# LUGWORM

*Abarenicola pacifica* Healy and Wells, 1959
(Arenicolidae)

**Global rank** GNR (recommended change to G5, 16Aug2005)
**State rank** S4S5 (15Jun2006)
**State rank reasons**
Distribution in poorly documented; abundant where it is known to occur. Population trend unknown. Plays an important ecological role in sediment turnover and has been recommended for use in monitoring chronically contaminated sediments. Threats are few and related to degradation of habitat through pollution, development, and subtidal trawling.

**Taxonomy**
Healy and Wells (1959) recognized *Abarenicola pacifica* as distinct from the Mediterranean lugworm *A. claparedi* based on morphological characteristics. Molecular work by Bleidorn et al. (2004) shows *A. pacifica* is most closely related to *A. claparedi.*

**General description**
A large, subsurface deposit eating polychaete; elongated body, tapered at both ends; coloration ranges from yellow and green to brown. Midsection has several pairs of bright red branched gills (Kozloff 1983). Young worms have pigmented photoreceptors, but adults lack these organs (Bleidorn et al. 2004). See Healy and Wells (1959) for detailed morphological description.
**Length (cm)** 8-10
**Weight (g)** 0.25-0.3 (dry weight)

**Reproduction**
Sexes are listed as separate (see Healy and Wells 1959), but there is no reference to specific investigations showing this to be strictly true (Linton and Taghon 2000). Broods are produced annually. Reproduces in the spring (March-May) which coincides with increased levels of lipid storage (Wilson 1981, Taghon et al. 1994). Embryos are brooded in the burrow; larvae are non-feeding and only briefly pelagic or possibly totally benthic (Wilson 1981, Brown 1997, Linton and Taghon 2000). Larvae move out of the cocoon no later than the 5-6 setiger stage and burrow in the top few millimeters of sediment (Wilson 1981). Generation time approximately 1-2 years (Linton and Taghon 2000).

**Ecology**
Lugworms play an important role in sediment turnover (bioturbation) and bioaccumulation of toxins by consuming deeper sediments, processing organic material, and depositing feces at the surface (Augenfeld 1980, Swinbanks 1981, Augenfeld et al. 1982, Kozloff 1983, Toonen 1998). In a study conducted at Boundary Bay on the Fraser Delta, B.C., high densities (200 individuals/$m^2$) of lugworms were able to completely rework the substrate to a depth of 10 cm in 100 days (Swinbanks 1981). *A. pacifica* may aid in the recovery of intertidal zones from the effects of oil pollution, by transporting sediment from the lower anoxic areas to the surface where hydrocarbons can be metabolized by aerobic microbes (Augenfeld 1980).

Sediment turnover can result in the release of heavy metals such as methylmercury into the overlying water (Brown 1997). Sediment movement by *A. pacifica* has been associated with mortality and a decline in abundance of the spinoid polychaete *Pygospio elegans* and the cumacean crustacean *Cumella vulgaris*; conversely, both species reduce the survivorship of juvenile *A. pacifica*, presumably by predation (Wilson 1981). Lugworm burrowing and feeding activities have also caused declines in abundance of juvenile clams *Macoma* and *Mya* (Lees et al. 2001). The Schmitt Pea Crab (*Pinnixa schmitti*) is found in the burrows of *A. pacifica* (O'Clair and O'Clair 1998). Migratory predators such as Rock Sandpipers (*Calidris ptilocnemis*), crangonid shrimp (*Crangon* spp.), and the large isopod, *Saduria entomon,* probably play a role in lugworm recruitment success and adult survival (Lees et al. 2001).

**Migration**
Nonmigratory.

**Food**
Subsurface deposit-feeder. Feeds upon microbial flora and organic matter in sediment and passes rope-like fecal strands to surface sediments (Kozloff 1983, Lees et al. 2001). Irrigates its

burrow to create an oxidizing micro-environment in which the micro-organisms on which it feeds (ciliates, flagellates, and nematodes) flourish (Swinbanks 1981).

**Habitat**

Near low tide line to 4.5 m; muddy sand in shallow bays. In areas where mud content is low and varies little, wetness of sediment during exposure at low tide is the dominant factor governing distribution; *A. pacifica* was most abundant in the upper sand wave zone (between mean sea level and +0.75 m) of Boundary Bay, B.C.; also found in eelgrass and lower sand wave zones below mean sea level (Swinbanks 1981). In Cook Inlet, Alaska, most common at sites with sandy silt, moderate or weaker current intensity, and moderate to weak wave action (Lees et al. 2001). Sediment must be somewhat unconsolidated rather than stiff and plastic (like some underlying consolidated clays) in order for lugworms to feed (Lees et al. 2001).

**Global range**

North Pacific; from California north through Alaska to Japan (Healy and Wells 1959, Toonen 1998).

**State range**

Distribution incomplete; probably occurs widely throughout coastal regions. Known occurrences include: Upper Cook Inlet at Redoubt Creek, southwest of the West Foreland, south of the Beluga River, Kalifornsky Beach, Chisik Island, Kalgin Island, and the north Tuxedni Bay Spit (Lees et al. 2001); in Lower Cook Inlet at Kachemak Bay (ADFG 2000), Glacier Spit, Chinitna Bay and Deep Creek (Dames & Moore 1979). A single individual was found on the East Reef of Three Saints Bay, Kodiak Island (Nybakken 1969).

**Global abundance**

Common in almost every bay from central California northward (Toonen 1998). Densities of 200 individuals/m² have been reported from Boundary Bay, on the Fraser Delta, B.C. (Swinbanks 1981). Kozloff (1983) gave a rough estimate of 50 individuals/m² (maximum densities) on the north Pacific Coast (Washington to California), and Wilson (1981) reported that adult densities often reached 1,000 individuals/m² in the Straits of Juan de Fuca, Washington. Common in Upper Cook Inlet, Alaska, where densities as high as 42 individuals/m² have been reported (Lees et al. 2001).

**State abundance**

Overall abundance unknown, but common in known areas of occurrence. In Upper Cook Inlet, densities of 42 individuals/m² reported from Kalifornsky Beach; 40 individuals/m² at southeast Kalgin Island, Redoubt Creek, northeast Chisik Island, and Light Point, Kalgin Island; less common at north Tuxedni Bay (9 individuals/m²) and Oldmans Bay, Kalgin Island; lowest densities reported at northeast Chisik Island (2 individuals/m²), northwest Kalgin Island, and southwest of the Beluga River (Lees et al. 2001).

**Global trend**

Unknown.

**State trend**

Unknown.

**Global protection**

Protected under the U.S. 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 2000).

**State protection**

Habitat protected in Kachemak Bay Reserve, a part of the National Estuarine Research Reserve System (ADFG 2000). Also, see Global protection comments.

**Global threats**

Threats include habitat loss or degradation due to pollution and development. Because this species feeds on bottom sediments, it may be sensitive to contamination through bioaccumulation and may also transfer concentrated carcinogens to marine predators (Augenfeld et al. 1982, Weston 1990, Penry and Weston 1998). Bioturbation by *A. pacifica* in contaminated sediments can significantly increase levels of methylmercury in overlying water by redistributing it from anoxic zone sediments to the surface where it can reenter the ecosystem (Brown 1997). Species is tolerant of direct contact with sediments containing 1,000 ppm crude oil (Augenfeld 1980). If oil pollution is not too severe, *A. pacifica* can continue to turn over the equivalent of its own body weight in sediment, but high concentrations of oil may reduce the sediment working rate of surviving worms by as much as 70%, which would substantially retard movement of sediments to the surface and recovery of polluted systems (Augenfeld 1980).

**State threats**
Threats include habitat loss due to filling and commercial or residential development, and habitat alteration due to trawling in subtidal areas or pollution by oil or heavy metals.

**Global research needs**
Research needed on reproductive ecology; in particular, determine if hermaphroditism is present (Linton and Taghon 2000). Further investigation needed on the role this species plays in recovery of oil-affected systems.

**State research needs**
Research needed on reproductive ecology; in particular, determine if hermaphroditism is present (Linton and Taghon 2000). Further investigation needed on the role this species plays in recovery of oil-affected systems. *A. pacifica* is considered the second most suitable sentinel species (after *Macoma balthica*) for monitoring contamination in Upper Cook Inlet because of its wide distribution and abundance near oil production facilities (Lees et al. 2001).

**Global inventory needs**
Species is widespread and apparently common. No inventory needs at this time.

**State inventory needs**
Knowledge of species' distribution in the state is incomplete; lugworms collected opportunistically during intertidal surveys may help to increase occurrence records and better define species' range. Conduct inventories and monitor populations at index sites to assess trends.

**State conservation and management needs:**
Species has been recommended for use in pollution monitoring for a number of reasons including its widespread distribution in sensitive sand and mud ecosystems; because petroleum hydrocarbons and other contaminants reach higher concentrations in lugworm tissues; because glycogen storage in lugworms is sensitive to contamination and anoxia and could provide a sensitive means to measure contamination (Anderson et al. 1978, Augenfeld et al. 1983); and because this species interacts with the sediment column rather than water-borne contaminants (Lees et al. 2001).

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