Pest Risk Assessment for Mitten Crabs in Oregon

IDENTITY

Name: *Eriocheir* spp.[1]
Taxonomic Position: order Decopoda, infraorder Brachyura, family Varunidae
Common Names: mitten crabs, hairy-fisted crabs, Chinese mitten crabs, Japanese mitten crabs, Shanghai hairy crabs

RISK RATING SUMMARY

Relative Risk Rating: MODERATE
Numerical Score: 5 (on a 1-9 scale)
Uncertainty: HIGH*

The high level of uncertainty attributed to this risk assessment is due to several factors. The format the risk assessment follows was originally developed for forest pest species and, as such, fails to taken into consideration characteristics of invasive species that may be unique to aquatic organisms. This risk assessment was completed for an entire genus based on arguably limited knowledge of a single species *Eriocheir sinensis*. Estimates of habitat suitability for reproductive success are based on limited information. Potential for direct interaction with threatened and endangered species (a situation which elevates the risk of this species considerably in this format) is purely hypothetical. Lastly, different invasion scenarios seem to be playing out with each new area colonized by *E. sinensis* making predictions about new invasions difficult.

RECOMMENDATION

Abundant estuarine and freshwater habitat, temperate climate, proximity to California, and significant shipping traffic from around the world would seem to put Oregon at relatively high risk of invasion by *Eriocheir* spp., the mitten crabs. Habitat suitability data indicate that successful reproduction of mitten crabs is unlikely in Oregon waters with the possible exception of Coos Bay. Were mitten crabs to become established in Coos Bay their potential impacts, environmental and economic, could be varied ranging from no impact to moderate effects. Three factors elevate the concern of a mitten crab population in Coos Bay: it is an active port thus at risk of receiving ballast water containing mitten crab larvae; an appropriate primary host for the Oriental lung fluke is present in the bay increasing the potential human health hazard posed by mitten crabs; and evolutionarily significant salmon stocks are present in the Coos River Basin that could be potentially impacted by this invader. Given the plasticity of many invasive species combined with limited knowledge about the entire *Eriocheir* genus, we conclude that mitten crabs present a low to moderate risk to Oregon, with a moderate to high risk to Coos Bay and all reasonable efforts should be made to keep it out of the State.

[1] The taxonomy of the genus *Eriocheir* remains unresolved. Please see the National Exotic Marine and Estuarine Species Information System for more information. http://invasions.si.edu/nemesis/

Coos Bay should continue to be on alert for this species. Although the Coos River watershed offers far less freshwater rearing habitat than San Francisco Bay or Chesapeake Bay, it could serve as a stepping stone for mitten crab invasion into the Northwest and into locations such as Puget Sound where more suitable habitat exists.

RISK RATING DETAILS

Establishment Potential is MODERATE

Justification: Mitten crabs, *Eriocheir* spp. – the Chinese mitten crab, *E. sinensis* - in particular, have an extensive invasion history. The first record of a mitten crab outside of their native range in Asia comes from a report of a large male Chinese mitten crab captured in Germany in 1912 (Panning 1938). Mitten crabs are now established throughout Western Europe and Great Britain. Although isolated reports of mitten crabs in the Great Lakes region can be traced back to 1965 (Nepzy and Leach 1973), it was not until 1994 in San Francisco Bay, California that a reproductive population of Chinese mitten crabs was reported in North America (Cohen and Carlton 1997). Since then mitten crabs have been reported from several locations in the mid-Atlantic region of the United States including Delaware Bay, Hudson River and Chesapeake Bay, prompting speculation of a second successful North American invasion.

In 1997, a single adult male Japanese mitten crab (*E. japonica*) was caught by a sturgeon angler in the Columbia River Estuary. In spite of additional anecdotal reports of mitten crabs in Oregon and Washington, no other verified reports of mitten crabs caught in the wild exist for the Pacific Northwest. Mitten crab reports to the Oregon Invasive Species Hotline have been determined, on follow-up, to be kelp crabs or other native marine crabs.

Unlike native Oregon crabs, mitten crabs are catadramous; spending most of their lives in freshwater and migrating to reproduce in brackish estuarine waters. Unlike true freshwater crabs, the larvae of mitten crabs undergo a series of free-floating planktonic stages characteristic of marine crabs. Successful Chinese mitten crab larval development requires large estuaries to provide adequate temperature and salinity regimes for optimal larval survival and flushing times of sufficient duration to support larval development within the estuary (Anger 1991, Hanson and Sytsma 2008). While the Columbia River basin offers a large area of potentially suitable freshwater rearing grounds, potential mitten crab populations would be limited by a very small amount of estuarine habitat suitable for egg and larval development. The Columbia River estuary, like many Oregon estuaries, is a river-dominated system and, as such, is unlikely to support reproducing mitten crab populations. Characterized by salinities below the threshold required for proper egg development and adhesion (~25psu) river-dominated estuaries often have flushing times less than the duration required for successful larval development (Anger 1991, Hanson and Sytsma 2008). Only one estuary in Oregon, Coos Bay, has suitable salinities and a flushing time similar to estuaries

that support successful mitten crab populations but Coos Bay remains below the threshold thought to be required for larval development within the bay (Hanson and Sytsma 2008).

Spread Potential is MODERATE

Justification: The nearest source population of mitten crabs is San Francisco Bay, California. Although these crabs do have a free-swimming larval life stage, mitten crab larvae are not physiologically suited to coastal or oceanic transport (Hanson and Sytsma 2008, Cohen and Carlton 1997) and the risk of natural dispersal of mitten crabs outside of San Francisco Bay is negligible. Other source populations of mitten crabs (larval and/or adult) include Western Europe, England, Mid-Atlantic coast of North America and Eastern Asia).

Mitten crabs may be spread via human-aided transport either intentionally as adults (as seafood) or unintentionally in their planktonic larval form (i.e. entrained in ballast water). Coastal and trans-oceanic ballast water exchange requirements should prevent the inoculation of Coos Bay with ballast water containing larvae from host regions however; the State of Oregon is not able to fully verify exchange compliance at this time. Ballast water, with its ability to inoculate a water body with numerous larvae at a time, should be considered the highest risk pathway of introduction.

Adult mitten crabs are a valuable live seafood commodity although possession of live crabs is prohibited under the Federal Lacey Act and the Oregon Wildlife Integrity Rules (OAR 635-056). After the federal ban on imports of mitten crabs in 1989, several live seafood importers have been arrested and sentenced for attempting to smuggle crabs into the US. .The high price that mitten crabs command may continue to fuel lucrative illegal importation attempts (small and large shipments of live crabs have been confiscated at ports in Los Angeles, San Francisco and Seattle) (Cohen and Carlton 1997). Gravid female crabs are especially prized and would represent the biggest risk as one escaped or released individual could introduce up to a million eggs into a new system.

Past speculation regarding the source of the San Francisco Bay mitten crab population postulated that it might have been the result of an illegal planting of crabs with the intent to start a fishery. Recent genetic analysis supports a different scenario, that the population in San Francisco Bay is the result of a single European introduction (Rainbow et al. 2003). Given the poor habitat fit of most coastal estuaries in Oregon, a desire to establish a harvestable population represents a negligible but not nonexistent risk to Oregon.

Due to their aquatic nature it is not unlikely that a newly established mitten crab population could go undetected for years until their population became large enough to come to the attention of the general public. Past and current efforts to educate the general public as well as fisher people and recreational users of Oregon's coastal estuaries may lessen the time to detection. Any increase in early detection will assist eradication efforts which will require

trapping and removal of as many individuals as possible. No other measures of eradication or control of mitten crabs is known.

Environmental Impact Potential is MODERATE to LOW

Justification: Potential and realized environmental impacts caused by mitten crabs fall into the following categories: habitat alteration, predation and competition.

Burrowing activity by the mitten crab may lead to increased rates of erosion and, in more extreme cases, bank destabilization (Panning 1938). In California, extensive burrowing by juvenile mitten crab in some steep tidal river bank locations has caused increased erosion and led to minor bank destabilization, slumping and collapse (Rudnick et al. 2000). Overall, California has reported minimal burrowing (compared to Germany and parts of England) with shorter burrow lengths and densities that have not led to major bank destabilization (Veldhuizen and Stanish 1999).

Competition with native crayfish could be a concern. Mitten crabs in California have been reported as utilizing existing crayfish burrows and often staying in deeper, mid-channel waters. Mitten crabs have may have some dietary overlap with the signal crayfish *Procambarius clarkii* (an Oregon native) and compete with individual crayfish for burrows (Rudnick and Resh 2005). The use of crayfish burrows may be one indication of competitive interactions between these species. In England, there is concern that mitten crabs are considered a threat to an already at risk native white-clawed crayfish (*Austropotamobius pallipes*) (Rainbow et al. 2003).

Mitten crabs are generalists/omnivores and will impose new predation pressure upon any new system. Predation by the Chinese mitten crab has been cited as the reason for the local extinction of a sphaerid clam in Germany (Gollash 1999). In England, researchers are concerned that voracious mitten crabs will scavenge eggs of native fish and amphibians (Rainbow et al. 2003). Direct predation on fish eggs and/or emerging fry of nest building fish in the San Francisco Bay Delta, such as bluegill and black bass, is a concern and leads to speculation that, if mitten crab populations expand further upstream into the colder spawning waters of trout and salmon they could pose a risk to those threatened and endangered species (Bacher 1997, Chinese Mitten Crab Working Group 2003).

Although evidence of measurable ecological impacts by Chinese mitten crabs in San Francisco Bay is limited there is one unusual exception; initial impacts to a threatened fish species the Delta smelt (*Hypomesus transpacificus)*. In California in the late 1990s, swarms of crabs were diverted into fish passage facilities initially developed to safely move delta smelt, trout and salmon past Bureau of Reclamation irrigation intakes for the Central Valley. In 1998, during peak mitten crab migration, these fish-salvage facilities reported mortality rates of migrating smelt of 98-99% (Rudnick et al. 2000). Traveling crab fences (similar to trash screens) have

been installed at these facilities with estimated 80-90% crab trapping efficiency and have greatly reduced the mortality of smelt. Similar mitten crab exclusion and control devices have been installed at other fish diversion facilities in the Bay Area (Rudnick 2000). Potential obstruction of fish passage facilities could be a concern for the Pacific Northwest as some endangered salmon runs may migrate downstream at the same time as the crabs.

Economic Impact Potential is LOW

Justification: Although the mitten crab is not an active predator upon fish, mitten crabs have had an impact on both commercial and recreational fishing in Germany, England, Belgium and California (Panning 1938, Mares 1999, Veldhuizen and Stanish 1999, Rainbow et al. 2003). In Germany, where mitten crab populations exploded in the mid 1930s, crabs caught as by-catch in bottom trawl fisheries and eel pots damaged both nets and catch (Panning 1938). In California, mitten crabs are caught in commercial trawls of bay shrimp (*Crangon franciscorum*) where they physically damage the delicate shrimp. Although bay shrimp are common in Oregon estuaries they are only harvested commercially in San Francisco Bay. The impact of the crab on California fisheries is poorly understood (Robinson 1999), however, the commercial and recreational fisheries it is affecting within the Bay are highly valuable. The bay shrimp trawl fishery was valued at $1.5 million in 1999 (Chinese Mitten Crab Working Group, 2003) and shrimpers have reported catching hundreds of crabs per trawl, the crabs literally crushing and/or shredding the shrimp before they can be removed from the nets (Robinson 1999). Competition with commercially harvested crayfish (a nonnative species with an annual retail value of $750,000) is also an ongoing concern in California (Chinese Mitten Crab Working Group 2003); both species overlap in dietary and habitat preference and it is feared that both crayfish abundance and growth rates could be negatively affected (Resh 1998). Coos County, Oregon has no commercial landings of crayfish or trawl caught estuarine shrimp or fish species and is unlikely to be economically impacted by mitten crabs (ODFW 2006).

The recreational fishery in San Francisco Bay, California (valued at over $98 million Chinese Mitten Crab Working Group 2003) has been affected by the presence of Chinese mitten crabs. The crab has a reputation as a live-bait thief and is seen as a nuisance by recreational anglers using shrimp and bullheads to catch sturgeon, striped bass, bluegills, etc. (Bacher 1997). Striped bass fishing in Coos Bay (the Northern-most extant of this non-native recreationally important species) as well as other live-bait targets could be impacted potentially.

Other economic impacts include increased operational costs: mitten crabs impede water flow, hinder the opening and closing of lock gates, foul water intake screens, obstruct fish salvage operations and generally increase the operating costs of these facilities (Veldhuizen and Stanish 1999, Chinese Mitten Crab Working Group 2003). Pacific Gas and Electric power plants in California also reported fouling of their cooling water intakes by migrating crabs (Chinese Mitten Crab Working Group 2003). In England, the Chinese mitten crab is a concern

for earthen flood defense systems in England along the Thames in York and Newcastle (Draheim 1999).

Human Health Impact Potential is MODERATE to HIGH

Justification: Mitten crabs are a known secondary intermediate host to a parasite known as the Oriental lung fluke (*Paragonimus westermani*). Mammals, including humans, serve as the final host and can become infected by eating raw or inadequately cooked crabs. While the lung fluke has not been found in the San Francisco Bay mitten crab population (Chinese Mitten Crab Working Group 2003), in 2007 a small estuarine snail that can serve as the primary intermediate host (*Assiminea parasitological*) was found in Coos Bay providing the potential to complete the complex life cycle of the lung fluke. The risk of Oriental lung fluke transmission to humans is heightened by the value of the crabs as a seafood species. Mitten crabs may also pose a higher risk for bioaccumulation of contaminants in their tissues than marine crabs.

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FORMAT

This pest risk assessment (PRA) is based on the format used by the Exotic Forest Pest Information System for North America. For a description of the evaluation process used, see Step 3 – Pest Risk Assessment under Guidelines at:
<http://spfnic.fs.fed.us/exfor/download.cfm>

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