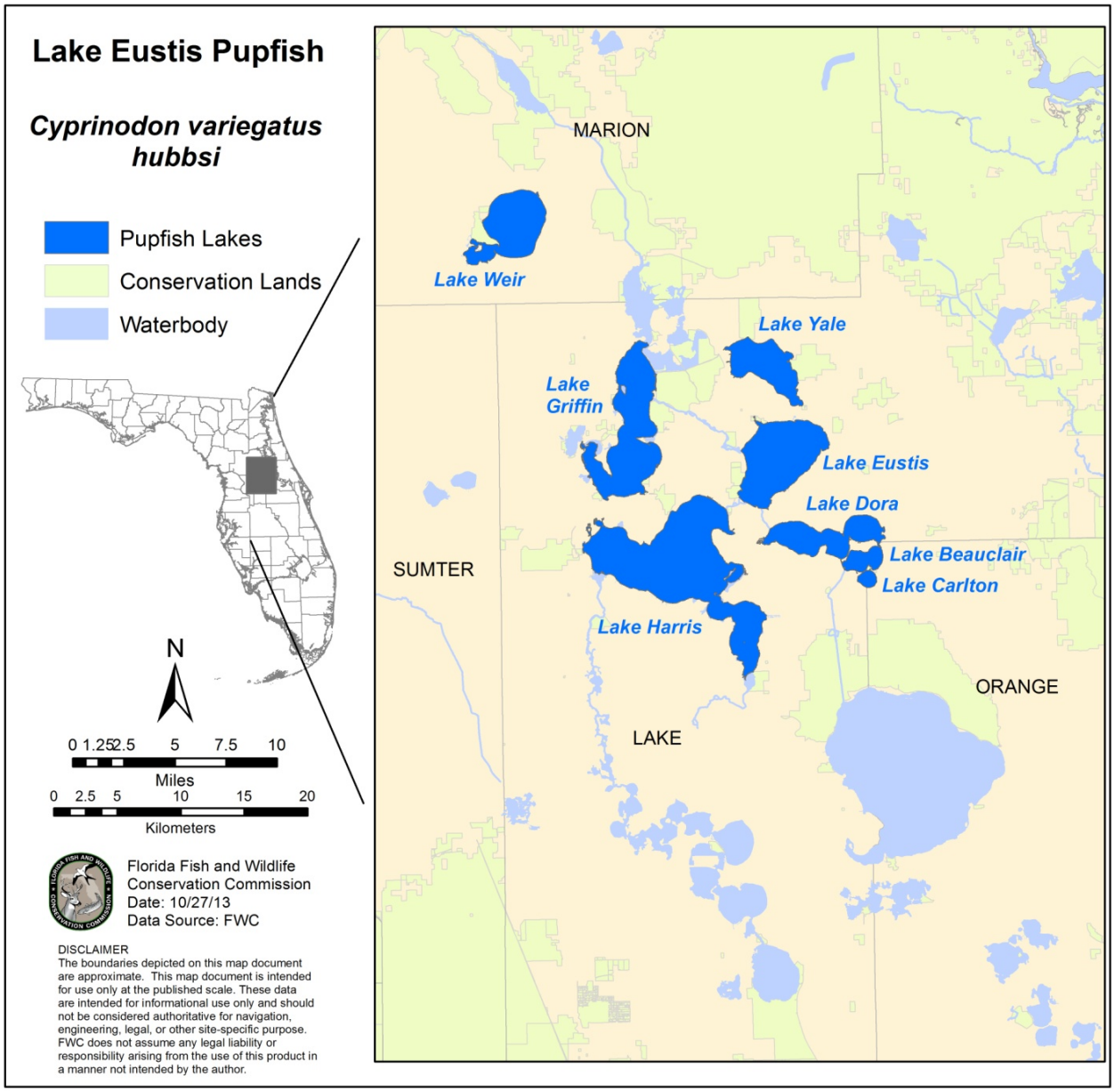

Figure 2. Lakes occupied by the Lake Eustis pupfish, *Cyprinodon variegatus hubbsi* from the most recent survey by Bass et al. (2004).

CONSERVATION ACTIONS

The following sections describe the conservation actions that will make the greatest contribution toward achieving the conservation objectives. Actions are grouped by category (e.g., Habitat Conservation and Management, Population Management). The Conservation Action Table (Table 2) provides information on action priority, urgency, potential funding sources, likely effectiveness, identified partners, and leads for implementation.

Habitat Conservation and Management

Most of the habitat used by Lake Eustis pupfish falls under the category of "waters of the state" under the authority of DEP for sovereign land use and water quality policy. The FWC manages aquatic vegetation through the Aquatic Habitat Restoration/Enhancement subsection and the Invasive Plant Management section. The SJRWMD (see SJRWMD website), through the U.S. Army Corps of Engineers, also controls aspects of habitat for Lake Eustis pupfish through water level management, which influences the amount and types of habitat available to the species. The FWC has been involved in discussions with SJRWMD staff and the public regarding Minimum Flows and Levels (MFL) in occupied lakes. The MFL program is legislatively established under s. 373.042(2), Florida Statutes (F.S.), which charges the water management districts to protect water resources and associated communities from significant harm caused by permitted water withdrawals by setting water level thresholds that prompt management action. The MFLs for the upper Ocklawaha basin lakes are scheduled for adoption in 2014. Any proposed change to existing water regulation schedules should consider the needs of the Lake Eustis pupfish.

Riparian owner control or management of aquatic plants currently permitted by FWC under Chapter 68F-20, F.A.C., may favor the Lake Eustis pupfish; these management actions can include clearing small sections of lakefront where other factors are suitable for the species (sand bottom and shallow slope). The FWC's Division of Habitat and Species Conservation's Invasive Plant Management Section regulates the scope of this activity. A potential threat to pupfish identified in the BSR was the possibility of aquatic plants changing the character of habitat occupied by the Lake Eustis pupfish. Currently, annual surveys of occupied lakes conducted by FWC's Invasive Plant Management staff provide an early detection system for new outbreaks of invasive aquatic plant species. Coordination among FWC staff in detecting and coping with such threats through Aquatic Plant Management annual work plans developed for occupied lakes is the primary strategy for minimizing this risk.

The current annual aquatic plant monitoring conducted by FWC's Invasive Plant Management staff functions as a sentinel program for detecting changes in the aquatic plant community but does not quantify aquatic plant communities or habitat (e.g., unvegetated shoreline). Aquatic habitat maps that might aid management and research programs are labor intensive and expensive to produce and maintain. Research in efficient collection of environmental data is underway within the FWC's long-term monitoring program. This research may lead to an adequate data set for use in this plan. A more detailed analysis of pupfish habitat within occupied lakes may be required to address methodology and intervals of sampling needed to detect and respond to aquatic habitat changes.

FWC's Aquatic Habitat Restoration/Enhancement subsection conducts large-scale aquatic revegetation projects in the upper Ocklawaha basin lakes. Native aquatic plant species used in

these projects and work locations should be selected to maximize the benefit to the Lake Eustis pupfish in the appropriate habitat. Proposed restoration projects should be reviewed by the appropriate subject matter experts. Proposed habitat enhancement projects that could benefit the pupfish may warrant additional consideration during prioritization and ranking process conducted by FWC staff.

Action 1 Acquire or develop aquatic habitat maps of occupied lakes to use in a geographic information system (GIS). This information would be used to design an efficient pupfish sampling protocol for quantitative surveys of the species. Vegetation type, substrate type, and bottom depth/slope are important parameters to collect.

Action 2 Integrate Lake Eustis pupfish presence and/or density data with aquatic habitat maps to delineate important habitat(s) in occupied lakes.

Action 3 Ensure that information regarding Lake Eustis pupfish habitat is collected and integrated among FWC sections and divisions that have responsibility for aspects of freshwater fish and habitat management (e.g., Freshwater Fish Research, Freshwater Fish Management, Division of Habitat and Species Conservation, Division of Law Enforcement) through a defined network on a regular basis.

Action 4 Incorporate information about habitat of the Lake Eustis pupfish into consideration of MFLs by SJRWMD.

Action 5 Combine information about water quality with habitat information for the species developed in Action 2 to adjust this Species Action Plan to maintain sufficient habitat for the species. The TMDL program administered by DEP may be considered as a potential mechanism for this purpose, as it is an established working group that includes city, local, state, and interested citizens working with an adopted Basin Management Action Plan (BMAP).

DEP and local governments that issue development permits for shoreline and adjacent upland areas in occupied lakes may influence aquatic habitat important to maintaining the Lake Eustis pupfish in a waterbody. This plan and data generated from recommended research should be used to inform decisions that affect habitat used by the Lake Eustis pupfish. Activities such as dredge and fill, seawall construction, shoreline alteration, and boat dock/marina construction that change the character of occupied sites could be a detriment to maintaining the species. FWC has the opportunity to review and comment on such activities under current operating guidelines.

The Lake Eustis pupfish tolerates a wide range of water quality, so either an improvement or a slight decline in water quality is not a direct factor in managing the species. Water quality has a stronger influence on the type and amount of habitat for the species. All of the upper Ocklawaha basin lakes are included on the adopted list of impaired water bodies under the TMDL program administered by DEP. There is an adopted BMAP for the upper Ocklawaha River, which serves as a framework for identifying and reversing negative trends in water quality for the upper Ocklawaha chain of lakes. The trend for most of the upper Ocklawaha basin lakes has been for stable or reduced levels of total phosphorus and stable or increased transparency of water as

measured by Secchi disk readings. Both of these trends favor habitat used by the Lake Eustis pupfish.

Population Management
No specific population management actions are proposed for the Lake Eustis pupfish.

Monitoring and Research

Action 6 Investigate literature or perform new research of life strategies of the Lake Eustis pupfish in order to guide sample design and analysis or habitat mapping actions for the species.

Action 7 Determine current presence of Lake Eustis pupfish in historically occupied lakes and those potentially occupied lakes directly connected to lakes where occupancy is established.

Action 8 Assess the ability of various gear types, particularly beach seine, fish traps, fyke nets, and electrofishing (barge or backpack), to efficiently quantify pupfish abundance in the variety of habitats this species inhabits. The end product of this research is to develop an efficient, repeatable index of population integrity.

Action 9 Survey occupied lakes established under Action 7 on a periodic basis to determine the continued presence of the species and that habitat required to support the species at levels that do not require relisting.

Action 10 Use existing FWC's Freshwater Fish Management and Invasive Plant Management monitoring programs to survey for aquatic plant and invasive fish species that may pose threats to the Lake Eustis pupfish population.

Sample gear selection and calibration (both for presence and quantitative measurements of fish in the variety of habitats that this species occupies) require species-specific research to arrive at an efficient and repeatable method of assessing the population within each waterbody, within the various habitats that the species uses, and over the range of its occurrence. Once a quantitative sampling method has been selected, research is required to determine the minimum number of samples to collect for a valid monitoring program (both presence/absence and for quantitative samples), possibly stratified by habitat based on targeted collections by habitat and occupied waterbody.

The 2 standard fish monitoring protocols presently used by FWC (Bonvechio 2009) in the long-term monitoring program (boat-mounted electrofishing and shoreline mini-fyke nets) can detect Lake Eustis pupfish, but the methods cannot be used to quantify the population on a waterbody level as currently implemented. The current sample schedule does not cover all lakes occupied by the Lake Eustis pupfish, and the frequency and intensity of the standard sampling events are not adequate to assess a single species. Boat-mounted electrofishing is not efficient at either collecting the species or sampling the shallow nearshore habitats that the pupfish typically use. Mini-fyke net samples do collect pupfish (FWC, unpublished data) but have unknown efficiency and are not calibrated to produce estimates of abundance.

A seine has traditionally been employed to detect Lake Eustis pupfish in a waterbody, typically at boat ramps or on clear, unvegetated shorelines. However, the seine is not effective in vegetated habitat or in areas with soft bottoms. The seine has not been used to produce quantifiable estimates of abundance for the species in prior collections or to define which habitats the species uses. Throw traps, fish toxicants, mini-fyke nets, and backpack or barge-mounted electrofishing gear have been used to sample the littoral fish community in upper Ocklawaha basin lakes but have not been evaluated as assessment tools specifically for the Lake Eustis pupfish. Therefore, research is required to select an efficient and practical method for quantifying Lake Eustis pupfish abundance in the various habitats they occupy within a waterbody. Plastic Breder traps (Breder 1960, Sargent and Carlson 1987) have proven to be an effective collection device for the sheepshead minnow in Florida salt marshes in a variety of habitats. Observation of gear performance and fish behavior by snorkeling or underwater video may aid in assessing and selecting appropriate gear.

Rule and Permitting Intent
No new protection is proposed for the Lake Eustis pupfish. The Lake Eustis pupfish will have protection under the rule covering Species of Special Concern (Rule 68A-27.005, F.A.C.) until such time the species is delisted; then it would be covered under the general classification for nongame fish as defined by Rule 68A-1.004 (46), F.A.C. Collection (taking) of nongame fish is controlled by rules of Chapter 68A-23, F.A.C., which specify devices and methods that may be used to take nongame fish by persons that possess a valid freshwater fishing license. There is no documented importance of Lake Eustis pupfish to recreational anglers, although they may be taken as incidental catch during bait-collection activities. Rule 68A-23.003, F.A.C., governs persons fishing under a commercial fishing license. Currently, there are no known commercial fishing operations that take significant numbers of Lake Eustis pupfish, although they may be taken as incidental catch by persons collecting freshwater grass shrimp (*Palomonetes* sp.) or golden shiners (*Notemigonus crysoleucas*) commercially for bait. There are no known recreational or commercial uses of the Lake Eustis pupfish at this time.

Law Enforcement
There is no additional law enforcement involvement proposed, outside of that normally afforded to nongame fish species under Chapter 68A-23, F.A.C. Some educational material on small non-game freshwater fish species may be developed to inform FWC law enforcement personnel about the Lake Eustis pupfish and other such fish species that are not frequently encountered.

Incentives and Influencing
No specific incentives or influencing actions are proposed for the Lake Eustis pupfish.

Education and Outreach

Action 11 Develop and publicize educational materials regarding the Lake Eustis pupfish and the essential aquatic habitat specific to lakes occupied by the Lake Eustis pupfish to the public and aquatic resource managers at the state, regional, and local level.

The Lake Eustis pupfish is not well known outside of the scientific community. It is a small species that is seldom encountered by lake users and is not important to anglers as bait. Many

riparian owners maintain a cleared portion of their shoreline for access to open water and for aesthetic purposes. This practice favors the Lake Eustis pupfish, where other principal life history factors of sand bottom and shallow gradient are met. Information and outreach material about the littoral zone, its function as a component of a healthy aquatic system, and its importance to the Lake Eustis pupfish and other aquatic life would be of benefit to compile or develop. The target audiences for these materials are riparian owners, private lakefront managers, and governmental bodies that have authority over pupfish habitat management (city, county, and state government).

FWC is a logical primary resource for developing educational material and publicizing the research results for the Lake Eustis pupfish through print and social media. It may be possible to incorporate some elements of the material in local K through12 education and through programs offered by Trout Lake Nature Center in Eustis, Florida. There are opportunities to educate city and county planners and elected officials through presentations at meetings.

Coordination with Other Entities

Habitat loss or change was identified in the BSR as one of the threats to the Lake Eustis pupfish. While FWC does have authority over aquatic vegetation, DEP and SJRWMD also share responsibilities for aquatic resource management as presented in the Habitat Conservation and Management section. To the extent that counties and cities exert control over shoreline or riparian property development, it is useful to inform planning and development officials about the species and its needs (see Actions 2, 4, 5, and 11).

Statute 163.3177, F.S., requires that county comprehensive growth management plans include a conservation element. The conservation element must include the identification of areas within the county that are locations of important fish, wildlife, or habitat resources, including state-listed species. This element must contain principles, guidelines, and standards for conservation that restrict activities known to adversely affect the survival of these species. FWC is identified as a state agency authorized to review county growth management plans and plan amendments to ensure important state fish, wildlife, and habitat resources are adequately considered. In addition, local government land development regulations require conditions for land or water use that specify how uses will be administered to be consistent with the conservation element of the county growth management plan. County and city governments have language in their comprehensive growth management plans (Table 1) that require coordination, which in turn guides development of local building code and ordinances. Once the actions in this plan are implemented, results of the surveys and studies will be available to the various local governments to guide decisions that may affect habitat used by the Lake Eustis pupfish.

Table 1. Locations of county and city comprehensive growth management plans in areas occupied by the Lake Eustis pupfish.

Government	**Comprehensive Growth Management Plan Website (as of June 30, 2013; subject to change)**
Lake County	Lake County Comprehensive Plan
Marion County	Marion County Comprehensive Plan 2035
Orange County	Orange County Comprehensive Plan 2010-2030
City of Eustis	City of Eustis Comprehensive Plan
City of Leesburg	Leesburg Planning and Zoning
City of Tavares	Tavares Land Development Regulations
City of Mount Dora	City of Mt. Dora Comprehensive Plan
City of Fruitland Park	Fruitland Park Building Department
City of Lady Lake	Town of Lady Lake 2030 Comprehensive Plan
City of Howey-in-the-Hills	Howey in the Hills 2025 Comprehensive Plan

Table 2. Lake Eustis Pupfish (*Cyprinodon variegatus hubbsi*) Conservation Action Table

NOTE: An explanation of acronyms used is below the table.

Objective(s) Addressed	Team Assigned Priority Level	Action Item Number	Action Items	Conservation Action Category	Ongoing, Expanded or New Effort?	Authority	Man Power	Estimated Cost To Implement	Funding Source(s)	Lead for Implementation: FWC Program(s) and/or Section(s)	External partners	Likely Effectiveness	Feasibility	Urgent?
2	1	1	Acquire or develop aquatic habitat maps of occupied lakes to use in a GIS system. This information would be used to design an efficient pupfish sample plan for quantitative surveys of the species. Vegetation type, substrate type, and bottom depth/slope are important parameters to collect.	Habitat Conservation & Mgmt, Monitoring & Research	ONGOING	YES	YES	$0-25k	Existing budget	FWRI	SJRWMD, USDA/NRCS, Lake County, Florida Lakewatch	High likelihood of success.	Feasible and practical. Methodology, personnel and equipment in place.	No. The species is apparently relatively abundant and stable in occupied lakes. We have no evidence of any immediate threat to the species.
2	3	2	Integrate Lake Eustis pupfish presence and/or density data with aquatic habitat maps to delineate important habitat(s) in occupied lakes.	Habitat Conservation & Mgmt, Monitoring & Research	NEW	YES	YES	$0-25k	Existing budget	FWRI	SJRWMD, Florida Lakewatch, Lake County	High likelihood of success.	Feasible and practical. Methodology, personnel and equipment in place.	No. The species is apparently relatively abundant and stable in occupied lakes. We have no evidence of any immediate threat to the species.
2, 3	1	3	Ensure information regarding Lake Eustis pupfish habitat is collected and integrated among FWC sections that have responsibility for aspects of freshwater fish and habitat management (Freshwater Fish Research, Freshwater Fish Management, Habitat and Species Management, Law Enforcement) through a defined network on a regular basis.	Habitat Conservation & Mgmt, Education & Outreach, Coordination with Other Entities	EXPANDED	YES	YES	$0-25k	Existing budget	FWRI, HSC, FFM, LE, Lake County government, LCWA	Lake County, Florida Lakewatch	High likelihood of success.	Feasible and practical. Methodology, personnel and equipment in place. Relationships already exist.	No. The species is apparently relatively abundant and stable in occupied lakes. We have no evidence of any immediate threat to the species
2, 3	3	4	Incorporate information about habitat of the Lake Eustis pupfish into consideration of minimum flows and levels by SJRWMD.	Habitat Conservation & Mgmt, Coordination with Other Entities	ONGOING	NO	YES	$0-25k	Existing budget	FWRI, FFM	SJRWMD, USACE	High likelihood of success.	Feasible and practical. Personnel in place. Relationships already exist.	No. The species is apparently relatively abundant and stable in occupied lakes. We have no evidence of any immediate threat to the species.
2 ,3	4	5	Combine information about water quality with habitat information for the species developed in Action 2 to adjust this Species Action Plan to maintain sufficient habitat for the species. The Total Maximum Daily Load program administered by the Florida DEP may be considered as a potential mechanism for this purpose, as it is an established working group that includes municipal, local, state, and interested citizens working with an adopted Basin Management Action Plan.	Habitat Conservation & Mgmt	ONGOING	YES	YES	$0-25k	Existing budget	FWRI, FFM, HSC	DEP, LCWA, Lake County Government, local municipalities	High likelihood of success.	Feasible and practical. Personnel in place. Relationships already exist.	No. The species is apparently relatively abundant and stable in occupied lakes. We have no evidence of any immediate threat to the species.
1	1	6	Investigate literature or perform new research of life strategies of the Lake Eustis pupfish to guide sample design and analysis or habitat mapping actions for the species.	Habitat Conservation & Mgmt, Monitoring & Research	ONGOING	YES	YES	$0-25k	Existing budget	FWRI	UF, USGS	High likelihood of success.	Feasible and practical. Personnel in place.	No. The species is apparently relatively abundant and stable in occupied lakes. We have no evidence of any immediate threat to the species.
1	1	7	Determine current presence of Lake Eustis pupfish in historically occupied lakes and those potentially occupied lakes directly connected to lakes where occupancy is established.	Monitoring & Research	NEW	YES	YES	$0-25k	Existing budget	FWRI, FFM	Lake County, UF, Florida Lakewatch	High likelihood of success.	Feasible and practical. Methodology, personnel and equipment in place.	No. The species is apparently relatively abundant and stable in occupied lakes. We have no evidence of any immediate threat to the species
1, 2	2	8	Assess the ability of various gear types, particularly seine, fish traps, fyke nets, and electrofishing (barge or backpack), to efficiently quantify pupfish abundance in the variety of habitats this species inhabits. The end product of this research is to develop a repeatable index of population integrity.	Monitoring & Research	NEW	YES	YES	$0-25k	Unknown	FWRI	UF, USGS	High likelihood of success.	Feasible and practical. Methodology can be developed quickly, personnel are available to begin a program. Equipment is either on hand or low cost to fabricate or acquire.	No. The species is apparently relatively abundant and stable in occupied lakes. We have no evidence of any immediate threat to the species.
1, 2, 3	2	9	Survey occupied lakes established under Action 7 on a periodic basis to determine the continued presence of the species and that habitat required to support the species at levels that do not require relisting.	Monitoring & Research	NEW	YES	YES	$0-25k	Unknown	FWRI, FFM	Lake County, UF, Florida Lakewatch	High likelihood of success.	Feasible and practical. Equipment is either on hand or low cost to fabricate or acquire. Cost to execute periodic monitoring of pupfish would be substantially reduced if a volunteer force could be used to collect field data.	No. The species is apparently relatively abundant and stable in occupied lakes. We have no evidence of any immediate threat to the species.

Table 2. Lake Eustis Pupfish (*Cyprinodon variegatus hubbsi*) Conservation Action Table

Objective(s) Addressed	Team Assigned Priority Level	Action Item Number	Action Items	Conservation Action Category	Ongoing, Expanded or New Effort?	Authority	Man Power	Estimated Cost To Implement	Funding Source(s)	Lead for Implementation: FWC Program(s) and/or Section(s)	External partners	Likely Effectiveness	Feasibility	Urgent?
1, 2	3	10	Use existing FWC's Freshwater Fish Management and Invasive Plant Management monitoring programs to survey for aquatic plant and invasive fish species that may pose threats to the Lake Eustis pupfish population.	Monitoring & Research, Habitat Conservation & Mgmt	ONGOING	YES	YES	$0-25k	Existing budget	FWRI, FFM,HSC	Lake County Mosquito & Aquatic Plant Management, LCWA, SJRWMD	High likelihood of success.	Feasible and practical. Sampling methodology is in place and likely to continue on most of the occupied lakes.	No. The species is apparently relatively abundant and stable in occupied lakes. We have no evidence of any immediate threat to the species.
3	2	11	Develop and publicize educational materials regarding both the Lake Eustis pupfish and the essential habitat specific to lakes occupied by the Lake Eustis pupfish to the public and aquatic resource managers at the state, regional, and local level.	Education & Outreach, Coordination with Other Entities	NEW	YES	YES	$0-25k	Existing budget	FWRI, FFM, CR	Lake County, Florida Lakewatch, LCWA, UF	High likelihood of success.	Feasible and practical. Relationships exist.	No. The species is apparently relatively abundant and stable in occupied lakes. We have no evidence of any immediate threat to the species.

Acronyms used in this table:

DEP:	Florida Department of Environmental Protection
FFM:	Freshwater Fisheries Management, a Division of the Florida Fish and Wildlife Conservation Commission
FWC:	Florida Fish and Wildlife Conservation Commission
FWRI:	Fish and Wildlife Research Institute, the research branch of the Florida Fish and Wildlife Conservation Commission
HSC:	Habitat and Species Conservation, a Division of the Florida Fish and Wildlife Conservation Commission
LCWA:	Lake County Water Authority
LE:	Law enforcement
SJRWMD:	St Johns River Water Management District
USACE:	United States Army Corps of Engineers
UF:	University of Florida, particularly the Fisheries and Aquatic Sciences program in the School of Forest Resources and Conservation
USGS:	United States Geological Survey
USDA/NRCS:	United States Department of Agriculture/Natural Resources Conservation Service
Lake County:	Lake County government

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