BALTIC MACOMA

Macoma balthica Linnaeus, 1758
(Tellinidae)

Global rank GNR – suggested change to G5 (21Sep2005)
State rank S5 (21Sep2005)
State rank reasons
Widespread and locally abundant; a dominant member of the intertidal invertebrate community. Trends unknown. Habitat receives protection in some key areas. A staple prey species to migrating shorebirds; bioaccumulation of toxins could amplify risks to its predators.

Taxonomy
Formerly, *M. inconspicua* (Harbo 1997, O'Clair and O'Clair 1998). Based on recent genetic work, Vainola (2003) suggested treating temperate individuals on the Atlantic coast of North America (Virginia north to the Bay of Fundy, also recently introduced to the Pacific coast in California) as a separate species, *M. petalum*; within the more northerly *M. balthica* complex, the related Pacific-Baltic-White Sea population should be distinguished as subspecies *M. b. balthica* and the northeast Atlantic population as *M. b. rubra*. Additional genetic work by Luttikhuizen et al. (2003) found the Alaskan population was closely related to the Baltic population which corroborates the divisions suggested by Vainola (2003).

General description
A small marine clam (shell length to >3 cm, most <2 cm); delicate shell is oval shaped and white externally with fine concentric growth lines and a smooth margin; usually deep pink internally, sometimes blue, yellow or orange. The thin, yellowish periostracum on the shell's exterior flakes off easily. Long translucent white siphons can measure up to 10 times the length of the shell and may resemble small white worms. Like other macomas, *M. balthica* has scars on the insides of the valves, the two siphons are separate to the base, and the incurrent siphon lacks tentacles near the tip. Unique among macomas because the pallial sinuses are large and equal in size with no gap between the pallial sinus and the pallial line (Bernard 1979, Foster 1991, O'Clair and O'Clair 1998, Field and Field 1999).
Length (cm) 2

Reproduction
Sexually mature at 8 to 10 mm; spawns late March and April (O'Clair and O'Clair 1998). Eggs and larvae are pelagic for a short period (2-5 weeks; Luttikhuizen et al. 2003). In England, most settlement of young clams occurs in April and May (O'Clair and O'Clair 1998). May live as long as 8 years with reduced growth and increased longevity at higher latitudes (e.g., Copper River Delta, Alaska; see Powers et al. 2002).

Ecology
An important food source for coastal birds, especially during winter and migration stopover. Predators include ducks, shorebirds, and gulls. The preferred and principle prey during winter for Red Knot (*Calidris canutus*) and comprises the entire diet of the Pribilof Rock Sandpiper (*Calidris ptilocnemis ptilocnemis*) while wintering in Cook Inlet, Alaska (Reading and McGrorty 1978, Dames and Moore 1979, Zwarts and Blomert 1992, Rosier 1993, O'Clair and O'Clair 1998, Field and Field 1999, De Goeij 2001, Lees et al. 2001, Edelaar et al. 2002, Gill et al. 2002, Richman and Lovvorn 2003, Warnock et al. 2004). Siphons can be nipped off by bottom fish, crabs and shrimp, and constitute an important food for commercially important King (*Paralithodes camtschaticus*) and tanner crab (*Chionoecetes bairdi*) in Alaska (Weihs and Burrell 1978). The isopod *Saduria entomon* preys on both adult and newly settled juvenile clams (Lees et al. 2001).

Migration
Dispersal takes place during the 2-5 week larval phase. During the first winter, may drift with the use of a mucoid thread (Luttikhuizen et al. 2003). In the Wadden Sea, post-larvae migrate to nurseries on high, silty tidal flats. After the first growth season, juveniles return to low intertidal and subtidal flats (generally between December and March; Hiddink and Wolfe 2002). The observed migration to and from nurseries in the Wadden Sea is presumably an adaptation to avoid predation by shrimp on juveniles and parasitic infection of adults (Hiddink 2003).

Food

Feeds on detritus from sediment surface using incurrent siphon. Sediments up to 6 cm from the burrow may be taken and ingested. Also a suspension feeder when currents are strong or where it occurs in clean sand substrate. Marine clams are able to turn over large quantities of sediment in a short time period; this process increases the flow of solutes from the sediment into the water and stimulates growth of diatoms and other microalgae and bacteria, thereby enhancing their own food resources (O'Clair and O'Clair 1998).

Habitat

Intertidal zone to 40 m, usually buried shallowly (to 20 cm, but usually within 5 cm of surface) in mud or silt, generally in bays and estuaries with lowered salinity (Dames and Moore 1979, Harbo 1997, O'Clair and O'Clair 1998, Coan et al. 2000). Burrowing depth varies throughout the year, generally shallow in spring/early summer and deeper in late fall/early winter (Edelaar et al. 2002).

In Alaska, associated with fine, soft-bottom sediments of quiet bays, estuaries, and occasionally inland rivers (Bernard 1979, Field and Field 1999, ADFG 2000). In Upper Cook Inlet, thrives in muddy areas near river sources and in the lee of promontories (Lees et al. 2001). At the Copper River Delta, highest densities were recorded where tidal inundation occurred for the longest time (Powers et al. 2002).

Global range

Circumboreal. From the Beaufort Sea, Alaska, south to San Francisco Bay, California. Also occurs throughout the Bering and Okhotsk Seas to Japan. Off northern Europe, occurs in the North Sea (England, Norway and Denmark), Baltic Sea, Barents Sea, White Sea, in the waters of the Faroe Islands north to Iceland (but no records from Greenland), and as far south as Spain. On the western Atlantic coast, present from Labrador to Georgia (Bernard 1979, Coan et al. 2000, Vainola 2003).

State range

Occurs in coastal areas from the Beaufort Sea southward, including the Bering Sea, Alaska Peninsula, Kodiak Archipelago, Cook Inlet, Prince William Sound, Gulf of Alaska and throughout Southeast Alaska (Myren and Pella 1977, Dames and Moore 1979, Shaw and Wiggs 1980, Foster 1981, Baxter 1983, Naidu et al. 1992, Rosier 1993, Lees et al. 2001, Powers et al. 2002).

Global abundance

Unknown, but apparently locally abundant in areas not affected by pollution.

State abundance

Locally abundant. The dominant infaunal organism of a number of tidal flats, including the Copper River Delta, Kachemak Bay, Dayville and Island Flats at the head of Port Valdez, and Upper Cook Inlet, where densities of over 4,000 individuals/m² have been recorded (Dames and Moore 1979, Naidu et al. 1991, Lees et al. 2001, Powers et al. 2002). Elsewhere, densities (individuals/m²) at Chinitna Bay were between 2,600 and 4,600 (Dames and Moore 1979), 1,000 at the West Foreland, 450 at Chickaloon Bay, 2.4 at Kalifornsky Beach in Upper Cook Inlet (Lees et al. 2001), and 182 at Three Saints Bay, Kodiak Island (Nybakken 1969).

Global trend

Unknown.

State trend

At Dayville Flats, Port Valdez, numbers of large *M. balthica* clams increased substantially between 1989-92; prior to that, low abundance of large clams was noted in 1971-72; small clam abundance also increased in 1989-1992 relative to 1971-1972, but to a lesser extent. The low numbers of large clams recorded during 1971-72 may have been due to population decline following the 1964 earthquake, which completely removed all fauna from the Dayville Flats (Naidu et al. 1992). The larger numbers recorded between 1989 and 1992 may more closely represent a recovered stock at or near equilibrium (Naidu et al. 1992).

Global protection

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

This species is common in Kachemak Bay Reserve, a part of the National Estuarine Research Reserve System (ADFG 2000). Protected by the Coastal Zone Management Act (CZMA) which aims to “preserve, protect, develop, and where possible, to restore or enhance the resources of the Nation’s coastal zone” (NOAA 1996, Committee on Environment and Public Works 2000a, Alaska Dept. of Natural Resources 2004). The Outer Continental Shelf Lands Act (OCSLA) mandates that 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 2000b).

Global threats

Potential threats include exposure to and bioaccumulation of toxins and heavy metals released from industrial waste (Coan et al. 2000), habitat destruction as a result of intertidal dredging through commercial fishing (Collie et al. 2000), commercial and residential development (Salomon et al. 2004), and erosion as a result of road construction (Myren and Pella 1977, Naidu et al. 1992). In the North Sea, rising seawater temperatures caused by climate change are already affecting *M. balthica* stocks by lowering reproductive output and shifting the spawning period to an earlier time of year (Philippart et al. 2003). In some areas, predation by migrating shorebirds may be intense (Lees et al. 2001, Powers et al. 2002).

State threats

Pollutant contamination: This species will bioaccumulate various toxins and heavy metals released from industrial waste and is especially sensitive to contamination by oil (Shaw et al. 1977, Stekoll et al. 1980, Powers et al. 2002). Petroleum production, marine transportation of crude and refined petroleum products, and discharge of fuel from merchant and fishing vessels occur in many areas of Alaska’s coastal waters where *M. balthica* densities are high, including Cook Inlet, Prince William Sound, Kachemak Bay and the Copper River Delta (Powers et al. 2002, Borland 2004). At high concentrations (3.0 mg/L), oil can cause decreases in clam burrowing rates and growth and increases in respiratory rates and mortality (Stekoll et al. 1980).

The Copper River Delta is an important stopover area for migrating shorebirds which rely largely on *M. balthica* as their principle prey while staging there. The acute, chronic and indirect effects of oiling of intertidal clams could impact the food web of the delta, having larger geographic impacts because of the importance of this area to migratory species (Powers et al. 2002).

Commercial fishing: Intertidal dredging has had serious negative consequences for intertidal organisms because it completely removes the substratum and its attendant fauna (in many cases, 100% of fauna is removed). Recovery of shelf-sea benthos can take 100 to 500 days, and therefore areas that are fished more than three times per year are likely to be in a permanently altered state (Collie et al. 2000). Impacts in Alaska are unknown.

Coastal development: Loss of habitat from commercial and residential development is a potential concern (Salomon et al. 2004). Road construction around Valdez resulted in a number of erosional channels on the flats and a simultaneous decrease in large *M. balthica* between 1978 and 1982 (Myren and Pella 1977, Naidu et al. 1992).

Climate change: Recent research from the North Sea indicates that rising seawater temperatures have affected *M. balthica* stocks by lowering reproductive output and shifting the spawning period to an earlier time of year (Philippart et al. 2003). Additionally, milder winters have advanced the onset of crustacean reproduction and settling of newborn shrimps that prey on juvenile *M. balthica* (Philippart et al. 2003). Philippart et al. (2003) predicted that as ocean temperatures continue to increase, *M. balthica* and other cold water species will decline and be replaced by warm water species. In Alaska, the effects of climate change on benthic invertebrates are unknown but of potential concern.

Natural limiting factors: Physical conditions are severe, especially near the water-sediment interface where temperatures and salinity fluctuate widely and ice-scouring and crushing can be substantial. Predation pressures and intra- and interspecific competition for food and space are probably intense, especially in spring when maximum densities of young clams are concentrated in the upper few cm of sediment and are exploited by high numbers of migratory birds.

Predation by adult clams on larval, metamorphosing and settling juvenile clams is also likely to be intense during major recruitment periods (Dames and Moore 1979).

State research needs

Research needed on the impacts of contaminants and disease on local populations (Salomon et al. 2004). Detrimental effects of climate change on *M. balthica* have been documented elsewhere (Philippart et al. 2003), but the impact on marine clams in Alaska is not understood; needs study (Salomon et al. 2004). A better understanding of trophic linkages within the benthic community is also needed (Powers et al. 2002).

State inventory needs

Better quantitative information on distribution and abundance is needed (Salomon et al. 2004). Condition and locations of key habitats are unknown, but need study. Monitoring of benthic invertebrate populations should be continued at index locations to better understand and ultimately predict temporal and spatial patterns of abundance, and to assess resilience of communities to major disturbance events (Powers et al. 2002).

State conservation and management needs

Salomon et al. (2004) suggest an ecosystem-based approach that encompasses ecological relationships among species, trophic levels and habitats as the most effective way to conserve and manage this species and others in nearshore soft benthic ecosystems.

Because of its slow, prolonged response to contamination, *M. balthica* has been used as an indicator species to monitor long-term effects of pollution in brackish environments (Broman and Ganning 1986). In Alaska, *M. balthica* has been used as an indicator species for oil contamination in Port Valdez because of its wide distribution and abundance, importance to migratory birds, and sediment feeding habit (Myren and Pella 1977, Shaw et al. 1977). In Cook Inlet, it is one of two suitable candidates for assessing chronic contamination of sediments (Lees et al. 2001).

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State Conservation Status, Element Ecology & Life History Author(s): Jansen, A. and T.A. Gotthardt,
Alaska Natural Heritage Program, University of Alaska Anchorage, 707 A Street, Anchorage, AK 99501.
http://aknhp.uaa.alaska.edu/zoology/Zoology_ADFG.htm.
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Reviewer(s): M. Dethier, Friday Harbor Laboratories, University of Washington, Seattle, WA.

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