

**BIOLOGICAL STATUS REPORT**  
**PANAMA CITY CRAYFISH**  
*(Procambarus econfinae)*

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**EXECUTIVE SUMMARY**

The Panama City crayfish (*Procambarus econfinae*) is a small crayfish known only from the Panama City area of Bay County in Northwest Florida. It was listed as a species of special concern in 1987. In 2001 the Florida Fish and Wildlife Conservation Commission (FWC) received a petition to list it as threatened and initiated review of the species' status. A Biological Status Report (BSR) was prepared in 2002 that recommended its listing as threatened, but a review of the FWC's listing process halted non-emergency listing actions until 2005. A second petition, this one recommending delisting the Panama City crayfish, was received in 2003 during the listing moratorium. In April 2005, new listing rules and definitions were approved, and listing action on the Panama City crayfish, including consideration of both petitions, could continue.

In order to accommodate the revised listing criteria and consider new information on the Panama City crayfish available since the original BSR was prepared, it was determined that a revised and updated BSR should be prepared. In June 2005 the FWC approved a five-member Biological Review Panel (BRP), whose charge was to review all available scientific data and previous listing action documents and evaluate the biological status of the Panama City crayfish based on the FWC listing criteria. The BRP did so at its meeting in November 2005, and unanimously recommended that the Panama City crayfish be listed as threatened. The panel's recommendation is supported by assessment of the species' geographic range (Criterion B). Specifically, this conclusion of threatened status is based on: (1) an estimated extent of occurrence of 51 square miles; (2) an estimated area of occurrence of 18 square miles; (3) evidence for a severely fragmented population; and (4) a continuing decline in the species' area of occupancy, area, extent, and/or quality of habitat, and number of locations or subpopulations.

Independent scientific review of the biological assessment was sought and all six independent reviewers concurred with the BRP's recommendation to list the crayfish as threatened. One independent reviewer questioned the objectivity in the application of criteria for assessing population size, but otherwise the reviewers stated that the listing criteria were applied appropriately. No substantive changes in the BSR were proposed by the independent reviewers.

## INTRODUCTION

On 22 August 2001, Florida Fish and Wildlife Conservation Commission (FWC) staff received an emergency petition to reclassify the Panama City crayfish (*Procambarus econfinae*) from species of special concern (Rule 68A-27.005 F.A.C.) to threatened (Rule 68A-27.004 F.A.C.) (Keppner 2001). Staff evaluated the submitted petition and determined that it did not meet the emergency standard in Rule 68A-27.0012 F.A.C. Although the petition was not sufficient to meet the emergency standard, FWC staff recommended consideration of this petition as a regular petition. At their October 2001 meeting, the agency's Commissioners determined the petition was sufficient as a regular petition and directed staff to undertake a comprehensive assessment of the Panama City crayfish's biological status pursuant to the criteria and definitions embodied in Rule 68A-1.004 F.A.C. In order to warrant state listing as an endangered species, threatened species, or species of special concern, the Panama City crayfish, range-wide, must meet at least 1 of the 5 criteria in 68A-1.004 F.A.C. Information concerning the status of the Panama City crayfish in relation to those criteria was presented in a Biological Status Report (BSR) approved May 2, 2002 (FWC 2002). That BSR led to the preparation of a statewide management plan approved October 31, 2003 (FWC 2003).

However, in 2003, before the final listing decision on the Panama City crayfish could be made, the FWC listing criteria were called into question, and a review of the listing process was initiated. Then began a moratorium on non-emergency listing actions, including any involving the Panama City crayfish, until such time as new listing rules were approved. On October 16, 2003, a second petition was submitted (Bingham 2003), this one to delist the Panama City crayfish. Further action on the two petitions was postponed due to the moratorium.

In April 2005, new FWC listing rules (68A-27.0012 F.A.C., Appendix 1) and revised definitions (68A-1.004 F.A.C., Appendix 2) were approved, and listing action on the Panama City crayfish, including consideration of both petitions, could continue. In order to accommodate the revised listing criteria and consider new information on the Panama City crayfish available since the original BSR was prepared, it was determined that a revised and updated BSR should be prepared. The present report constitutes the resulting document.

## ACKNOWLEDGMENTS

Many FWC staff contributed to the preparation of the 2002 Biological Status Report, and that information served as the foundation for this report. Karen Lamonte (formerly FWC) should be recognized as the lead writer for the earlier BSR. Dan Sullivan (FWC) provided guidance to the Biological Review Panel on application of the International Union for the Conservation of Nature (IUCN) criteria at the BRP meeting and afterwards. Wendy Gierhart (U.S. Fish and Wildlife Service - USFWS) and John Himes (FWC) also participated in the BRP meeting. Ted Hoehn (FWC) and Bob Kawula (FWC) assisted in analyzing habitat change data for Criterion A. Wendy Gierhart prepared the aerial photo range map (USFWS 2005), which was consulted

during the BRP meeting, and provided data for Figure 1, which was prepared by Bob Kawula. Edwin and Lisa Keppner provided the extensive Panama City crayfish survey data for consideration. Special thanks to the BRP members and independent reviewers who were generous with their time and expertise.

## BIOLOGICAL INFORMATION

### Taxonomic Classification

The Panama City crayfish (*Procambarus econfinae*) belongs to the phylum Arthropoda, subphylum Crustacea, class Malacostraca, order Decapoda, and family Cambaridae. Hobbs (1972) subdivided the genus *Procambarus* into subgenera, and assigned *P. econfinae* to the subgenus *Leonticambarus*.

### Life History and Habitat

The Panama City crayfish is a small crayfish, growing to about 2 inches in size (body length minus claws), known only from the Panama City area of Bay County in Northwest Florida. It is brown overall with a light brown to tan stripe and a dark brown to black stripe extending from head to abdomen ("tail") along each side. The sides of the cephalothorax are light brown with reddish-brown dots. Although the color pattern is relatively distinct from that of other crayfish species collected within the range of the Panama City crayfish (Keppner and Keppner 2001), it is similar to that of related species that occur to the east (*Procambarus kilbyi*), north, and south (*P. apalachicola*). Definitive identification to species is based on the morphology of the first pair of pleopods (swimmerets) of reproductive (Form I) males (Hobbs 1942; Mansell 1994; Keppner and Keppner 2001, 2005). A detailed morphological description of the Panama City crayfish is presented in Hobbs (1942).

The Panama City crayfish is a secondary burrower, meaning it generally occupies burrows but will move into open water when it is available during rainy seasons. The burrows this crayfish constructs are simple downward passages from 1 to 3 feet deep, depending upon the depth of the water table. Burrows branch no more than once and burrow entrances are marked with crude chimneys made of excavated soil (Hobbs 1942, Keppner and Keppner 2001).

Little information is available on the historical habitat of the Panama City crayfish. Hobbs (1942:52) characterized the habitat at the 2 locations from which he collected specimens of the Panama City crayfish as, "flatwoods where the water table is only a foot or so below the surface, and standing water is present in them during the rainy season." Given this description, original habitat of the Panama City crayfish is thought to have been wet pine flatwoods (Keppner and Keppner 2001).

As of 2002 (FWC 2002), all 26 known locations of the Panama City crayfish were highly human-altered settings, including roadside ditches and swales and powerline rights-of-way.

Common characteristics of these sites include little to no overstory vegetation, abundant grass or herbaceous groundcover, and subject to temporary flooding during rainy seasons. Extensive additional sampling has been conducted since 2002, including at seemingly more natural sites (Keppner and Keppner 2005), but this general habitat description (i.e., open wetlands with herbaceous vegetation) has been corroborated.

Preference for certain hydric soils appears to be a key determinant of Panama City crayfish presence. Keppner and Keppner (2005:5) recognized 6 “core” soils, which they defined as “those soil types that support the PCC during the drought and during the normal dry season.” These core soils include: Pamlico-Dorovan Complex (Soil #22), Rutlege Sand (Soil #29), Plummer Sand (Soil #32), Pelham Sand (Soil # 33), Rutlege Sandy Loam (Soil #39), and Rutlege Pamlico Complex (Soil #51) (Keppner and Keppner 2005). As a result of surveys on sites along a pipeline corridor (Lawrence and Barth 2005), Deron Lawrence (see Appendix 4) concluded that the PCC is more strongly tied to the vegetative habitat (herbaceous wetlands) than to specific hydric soils, so long as the wetlands have < 50% closed canopy.

## **Threats**

Present threats to the Panama City crayfish are summarized in FWC (2003) and Keppner and Keppner (2005). The foremost perceived threat is habitat loss and degradation: “Much of the Panama City crayfish’s natural habitat (wet pine flatwoods) has been lost or degraded through residential, commercial, and industrial development, and through conversion to pine silviculture” (FWC 2003:5). Keppner and Keppner (2005) provide aerial photos of Bay County from 1941 and 2003 that dramatically illustrate the land use change from rural to urban across the Panama City crayfish range.

Habitat fragmentation and group isolation are proposed as additional threats, if they “increase vulnerability of sites to local extirpations due to adverse genetic, demographic, and environmental events” (FWC 2003:6). Another threat is direct mortality due to roadside ditch maintenance and dredging, infrastructure development, soil-disturbing silvicultural practices, pesticides and herbicides, off-road vehicles, and collection for fish bait. Also, potential competition and/or displacement due to the introduction of nonnative crayfish species is a possible concern (FWC 2003, Keppner and Keppner 2005).

## **BIOLOGICAL STATUS ASSESSMENT**

Available data on the range-wide Panama City crayfish population were evaluated by the Biological Review Panel (BRP) on November 1, 2005, relative to each of the five criteria for state listing under Rule 68A-1.004 F.A.C. (Appendix 2). In order to qualify for state listing as either endangered, threatened, or species of special concern, the Panama City crayfish must be shown to meet at least one of the five criteria. Details of the BRP meeting discussion that support the biological status assessment are provided in Appendix 4.

**Criterion A: Population Reduction**

This criterion requires the assessment of an observed, estimated, inferred, or suspected population reduction exhibited by the range-wide Panama City crayfish population over either the previous or the next 10 years or 3 generations (where generation time is the average age of mature individuals [capable of reproduction] in the population), whichever is longer. To meet this criterion for listing as endangered, threatened, or species of special concern, the population reduction percentage must be at least 80%, 50%, or 30%, respectively.

Data on the reproduction and life history of Panama City crayfish are limited. However, an estimate of the generation time for the Panama City crayfish can be made based on the general life history of cambarid crayfishes. According to Hobbs (2001), in cambarid crayfishes, most adults live 2.5-3 years, with the longest life span reported for non-cave dwelling cambarids being 6 or 7 years. The majority of cambarid crayfish breed more than once, with mating among mature yearlings frequent; however, many individuals don't become sexually active until the following late summer or fall.

If we assume this general life history information applies to the Panama City crayfish, then the age range of mature individuals is between 1 year and 7 years. This would place the generation time at about 2 to 4 years, and 3 generations would be between 6 and 12 years. Since we don't know the exact generation time of the Panama City crayfish, but because the estimated time for 3 generations is approximately 10 years (the default minimum for this assessment), we used a 10-year timeframe for our evaluation.

*Previous Trend.*— For discussion purposes, the evaluation period will refer to the years 1995-2005. Although the Panama City crayfish was listed as a species of special concern in the late 1980s, no survey work was conducted from the time the crayfish was listed until the spring of 2000 (Paul Moler pers. comm., Keppner and Keppner 2000). Survey work conducted prior to listing was not comprehensive and did not attempt to document numbers of extant populations or numbers of individuals (Hobbs 1942). At the time of the first petition (Keppner 2001), 22 extant Panama City crayfish sites were known. Since then, an extensive survey of St. Joe Timberland properties was conducted, and the current number of extant sites is about 800 (Keppner and Keppner 2005). However, despite our increased information on the number of occupied sites, we are not able to directly evaluate numerical population change of the Panama City crayfish during the last decade. At least seven known Panama City crayfish sites within urban Panama City appear to have been altered to the extent that they no longer support Panama City crayfish (Ed Keppner pers. comm., Appendix 4). This suggests that Panama City crayfish population reduction has not ceased, but continues, so that subcriterion (a)4 under the definitions in 68A-1.004 F.A.C. (Appendix 2) does not apply.

As an alternative to using actual population figures to measure population decline, changes in populations can be inferred from changes in the amount and suitability of habitat if relationships between the two are unambiguous. Panama City and Bay County, like most of Florida, have experienced rapid population growth over the last century. The majority of

commercial and residential development and silvicultural conversion likely occurred prior to 1990, but during the decade 1990-2000, the Bay County human population increased 16.7% (Bay County Economic Development Alliance 2001). This suggests a concurrent increase in loss of natural Panama City crayfish habitat.

A more direct assessment of loss of natural habitat was obtained by comparing landcover data available from 1988 with those from 2003. That 15-year timeframe was considered for the area within the 51 square mile crayfish extent of occurrence (see Criterion B below). If pineland, forested wetlands, freshwater marsh and wet prairie, and shrub swamps are assumed to comprise the Panama City crayfish's natural habitat, we calculate that 9.8% of that habitat was lost over the last 15 years by conversion to grass/agriculture, urban/barren, and open water. If conversion of "shrub and brushland" is also included as crayfish habitat, the habitat lost increases to 30.5% over the 15-year timeframe. Either scenario suggests that the amount of habitat loss within the Panama City crayfish range over the last 10 years was still less than the 30% required to infer ranking as a species of special concern (see Appendix 3).

It should be noted that the effects of the loss of natural habitat on the crayfish may have been offset to some degree because the Panama City crayfish uses man-made, artificial landscapes (e.g., roadside ditches; Mansell 1994). Creation of artificial habitats may have reduced the extent of population reduction that would have otherwise occurred for the Panama City crayfish over the last decade.

*Future Trend.*— What level of population reduction is projected or suspected to occur over the next 10 years (2005-2015)? It is estimated that the human population of Bay County will reach 175,499 by the year 2010, an 18% increase from 2000 (Bay County Economic Development Alliance 2001). While much of the natural habitat in the Panama City area has already been lost to commercial and residential development or converted to pine silviculture, future increases in the human population threaten both remaining natural habitats and the recently created artificial habitats known to support crayfish populations.

At the time the first BSR (FWC 2002) was written, there were only 26 Panama City crayfish sites known, with most of these in roadside ditches in urbanizing Panama City. That document (FWC 2002) suggested that most of these sites were threatened, and concluded that it was plausible that 50-80% of the total Panama City crayfish population could be extirpated over the next 10 years. That scenario of projected future population reduction would have qualified the Panama City crayfish for threatened status.

However, extensive survey efforts have subsequently identified about 800 Panama City crayfish sites on St. Joe Timberland Company (St. Joe) land east of Panama City, along powerline corridors and in and around pine plantations (Keppner and Keppner 2005). Although the continued persistence of urban crayfish sites is important to maintaining the species' total range (extent of occurrence, EOO), the long-term fate of the Panama City crayfish is not as dependent on the fate of the urban sites as previously thought. Since most of the known habitat actually occupied (area of occupancy, AOO) by the species is contained in the St. Joe property

recently surveyed, loss of the urban sites would not decrease the AOO by as much as 30%, the threshold of projected population reduction to qualify for species of special concern status.

Three current proposals have the potential to significantly impact future population trends. First, St. Joe, the U.S. Fish and Wildlife Service (USFWS), and FWC are considering a proposed Candidate Conservation Agreement (CCA) that would ensure Panama City crayfish protection on a core portion of the St. Joe land and mitigate for anticipated take of the species elsewhere. If approved, this agreement has the potential to conserve a large number of crayfish sites into the foreseeable future. A second proposal is the development of the Gulf Coast Parkway, a major roadway along the eastern boundary of the known Panama City crayfish range. The specific footprint of this road, its associated impact on crayfish habitat, and what mitigating actions may be involved, have yet to be determined. Third, Keppner and Keppner (2005) reference a plan by the Metropolitan Planning Organization for Bay County to construct a new road north to south through the center of Panama City crayfish habitat.

As of now, the balance sheet of future population reduction for the Panama City crayfish must include anticipated growth and development in Bay County, including impacts from the proposed Gulf Coast Parkway and other road projects, and possible mitigating benefits from long-term conservation agreements, including the proposed CCA. The BRP determined that more information is needed in order to demonstrate at least a 30% projected population decline for the Panama City crayfish over the next 10 years (Appendix 3).

### **Criterion B: Geographic Range**

This criterion requires an estimate of the Panama City crayfish's extent of occurrence (i.e., total range - EOO) and area of occupancy (i.e., area within the total range where the species actually occurs - AOO). These 2 parameters may differ considerably for species that are patchily distributed. To meet this criterion for listing as endangered, threatened, or species of special concern, the EOO must be less than 40 square miles, 2,000 square miles, or 7,700 square miles, respectively, or the AOO must be less than 4 square miles, 200 square miles, or 770 square miles, respectively. The criterion also includes an assessment of the species' distribution (i.e., severely fragmented or a limited number of locations) and a determination of whether or not the species is experiencing declines and/or fluctuations in extent of occurrence, area occupied, habitat quality, number of locations, or number of mature individuals.

The Panama City crayfish is endemic to Florida and is only known from the portion of Bay County in and around the city of Panama City. Hobbs (1942) estimated that the Panama City crayfish occurred over a 200 square mile area bordered by St. Andrews Bay on the north, west, and south, and possibly by a brackish creek on the east. Although this 200 square mile estimate now appears to be too generous, recent survey work by Keppner and Keppner (2001, 2005) supports Hobbs' general assessment of the distribution of the species, confirming the northern, western, and southern boundaries, and delimiting the extent of the eastern boundary (Callaway Bayou and Callaway Creek and tributaries). Keppner and Keppner (2005:3) note that the "boundary on the northeast has not been established but may be the unsuitable, well-drained



soils located in this area between Bayou George Creek and Callaway Creek headwaters.” Similar habitats to the east and north are occupied by more common and widespread species *Procambarus kilbyi* to the east (Keppner and Keppner 2001, 2005) and *P. apalachicola* to the north of Bayou George (and south of East Bay) (P. Moler, pers. comm.). Throughout the range of the Panama City crayfish, as indicated above, the species’ distribution appears to be highly fragmented and restricted to areas with appropriate soil type and habitat characteristics. We used this information (i.e., historical range and soil type) to estimate EOO and AOO for the Panama City crayfish.

*Extent of Occurrence.*— The Panama City crayfish occurs in and around Panama City, Bay County, and is bordered by St. Andrews Bay on the north, west, and south, and by Callaway Creek on the east. The maximum size of this historical range was calculated by drawing a convex polygon around the outer perimeter of the range, which yielded an estimate of approximately 81 square miles. It could be argued that calculating the extent of occurrence using the furthest extent of the boundaries of the historical range is overestimating the true extent of occurrence, because many areas within this range have been developed or do not have the proper soil type, and cannot support Panama City crayfish. To address this, we estimated the minimum EOO by calculating the area of a minimum convex polygon that encompassed the current (2005) known crayfish sites. The area of this minimum convex polygon (minimum EOO) was approximately 37 square miles. (Note that this is slightly larger than the 33 square mile EOO calculated in FWC [2002], when only 26 sites were known.)

On maps illustrating the distribution of the Panama City crayfish, Keppner and Keppner (2002, 2005) show a buffer zone or band around the EOO indicated by the known locations. This band suggests that the actual EOO could be greater than the 37 square miles calculated and underscores the fact that surveys have not been conducted throughout the entire range. The calculated area in the “Keppner EOO” is 51 square miles, and the BRP (Appendix 4) elected to use this as the best available EOO estimate for the Panama City crayfish. This EOO is shown in Figure 1 between the maximum EOO (81 square miles) and the minimum EOO (37 square miles).

We conclude the actual extent of occurrence for the Panama City crayfish lies somewhere between a minimum of 37 square miles and a maximum of 81 square miles. Accepting 51 square miles as a reasonable estimate places the crayfish within the definition for threatened under this criterion (Appendix 3). However, it should be noted that if future surveys indicate that the species does not occupy the “Keppner buffer band”, and/or if key localities in the western portion of the range are lost, the Panama City crayfish EOO could be estimated at less than 40 square miles, thus meeting the threshold for endangered listing under this criterion.

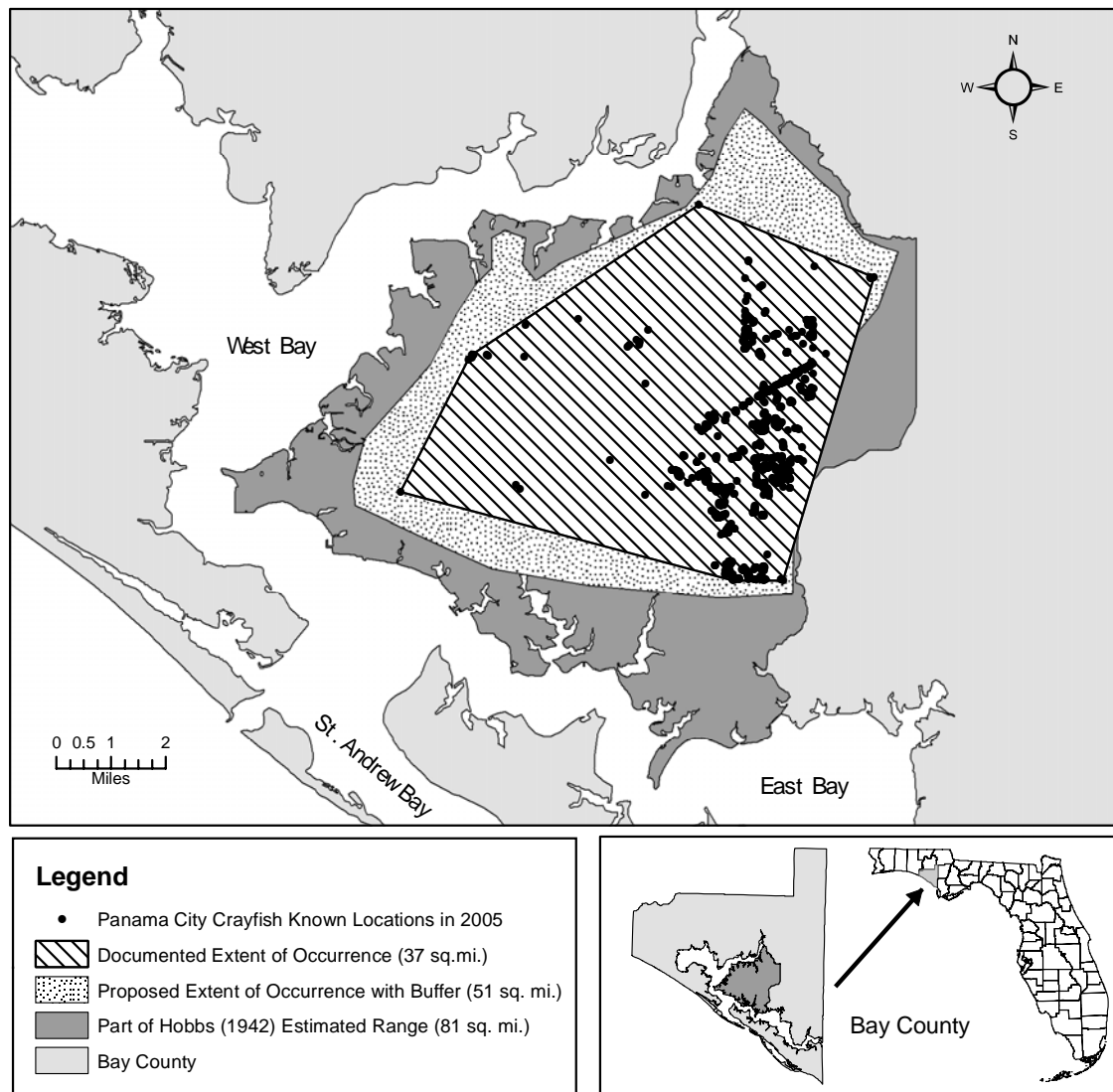


Figure 1. Extent of occurrence of the Panama City crayfish, Bay County, Florida. See text for explanation of the areas indicated. Data courtesy of USFWS.

*Area of Occupancy.*— As discussed above, the extent of occurrence of the Panama City crayfish is estimated to be between 37 and 81 square miles. For area of occupancy, the threshold for listing as threatened is an AOO less than 200 square miles; that for endangered is an AOO less than 4 square miles. Even if the Panama City crayfish is assumed to actually occupy all of the area within its range (81 square miles), it meets the area of occupancy threshold for listing as a threatened species under this criterion.

The U.S. Fish and Wildlife Service (unpub. data; see Appendix 4) estimated the AOO of the Panama City crayfish by overlaying a 1 km<sup>2</sup> (0.39 mi<sup>2</sup>) grid on a map of the known locations. This resulted in an AOO calculated to be 46 km<sup>2</sup> (18 mi<sup>2</sup>). The BRP accepted 18 square miles as

the estimated AOO for the crayfish, which places it in the threatened species designation under this criterion (Appendix 3).

Although the Panama City crayfish meets extent of occurrence and area of occupancy thresholds for the threatened category under this criterion, 2 of the following 3 conditions (subcriteria) must also apply for it to fully qualify: (1) the species' range must be severely fragmented or occupy < 5 locations; (2) the species must be experiencing declines and/or fluctuations in extent of occurrence, area occupied, habitat quality, number of locations, or number of mature individuals; or (3) the species must be experiencing extreme fluctuations in extent of occurrence, area occupied, number of locations, or number of mature individuals.

*Severely Fragmented or Number of Locations.*— The IUCN guidelines (IUCN 2004:20-21), upon which the FWC listing rules are founded, use “severely fragmented” to refer to the “situation in which increased extinction risks to the taxon results from the fact that most of its individuals are found in small and relatively isolated subpopulations.” A map of currently known Panama City crayfish locations (USFWS 2005; see also Keppner and Keppner 2005) exhibits a dichotomy of sites. There are a few, widely scattered sites known from the western, mostly urban half of the range, whereas there is a large number of sites distributed somewhat evenly across the recently surveyed St. Joe property in the eastern half of the range. It is unlikely that isolated urban sites in the western portion of the range could become connected and exchange individuals; crayfish distribution here can reasonably be considered “severely fragmented.” Assessing the distribution in the eastern part of the range is less straightforward and generated considerable discussion by the BRP (Appendix 4). On the large scale, the St. Joe sites do not exhibit obvious aggregations or subpopulations based on watersheds or hydrologic units; the BRP consensus was that the population is not fragmented in the areal extent of this “core area.” However, on the smaller scale, Panama City crayfish are considered poor dispersers; their distribution is naturally fragmented because they live in wetlands separated by uplands, and only small ridges are needed to restrict dispersal (P. Moler, Appendix 4). It was the BRP's consensus that the uplands, forested wetlands, roads, and dry periods function to fragment the population except during major rain events when subpopulations may be temporarily connected by sheet flow. Most of the time, however, the crayfish are unable to readily cross the many barriers separating the herbaceous wetlands that are their typical habitat. These wetlands are generally not functionally interconnected from the point of view of the crayfish, and the BRP reached the consensus that the Panama City crayfish population is severely fragmented (Appendix 3).

A “location” is defined as 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” (IUCN 2004:27-28). The BRP posed whether, if a major hurricane hit the Panama City peninsula, would it affect the whole Panama City crayfish population; i.e., is there only one location? Or, at a smaller scale, if a tanker truck spill could affect many sites at once, would this imply multiple locations?

Although pertinent, these points were not resolved, and the discussion on location was truncated by the consensus on severe fragmentation.

*Continuing Decline.*— This term is defined as “a recent, current or projected future decline (which may be smooth, irregular or sporadic) which is liable to continue unless remedial measures are taken” (IUCN 2004:19). To qualify under this subcriterion, the Panama City crayfish must exhibit a continuing decline in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent, and/or quality of habitat; (iv) number of locations or subpopulations; or (v) number of mature individuals. Based on the continued pace of growth and development in Bay County and concurrent loss of habitat, and the observed loss of some urban crayfish sites (see Criterion A above), the BRP determined that the Panama City crayfish population is subject to continuing decline in 3 categories (Appendix 3). These were categories (ii) area of occupancy; (iii) area, extent, and/or quality of habitat; and (iv) number of locations or subpopulations. The group agreed that a continuing decline was not occurring in (i) extent of occurrence, but this should be watched closely. Also, a continuing decline in (v) number of mature individuals may possibly be applicable, but relevant data are currently unavailable.

*Extreme Fluctuations.*— This is defined as occurring “where population size or distribution area varies widely, rapidly and frequently, typically with a variation greater than one order of magnitude (i.e., a tenfold increase or decrease)” (IUCN 2004:20). To qualify under this subcriterion, the Panama City crayfish population must exhibit extreme fluctuations in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; or (iv) number of mature individuals. Researchers note that the total number of crayfish visible at individual sites is seen to fluctuate with changing water levels determined by precipitation and drought, and extended dry periods may lead to mortality (Appendix 4). However, the number of mature individuals at a given site is hard to assess, due to their burrowing habit, and data are not available to demonstrate tenfold fluctuations. The BRP reached a consensus that this subcriterion is not applicable (Appendix 3).

Collectively, taking into account the above aspects of its geographic range, we conclude that listing of Panama City crayfish as a threatened species is supported under Criterion B. This conclusion is based on: (1) an estimated extent of occurrence of 51 square miles; (2) an estimated area of occurrence of 18 square miles; (3) evidence for a severely fragmented population; and (4) a continuing decline in the species’ area of occupancy, area, extent, and/or quality of habitat, and number of locations or subpopulations. This conclusion is summarized in Appendix 3.

### **Criterion C: Small Population Size and Decline**

This criterion combines an estimate of range-wide population size (in terms of the number of mature individuals) with an estimate of the population trend. To meet this criterion for listing as endangered, threatened, or species of special concern, the number of mature individuals must be less than 250; 2,500; or 10,000 respectively, with an estimated population decline of at least 25% over 3 years, 20% over 5 years, or 10% over 10 years, respectively. This

criterion also includes an assessment of the species' distribution among subpopulations and fluctuation in numbers.

Most survey work to date (Hobbs 1942; Mansell 1994; Keppner and Keppner 2000, 2001) has focused on locating and documenting sites containing Panama City crayfish populations, and not on attempting to count the number of individuals present. During recent surveys that located hundreds of new sites, Keppner and Keppner (2005) introduced a subjective ranking of sites by assessing relative numbers of crayfish (adults and juveniles) encountered in 5 net sweeps: sparse (1-2 specimens); moderate (3-5 specimens), and abundant (more than 5 specimens). They recorded dozens of sites ranked as abundant (Keppner and Keppner 2005, Fig. 3). Lawrence and Barth (2005) recorded size, gender, and number of crayfish caught during periodic surveys to monitor 7 disjunct populations in wetlands along a powerline right-of-way. Sampling with a varying number of sweeps, they recorded 0-57 Panama City crayfish, including up to 9 adults per site, in the study wetlands.

Based on such information and the panel's collective experience with the species, the BRP determined that it is reasonable to expect that, on average, each of the >800 known Panama City crayfish sites has more than 10 mature individuals, i.e., >8,000 total. The group therefore estimated that the number of mature individuals of the Panama City crayfish range-wide exceeds 10,000, the threshold for species of special concern. The panel thus determined that this criterion is not applicable (Appendix 3), and did not consider further aspects related to small population size and decline.

#### **Criterion D: Very Small or Restricted Population**

This criterion requires either: (1) the number of mature individuals to be no greater than 50, 250, or 1,000 mature individuals for listing as endangered, threatened, or species of special concern, respectively; or (2) an area of occupancy estimated at less than 8 square miles; or (3) no more than 5 locations. Subcriteria (2) and (3) would qualify for species of special concern.

However, as indicated above, the estimated number of mature individuals is greater than 10,000 (see Criterion C), and the AOO is estimated at 18 square miles (see Criterion B). The question on number of locations was not fully explored (see Criterion B), but the conclusion of severe fragmentation seems to imply the presence of more than 5 locations. Therefore, the BRP determined that this criterion is not applicable (Appendix 3).

#### **Criterion E: Quantitative Analysis**

This criterion requires a quantitative estimate of the probability of a species' extinction in the wild within a particular time frame. In order to be listed as endangered, threatened, or species of special concern, that probability would have to be at least 50% within the next 3 generations, 20% within the next 5 generations, or 10% within the next 100 years, respectively.

Available data are not sufficient to permit estimation or modeling of the probability of extinction of Panama City crayfish in the wild. Therefore, we are currently unable to evaluate this species relative to this criterion (Appendix 3).

## **LISTING RECOMMENDATION**

The Panama City crayfish is currently listed by the FWC as a species of special concern. Review of the available information on the Panama City crayfish supports the petition by Keppner (2001) that the species meets the criteria for threatened status under Criterion B (Geographic Range). At the same time, the petition by Bingham (2003) to delist the species is not supported. Consequently, it is the recommendation of the BRP that the Panama City crayfish be reclassified as a threatened species in Florida at this time. Florida's listing category of threatened is the same as the IUCN category of endangered; in IUCN terminology, the Panama City crayfish warrants an IUCN rating of ENB1a,b(ii, iii, iv); B2a,b(ii, iii, iv).

## **PUBLIC COMMENTS ON BIOLOGICAL STATUS**

Information on the public comments for the first BSR is presented in FWC (2002). On July 15, 2005, a request for written comments on the biological status of the Panama City crayfish was published in the Florida Administrative Weekly (Volume 31, Number 28:2577). The deadline for receipt of comments was 5:00 PM on August 31, 2005. During the specified time period, we received no written comments.

## **BIOLOGICAL REVIEW PANEL**

Information on the earlier BRP that led to the preparation of the first BSR is presented in FWC (2002). At their June 2005 meeting, the FWC Commissioners approved a new BRP for the Panama City crayfish (members listed in Appendix 4). This BRP held a meeting November 1, 2005, to review all available scientific data, previous listing action documents (including Keppner 2001, FWC 2002, and Bingham 2003), and evaluate the biological status of the Panama City crayfish based on the FWC listing criteria. Notes from that meeting are attached as Appendix 4. A draft of the present document was circulated to BRP members for review and concurrence both prior to, and following, submission to independent reviewers.

## **INDEPENDENT REVIEWERS**

Following review by BRP members, an earlier draft of this BSR was sent for review by the independent reviewers listed in Appendix 5. The reviews and comments submitted by the independent reviewers are presented in Appendix 6. Staff carefully considered these comments in development of the final biological status report.

## SUPPLEMENTAL INFORMATION AVAILABILITY

Comments from the BRP members, comments from the independent reviewers, copies of the literature cited in this report, and other information used in the development of this report may be reviewed at the FWC headquarters office in Tallahassee. Please call the Division of Habitat and Species Conservation (850-488-3831) to make arrangements for reviewing these materials.

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## **APPENDIX 1. Procedures for Listing, Delisting and Reclassifying Endangered, Threatened and Species of Special Concern.**

### **Rule 68A-27.0012, Florida Administrative Code (F.A.C.)**

- (1) Petition to list, delist, or reclassify a species in Rule 68A-27.003, 68A-27.004, or 68A-27.005, F.A.C.
  - (a) Persons wishing to add, delete or reclassify species in Rule 68A-27.003, 68A-27.004, or 68A-27.005, F.A.C., shall submit a written petition to the Commission. Petitions will be reviewed for completeness from July 1 through December 31.
  - (b) Petitions shall be clearly identified as such, and must contain the following in order to be considered complete:
    1. The rule to which the species is proposed to be added, removed from, or reclassified to,
    2. The name, address, and signature of the petitioner, and
    3. Sufficient information on the biology and distribution of the species to warrant investigation of its status using the criteria contained in definitions of endangered, threatened, or species of special concern in Rule 68A-1.004, F.A.C.
  - (c) Incomplete petitions will be returned to the petitioner with insufficiencies clearly noted in writing. Corrected petitions may be resubmitted for consideration.
  - (d) Complete petitions will be evaluated in accordance with the provisions in subsection (2).
  - (e) Emergency petitions may be submitted at any time and, if in the opinion of the Executive Director, immediate inclusion of a species in Rule 68A-27.003, F.A.C., is essential to prevent imminent extinction, such listing may be effected on a temporary basis by Executive Order; provided that the Executive Order shall be approved or terminated at the next regularly scheduled meeting of the Commission. Commission staff shall, within 365 days after the effective date of such approval, conduct the evaluations prescribed in subsections (2) and (3) of this rule to determine the appropriate final classification of the species. The Commission shall take final action on the listing at the next regularly scheduled meeting following the 365 day evaluation period.
  - (f) Notwithstanding the provisions contained in this paragraph, these procedures shall not be applied to harvested marine species that: would only meet the listing criteria in Rule 68A-1.004, F.A.C., due to declines caused by either recreational harvest, commercial harvest, or both; that are monitored through periodic stock assessments or other techniques; that are the subject of any rule in Title 68B, F.A.C., that allows harvest; and that have a management plan or other system of rules and processes that functions as a management plan.
- (2) Review of petitions to determine biological status; Phase 1.
  - (a) The Commission shall establish an annual work plan for investigating pending complete petitions, considering conservation priorities and available resources. The work plan shall establish a deadline for completion of each biological status review. Complete petitions not identified for staff action will be reconsidered with new complete petitions each subsequent year.
  - (b) The Commission shall provide notice by mail to parties who request such notification and

shall publish in the Florida Administrative Weekly a solicitation of information on the biological status of the petitioned species. Written comments regarding biological status shall be accepted by the Commission for a period of no less than 45 days following public notice.

- (c) Staff shall recommend and the Commission shall designate a biological review panel of scientists with demonstrated knowledge of species conservation and management that consists of an odd number of three to seven members. The biological review panel shall summarize information provided in the petition, information obtained from the public, and other available biological data on the status of the petitioned species into a biological status report. When assessing a species, this panel shall follow “Guidelines for Application of IUCN Red List Criteria at Regional Levels Version 3.0” and “Guidelines for Using the IUCN Red List Categories and Criteria, March 2004.” The biological status report shall contain a listing classification based on the IUCN guidelines and criteria in Rule 68A-1.004, F.A.C. In addition, the panel may provide within the report a biologically justified recommended classification which differs from the criteria-based classification by one level.
  - (d) Staff shall seek a minimum of three independent scientific reviews focused on the science used in the biological status report, including methodology, data, analysis, and interpretation. Reviewers will be provided no less than 45 days to comment on the biological status report.
  - (e) The Commission shall consider the biological status report, independent scientific reviews received, and public comments regarding the biological status in making a final determination whether addition, deletion or reclassification of the petitioned species in Rule 68A-27.003, 68A-27.004, or 68A-27.005, F.A.C., is warranted.
  - (f) If the petitioned species is determined by the Commission to warrant inclusion in or removal from Rule 68A-27.003, 68A-27.004, or 68A-27.005, F.A.C., the Commission shall:
    - 1. Specify the appropriate listing category for the species based on biological status.
    - 2. Establish a deadline for completion of Phase 2 for the species as described in subsection (3) below, considering the recommendation of Commission employees and other interested parties.
    - 3. If the species is not already listed in Rule 68A-27.003, 68A-27.004, or 68A-27.005, F.A.C., it shall be added to the list of candidate species in Rule 68A-27.0021, F.A.C., and the protective provisions therein shall apply to the species.
- (3) Development of management plans; Phase 2.
- (a) Phase 2 will be initiated subsequent to Commission action pursuant to subsection (2) except for a decision not to list a previously unlisted species. Within 45 days following the Commission meeting, the Commission shall provide notice by mail to parties who request such notification and shall publish in the Florida Administrative Weekly a solicitation of information on the conservation needs of the species, and any economic and social factors that should be considered in its management.
  - (b) The Commission shall use information obtained from the public and other available information to develop a draft management plan for each species described in paragraph (3)(a) of this rule section. This draft plan shall at a minimum address:

1. Biological status as determined in Phase 1,
  2. Conservation objectives,
  3. Recommended management actions,
  4. Recommended regulations and incentives,
  5. Anticipated economic, ecological, and social impacts of implementing or not implementing the recommended conservation actions.
- (c) The Commission shall provide notice by mail to parties who request such notification and shall publish in the Florida Administrative Weekly a notice of the availability of the draft management plan. Written comments regarding conservation recommendations and expected economic and social impacts of implementation of the management plan shall be accepted by the Commission for a period of no less than 45 days following public notice.
- (d) Final Commission action on the petition shall include:
1. Deletion of the species from Rule 68A-27.0021, F.A.C., if appropriate, and addition to and/or deletion from Rule 68A-27.003, 68A-27.004, or 68A-27.005, F.A.C., in accordance with the determination made in subsection (2) of this rule.
  2. A determination on any proposed regulations in the management plan.

## **APPENDIX 2. Definitions of the Florida Fish and Wildlife Conservation Commission Relative to Listed Species.**

### **Rule 68A-1.004, Florida Administrative Code (F.A.C.)**

- (27) Endangered species – As designated by the Commission, a species, subspecies, or isolated population of a species or subspecies which is so few or depleted in number or so restricted in range or habitat due to any man-made or natural factors that it is in imminent danger of extinction, or extirpation from Florida, as determined by paragraph (a), (b), (c), (d), or (e) below in accordance with Rule 68A-27.0012, F.A.C.
- (a) Reduction in population size based on any of the following:
1. An observed, estimated, inferred or suspected population size reduction of at least 80% over the previous ten years or three generations, whichever is longer, where the reduction or its causes may not have ceased or may not be understood or may not be reversible, based on (and specifying) any of the following:
    - a. Direct observation,
    - b. An index of abundance appropriate for the taxon,
    - c. A decline in area of occupancy, extent of occurrence, or quality of habitat,
    - d. Actual or potential levels of exploitation,
    - e. The effects of introduced taxa, hybridization, pathogens, pollutants, competitors, or parasites.
  2. A population size reduction of at least 80%, projected or suspected to be met within the next ten years or three generations, whichever is longer (up to a maximum of 100 years), based on (and specifying) any of subparagraph 1.b., 1.c., 1.d., or 1.e. above.
  3. An observed, estimated, inferred, projected, or suspected population size reduction of at least 80% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both past and future, and where the reduction or its causes may not have ceased or may not be understood or may not be reversible, based on (and specifying) any of subparagraph 1.a., 1.b., 1.c., 1.d., or 1.e. above.
  4. An observed, estimated, inferred, or suspected population size reduction of at least 90% over the last 10 years or three generations, whichever is longer, where the causes of reduction are clearly reversible and understood and ceased, based on (and specifying) any of subparagraph 1.a., 1.b., 1.c., 1.d., or 1.e. above.
- (b) Geographic range in the form of either extent of occurrence estimated to be less than 40 square miles or area of occupancy estimated to be less than 4 square miles, and estimates indicating any two of the following:
1. Severely fragmented or known to exist at only a single location.
  2. Continuing decline, observed, inferred or projected, in any of the following:
    - a. Extent of occurrence
    - b. Area of occupancy
    - c. Area, extent, and/or quality of habitat
    - d. Number of locations or subpopulations
    - e. Number of mature individuals

3. Extreme fluctuations in any of the following:
    - a. Extent of occurrence
    - b. Area of occupancy
    - c. Number of locations or subpopulations
    - d. Number of mature individuals
  - (c) Population size estimated to number fewer than 250 mature individuals and either:
    1. An estimated continuing decline of at least 25% within three years or one generation, whichever is longer (up to a maximum of 100 years in the future), or
    2. A continuing decline, observed, projected or inferred, in numbers of mature individuals and at least one of the following:
      - a. Population structure in the form of either no subpopulation estimated to contain more than 50 mature individuals, or at least 90% of mature individuals in one subpopulation.
      - b. Extreme fluctuations in number of mature individuals.
  - (d) Population size estimated to number less than 50 mature individuals.
  - (e) Quantitative analysis showing the probability of extinction in the wild is at least 50% within ten years or three generations, whichever is longer (up to a maximum of 100 years).
- (74) Species of special concern – As designated by the Commission, a species, subspecies, or isolated population of a species or subspecies which is facing a moderate risk of extinction, or extirpation from Florida, in the future, as determined by paragraph (a), (b), (c), (d), or (e) below in accordance with Rule 68A-27.0012, F.A.C.
- (a) Reduction in population size based on any of the following:
    1. An observed, estimated, inferred or suspected population size reduction of at least 30% over the last ten years or three generations, whichever is longer, where the reduction or its causes may not have ceased or may not be understood or may not be reversible, based on (and specifying) any of the following:
      - a. Direct observation.
      - b. An index of abundance appropriate for the taxon.
      - c. A decline in area of occupancy, extent of occurrence, and/or quality of habitat.
      - d. Actual or potential levels of exploitation.
      - e. The effects of introduced taxa, hybridization, pathogens, pollutants, competitors, or parasites.
    2. A population size reduction of at least 30%, projected or suspected to be met within the next ten years or three generations, whichever is longer (up to a maximum of 100 years), based on (and specifying) any of subparagraph 1.b., 1.c., 1.d., or 1.e. above.
    3. An observed, estimated, inferred, projected, or suspected population size reduction of at least 30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both past and future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of subparagraph 1.a., 1.b., 1.c., 1.d., or 1.e. above.
    4. An observed, estimated, inferred, or suspected population size reduction of at least

50% over the last 10 years or three generations, whichever is longer, where the causes of reduction are clearly understood and reversible and ceased, based on (and specifying) any of subparagraph 1.a., 1.b., 1.c., 1.d., or 1.e. above.

- (b) Geographic range in the form of either extent of occurrence estimated to be less than 7,700 square miles or area of occupancy estimated to be less than 770 square miles, and estimates indicating any two of the following:
  - 1. Severely fragmented or known to exist at no more than 10 locations.
  - 2. Continuing decline, observed, inferred or projected, in any of the following:
    - a. Extent of occurrence.
    - b. Area of occupancy.
    - c. Area, extent, and/or quality of habitat.
    - d. Number of locations or subpopulations.
    - e. Number of mature individuals.
  - 3. Extreme fluctuations in any of the following:
    - a. Extent of occurrence.
    - b. Area of occupancy.
    - c. Number of locations or subpopulations.
    - d. Number of mature individuals.
- (c) Population size estimated to number fewer than 10,000 mature individuals and either:
  - 1. An estimated continuing decline of at least 10% within ten years or three generations, whichever is longer (up to a maximum of 100 years in the future); or
  - 2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals and at least one of the following:
    - a. Population structure in the form of either no subpopulations estimated to contain more than 1,000 mature individuals, or all mature individuals are in one subpopulation.
    - b. Extreme fluctuations in number of mature individuals.
- (d) Population very small or restricted in the form of either of the following:
  - 1. Population size estimated to number fewer than 1,000 mature individuals.
  - 2. Population with a very restricted area of occupancy (typically less than 8 square miles) or number of locations (typically 5 or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future.
- (e) Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

(78) Threatened species – As designated by the Commission, a species, subspecies, or isolated population of a species or subspecies which is facing a very high risk of extinction, or extirpation from Florida, in the future, as determined by paragraph (a),(b), (c), (d), or (e) below in accordance with Rule 68A-27.0012, F.A.C.:

- (a) Reduction in population size based on any of the following:
  - 1. An observed, estimated, inferred, or suspected population size reduction of at least 50% over the last ten years or three generations, whichever is longer, where the reduction or its causes may not have ceased or may not be understood or may not be reversible, based on (and specifying) any of the following:

- a. Direct observation
  - b. An index of abundance appropriate for the taxon
  - c. A decline in area of occupancy, extent of occurrence, and/or quality of habitat
  - d. Actual or potential levels of exploitation
  - e. The effects of introduced taxa, hybridization, pathogens, pollutants, competitors, or parasites
2. A population size reduction of at least 50%, projected or suspected to be met within the next ten years or three generations, whichever is longer, (up to a maximum of 100 years), based on (and specifying) any of subparagraph 1.b., 1.c., 1.d. or 1.e. above.
3. An observed, estimated, inferred, projected, or suspected population size reduction of at least 50% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both past and future, and where the reduction or its causes may not have ceased or may not be understood or may not be reversible, based on (and specifying) any of subparagraph 1.a., 1.b., 1.c., 1.d., or 1.e. above.
4. An observed, estimated, inferred, or suspected population size reduction of at least 70% over the last 10 years or three generations, whichever is longer, where the causes of reduction are clearly understood and reversible and ceased, based on (and specifying) any of subparagraph 1.a., 1.b., 1.c., 1.d., or 1.e. above.
- (b) Geographic range in the form of either extent of occurrence estimated to be less than 2,000 square miles or area of occupancy estimated to be less than 200 square miles, and estimates indicating any two of the following:
  1. Severely fragmented or known to exist at no more than five locations.
  2. Continuing decline, observed, inferred or projected, in any of the following:
    - a. Extent of occurrence
    - b. Area of occupancy
    - c. Area, extent, and/or quality of habitat
    - d. Number of locations or subpopulations
    - e. Number of mature individuals
  3. Extreme fluctuations in any of the following:
    - a. Extent of occurrence
    - b. Area of occupancy
    - c. Number of locations or subpopulations
    - d. Number of mature individuals
- (c) Population size estimated to number fewer than 2,500 mature individuals and either:
  1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer (up to a maximum of 100 years in the future); or
  2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals and at least one of the following:
    - a. Population structure in the form of either no subpopulation estimated to contain more than 250 mature individuals, or at least 95% of mature individuals in one subpopulation
    - b. Extreme fluctuations in number of mature individuals
- (d) Population size estimated to number fewer than 250 mature individuals.

- (e) Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is longer (up to a maximum of 100 years).



**APPENDIX 3. Summary of the biological status of the Panama City crayfish relative to listing criteria.**

<b>Criterion/Listing Measure/(Rank)</b>	<b>Data</b>	<b>Criterion Satisfied?</b>	<b>Source</b>	<b>Confidence</b>
<b>A. Population Reduction</b>				
Previous trend $\geq$ 30% decline over last 10 yr (SSC) OR	Habitat loss, human pop. growth $<$ 30%	No	Inferred	Moderate
Future trend $\geq$ 30% decline over next 10 yrs (SSC)	Not available	Unknown		
<b>B. Geographic Range</b>				
Extent of occurrence $<$ 2,000 sq. miles OR (T)	37-81 sq. miles; best est. 51 sq. miles	Yes	Estimated	High
Area of occupancy $<$ 200 sq. miles AND (T)	18 sq. miles	Yes	Estimated	High
Severely fragmented or number of locations AND/OR	Severely fragmented as inferred by hydrology	Yes	Inferred	Moderate
Continuing decline in area of occupancy; area, extent and/or quality of habitat; number of locations or subpopulations AND/OR	Loss of known sites	Yes	Observed	High
Extreme fluctuations	Not available	Unknown		
<b>C. Small Population Size and Decline</b>				
Number of mature individuals $<$ 10,000 (SSC)	Survey records	No	Estimated	Moderate
<b>D. Very Small or Restricted Population</b>				
Mature inds. $\leq$ 1,000 AND/OR AOO $<$ 8 sq.mi (SSC)	Survey records	No	Estimated	High
<b>E. Quantitative Analysis</b>				
Est. extinction $\geq$ 10% in 100 yrs (SSC)	Not available	Unknown		

#### **APPENDIX 4. Panama City Crayfish Biological Review Panel notes from meeting held November 1, 2005, Tallahassee.**

##### **Attendees:**

David Cook (DC), Paul Moler (PM), Dan Sullivan\* (DS), John Himes\* (JH) – FWC

Patty Kelly (PK), Wendy Gierhart\* (WG) – FWS

Richard (Dick) Franz (DF) – FL Museum of Natural History

Deron Lawrence (DL) – Biological Research Associates

\* - not members of the Biological Review Panel

##### **Preliminary Discussion:**

Timeline of events for the Panama City crayfish (PCC)

1980's: It had been suggested that PCC might be extinct, so Paul Moler surveyed an area in Panama City in the late 1980's and found PCC. He proposed listing the PCC as a Species of Special Concern (SSC) in 1987.

2001: FWC received a petition (1) from Ed Keppner; based on surveys, he recommended up-listing PCC from SSC to Threatened (T)

2002: FWC Biological Status Report (BSR) recommended listing as T

2003: FWC management plan prepared for PCC; FWC listing criteria called into question and review of listing process began; FWC received a petition (2) from Frasier Bingham recommending de-listing PCC; both petition 1 and 2 are put on hold

4/2005: new FWC listing rules were approved

6/2005: Commission approved Biological Review Panels (BRPs) for 4 species, including PCC

11/2005: PCC BRP convened and will prepare a new BSR

Dan Sullivan presented IUCN training to the group and discussed the five criteria used to assess a species' status. He reminded the BRP that its charge is to make a recommendation to the Commission on PCC status; the BRP itself will not make the listing action. He also emphasized the importance of documenting any assumptions made where data are lacking.

##### **Biological Assessment:**

The review panel began by discussing PCC generation time, because a time frame is needed to address the IUCN criteria. The generation time is the average age of breeding adults of the current cohort.

DL: Based on Hobbs (2001), crayfish average age is 2-1/2 to 3 years, with some crayfish living up to 7 years. This is not necessarily specific to PCC.

DF: Asked Deron if he always found adults during his quarterly powerline surveys for PCC.

DL: His survey results varied throughout the year, with fluctuations in the number of adults caught. Deron is surveying a powerline R-O-W for Bay County, from Transmitter Road northeast to John Pitts Road, to monitor the construction effects of a pipeline installation. Some of his survey data included ~100 individuals in the summer of 2003, 12 individuals in March 2004, 30 individuals in March 2005, 12 individuals in June 2005, and no individuals in September 2005. The initial baseline survey and the subsequent relocation event consisted of daytime dipnetting, although some minnow traps and night-time dipnet surveys were conducted during the relocation. Additionally, burrow locations and activity levels were documented.

Deron offered to provide copies of his survey report.

PM: Is the daytime dipnet survey method proven to be the most successful? Some crayfish, such as *P. hubbellei*, are active at night so surveys may be best conducted at night.

DL: Only a few adults were collected in the minnow traps left out overnight, and minimal night-time dipnet surveys were not very productive.

DF: Feels that there are fluctuations in the adult population throughout the year, and the PCC population is correlated with precipitation.

DL: During his surveys, he noticed many adults in the water and active chimneys at the water's edge. He noted that there has been an ongoing debate as to whether the PCC retreats to burrows during drying of wetlands, or whether PCC migrates with retreating waters. He has observed that following re-inundation of wetlands following dry periods, the PCC is not immediately present, which would indicate that there is not a large number of them emerging from local burrows.

PM: Concerned that the summertime (June, July, August) surveys are not a good indication of fluctuations in the population. The water gets too hot in these small wetlands, and the PCC burrow underground. They can stay underground for months at a time. Also, Paul would rather see a comparison between September 2004 and September 2005 survey data instead of a comparison between the 4 quarters of 2005.

DL: Noted that he has quarterly data for 2 years, and that the December comparisons indicate that population levels track wetland water level more strongly than season. Because of drier than average weather, the PCC population has been very low at the monitoring wetlands both during summer and winter months.

PK: The October 2004 Keppner report discusses PCC life history, and suggests that reproduction occurs from March through December if suitable conditions are met. This is based on survey results, including observing various size juveniles and also ovigerous females during different times of the year.

DC: The first FWC BSR did look at generation time, and David read from the report (page 3, 3<sup>rd</sup> paragraph under Criterion A: Population Reduction). The report says that adults range from 1 to 7 years old, with generation times at 2 to 4 years. This puts 3 generations at 6 to 12 years. The minimum time frame for the IUCN assessment is 10 years.

There was consensus among the panel members that the information from the previous FWC BSR represented the best available scientific information on generation time to date for the PCC.

**Therefore this analysis uses a generation time of 10 years.**

### **Criterion A: Population Reduction**

**A.1. Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction are clearly reversible AND understood AND have ceased, based on a-e.**

WG: At least 2 sites have been destroyed: industrial site at Hwy 231 and Hwy 77 across from the Panama City mall and the PCC site on 26<sup>th</sup> St. and Jenks Ave. which is now the Talkington development.

PK: Will check with Ed Keppner to see how many of his survey sites within the city are still extant. [Nov. 22, 2005 field visit with EK report that seven of his survey sites within the city appear altered to the extent to no longer contain the PCC. Most were from box cutting ditch

maintenance practices. Drought prohibited actual surveys to confirm.]

PM: Habitat destruction associated with increased development has been ongoing. This is an ongoing cause and it has not ceased.

**There is panel consensus that criterion A.1. is not applicable.**

**A.2. Population reduction observed, estimated, inferred or suspected in the past where the causes of reduction may not have ceased OR may not be understood, OR may not be reversible, based on a – e.**

DS: Reminded the panel to be careful not to look at historical conditions compared to today's condition to find a trend. Also, that the generation time was set at 10 years, so we must look at population reductions from 1995 to 2005.

PK: Some of the analysis from the ongoing FWS Candidate Conservation Agreement with Assurances (CCAA) indicates around 60% of the core soils still remain in the PCC range. This analysis compared pre-development soils to the current (2005) condition, removing soils impacted by development that would no longer be suitable for PCC.

DS: But, the resulting 40% decrease in habitat (based on soils) did not occur solely within the last 10 years - the PCC generation time. It was suggested that perhaps there was only a 10% decline in suitable habitat due to development over the last 10 years. The IUCN threshold for Vulnerable (State Species of Special Concern) ranking is  $\geq 30\%$ .

DC: Suggested that we analyze development trends over the past 10 years to better quantify habitat destruction. Aerial imagery is available from 1994 and 2004 to make this comparison.

WG: This analysis would be time consuming, suggested using Landsat satellite imagery instead to document urbanization. The scale is 30 square meters, but analysis would quickly tell us if we are reaching the 30% threshold. *USFWS and/or FWC will address this task.*

PM: Began discussion on core soils and whether this classification is accurate.

WG: Core (5) and secondary (6) soils are defined by Keppner reports and are primarily based upon PCC capture locations and soil survey datasets.

PM: PCC love the ditches, and these ditches were created to drain the adjacent wetlands. Core soils may no longer be suitable because of altered hydrology, so only addressing soils may not be accurate.

PK: Poor land management, including fire suppression, alters the vegetation and speeds succession. Even if the core soils are present, the right canopy density may not be present.

DL: In his surveys, PCC are found in herbaceous wetlands and in pine plantations adjacent to wetlands with  $< 50\%$  closed canopy.

DL: Would like to see the core and secondary soils reassessed, possibly to be replaced by hydric and non-hydric soils mapping combined with vegetative assessment. It appears that the PCC is most strongly tied to vegetative habitat (herbaceous wetlands), and that soil type is not a good indicator because the PCC is found in all hydric soils within the EOO.

DF: To quantify a population decline, he would like to know how many of the Keppners' urban survey sites have been lost.

DL: Asked if we could quantify the amount of urbanization in herbaceous wetlands.

DF: Stated that introduction of invasives and pine plantations can lower the suitability of a site, and wondered if the Keppners have documented any occurrence of this.

PK: The Keppners have found PCC within pine plantations, primarily in the bedded furrows that retain water. PCC were only found in plantations with a low amount of duff and open canopies. They have been confirmed using edges of pine plantations where the canopy is still open.

Referring to DL's statement above, it seems logical that they may only occur in pine plantations that are in close proximity to wetlands with <50% closed canopy.

**The panel agreed on the assumption that the number of crayfish is tied to the habitat condition.**

DS: Asked the group if the changes in fire, succession, and canopy closure occurred within the last 10 years.

There was some discussion on pine rotations and the variability of vegetative conditions. The information on PCC habitat requirements and preferences is either not readily available or unknown at this time.

**The panel decided that criterion A.2.c. may apply, but the data are not readily available.**

### **A.3. Population reduction projected or suspected to be met in the future based on b – e.**

WG: Based on the current known locations, a minimum convex polygon would result in a minimum EOO of 37 mi<sup>2</sup>. The maximum EOO would be 81 mi<sup>2</sup> if the entire peninsula was considered occupied.

There was some discussion that these numbers may warrant a threatened or endangered listing under Criterion B; however, Criterion A concerns population levels and not the geographic range, so this discussion was deferred until we talked about Criterion B.

DL: If certain of the outlying urban sites are lost in the future, the EOO and AOO would dramatically decrease, without dramatically affecting the population size.

All: If the urban sites were lost, the population size would not decrease by 30%, which is the IUCN threshold for Vulnerable (State Species of Special Concern).

PM: The site he documented in 1987 is degraded by ditch maintenance and adjacent development.

DF: Ditches are maintained, but changes in hydrology can be detrimental. An example was given about a *Procambarus* species in Osceola National Forest. Ditches there were connected to other water bodies. This can introduce new crayfish to the area which extirpates the existing crayfish species. The ditches in the PCC range are in a somewhat fragile state and should be considered vulnerable sites.

DC: One concern to the future PCC population size is the proposed Gulf Coast Parkway. The plans for this highway include expanding Star Ave. into a four-lane divided road from Hwy 231 south to Tram Road. Two options are being looked at for the northern connection to Hwy 231, using either Star Avenue or Nehi Road. An additional option is to widen Tram Road from Star Avenue west to Hwy 98. Ted Hoehn, FWC, is reviewing and commenting on the proposed road for the agency.

PK: Mary Mittiga, FWS, is reviewing the proposed plan and submitting comments to DOT this November (2005). Both FWC and FWS are including comments regarding PCC and potential adverse impacts related to this development project.

DC: FWC will conduct GIS analysis to determine the number of known PCC sites projected to be impacted. They will then see if the population reduction proportion meets the IUCN criteria threshold.

PK: It may be possible to include DOT as a partner in the ongoing FWS CCAA, to provide mitigation options.

All: There are many unknown consequences to PCC if the proposed Gulf Coast Parkway is built. There will be habitat loss and direct take of PCC along Star Avenue, Nehi Road, and Tram Road. It is unknown whether DOT has a mitigation plan for these losses. Also unknown is whether the

mitigation would be enough to recover the PCC population size to pre-construction levels. It was agreed that the proposed road expansion be monitored closely to alleviate negative impacts to PCC.

**The panel determined that criterion A.3 might apply, but more information is needed, especially on potential impacts of the Gulf Coast Parkway and the pending CCAA.**

## **Criterion B: Geographic Range**

### **B.1. Extent of Occurrence (EOO)**

WG: Based on the 2005 current PCC locations, a minimum convex polygon would result in a minimum EOO of 37 mi<sup>2</sup>. The maximum EOO could be 81 mi<sup>2</sup> if the entire peninsula was considered occupied. This maximum EOO covers the entire historic range, and is not a convex polygon around PCC locations.

DF: The 81 mi<sup>2</sup> range seems to be too large, because that entire area is not completely occupied. Perhaps the range delineated by Ed Keppner could be applied. That range has been published in a couple of Keppner reports, and represents some of the best available scientific data.

WG: The Keppner EOO is approximately 51 mi<sup>2</sup>.

DL: The Keppner EOO assumed a buffer around the minimum convex polygon, which is probably overly expansive given the sampling that has been done outside of the known population in order to document additional PCC locations. If one of the western PCC sites were lost, there would be a significant decline in the EOO for the PCC.

All: The panel decided on using a range for the EOO between 37-81 mi<sup>2</sup>, with 51 mi<sup>2</sup> as the best available estimate. The threshold range on the IUCN criteria are between 40 and 2,000 mi<sup>2</sup>, so the panel did not try to nail down the most accurate EOO.

**This places the PCC within either the Critically Endangered (State Endangered) or Endangered IUCN category (State Threatened). Accepting 51 mi<sup>2</sup> as the best available EOO estimate puts the PCC in the IUCN Endangered (State Threatened) category.**

### **B.2. Area of Occupancy (AOO)**

WG: The herbaceous wetlands presently occupied by PCC have not been mapped. To estimate the AOO, a 1 km<sup>2</sup> grid was overlaid with known PCC locations. The AOO was calculated to be 46 km<sup>2</sup> (18 mi<sup>2</sup>). The process was also done with a 2 km<sup>2</sup> grid, resulting in the same size AOO.

**All: This places the PCC within the Endangered IUCN category (State Threatened).**

### **B.1. or B.2. AND at least 2 of the following (a-c):**

#### **a. Severely fragmented or # of locations**

All: The western urban half of the PCC population is fragmented from the remaining PCC east of Transmitter Road. There are no longer hydrologic connections between the two halves of the population. The panel discussed the number of locations represented by the PCC population.

DS: The IUCN defines a location in relation to credible threats. For instance, if a hurricane hit the Panama City peninsula, would it affect the PCC population as a whole? If so, then you would have 1 location/population. Or if there was a tanker truck spill, it might only affect a portion of the PCC population within that watershed, which would imply multiple locations/

populations.

All: It is agreed that the urban unit is severely fragmented. However, there is discussion over the eastern half of the PCC population (referred to as the core area). Should this be considered one management unit, or is this area also fragmented? If the area is already fragmented, is it severely fragmented?

DL: Pointed out that the IUCN guidelines identify 'severely fragmented' to mean "most of its individuals are found in small and relatively isolated subpopulations" (p21). Most of the PCC are found in the eastern part of the range, and it appears difficult to draw areas of aggregation for isolated subpopulations in this area. Since there don't appear to be separate subpopulations within the core area, it seems that it would be difficult to argue that the population is severely fragmented.

DF: Asked whether the hydrologic units could be used to identify subpopulations. If so, watershed lines would be appropriate for identifying fragmentation lines.

PK: Reviewed FWS hydrologic map with PCC populations plotted, and did not see a clear segregation of subpopulations by watershed. Since there is very low topographic relief, it appeared that some populations crossed over watershed lines where wetlands drained into different sub-basins.

PM: He is not comfortable dividing the core area by HUCs (16-digit hydrologic units, created by FL DEP). The HUCs are drawn based on elevation and the only thing separating each watershed unit is a perched herbaceous wetland. The PCC inhabit these wetlands, which can be connected through sheet flow and underground burrows.

DS: Warned the panel not to get off target by defining PCC locations. Instead, focus on answering whether the population is severely fragmented or not.

All: The natural dispersion of PCC is through sheet flow movement, but there could be some minimal terrestrial movement. Some barriers to movement include hardwood swamps, four-lane roads, and Star Avenue. It is unknown whether PCC move through culverts.

DL: PCC are naturally fragmented because they live in wetlands which are separated by uplands.

PM: PCC are poor dispersers, which is partly why they are endemic to this area. Only small ridges of elevation are needed to restrict dispersal. PCC move more through water and especially during high water events.

DL: Still wonders if terrestrial movement, or wandering, is more common. When the water begins to recede, do the PCC follow the water, burrow into the ground, or die?

DF: It is unknown whether PCC are obligate burrowers. They are secondary burrowers.

DF/PM: PCC can stay in burrows for long periods of time, up to many months.

DF: The young PCC may group together in wetlands and ditches as their habitats start to dry up. It is unknown whether the young are even equipped to dig burrows, or to dig burrows deep enough to remain in contact with the water table. It is possible that young PCC could occupy abandoned burrows.

DS: The panel seems to be seeing at least 2 different units. The urban area is a large area with a few populations that are severely fragmented. The eastern area is a small core area with a large number of individuals that may be fragmented at a local level.

DL: Some factors causing fragmentation include drought, uplands, and other unsuitable habitat, such as hardwoods swamps, thick titi stands, and pine plantations.

All: Perhaps high water events are needed for reproduction. If so, the PCC may be separated into each HUC. The interval between high water events is unknown. For example, there was a 5 year drought in the late 1990's – how could this relate to a 3 year generation time for PCC?

WG: Fragmentation may not be easy to infer when looking at the maps. Twenty points clustered together may really indicate one wetland used by PCC.

All: The maps will have to be redone prior to the June 2006 Commission meeting, so as to not bias an opinion on fragmentation.

DL: Concerned over calling the eastern half of the range fragmented.

PM: If the panel does not want to say that the population is fragmented, then look at the number of locations. There are probably fewer than 10 locations, and the IUCN threshold for Vulnerable is  $\leq 10$  locations. When looking at the HUCs in the urban areas, many are probably connected now by ditches. If this is the case, you have an even smaller number of locations. If you define location by threat, this scale is at some degree of a drainage unit, so there are probably  $<10$  locations which means the population is fragmented.

DF: Fragmentation in the core area can cause temporary isolation, so the case could be argued both ways.

PK/PM: Believe the term severely fragmented does apply to PCC.

DC: Needs more information before deciding on fragmentation of the core area. If the HUCs are all connected at their headwaters, then PCC might not be fragmented. However, bedded furrows, plow lines, ditches, and uplands break apart a watershed within one HUC, so is the connectivity even still there?

DL: Summarized the group's consensus that the population is not fragmented in aerial extent of the core area, but that the fragmentation is related to the inability of crayfish to readily cross the many barriers among herbaceous wetlands that are their typical habitat. The uplands, forested wetlands, roads, and dry periods function to fragment the population except during times of sheet flow or possible migrations. The majority of the time, the PCC probably remains in the small herbaceous wetlands that are generally not functionally interconnected from the point of view of the PCC.

**After much discussion, the panel reached consensus that sub-criterion a. was applicable. The PCC population is severely fragmented.**

**b. Continuing decline in any of i-v**

- i) extent of occurrence
- ii) area of occupancy
- iii) area, extent, and/or quality of habitat
- iv) number of locations or subpopulations
- v) number of mature individuals

**Group discussion quickly agreed that criterion (i) was not yet occurring but should be watched closely. Criteria (ii), (iii), and (iv) were indeed applicable to PCC, and criterion (v) was possibly applicable.**

**c. Extreme fluctuations in any of i-iv**

- i) extent of occurrence
- ii) area of occupancy
- iii) number of locations or subpopulations
- iv) number of mature individuals



DL: Has observed that there are fluctuations in the population because of changing water levels.  
PM: Brought up concerns over powerline survey methods and whether comparisons should be made on the PCC population size.

DL: Precipitation levels and drought can cause fluctuations, and the stress can cause mortality unless most PCC are moving to burrows or adjacent wet areas. During extended dry periods, there is likely mortality under both scenarios.

DF: There is also a white fungus that is found on some crayfish species that can cause mortality. This has not been documented with PCC, but should be monitored as it could cause a population fluctuation.

DC: Population fluctuation is specific to adults; is population of adults fluctuating severely?

DL: Not likely as much as total population. Unsure what exact level of fluctuation is, but is more comfortable with assessment that population not fluctuating more than 10X frequently.

**After much discussion, the panel reached consensus that sub-criterion c. was not applicable.**

### **Criterion C: Small Population Size and Decline**

The panel estimates that the number of mature individuals is over 10,000 and this is the IUCN threshold for Vulnerable (State Species of Special Concern). There are over 800 collection points, so if there are at least 10 adults per site, there would be 8,000 individuals. The number of collection sites may represent a smaller number of occupied wetlands, but there are probably many more adults per site.

**The panel agreed that Criterion C is not applicable.**

### **Criterion D: Very Small or Restricted Population**

The estimated AOO for PCC is 46 km<sup>2</sup> (18 mi<sup>2</sup>). The IUCN threshold for Vulnerable (State Species of Special Concern) is 20 km<sup>2</sup> (8 mi<sup>2</sup>) so **Criterion D is not applicable.**

### **Criterion E: Quantitative Analysis**

**No analysis has been performed, so Criterion E is not applicable.**

### **Final Discussion:**

DS: Now that the panel has run through the IUCN criteria, the panel must decide on the PCC status recommendation that will go before the Commission. The panel does not have to choose the status based solely on the results of the IUCN criteria, and may incorporate other factors into their final decision.

**The panel concluded that Criterion B.1., along with sub-criteria B.1.a. and B.1.b. (ii through iv) would place PCC in either the Critically Endangered (State Endangered) or Endangered (State Threatened) category.**

PK: Surveys have not been conducted throughout the potential range, so the EOO could be higher than 37 mi<sup>2</sup>. Also, the Keppner range is about 51 mi<sup>2</sup> and the maximum range is 81 mi<sup>2</sup>. This would make the Endangered (State Threatened) category a better fit.

DS: The panel feels that the IUCN ranking comes out as Endangered (State Threatened) and asked if anyone felt the ranking recommendation should be higher or lower.

PM/PK/DF/DC: agree with the Endangered (State Threatened) ranking recommendation.

DL: Feels that the imminent threat of the proposed Gulf Coast Parkway could further fragment the core area. Also, future build-out of undeveloped lands is probable. Finally, if any of the outlying urban PCC sites are destroyed, the EOO would be greatly reduced, which would compress the EOO to less than 30 mi<sup>2</sup>. He would feel more comfortable making the ranking recommendation of Endangered (State Threatened) if there were a mechanism in place to regularly monitor the population and more accurately evaluate the population response to development.

DS: The status of PCC will be addressed anytime a petition is submitted to FWC. These petitions can come from within or outside of FWC. Also, safeguards can be written into the PCC management plan. The plan can call for a periodic review of the species' status, or it can incorporate language that states what actions will be taken if certain sites are lost or the population begins to decrease. There is also an emergency listing clause if a catastrophic event occurs.

DL: Weighing all of this information, he now feels comfortable making the Endangered (State Threatened) ranking recommendation.

### **Final BRP Recommendation**

**The BRP will recommend to the Commission that the Panama City crayfish state status be changed from Species of Special Concern to Threatened.**

## **APPENDIX 5. Panama City Crayfish BSR Independent Reviewers**

Mr. Robert S. Butler  
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Dr. Neil Cumberlidge  
Professor and Head, Department of Biology  
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Dr. James W. Fetzner, Jr., Visiting Assistant Curator  
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Mr. Russel Frydenborg  
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## **APPENDIX 6. Reviews of Panama City Crayfish BSR Provided by Independent Reviewers**

**All six independent reviewers concurred with the BRP's recommendation to reclassify the Panama City crayfish as threatened.**

Five reviewers provided reviews in letter format; these are reproduced in subsequent pages. One of these reviewers, Dr. Jim Fetzner, provided comments relating to obtaining and using genetic data for the species, and cautions about monitoring urban sites and minimizing loss due to road projects. These observations will not be addressed here, but are expected to be incorporated in the management plan to be drafted following approval of the BSR.

The sixth reviewer, Mr. Robert Butler, provided his March 2, 2006, review as an edited hardcopy of the BSR; an electronically scanned copy of his complete review is available upon request from the FWC. Many of his suggested changes involved typographical or format issues; most of those were faithfully executed in the BSR. The more substantive comments are transcribed below, identified by associated section and paragraph, with the responding action described.

### **Robert Butler comments:**

Criterion A: Population Reduction.

Paragraph 1. Comment: Can you provide a rough estimate on size of total range (acres/hectares or dimensions) in the text?

Response: The areal distribution of the crayfish is discussed in detail in the subsequent Geographic Range section, so this comment was not addressed here.

Paragraph 10. Comment [referring to St. Joe Timberland Company]: Since they are dev. corp., is this land "secure" or might it be sold for development?

Response: As mentioned in the subsequent paragraph, the USFWS and FWC are presently working with St. Joe to prepare a Candidate Conservation Agreement involving a large area of as-yet undeveloped land within the eastern range of the Panama City crayfish. A goal of this agreement will be to conserve populations of the crayfish in perpetuity in a core area, while managing the impact of development on the species elsewhere.

Criterion C: Small Population Size and Decline.

Paragraph 3. Comment [referring to last sentence statement "this criterion is not applicable"]: I'm not following this logic – further, it sounds like you're picking and choosing criteria that are important/not important and being somewhat subjective. You quantify pop size, then disregard.

Response: Further assessment of this criterion is only called for if population size is estimated to number fewer than 10,000 mature individuals. Since the BRP's consensus was that the total population size of the Panama City crayfish exceeds 10,000 mature individuals, the criterion was deemed inapplicable and its further consideration judged irrelevant.



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23 March, 2006

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Dear David,

My comments on the draft biological status report (BSR) for the Panama City crayfish, *Procambarus econfinae*, are as follows. The report is carefully considered and makes appropriate use of the guidelines for this process. Luckily for these reviewers, there is quite a bit of current information on the distribution over time and on the population levels of this species that allows for an informed evaluation of possible trends in EOO and AOO, and population levels. In addition there is a reasonable amount of quantitative data available for making estimates of the impact of human-induced threats (land use changes) and pollution on the long-term survival of this species. The totality of this information has allowed a thorough review of its conservation status.

After a careful reading of the dataset available (summarized in Appendix 3), it would seem to me that the species warrants an IUCN rating of ENB1a,b(ii, iii, iv); B2a,b(ii, iii, iv). This would agree with the conclusions of the review panel, that the PCC should be classified as 'State Threatened' (IUCN EN).

The EOO (estimated to be 132.09 km<sup>2</sup>, with a range between 100 km<sup>2</sup> and 209 km<sup>2</sup>) and an AOO of 46.6 km<sup>2</sup> both fall within the low end of the range for EN. However, the population size of the PCC is estimated to be greater than 2,500 adults, which exceeds the parameters for part C of the EN category. The fact that this species has been collected recently from a healthy number of localities (up from 26 in 2002 to over 800 in 2005) on the face of it would argue for a positive view of the current health of the populations of this species, despite identified fragmentation.

In conclusion, in my opinion based on the entirety of available data, the most appropriate assessment of the Panama City Crayfish would be State Threatened (IUCN EN).

Sincerely,

Neil Cumberlidge, Ph.D.  
Professor and Head

**Review of**

**Preliminary Draft Biological Status Report  
Panama City Crayfish (*Procambarus econfinae*)**  
[Prepared by the Panama City Crayfish Biological Review Panel]

**By**

**Dr. James W. Fetzner Jr.**

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April 10, 2006

**Biological Status Report Overview:** The draft biological status report covers the discussions by the Panama City Crayfish Biological Review Panel about the status and conservation ranking of the Panama City crayfish (*Procambarus econfinae*). These rankings are based on IUCN Red List guidelines for classifying species into the state endangered, threatened, and species of special concern categories. The Panama City Crayfish is endemic to Bay County, Florida and is currently known from about 800 "sites" within the county. The panel discussed ranking this species based on five different IUCN criteria: 1) Population reduction, 2) Geographic range, 3) Small population size and decline, 4) Very small or restricted population, and 5) by Quantitative analysis. They found that the species qualified for listing as threatened under the second criterion, Geographic range. The species did not meet the minimum limits of the other four criteria, either because the criteria were not applicable or there was a lack of available data to render a decision one way or the other. The panel then made a recommendation to reclassify the Panama City crayfish from a species of special concern to a threatened species.

**General Review Comments:**

I think that the methodologies, analyses, and interpretations used by the Biological Review Panel (BRP) to assess the status of the Panama City crayfish (PCC) are adequate and I agree with the assessment of the BRP in recommending a listing of Threatened for this species. However, I think that it is abundantly evident that there is an overwhelming lack of biological and life history data available for this species. If the species is to persist, such data shortfalls will need to be addressed so that populations can be sustained into the future.

Plans for a large road construction project (Gulf Coast Parkway) through PCC habitat could have

an immediate adverse impact on the species and should be considered by officials very carefully.

Ways to minimize the loss of populations, or large numbers of individuals, should be sought, with possible consideration of the capture and removal of individuals from the proposed construction site and later restocking them back to the same area after the project has been completed. If this is done, the genetic integrity of the population should be maintained (i.e., by returning all individuals to their original place of capture).

One potential source of very useful data which was not discussed by the BRP is the use of genetic data to address many of the issues raised by the panel (see discussion below). Unfortunately, genetic data is also currently lacking for this species, so many of these questions still could not be answered by the BRP, but such data is relatively easy to generate once the proper samples have been obtained. Genetic data can also be used to directly answer many of the IUCN listing criteria, thus giving managers access to more rigorous and quantitative numbers when making these types of status assessments. Often, I think that agencies forget or ignore the potential benefits that genetic data can bring to bear on species conservation issues.

Many conservation questions can only adequately be answered through an analysis of genetic variation (i.e., forensic applications, assessment of population distinctiveness, etc.).

### **Specific Review Comments:**

#### *Using Genetic Data*

I think one of the main questions still remaining to be answered regarding the Panama City crayfish is: Do the 800+ sites in Bay County constitute a single interbreeding (i.e., panmictic) population, or are distinct subpopulations present, thus indicating a lack of geneflow (i.e., distinct gene pools), each of which might require more individually focused conservation efforts?

The resulting answer to this question directly impacts or influences every conservation action related to this (and many other) rare species. For example, if the species is panmictic (with most populations sharing similar genetic alleles) the loss of a few sites should not greatly impact the overall genetic diversity of the species (and thus its future adaptive potential remains intact). On the other hand, if the species actually represents a conglomeration of multiple independent subpopulations, each containing unique genetic variants, the loss of a few sites may greatly impact the viability and survival of the species. Knowing ahead of time that unique subpopulations may be impacted or lost due to the approval of road construction permits, utility upgrades, or urban sprawl, would enable managers to easily assess what should be done to reduce impacts to these unique populations.

The PCC currently occupies a relatively small geographic area (the BRP conservatively estimated this as 51 mi<sup>2</sup>). One might not expect to see too much genetic variation in such a small area, but given that the population has been fragmented by the urban areas of Panama City for quite some time, and there is the potential that the core population to the east may possibly be fragmented by upland areas separating the wetlands where the species occurs, the existence of multiple subpopulations can not be ruled out. The BRP touched on many points related to fragmentation (see pgs. 30-31 of the report), but they had no hard evidence available to them to make any concrete conclusions, besides the locations of the populations. One panel member suggested using hydrological drainage units (HUCs) as delimiters of sub-population groups, but others on the panel had reservations about doing this since times of flooding would make it "possible" for PCC individuals to migrate among different HUCs.

Available genetic data from other crayfish species suggests that populations residing in different stream drainages tend to be quite different genetically (e.g., Fetzner and Crandall 2003; Fetzner and DiStefano 2005). Currently, no population genetic studies have been conducted which look at variation in burrowing crayfish species. Thus, direct comparisons of genetic correlates to

stream-dwelling species may not be straightforward, as one would expect that the routes for migration among populations in these two very different ecological groups may be more limiting for burrowing species because they would have to traverse large areas of unsuitable habitat. This would mean that burrowers should show higher levels of population subdivision (i.e., are probably more highly fragmented than their stream-dwelling counterparts).

#### *Criterion A: Population Reduction*

It is clear that several PCC sites have been either impacted or lost in the western (urban) portion of the range due to population growth and construction projects, as documented by the Keppner reports. This seems to have been offset somewhat by the species' use of man-made ditch habitats. However, the projected increase in human population size within the county by 2010 suggests that many of these urban sites may be lost due to development. These populations are clearly at a higher risk of being lost due to their urban setting, and I echo the opinion of several panel members on the issues of continued monitoring of these populations. If these populations are lost, there is a great impetus for listing the PCC as endangered due to the drastic reduction in the area of occurrence that would result. Are there plans for continued monitoring of these urban sites? It would be difficult to establish the loss of a population due to construction, etc., without some sort of periodic monitoring efforts. What would the reduction in overall genetic diversity be in the PCC if these more "remote" sites are lost?

#### *Criterion B: Geographic Range*

Most of the BRP discussion revolved around this criterion, mainly because data were available or could be easily generated regarding the geographic range of the species. Estimates for the values of the extent of occurrence and area of occurrence were made. The estimate of 51 mi<sup>2</sup> includes the "Keppner buffer zone". Survey efforts should be made to sample this area to see if the species actually occurs there or not, as this may eventually affect the status listing of the species (i.e., upgrading to Endangered). The area of occurrence estimate agreed upon by the BRP places the PCC in the Threatened category. I concur with the BRP that the current best estimate of area of occurrence is 51 mi<sup>2</sup>. Therefore, upgrading the PCC status to Threatened is warranted.

#### *Criterion C: Small Population Size and Decline*

The BRP arrived at a reasonable estimate of >10,000 mature individuals for the PCC. This value was generated based on field work done by the Keppners and others, who used open water net sweeps as an estimate of population abundance. The PCC is a burrower, so it seems reasonable to assume that not all individuals will be out in the open water, but rather spend most of their time inside their burrows. Therefore, I think the BRP estimate is probably a conservative estimate of the number of mature individuals and that the PCC does not meet the minimum values for listing under this criterion. Population decline (or increase) can also be inferred from genetic profiles, as these phenomena leave characteristic "signatures" that can be analyzed statistically.

#### *Criterion D: Very Small or Restricted Population*

As stated by the BRP, the number of mature individuals was estimated to be greater than 10,000. This is based on assuming that at least 10 adult individuals are present at each site, a wholly realistic estimate, if not an underestimate. Additionally, not all lands with suitable PCC habitat have been surveyed yet, so additional sites may still be found, thus increasing this estimate of population size. The BRP concluded that this criterion was not applicable because the number of estimated adult individuals exceeded the minimum number for listing.



*Criterion E: Quantitative Analysis*

This is essentially a species or population viability analysis where life history data are used to assess the combined impact of deterministic and random factors on the probability of extinction.

The BRP was not able to assess this criterion due to a lack of available biological and natural history data. Such analyses can also be done separately or in combination with genetic data. There is a clear relationship between the loss of genetic diversity and extinction risk, so assessing levels of genetic variability can give an indication of persistence of the species into the future.

*Conclusion*

The available data (i.e., extent of the species geographic range), as well as the presumed threat to natural habitats in the near future (road construction, etc.), along with estimated human population growth and expansion in the county by 2010 suggests that this species will need further protective measures in order to remain viable into the future. Given the available data, I think the BRP made the right decision in reclassifying the PCC as Threatened at this time.

**Literature Cited:**

- Fetzner, J. W., Jr., and K. A. Crandall. 2003. Linear habitats and the nested clade analysis: an empirical evaluation of geographic versus river distances using an Ozark crayfish (Decapoda: Cambaridae). *Evolution* 57:2101-2118.
- Fetzner, J. W., Jr., and R. J. DiStefano. 2005. Phylogeographic analysis of *Orconectes williamsi*, a critically imperiled crayfish from the upper White River drainage of Missouri: Implications for conservation. Pp. 32. Missouri Department of Conservation, Final Report, Columbia, MO.

Review of Panama City Crayfish Biological Status Report  
Russ Frydenborg  
FDEP Bureau of Laboratories  
March 13, 2006

As a peer reviewer, I evaluated the scientific rigor and legal defensibility of the process utilized by the committee to make their final decision concerning the status of the Panama City Crayfish (PCC) (*Procambarus econfinae*).

I determined that the committee gathered available data to methodically address the criteria presented in Rule 68A-1.004 FAC, which is the Florida Fish and Wildlife Conservation Commission's rule governing the procedure by which taxa are placed on the State threatened or endangered list. Committee members met on November 1, 2005 to review all available scientific data, as well as previous listing action documents, and evaluated the data against the above rule.

### **Population Reduction**

Survey work by Keppner and Keppner showed that the number of active PCC sites increased from 22 in 2001 to 800 in 2005, with the loss of only seven previously known sites. A Geographic Information System analysis determined that the predominant habitats for the PCC (pineland, forested wetlands, freshwater marsh/prairie, and shrub swamps) were reduced by 9.8% from 1988-2001. These data suggest that the PCC does not meet the criterion that the species experience a  $\geq 30\%$  decline in the past 10 years to be listed as a species of special concern. Because of many current proposals that would potentially mitigate habitat loss for the species, the committee could not establish whether there would be a  $\geq 30\%$  decline in future populations.

### **Geographic Range**

The data clearly indicate that the PCC is endemic to Florida and its range is confined to the area in the vicinity of Panama City. The aerial extent of the species occurrence was estimated to be 51 square miles, based on a reasonable buffer band around the minimum convex polygon of the known PCC sites. This meets the State's threatened listing criterion (extent of occurrence  $< 2000$  square miles). By placing a  $1 \text{ km}^2$  grid over the known PCC locations (a practical approach, given the limited dispersion of the species), an area of occupancy of 18 square miles was estimated. This meets the State's threatened listing criterion (area of occurrence  $< 200$  square miles). To fully qualify as a threatened species, two out of three additional criteria must be met. Due to the continual hydrologic disruption (ditching, draining, and filling of wetlands, as well as natural droughts, etc.) in the study area, the committee judged that there was severe habitat fragmentation. Due to the known loss of occupied sites, the committee decided that there were declines of the PCC in area of occupancy, area and extent of habitat, and numbers of locations. These final two determinations fully qualify the PCC as a threatened species. I concur with the assessment.

### **Small Population Size and Decline**

To gain status as a species of special concern, it must be determined that the number of mature individuals is less than 10,000. Since there are  $> 800$  known sites, and based on field survey data, each site should have at least 10 mature individuals, it is estimated that there are more than 8000 mature individuals in the area of occupancy. The committee judged that it was unlikely that the PCC qualified under this criterion, and I agree.

### **Very Small or Restricted Population**

To gain status as a species of special concern, it must be determined that the number of mature individuals is  $< 1000$  and/or the area of occupancy is less than 8 square miles. Survey data indicated that neither of these criteria were met.

### **Quantitative Analysis**

Because data were insufficient to establish a predictive model capable of estimating the extinction of the PCC, this criterion was not evaluated.

### **Summary**

The committee assessed the available scientific information in the context of applicable Florida Administrative

Code, deliberated in an objective and rational manner, and determined that the Panama City Crayfish should be reclassified as a threatened species, based on the geographic range criterion. In my opinion, the process was scientifically sound, and based on the data presented in the biological status report, I agree with the committee's findings. I would urge that the species be routinely monitored to determine whether protective strategies (conservation easements, etc.) are effective, thereby preventing the taxon from achieving endangered status in the future.



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26 February 2006

David G. Cook  
Wildlife Biologist / Invertebrate Taxa Coordinator  
Species Conservation Planning Section  
Division of Habitat & Species Conservation  
Florida Fish & Wildlife Conservation Commission  
620 South Meridian Street  
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Dear Mr. Cook:

I have read the "Preliminary Draft Biological Status Report" on the Panama City Crayfish, *Procambarus econfinae*, and concur with the conclusion of the Biological Review Panel that the Panama City Crayfish should be listed as a threatened species in Florida. The information used in the biological status report, including methodology, data, analysis, and interpretation, is the best available and is summarized objectively and accurately.

Listing the Panama City Crayfish as a threatened species is clearly supported under Criterion B. The evidence for a severely fragmented population and a continuing decline in the species' area of occupancy and quality of habitat appears indisputable.

Given the extremely small range of the Panama City Crayfish and the fact that all known localities for the species are in highly human-altered settings, there appears to be little doubt that the species is threatened by habitat loss and degradation, and that this threat is likely to increase in the near future. In my opinion, the Panama City Crayfish is likely to go extinct unless it is protected by the State of Florida.

Sincerely,

A handwritten signature in black ink that reads "Lawrence M. Page".

Lawrence M. Page,  
Adjunct Curator of Fishes

**From:** James D Williams [jdwilliams@usgs.gov]  
**Sent:** Thursday, April 13, 2006 2:15 PM  
**To:** Cook, David  
**Subject:** Panama City Crayfish Review Comments

David

I have reviewed the biological and ecological information on the Panama City Crayfish presented in the Biological Status Report. First let me say I think this is one of the best documented status reports for a narrow endemic that I have ever read. It is clearly a very thorough job and is well written.

The taxonomic status of *Procambarus econfinae* appears to be valid. The fact that it has been examined by several specialist since its description provides a solid foundation for recognizing this species. The documentation of threats and population reduction was very clearly presented. The limited range of this species makes it extremely vulnerable. This biological fact combined with the rapid growth and development of its wet pine flatwoods habitat clearly indicates a need for conservation attention. This data makes it abundantly clear that without some pro-active conservation measures this species will become extinct. I found no flaws in the reasoning that lead to the recommendation of Threatened status for the Panama City Crayfish.

After review, I concur with the conclusions of the Review Panel in assigning a conservation status of Threatened to the Panama City Crayfish.

If you have any questions please dont hesitate to contact me. Thank you for the opportunity to review this report.

Sincerely,

Jim Williams

<> <> <> <> <> <> <>

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