U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Procaris hawaiana*

COMMON NAME: Anchialine pool shrimp

LEAD REGION: Region 1

INFORMATION CURRENT AS OF: April 2010

STATUS/ACTION

___ Species assessment - determined we do not have sufficient information on file to support a proposal to list the species and, therefore, it was not elevated to Candidate status
___ New candidate
_X__ Continuing candidate
___ Non-petitioned
_X__ Petitioned - Date petition received: May 11, 2004
_ 90-day positive - FR date:
_X_ 12-month warranted but precluded - FR date: May 11, 2005
_N_ Did the petition request a reclassification of a listed species?

FOR PETITIONED CANDIDATE SPECIES:
a. Is listing warranted (if yes, see summary of threats below)? Yes
b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? Yes
c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded.
Higher priority listing actions, including court-approved settlements, court-ordered and statutory deadlines for petition findings and listing determinations, emergency listing determinations, and responses to litigation, continue to preclude the proposed and final listing rules for the species. We continue to monitor populations and will change its status or implement an emergency listing if necessary. The "Progress on Revising the Lists" section of the current CNOR (*http://endangered.fws.gov/*) provides information on listing actions taken during the last 12 months.

_N_ Listing priority change
Former LP: ___
New LP: ___

Date when the species first became a Candidate (as currently defined): October 25,1999

___ Candidate removal: Former LPN: ___

___ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
___U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.
___ F – Range is no longer a U.S. territory.
___ I – Insufficient information exists on biological vulnerability and threats to support listing.
___ M – Taxon mistakenly included in past notice of review.
___ N – Taxon does not meet the Act's definition of "species."
___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Crustaceans; Family Procarididae (anchialine pool shrimp)

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Hawaii, islands of Maui and Hawaii.

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Hawaii, islands of Maui and Hawaii.

LAND OWNERSHIP : The two Maui pools known to contain *Procaris hawaiana* occur on State land within the Ahihi-Kinau Natural Area Reserve (NAR). On the island of Hawaii, 12 pools occur on State land within the Manuka NAR and one pool occurs on State land, owned and managed by the Department of Hawaiian Home Lands (DHHL).

LEAD REGION CONTACT: Linda Belluomini, (503) 231-6283, linda_belluomini@fws.gov

LEAD FIELD OFFICE CONTACT: Pacific Islands Fish & Wildlife Office, Christa Russell (808) 792-9400, christa_russell@fws.gov

BIOLOGICAL INFORMATION

Species Description

Procaris hawaiana (Holthuis 1973, pp. 12-19) ranges in total length from 0.4 to1.2 inches (10 to 30 millimeters). This species has a pink to light-red pigmentation which is darkest along the midline with the dorsal thorax white to yellow. Black pigments are associated with the eyes. Conspicuous chelapeds (claws) are lacking. Locomotion is accomplished by swimming with the swimmerets (pareopods and uropods) and occurs just above the substrate to mid-water (Holthuis 1973, pp. 12-19). Little is known about the reproductive biology or the diet of this shrimp although it has been documented to scavenge other species of anchialine shrimp and has taken frozen brine shrimp (Holthuis 1973, pp. 12-19) when in captivity. The shrimp family Procarididae is represented by a small number of species globally and there are only two species

within the genus *Procaris* (Holthuis 1973, pp. 12-19). The second species, *P. ascensionis*, is restricted to similar habitats on Ascension Island in the south Atlantic Ocean.

Taxonomy

Procaris hawaiana was described by Holthius in 1973. This species is recognized as a valid taxon in MacLauglin *et al*. (2005).

Habitat/Life History

Procaris hawaiana is known to occur from mid-salinity (19 to 25 parts per thousandth (ppt)) anchialine pools. Anchialine pools are land-locked bodies of water that occur coastally but are not openly connected to the ocean (Macioleck 1983, pp. 607-612). They are mixohaline, with salinities typically ranging from 2 ppt to concentrations just below that of sea water (32 ppt), although there are pools recorded as having salinities as high as 41 ppt (Maciolek 1983, pp. 607-612; Brock *et al*. 1987, p. 200). Anchialine pools are subject to tidal fluctuations. Except for some records of endemic eels, anchialine pools in Hawaii do not support native species of fish although some species of nonnative fish have been introduced and are currently recognized as problems (see Disease or Predation section below) (Bailey-Brock and Brock 1993, p. 354; Brock 2004, p. i).

Historical Range/Distribution

Although anchialine pools are widespread, being found in areas such as Saudi Arabia, Madagascar, Fiji, and other Indo-Pacific islands, the total area occupied by them globally is extremely small (Maciolek 1983, pp. 607-612). While a number of species of anchialine shrimp have disjunct, global distributions within these habitats, most geographic locations contain some endemic taxa (Maciolek 1983, pp. 607-612). *Procaris hawaiana* is one of these endemic taxa known only from the islands of Hawaii and Maui in the state of Hawaii.

Current Range/Distribution

Currently in the state of Hawaii, there are estimated to be over 650 anchialine pools, approximately 90 percent of which occur on the island of Hawaii (Brock 2004, p. i). Of the approximately 585 anchialine pools found on the island of Hawaii, only 15 pools are known to contain *Procaris hawaiiana*. There are 12 pools at Manuka NAR (T. Sakihara, Division of Aquatic Resources (DAR), *in litt.*, 2010) and 1 located at Lua o Palahemo, where *P. hawaiiana* co-occurs with *Vetericaris chaceorum* (Holthuis 1973, pp. 12-19; Maciolek 1983, pp. 607-614; Brock 2004, pp. 30-57), another candidate species. On Maui, *Procaris hawaiana* occurs in two pools at Ahihi-Kinau NAR (Holthuis 1973, pp. 12-19; Maciolek 1983, pp. 607-614; Brock 2004, pp. 30-57).

Population Estimates/Status

Like other anchialine pool shrimp species, this species inhabits an extensive network of water-filled interstitial spaces (cracks and crevices) leading to and from the actual pool, and this trait has precluded researchers from obtaining more accurate population size estimates during surveys for the species (Holthuis 1973, p. 36; Maciolek 1983, pp. 613-616). Many of the rare species of anchialine shrimp, including *Procaris hawaiana*, have merely been noted as present or absent from pools that have been surveyed (often with the aid of baiting). Loss of shrimp species from

suitable habitat is likely the best or only, measure of species decline since population sizes are not easily determined (Holthuis 1973, pp. 7-12; Maciolek 1983, pp. 613-616).

THREATS

A. The present or threatened destruction, modification, or curtailment of its habitat or range. On the island of Hawaii it is estimated that up to 90 percent of the anchialine pools have been destroyed or altered by human activities (Brock 2004, p. i). The more recent human modifications of anchialine pools include the bulldozing and filling of pools (Bailey-Brock and Brock 1993, p. 354). Dumping of refuse and the introduction of nonnative fish (see Disease or Predation section below) have impacted other anchialine pools on this island (Brock 2004, pp. 13-17).

Brock (2004, pp. 13-17) identified the use of anchialine pools as refuse receptacles as an example of habitat degradation. He also stated that refuse, like bottles and cans, appears not to have any short-term negative impact but the dumping of used oil, grease and oil filters has resulted in the disappearance of another species of anchialine pool shrimp, *Halaocaridina rubra*, from a pool adjacent to Honokohau Harbor on the island of Hawaii. Lua o Palahemo lies within lands administered by the State's DHHL and is accessible to the public. Currently, there are no known plans for future use of these lands. In 2005, U.S. Fish and Wildlife Service (Service) employees, noted no evidence of dumping, though dumping had previously occurred there (Brock 2004, pp. 13-17).

The two Maui pools known to contain *Procaris hawaiana*, were modified by early Hawaiians and later inhabitants of the area, but are within Ahihi-Kinau NAR. Dumping does occur in the Maui NAR, and while none has yet occurred within the pools, this threat remains a possibility (Brock 2004, pp. 13-17).

Damage from use of anchialine pools for swimming and bathing has been documented in the Hawaiian Islands (Brock 2004, pp. 13-17). Similar impacts to the anchialine pools on the islands of Hawaii and Maui are possible but have not, at present, been documented.

B. Overutilization for commercial, recreational, scientific, or educational purposes. The Service has become aware of companies and private collectors using anchialine pool shrimp and related shrimp species for self-contained aquariums similar to those marketed by Ecosphere Associates, Inc. (Ecosphere Associates 2006, p. 1). One company located in Hawaii, Fuku Bonsai, has already begun using Hawaiian anchialine pool species for the aquarium hobby market (Fuku-Bonsai 2007, p. 1). For commercial purposes, currently only a State Commercial Marine License is required to collect anchialine pool shrimp. Collection is prohibited in State Natural Area Reserves but not on DHHL lands.

C. Disease or predation.
In Hawaii, predation by introduced nonnative fish is considered to be the greatest threat to native shrimp within anchialine pool ecosystems (Bailey-Brock and Brock 1993, p. 354; Brock 2004, pp. 13-17).

Anchialine pools have been used to discard or hold bait-fish and/or aquarium fish (Bailey-Brock and Brock 1993, p. 354). These fish either directly consume the native shrimp or, as with introduced tilapia (*Oreochromis mossambica*), out-compete the native herbivorous species of shrimp that typically serve as the prey-base for the rarer, predatory species of shrimp (Bailey-Brock and Brock 1993, p. 354). Introduction of nonnative fish including bait-fish into such pools may have been a major contributor to the decline of these shrimp (Brock 2004, pp. 13-17). Invasion, with human assistance, of anchialine pools by nonnative fish is a potential threat and is the most significant impact to pool shrimp and their habitat since the pools are easily accessible to the public. Within the State NARs, disturbance of the pools is prohibited and informative signs have been placed at the sites. At Lua o Palahemo a sign stating "Lua o Palahemo site disturbance subject to fine HRS 6E and 16 USC 3701" has been placed at the single pool. However, signs may not be an adequate deterrent. For example, since 1985 signage was used to keep people from entering the Waikoloa Achialine Pond Preserve at Waikoloa, North Kona, Hawaii. Visitors were not allowed into the pool preserve but could walk around the perimeter. In December 2003, it was discovered that someone had released tilapia and mosquito fish into the system. Within six months time, alien fish had invaded two thirds of the system and all the anchialine pool shrimp disappeared (Brock 2004, pp. 13-17).

No alien fish species were seen during the most recent survey of the Maui pools where these shrimp occur (Brock 2004, p. i). On the island of Hawaii, there was no evidence of nonnative fish in the pool at Lua o Palahemo during a site visit by Service employees in 2005.

D. The inadequacy of existing regulatory mechanisms.

Procaris hawaiana currently receives no protection under Hawaii's endangered species law (HRS, Sect. 195-D) or the Federal Endangered Species Act (16 U.S.C. §1531-1544). Although there are no existing regulatory mechanisms that specifically protect this species, 2 Maui pools and 12 Hawaii Island pools are located within the Ahihi-Kinau NAR and Manuka NAR, respectively. This designation specifically prohibits the removal of any native organism and the disturbance of pools (Administrative Rules, Sec. 13-209-4). The State NARs were created to preserve and protect samples of Hawaiian biological ecosystems and geological formations; and are actively managed and monitored for their unique ecosystems. Though signs are posted that provide notice to the public that the pools are off-limits to bathers and other activities that could damage the pools, the State's NARs have no funding for proper enforcement to stop such activity.

E. Other natural or manmade factors affecting its continued existence.

Even if the threats responsible for the decline of this species were controlled, the persistence of existing populations is hampered by the small number of extant populations and the small geographic range of the known populations. This circumstance makes the species more vulnerable to extinction due to a variety of natural processes. Small populations are particularly vulnerable to reduced reproductive vigor caused by inbreeding depression, and they may suffer a loss of genetic variability over time due to random genetic drift, resulting in decreased evolutionary potential and ability to cope with environmental change (Lande 1988; Center for Conservation Biology 1994). Small populations are also demographically vulnerable to extinction caused by random fluctuations in population size and sex ratio (Lande 1988).

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

On Maui, *Procaris hawaiana* pools lie within the Ahihi-Kinau State NAR. Ahihi-Kinau was the first NAR to be established by the State of Hawaii, and in fact, the presence of the anchialine pools and their rare resident shrimp species was a key reason this area received this designation (Holthuis 1973, pp. 4-5). On the island of Hawaii, 12 pools lie within the Manuka NAR. This species receives some protection under the state statutes that specifically prohibit the disturbance or removal of any plant or wildlife and the disturbance of any pond or lake. In addition, signs have been placed at the pool locations at Lua o Palahemo and Ahihi-Kinau State NAR forbidding disturbance of the pools.

In August 2007, we jointly resurveyed Ahihi-Kinau State NAR with the State Division of Aquatic Resources. We found no evidence of any non-native fish and found *Procaris hawaiana* in one of the pool groups it was known from. We were scheduled to resurvey the Ahihi-Kinau State NAR at night during the high-high tide in July 2008 with DAR staff, however, due to State budget shortfalls the trip was cancelled. Our joint efforts with the State's DAR to develop a statewide monitoring plan for anchialine pool shrimp, including *P. hawaiana*, has also been put on hold.

On June 16, 2008, a symposium on anchialine pool conservation and management was held at the 89th annual meeting of the American Association for the Advancement of Science, Pacific Division. In addition, a statewide meeting concerning the monitoring of anchialine pools was hosted by the Service on January 15, 2009. Results of that meeting include: an update on the status of monitoring efforts across the State; initiation of the development of a common monitoring protocol; the establishment of a listserv; and development of an anchialine pool symposium annually at the Hawaii Conservation Conference beginning in 2010.

SUMMARY OF THREATS

Based on our evaluation of habitat degradation and loss due to bulldozing, fill, and trash dumping in anchialine pools and the effects of predation by nonnative fish we conclude there is sufficient information to develop a proposed listing rule for this species due to the threat of habitat destruction or contamination by dumping, fill, and bulldozing, and the threat of the release of nonnative fish in any one of the known pools where *Procaris hawaiana* occurs. In addition, overcollection by the aquarium hobby market is a potential threat to *P. hawaiana.* Collection of the species is prohibited in the Ahihi-Kinau and Manuka NARs, but is not prohibited at Lua o Palahemo. Disturbance of the pools is prohibited at both locations. However, enforcement of these prohibitions is difficult and the negative effects from the introduction of nonnative fish are extensive and happen quickly. We find that this species is warranted for listing throughout all its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

For species that are being removed from candidate status:

___Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions (PECE)?

RECOMMENDED CONSERVATION MEASURES:

- Monitor known pools for evidence of dumping, and presence of nonnative fish and other habitat changes
- Conduct ecological research on habitat requirements and basic life history of *Procaris hawaiana*

LISTING PRIORITY

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	**5***
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude:
The threats to *Procaris hawaiana* from habitat degradation and destruction, and predation by nonnative fish are of high magnitude because this species occurs in only three pool groups on two islands. All individuals of this species within a pool may be adversely impacted by a single dumping of trash or release of nonnative fish in any of its three remaining sites.

Immediacy of Threats:
Threats to *Procaris hawaiana* from nonnative fish, dumping, fill, recreational activities, development and overcollection are nonimminent because they are not on-going. Nonnative fish are not currently present in the pools in which *Procaris hawaiana* currently occurs.

Rationale for Change in Listing Priority Number (insert if appropriate)

Yes___ Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed?

Is Emergency Listing Warranted?
No. *Procaris hawaiana* is currently known from three populations, two of which are located within the State's Ahihi-Kinau and Manuka NARs. State statutes may provide some protection to the species. The species does not appear to be appropriate for emergency listing at this time because the immediacy of the threats is not so great as to imperil a significant proportion of the species' total populations within the time frame of the routine listing process. If it becomes apparent that the routine listing process is not sufficient to prevent large losses that may result in this species' extinction, then the emergency rule process for this species will be initiated. We will continue to monitor the status of *Procaris hawaiana* as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures.

DESCRIPTION OF MONITORING
We conducted literature searches for recent articles on this species and contacted relevant species experts. The U.S. Geological Survey-Biological Resource Discipline (BRD), State officials with the Department of Land and Natural Resources, and Bishop Museum, University of Hawaii, and Auburn University researchers were contacted regarding the current status of this species. No additional information on the species' status was found over the past year.

This level of monitoring is appropriate to update the status of the species because a thorough literature search was conducted as well as relevant species experts contacted. Information contained in this assessment form was verified by species experts.

List of Experts Contacted:

Name	Date	Affiliation
Thomas Iwai	February 19, 2010	Division of Aquatic Resources (Retired)
Michael Yamamoto	February 19, 2010	Division of Aquatic Resources (Retired)
Annette Tagawa	February 19, 2010	Division of Aquatic Resources
Troy Sakihara	February 19, 2010	Division of Aquatic Resources
Dan Polhemus	February 19, 2010	Division of Aquatic Resources
Robert Nishimoto	February 19, 2010	Division of Aquatic Resources
Richard Brock	February 19, 2010	University of Hawaii
Scott Santos	February 19, 2010	Auburn University
David Foote	February 19, 2010	USGS
Sallie Beavers	February 19, 2010	National Park Service
Tahzay Jones	February 19, 2010	National Park Service
Matt Ramsey	February 19, 2010	Division of Forestry and Wildlife

The Hawaii Biodiversity and Mapping Program (HBMP) lists this species as critically imperiled (HBMP 2006). *Procaris hawaianai* is included in the list of species in Hawaii's 2005 Comprehensive Wildlife Conservation Strategy (Mitchell *et al*. 2005). In addition, in March 2007 the State of Hawaii initiated a separate strategic plan focusing exclusively on invertebrates.

It is expected that *Procaris hawaiana* will be one of the species covered by the new plan (Mitchell *et al*. 2005).

COORDINATION WITH STATES

On February 11, 2010, we provided the Hawaii Division of Forestry and Wildlife with copies of our most recent candidate assessments for their review and comment. No response was received.

LITERATURE CITED

Bailey-Brock, J.H. and R.E. Brock. 1993. Feeding, reproduction, and sense organs of the Hawaiian anchialine shrimp Halocaridina rubra (Atyidae). Pacific Science 47:338-355.

Brock, R.E. 2004. Anchialine Resources in Two Hawaii State Natural Area Reserves: Ahihi Kinau, Maui Island and Manuka, Hawaii Island with Recommendations for Their Management. Prepared for the U.S. Fish and Wildlife Service by Environmental Assessment, LLC.

Brock, R.E., J.E. Norris, D.A. Ziemann, and M.T. Lee. 1987. Characteristics of water quality in anchialine ponds of the Kona, Hawaii, coast. Pacific Science 41:200-208.

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Holthuis, L.B. 1973. Caridean shrimps found in land-locked saltwater pools at four Indo-west Pacific localities (Sinai Peninsula, Funafuti Atoll, Maui and Hawaii Islands), with the description of one new genus and four new species. Zool. Verhadenlingen 128:3-55.

Lande, R. 1988. Demographic models of the northern spotted owl (Strix occidentalis caurina). Oecologia 75: 601-607.

Maciolek, J.A. 1983. Distribution and biology of Indo-pacific insular hypogeal shrimps. Bulletin of Marine Science 33:606-618.

MacLaughlin, P.A., D.K. Camp, M.V. Angel. 2005. Common and scientific names of aquatic invertebrates from the United States and Canada: Crustaceans. American Fisheries Society Special Publication 31. Bethesda MD, USA. 545pp.

Mitchell, C., C. Ogura, D.W. Meadows, A. Kane, L. Strommer, S. Fretz, D. Leonard, and A. McClung. 2005. *Hawaii's Comprehensive Wildlife Conservation Strategy*. Department of Land and Natural Resources. Honolulu, Hawaii. 722 pp.

Personal Communications:

Gagne, Betsy, Executive Secretary for the Hawaii Natural Area Reserves System Commission. Email regarding State's response to candidate assessment forms, dated August 29, 2006.

U.S. Fish and Wildlife Service. 2005. Notes regarding site visit to Lua o Palahemo.

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve:

Acting Carolyn A. Bohan
Regional Director, Region 1, Fish and Wildlife Service

5/18/10
Date

Rowan W. Gould
ACTING
Director, Fish and Wildlife Service

October 22, 2010

Concur:

Do not concur: _____
Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: April 14, 2010
Conducted by: Lorena Wada, Pacific Islands FWO
Biologist, Prelisting and Listing Program

Comments:
PIFWO Review

Reviewed by: Christa Russell Date: April 19, 2010
Prelisting and Listing Program Coordinator

Marilet Zablan Date: April 26, 2010
Assistant Field Supervisor, Endangered Species Division

Gina Shultz Date: April 30, 2010
Acting Field Supervisor