CANDIDATE ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Megalagrion pacificum*

COMMON NAME: Pacific Hawaiian Damselfly

LEAD REGION: Region 1

INFORMATION CURRENT AS OF: February 2003

STATUS/ACTION (Check all that apply):
___ New candidate
_X_ Continuing candidate
  _X_ Non-petitioned
  ___ Petitioned - Date petition received: ___
    ___ 90-day positive - FR date: ___
    ___ 12-month warranted but precluded - FR date: ___
    ___ Is the petition requesting a reclassification of a listed species?
  ___ Listing priority change
    Former LP: ___
    New LP: ___
Latest date species first became a Candidate: November 15, 1994
___ Candidate removal: Former LP: ___ (Check only one reason)
  ___ A - Taxon more abundant or widespread than previously believed or not subject to a degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
  ___ F - Range is no longer a U.S. territory.
  ___ M - Taxon mistakenly included in past notice of review.
  ___ N - Taxon may not meet the Act's definition of "species."
  ___ X - Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Coenagrionidae (Damselfly)

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Hawaii, islands of Kauai, Oahu, Molokai, Maui, Lanai, and Hawaii

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

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BIOLOGICAL INFORMATION:

Because of the extreme geographic isolation of the Hawaiian islands and the poor dispersal capabilities of many aquatic insects, the freshwater insect fauna of Hawaii is depauperate compared to continental areas despite the diversity of aquatic habitats. Many groups of insects that typify freshwater habitats in continental areas are absent from the native fauna. Some notable examples of such groups are mayflies (Ephemeroptera), stoneflies (Plecoptera), caddisflies (Trichoptera), and alderflies and dobsonflies (Neuroptera), all of which are absent from Hawaii. Like most of the native fish, mollusc, and crustacean faunas (Ford and Kinsey 1994), most of Hawaii's freshwater insects evolved from marine or intertidal ancestors (Hardy and Delfinado 1980) that could easily colonize the islands.

One group of insects in Hawaii that does appear to be derived from the unlikely colonization by a continental freshwater ancestor is the narrow-winged damselflies (Coenagrionidae) in the genus *Megalagrion*. The genus *Megalagrion* is endemic to the Hawaiian Islands and appears to be most closely related to species of *Pseudagrion* elsewhere in the Indo-Pacific (Zimmerman 1948b).

Native Hawaiians apparently did not differentiate among the different species, but referred to the native damselflies collectively as pinao'ula. There has been no traditional European use of a common name for species in the genus *Megalagrion*. In a recent taxonomic review of the candidate species of insects in Hawaii, Nishida (1994b) proposed the name, Hawaiian damselflies. Because this name reflects the restricted distribution of these insects and should be easy for use by nontechnical persons, the name, Hawaiian damselflies, is adopted for use in this document with additional descriptive terms that identify each species.

The general biology of Hawaiian damselflies is typical of other narrow-winged damselflies. The males of most species are territorial, guarding areas of habitat where females will lay eggs (Moore 1983a). During copulation, and often while the female lays eggs, the male grasps the female behind the head with his terminal abdominal appendages to guard her against rival males, thus males and females are frequently seen flying in tandem. In species with fully aquatic immature stages, females lay eggs in submerged aquatic vegetation or in mats of moss or algae on submerged rocks, and hatching occurs in about ten days (Williams 1936; Polhemus 1994b). In most species of Hawaiian damselflies, the immature stages (naiads) are aquatic, breathing though three flattened, abdominal gills, and are predacious, feeding on small aquatic invertebrates or fish (Williams 1936). Naiads may take up to 4 months to mature (Williams 1936), after which they crawl out of the water onto rocks or vegetation, molt into winged adults, which typically remain very close to the aquatic habitat from which they emerged. Adults are also predacious and feed on small flying insects such as midges. In a remarkable example of adaptive radiation in Hawaii, some species of Hawaiian damselflies have foregone the aquatic lifestyle, either partly, with naiads living on wet rock faces, or completely, with terrestrial naiads living in the damp leaf litter, or others inhabiting moist leaf axils of native plants up to several meters above the ground (Zimmerman 1970; Simon *et al*. 1984). Adults are also unusual in that they have a highly developed behavior of feigning death when caught or attacked (Moore 1983b).

The Hawaiian damselflies are represented by 23 species and five subspecies, all confined to the

Hawaiian Islands. Historically these were among the most common and conspicuous native Hawaiian insects. Some species inhabited water gardens in residential areas, artificial reservoirs, and watercress farms, and were abundant in the city of Honolulu (Perkins 1913; Williams 1936). As early as 1948, Zimmerman noted a decline of the more common species, particularly on Oahu. By the late 1970s, less than six populations of the Pacific Hawaiian damselfly could be located (Harwood 1976; Gagne 1980; Moore and Gagne 1982), and the conservation of this species was identified as a priority by the International Union for Conservation of Nature and Natural Resources (Moore 1982). A review of the status of Hawaiian damselflies in 1981 (Gagne and Howarth 1982) lead to the placement of several species on the Service's list of candidate species for Federal listing (49 FR 21664). Due to a continued decline of these damselflies, particularly on the island of Oahu, intensive surveys were initiated in 1990, supported by both the Service and the State of Hawaii. The results of these surveys demonstrate that six species of Hawaiian damselflies are now threatened with extinction.

Historically the pacific Hawaiian damselfly (*Megalagrion pacificum*) was found on all the major islands except Niihau and Kahoolawe. It was recorded from the following general localities--Lihue and Waimea on Kauai (Polhemus 1994b); Honolulu and Kawailoa Stream on Oahu, Kalae (Polhemus 1994b) and Waialua Stream (Harwood 1976) on Molokai; Hahalawe (Polhemus 1994b), Haipuaena (Harwood 1976), Iao, Palikea (Polhemus 1994b), Puaaluu (Moore and Gagne 1982), Puohokamoa, and Waikamoi Streams (Harwood 1976) on Maui; Lanai (Polhemus 1994b); and Hilo (Perkins 1907) on Hawaii. It is now apparently extirpated on the islands of Kauai, Oahu, Lanai and Hawaii. Extant populations are known from Pelekunu and Waikolu streams on Molokai, and Haipuaena, Hanawi, Keanae, Palikea and Kuhiwa Streams on Maui (Polhemus 1994b). Damselflies do not occur along the entire reaches of these streams, but rather have very small populations in restricted locations.

Historically this species was most common at low elevations, and Perkins (1913) described it as breeding in stagnant water, large ponds at higher elevations, and small, quiet pools in gulches that have been cut off from the main channel of the stream. It can no longer utilize most lentic habitats in Hawaii such as ponds and taro fields due to predation by alien fish (Moore and Gagne 1982). Recent observations have confirmed that the species is now restricted almost exclusively to seepage fed pools along overflow channels in the terminal reaches of perennial streams, usually in areas with thick, surrounding vegetation (Moore and Gagne 1982; Polhemus 1994b). Adults usually do not stray far from the vicinity of the breeding pools, perching on bordering vegetation and flying only short distances if disturbed. They are rarely seen along the main stream corridors. The primary threats to the remaining populations of the Pacific Hawaiian damselfly are predation by alien aquatic species such as fish and aquatic insects and habitat loss through channel alteration and dewatering of streams.

THREATS:

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>.

Freshwater habitats on all the main Hawaiian Islands have been severely altered and degraded because of past and present land and water management practices including agriculture, urban development, development of ground water, perched aquifer and surface water resources, and the deliberate introduction of alien animals (Harris *et al*. 1993; Meier *et al*. 1993; Service 1985, 1995).

Extensive modification of lentic (standing water) habitats in the Hawaiian Islands began about 1100 AD with a rapid population increase among native Hawaiians (Kirch 1982). Hawaiians cultivated taro (*Colocasia esculenta*) by creating shallow, walled ponds called lo'I, in marshes and riparian areas (Handy and Handy 1972). By 1778, virtually all valley bottoms with permanent stream flow and most basin marshes were converted to irrigated taro cultivation (Handy and Handy 1972). While this represents a significant alteration of the natural aquatic system, these extensive artificial wetlands were probably suitable habitat for many native Hawaiian species, particularly waterbirds (Olson and James 1982). Native Hawaiian dragonflies were recorded in taro lo'I (Handy and Handy 1972) and some damselflies may also have utilized these systems (Moore and Gagne 1982), since the lo'I remained flooded for months or years at a time (Handy and Handy 1972).

Hawaiians also modified wetlands by constructing fishponds, many of which were primarily freshwater, fed by streams or springs (Summers 1964). Despite this habitat modification by early Hawaiians, many areas of extensive marsh land remained intact. The best example of this was the Mana marsh of western Kauai. In this area, sedimentary deposits restrict the flow of ground water seaward, creating basal water spring discharge 3-4 meters (m) (8-12 feet (ft)) above sea level, and the development of an extensive marsh system (MacDonald *et al*. 1960). This area was famous for its mirages on open water surfaces (MacDonald *et al*. 1960) and Hawaiians traveled by canoe for miles between villages (Bennett 1931).

Some wetlands which had been converted to taro lo'I were maintained and others were utilized for rice cultivation between 1850 and 1930. In 1900, there was approximately 7,689 hectares (ha) (19,000 acres (ac)) of taro and 6,475 ha (16,000 ac) of rice in production in Hawaii (Service 1995). By 1960, taro production was reduced to only 206 ha (510 ac) and the rice industry had been completely abandoned. Many of these wetlands formerly used for taro or rice were drained and filled for dry-land agriculture (Stone 1989; Meier *et al*. 1993). The Mana marsh on Kauai is also one of the best examples of extensive freshwater habitat loss due to modern agriculture. The margins of the Mana marsh were used for rice cultivation until 1922, when the land, including several open ponds, were leased to Kekaha Sugar Company for sugarcane cultivation (Joesting 1984). By the late 1940s, the entire Mana marsh had been drained and filled and was under sugarcane cultivation (Wenkam 1969).

Most urban, residential and resort development in Hawaii has occurred in the coastal plains and as a result, many freshwater lentic habitats have been negatively affected (Service 1985). Most of this development has occurred on Oahu, which now supports four fifths of the State's population (Dept. of Geography 1983). The Ala Moana and Waikiki areas of Honolulu were once extensive marshlands that were converted to hundreds of taro lo'I and fishponds by Hawaiians (Handy and Handy 1972). Small development projects began in Waikiki in 1910, but even as late as 1920, 85 percent of Waikiki remained under water, used as duckponds, fishponds, and for the cultivation of rice and taro (Hibbard and Franzen 1991). In 1928, the Ala Wai Canal was completed, resulting in the complete drainage and development of the Waikiki wetlands, which now on an average day hosts over 60,000 people (Hibbard and Franzen 1991). Construction for housing and civil works projects on Oahu also resulted in the draining and filling of large fresh and brackish water marshes at Wailupe Peninsula, Hawaii Kai, Kaelepulu Pond, and Salt Lake (Service 1995). The Service now estimates that 30 percent of all coastal plain wetlands in Hawaii have been lost to agriculture and urban development (Ernie Kosaka, Service, Pacific Islands Office, *in litt*. 1990), and if only freshwater habitat was considered the loss would be proportionately much higher, probably approaching 80 to 90 percent. While intentional filling of freshwater wetlands with open water is rarely permitted today (Karen Evans, Service, Pacific Islands Office, pers. comm., 1995), loss of smaller areas utilized by damselflies, such as narrow strips of freshwater seeps within anchialine pool complexes, and loss of emergent vegetation still occurs. In addition, marshes are slowly filled and converted to meadow habitat due to increased sedimentation resulting from increased storm water runoff from upslope development, and blockage of downslope drainage (Wilson Okamoto & Associates, Inc. 1993).

Presently the most significant threat to natural ponds and marshes in Hawaii is the alien species, California grass (*Brachiaria mutica* (Forssk.) Stapf). The area of origin of this sprawling perennial grass is unknown, but it was first noted on Oahu in 1924 and now occurs on all the major islands (O'Connor 1990). This plant forms dense, monotypic stands that can completely eliminate any open water by layering of its trailing stems (Smith 1985). The most extensive remaining marsh system on the island of Oahu, Kawainui, is now almost entirely choked with California grass, facilitating its conversion to meadowland (Wilson Okamoto & Associates, Inc. 1993). The James Campbell and Pearl Harbor National Wildlife Refuges on Oahu, and Kakahaia National Wildlife Refuge on Molokai must be constantly managed to control this plant (John Beale, Service, Oahu National Wildlife Refuge, pers. comm., 1995). The Pacific Hawaiian damselfly and the orangeblack Hawaiian damselfly have both sustained loss of palustrine habitat on all islands due to human activities and California grass. Presently, two populations of the orangeblack damselfly along the Kona coast of Hawaii are threatened with further habitat loss from overdraw of the aquifer that feeds coastal marshes (Bill Meyers, U.S. Geological Survey, pers. comm., 1995). The only known population of the orangeblack damselfly on Oahu is threatened with habitat degradation from a proposed construction project (Ogden Environmental 1994).

Early Hawaiians also modified stream systems by diverting water from the main channel to irrigate taro <u>lo’I</u>. In some cases these diversions, or <u>‘auwai</u>, were elaborate, such as the cut and fitted stone ditch of Kiki a Ola in Waimea Canyon on Kauai (Bennett 1932). Other diversions were several kilometers long (Kirch 1985) and moved water between drainages (Devaney *et al*. 1983). However, these diversions were closely regulated and were not allowed to take more than half the stream flow, and diversions were typically periodic to flood <u>lo’I</u> rather than continuous (Handy and Handy 1972).

The advent of plantation sugarcane cultivation in 1835 led to more extensive stream diversions. The first irrigation system for sugar, built in 1856 on Kauai, was 16 kilometer (km) (10 miles (mi)) long. In 1900, the Maunawili Ditch on windward Oahu diverted all the water from Maunawili Stream into Waimanalo Valley (Takasaki *et al*. 1969). By 1906, the Kohala Ditch system on Maui utilized 15 km (9 mi) of tunnels, 7 km (4.5 mi) of open ditch, and 20 flumes, and now the East Maui Irrigation system may be the largest private water company in the United States (Harris *et al*. 1993). These systems typically tap water at upper elevations (> 300 m (984 ft)) by means of a concrete weir in the stream. All or most of the low or average flow of the stream is diverted into fields or reservoirs (Takasaki *et al*. 1969; Harris *et al*. 1993). By the 1930s, major water diversions had been developed on all the major islands and currently one third of Hawaii's perennial streams are diverted (Hawaii Stream Assessment 1990). Some systems are extensive, such as the Waiahole Ditch which takes water from 37 streams on the windward side of Oahu, and transports it to the leeward plains via a tunnel cut through the Koolau Mountain Range (Stearns and Vaksvik 1935). On West Maui, as of 1978, over 79 km (49 mi) of stream habitat in 12 streams have been lost due to diversions, and all of the 17 perennial streams on West Maui are diverted to some extent (Macioleck 1979). In addition to diverting water for agriculture and domestic water supply, streams have also been diverted for use in hydroelectric power. There are currently 18 active hydroelectric plants operating on Hawaiian streams, with another 10 proposed for construction, and another 28 sites identified for potential development (Hawaii Stream Assessment 1990).

In addition to diverting surface flow in the stream channels, the perched aquifers which feed the streams have also been tapped by means of tunnels (Stearns and Vaksvik 1935; Stearns 1985)). For example, both the bore tunnels and the contour tunnel of the Waiahole Ditch system pierced perched aquifers which were drained to the level of the tunnels (Stearns and Vaksvik 1935). Many of these aquifers were also the sources of springs which contributed flow to the windward streams. The boring of the Haiku tunnel in 1940 caused a 25 percent reduction in the base flow of Kahaluu Stream, over 4 km (2.5 mi) away (Takasaki *et al*. 1969). The draining of these aquifers caused many of the springs to dry up, including some over 0.5 km (0.3 mi) away from the bore tunnels (Stearns and Vaksvik 1935). Frequently the actual springs were tapped by driving tunnels into the rock from where the water emerged, and on the water-poor island of Lanai, almost every spring and seep was bored or captured (Stearns 1940).

Surface waters in streams have also been captured by tunnels in the alluvium of the stream channel. Historically, Maunalei Stream was the only perennial stream on Lanai, and Hawaiians constructed taro lo’i in the lower portions of this system. In 1911, a tunnel was developed at 335 m (1,100 ft) elevation which undercut the stream bed, capturing both the surface and subsurface flow and dewatering the stream from this point to the mouth (Stearns 1940).

Stream degradation has been particularly severe on the island of Oahu, where, in 1978, 57 percent of the perennial streams had been channelized (lined, partially lined or altered stream course) and 89 percent of the total length of these streams were channelized (Parrish *et al*. 1984). Channelization of streams has not been restricted to lower reaches, in Kalihi Stream there is extensive channelization above 328 m (1,000 ft). Channelization results in removal of riparian vegetation, increased velocity, increased illumination, and higher water temperatures. Hawaiian damselflies do not utilize channelized portions of streams.

Surface flow of streams has also been affected by vertical wells, because the basal aquifer and alluvial caprock through which the lower sections of streams flow can be hydraulically connected (William Meyers, U.S. Geological Survey, *in litt*. 1995). Historically, for example, there was sufficient surface flow in Makaha and Nanakuli streams on Oahu to support taro lo’i in their lower reaches, but this flow disappeared subsequent to construction of wells upstream (Bill Devick, State of Hawaii, Division of Aquatic Resources, pers. comm., 1995).

This damselfly has sustained habitat loss due to water diversions and stream alterations on all the islands.

B. Overutilization for commercial, recreational, scientific, or educational purposes.

Healthy populations of stream-inhabiting Hawaiian damselflies are composed of large numbers of individuals. Moore (1983a) recorded 75 males per 100 m (328 ft) of stream edge for *Megalagrion heterogamias* on Kauai. In addition, there are often more males than suitable territorial habitat, and when males are removed from their territories, they are immediately replaced by other individuals (Moore 1983a). However, populations of these damselflies are now extremely reduced, with fewer than 10 males per 100 m (328 ft) of stream edge at all localities. Publication of the rarity of these species will likely increase the interest of professional and amateur Odonata collectors. Unrestricted collecting and handling could impact these small populations and are considered significant threats to the species.

C. <u>Disease or predation</u>.

The geographic isolation of the Hawaiian Islands has restricted the number of original successful colonizing arthropods and resulted in the development of an unusual fauna. An unusually small number (15 percent) of the known families of insects are represented by native Hawaiian species (Howarth 1990). Some groups that often dominate continental arthropod faunas, such as social Hymenoptera (group nesting ants, bees, and wasps), are entirely absent. Commercial shipping and air cargo to Hawaii has now resulted in the establishment of over 2,500 species of alien arthropods (Howarth 1990; Howarth *et al*. 1994), with a continuing establishment rate of 10-20 new species per year (Beardsley 1962; 1979). In addition to the accidental establishment of alien species, alien predators and parasites for biological control of pests have been purposefully imported and released by individuals, Republic, Territorial, State, and Federal agencies, since 1865. Between 1890 and 1985, 243 alien species were introduced, sometimes with the specific intent of reducing populations of native Hawaiian insects (Funasaki *et al*. 1988; Lai 1988). Alien arthropods, whether purposefully introduced or adventive, pose a serious threat to Hawaii's native insects, through direct predation and parasitism, and competition for food or space (Howarth and Medeiros 1989; Howarth and Ramsay 1991).

Ants are not a natural component of Hawaii's arthropod fauna, and endemic species evolved in the absence of predation pressure from ants. Ants can be particularly destructive predators because of their high densities, recruitment behavior, aggressiveness, and broad range of diet (Reimer 1993). The latter attribute allows some ants to affect prey populations independent of prey density, and ants can therefore locate and destroy isolated individuals and populations (Nafus 1993). At least 36 species of ants are known to be established in the Hawaiian Islands, and three particularly aggressive species have had severe effects on the native insect fauna (Zimmerman 1948a). By the late 1870s, the big-headed ant (*Pheidole megacephala*) was present in Hawaii and its predation on native insects was noted by Perkins (1913)—“It may be said that no native Hawaiian Coleoptera insect can resist this predator, and it is practically useless to attempt to collect where it is well established. Just on the limits of its range one may occasionally meet with a few native beetles, e.g.,species of *Plagithmysus*, often with these ants attached to their legs and bodies, but sooner or later they are quite exterminated from these localities.”

With few exceptions, native insects, including most moths, have been eliminated from areas where the big-headed ant is present (Perkins 1913; Gillespie and Reimer 1993). This predator generally does not occur at elevations higher than 610 m (2,000 ft), and is also restricted by rainfall, rarely being found in particularly dry (less than ca 38-51 cm (15-20 in.) annually) or wet areas (more than ca 250 cm (100 in.) annually) (Reimer *et al*. 1990).

The long-legged ant (*Anoplolepis longipes*) appeared in Hawaii in 1952 and now occurs on Oahu, Maui, and Hawaii (Reimer *et al*. 1990). It inhabits low elevation (less than 610 m (2,000 ft)), rocky areas of moderate rainfall (less than 250 cm (100 in.) annually) (Reimer *et al*. 1990). Direct observations indicate that Hawaiian arthropods are susceptible to predation by this species (Gillespie and Reimer 1993) and Hardy (1979) documented the disappearance of most native insects from Kipahulu Stream on Maui after the area was invaded by the long-legged ant.

At least two species of fire ants, *Solenopsis geminita* and *Solenopsis papuana*, are also important threats (Gillespie and Reimer 1993) and occur on all the major islands (Reimer *et al*. 1990). *Solenopsis geminita* is also known to be a significant predator on pest fruit flies in Hawaii (Wong and Wong 1988). *Solenopsis papuana* is the only abundant, aggressive ant that has invaded intact mesic forest above 610 m (2,000 ft) and is still expanding its range in Hawaii (Reimer 1993). At least some populations of all the damselfly taxa included in this proposed rule are threatened by one or more of the ant species described above.

Backswimmers are aquatic true bugs (Heteroptera) in the family Notonectidae, so called because they swim upside down. Backswimmers are voracious predators and frequently feed on prey much larger than themselves, tadpoles, small fish, and other aquatic insects including damselfly naiads (Boror *et al*. 1989). Backswimmers are not native to Hawaii, but several species have been introduced in recent times. *Buenoa pallipes* (Fabricus) (NCN) has been known from Hawaii since 1900 (Zimmerman 1948c) and has been recorded from all the major islands except Lanai (Nishida 1994a). This species can be abundant in lowland ponds and reservoirs and feeds on any suitably sized insect, including damselfly naiads. More recently, two additional species of backswimmers have become established in Hawaii (Polhemus 1995). *Anisops batillifrons* was first collected in 1991 and is known only from Maui. *Notonecta indica* was first collected on Oahu in the mid 1980s and is presently known from Maui and Hawaii. Species of *Notonecta* are known to prey on damselfly naiads and the mere presence of this predator in the water can cause naiads to reduce foraging (Heads 1985) which can reduce growth, development, and survival (Heads 1986). Backswimmers pose a threat to all populations of this damselfly.

Similar to the aquatic insects, Hawaii has a depauperate freshwater fish fauna with only five native species comprised of gobies (Gobiidae) and sleepers (Eleotridae), that occur on all the major islands. The ‘o’opu okuhe (*Eleotris sandwicensis*) and the ‘o’opu naniha (*Stenogobius hawaiiensis*) are coastal fishes, occurring in brackish and freshwater ponds and in lower reaches of streams below the first waterfall. While the ‘o’opu okuhe is the most predaceous of the Hawaiian freshwater fishes (Mike Kido, University of Hawaii, *in litt*. 1995), it occurs infrequently with damselflies in the lower reaches of larger streams. The ‘o’opu nakea (*Awaous stamineus*) and the ‘o’opu nopili (*Sicyopterus stimpsoni*) frequent the middle reaches of streams up to 308 m (1,000 ft) elevation. The ‘o’opu alamo’o (*Lentipes concolor*) usually occupies the upper sections streams above 800 m (2,600 ft) and can apparently navigate Hawaii's largest waterfalls (Devick *et al*. 1992). Prior to human alteration of the aquatic habitats, the ‘o’opu nakea, ‘o’opu nopili, and the ‘o’opu alamo’o would have all occurred with the naiads of some of the Hawaiian damselflies, at least occasionally. The ‘o’opu nakea has been reported to feed on Hawaiian damselfly naiads (Ego 1956), but this species is apparently primarily herbivorous and ingestion of naiads probably occurs incidental to feeding on algae (Kido *et al*. 1993). The ‘o’opu noplili feeds predominately on algae and ‘o’opu alamo’o, while facultatively predaceous and not known to feed on damselfly naiads (Mike Kido, University of Hawaii, *in litt*. 1995). Therefore, the Hawaiian damselflies probably experienced limited natural predation pressure from the native fishes.

Fish predation has been an important factor in the evolution of behavior in damselfly naiads in continental systems (Johnson 1991). Some species of damselflies are not adapted to cohabitat with fish, and are found only in bodies of water without fish (Henrickson 1988; McPeek 1990a). The naiads of these species tend to occupy more exposed positions and engage in conspicuous foraging behavior, thereby being susceptible to fish (Macan 1977; McPeek 1990b). The evolutionary history of the Hawaiian damselflies coexisting with few, if any predatory fish, and the exposed behavior of most of the fully aquatic species, make them particularly vulnerable to predation by alien fish introductions.

Over 60 species of aquatic organisms have been introduced into Hawaiian freshwater habitats, including at least 45 species of fish (Devick 1991). The impact of fish introductions prior to 1900 cannot be assessed because this predated the initial collection of damselflies in Hawaii (Perkins 1913). In 1905, two species, the Mosquito fish (*Gambusia affinis*), and the Sailfin molly (*Poecilia latipinna*), were successfully introduced for biological control of mosquitoes (Van Dine 1907). In 1922, three additional species were established for mosquito control, the Green swordtail (*Xiphophorus helleri*), the Moonfish (*Xiphophorus maculatus*), and the Guppy (*Poecilia reticulata*). The introduction of these species has been implicated in the extinction of the Pacific Hawaiian damselfly from most of the main islands (Moore and Gagne 1982), and by 1935 on Oahu, the orangeblack Hawaiian damselfly was found only in waters without these introduced fish (Williams 1936; Zimmerman 1948b; Polhemus 1993b). Most of the fish introduced early into Hawaii are now established on all the major islands, and are primarily pond and reservoir inhabitants.

Beginning in about 1980, a large number of new fish introductions began in Hawaii, originating primarily from the aquarium fish trade (Devick 1991). By 1990, an additional 15 species of fish were established in waters on Oahu, including catfish, cichlids, gobies, top minnows, needlefish, and piranha many which readily invaded stream systems. By early 1990, the lower to middle reaches of two widely separated streams on Oahu, Manoa on the south leeward side, and Kaukanohua on the north windward side, were choked with dense populations of armored catfish (*Hypostomus* sp. and *Pterygoplichthys multiradiatus*) (Devick 1991). This recent wave of fish introductions on Oahu corresponded with the drastic decline and range reduction of the crimson Hawaiian damselfly, the oceanic Hawaiian damselfly, and the blackline Hawaiian damselfly. Currently, these damselflies occur only in drainages or higher parts of stream systems where alien fish are not yet established (R. Englund, *in litt*., 1994). The continued introduction and establishment of new species of alien fish, and the movement of established species to new drainages (Richard Brock, University of Hawaii, pers. comm., 1994) presents the greatest threat to this Hawaiian damselfly species.

D. <u>The inadequacy of existing regulatory mechanisms</u>.

The State of Hawaii considers all natural flowing surface water (streams, springs and seeps) as State property (Hawaii Revised Statutes 174c 1987), and the Hawaii Department of Land And Natural Resources has management responsibility for the aquatic organisms in these waters (B. Devick, pers. comm., 1995). Thus, damselfly populations associated with streams, seeps and springs are under the jurisdiction of the State of Hawaii, regardless of the ownership of the property across which the stream flows. This includes all populations of the crimson Hawaiian damselfly, the blackline Hawaiian damselfly, and the oceanic Hawaiian damselfly, as well as some populations of the Pacific Hawaiian damselfly and the orangeblack Hawaiian damselfly occurring in streams.

State regulatory mechanisms currently in effect do not provide adequate protection for the Hawaiian damselflies or their habitat. The State of Hawaii has not listed these damselflies as endangered or threatened and so does not afforded them any protection under the State endangered species act. Nor does the State Water Code afford adequate protect from the adverse effects of water development projects. The State of Hawaii manages the use of surface and ground water resources through the Commission on Water Resource Management (Water Commission), as mandated by the 1987 State Water Code (State Water Code, Hawaii Revised Statutes Chapter 174C-71, 174C-81-87, and 174C-9195 and Administrative Rules of the State Water Code, Title 13, Chapters 168 and 169). In the State Water Code, there are no formal requirements that project proponents or the Water Commission protect the habitats of fish and wildlife prior to issuance of a permit to modify surface or ground water resources.

The maintenance of instream flow, which is required to protect the habitat of damselflies and other aquatic wildlife, is regulated by the establishment of standards on a stream-by-stream basis (State Water Code, Hawaii Revised Statutes Chapter 174C-71 and Administrative Rules of the State Water Code, Title 13, Chapter 169). Currently, the interim instream flow standards represent the existing flow conditions in streams in the State as of 15 June 1988 for Molokai, Hawaii, Kauai and East Maui, and 19 October 1988 for West Maui and Leeward Oahu (Administrative Rules of the State Water Code, Title 13, Chapter 169-44-49). However, the State Water Code does not provide for permanent or minimal instream flow standards for the protection of aquatic wildlife. Instead, modification of instream flow standards and stream channels can be undertaken at any time by the Water Commission or via public petitions to revise flow standards or modify stream channels in a specified stream (Administrative Rules of the State Water Code, Title 13, Chapter 169-36). Additionally, the Water Commission must consider economic benefits gained from out-of-stream water uses, and is not required to balance these benefits against instream benefits to aquatic fish and wildlife. Consequently, any stabilization of stream flow for the protection of Hawaiian damselfly habitat is subject to modification at a future date.

The natural value of Hawaii's stream systems has been recognized under the State of Hawaii Instream Use Protection Program (Administrative Rules of the State Water Code, Title 13, Chapter 169-20(2)). In the Hawaii Stream Assessment Report, prepared in coordination with the National Park Service (National Park Service 1990), the State Water Commission identified high quality rivers or streams, or portions of a rivers or streams, that may be placed within a wild and scenic river system. This report recommended that streams meeting certain criteria be protected from further development. However, there is no formal or institutional mechanism within the Water Code to designate and set aside these streams, or to identify and protect stream habitat for Hawaiian damselflies.

Existing Federal regulatory mechanisms that may protect Hawaiian damselflies and their habitat are also inadequate. The Federal Energy Regulatory Commission (FERC) has very limited jurisdiction in Hawaii. Hydroelectric power projects in Hawaii are not on navigable water, public lands, or United States reservations; do not use surplus water or water power from a Federal Government Dam; and do not affect the interests of interstate or foreign commerce.

Thus, licensing of hydroelectric projects do not come under the purview of FERC. However, hydropower developers in Hawaii may voluntarily seek licensing under FERC.
The U.S. Army Corps of Engineers (COE) also has some regulatory control over modifications of freshwater streams in the United States. For modifications (i.e. discharge of fill) of streams with an average annual flow greater than 5 cubic feet per second (cfs), the COE can issue individual Department of the Army (DOA) permits under section 404 of the Clean Water Act. These permits are subject to public review, and must comply with the Environmental Protection Agency's 404(b)(1) guidelines and public comment requirements. However, in issuing these permits, the COE does not establish instream flow standards as a matter of policy. The COE normally considers that the public interest for instream flow is represented by the state water allocation rights or preferences (Regulatory Guidance Letter No 85-6), and project alternatives that supersede, abrogate, or otherwise impair the state water quantity allocations are not normally addressed as alternatives during permit review.

In cases where the COE district engineer does propose to impose instream flow standard on an individual DOA permit, this flow standard must reflect a substantial national interest. Additionally, if this instream flow standard is in conflict with a State water quantity allocation, then it must be reviewed and approved by the Office of the Chief Engineer in Washington, D.C. Currently, the setting of instream flow standards sufficient to conserve Hawaiian damselflies is not a condition that would be considered or included in a DOA individual permit. If this damselfly was listed as endangered or threatened, Federal interest in its conservation would be assured through consultation under section 7 of the Endangered Species Act.

The COE may also authorize the discharge of fill into streams with an average annual flow of less than 5 cfs. These discharges are covered under a nationwide permit (33 CFR 330 Appendix A, Nationwide Permit 26). This permit is designed to expedite small-scale activities that the COE considers to have only minimal environmental impacts (33CFR 330.1(b)). The Service and the State Department of Land and Natural Resources have only 15 days to provide substantive site-specific comments following the issuance of a nationwide permit (33 CFR 330 Appendix A, Nationwide Permit Condition 13). Given the complexity of the impacts on Hawaiian damselflies from stream modifications and surface water diversions, the remoteness of project sites, and the types of studies necessary to determine project impacts and mitigation, this limited comment period does not allow for an adequate assessment of impacts. The listing of the Hawaiian damselflies as endangered or threatened species will insure that their conservation is adequately considered during consultation, as required under section 7 of the Endangered Species Act.

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

Not applicable.

FOR RECYCLED PETITIONS:

a. Is listing still warranted? ___

b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? ___

c. Is a proposal to list the species as threatened or endangered in preparation? ___

d. If the answer to c. above is no, provide an explanation of why the action is still precluded.

LAND OWNERSHIP:

This species occurs in State managed waters.

PRELISTING:

None.

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LISTING PRIORITY (* after number)

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:

Imminence:

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes to the candidate list, including listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all additions of species to the candidate list, removal of candidates, and listing priority changes.

Approve: ___Rowan Gould_______________________________ __March 6, 2003_
Regional Director, Fish and Wildlife Service Date

Concur: _______________________________ ___________
Director, Fish and Wildlife Service Date

Do not concur:_______________________________ ____________
Director, Fish and Wildlife Service Date

Director's Remarks:

-

-

Date of annual review: 2/03______
Conducted by:______

Comments:

-

-