PETITION TO LIST THE
Bumphead Parrotfish *(Bolbometopon muricatum)*
UNDER THE U.S. ENDANGERED SPECIES ACT

Photo: J.E. Maragos, USFWS

Petition Submitted to the U.S. Secretary of Commerce, Acting Through the National Oceanic and Atmospheric Administration Fisheries Service & the U.S. Secretary of Interior, Acting through the U.S. Fish and Wildlife Service

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WildEarth Guardians
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Executive Summary

The Bumphead Parrotfish (*Bolbometopon muricatum*) is a marine fish that feeds primarily on coral. It occurs in many countries in the Pacific and Indo-Pacific, including islands governed by the United States. While wide-ranging, scientists describe it as declining across its range and nearly eliminated from many areas. The primary threat has been overfishing, to which this fish is especially vulnerable due to its behavior of sleeping in large groups at night near reefs. Growing threats are coral bleaching and ocean acidification, both due to climate change. The Bumphead Parrotfish's fate is tied to coral, as each fish consumes over 5 tons of coral every year.

Coral consumed by the Parrotfish is excreted as coral sand, which is important to sustain the coral ecosystem, as well as providing beautiful white sand beaches enjoyed by tourists. Given the economic importance of tourism in the range of the Parrotfish, this species provides an invaluable ecosystem service to humans. An even more important way in which Parrotfish benefit humans is by protecting coral reef ecosystems, which are vital to safeguarding human coastal populations from impacts of extreme weather events. We do not respond in kind: the Parrotfish continues to be overfished; is in decline across much of its range; and faces devastating effects from climate change-induced coral bleaching.

With the potential to reach 1.3 meters (4 feet) in length, Bumphead Parrotfish are the largest of all parrotfish and may thus be especially vulnerable to extinction due to their large body size. In addition to being targeted by fishers, they possess other biological traits – especially slow maturation and low reproductive rates – that make them vulnerable to extinction. Compounding these factors are shrinking remnant populations and range reductions, which expose the species to elimination from random events.

Marine protected areas further the conservation of this species, but existing protected areas and fishing restrictions are not currently extensive or well-enforced enough to prevent the Bumphead Parrotfish from extinction or endangerment in the foreseeable future. This is especially true in light of the burgeoning human population within the Parrotfish's range. Some countries within its range have astoundingly high fertility rates, of more than 5.0 children per adult female: more than double the replacement rate. The U.S. territory of Guam plans a massive influx of military personnel to the island. With more people in its range, and large numbers of those people targeting Bumphead Parrotfish for food or ceremony, or degrading its coastal reef habitat, this species requires maximum legal protection.

WildEarth Guardians therefore requests that the National Marine Fisheries Service and U.S. Fish and Wildlife Service list the Bumphead Parrotfish as Endangered or Threatened under the Endangered Species Act and provide it with critical habitat.

Introduction

The Bumphead Parrotfish (*Bolbometopon muricatum*) is the largest species of parrotfish and inhabits a wide area in the Pacific and Indo-Pacific. Its habits and requirements expose it to serious threats: because it sleeps in large groups at night, it is vulnerable to fishing; and due to its dependence on large quantities of coral, this fish's fate is tied to healthy coral reef ecosystems. Scientists recognize this parrotfish as performing an important ecological role, through its grazing of coral and excretion of coral sands (Bellwood et al. 2003; Green and Bellwood 2009). Due to overfishing and degradation of coral habitats, the Bumphead Parrotfish has experienced declines throughout its extensive range. While apparently stable in some areas, it has become extirpated or very rare in a significant portion of its range.

Climate change represents a growing threat, given the susceptibility of coral to bleaching when sea temperatures rise, as well as ocean acidification, which impedes coral growth. Researchers at the National Oceanic and Atmospheric Administration (NOAA) have noted the decline of coral reefs across the globe and the particularly severe threat from climate change:

> …nearly half of coral reefs of the U.S. and Pacific Freely Associated States are not in good condition and are continuing steadily on a long-term decline.
>
> Global climate change presents urgent challenges for coral reef ecosystem management at the broadest spatial and longest temporal scales. Remedies for global climate change are far beyond measures that can be implemented by local management and require bold actions on an international scale to affect change. (Waddell et al. 2008: 552).[1]

In light of these grave dangers to the coral reef ecosystem it relies upon and helps create, WildEarth Guardians requests listing of the Bumphead Parrotfish under the Endangered Species Act (ESA). Federal protection will give this unique and ecologically vital fish its best chance of survival. Over 99% of the species listed under the ESA still exist.[2] The ESA is the Bumphead Parrotfish's best hedge against extinction.

Endangered Species Act Implementing Regulations

Section 424 of the regulations implementing the Endangered Species Act (50 C.F.R. § 424) is applicable to this petition. Subsections that concern the formal listing of the Bumphead Parrotfish as an Endangered or Threatened species are:

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[1]Petitioners also attach earlier NOAA reports on coral reef ecosystems: Waddell (ed.) (2005) and Turgeon et al. (2002).

[2]Compare the number of species currently listed under the ESA (1321) with the species that have been delisted due to extinction (9). *See* **http://www.fws.gov/endangered/wildlife.html** [Accessed November 2009].

> 424.02(e) "*Endangered species* means a species that is in danger of extinction throughout all or a significant portion of its range."…(k) "species" includes any species or subspecies that interbreeds when mature. *See also* 16 U.S.C § 1532(6).
>
> (m) "*Threatened species* means any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." *See also* 16 U.S.C § 1532(20).

ESA Section 4 (16 U.S.C. § 1533(a)(1)) sets forth listing factors under which a species can qualify for ESA protection (see also 50 C.F.R. § 424.11(c)):

- A. The present or threatened destruction, modification, or curtailment of habitat or range;
- B. Overutilization for commercial, recreational, scientific, or educational purposes;
- C. Disease or predation;
- D. The inadequacy of existing regulatory mechanisms; and
- E. Other natural or manmade factors affecting its continued existence.

All five factors set forth in 50 C.F.R. § 424.11(c) and in ESA Section 4 (16 U.S.C. § 1533(a)(1)) have resulted in the continued decline of the Bumphead Parrotfish and are causing the species to face extinction or endangerment in the foreseeable future. A taxon needs to meet only one of the listing factors outlined in the ESA to qualify for federal listing.

Classification and Nomenclature

Common Name. *Bolbometopon muricatum* is known by the common names "bumphead parrotfish," "doubled-headed parrotfish," "green humphead parrotfish," "humphead parrotfish," and "giant humphead parrotfish" (Dulvy and Polunin 2004; Chan et al. 2007).[3] Throughout the petition, we refer to this species as the Bumphead Parrotfish or Parrotfish.

Taxonomy. The petitioned species is *Bolbometopon muricatum* Valenciennes, 1840. Synonyms are: *Callyodon muricatus* (Valenciennes, 1840) and *Scarus muricatus* (Valenciennes, 1840) (Chan et al. 2007). The taxonomic classification for *Bolbometopon muricatum* is shown in Table 1.

[3]This species is known by a variety of non-English common names as well.

Table 1. Taxonomy of *Bolbometopon muricatum*.

Phylum	Chordata (chordates)
Class	Actinopterygii (ray-finned or spiny rayed fishes)
Order	Perciformes (perch-like fishes)
Family	Scaridae (parrotfishes)
Genus	*Bolbometopon*
Species	*muricatum*

Description

The Bumphead Parrotfish can grow to 4 feet (1.3 m) in length and 110 lbs (50 kg), making it the largest parrotfish. Adults have dull green coloring, with pale yellow or pink on the front of the head. Adults maintain uniform coloration in males and females. Juvenile coloring ranges from green to brown, with five rows of small, white spots. Adults have a steep head profile, with a distinct, bulbous foreheads and fleshy lips, with exposed teeth. In large individuals (more than 60 cm or 23.6 in long), it has an almost vertical profile (Bellwood 2001; Chan et al. 2007; NMFS 2009).[4] *See* Figure 1.

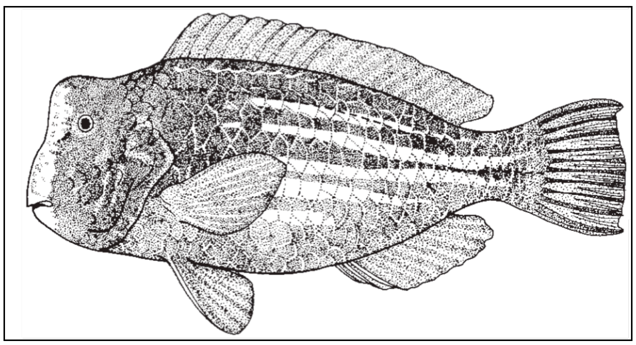

Figure 1: Sketch of Bolbometopon muricatum. Source: Bellwood (2001).

Distinctive traits

The Bumphead Parrotfish is distinguished from other parrotfish by its large size and its uniform coloring (except for the light green to pink coloring on the front of its head). While the species is sometimes mistaken for the humphead wrasse[5] or other parrotfishes, it can be distinguished by its vertical head profile (Myers 1991).

Geographic Distribution: Historic and Current

The Bumphead Parrotfish has a wide range (Figure 2). It is reported from the Red Sea

[4]See also Species Account for *Bolbometopon muricatum* at **www.fishbase.org** [Accessed November 2009].
[5]The Humphead Wrasse (*Cheilinus undulatus*) is ranked by the IUCN as endangered. Russell, B. 2004. *Cheilinus undulatus*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. Online at: **www.iucnredlist.org**. [Accessed November 2009]. While a NMFS Species of Concern, it is not listed under the ESA. See **www.nmfs.noaa.gov/pr/species/fish/** [Accessed November 2009].

east to French Polynesia and the Line Islands; north to Taiwan, the Yaeyama Islands (Japan), and Wake Island; south to Australia, the Great Barrier Reef, and New Caledonia (Randall et al. 1990; Myers 1991; Chan et al. 2007). Within the U.S., it occurs in American Samoa, Guam, Pacific Remote Island Areas (Line Islands (Jarvis Island, Palmyra Atoll, Kingman Reef), Howland Island, and Wake Island), and the Northern Mariana Islands. It also occurs in waters governed by Australia, Egypt, Fiji, France (New Caledonia and French Polynesia), Indonesia, Japan (Yaeyama Islands), Kenya, Kiribati (Phoenix Islands, Christmas Island), Madagascar, Malaysia, Maldives, Marshall Islands, Mauritius, Micronesia, Mozambique, Myanmar, New Zealand (Niue), Palau, Papua New Guinea, Phillipines, Samoa, Seychelles, Solomon Islands, Somalia, Taiwan, Tanzania, Tonga, Vanuatu, and Yemen (Chan et al. 1997; NMFS 2009).

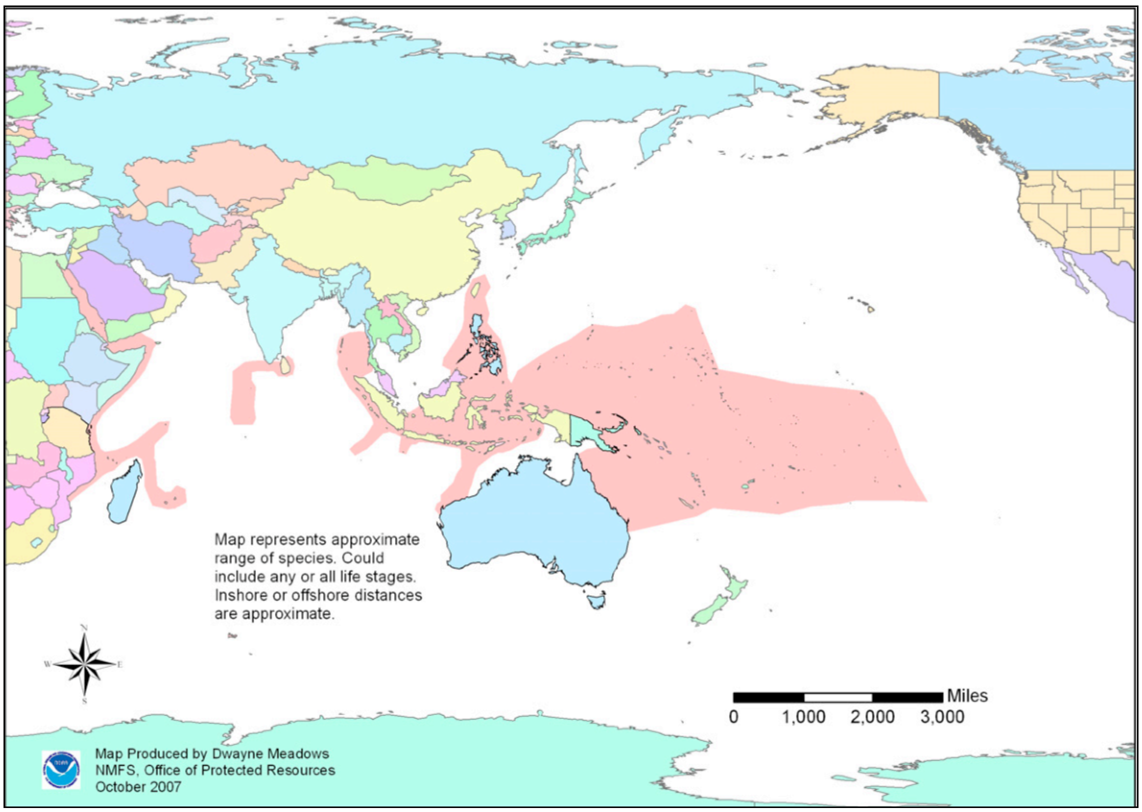

Figure 2: Range of Bumphead Parrotfish. Source: NMFS 2007.

This parrotfish does not occur on Hawaii or Johnston Atoll (NMFS 2009).

Figure 3: Map of US Pacific Islands. Source: OIA 2009.[6]

Habitat Requirements

The Bumphead Parrotfish occupies coral reef habitats from 3-100 feet (0.9-30.5 m) deep in the western Pacific, central Pacific, and Indo-Pacific (Figures 2 and 4). During the day, they occupy barrier and fringing reefs, whereas at night they rest in shallow sandy lagoons or caves. While juveniles occupy seagrass beds within lagoons, adults usually inhabit outer lagoons and seaward reefs (NMFS 2009).

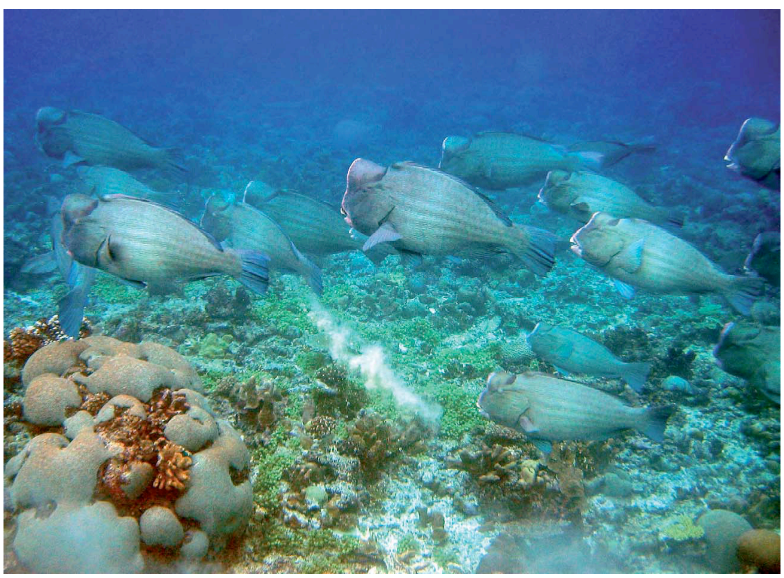

Figure 4: Bumphead Parrotfish in Coral Reef Habitat.
Photo: R. Hamilton, in Green and Bellwood 2009.

[6]Online at: http://www.doi.gov/oia/Islandpages/palmyrapage.htm [Accessed November 2009].

Life History

This species is slow-growing and can live up to 40 years. It usually occurs in small groups, but group size can reach 75 or more individuals. Bumphead Parrotfishes sleep in groups near reefs (NMFS 2009).

Diet

The Bumphead Parrotfish primarily feeds on coral, but also eats algae. They ram their heads against coral to break them into smaller pieces, which are then consumed. One individual parrotfish eats over 5 tons of coral every year, which are excreted as coral sands (Bellwood et al. 2003; Chan et al. 2007; NMFS 2009).

Reproduction and Dispersal

Reproduction is delayed, and replenishment rates are low. Females reach sexual maturity at approximately 610-650 mm (24-25.6 in) (Chan et al. 2007). They spawn on outer reef slopes, promontories, gutters, or channel mouths. Courtship and spawning occurs in early morning and perhaps at other times (NMFS 2009). The species has low resilience to fishing: its minimum population doubling time is 4.5-14 years.[7]

Ecology

The parrotfish's massive consumption of coral reefs makes it both dependent on, and a keystone species within, coral reef ecosystems. Groups of parrotfish are important in producing coral sands and may enable ecosystem resilience (Bellwood et al. 2003; Donaldson and Dulvy 2004; Chan et al. 2007; NMFS 2009; Green and Bellwood 2009). State Bellwood et al. (2003: 283),

> Despite supporting over 3000 fish species, only one family, the parrotfishes, consistently removes reef carbonate when feeding. Of the 35 parrotfish species present on the study reefs, almost all erosion on oceanic reefs can be attributed to just one species: *B. muricatum*. It is a major contributor to reef ecosystem processes and its absence highlights the potential for marked changes in ecosystem function.

The Bumphead Parrotfish likely affects coral growth rates, mortality rates, distribution, colony fitness, and colony shape. The loss of this species from its native coral reefs would lead to structural instability, making the reefs more susceptible to significant, permanent damage from storms and sea urchin invasions. *Id*. The petitioned species should be considered a keystone species,[8] given the inordinate magnitude of its actions

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[7]See Fishbase account for this species at:
http://www.fishbase.org/Summary/SpeciesSummary.cfm?ID=5537 [Accessed November 2009].

[8]For a discussion of keystone species, see: Kotliar, Natasha B., Bruce W. Baker, April D. Whicker, Glenn Plumb. 1999. A critical review of assumptions about the prairie dog as a keystone species. Environmental

and its uniqueness – no species duplicates the actions of the Bumphead Parrotfish (Bellwood et al. 2003; Chan et al. 2007).

Coral consumed by the Bumphead Parrotfish is excreted as coral sand, which is important to sustain the coral ecosystem (Bellwood et al. 2003), as well as creating beautiful white sand beaches enjoyed by tourists and used by sea turtles for nesting. Given the economic importance of tourism in the range of the Parrotfish, this species provides an invaluable ecosystem service to humans. The Bumphead Parrotfish should also be protected as an indicator of coral reef ecosystems (Bellwood et al. 2003). Clarke et al. (2008) report high values of reefs, primarily due to tourism, for Guam ($127.3 million per year)[9] and Saipan, Northern Mariana Islands ($61.2 million). The Great Barrier Reef provides over $5 billion per year in tourism revenue to Australia (Access Economics 2007, cited in Munday et al. 2008a). Another important way in which this parrotfish benefits humans is by protecting coral reef ecosystems, which are vital to safeguarding human coastal populations from impacts of extreme weather events (Waddell and Clarke 2008). Karl et al. (2009) estimate that coral reefs provide billions of dollars in ecosystem services, including fish habitat, tourism, and protection of coastlines.

Figure 5: Green Sea Turtle on Guam Beach.
Sea turtles benefit from coral sands created by Bumphead Parrotfish.
Photo: Guam Division of Aquatic and Wildlife Resources.

As indicated at the outset of this petition, NOAA has recognized that coral reefs are in decline. We discusse the reasons for those declines in our discussion of threats, below. In addition, the IUCN reports that more than one-quarter (27%) of reef-building coral are threatened across the globe (Polidoro et al. 2009). The primary reasons for this are climate change, coastal development, sedimentation, pollution, and coral extraction. *Id.* Bellwood et al. (2003: 284) conclude:

> If coral reefs are the world's canary, our global early warning system… then the fate of parrotfishes is a critical issue.

Management 24 (2): 177-192 and Kotliar, N.B. 2000. Application of the New Keystone-Species Concept to Prairie Dogs: How Well Does it Work? Conservation Biology 14(6): 1715-1721.

[9]The contribution of fisheries to this figure is rather small, comprising approximately $4 million of Guam's $127 million annual value of reefs, or about 3% (Burdick et al. 2008).

> The sobering fact is that despite high biodiversity on coral reefs, with over 3000 fish species, a major ecosystem process may be shaped by the activities of just one species.

This one species is the Bumphead Parrotfish.

Historic and Current Population Status & Trends

While historically common or abundant throughout its range (Donaldson and Dulvy 2004; Chan et al. 2007), the Bumphead Parrotfish is now declining and globally rare (Dulvy and Polunin 2004; Chan et al. 2007; NMFS 2009). Chan et al. (2007) estimate that Bumphead Parrotfish populations have declined at least 30% over the past 30 years. The species is extirpated or nearly extirpated from a significant portion of its range (Table 2).

Table 2. Imperilment of Bumphead Parrotfish in Significant Portion of Range. Sources: Hasurmai et al. 2005; Foster et al. 2006; Chan et al. 2007; Habibi et al. 2007; Waddell and Clarke 2008; NMFS 2009.

Location	Status
Guam (U.S.)	Nearly extirpated
American Samoa (U.S.)	Rare since 1970s; Observed only at a few islands in American Samoa in surveys conducted from 2002-2006 and was rarely encountered during those surveys
U.S. Line & Phoenix Islands	Rarely encountered during surveys from 2002-2006
Wake Atoll (U.S.)	Relatively common, but large individuals are rare
Fiji	Nearly extirpated; While commercial important in the 1990s, the species is now rare in markets
East Africa	Nearly extirpated
Marshall Islands	Nearly extirpated
Palau	Rapidly declining
Great Barrier Reef (south end)	Declining
Kosrae, Micronesia	Declining
Indonesia	Steeply declining

Waddell and Clarke (2008: 5) state that Bumphead Parrotfish “have declined in many places but are still present in a few remote parts” of the Pacific Remote Islands, Marshall Islands, and Micronesia. Miller et al. (2008: 380) describe the species as “very rare in most other areas of the U.S. Pacific” except Wake Atoll, at which individuals were observed in nearly every dive during fish surveys in October 2005 and April-May 2007, sometimes in schools of up to 30. During 2006 surveys, these same researchers reported no sightings of the species at Howland and Baker Islands; sightings of only one individual at Jarvis Island; no individuals at Kingman Reef; and 2 individuals at Palmyra

Atoll. *Id*. Burdick et al. (2008: 481) state that "large reef fish are conspicuously absent from many reefs" in Guam.

Other researchers describe the species as still abundant in parts of the Great Barrier Reef and other parts of Australia, Papua New Guinea, Micronesia, Solomon Islands, Red Sea, and New Caledonia (Chan et al. 2007; NMFS 2009). However, interviews with spearfishers in Roviana Lagoon (Solomon Islands) in 2000-20001 indicated that major declines are occurring there, especially of male fish larger than 100 cm (39.4 in) (Chan et al. 2007). In Kosrae, Micronesia, only 3 Bumphead Parrotfish were recorded in 75 dives (Hasurmai et al. 2005). In 2005, surveys in the Mariana Islands found no individuals, in contrast to 2003 when several Bumphead Parrotfish were recorded (Starmer et al. 2008). Moreover, in a global survey of over 300 reefs, the Bumphead Parrotfish was not found in 67% of the sites in the Indo-Pacific (NMFS 2009). In a report for the years 1997-2003, Reef Check considered the Bumphead Parrotfish to be one of 4 species of fish in critical condition, as it was missing from 89% of Indo-Pacific reefs (Hassan et al. undated). *See also* Table 2 in Dulvy and Polunin (2004), which lists the status of this species in select Indo-Pacific locations.

Reef Check surveys have been especially important in documenting the absence or decline or the Parrotfish. Figure 6 illustrates that surveys often find few or zero individuals of this species.

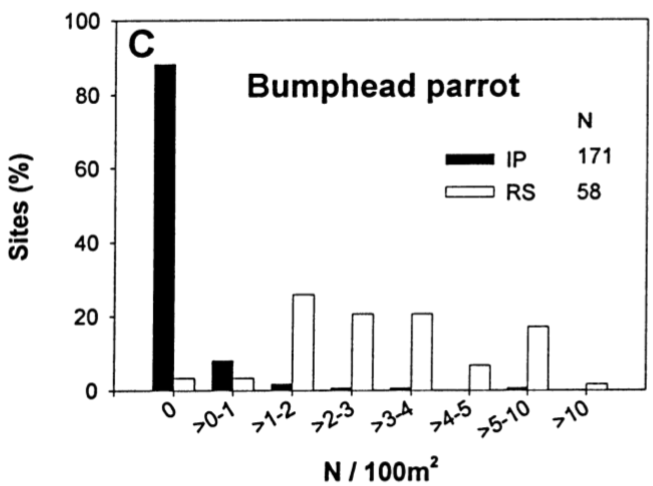

Figure 6: Reef Check Surveys of Bumphead Parrotfish.
(IP=Indo-Pacific; RS=Red Sea). Source: Hodgson (1999).

The Society for Conservation of Reef Fish Aggregations interviewed local fishers in Palau in 2003 and recorded the following observations over time:

- Caught 60 at one go in shallow water at night with a spear in the 1970s; could remove the whole school at a time using SCUBA;
- Maximum catch was 250 fish in 1 fishing trip in 1975; 30 to 50 fish per trip after 1975; very few now;
- *B. muricatum* sleeps in predictable places and can be found easily;

- *B. muricatum* are now caught at greater depth using SCUBA;
- The number of *B. muricatum* had declined dramatically and noticeably by the early 1990s;
- Could catch 100 to 150 fish (about 60 lbs each) in a month between 1960 and 1970; could catch 30 to 60 fish (30 lbs each) in a month after 1990; a lot of females with eggs were caught about 8 to 9 days after each full moon;
- Easier to catch at new moon in shallow (2 to 3 m) waters at low tides in very predictable places; caught 1,000 lbs in the early 1980s.

See Chan et al. (2007). In addition to indicating a decline in parrotfish in Palau, these accounts underscore the vulnerability of this species to fishing. In fact, the species faces multiple threats to their long-term persistence, as petitioners demonstrate below.

Identified Threats to the Petitioned Species: Criteria for Listing

The Bumphead Parrotfish may meet all of the criteria for listing under the ESA:

A. Present and threatened destruction, modification, and curtailment of habitat and range;
B. Overutilization for commercial and recreational purposes;
C. Disease or predation;
D. The inadequacy of existing regulatory mechanisms; and
E. Other natural or manmade factors affecting its continued existence.

The coral reef habitats used by this species are vulnerable to adverse impacts from human activities, climate change, and natural disasters (Factors A and E). It has declined drastically due to overfishing (Factor B). Its coral habitat and diet are threatened by disease and predation (Factor C). The increased rarity of this species makes it increasingly vulnerable to extirpation from stochastic events (Factor E). Finally, there are inadequate regulatory mechanisms to address all of these threats (Factor D).

I. Present and Threatened Destruction, Modification, or Curtailment of Habitat or Range.

Because the parrotfish primarily feeds on coral, with each individual fish ingesting over 5 tons of coral every year (Bellwood et al. 2003), it is vulnerable to degradation of its coral habitat (NMFS 2009). Coral bleaching from elevated water temperatures and unusually calm conditions (Dulvy et al. 2003) present a significant threat and are discussed below under Factor E.

Scientists have documented human destruction of coral reefs as an important threat to reef fishes (Dulvy et al. 2003; Waddell and Clarke 2008). For example, Hasurmai et al. (2005) report coastal development, ship groundings, and blast fishery practices on Micronesia, all of which are adversely impacting coral reefs. Beger et al. (2008) report severe waste management problems in the Marshall Islands, which are leading to marine pollution, including from highly toxic batteries and electronics; additional threats to coral reefs are from quarrying and mining activities; ship groundings (causing both physical damage to reefs and pollution from fuel and other waste) and pollution, both from local sources and from places as far away as Central and South America. In the Mariana Islands, Starmer et al. (2008) reported that the primary anthropogenic stressor to coral reefs is non-point source pollution. Habibi et al. (2007: iii) report that "the pressure on our coral reefs is increasing in line with development and resource use across Indonesia." Harmful practices include coral mining, breaking coral apart to collect clams and abalone, blast fishing, trampling, sedimentation, net abandonment, and indiscriminate anchoring. These authors indicate that hard coral cover in Indonesian waters is trending downwards. *Id*. *See also* Foster et al. (2006) and George et al. (2008). Activities causing sedimentation and pollution have been reported from American Samoa (Aeby et al. 2008). Discarded metallic debris – including boats, chains, anchors, and World War II military debris – may also factor in coral reef declines (Miller et al. 2008). Indeed, Marino et al. (2008) found that a 2005 grounding of a US navy ship in Palau caused a 300 m^2 bleaching event that resulted in full coral mortality, with no signs of subsequent recovery. Other concerns on Palau are water pollution from coastal development, sewage, fuel spills, agriculture, roads, and marine debris. *Id*.

Guam's reefs face many of these and other threats, such as heavy recreational use (especially by SCUBA divers[10]), given visitation rates as high as 1.2 million tourists in 2006; dredging and reef removal for military operations, which include underwater demolition and landing craft exercises; mechanical beach clearing; and sedimentation and pollution of river water emptying onto coral reefs, some of which is caused by the serious and ongoing problem of arson by poachers on the island. The coral reefs located near river mouths are in the worst condition due to pollution in these rivers. Many of these threats will escalate due to a planned addition to Guam of 26,000 military personnel and their dependants (Burdick et al. 2008).

The latest U.S. report on coral reef ecosystems, which includes analysis of U.S. Pacific territories, as well as Palau, Marshall Islands, and Micronesia, notes that in general,

> …coral reef condition is declining in many locations while threats to them are increasing. Coral reef ecosystems in the U.S. and FAS [Freely Associated States] continue to be beset by a number of serious threats stemming from natural and anthropogenic factors, which stress and degrade the living marine resources inhabiting coral reef ecosystems in addition to the corals themselves (Waddell and Clarke 2008: 3).

This broad-ranging problem of declining coral ecosystems adversely impacts the Bumphead Parrotfish.

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[10]In some areas, such as Piti Bombs Hole Marine Preserve, approximately 18,000 dives per year occur within a 0.25 ha (0.6 acre) location, resulting in significant coral loss and damage (Burdick et al. 2008).

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

Overfishing (both commercial and subsistence) is a significant threat to this species. Indeed, it is one of the most vulnerable species to fishing pressure (Donaldson and Dulvy 2004; NMFS 2009).[11] It is particularly susceptible to spear- and net-fishing, as individuals sleep in large groups at night. The use of cyanide and dynamite to take parrotfish is also a significant threat. Certain cultures use this species in ceremonial events, and it is a target species among spearfishers and for the live food fish trade (Dulvy and Polunin 2004; Chan et al. 2007; Waddell and Clarke 2008; NMFS 2009).

Parrotfish catches have decreased dramatically in recent decades, indicating the species' decline (NMFS 2009). Dulvy and Polunin (2004) report that the species is locally common only inside areas where fishing is prohibited. This species is taken by commercial and subsistence fishers, both legally and illegally. There are reports in Micronesia of Taiwanese and Hong Kong long-liners illegally fishing Bumphead Parrotfish (and other species) at night (Hasurmai et al. 2005). Reef Check reports overfishing at all monitored sites in Indonesia (Habibi et al. 2007).[12] NOAA researchers describe Guam's fish stocks as depleted, with individual reef fish greater than 25 cm (9.8 in) uncommon or rare in Guam (Burdick et al. 2008). Illegal fishing, especially of large reef fish, occurs in Guam's protected areas. *Id*.

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[11] *See also* Dulvy et al. (2003: 53), which states, "Target species that aggregate in large numbers at locations that are consistent in time and space and which are easy to find can be readily overfished, leading to local depletions or extinctions…" These conditions fairly accurately describe the Bumphead Parrotfish.
[12] Reporting on Indonesia, Foster et al. (2006: 24) state, "Additional demands on the already overfished stocks could push local coral reef populations to the point of collapse."

Figure 7: Traditional Spearfishing Method on Solomon Islands. Source: Hamilton (2003).

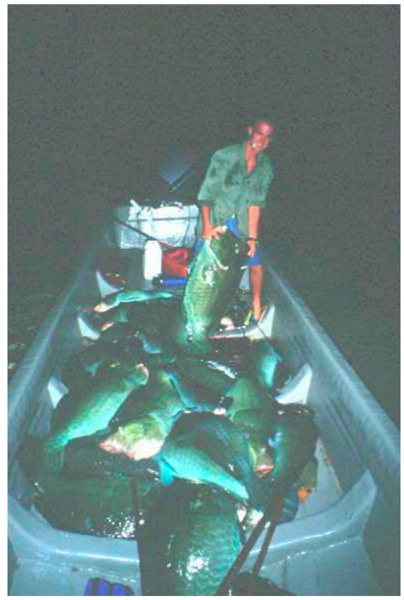

Figure 8: Modern Spearfishing Method Allows Larger Catches. Source: Hamilton (2003).

Hamilton (2003) documented that catch rates in the Solomon Islands by indigenous fishers, using burning coconut leaves for illumination and fishing from dugout canoes, were below the maximum sustainable yield until the technological development of the underwater flashlight. In contrast, underwater fishers, using goggles and spears, could take 4-5 times more fish per night (Figures 7 and 8).

Aswani and Hamilton (2004a) also described differences in catch rates using traditional and modern methods in the Solomon Islands. With traditional methods, a few individuals were captured in a night, whereas the use of dive goggles, flashlights, and spear guns enabled divers to take over 50 fish in a night. They also documented the selective fishing of large parrotfish in Roviana Lagoon; and significant variation in parrotfish catch rates and sizes between lightly fished and heavily fished areas. They warn:

> In the Solomon Islands, the increasing subsistence and commercial exploitation of this species is threatening the fishery's viability. Anecdotal evidence suggests that fishing pressure has had a significant impact on bumphead parrotfish populations in the Roviana and Vonavona Lagoons. *Id*. at p. 70.

These researchers add that the fishery in this area has not yet collapsed, but they document that "bumphead parrotfish have declined markedly following the advent of market-driven spearfishing and that large fish are rare." *Id*. at p. 77.

The same dynamic rather dramatically occurred in American Samoa. SCUBA spearfishing took hold in 1994 and continued to 2000. This method increased fishing efficiency by 15 times, and nearly 20% of the parrotfish stock was removed during this timeframe. Parrotfish were especially targeted at night while sleeping. The result was a shift in the fish community: whereas in the late 1970s, Scaridae were the dominant fish in terms of biomass, Acanthuridae is now dominant in terms of biomass (Aeby et al. 2008). Fishing of Bumphead Parrotfish was recently prohibited on American Samoa (along with sharks and three other species of reef fish). However, surveys continue to find few or no individuals of this species. *Id*.

Scientists have documented that exploitation is a leading cause of marine extinctions (Dulvy et al. 2003) and have cited this as the single cause of extirpation of the Bumphead Parrotfish from the Lau Islands, Fiji (Dulvy et al. 2003). NOAA has recognized that overfishing on coral reefs is the most widespread threat globally and a high threat in every populated U.S. jurisdiction except the Mariana Islands (Clarke et al. 2008).

III. Disease or Predation

While disease and predation of the Parrotfish is not known to be a threat, NMFS should investigate whether either disease or predation that affects coral reefs constitutes a threat, or may exacerbate anthropogenic threats, to this parrotfish. In particular, disease has been implicated in extensive coral loss in the Carribbean (Dulvy et al. 2003), and NMFS should consider whether diseases are or have adversely impacted coral hosts in the Indo-Pacific, given the dependence of parrotfishes on coral. Aeby et al. (2008) report that coral disease is emerging as a problem in the Indo-Pacific and describe the prevalence of two coral diseases – *Acropora* white syndrome and *Acropora* growth anomalies – in American Samoa. Beger et al. (2008) note a correlation between sea temperature rise and an outbreak of Acropora white syndrome in the Marshall Islands in 2003. These researchers describe an increasing incidence of coral disease for this country. *Id*. In the Mariana Islands, Starmer et al. (2008) assert that coral disease increased from 2002-2005 and described increases as potentially correlated with increased diving activity. In Guam, where researchers report disease as a serious threat, there appears to be some correlation between disease and increased water temperature (Burdick et al. 2008). *See also* Polidoro et al. (2009).

Coral reefs can experience significant mortality from outbreaks of Crown-of-Thorns Sea Star (*Acanthaster planci*) (COTS), which feed on coral. Figure 9 shows the distribution of COTS in the Indo-Pacific. Waddell and Clarke (2008) report COTS occurrence throughout U.S. territories in the Pacific, as well as Marshall Islands, Palau, and Micronesia. Wilson et al. (in press) report an outbreak in Fiji. These starfish outbreaks may be linked with over-fishing. *Id*. George et al. (2008) report an outbreak in Micronesia that may be restructuring coral communities. Beger et al. (2008) report high concentrations of COTS in areas within the Marshall Islands from 2004-2007. Starmer et al. (2008) note high COTS concentrations in the Mariana Islands in 2003 and 2004. Burdick et al. (2008) describe widespread outbreaks of COTS across Guam's reefs, with large-scale mortality since 2004. These researchers describe COTS as having "a severe impact on many of Guam's reefs." *Id*. at p. 483.

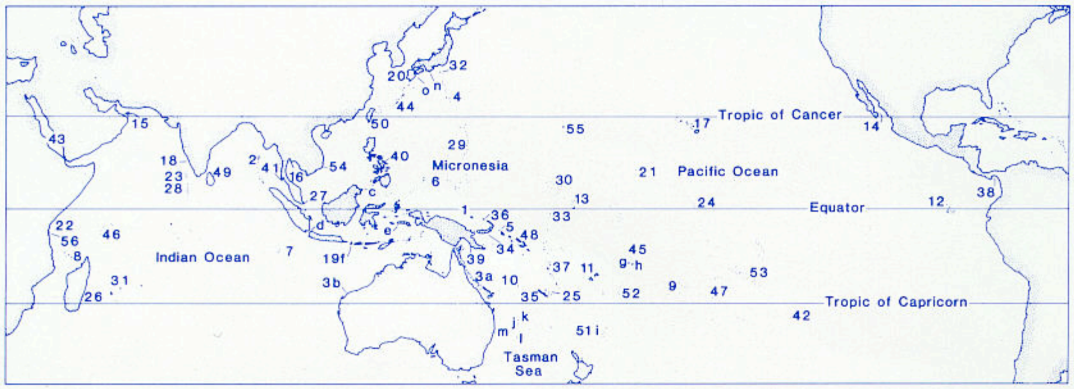

Figure 9: Crown-of-Thorns Starfish Distribution in the Indo-Pacific.
(Numbers indicate sites where presence has been reported.)
Source: Australian Institute of Marine Science.[13]

NMFS should investigate whether Crown-of-Thorns predation of coral constitutes a threat to the Bumphead Parrotfish either under ESA Listing Factor C (Predation) or A (Habitat Loss).

IV. The inadequacy of existing regulatory mechanisms

The Bumphead Parrotfish is not adequately protected by federal or state laws or policies to prevent its endangerment or extinction.

IUCN ranks the Bumphead Parrotfish as "Vulnerable," defined as "considered to be facing a high risk of extinction in the wild."[14]

NMFS ranks the Bumphead Parrotfish as a Species of Concern (NMFS 2009).

The Bumphead Parrotfish is listed as a Management Unit Species (MUS) under the Western Pacific Coral Reef Ecosystems Fishery Management Plan, which indicates that it warrants monitoring by NMFS and the Western Pacific Regional Fishery Management Council. Permits are required for take of MUS species on Wake and Palmyra Atolls, and night spearfishing with SCUBA gear is prohibited in these areas. However, restrictions on spearfishing in American Samoa are under-enforced (NMFS 2009). Similarly, in the Pacific Remote Islands of the U.S., NOAA researchers have noted that occasional commercial fishing incursions likely occur and little monitoring is possible in these areas, given their remoteness and despite their National Wildlife Refuge status (Miller et al. 2008).

Palau has adopted a ban on export of this fish and has a national minimum size limit of 25 inches (63.5 cm). However, NOAA researchers reported surveys indicating that

[13]Map available online at: **http://www.aims.gov.au/pages/reflib/cot-starfish/pages/cot-f03.html** [Accessed November 2009].
[14]See **http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria#categories** [Accessed November 2009].

nearly half of the respondents felt that restrictions on fishing in Palau were ineffective, and most – 68% – felt that Bumphead Parrotfish needed to be further protected (Marino et al. 2008).

Scientists have suggested a range of protective measures, including:

- protection of large females, given their high fecundity;
- moratoria on commercial fishing and export and restrictions on fishing gear;
- public education on need for conservation;
- creation of larger marine reserves with key habitats included;
- more research on biological requirements and ecology;
- protection and monitoring of the species given its important ecological role; and
- blanket protection for the species.

See Chan et al. (2007). Some scientists have suggested that current marine protected reserves in heavily fished areas are too small to show positive effects for parrotfishes (Russ and Alcala 1988; Chan et al. 2007).

Despite the long list of recommendations by scientists – and the overwhelming recognition by scientists that the Bumphead Parrotfish is declining and continues to face multiple threats, this species suffers from inadequate protection. For example, Chan et al. (2007) noted:

> In Roviana Lagoon (Solomon Islands), artisanal spear fishers use their sophisticated indigenous knowledge of the spawning behaviour and ecology of *B. muricatum* to catch as many fish as possible in a night (Hamilton 2003).
>
> Low priority to enforcing legislation related to spearfishing in Fiji (Gillett and Moy 2006).
>
> In 2001, the Samoa Fisheries Projected reported that SCUBA spearfishing activities at night had been increased rapidly in the past 12 months, in which *B. muricatum* was one of the target species (Gillett and Moy 2006).
>
> Gillett and Moy (2006) pointed out that sleeping *B. muricatum* was one of the three main types of fish to be targeted by spearfishing.

In the Solomon Islands, Aswani and Hamilton (2004a: 79) describe the species as “in urgent need of protection” and describe the parrotfish and its habitats as “most urgently need[ing] management.” Small marine protected areas (MPAs) have been created to conserve the Bumphead Parrotfish, as well as bans on fishing in some areas, but Aswani and Hamilton (2004a) note that fishing restrictions in highly contested waters would likely be difficult to monitor and enforce. Hasurmai et al. (2005) also cite fishers’ reports of illegal fishing by foreign long-liners in Micronesia. Burdick et al. (2008) report illegal fishing in Guam’s MPAs.

Aswani and Hamilton (2004b) report the establishment of 12 small MPAs in the Solomon Islands, ranging in size from 25-266 ha (61.8-657 acres), and indicate they are working to establish 10 additional MPAs. While the designated MPAs represent 5.7% of all lagoon habitats, this proportion falls short of the 15-20% scientists estimate is necessary to safeguard biodiversity and fisheries function. *Id*.[15] Results of MPAs are mixed. Habibi et al. (2007) report increases in hard coral cover in protected areas versus unprotected areas. Waddell and Clarke (2008) note research finding that fish biomass is eight times higher in MPAs versus unprotected areas. Alternatively, Hasurmai et al. (2005) report no significant difference in parrotfish biomass when comparing MPAs on Micronesia to unprotected areas, which they attribute to lax enforcement. For the Mariana Islands, Starmer et al. (2008) describe a relevant study in contrasts: the Mañagaha Marine Conservation Area has benefited from U.S. federal funding to enforce its no-take regulations, while the Sasanhaya Bay Fish Reserve has analogous no-take regulations but lacks federal funding. Fish recovery has been documented for the former MPA, but positive trends have not been documented for the latter.

Palau's network of MPAs is impressive: as of 2007, the country had 31 MPAs covering 40% of its nearshore marine areas (Marino et al. 2008). A program was recently begun to access the effectiveness of these MPAs. *Id*.

NOAA's 2008 coral reef report maintains that these current regulatory mechanisms are inadequate to protect coral reef ecosystems:

> Despite the investments made to date in managing and monitoring U.S. coral reef ecosystems and increasing management capacity at all levels, coral reef ecosystem resources have continued to decline over the short- and long-term. Present monitoring efforts are inadequate to support effective management and document the impacts of key threats and resource condition with sufficient confidence to detect change at meaningful temporal and spatial scales. Further support at all levels is needed to augment our ability to understand the impacts of threats and mitigate damage that occurs. Significant actions and bold protective measures are required if reef conditions are expected to improve in the future (Waddell and Clarke 2008: 8).

From these observations and the documented rangewide decline, it is clear that regulatory mechanisms are currently inadequate to protect the Bumphead Parrotfish.

V. Other natural or manmade factors affecting its continued existence

Climate Change. Excessive greenhouse gas emissions are causing a range of effects on coral reefs and their resident fishes, including warming ocean temperatures, with consequent coral bleaching; increased acidity of oceans as they absorb carbon dioxide, with consequent decreases in growth rates of scleractinian corals (the primary reef-

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[15] Clarke et al. (2008) report on the "Micronesia Challenge," wherein the Governor of Micronesia announced in 2006 a commitment by Guam, the Northern Mariana Islands, Micronesia, the Marshall Islands, and Palau to conserve 30% of nearshore marine resources and 20% of terrestrial resources by 2020.

builders); more extreme whether events, leading to coral damage; the breakdown in trophic linkages and ecosystem processes; and many other effects (Munday et al. 2008a; *see also* Munday et al. 2008b). For the Bumphead Parrotfish, scientists have underscored coral bleaching as the primary way in which climate change adversely impacts this species. Reporting on coral bleaching in Fiji, Wilson et al. (in press: p. 2) state, "Overfishing and habitat degradation through climate change pose the greatest threats to sustainability of marine resources on coral reefs." Coral bleaching is the result of coral hosts losing their symbiotic algae and therefore looking white or bleached (Dulvy et al. 2003; Miller et al. 2008; Karl et al. 2009). While coral bleaching does not always result in coral mortality, it can stunt coral growth and therefore have a chronic negative impact (Aeby et al. 2008). In order to survive, coral must be able to recruit new algae in time to fulfill their nutritional needs (Miller et al. 2008).

Elevated water temperatures are the primary cause of bleaching (Dulvy et al. 2003; Miller et al. 2008). Coral are very sensitive to changing water temperatures, as they live near their thermal maximum: "Sea surface temperatures 1°C [1.8°F] greater than the maximum summer monthly average for a number of weeks are known to cause mass coral mortality" (Dulvy et al. 2003: 38; *see also* Miller et al. 2008). Bleaching can extend down to 50 m (54.7 yards), throughout the entire depth-range at which the Bumphead Parrotfish occurs. Climate-change related coral bleaching may become annual events in southeast Asia by the year 2020 and around the Great Barrier Reef by 2040-2070 (depending on latitude) (Dulvy et al. 2003).

Coral bleaching events have occurred in American Samoa in 1994, 2002, and 2003 (Aeby et al. 2008); Palmyra Atoll and Kingman Reef in 2002-2004 (Clarke et al. 2008); Jarvis Island in 2002-2004 (*Id*.); Howland Island in 2002-2007 (*Id*.); Mariana Islands in 2000, 2001, and 2006 (*Id*.; Starmer et al. 2008); Marshall Islands in 2001, 2003, 2004, and 2006 (Beger et al. 2008); Indonesia in 1998 (Habibi et al. 2007); Micronesia in 2004, 2007, and possibly in the late 1990s (George et al. 2008); Palau in 1998 (Marino et al. 2008); and Guam in 2006 and 2007 (Burdick et al. 2008). Researchers predict that bleaching may become more frequent and severe in Guam. *Id*.

Additional climate change effects that harm coral reef ecosystems are increased frequency and intensity of extreme events, such as typhoons, cyclones, hurricanes, and tsunamis (IPCC 2007; CCSP 2008; Karl et al. 2009). Hasurmai et al. (2005) documented significant damage to coral reefs in Micronesia due to typhoons. *See also* George et al. (2008). Foster et al. (2006) documented damage to coral reefs in Indonesia due to tsunamis, although the damage was not as extensive or severe as predicted. Aeby et al. (2008) documented impacts from hurricanes and cyclones in American Samoa. Beger et al. (2008) described significant coral damage from a 2006 storm in the Marshall Islands. Starmer et al. (2008: 440) noted that the Mariana Islands are located in "Typhoon Alley," an area that experiences 3 typhoons per year, but they note that coral reefs in this area evolved with these regularly storm conditions. Guam is also in a high activity area for typhoons (Burdick et al. 2008). NMFS should consider whether altered storm regimes – potentially more intense and/or more frequent – pose a threat to coral reef ecosystems, especially in conjunction with anthropogenic threats.

The Intergovernmental Panel on Climate Change (IPCC) underscored the risk facing coasts and coral reefs worldwide from climate change:

> Coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea level rise. The effect will be exacerbated by increasing human-induced pressures on coastal areas (*very high confidence*)… (IPCC 2007: 28)
>
> Deteriorations in coastal conditions, for example through erosion of beaches and coral bleaching, is expected to affect local resources (IPCC 2007: 52).

The IPCC (2007) and Karl et al. (2009) also note the danger to coral from increased ocean acidification, a threat that NOAA also recognizes (Miller et al. 2008; Waddell and Clarke 2008). Karl et al. (2009: 85) describe the significance of ocean acidification to coral as follows:

> As the carbon dioxide concentration in the air increases, more carbon dioxide is absorbed into the world's oceans, leading to their acidification. This makes less calcium carbonate available for corals and other sea life to build their skeletons and shells…If carbon dioxide concentrations continue to rise and the resulting acidification proceeds, eventually, corals and other ocean life that rely on calcium carbonate will not be able to build these skeletons and shells at all.

In addition, Karl et al. (2009) report that disease rates among marine species (including corals) may be increasing due to global temperature rise, in line with the above discussion under ESA Listing Factor C (Disease and Predation). *See also* Polidoro et al. (2009).

A recent U.S. report specifically focused on weather extremes due to climate change (CCSP 2008) predicts increases in hurricane rainfall and wind speeds in the Pacific due to human-caused increases in sea surface temperatures.

The U.S. national report on *Global Climate Change Impacts in the United States* (Karl et al. 2009) estimates that one-third of the world's corals have died or been severely damaged by bleaching events, which have increased significant in the past 30 years. Karl et al. (2009: 148) indeed emphasize the vulnerability of coral reef ecosystems to climate change impacts:

> Coral reef ecosystems are particularly susceptible to the impacts of climate change, as even small increases in water temperature can cause coral bleaching, damaging and killing corals. Ocean acidification due to a rising carbon dioxide concentration poses an additional threat...Coral reef ecosystems are also especially vulnerable to invasive species…These

> impacts, combined with changes in the occurrence and intensity of El Niño events, rising sea level, and increasing storm damage, will have major negative effects on coral reef ecosystems.

A recent United Nations Environment Programme report on climate change science also described climate-change caused dynamics of relevance, including increasing ocean acidification; coral bleaching; increases in coral disease; concentration of predators on remaining coral populations; and, overall, "catastrophic loss of coral cover in some locations and…changed coral community structure in many others" (McMullen and Jabbour 2009: 31). Beger et al. (2008) list sea level rise as a threat to coral reef ecosystems in the Marshall Islands. Starmer et al. (2008) describe potential threats from mitigations to climate change to maintain existing coastal structures, including artificial reef construction.

Through a multitude of ways, climate change poses a significant threat to coral reef ecosystems and the reef fish – including the Parrotfish – they support. Burdick et al. (2008: 504) underscored this threat, stating:

> Global climate change poses a particularly grave and increasingly pressing threat to the vitality of Guam's reefs. The expected increase in incidences of coral bleaching, ocean acidification and the potential for stronger storms will directly affect reef health, challenging even the most resilient reefs.
>
> It is clear that the ability of Guam's reefs to cope with climate change must be enhanced significantly if productive reef systems, and the goods and services they provide, are to be available to future generations. To achieve this will require a deep commitment to the rapid, large-scale reduction in the threats currently affecting Guam's reefs.

We urge NMFS to consider the multiple effects of climate change on coral reef ecosystems in a status review for the parrotfish.

Biological Vulnerability. As discussed above, the Bumphead Parrotfish is nearly extirpated from many areas within its range. The resultant small population sizes and narrowing range increase the likelihood of regional and global extinction.[16] The U.S. Fish and Wildlife Service (FWS) has recognized this threat for other species. For the Langford's tree snail (*Partula langfordi*), the Service states:

> Even if the threats responsible for the decline of this species were controlled, the persistence of existing populations is hampered by the limited number of known individuals of this species. This circumstance makes the species more

[16]See, e.g., Service candidate assessment forms for *Doryopteris takeuchii, Huperzia stemmermanniae, Megalagrion nesiotes, Melicope degeneri, Melicope hiiakae, Myrsine mezii, Ostodes strigatus, Partula langfordi, Peperomia subpetiolata, Phyllostegia bracteata*, and *Tryonia circumstriata*. Accessible via FWS website at **http://www.fws.gov/endangered/wildlife.html** [Accessed November 2009].

> 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; Pimm et al. 1988; Center for Conservation Update 1994; Mangel and Tier 1994).[17]

FWS here relies on citations not specific to *Partula langfordi* that indicate the threat to survival presented by limited population numbers even without other known threats. This agency likewise notes for a snail called Sisi (*Ostodes strigatus*), "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."[18] NMFS should similarly consider whether population and range reductions are a threat to the Bumphead Parrotfish or may become a threat in the foreseeable future.

In addition, the slow growth rates and delayed reproduction make the Bumphead Parrotfish vulnerable to stressors (NMFS 2006; 2009). Dulvy et al. (2003) also discuss the correlation between body size and extinction risk, with larger animals at increased risk. This relationship may exist because larger animals are targeted and because of correlation of large size with additional factors, such as low population increase rates, late maturity, dependence on more vulnerable habitats, and behavior that may make them more catchable. *Id*. As a relatively large fish (1.3 m or 4 ft), and the largest of the parrotfishes, the Bumphead Parrotfish is particularly vulnerable to extinction. Likewise, Gillett and Moy (2006: 56) describe this species as "inherently unable to sustain much fishing pressure." Unfortunately, it has been subjected to a high degree of fishing pressure and has declined as a result.

Human population growth. Human population increases within the range of the Bumphead Parrotfish present an additional threat to this species. NOAA has noted the threat of growing human populations to coral reef ecosystems:

> As the global population continues to increase and demographic shifts toward coastal areas persist, even greater pressures will be placed on nearshore resources to satisfy human desires for food, culture, tourism, recreation and profit (Waddell and Clarke 2008: 8).

Referring to the Solomon Islands, Aswani and Hamilton (2004b: 3) write, "Pressures from a population explosion and rampant development…are increasingly threatening the ecology and social stability of the region." A World Wildlife Fund report similarly states,

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[17]See 2009 Listing Form for Partula langfordi at:
http://ecos.fws.gov/docs/candforms_pdf/r1/G0AI_I01.pdf [Accessed November 2009] at p. 5.

[18]See 2009 Listing Form for *Ostodes strigatus* at:
http://ecos.fws.gov/docs/candforms_pdf/r1/G0A5_I01.pdf [Accessed November 2009] at p. 4.

> Nearly 40 per cent of the global population now lives within 100 kilometers of a coast, and many of these people depend on the productivity of the sea. As coastal populations soar, pressure on marine resources has become unsustainable in many places.[19]

Dulvy et al. (2003: 26) write:

> …more than half of the world's human population lives within the coastal zone and depends on fish for the bulk of their protein intake. This proportion could reach 75% by the year 2020…

Habibi et al. (2007) note that 80% of the Indonesian population is in the coastal zone. Hasurmai et al. (2005) describe rapid population growth in Micronesia. Even more specific evidence of the impact of human population is reported from Dulvy and Polunin (2004: 369-371): "The giant humphead parrotfish is consistently rare or very rare at locations with very high human population densities, such as the Philippines, Tanzania and Indonesia." NOAA researchers write, "Some species of large reef fish are currently considered uncommon to rare, as is typical of coral reefs near human populations…" (Aeby et al. 2008: 310).

The International Ocean-Colour Coordinating Group (IOCCG)[20] (2009) reports a direct relationship between human population density and unsustainable coral reef fisheries (Figure 10). Indeed, the human fertility rates in the range of the Bumphead Parrotfish include a region and specific countries whose rates are among the highest in the world. The region of **East Africa** has a female fertility rate of 5.6, one of the highest globally (UN 2007). Other regions over the replacement rate of 2.0 include:

- **Melanesia**, which has a female fertility rate of 4.1.
- **Polynesia**, which has a female fertility rate of 3.3.
- **Micronesia**, which has a female fertility rate of 3.0.
- **Southeastern Asia**, which has a female fertility rate of 2.5. *Id*.

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[19]See World Wildlife Fund report, "Marine protected areas: providing a future for fish and people." Online at: **http://assets.panda.org/downloads/marineprotectedareas.pdf** [Accessed November 2009]. This report was focused on the role of MPAs in safeguarding marine biodiversity and sustaining fisheries.

[20]The International Ocean-Colour Coordinating Group is an international committee of experts on the subject area of global satellite ocean colour. See website at: **http://www.ioccg.org/about_ioccg.html** [Accessed December 2009].

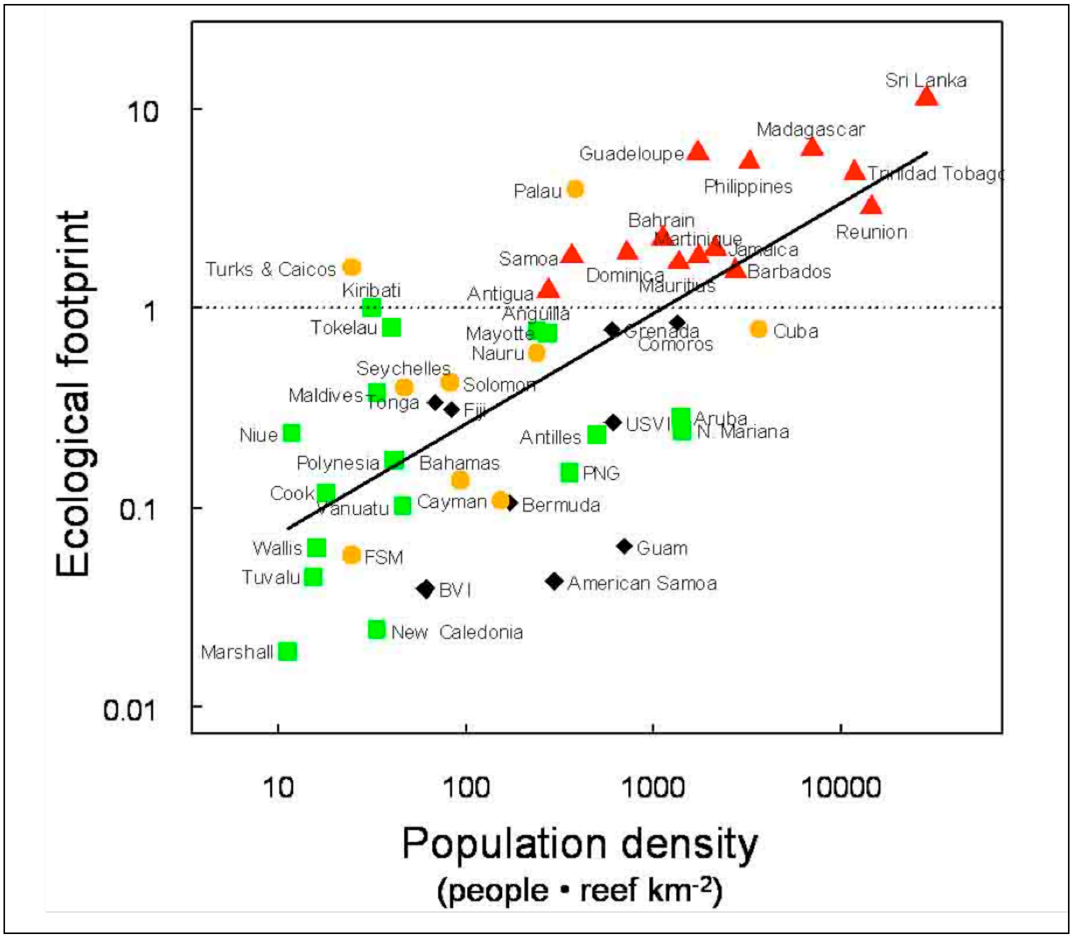

Figure 10: Human Population Density and Status of Reef Fisheries.
(Island reef fishery statuses are represented by four colors: green squares=underexploited, orange circles=fully exploited, red triangles=overexploited, black diamonds=collapsed.)
Source: IOCCG (2009).

Individual countries with high rates (3.0 or greater) include:

- **Egypt**, with a female fertility rate of 3.2.
- **Kenya**, with a female fertility rate of 5.0.
- **Madagscar**, with a female fertility rate of 5.4.
- **Malaysia**, with a female fertility rate of 3.0.
- **Micronesia**, with a female fertility rate of 4.4.
- **Mozambique**, with a female fertility rate of 5.6.
- **Papua New Guinea**, with a female fertility rate of 4.8.
- **Philippines**, with a female fertility rate of 3.6.
- **Samoa**, with a female fertility rate of 4.4.
- **Solomon Islands**, with a female fertility rate of 4.8.
- **Somalia**, with a female fertility rate of 5.7.
- **Tanzania**, with a female fertility rate of 5.7.
- **Tonga**, with a female fertility rate of 3.9.
- **Vanuatu**, with a female fertility rate of 4.8.

- **Yemen**, with a female fertility rate of 6.2. *Id*.

Many other countries have above-replacement rates between 2.0-2.9: Fiji (2.5), Guam (2.7), Indonesia (2.6), Myanmar (2.6), New Caledonia (2.3). *Id*. Beger et al. (2008) noted that the Marshall Islands population is increasing by 1.5% every year and considers this a significant threat to the islands' coral reef ecosystems. Guam is a heavily populated island, with a population of 173,500 as of 2007. The population is predicted to rise to 230,000 within 10 years because of a large U.S. military personnel expansion (Burdick et al. 2008).

Due to these above-replacement fertility rates, the human populations of all of the above countries are predicted to rise substantially in coming decades (UN 2009).

A straightforward demonstration of the impact of human populations on coral reef communities is seen in Fiji, where Wilson et al. (in press) noted the decline in fishing pressure in the Lau Islands after human populations declined. However, changing demographics and fishing prohibitions can also help reduce fishing pressure (Aeby et al. 2008).

Cumulative Impacts. As demonstrated above, the Bumphead Parrotfish suffers from multiple threats. In analyzing coral reef fish communities in Fiji, Wilson et al. (in press) found that overfishing and habitat degradation are intersecting threats, with overfishing's impact being most significant for large-bodied adults and habitat loss resulting in fewer small-bodied juveniles and prey. Moreover, these researchers state:

> As perturbation of reefs increases due to climate change, human population growth and expansion, the influence of habitat will have an increasingly important role in structuring reef fish communities, particularly in areas protected from fishing. (Wilson et al., in press: 17-18).

Other researchers also point out these intersecting impacts to coral ecosystem health:

> If coral reefs were only threatened by rising sea levels they could possibly grow at the accelerated rates that are likely for the next century at least. But acidification and warming, as well as pollution and physical destruction, are weakening reefs further and they are unlikely to continue to provide 'fish nursery services' at the optimal rates required for healthy marine ecosystems… (McMullen and Jabbour 2009: 31).

Researchers on Guam likewise describe current degradation and multiple threats as impeding reef recovery:

> The ability of some reefs on Guam to recover from their current degraded state and from acute disturbance events such as COTS outbreaks, storms and bleaching events, is likely hindered by poor water quality, low target

herbivorous fish abundance and low coral recruitment (Burdick et al. 2008: 503).

Munday (2004) documented catastrophic declines in coral-dwelling fish (gobies) in Papua New Guinea, which he attributed to the intersecting effects of coral bleaching and sedimentation of coral reefs (e.g., from terrestrial development). Sedimentation appeared to increase the rate of coral mortality following bleaching and suppressed the growth of new corals, thereby thwarting recovery. *Id*. Munday et al. (2008a) also point out the cumulative impact of climate change, pollution, and COTS invasions on coral reefs. NMFS should consider the synergistic effects from multiple threats in its status review for the Bumphead Parrotfish.

Value of ESA Listing

The Bumphead Parrotfish occurs in U.S. as well as foreign waters. Federal listing of this species under the ESA would help ensure:

- Adequate habitat protections, restrictions on take, recovery planning, and funding for this species in U.S. waters;
- Prohibition on take of this species within U.S. waters;
- Prohibition on import, export, or possession of this species by U.S. individuals and corporations; and
- Consultation by U.S. agencies on federal permitting or funding of activities by U.S.[21] and foreign entities[22] that may jeopardize this species.

U.S. programs within the range of the Bumphead Parrotfish that influence domestic or foreign exploitation of coral reefs or reef fish; human population growth; greenhouse gas emissions; watershed management; agriculture; and other activities that may jeopardize this species or impede its recovery would all need to be reviewed if it was listed under the ESA.

Moreover, NOAA has previously recognized that ESA protections for Elkhorn (*Acropora palmata*) and Staghorn Coral (*A. cervicornis*) would benefit these species even though the majority of their ranges existing in other countries: through the recovery planning process, the U.S. can encourage international conservation measures (Clarke et al. 2008). Similar logic applies to the Bumphead Parrotfish.

Summary

The Bumphead Parrotfish merits listing as an Endangered or Threatened species under the Endangered Species Act. The species faces overwhelming threats from degradation

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[21]For example, U.S. military expansion on Guam is expected to significantly stress coral reef ecosystems around the island (Burdick et al. 2008).
[22]For example, the U.S. has allocated federal monies to Micronesia for coastal development projects that harm coral reef systems and possibly the Bumphead Parrotfish. *See* George et al. (2008) and **http://www.doi.gov/oia/Firstpginfo/compactgrants/index.html** [Accessed November 2009].

of coral reefs and overfishing. Its coral reef habitat and diet faces severe and growing threats from numerous effects due to climate change, including bleaching, ocean acidification, disease, and rapidly expanding human populations. With its reduced population levels and low rate of reproduction, it is biologically vulnerable. It does not enjoy regulatory protections sufficient to address the threats it faces.

The Bumphead Parrotfish's range is extensive, occurring in the Pacific and Indo-Pacific. However, there are numerous areas, including U.S. territories and foreign nations, where it is extirpated, near extirpated, or in significant decline. This petition is submitted with the hope that federal protection will be granted and will prevent this species' extinction. We believe ESA listing is vital to preserving and recovering this species.

Requested Designation

WildEarth Guardians hereby petitions the National Marine Fisheries Service within the U.S. Department of Commerce and the Fish and Wildlife Service within the Department of Interior to list the Bumphead Parrotfish (*Bolbometopon muricatum*) as an Endangered or Threatened species pursuant to the Endangered Species Act. This listing action is warranted, given the numerous threats this species faces, as well as its extreme decline in numbers. The Bumphead Parrotfish or the coral reef ecosystems upon which it relies are likely threatened by all five listing factors: present and threatened destruction, modification and curtailment of habitat and range; overutilization; disease and predation; the inadequacy of existing regulatory mechanisms; and other natural or manmade factors affecting its continued existence.

Critical habitat

Given that threats to its coral reef habitat is a significant cause of imperilment for the Bumphead Parrotfish, Petitioner requests that critical habitat be designated for this species concurrent with final ESA listing.

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