A Species Action Plan for the
Black Creek Crayfish
Procamburus pictus

Final Draft
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BLACK CREEK CRAYFISH ACTION PLAN TEAM

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EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission developed this plan to guide conservation actions for the benefit of the Black Creek crayfish (*Procambarus pictus*), a stream-dwelling crustacean endemic to northeast Florida. This species requires high-quality streams with cool, unpolluted water, constant flow, and high oxygen content. Habitat attributes include a sandy bottom with aquatic vegetation and woody debris to serve as daytime retreats, plus a forested overstory that gives shade, cools the air and water, and provides a consistent influx of leafy and woody debris to serve as food sources. Potential threats to the Black Creek crayfish are those that would impact the high-quality streams where it dwells. These threats include pollution, change in water temperature, siltation, damming, and other changes in water and habitat quality. Another potential source of mortality is an apparent fungal disease observed in some populations.

State-listed as a Species of Special Concern since 1989, the Black Creek crayfish’s status was reviewed in 2010. The review panel determined that it met the criteria for listing on the state’s Threatened species list. The proposed conservation goal is to improve the status of the Black Creek crayfish to a point that it can be removed from the Florida Endangered and Threatened Species List and will not again need to be listed. The conservation objectives are to: 1) identify and reduce threats to quality of habitat for the Black Creek crayfish throughout its range, and 2) locate and conserve Black Creek crayfish populations outside the Black Creek watershed. Major proposed conservation actions for the Black Creek crayfish include: 1) working with land managers and landowners to protect, monitor, and enhance the habitat quality of known crayfish sites; 2) drafting and disseminating stream-centered habitat management recommendations to reduce threats and safeguard crayfish and riparian corridors; and 3) continuing to survey to determine the extent of occupied stream reaches and to identify additional occupied drainages that extend the known range of the species, decentralize its vulnerability to threats, and reduce its overall risk of extinction.

Effective partnerships among Florida Fish and Wildlife Conservation Commission staff and other agencies, organizations, companies, counties, municipalities, and the public are critical to moving forward with initiatives that will achieve the conservation goal and objectives in this plan. The Black Creek crayfish is an example of a species dependent on a high-quality, unpolluted, and undisturbed habitat. The species’ long-term survival requires maintaining or restoring that habitat, identifying and reducing threats, and coordinating with public and private stakeholders to promote and implement actions that conserve stream habitats and wildlife.

This plan details the actions necessary to improve the conservation status of the Black Creek crayfish. A summary of this plan will be included in the Imperiled Species Management Plan (ISMP), in satisfaction of the management plan requirements in Rule 68A-27, Florida Administrative Code, 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. Any significant changes to this plan will be made with the continued involvement of stakeholders.
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GLOSSARY OF TERMS AND ACRONYMS

Area of occupancy, the area within its extent of occurrence (see extent of occurrence) that is occupied by a taxon, excluding cases of vagrancy. This reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats (as defined by International Union for Conservation of Nature [IUCN]).

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.

BMP: Best Management Practices. Generally, BMPs represent methods, measures, or practices that are developed, selected, or approved by various agencies to protect, enhance, and preserve natural resources including wildlife habitat. They include, but are not limited to, engineering, conservation, and management practices for mining, agriculture, silviculture, and other land uses, that are designed to conserve water quality and quantity, soil and associated nutrients, and to simultaneously control nonpoint and point source pollution and other impacts to natural resources, including aquatic and terrestrial wildlife habitat.

BRG: Biological review group, a group of taxa experts convened to assess the biological status of taxa using criteria specified in Rule 68A-27.001, Florida Administrative Code, and following the protocols in the Guidelines for Application of the 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 criteria for listing as a state-designated Threatened Species based on the IUCN guidelines and criteria in Rule 68A-27-001, Florida Administrative Code. These criteria, based on IUCN criteria and IUCN guidelines, are used to help decide if a species should be added or removed from the Florida Endangered and Threatened Species List. In addition, FWC staff may provide within the report a biologically justified opinion that differs from the criteria-based finding.

Carapace: the upper (dorsal) and forward portion of the crayfish exoskeleton that covers the cephalothorax (head-chest region).

CBJTC: Camp Blanding Joint Training Center, Clay County.

Conservation easement: A power invested in a qualified private land conservation organization or government (municipal, county, state or, federal) to constrain, as to a specified land
area, the exercise of rights otherwise held by a landowner so as to achieve certain conservation purposes.

DEP: Florida Department of Environmental Protection

Detritus: Non-living particulate organic material (as opposed to dissolved organic material) that typically includes the bodies or fragments of dead organisms as well as fecal material, and is colonized and decomposed by communities of microorganisms.

Extent of occurrence, the geographic area encompassing all observations of individuals of a species, including intervening areas of unoccupied habitat. Synonymous with range. See also Area of Occupancy, (as defined by IUCN).

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.

FDOT: Florida Department of Transportation

FFS: Florida Forest Service, formerly the Florida Division of Forestry

FNAI: Florida Natural Areas Inventory, a non-profit organization administered by Florida State University and dedicated to gathering, interpreting, and disseminating information critical to the conservation of Florida’s biological diversity.

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

GIS: Geographic Information System

GPS: Global Positioning System

ISMP: Imperiled Species Management Plan


IUCN Red List (IUCN Red List of Threatened Species): An objective, global approach for evaluating the conservation status of plant and animal species to identify and document 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.

Location: A geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present (as defined by IUCN).
SF: State Forest

SJRWMD: St. Johns River Water Management District

SMZ: Special Management Zone. The SMZ is a BMP that consists of a specific area associated with a stream, lake, or other waterbody that is designated and maintained during silviculture operations. The purpose of the SMZ is to protect water quality by reducing or eliminating inputs of sediment, nutrients, debris, chemicals, and water temperature changes that can adversely affect aquatic communities. SMZs provide shade, streambank stability, and erosion control, as well as detritus and woody debris that benefit the aquatic ecosystem in general. In addition, the SMZ is designed to maintain certain forest attributes that will provide specific wildlife habitat values. Snags, den, and cavity trees, as well as mast-producing trees left in the SMZ are necessary to meet habitat requirements for certain types of wildlife.

Species of Special Concern: Protected under Rule 68A-27.005, 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-1.004, F.A.C., applies."

Threatened: Refers to species listed as Threatened on the Florida Endangered and Threatened Species List. As designated by the FWC, species of fish or wild animal life, subspecies, or isolated population of a species or subspecies, whether vertebrate or invertebrate, that are native to Florida and are classified as Threatened as determined by criteria in accordance with Rule 68A-27.0012, F.A.C. No person shall take, possess, or sell any Threatened species or parts thereof or their nests or eggs except as authorized by FWC rule or by permit from the FWC.

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

Species Description
The Black Creek crayfish, *Procambarus (Ortmannicus) pictus* (Figure 1), was first described in 1940 by Horton H. Hobbs, Jr., as *Cambarus pictus*, but later moved to the genus *Procambarus*, the largest genus of North American crayfish (Hobbs 1940, 1942). Hobbs became especially interested in *P. pictus*, its relationships with other crayfish, and its proposed role in the evolution of divergent forms (Hobbs 1958). He postulated a primitive, surface stream-dwelling “Propictus stock” that invaded Florida when it was a much shorter peninsula, and then gave rise to subterranean forms when the underlying Eocene limestone became honeycombed and developed underground streams and pools. Based on its relatively primitive characters, Hobbs (1958) considered *P. pictus* to be a “relict,” most closely approximating the ancestral stock of the Propictus Group. In a subsequent sorting of the multitude of crayfish, Hobbs (1972) subdivided *Procambarus* into subgenera and assigned *P. pictus* to the subgenus *Ortmannicus*, which aligns it with more than 3 dozen other taxa, including both surface-dwelling and cave forms. Building on the earlier work of Hobbs (1958), Franz and Lee (1982) recognized *P. pictus* as being closely related to the *lucifugus* complex, a group of 5 taxa of cave crayfish (with the name of the nominate species *P. lucifugus* deriving from the Latin for “light fleeing”), including the Santa Fe cave crayfish (*Procambarus erythrops*), which is known only from caves and sinkholes in southern Suwannee and Columbia counties in Florida.

![Figure 1. Black Creek crayfish, *Procambarus pictus*. Photograph copyright Barry Mansell.](image-url)
The Black Creek crayfish is medium-sized (about 7.6 cm [3 in]) with dark claws and a dark carapace that has a white or yellowish mid-dorsal stripe, white spots or streaks on its sides, and a rust-colored abdomen (Franz et al. 2008; see cover photo and Figure 1). This distinctive pattern is unique among cambarid crayfish (Franz et al. 2008). This crayfish is also known as the “spotted royal crayfish.” Its color pattern makes for good camouflage and allows the species to hide during the day in stream bottom detritus, tree roots, and vegetation (Franz 1994). The specific epithet pictus, Latin for “picture,” is presumably a reference to the striking color pattern.

Habitat and Range
The Black Creek crayfish is endemic to northeastern Florida, where it inhabits small, relatively cool and swift, sand-bottomed, and tannic-colored headwater and tributary streams (Franz and Franz 1979, Franz 1994; Figure 2). These streams typically emanate from sandhills and occasionally flow through or from swampy terrain (Franz and Franz 1979, Brody 1990, Franz 1994, Florida Natural Areas Inventory [FNAI] 2001, Nelson and Floyd 2011). Streams occupied by Black Creek crayfish are often referred to as “high-quality” streams due to their cool, unpolluted water, constant flow, and high oxygen content. The small gill chamber of the Black Creek crayfish is an adaptation requiring highly oxygenated cool waters (Franz et al. 2008). Habitat attributes include a sandy bottom with aquatic vegetation and woody debris to serve as daytime retreats, plus a forested overstory (with sunny openings) that gives shade, cools the air and water, and provides a consistent influx of leafy and woody debris to serve as food sources (Franz et al. 2008, Florida Fish and Wildlife Conservation Commission [FWC] 2010).
Hobbs (1940, 1942, 1958) based his early writings on *P. pictus* from specimens collected 3.2 and 6.4 km (2 and 4 mi) southwest of Green Cove Springs, apparently from Governors Creek and Peters Creek, tributary streams close to the St. Johns River in Clay County. Major fieldwork with the species did not occur until the late 1970s, when the species was found to inhabit the extensive Black Creek drainage originating in western Clay County. Franz and Franz (1979) and Brody (1990) encountered the species now known as the Black Creek crayfish on surveys of streams in the Black Creek drainage in both Clay and Duval counties. Subsequent surveys have discovered Black Creek crayfish in several streams outside of the Black Creek drainage, and there are records in Putnam County to the south and in Duval and St. Johns counties on the east side of St. Johns River (Franz et al. 2008, FWC 2011a; P. Moler, FWC, personal communication). To date, all documented occurrences of the Black Creek crayfish have been restricted to the single watershed basin encompassing the lower St. Johns River (Figure 3).

The range of the Black Creek crayfish includes public lands managed by the Florida Army National Guard (Camp Blanding Joint Training Center [CBJTC]) and the Florida Forest Service (FFS), specifically 2 state forests (SF): Jennings SF and Etoniah Creek SF. These lands are wildlife management areas wherein wildlife is managed by the FWC. FWC conducted recent surveys for Black Creek crayfish on both CBJTC and Jennings SF (Franz et al. 2008, Nelson and Floyd 2011). Additional conservation lands with occurrence records for Black Creek crayfish include parcels managed by the St. Johns River Water Management District (SJRWMD) (FNAI 2013).

The great majority of occurrence records for Black Creek crayfish are in streams and tributaries that are part of the extensive Black Creek drainage (see Figure 3), which could have bearing on the species’ vulnerability to threats (see discussion below under Threats and Recommended Listing Status). The handful of other streams outside of the Black Creek drainage where Black Creek crayfish have been found include the Etoniah Creek drainage in Putnam County; Trout Creek in St. Johns County; and Corklan Branch, Big Davis Creek, and Holly Creek in Duval County. These outlying streams (and any others that may yet be discovered) could have important conservation value to the Black Creek crayfish by expanding its known extent of occurrence and spreading the vulnerability to threats among a greater number of separate drainages. This could serve to reduce the species’ overall risk of extinction.

*Life History*

As is true of with other crayfish species, male Black Creek crayfish periodically alternate between a reproductively ready form (Form I) and a form that is not reproductive (Form II). Reproductive males occur from January to September (Franz 1994). A female crayfish carries her eggs on the underside of her abdomen (Figure 4), attached to leg-like appendages called swimmerets, and they are protected there in a sort of “brood chamber.” The clutch of eggs can number from 47 to 146, and the newly hatched young hold onto the swimmerets and each other. They may remain with the mother, protected by her, for 2 to 3 weeks. Black Creek crayfish young that hatch in late summer are mature by the following spring (Franz 1994). Black Creek crayfish can live up to 16 months (Franz 1994), so a female apparently produces just 1 clutch of eggs in her lifetime.
Black Creek crayfish have similar food habits as other stream-dwelling crayfish. They eat aquatic plants, dead plant and animal material, and detritus. Potential predators of Black Creek crayfish include fish, softshell (*Apalone* spp.) and snapping turtles (e.g., *Chelydra serpentina*), and birds; in general, crayfish populations should be resilient to natural predators (FWC 2010). Another potential source of mortality is an apparent fungal disease observed in some populations (Franz et al. 2008, FWC 2010); the extent and impact of this disease is unknown.

Figure 3. Map showing occurrence records for the Black Creek crayfish, *Procambarus pictus*. 
Black Creek crayfish are occasionally found with other crayfish species, including the slough crayfish *Procambarus fallax*, the peninsula crayfish *P. paeninsulanus*, the brushpalm crayfish *P. pubischelae*, and the white tubered crayfish *P. spiculifer* (Franz 1994, Franz et al. 2008, Nelson and Floyd 2011). The mole crayfish (*P. talpoides*) is a burrowing species that was found to be common in the forested floodplain behind the levee-like banks of some deeply entrenched stream channels (Franz et al. 2008).

**Conservation History**
The Black Creek crayfish was listed by the State of Florida as a Species of Special Concern in 1989 (Florida Game and Fresh Water Fish Commission 1989, Wood 1991). This status makes it illegal to take, possess, transport, or sell Black Creek crayfish except as authorized by permit from the FWC. Permits are issued upon reasonable conclusion that the permitted activity will not be detrimental to the survival potential of the species.

The Black Creek crayfish is also among those invertebrates considered Species of Greatest Conservation Need according to FWC’s State Wildlife Action Plan (FWC 2011b). The International Union for Conservation of Nature (IUCN) Red List (Moler and Crandall 2010) assessed the Black Creek crayfish as Near Threatened, a lower imperilment category than its earlier (1996) status of Vulnerable, and referenced a reported continuing decline in the quality of habitat due to ecosystem modification and ongoing habitat destruction and degradation. Another assessment was provided by the American Fisheries Society (Taylor et al. 2007), which gave the Black Creek crayfish a status of Threatened based on: 1) existing or potential destruction, modification, or reduction of the species’ habitat or range and 2) restricted range. The state natural heritage program assesses this species’ status as G2/S2 –Imperiled (NatureServe 2013). The U.S. Fish and Wildlife Service has been petitioned to federally list the Black Creek crayfish under the Endangered Species Act, along with several hundred other aquatic species from the southeastern United States (Center for Biological Diversity 2010). The timetable for a federal review and listing determination for this species has not been determined.

**Threats and Recommended Listing Status**

*Threats*
Potential threats to the Black Creek crayfish are those that would impact the high-quality streams where it dwells. These threats include pollution, change in water temperature, siltation, damming, and other changes in water and habitat quality (Franz and Franz 1979, Brody 1990, Figure 4. Female Black Creek crayfish carrying eggs (“in berry”) from CBJTC survey project. Source: Nelson and Floyd (2011, Photograph 201). FWC photograph.
INTRODUCTION

For example, damming immediately changes the character of a stream and its suitability for Black Creek crayfish, resulting in reduced oxygen, increased siltation, and higher water temperature.

It should be mentioned that land managers of public conservation lands do not necessarily manage stream habitat and the fauna that live in it. Populations on public lands (CBJTC and Jennings SF) may receive some protection, but no range-wide conservation actions have yet been undertaken for the Black Creek crayfish. Those sites on private lands may be especially threatened with expanding urbanization, mining, and silviculture (Franz and Franz 1979, Brody 1990, FNAI 2001). Improperly controlled effluent from mining sites may degrade water quality and negatively impact Black Creek crayfish populations. Brody (1990) reported the lack of crayfish and other stream fauna from a stream (Boggy Creek) that receives effluent from the mine tailing ponds of a titanium extraction operation. This stream is a tributary to the North Fork of Black Creek just north (and downstream) of CBJTC.

Road crossings can be sources of toxic substances from illegal dumping and weed control (Franz et al. 2008). Roadwork associated with bridges being newly constructed, repaired, or retrofitted is a potential source of impact to water quality, primarily through siltation and other construction-related pollution. Plans for the construction of Jacksonville’s First Coast Outer Beltway are being finalized; this project will pass through a portion of the Black Creek crayfish range (Florida Department of Transportation [FDOT] 2013) and would be expected to impact stream crossings. As with bridges, construction and maintenance activities on utility corridors and associated infrastructure (e.g., substations, transmission rights of way, and equipment maintenance yards) have the potential to negatively impact streams that they cross or are near.

Little is known about the potential impact of disease and parasites on Black Creek crayfish. Specimens with an apparent fungal disease have been reported by Franz et al. (2008) and Nelson and Floyd (2011). Infected specimens had chalky white muscle tissues visible through the exoskeleton on the underside of the abdomen (Figure 5). Franz stated this condition is believed to be highly contagious and often fatal, but the impact on crayfish populations is unknown (Franz et al. 2008, FWC 2010). Further research on this condition is warranted.

Figure 5. Female Black Creek crayfish from CBJTC with apparent fungus infection. Source: Nelson and Floyd (2011, Photo 337). FWC photograph.
INTRODUCTION

The Florida Department of Environmental Protection (DEP) coordinates the development and implementation of basin management action plans (BMAPs) to assess, monitor, and improve the water quality of water bodies in the basin that are considered “impaired” by pollution. “Total maximum daily loads (TMDLs) are water quality targets for specific pollutants (such as fecal coliforms) that are established for impaired waterbodies that do not meet their designated uses based on Florida water quality standards” (DEP 2010). A BMAP prepared for tributaries to the Lower St. Johns River (DEP 2010) addresses water quality issues for some drainages in or near the range of the Black Creek crayfish. Currently, the great majority of known Black Creek crayfish sites are in high-quality, “pristine,” streams with clear, unpolluted water. However, TMDLs have been established for two urbanizing streams, Big Davis Creek and Durbin Creek, where Black Creek crayfish have been documented. These streams are in southeastern Duval and northwestern St. Johns counties, separated by the St. Johns River from the Black Creek and other drainages that harbor most known Black Creek crayfish populations.

Recommended Listing Status

In 2010, the FWC directed staff to evaluate the status of all species listed as Threatened or Species of Special Concern that had not undergone a status review in the past decade. To address this charge, staff conducted a literature review and solicited information from the public on the status of the Black Creek crayfish. The FWC convened a Biological Review Group (BRG) to assess the biological status of the species using criteria specified in Rule 68A-27.001, Florida Administrative Code (F.A.C.), following the protocols in the Guidelines for Application of the 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 (BSR) report, which included the BRG’s findings and a preliminary listing recommendation from staff. FWC distributed the draft for peer review and the reviewers’ input was incorporated into a final report (FWC 2011a).

The Black Creek crayfish BRG concluded from the biological assessment that the Black Creek crayfish met criteria necessary to warrant listing it as Threatened on the Florida Endangered and Threatened Species List.

The Black Creek crayfish met the following criterion for listing:

- Criterion B, Geographic Range: the extent of occurrence <20,000 km² (7,722 mi²) and/or area of occupancy <2,000 km² (772 mi²) and the population is severely fragmented and may exist in fewer than 10 locations; and a continuing decline is observed or projected in area of occupancy and quality of habitat due to continuing development in Clay County and portions of Duval County.

Discussion of “Location”

It is important to recognize that with regard to listing criteria, the term location has a specific meaning. According to IUCN guidelines, “The term location defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a taxon is affected by more than one threatening event, location should be defined by considering the most serious plausible threat.”
Therefore, in this document, places where Black Creek crayfish are found may be referred to as 
sites or occurrences, whereas the term location (or threat-defined location) is reserved to
designate an area within the species’ range that is subject to a common threat. Determining the
number of locations represented by the distribution of Black Creek crayfish is a matter of
interpretation. Threats of varying magnitude could presumably impact a differing number of
drainages with impacts felt downstream. The BRG exercised precautionary principles by
considering that the Black Creek crayfish occupies close to the target threshold of locations
(~10) to meet listing Criterion B. This conclusion was derived from the observation that the
North Fork and the South Fork of Black Creek originate on CBJTC, as do several of their
upstream tributaries. With respect to possible threats, the BRG considered a worst-case scenario
in which a major catastrophe (e.g., chemical spill, munitions accident) occurring on CBJTC
could potentially impact a large portion of the Black Creek crayfish population.

Subsequent to drafting of the BSR (FWC 2011a), a detailed listing of drainages documented as
occupied by the Black Creek crayfish was prepared (Table 1). The Black Creek watershed
accounts for 85% (47 out of 55) of the occupied drainages or tributaries, and about half of those,
including the North Fork and South Fork, originate on CBJTC. Using the information in Table 1,
if all of CBJTC were to be considered a single threat-defined location, 24 of the 55 (44%)
drainages and 156 of the 202 (77%) sites depicted in Figure 3 could be impacted. The
plausibility of a single threat impacting all of CBJTC is not known, but this discussion draws
attention to the importance of identifying and conserving populations of the Black Creek crayfish
outside of the Black Creek watershed.
Table 1. Creek drainages occupied by Black Creek crayfish<sup>1</sup>.

<table>
<thead>
<tr>
<th>Name of creek drainage (from DeLorme Florida Atlas and Gazetteer)</th>
<th>Counties</th>
<th>Estimated number of sites</th>
<th>Ownership of occupied sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Fork of Black Creek</td>
<td>Clay</td>
<td>27</td>
<td>Camp Blanding, Jennings State Forest, Private</td>
</tr>
<tr>
<td>Unnamed tributaries (5)</td>
<td>Clay</td>
<td>52</td>
<td>Camp Blanding</td>
</tr>
<tr>
<td><em>Unnamed tributaries (3)</em></td>
<td>Clay</td>
<td>3</td>
<td>Jennings State Forest</td>
</tr>
<tr>
<td><em>Mill Branch</em></td>
<td>Clay</td>
<td>1</td>
<td>Private</td>
</tr>
<tr>
<td><em>Gum Branch</em></td>
<td>Clay</td>
<td>1</td>
<td>Private</td>
</tr>
<tr>
<td><em>Long Branch</em></td>
<td>Clay</td>
<td>3</td>
<td>Private, Jennings State Forest</td>
</tr>
<tr>
<td><em>Yellow Water Creek</em></td>
<td>Duval, Clay</td>
<td>5</td>
<td>Jennings State Forest</td>
</tr>
<tr>
<td><em>Big Branch (North)</em></td>
<td>Clay</td>
<td>3</td>
<td>Jennings State Forest</td>
</tr>
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<td><em>Wheeler Branch</em></td>
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<td>Jennings State Forest</td>
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<td>Jennings State Forest</td>
</tr>
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<td>South Fork of Black Creek</td>
<td>Clay</td>
<td>19</td>
<td>Camp Blanding, Private</td>
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<td>Unnamed tributaries (8)</td>
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<td>Camp Blanding</td>
</tr>
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<td><em>Ates Creek</em></td>
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<td>Private</td>
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<tr>
<td><em>Unnamed tributary</em></td>
<td>Clay</td>
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<td>Private</td>
</tr>
<tr>
<td><em>Unnamed tributary</em></td>
<td>Duval, Clay</td>
<td>9</td>
<td>Camp Blanding</td>
</tr>
<tr>
<td><em>Greens Creek (4 tributaries)</em></td>
<td>Clay</td>
<td>4</td>
<td>Private</td>
</tr>
<tr>
<td><em>Bull Creek</em></td>
<td>Clay</td>
<td>2</td>
<td>Camp Blanding, Private</td>
</tr>
<tr>
<td>Unnamed tributaries (3)</td>
<td>Clay</td>
<td>14</td>
<td>Camp Blanding</td>
</tr>
<tr>
<td><em>Mill Creek</em></td>
<td>Clay</td>
<td>1</td>
<td>Private</td>
</tr>
<tr>
<td><em>Unnamed tributary</em></td>
<td>Clay</td>
<td>1</td>
<td>Private</td>
</tr>
<tr>
<td><em>Black Creek</em></td>
<td>Clay</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Grog Branch</em></td>
<td>Clay</td>
<td>1</td>
<td>Private</td>
</tr>
<tr>
<td><em>Black Creek Ravines CA</em></td>
<td>Clay</td>
<td>2</td>
<td>St. Johns River WMD</td>
</tr>
<tr>
<td><em>Little Black Creek</em></td>
<td>Duval, Clay</td>
<td>1</td>
<td>Private</td>
</tr>
<tr>
<td><em>Bradley Creek</em></td>
<td>Clay</td>
<td>1</td>
<td>Private</td>
</tr>
<tr>
<td><em>Peters Creek</em></td>
<td>Clay</td>
<td>2</td>
<td>Private</td>
</tr>
<tr>
<td>Lake Lowery tributaries (2)</td>
<td>Clay</td>
<td>8</td>
<td>Camp Blanding</td>
</tr>
<tr>
<td>Magnolia Lake tributary</td>
<td>Clay</td>
<td>1</td>
<td>Camp Blanding or DEP</td>
</tr>
<tr>
<td>Governors Creek</td>
<td>Clay</td>
<td>1</td>
<td>Private</td>
</tr>
<tr>
<td>Etoniah Creek</td>
<td>Putnam</td>
<td>1</td>
<td>Private</td>
</tr>
<tr>
<td><em>Rice Creek (North; 2 tributaries)</em></td>
<td>Putnam</td>
<td>3</td>
<td>Etoniah Creek State Forest</td>
</tr>
<tr>
<td>Holly Oaks Creek</td>
<td>Duval</td>
<td>1</td>
<td>Private</td>
</tr>
<tr>
<td>Big Davis Creek</td>
<td>Duval</td>
<td>1</td>
<td>Private</td>
</tr>
<tr>
<td>Durbin Creek (Corklan Branch)</td>
<td>Duval</td>
<td>1</td>
<td>St. Johns River WMD or Private</td>
</tr>
<tr>
<td>Trout Creek</td>
<td>St. Johns</td>
<td>1</td>
<td>Private</td>
</tr>
</tbody>
</table>

*Florida Fish and Wildlife Conservation Commission*
Table 1, continued.

<table>
<thead>
<tr>
<th>Name</th>
<th>Number of drainages</th>
<th>Number of Sites</th>
<th>Total percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAMP BLANDING IMPACTED DRAINAGES</td>
<td>24</td>
<td>156</td>
<td>44% of drainages; 77% of sites</td>
</tr>
<tr>
<td>OTHER BLACK CREEK TRIBUTARIES</td>
<td>23</td>
<td>37</td>
<td>42% of drainages; 18% of sites</td>
</tr>
<tr>
<td>NON-BLACK CREEK TRIBUTARIES</td>
<td>8</td>
<td>9</td>
<td>14% of drainages; 4% of sites</td>
</tr>
<tr>
<td>TOTAL</td>
<td>55</td>
<td>202</td>
<td></td>
</tr>
</tbody>
</table>

1The number of sites are estimated from the documented occurrences shown in Figure 2. The majority of drainages in the large "Black Creek" group, including both North and South forks of Black Creek, originate on Camp Blanding. If all drainages originating on Camp Blanding are considered to be subject to the same threat, they could represent a single threat-defined "location." Those tributaries that don't originate on Camp Blanding, identified by *italics* in the large group, plus the others listed at the bottom, could be considered separate "locations."
CONSERVATION GOAL AND OBJECTIVES
The BRG found that the Black Creek crayfish met the criteria for listing as a Threatened species. The conservation goal and objectives for the Black Creek crayfish are:

Goal
The conservation status of the Black Creek crayfish is improved to a point that the species can be removed from the Florida Endangered and Threatened Species List and will not need to be listed again.

_Rationale_
The key to improving the conservation status of the species is ensuring that robust populations inhabit high-quality habitat across its range. The objectives below address these challenges by coordinating effective habitat management that reduces threats and continuing to search for and protect additional populations.

Objectives
I. Identify and reduce threats to quality of habitat for the Black Creek crayfish throughout its range within 10 years of plan implementation.

_Rationale_
The long-term survival of Black Creek crayfish populations depends on maintaining or enhancing the habitat quality of the streams where they are found. These crayfish are themselves indicators of high-quality habitats that meet their needs for streams with water that is cool, flowing, highly oxygenated, unpolluted, and unsilted, with sandy bottoms and sufficient aquatic vegetation and hiding places. Populations in drainages where immediate and forecasted threats are identified and ameliorated should be robust and contribute to the overall survival of the species. Reducing threats will entail working with public and private landowners to lessen potential impacts of silviculture, agriculture, and development; working with mining and other industry interests to ensure containment of potential pollutants; and working with state agencies and local governments to promote and implement practices that conserve stream habitats and wildlife. Associated actions will address decline in habitat quality (listing Criterion B), decline in area of occupancy (Criterion B), and vulnerability to threats (Criterion B).

II. Locate and conserve Black Creek crayfish populations outside the Black Creek watershed within 10 years of plan implementation.

_Rationale_
The BRG’s concern with increasing the number of threat-defined locations was motivated by the observation that the great majority of documented occurrences of Black Creek crayfish are in tributaries and drainages that comprise the North Fork and South Fork of Black Creek. These 2 major streams originate in close proximity on CBJTC, suggesting that they (and their downstream populations) could be simultaneously impacted by a single catastrophic event. While the likelihood of such a threat occurring may be small, this scenario draws attention to the potential conservation importance of Black Creek crayfish populations that occupy outlying drainages separated from the Black Creek system. Locating additional such populations and
safeguarding all of them by reducing identified threats as described in Objective I should help reduce the species’ overall risk of extinction. Associated actions will address decline in area of occupancy and extent of occurrence (Criterion B) and vulnerability to threats (Criterion B).
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.

These conservation actions emphasize protection and management of occupied sites and their high-quality stream habitat and searches that would lead to discoveries of new sites that extend the species’ known distribution. Other actions assess potential threats from urbanization, mining, road crossings, and associated impacts to water quality and riparian corridors. One action proposes the drafting and dissemination of stream-centered habitat management recommendations for stakeholders who could implement them to benefit the Black Creek crayfish. Completing these actions will allow us to measure progress toward the conservation goal and objectives for the Black Creek crayfish.

Habitat Conservation and Management
The conservation of the Black Creek crayfish is primarily dependent on the protection of the high-quality stream habitats in which it lives (see Figure 6). Stream habitats are threatened by
direct and indirect impacts such as expanding urbanization, silviculture, mining, and other activities that degrade water quality or water flow. Habitat conservation and management actions are focused on reducing potential threats from direct and indirect sources, as well as monitoring and managing known sites to ensure their long-term viability.

**Action 1** Coordinate with CBJTC, FFS, and SJRWMD to develop long-term plans for the protection, management, and monitoring of Black Creek crayfish populations on their lands.

Maintaining robust, viable populations of Black Creek crayfish in streams within CBJTC, Jennings SF, and SJRWMD lands is essential to achieving the conservation goal for the Black Creek crayfish. Public conservation lands provide the best opportunity for maintaining or enhancing habitat to maximize benefits to the species. CBJTC and the FFS have primary responsibilities for managing upland habitats adjacent to Black Creek and other streams within the Black Creek crayfish area of occupancy. But it is SJRWMD that has primary responsibility for managing the aquatic habitats in those streams. FWC staff has coordinated with these land managers on previous Black Creek crayfish surveys (Franz et al. 2008, Nelson and Floyd 2011; see Figure 7).

Figure 7. Example voucher photo of Black Creek crayfish from CBJTC survey. Source: Nelson and Floyd (2011, Photograph 121). FWC photograph.
It is a high priority to continue ongoing productive working relationships with these land managers and to foster expanded coordination with others (e.g., SJRWMD and perhaps DEP) on the conservation of Black Creek crayfish populations that are known to occur on their lands or may later be discovered on them.

Coordination between FWC staff and CBJTC on Black Creek crayfish issues is ongoing and has been very productive. In February 2010 CBJTC hosted a Black Creek crayfish issues meeting (FWC 2010) with participation by representatives of CBJTC, state and federal agencies, conservation groups, and the University of Florida. This meeting provided a forum for sharing and discussing information pertinent to the Black Creek crayfish and its habitat, including natural history and survey data, wildlife buffers, FWC listing process, and next steps (FWC 2010).

**Action 2** Work with private landowners to protect and monitor known sites on their land and to encourage land management techniques that improve habitat quality.

It is a high priority to periodically assess the status of Black Creek crayfish populations throughout the species’ range and to take appropriate steps to ensure that these sites are protected from threats and managed for long-term suitability. As suggested by Franz et al. (2008), the designation for annual monitoring of 1 or more reference sites within each drainage would provide consistent minimal information on the status of that stream system. Determining how best to protect sites will depend on an assessment of their immediate threats (Action 6) and an evaluation of their habitat and water quality attributes (Action 7).

**Action 3** Assess the feasibility of improving stream quality where crayfish are not found but to which the species would be capable of migrating.

Maintenance of suitable stream conditions where they occur and improvement of conditions where needed should increase the chances for long-term survival of robust populations of Black Creek crayfish. Improving the habitat of unoccupied areas so that they become suitable and occupied would directly increase the species’ area of occupancy. Making physical in-stream habitat improvements would probably be very expensive, so ensuring that currently occupied sites remain suitable should be a priority. However, protecting riparian buffers through best management practices (BMPs; see Action 10) or conservation easements does not have to be expensive. A protected riparian buffer could be created by planting in an area that has lost trees and vegetation, and the in-stream habitat monitored to document improvement. These actions would benefit other stream species and should not be discounted if certain sites are identified as relatively easy to improve. A study of the migration ability and propensity of Black Creek crayfish to move into new areas (Action 8) could provide information to help support restoration efforts. Potential target sites may be on conservation lands managed by CBJTC, FFS, SJRWMD, and possibly DEP.

**Population Management**

Most conservation actions in this plan primarily involve identification, protection, and management of the stream habitats where the Black Creek crayfish are found. However, there are at least 2 projects proposed in Monitoring and Research pertinent to population management.
They include conducting comprehensive surveys to address area of occupancy issues (Action 5) and assessing the migration ability and propensity of Black Creek crayfish (Action 8), which has bearing on colonization of restored habitats as well as potential translocation.

**Monitoring and Research**

Although the Black Creek crayfish has been known to science since 1940, only in relatively recent years have strides been made to learn features of its life history and the extent of its distribution (e.g., Franz and Franz 1979, Brody 1990, Franz et al. 2008, Nelson and Floyd 2011). Ongoing efforts should continue to address this in order to provide a better understanding for effective management and long-term conservation of the Black Creek crayfish.

**Action 4** Conduct additional surveys to determine the limits of distribution of the Black Creek crayfish.

Assessment of the distribution of the Black Creek crayfish is an ongoing process, and the species has recently been documented at additional sites (P. Moler, personal communication) subsequent to the drafting of the BSR (FWC 2011a). Beyond formal surveys conducted on CBJTC and Jennings SF (Franz et al. 2008, Nelson and Floyd 2011), recent documentation of occurrences has been the result of opportunistic sampling (FWC 2010). Additional extensive surveys within the watershed (see Figure 3) will provide a clearer picture of the species’ distribution and habitat requirements. Example target drainages include McGirts Creek/Ortega River drainage, Simms Creek, Southern Rice Creek, more widely in Etoniah Creek, and in Trout Creek (St. Johns County). In some cases these surveys will require coordination with existing partners (e.g., CBJTC, FFS) and new partners (e.g., SJRWMD, private landowners). Where feasible, surveys should assess a wide range of physical and chemical attributes (Appendix 1). Comparison of attributes at sites that are occupied with those at sites where crayfish are not found should help identify conditions that are optimal for the Black Creek crayfish (Action 7).

**Action 5** Conduct comprehensive surveys throughout the species’ range to determine area of occupancy within each basin and location.

Extensive surveys would be essential for defining the species’ area of occupancy; surveys will be helpful to determine the relative continuity of Black Creek crayfish distribution and to estimate the number of stream-miles occupied by the species. Although the current area of occupancy is unknown, the BRG estimated it to be <1,999 km² (<772 mi²) due to the crayfish’s restriction to stream habitat. Comprehensive surveys throughout the species’ range should improve the area of occupancy estimate and provide information about how to maintain or increase it despite the projected threat of continuing development.

The first step will be to standardize the method of measuring area of occupancy, (e.g., measure bank to bank or measure width of riparian zone). Then it should be determined, based on sampling, what minimum relative abundance of crayfish (or robustness of the population) constitutes occupancy. This could also lead to an assessment of how one should define a viable population. Better estimates of the area of occurrence, its comparison to the minimum threshold, and periodic estimates of whether it is decreasing or increasing will help address the listing.
concerning the area of occupancy. These more extensive surveys would be led by FWC and would require coordination with existing partners (e.g., CBJTC, FFS) and new partners (e.g., SJRWMD, private landowners).

**Action 6** Assess potential threats to sites occupied by Black Creek crayfish, including chemical spill, channelization, siltation, urban runoff, loss of quality riparian zone habitat (forest canopy), and rare earth mining activities.

**Action 7** Determine optimal physical and chemical stream properties for Black Creek crayfish habitat on occupied sites.

These 2 actions could be addressed in conjunction with comprehensive surveys (**Action 5**) or included with site-specific management actions on public lands (**Action 1**) and private lands (**Action 2**). Identifying threats at individual sites and determining optimal conditions to support Black Creek crayfish are important steps toward informing management actions to improve sites for crayfish. This information can help guide efforts to coordinate with other entities, including FDOT (**Action 14**), utility companies (**Action 15**), and local governments (**Action 16**).

The headwater and tributary streams that contain Black Creek crayfish are considered to be high quality and provide a consistent flow of clean water free of siltation and other pollutants. It is not known whether the contamination due to mining reported by Brody (1990) is still impacting stream habitats or how widespread the problem may be, now some 25 years later. A reassessment of the water quality and faunal presence in Boggy Creek and downstream reaches would directly address this question. Occupied streams known to be impacted by urban runoff include Big Davis Creek and Durbin Creek in southeastern Duval and northwestern St. Johns counties. DEP is continuing to monitor their water quality status and improvements through TMDL studies (DEP 2006, 2009); conservation of Black Creek populations in these and other streams outside the Black Creek watershed is important for achieving **Objective II**.

Incidents involving siltation of Black Creek have occurred on CBJTC (T. Doonan, FWC, personal communication; see **Figure 8**). In 2011 CBJTC consulted with FWC to minimize siltation during a culvert replacement project (T. Doonan, personal communication). Expanding development, primarily from greater Jacksonville, may pose a threat to some Black Creek crayfish sites, especially due to creek alteration and urban stormwater runoff (Franz and Franz 1979, Brody 1990, FNAI 2001). It is important to periodically assess the quality of the stream waters and the ability of the forested riparian zone to buffer the

![Figure 8. Example of siltation and turbidity impact to stream resulting from development activity. FWC photograph.](image-url)
stream from impact of detrimental upland activities. Recent studies (Franz et al. 2008, Nelson and Floyd 2011) collected water quality information during surveys at CBJTC and Jennings SF. The type of physical and chemical information collected during stream surveys by Nelson and Floyd (2011) is presented in Appendix 1. It would be instructive to collect comparable and expanded information at additional sites throughout the Black Creek crayfish’s range. A comparison of the physical and chemical parameter information at occupied versus unoccupied sites may imply critical threshold values needed to support a viable Black Creek crayfish population.

**Action 8** Assess the ability and propensity of Black Creek crayfish to migrate.

Efforts may be made to restore the habitat quality of disturbed or degraded streams with a goal of making them suitable for colonization by Black Creek crayfish (Action 3). A research study could be designed using individually marked crayfish to test the potential and ability of Black Creek crayfish to migrate to different sections of the stream. The results would yield information about the expected timeframe for successful colonization by the species into adjacent restored or improved habitats, or following a perturbation, such as a chemical spill or siltation event, that caused temporary local extirpation. Information on migration ability and propensity would also be pertinent to a discussion of potential translocation of Black Creek crayfish.

**Action 9** Determine the occurrence and potential impacts on Black Creek crayfish from fungus, diseases, and parasites.

As noted above, some Black Creek crayfish have been observed with an apparent fungal disease (Franz et al. 2008, FWC 2010, Nelson and Floyd 2011; Figure 5), but the significance of this is presently unknown. It should be straightforward to assess affected specimens, perhaps through a contract with a university with fungus identification expertise. Then a determination would be made about whether and how this disease may be a threat to wild populations, and what follow-up actions may be warranted. A protocol could be added into crayfish field studies to include a health assessment, and to collect samples for further testing of individuals that exhibit symptoms of fungal attack, disease, or parasitism.

**Rule and Permitting Intent**

As a Threatened species, the Black Creek crayfish is protected under Chapter 68A-27, F.A.C. The protective measures contained in Chapter 68A-27, F.A.C., should provide adequate protections for the species. These rules prohibit harm and harassment of Threatened species. The permit requirements and exemptions as currently provided in Rule 68A-27.007(2), F.A.C., are applicable to the Black Creek crayfish.

Although this is an attractive, boldly marked crayfish, we are not aware of particular pressure due to collection. Therefore, over-collecting for personal use or other forms of intentional take is unlikely to become a significant problem. Scientific collecting permits issued by FWC’s permitting staff for educational or research purposes should require that information on Black Creek crayfish observations including date, location, and habitat be provided in reports. In
addition, if incidental mortality occurs, Black Creek crayfish specimens must be provided to the FWC along with pertinent data related to the incidental mortality.

More serious threats to the crayfish involve disturbances that could alter its stream habitat or negatively impact the stream water quality and flow and result in incidental take. Non-regulatory conservation measures such as establishing and maintaining conservation easements, implementation and maintenance of water quality BMPs, and establishing memorandums of agreement/understanding are essential elements in providing the needed protections for the Black Creek crayfish’s habitat. Actions that reduce these threats and result in protection of riparian zones have a high priority and are discussed in other sections of this species action plan. No specific actions related to rule and permitting intent are identified.

Law Enforcement
We are not aware of particular law enforcement issues concerning the Black Creek crayfish. No specific actions related to law enforcement are identified.

Incentives and Influencing
FWC staff should investigate specific incentive programs that might help achieve conservation objectives for the Black Creek crayfish and seek opportunities to work with stakeholders to ensure that their activities have low potential to negatively impact crayfish habitat. Note that Action 16 mentions providing incentives information to local governments.

Action 10 Encourage landowners and land managers engaged in agricultural or silvicultural land uses to follow BMPs for water quality and establish special management zones (SMZs) to protect riparian buffer zones for streams on their property.

High-quality stream conditions for the Black Creek crayfish and other wildlife occur when there is an adequate corridor of forest cover. This forest cover provides shade that maintains low water temperature and buffers the stream from upland disturbances (including siltation, pollution). The presence of Black Creek crayfish populations indicates that previous and ongoing land management activities may be compatible with the species’ long-term survival. Silvicultural methods that balance timber harvest with water quality protections are an example of that concept. In support of the development and implementation of site-specific habitat protection and management plans (Actions 1 and 2), it is a high priority to encourage land managers (CBJTC, FFS, SJRWMD, and perhaps DEP) as well as private landowners to follow BMPs, including the establishment of SMZs. These voluntary actions will help protect the water quality of aquatic communities by reducing or eliminating negative impacts from agricultural and silvicultural land uses and securing riparian buffer zones that maintain the attributes of high quality streams required by the Black Creek crayfish.

Education and Outreach
Introducing the public to the unique and interesting forms of wildlife that depend on streams and other natural wetlands will help build a constituency who recognizes the importance of protecting water quality and Florida’s natural resources. Preparing and sharing information that
explains or reminds the public how to ensure that their activities on land adjacent or upstream do not hurt the habitats and wildlife downhill or downstream can be an effective conservation tool.

**Action 11** Develop habitat management recommendations for stream protection and distribute to stakeholders who could implement them to benefit the Black Creek crayfish.

Land managers, private landowners, citizen scientists, and schools near Black Creek crayfish streams represent a segment of the public that can take action to help ensure the long-term survival of the species. County planning, zoning, and growth management offices; regional planning councils; homeowner associations; and other agencies and organizations are also poised to make decisions that impact stream habitat. Recommending habitat management techniques to maintain or enhance high-quality Black Creek crayfish streams may foster responsible stewardship and reduce the likelihood of incidental take of the species. These habitat management recommendations would outline tangible management activities compatible with stream-dependent wildlife, including Black Creek crayfish. This action is a lower priority than conservation actions that provide direct protection to known sites, but it has the potential to raise awareness of stream protection issues with a broad cross-section of the public. A determination that brochures or other disseminated information will meet receptive target audiences should be made beforehand to ensure that efforts and materials are not wasted.

**Coordination with Other Entities**

Effective partnerships with FWC staff and other agencies, organizations, companies, counties, municipalities, and the public are critical to achieving the conservation goal and objectives in this species action plan. The Black Creek crayfish is an example of a species dependent on high-quality stream habitat. However, preserving the integrity of that habitat and ensuring the long-term survival of the crayfish will require communication and coordination with multiple entities on the state, local, and private levels. These entities can help regulate, ameliorate, or avoid potential threats, and their responsibilities, policies, and actions directly or indirectly impact the Black Creek crayfish and its habitat.

**Action 12** Encourage use of stormwater retention ponds to prevent downstream contamination of Black Creek crayfish sites from urban runoff.

Rainwater runoff from urban areas can carry oil and other contaminants downstream. Properly located and constructed stormwater retention ponds settle particulate matter and toxins, making them less likely to impact plants and wildlife in streams and other wetlands. Coordination with SJRWMD, counties, and municipalities would be needed; however, the effectiveness of stormwater retention ponds at improving Black Creek crayfish habitat would be indirect and difficult to assess.

**Action 13** Coordinate with SJRWMD, DEP, and U.S. Army Corps of Engineers with regard to permitting, including stormwater management plans.

In addition to coordination with SJRWMD with regard to Black Creek crayfish sites on its property (Action 1) and the use of stormwater retention ponds (Action 12), FWC staff could also
work with DEP and the U.S. Army Corps of Engineers to learn which of their permitting responsibilities presents an opportunity to improve crayfish habitat. Information on how municipal stormwater management plans are drafted, permitted, and implemented would be relevant to downstream water quality. This action is a moderate priority since its effectiveness would be indirect and difficult to assess.

**Action 14** Coordinate with FDOT to minimize impacts to Black Creek crayfish and stream habitat from new or modified stream crossings.

Roadwork associated with bridges being newly constructed, repaired, or retrofitted is a potential source of impact to water quality, including siltation and other construction-related pollution. Plans for the construction of Jacksonville’s First Coast Outer Beltway are being finalized (FDOT 2013); this project will pass through a portion of the Black Creek crayfish range and may impact stream crossings. Coordination with FDOT could include sharing of the schedule of proposed stream crossing construction projects, including those for the Outer Beltway. FWC staff could then prioritize such projects by their potential to negatively impact occupied stream reaches and offer consultation on appropriate actions to avoid, minimize, or mitigate impacts.

**Action 15** Coordinate with utility companies to ensure their activities avoid streams or minimize impact to them.

Effective coordination with utility companies (e.g., JEA, Clay Electric Cooperative, etc.) could have a tangible benefit to the Black Creek crayfish. As with bridges, construction and maintenance activities on utility corridors and associated infrastructure (e.g., substations, transmission rights of way, and equipment maintenance yards) have the potential to negatively impact streams that they cross or are near.

**Action 16** Coordinate with local governments and provide technical assistance to local government staff on Black Creek crayfish habitat needs and range information for use in permitting and development planning.

FWC staff plans to meet directly with local government staff to provide technical assistance, share research, range and distribution, geographic information system (GIS) information, and BMPs with local planners, biologists and other staff. Information provided to local governments will be given to property owners adjacent to known sites through local government permitting programs. Information could be distributed with permit information or materials. FWC offers conservation planning services to local governments during the development of amendments to comprehensive growth management plans, associated development proposals, and other local and regional development projects. In order to promote an understanding of technical assistance and incentives available to landowners, FWC typically provides information to local governments regarding species management plans, permitting options and incentive programs that are available to applicants, developers, and landowners, as well as the general public. Local governments could also assist in distributing information to businesses receiving occupational licenses such as contractors, landscapers, golf courses, and others.
### Table 2. Black Creek Crayfish (Procambarus pictus) Conservation Action Table

<table>
<thead>
<tr>
<th>Objective(s) Addressed</th>
<th>Team Assigned Priority Level</th>
<th>Action Item Number</th>
<th>Action Item</th>
<th>Conservation Action Category</th>
<th>Ongoing, Expanded or New Effort?</th>
<th>Authority</th>
<th>Man Power</th>
<th>Estimated Cost to Implement</th>
<th>Funding Source(s)</th>
<th>Lead for Implementation: FWC Program(s) and/or Section(s)</th>
<th>External partners</th>
<th>Likely Effectiveness</th>
<th>Feasibility</th>
<th>Urgent?</th>
</tr>
</thead>
<tbody>
<tr>
<td>I 1 1 1</td>
<td></td>
<td>Coordinate with CBJTC, FWS, and SJRWMD to develop long-term plans for the protection, management, and monitoring of Black Creek crayfish populations on their lands.</td>
<td>Habitat Conservation &amp; Mgmt, Monitoring &amp; Research, Coordination with Other Entities</td>
<td>ONGOING</td>
<td>YES</td>
<td>YES</td>
<td>$50,000</td>
<td>Existing</td>
<td>HSC</td>
<td>Camp Blanding, Florida Forest Service, SJRWMD, perhaps DEP</td>
<td>Likely</td>
<td>It can be done; practical; some relationships already exist</td>
<td>Not urgent</td>
<td></td>
</tr>
<tr>
<td>I 1 1 2</td>
<td></td>
<td>Work with private landowners to protect and monitor known sites on their land to encourage land management techniques that improve habitat quality.</td>
<td>Habitat Conservation &amp; Mgmt, Monitoring &amp; Research</td>
<td>EXPANDED</td>
<td>YES</td>
<td>YES</td>
<td>TBD</td>
<td>Existing; other sources to protect and manage</td>
<td>HSC</td>
<td>Private landowners</td>
<td>Likelihood depends on relationships already developed</td>
<td>It can be done; practical; relationships need to be developed</td>
<td>Not urgent</td>
<td></td>
</tr>
<tr>
<td>I 3 3</td>
<td></td>
<td>Assess the feasibility of improving stream quality where crayfish are not found but to which the species would be capable of migrating.</td>
<td>Habitat Conservation &amp; Mgmt, Monitoring &amp; Research</td>
<td>NEW</td>
<td>NO</td>
<td>NO</td>
<td>TBD</td>
<td>Unknown</td>
<td>HSC</td>
<td>Camp Blanding, Florida Forest Service, SJRWMD, perhaps DEP</td>
<td>May be possible, but lower priority for sites on conservation lands. Results would likely increase area of occupancy</td>
<td>Feasibility can be assessed; moving forward will depend on funding and good working relationships with partners</td>
<td>Not urgent</td>
<td></td>
</tr>
<tr>
<td>I 1 1 1 1</td>
<td></td>
<td>Conduct additional surveys to determine the limits of distribution of the Black Creek crayfish.</td>
<td>Monitoring &amp; Research</td>
<td>ONGOING</td>
<td>YES</td>
<td>YES</td>
<td>$21,000</td>
<td>Existing</td>
<td>FWR, HSC</td>
<td>Camp Blanding, Florida Forest Service, SJRWMD, perhaps DEP</td>
<td>Likely</td>
<td>It can be done; practical; some relationships already exist</td>
<td>Not urgent</td>
<td></td>
</tr>
<tr>
<td>I 1 1 4 3</td>
<td></td>
<td>Conduct comprehensive surveys throughout the species’ range to determine area of occupancy within each basin and location.</td>
<td>Monitoring &amp; Research, Population Mgmt, Coordination with Other Entities</td>
<td>EXPANDED</td>
<td>YES</td>
<td>YES</td>
<td>TBD</td>
<td>Grant</td>
<td>FWR, HSC</td>
<td>Camp Blanding, Florida Forest Service, SJRWMD, perhaps DEP</td>
<td>Likely</td>
<td>Extensive undertaking; might require pilot study; some relationships already exist</td>
<td>Not urgent</td>
<td></td>
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<tr>
<td>I 1 1 4 7</td>
<td></td>
<td>Determine optimal physical and chemical stream properties for Black Creek crayfish habitat on occupied sites.</td>
<td>Monitoring &amp; Research</td>
<td>EXPANDED</td>
<td>NO</td>
<td>NO</td>
<td>$8,000</td>
<td>Existing or grant</td>
<td>FWR, HSC</td>
<td>Camp Blanding, Florida Forest Service, SJRWMD, perhaps DEP</td>
<td>Likely</td>
<td>Potential could be developed</td>
<td>Not urgent</td>
<td></td>
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<tr>
<td>I 1 1 8</td>
<td></td>
<td>Assess the ability and propensity of Black Creek crayfish to migrate.</td>
<td>Monitoring &amp; Research, Population Mgmt</td>
<td>NEW</td>
<td>YES</td>
<td>YES</td>
<td>$21,000</td>
<td>Existing, grant</td>
<td>FWR, HSC</td>
<td>Camp Blanding, Florida Forest Service, SJRWMD, perhaps DEP</td>
<td>Likely</td>
<td>It can be done; practical; some relationships already exist</td>
<td>Not urgent</td>
<td></td>
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<tr>
<td>I 1 1 9</td>
<td></td>
<td>Determine the occurrence and potential impacts on Black Creek crayfish from fungus, diseases, and parasites.</td>
<td>Monitoring &amp; Research</td>
<td>NEW</td>
<td>NO</td>
<td>NO</td>
<td>$8,000</td>
<td>Existing, based on cost</td>
<td>FWR, HSC</td>
<td>Camp Blanding, Florida Forest Service, SJRWMD, perhaps DEP</td>
<td>Likely</td>
<td>It can be done; practical; some relationships already exist</td>
<td>Not urgent</td>
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<td>I 1 1 1 10</td>
<td></td>
<td>Encourage landowners and land managers engaged in agricultural or silvicultural land use to follow BMPs for water quality and establish special management zones (SMZs) to protect riparian buffer zones for streams on their property.</td>
<td>Incentives &amp; Influencing</td>
<td>EXPANDED</td>
<td>YES</td>
<td>YES</td>
<td>$20,000</td>
<td>Existing</td>
<td>HSC</td>
<td>Camp Blanding, Florida Forest Service, SJRWMD, perhaps DEP</td>
<td>Likely</td>
<td>It can be done; practical; some relationships already exist</td>
<td>Not urgent</td>
<td></td>
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<tr>
<td>I 1 1 1 11</td>
<td></td>
<td>Develop habitat management recommendations for stream protection and distribution to stakeholders who could implement them to benefit the Black Creek crayfish.</td>
<td>Education &amp; Outreach, Coordination with Other Entities</td>
<td>NEW</td>
<td>YES</td>
<td>YES</td>
<td>$21,000</td>
<td>Unknown</td>
<td>HSC</td>
<td>Camp Blanding, Florida Forest Service, SJRWMD, perhaps DEP</td>
<td>Likely</td>
<td>It can be done; practical; some relationships already exist</td>
<td>Not urgent</td>
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<tr>
<td>I 1 1 1 12</td>
<td></td>
<td>Encourage use of storm-water retention ponds to prevent downstream contamination of Black Creek crayfish sites from urban runoff.</td>
<td>Habitat Conservation &amp; Mgmt, Coordination with Other Entities</td>
<td>NEW</td>
<td>NO</td>
<td>NO</td>
<td>TBD</td>
<td>Existing or grant</td>
<td>HSC</td>
<td>SJRWMD, counties, municipalities</td>
<td>Likely; would raise public and private awareness of stream issues</td>
<td>Encouragement can certainly be done; relationships with partners would need to be developed</td>
<td>Not urgent</td>
<td></td>
</tr>
<tr>
<td>Objective(s) Addressed</td>
<td>Team Assigned</td>
<td>Action Item Number</td>
<td>Action Items</td>
<td>Conservation Action Category</td>
<td>Ongoing, Expanded or New Effort?</td>
<td>Authority</td>
<td>Man Power</td>
<td>Estimated Cost To Implement</td>
<td>Funding Source(s)</td>
<td>Lead for Implementation: FWC Program(s) and/or Section(s)</td>
<td>External partners</td>
<td>Likely Effectiveness</td>
<td>Feasibility</td>
<td>Urgent?</td>
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<td>I, II</td>
<td>3</td>
<td>13</td>
<td>Coordinate with SJRWMD, DEP, and U.S. Army Corps of Engineers with regard to permitting, including stormwater management plans.</td>
<td>Coordination with Other Entities</td>
<td>NEW</td>
<td>YES</td>
<td>YES</td>
<td>$0-25k</td>
<td>Existing</td>
<td>SJRWMD, DEP, Army Corps of Engineers</td>
<td>FWC</td>
<td>Likely</td>
<td>Feasible</td>
<td>Not urgent</td>
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<tr>
<td>I, II</td>
<td>2</td>
<td>14</td>
<td>Coordinate with FDOT to minimize impacts to Black Creek crayfish and stream habitat from new or modified stream crossings.</td>
<td>Coordination with Other Entities</td>
<td>EXPANDED</td>
<td>NO</td>
<td>YES</td>
<td>$0-25k</td>
<td>Existing</td>
<td>FWR, HSC</td>
<td>FDOT</td>
<td>Likely</td>
<td>Feasible</td>
<td>Not urgent</td>
</tr>
<tr>
<td>I, II</td>
<td>2</td>
<td>15</td>
<td>Coordinate with utility companies to ensure their activities avoid streams or minimize impact to them.</td>
<td>Coordination with Other Entities</td>
<td>EXPANDED</td>
<td>NO</td>
<td>YES</td>
<td>$0-25k</td>
<td>Existing</td>
<td>FWR, HSC</td>
<td>Utilities</td>
<td>Likely</td>
<td>Feasible</td>
<td>Not urgent</td>
</tr>
<tr>
<td>I, II</td>
<td>2</td>
<td>16</td>
<td>Coordinate with local governments and provide technical assistance to local government staff on Black Creek crayfish habitat needs and range information for use in permitting and development planning.</td>
<td>Coordination with Other Entities</td>
<td>EXPANDED</td>
<td>YES</td>
<td>YES</td>
<td>$0-25k</td>
<td>Existing</td>
<td>HSC</td>
<td>Local governments</td>
<td>Likely</td>
<td>Feasible</td>
<td>Not urgent</td>
</tr>
</tbody>
</table>

Acronyms used in this table:
- BMP: Best Management Practices
- BRTC: Base and Range Training Center
- DEP: Florida Department of Environmental Protection
- FDO: Florida Department of Transportation
- FFS: Florida Forest Service
- FWCC: 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
- SJRWMD: St. Johns River Water Management District
LITERATURE CITED


Florida Fish and Wildlife Conservation Commission
Florida Natural Areas Inventory (FNWI). 2013. Conservation Lands webpage
http://www.fnai.org/conservationlands.cfm. Florida Natural Areas Inventory,


Appendix 1. Example of physical and chemical data collected at Black Creek crayfish survey sites. Source: Nelson and Floyd (2011). Mention of product name does not imply endorsement.

At each location the following site, habitat and water quality characteristics were recorded on a data sheet:

1. **site name** – Global positioning system (GPS) location number or name
2. **location comments** – name or initials of who performed the sampling, other comments
3. **date** – date the location was sampled
4. **managed area** – description of the land management for that location
5. **latitude** – GPS latitude location in decimal degrees
6. **longitude** – GPS longitude location in decimal degrees
7. **start time** – time arrived at the location
8. **end time** – time left the location
9. **observers** – name of dip netter
10. **dip netting time** – time spent dip netting for crayfish by each dip netter
11. **water temperature** – a quantitative measure of water temperature in degrees Celsius at the time of the survey with a YSI 556 Multi-Parameter meter
12. **turbidity** – a quantitative measure of turbidity in national turbidity units at the time of the survey with a Orbeco-Hellige TB200 Turbidimeter
13. **dissolved oxygen** – a quantitative measure of dissolved oxygen in milligrams per liter with a YSI 556 Multi-Parameter meter
14. **pH** – a quantitative measure of water acidity with a Oakton pH tester 30-meter or a Hach wide-range pH test kit model #17-N (range 4.0 to 10.0)
15. **catch *P. pictus* per first 10 dips** – number of Black Creek crayfish captured in the first 10 dip net sweeps
16. **stream width** – a quantitative measure of width of the wetted stream to the nearest decimeter at the site
17. **channel width** – a qualitative measure of width of the stream channel to the nearest meter from top of bank to top of bank. A channel width ≥ 40 m (131 ft) was listed as 40.
18. **maximum depth** – a quantitative measure of the maximum water depth in meters within 10 m (33 ft) of a site (GPS locality)
19. **flow level** - a qualitative measure of apparent water level at the time of the survey into categories: a. normal; b. high; c. low.
20. **flow speed** – a quantitative measure of water flow in meters per second at the site with a Marsh-McBirney Flo-Mate 2000 portable flow meter
21. **water color** – a qualitative measure of apparent color at the time of the survey into categories; a. clear; b. light stain; c. dark stain.
22. **siltation** – a qualitative assessment of the amount of siltation at a site
   a. none – organic material if present is coarse leaf litter, no accumulation of silt on surfaces
   b. low – a little silt trapped in moss/algae on stones; refugia clear of silt
   c. moderate - usually abundant silt on streambed surfaces clouding water when moved, but clearing slowly. May be some silt below stones or other refuges.
d. high – Heavy silt cover on all streambed surfaces, all refugia covered with a layer of silt.

23. water clarity – a qualitative assessment of water clarity into categories
   a. good – water clear, visibility to bed good to 50-cm (20-in) depth
   b. moderate – water mostly clear, though suspended solids may be present. Visibility reasonably good to 30 cm (12 in), but more difficult to see clearly at 30 to 60 cm (24 in).
   c. poor – High degree of turbidity/suspended solids.

24. dominant substrate – the primary substrate at the survey site: a. bedrock; b. boulder; c. cobble; d. gravel; e. silt; f. sand.

25. canopy closure – estimated percent canopy cover over the site (<25, 25 to 50, 51 to 75, 75 to 100)

26. woody debris cover – visually estimated percent woody debris cover at a site (<25, 25 to 50, 51 to 75, 75 to 100)

27. submergent vegetation cover – visually estimated percent submergent cover at a site (<25, 25 to 50, 51 to 75, 75 to 100)

28. emergent vegetation cover – visually estimated percent emergent cover at a site (<25, 25 to 50, 51 to 75, 75 to 100)

29. surrounding land use – a qualitative assessment of primary land use around the site into categories: a. natural/forested; b. silviculture; c. agriculture – crops/pasture; d. urban/developed.

30. site construction – the presence of construction activity at or near the site

31. notes – descriptions of photographs taken (i.e., downstream or upstream) and unique site features