GUMBOOT CHITON

Cryptochiton stelleri Middendorff, 1846
(Acanthochitonidae)

Global rank G5 (26Jun2006)
State rank S5 (26Jun2006)

State rank reasons
Overall population and trends unknown, but the species is considered locally abundant and widespread in coastal areas. Threatened by human harvest; low recruitment rates make the species vulnerable to overharvest. There is also concern about contamination as a result of coastal development and oil spills and the potential effects of climatic warming.

TaxonomyRecent work by Okusu et al. (2003) places the genus *Cryptochiton* in a subclade within the Acanthochitonina along with *Tonicella*, *Mopalia*, and *Katharina*, based on genetic and morphological similarities.

General description
The largest chiton in the world, up to 33 cm long. In Southeast Alaska, typically smaller, about 15 cm (Yates 1989, O'Clair and O'Clair 1998). Species is unique among chitons because all eight plates are completely concealed by the thick and leathery reddish brown or brown mantle (Field and Field 1999, Cowles 2005). The underside is yellow or orange, with a broad foot (Harbo 1997). The butterfly-shaped valve plates are white or robins egg blue (Cowles 2005). Radular teeth are capped with magnetite (Yates 1989).

Length (cm) to 33
Weight (g) 500-800

Reproduction
Dioecious. Reproduction occurs once a year by free spawning of gametes (Tucker and Giese 1962, Yates 1989). In California, spawning occurs from March to May (O'Clair and O'Clair 1998, Cowles 2005); spawning was observed both prior to June and between June and early July along the Oregon Coast (Yates 1989). Dark green eggs (275-285 µm in diameter) are released in gelatinous strings that are quickly broken apart by wave action. Release of eggs by the female triggers male to release sperm into the water. After two to five days of development, yolky trochophores hatch into the plankton (O'Clair and O'Clair 1998). After hatching, larvae swim for about 20 hours, then settle and metamorphose (Cowles 2005). Small juvenile

individuals are rarely observed (MacGinitie and MacGinitie 1968).

Ecology
Very few predators; they include the lurid rocksnail (*Ocinebrina lurida*), tidepool sculpin (*Oligocottus maculosus*), river otter (*Lontra canadensis*; O'Clair and O'Clair 1998) and the large asteroid (*Pycnopodia helianthoides*; Yates 1989). A traditional source of food for humans, but the meat is very tough (Harbo 1997, O'Clair and O'Clair 1998). The purple urchin (*Strongylocentrotus purpuratus*) and red urchin (*S. franciscanus*) may compete with the gumboot chiton for space and food (Yates 1989). May be an indirect commensal to coralline algae by eating the fleshy red algae that grows on its surface and reducing the negative effects of algae overgrowth (Yates 1989). Both the red and red-banded scaleworms (*Arctonoe pulchra* and *A. vittata*) and the pea crab (*Opisthopus transversus*) can be found living as commensals in the gill chamber of the gumboot chiton (MacGinitie and MacGinitie 1968, Cowles 2005), although O'Clair and O'Clair (1998) report no commensals found in the species in Southeast Alaska.

Very slow growing; chitons that are more than 15 cm long are probably at least 20 years old and they may live for 25 years or more (MacGinitie and MacGinitie 1968).

Migration
Home ranges are restricted, as adults do not travel far (usually less than 20 m in over a year); more movement was observed in subtidal habitats (approx. 7 m/day) than intertidal habitats (approx. 1 m/day) by Yates (1989). Species is sensitive to light and prefers to remain on rocks below the low-tide line or the undersides of intertidal rocks during daylight hours; forages at night (Field and Field 1999). During spring, large numbers may gather on rocky beaches, probably

venturing in from deeper waters to spawn (Ricketts et al. 1985).

Phenology
Primarily active at night (MacGinitie and MacGinitie 1968, Field and Field 1999).

Food
Nocturnal grazer. Feeds mainly on red algae, but will also eat young kelp and some green algae (O'Clair and O'Clair 1998, Field and Field 1999). Along the Oregon Coast, prefers perennial red algae, especially *Iridaea cordata* and *Cryptopleura* spp., and ulvoids (Yates 1989). In California, foods consist mainly of *Ulva, Monostrema, Iridia* and other thin-fronded algae (MacGinitie and MacGinitie 1968). Food preferences are unlike those of other chitons and most other molluscan herbivores that generally prefer brown algae (kelps) and ephemeral green algae over red algae (Yates 1989). Gumboot chitons are able to feed on *Odonthalia dentata*, a red algae containing Lanosol, which is avoided by most other herbivores (DeBusk et al. 2000). Remains in tide pools during the day to feed when there is fog (Ricketts et al. 1985).

Habitat
Rocky intertidal. Found predominately in the low intertidal and subtidal zone of wave-swept rocky shores to 20 m depth, on both rocky and muddy substrate (MacGinitie and MacGinitie 1968, Baxter 1983, Yates 1989, Harbo 1997, O'Clair and O'Clair 1998); seldom collected above the low tide mark (Bailey 1935). Although wave shock is a source of mortality and inhibits chiton activity and feeding, this species is found most commonly in areas where wave shock and surge are moderate to low (Yates 1989, Field and Field 1999). In Southeast Alaska, the species is found on the coralline belt (this consists of an almost continuous belt of encrusting coralline algae) of the low intertidal on the exposed outer coast (O'Clair and O'Clair 1998). In the Puget Sound region, associated with the infralittoral fringe (exposed only by very low tides) of rocky intertidal habitats (Kozloff 1983). Along the Oregon coast, highest densities found in habitats with abundant tidepools and surge channels (Yates 1989).

Global range
Patchily distributed from Alaska west through Aleutian Islands to northern Hokkaido Island, Japan and the Kurile Islands, Kamchatka and south to the Channel Islands, southern California (Yates 1989, Harbo 1997, O'Clair and O'Clair 1998). More abundant at northern latitudes probably due to sensitivity to high temperatures when exposed at low tide (Yates 1989).

State range
Patchily distributed from Southeast Alaska west through the Gulf of Alaska to the Pribilof and Aleutian Islands (Barr and Barr 1983, Harbo 1997, O'Clair and O'Clair 1998). Specimens documented from Southeast Alaska, Prince William Sound, Kenai Peninsula to Cook Inlet, northern Gulf of Alaska to Kodiak, the Aleutians, and the eastern Bering Sea (Baxter 1983).

Global abundance
See Yates (1989) for abundance information along the Oregon Coast.

State abundance
Unknown, but with some populations considered abundant; probably most abundant on exposed outer coasts (O'Clair and O'Clair 1998).

Global trends
Localized declines in density have been reported. Long-time residents of Kachemak Bay, Alaska, observed marked decreases over the past two decades in intertidal species, including the gumboot chiton (Moss-Walker 2000). Similarly, Cowles (2005) observed far fewer gumboot chitons at San Simeon, California, where they were formerly abundant; this followed an episode in the late 1990s when large numbers of chitons washed up dead on the beach, presumably due to disease.

State trends
Localized declines in density and size structure have been reported. Long-time residents of Kachemak Bay, Alaska, observed marked decreases over the past two decades in intertidal species, including the gumboot chiton (Moss-Walker 2000); however, without long-term monitoring it is difficult to determine the cause (Moss-Walker 2000). Salomon et al. (2005 and Salomon pers. comm.) reported a decline in local abundance at sites on the Kenai Peninsula between the 1960s and 1980s, with no recovery to date.

Global protection
Occurs in habitats which may be protected under the Coastal Zone Management Act (CZMA; NOAA 1996). The outer Continental Shelf Lands Act (OCSLA) mandates that orderly development

of Outer Continental Shelf resources be balanced with protection of human, marine, and coastal environments and any project that could adversely impact the Coastal Zone is subject to federal consistency requirements under the CZMA (Committee on Environment and Public Works 2000a).

State protection
Occurs in Kachemak Bay National Estuarine Research Reserve, and in habitats which may be protected by the Coastal Zone Management Act (CZMA; NOAA 1996, Committee on Environment and Public Works 2000b, Alaska Dept. of Natural Resources 2004). Also, see Global protection comments.

Global threats
Cowles (2005) suspected disease was responsible for the death and subsequent population decline of gumboot chitons in San Simeon, California, after a large number washed ashore in the late 1990s. A traditional and current source of food for coastal native people throughout the species' range (Harbo 1997, Field and Field 1999); the degree of current subsistence harvest is unknown. This species cannot grip rocks as tightly as other chitons and is easily pulled off, so there may be a temptation to overharvest this species. Overharvesting would quickly eradicate the species locally due to low recruitment rate and long life span (O'Clair and O'Clair 1998).

Intertidal zones may be affected by industrial activities, such as timber harvest, oil and gas development, mining, and seafood processing. Coastal development, sewage discharge, and over-visitation resulting in trampling and collecting by beachcombers are also of concern (Tindall 2004). Natural perturbations such as earthquakes and scouring incurred by major storms threaten subtidal and intertidal communities. Though little understood, the effects of global warming will likely result in changes to intertidal community structure and diversity; in California, researchers have already noted a reduction in cold-water species in intertidal communities attributed to warming water temperatures (Tindall 2004).

State threats
A traditional and current source of food for coastal native people throughout the species' range (Harbo 1997, Field and Field 1999); the degree of current subsistence harvest is unknown. This species cannot grip rocks as tightly as other chitons and is easily pulled off, so there is concern about localized depletion due to overharvest. This species is vulnerable to overharvest due to low recruitment rate and long life span (O'Clair and O'Clair 1998).

Intertidal zones may be affected by industrial activities such as timber harvest, oil and gas development, mining, and seafood processing. Coastal development, sewage discharge, and over-visitation resulting in trampling and collecting by beachcombers are also of concern (Tindall 2004). Oil spills pose serious threats to slow moving or sessile coastal organisms (e.g. numerous intertidal organisms were killed and/or contaminated as a result of the *Exxon Valdez* oil spill; Varanasi et al. 1993). Also, see Global threats.

Global research needs
Research the role that natural predation versus fishing mortality plays in altering density and size structure of gumboot chitons. The effects of subsistence harvest and over-visitation on localized populations and community structure need study. Investigate the potential effects of global warming on intertidal organisms. Summarize indigenous ecological knowledge for this species; archeological data from middens may provide insight into historical trends in size and density.

State research needs
Effects of subsistence harvest, trampling, and over-visitation on localized populations and community structure need study, as do the potential effects of global warming on intertidal community structure. Also, see Global research needs.

Global inventory needs
An accurate assessment of range-wide population status is needed. This may be available through analysis of data collected in range-wide surveys by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) Coastal Biodiversity Surveys. Monitoring of localized populations at index locations should be initiated to assess long and short-term trends in abundance, and may also be available through repeat PISCO survey work. Harvest surveys are needed to monitor the extent of subsistence harvest on local populations.

State inventory needs
Monitor local populations at index locations to assess long and short-term trends in abundance. Harvest surveys are needed to monitor the extent of subsistence harvest on local populations.

Global conservation and management needs
An ecosystem-based approach that addresses threats to food web dynamics among all rocky reef organisms may be the best way to manage and conserve this species (Salomon et al. 2004). Intertidal areas receiving heavy human traffic should be conserved by restricting and/or monitoring access.

State conservation and management needs
Develop clear cooperative management plans for estuarine and intertidal/subtidal resources. Train local communities to monitor chiton densities; this will help ensure sustainability of chiton populations and encourage local stewardship of the resource. Also, see Global conservation and management needs.

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State Conservation Status, Element Ecology & Life History Author(s): T.A. Gotthardt and A. Jansen,
Alaska Natural Heritage Program, Environment and Natural Resources Institute, University of Alaska Anchorage, 707 A Street, Anchorage, AK, http://aknhp.uaa.alaska.edu.
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Reviewer(s): Ginny Eckert, University of Alaska Southeast, Juneau, AK.

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