

Draft Assessment Report: Application to amend the List of Specimens Suitable for Live Import (*Haliotis rufescens*)

CSIRO Australian Animal Health Laboratory

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1. Introduction

This draft assessment report was prepared with assistance from Aquagestion, Chile and is based on current knowledge and information on the Californian red abalone (*Haliotis rufescens*). Much of the information on this species' biology was sourced from California Department of Fish and Game (2005).

2. Objectives of the draft assessment

The draft assessment was undertaken to address the potential impacts on the Australian environment, based on the terms of reference as outlined in the application process to amend the List of Specimens Suitable for Live Import, administered by the Australian Government Department of the Environment.

3. Terms of Reference

3.1 Taxonomy of the species

PHYLUM: Mollusca

CLASS: Gastropoda

SUBCLASS: Vetigastropoda

ORDER: Archaeogastropoda

FAMILY: Haliotidae

GENUS: *Haliotis*

SPECIES: *Haliotis rufescens*

TAXONOMIC REFERENCES: <http://www.marinespecies.org/aphia.php?p=taxdetails&id=445357>;

Rosenberg (2014).

COMMON NAMES: Red abalone

GMO: Not a GMO

3.2 CITES Status

Not listed in CITES Appendices I, II or III.

The red abalone population has been drastically reduced as a result of over-exploitation by the commercial and/or recreational fishery. Predation and disease have also contributed to the decline of red abalone stocks. The State of California, USA has passed strict regulations to protect the red abalone (California Department of Fish and Game, 2005). Even though most of the following examples of conservation measures are related to the Californian fishery, these regulations could be applied elsewhere:

- Enacting fishing laws that specify the minimum size of fished abalone (20 cm in diameter)
- Prohibiting the canning of abalone and shipment of fresh or frozen meat out of state
- Closing the commercial red abalone fishery such as occurred in 1997
- Limiting the recreational abalone fishery to specific locations
- Launching an Abalone Recovery and Management Plan (ARMP) in 2005
- Specifying legal fishing gear to ensure the catch of legal size abalone only
- Fishing quota per day or per year have been established.

Globally, there is a high demand for abalone species in general and there is a decline in wild stocks. To meet this high demand, abalone farming is expanding globally. The commercial farming of *Haliotis rufescens* in Chile began in the late 1990s. This species is not native to South America.

3.3 Ecology of the species

3.3.1 Lifespan of the species

Up to 20 years.

3.3.2 Size and weight range

Red Abalone is the largest abalone species in the world and individuals can grow up to 30 cm in shell length

and can weigh up to 500 g. The largest recorded red abalone was taken in September 1993, off the Humboldt coast (California), measuring 31.5 cm.

3.3.3 Species identification

Usually the epipodium is black, but can have a striped black and cream colour pattern. The surface of the epipodium is smooth and broadly scalloped along the edge. The area around the foot is black and the sole is tan-to-grey. Tentacles are black. The shell surface is generally brick red (colour may be masked by encrusting organisms) and the inside edge is often red; there are 3-4 open pores, moderately elevated above the shell surface. There is considerable variation in morphology making speciation based on traditional morphological characters difficult. The phylogenetic relationship among abalone species inferred from 16S rRNA and COI gene sequences may provide a useful, laboratory-based tool for speciation (An et al., 2005).

3.3.4 Natural geographic range

The red abalone can be found along the west coast of North America, from southern Oregon to Baja California, Mexico. Stocks have declined significantly along the Pacific coast.

3.3.5 Habitat

Red abalone are found from the intertidal zone down to at least 30 metres depth but are most abundant attached to rocks colonised by kelp from 20 to 40 m depth. One individual has been found down to 180 m depth. Red abalone prefer water temperatures in the range 7–15°C.

3.3.6 Diet, including potential to feed on agricultural plants

Larvae are lecithotrophic relying on their yolk sac for nutrition, although they also absorb some organic nutrients from the water column during their planktonic phase; juveniles graze on epiphytic diatoms and adults consume seaweeds.

3.3.7 Social behaviour and groupings

Like other abalone species, the red abalone has a sedentary lifestyle, remaining in the same general area for its entire life. It moves around by shuffling forward on its muscular foot which has a surface area usually equal to that of the shell. The foot is a very powerful suction cup with considerable surface adhesion force. Thus, the abalone has a remarkable way of protecting itself and becoming nearly invulnerable to predators. Using its foot, it can propel itself forward at a considerable speed as well as cling firmly to a rock. They exhibit a galloping, zigzag escape response from predators, with the upper part of the foot extended over the edge of the shell. If the presence of a predator is sensed, the abalone instantly clamps down, pulling its shell over its soft body. In this position it is difficult for most predators to dislodge the abalone from the substrate.

3.3.8 Territorial and aggressive behaviours

Abalone are sedentary, nocturnal, non-aggressive, non-territorial animals living in rock crevices during the day.

3.3.9 Natural predators

Throughout their lives, abalone contend with a variety of predators. The eggs and larvae are eaten by filter-feeding animals. Predation by polychaete worms occurs on larval and post-settlement abalone. Although juvenile abalone are cryptic during the day, they are active at night and are prey to crabs, lobsters, octopuses, starfish, fish and predatory snails. In addition, large abalone can be dislodged by larger predators, such as larger fish, rays and otters, and swallowed whole.

3.3.10 Characteristics that may cause harm to humans and other species

No data are available but it is noted that juveniles feed on diatoms; adults are herbivores and feed on seaweed. During grazing there is potential to inadvertently consume toxic algal cysts, but algal toxins

accumulate in the abalone gut, rather than in the edible foot. No instances of human poisoning are known from the available literature.

3.3.11 Anatomical features

From the veliger stage the bilateral symmetry of the abalone body develops into a spiral shape. Its body is divided into three parts: head, foot and saccate intestine. The head is located at the anterior of the body and is bilaterally symmetrical. It comprises a mouth, appendages and sensory organs. Compared to other shellfish, abalone have a developed and complex head with a pair of tentacles and two eyes at the tip of eye stalks which originate at the bottom of the tentacles. The foot of the abalone is a creeping organ of muscular tissue which lies ventrally. The well-developed foot has a broad "sole" which allows the animal to adhere strongly to rocks or other hard substrates. Usually the epipodium is black, but it is not uncommon to find specimens with a striped black and cream colour pattern. The surface of the epipodium is smooth and broadly scalloped along the edge. The area around the foot is black and the sole is tan-to-grey. Tentacles are black. The shell surface is generally brick red (colour may be masked by encrusting organisms) and the inside edge is often red; there are 3-4 open pores, moderately elevated above the shell surface.

3.4 Reproductive biology of the species

3.4.1 The age at maturity (first breeding)

This species reaches sexual maturity within 4 years at a size of about 13 cm and may live for 20 years.

3.4.2 Breeding frequency

They spawn throughout the year, but particularly in spring (February to April in California).

3.4.3 Mode of fertilisation

The female does not store sperm. Fertilisation occurs in the water column. The eggs and sperm are released from females and males respectively into the anatomical region where the gills and anus are located. There is always a gentle flow of water out of this area and the eggs and sperm are washed out through the holes in the shell by this respiratory/sanitary current. If the mantle cavity, under the holes, becomes congested with eggs or sperm the abalone may raise its shell then quickly pulls it down, creating a squirt of water out of the holes. This may occur several times to clear the eggs or sperm from the gill area.

3.4.4 Fecundity

The sexes of this abalone are separate. During spawning, abalone broadcast their eggs and sperm into the ocean. Fecundity, as measured in the number of gametes produced, is directly related to female size; a large female may produce >12 million oocytes, whereas smaller/younger females will produce fewer eggs.

If the temperature is optimal (14-16°C), red abalone larvae hatch at about one day post-fertilization, develop into morphologically mature veliger larvae after three days, and are capable of metamorphosis after about seven days. Settlement and metamorphosis are stimulated by compounds released from coralline algae, on which the young abalone graze. Within 2 months, larvae develop into small sized adults. One-year-old abalone are about 25 mm long. Within 4 years they reach sexual maturity.

3.4.5 Ability of the species to hybridise with any other species

Abalone species can hybridise and the progeny are fertile (Lafarga de la Cruz and Gallardo-Escarate, 2011). It has been reported that *H. rufescens* can form viable hybrids. Hybrids tend to be less prevalent and persistent in the wild than their parent species. Inter-specific-induced hybridization between *H. rufescens* and *H. corrugata*, *H. fulgens*, *H. kamtschatkana assimilis* and *H. sorenseni* has been reported.

3.5 Information on feral populations

There is no available information on whether this species has established feral populations. While this species does not occur naturally in Chile it was introduced to Chile in the 1980s for aquaculture purposes as an option to diversify the local aquaculture industry.

3.6 Previous environmental risk assessments

No data are available. AQIS assesses disease introduction risk and has informed us that an import permit can be issued with the condition that the abalone are transferred to the high-level biocontainment facility at CSIRO-AAHL and used for research purposes only.

As part of an earlier successful application to list NZ Paua (*Haliotis iris*) for research purposes, CSIRO-AAHL has undertaken a similar environmental risk assessment for *H. iris*. Subsequently, NZ Paua was added to the List for Live Import and an import permit was issued (Import Permit Number: WT2013-000177). However, due to an outbreak of Perkinsiosis (due to infection with *Perkinsus olseni*) in the NZ Paua population in 2013 (OIE, 2014), NZ Paua have not been imported to Australia using this import permit.

3.7 Potential for establishment of a breeding population in Australia

3.7.1 Ability to find food sources

Assuming that the species does not require plankton or seaweed that are specific to Californian waters, *H. rufescens* should have no difficulty in finding food. Abalone are able to detect food only at close proximities. Once food is detected, the abalone glides slowly along until it reaches the alga. It then raises its foot and comes down on the plant, trapping it beneath its body. It then consumes the alga, using its small rasp-like teeth and extruding tongue.

3.7.2 Ability to survive and adapt to different climatic conditions (e.g. temperatures, rainfall patterns)

As with other species of abalone, *H. rufescens* has a restricted temperature range. *H. rubra* and *H. laevigata* are common cold-water abalone species native to Australia, with a preferred temperature range of 8-17°C. The preferred temperature range for *H. rufescens* is 7-16°C, but the optimal temperature range for fertilization and hatching is 14-16°C. Thus, if *H. rufescens* did escape into southern Australian waters adaptation to local conditions would be likely.

3.7.3 Ability to find shelter

Normal habitat is under stones and in rock crevices – therefore no issues with finding shelter.

3.7.4 Rate of reproducing

This species reaches sexual maturity within 4 years and may live for 20 years. They spawn throughout the year, particularly during the spring.

3.7.5 Any characteristics that the species has which could increase its chance of survival in the Australian environment

None known.

3.8 Potential impact if establishment in Australia occurred

3.8.1 Niche/living requirements

Haliotis rufescens lives in shallow water relative to the habitats of the greenlip and blacklip species found in Southern Australian waters of a similar temperature range. Red abalone are likely to be equally as susceptible to predators as the native species in these waters. Abalone are opportunistic feeders that rely predominantly on drift algal fragments for their nutrition. Competition for food and impact on native abalone habitat from a non-native abalone species under these circumstances would be improbable. In addition, red abalone exist in a narrower depth range than abalone native to Australia. Thus it could be argued that their fitness for survival in Australian marine environments would be less than that for native Australian abalone species. Overall, red abalone would be less competitive and unlikely to cause adverse ecological impact should they escape into the Australian environment.

3.8.2 Species susceptibility to, or ability to transmit, any pests or disease

No data are available concerning diseases/pests that are not already present in marine environment.

A condition of the import could be that the animals are healthy and accompanied by a health certificate from the Veterinary Authority of the exporting country which specifies freedom from the known Haplosporidium (Diggles *et al.*, 2002), fungus (Friedman *et al.*, 1997; Nollens *et al.*, 2004) and other known diseases/infectious agents of abalone (Bower *et al.*, 1994; OIE, 2014a).

With respect to our needs, all animals will be used for research only. Once imported, animals will be housed in the high-level bio-security facility at CSIRO-AAHL Geelong from where there is no possibility of escape of live animals or infectious agents, including Haplosporidia and fungi. All effluent water from animal experiments at AAHL is inactivated by heat treatment (100°C for 20 minutes) prior to release into the local sewer system.

All materials for laboratory analysis (e.g. tissues samples) will be inactivated as part of the experimental protocols. Such inactivation will include fixation in ethanol for PCR testing and fixation in formaldehyde for routine histology.

All other waste (e.g. shell) that is not used for analysis will be autoclaved prior to disposal by incineration. The standard waste parameters for autoclaves are 121°C for 45 minutes.

3.8.3 Probable prey/food sources

Larvae are lecithotrophic; adults are herbivores and feed on seaweed.

3.8.4 Impacts on habitat and local environments

Abalone are opportunistic feeders that rely predominantly on drift algal fragments for their nutrition. As a consequence, they exert only limited pressure on algal communities. Indeed, the presence of abalone is thought to be beneficial in terms of habitat maintenance. In this sense abalone are classified as habitat responders, in contrast to sea urchins which are considered habitat modifiers. Thus, red abalone are unlikely to cause adverse ecological impact should they escape into Australian waters.

3.8.5 Any control/eradication programs that could be applied in Australia if the species was released or escaped

Unlikely. There is no evidence that *H. rufescens* would have any competitive advantage if escape into the environment occurred in Australia. Application of lime would destroy all shellfish in an affected area, but such intervention is unlikely to be acceptable from an ecological perspective.

3.8.6 Behaviours that cause environmental degradation

None known.

3.8.7 Impacts on primary industries

None known.

3.8.8 Damage to property

None known.

3.8.9 Is the species a social nuisance or danger?

No.

3.8.10 Any potential threat to humans?

None known.

3.9 Import conditions to mitigate potential negative environmental impacts

It would require very large numbers (in excess of what is required in this instance i.e. research only) of animals to be released into the environment to create a substantial threat. Conditions or restrictions applied to the import of this species could include: Imported animals must be housed in bio-secure research facilities only.

3.10 Summary of proposed activity

While abalone are a highly desirable seafood for the Asian market, it is unlikely that *H. rufescens* will be viewed as a viable commercial species in Australia because greenlip (*Haliotis laevis*) and blacklip (*H. rubra*) abalone are considered more desirable and are successfully commercialised for the export market. Abalone must be in high abundance to be commercially viable and it would take decades for a new abalone population to become established as a commercial stock, even in the absence of ecological constraints on its survival and growth.

The purpose of importing red abalone (*H. rufescens*) into Australia would be for research only. This species has been chosen because the CSIRO Australian Animal Health Laboratory (AAHL) in Geelong was requested by the Undersecretary of Fisheries in Chile (via Aquagestion) to undertake trials in AAHL's bio-secure aquarium facility to determine red abalone's susceptibility to abalone viral ganglioneuritis caused by Abalone herpesvirus (AbHV; Hooper et al., 2007; Corbeil et al., 2012). We, at AAHL, are interested in doing these trials because AAHL is a World Organisation for Animal Health (OIE) Reference Laboratory for this agent, and knowledge about the host range for AbHV is important information of interest to the international scientific community and government regulators.

3.11 Housing conditions

No special housing conditions for this species are required.

Transportation: Abalone species will be transported chilled (with ice packs) in a secure, insulated container such as an esky with a secured lid.

Housing: A secure marine aquarium with normal, aerated seawater maintained within the temperature range of 13-20°C. At AAHL there is a range of tank sizes from 2 litres (for housing single animals) up to 100 litres (for housing dozens of animals). Abalone are relatively sedentary but tank covers are used to prevent any possibility of escape from the tanks. The bio-secure aquarium at AAHL is located in the high-level bio-secure area of the facility which is engineered to prevent any escape of air-borne or water-borne infectious organisms, or animals infected with disease agents.

Animal welfare considerations: Animals are for research purposes. Even though abalone are not included in animal welfare regulations, the research team have collaborated with the AAHL Animal Ethics Committee to ensure experimental abalone are treated humanely.

Disposal: At AAHL, all animals are disposed of following the completion of experiments. The animals are euthanized in a humane manner and then incinerated. For abalone, the method of euthanasia involves chilling the abalone on ice to sedate them and then, with a scalpel, slicing the animal through the head region.

3.12 State/Territory controls

Biosecurity Australia/AQIS: There are import permit conditions specific to live aquatic animals for laboratory use. The conditions include that the animals will be contained permanently at a Quarantine Approved Premises (approved by AQIS) – such as AAHL - and after the experiment(s), they will need to be disposed of in an AQIS-approved manner.

New South Wales: There are no specific restrictions with respect to *H. rufescens* in NSW.

Northern Territory: No specific regulations but this species is not an allowable import to NT under existing legislation.

Queensland: Possession and/or placement of non-endemic species is not permissible under the *Queensland Fisheries Act* unless there is authority to do so.

South Australia: There are no specific controls on *H. rufescens* in South Australia.

Tasmania: All abalone species are currently banned for import into Tasmania under the *Animal Health Act 1995*.

Victoria: Victoria does not have any regulations pertaining to the species *H rufescens*.

Western Australia: All live *Haliotis* spp. are prohibited from entry into WA.

4. References

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