

and



Blue swimmer crab

Portunus armatus



Image © R. Swainston/www.anima.net.au

Australia

Pot, Bottom trawl

June 4, 2015

The Safina Center Seafood Analysts

Disclaimer

Seafood Watch and The Safina Center strive to ensure that all our Seafood Reports and recommendations contained therein are accurate and reflect the most up-to-date evidence available at the time of publication. All our reports are peer-reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science or aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch program or of The Safina Center or their recommendations on the part of the reviewing scientists. Seafood Watch and The Safina Center are solely responsible for the conclusions reached in this report. We always welcome additional or updated data that can be used for the next revision. Seafood Watch and Seafood Reports are made possible through a grant from the David and Lucile Packard Foundation and other funders.

About The Safina Center

The Safina Center (formerly Blue Ocean Institute) translates scientific information into language people can understand and serves as a unique voice of hope, guidance, and encouragement. The Safina Center (TSC) works through science, art, and literature to inspire solutions and a deeper connection with nature, especially the sea. Our mission is to inspire more people to actively engage as well-informed and highly motivated constituents for conservation.

Led by conservation pioneer and MacArthur fellow, Dr. Carl Safina, we show how nature, community, the economy and prospects for peace are all intertwined. Through Safina's books, essays, public speaking, PBS television series, our Fellows program and Sustainable Seafood program, we seek to inspire people to make better choices.

The Safina Center was founded in 2003 by Dr. Carl Safina and was built on three decades of research, writing and policy work by Dr. Safina.

The Safina Center's Sustainable Seafood Program

The Center's founders created the first seafood guide in 1998. Our online seafood guide now encompasses over 160-wild-caught species. All peer-reviewed seafood reports are transparent, authoritative, easy to understand and use. Seafood ratings and full reports are available on our website under [Seafood Choices](#). TSC's Sustainable Seafood Program helps consumers, retailers, chefs and health professionals discover the connection between human health, a healthy ocean, fishing and sustainable seafood.

- Our online guide to sustainable seafood is based on scientific ratings for more than 160 wild-caught seafood species and provides simple guidelines. Through our expanded partnership with the Monterey Bay Aquarium, our guide now includes seafood ratings from both The Safina Center and the Seafood Watch® program.
- We partner with Whole Foods Market (WFM) to help educate their seafood suppliers and staff, and provide our scientific seafood ratings for WFM stores in the US and UK.
- Through our partnership with Chefs Collaborative, we created [Green Chefs/Blue Ocean](#), a free, interactive, online sustainable seafood course for chefs and culinary professionals.
- Our website features tutorials, videos, blogs, links and discussions of the key issues such as [mercury in seafood](#), bycatch, overfishing, etc.

Check out our Fellows Program, learn more about our Sustainable Seafood Program and Carl Safina's current work at www.safinacenter.org .

The Safina Center is a 501 (c) (3) nonprofit organization based in the School of Marine & Atmospheric Sciences at Stony Brook University, Long Island, NY. www.safinacenter.org admin@safinacenter.org | 631.632.3763

About Seafood Watch®

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch®'s sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

Guiding Principles

The Safina Center and Seafood Watch define sustainable seafood as originating from sources, whether fished¹ or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

Based on this principle, Seafood Watch and the Safina Center have developed four sustainability **criteria** for evaluating wild-catch fisheries for consumers and businesses. These criteria are:

- How does fishing affect the species under assessment?
- How does the fishing affect other, target and non-target species?
- How effective is the fishery's management?
- How does the fishing affect habitats and the stability of the ecosystem?

Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and **rating**

Once a rating has been assigned to each criterion, we develop an overall recommendation. Criteria ratings and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide and the Safina Center's online guide:

Best Choice/Green: Are well managed and caught in ways that cause little harm to habitats or other wildlife.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught.

Avoid/Red: Take a pass on these for now. These items are overfished or caught in ways that harm other marine life or the environment.

¹ "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates.

Summary

Blue swimmer crab (*Portunus armatus*) is a tropical species found in estuaries and inshore marine waters throughout the Indo-Pacific region. This report evaluates the blue swimmer crab fisheries in four regions of Australia: Queensland, New South Wales, South Australia, and Western Australia. In Australia, blue swimmer crabs are primarily caught using pots but they are also caught in the Shark Bay prawn trawl fishery in Western Australia.

In both Queensland and New South Wales, there is believed to be a single blue swimmer crab population. Blue swimmer crab abundance and fishing levels in Queensland and New South Wales are uncertain because there have been limited assessments of these populations.

In South Australia, three separate biological populations of blue swimmer crab have been identified: Spencer Gulf, Gulf St. Vincent, and West Coast. Nearly all (99%) blue swimmer crab fishing occurs in Spencer Gulf and Gulf St. Vincent. The Spencer Gulf population is being sustained at an appropriate level. Abundance of blue swimmer crabs in Gulf St. Vincent is low, but managers have taken appropriate action to limit fishing.

In Western Australia, the biological structure of blue swimmer crabs is uncertain, but there is some evidence of distinct separation between the three management units in this region: Cockburn Sound, Peel-Harvey Estuary, and Shark Bay. Blue swimmer crab abundance is low in both Cockburn Sound and Shark Bay, and these populations have been classified as environmentally limited. Fishery managers have taken measures to limit fishing on these populations. Blue swimmer crab abundance in Peel-Harvey Estuary is believed to be healthy, but further assessment of this population is needed.

The pot fisheries in all regions solely target blue swimmer crab, and non-target catch or bycatch is typically low. However, in the Queensland pot fishery there is concern about incidental catches of vulnerable green sea turtles. In the Western Australia Shark Bay prawn trawl fishery that catches blue swimmer crabs, the catch of non-target species is high and includes some species of concern (i.e., sea snakes and sea turtles).

The Australia blue swimmer crab fisheries are generally well-managed and recovery efforts are in place for populations at low abundances. But in some states research/monitoring could be improved. In the Queensland pot fishery and Western Australia Shark Bay trawl fishery, further management measures are needed to reduce impacts on vulnerable bycatch species.

The crab pots used to catch blue swimmer crab cause low damage to the physical and biological structures of the seafloor, while bottom trawls can cause high damage. Managers have established several spatial closures to limit fishing impacts on bottom habitats and the ecosystem as a whole.

Overall, the blue swimmer crab pot fisheries in New South Wales, Spencer Gulf (South Australia), and Peel-Harvey Estuary (Western Australia) are rated “Green” due to low impacts on blue swimmer crab, other species, and habitats. The blue swimmer crab pot fisheries in Gulf St. Vincent (South Australia), Cockburn Sound (Western Australia), and Shark Bay (Western Australia) are rated “Yellow” due to concerns about the abundance of blue swimmer crabs in these areas. The Queensland blue swimmer crab pot fishery is also rated “Yellow” due to concern about the fishery’s effect on vulnerable green sea turtles. The Shark Bay trawl fishery is rated “Red” because of the high impact on blue swimmer crabs and non-target species.

Table of Conservation Concerns and Overall Recommendations

Species / Fishery	Impacts on the Species	Impacts on other Spp.	Management	Habitat and Ecosystem	Overall Recommendation
Blue swimmer crab Queensland South Pacific - Pot	Yellow (2.64)	Red (2.05)	Yellow (3.00)	Green (3.74)	Yellow/Good Alternative (2.793)
Blue swimmer crab New South Wales South Pacific - Pot	Yellow (2.64)	Green (4.50)	Green (3.46)	Green (3.74)	Green/Best Choice (3.524)
Blue swimmer crab Southern Australia Spencer Gulf - Pot	Green (3.83)	Green (3.15)	Green (4.47)	Green (3.74)	Green/Best Choice (3.770)
Blue swimmer crab Southern Australia Gulf of St. Vincent - Pot	Red (2.16)	Green (3.15)	Green (3.87)	Green (3.74)	Yellow/Good Alternative (3.151)
Blue swimmer crab Western Australia Cockburn Sound - Pot	Red (2.16)	Green (4.75)	Green (3.87)	Green (3.74)	Yellow/Good Alternative (3.492)
Blue swimmer crab Western Australia Shark Bay - Pot	Red (2.16)	Green (4.75)	Green (3.87)	Green (3.74)	Yellow/Good Alternative (3.492)
Blue swimmer crab Western Australia Shark Bay - Trawl, Bottom	Red (2.16)	Red (1.15)	Yellow (3.00)	Yellow (2.45)	Red/Avoid (2.065)
Blue swimmer crab Western Australia Peel-Harvey Estuary - Pot	Yellow (3.05)	Green (4.75)	Green (3.87)	Green (3.74)	Green/Best Choice (3.808)

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

- **Best Choice/Green** = Final Score >3.2, **and** no Red Criteria, **and** no Critical scores

- **Good Alternative/Yellow** = Final score >2.2, **and** neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern,² **and** no more than one Red Criterion, **and** no Critical scores, **and** does not meet the criteria for Best Choice (above)
- **Avoid/Red** = Final Score <=2.2, **or** either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern,² **or** two or more Red Criteria, **or** one or more Critical scores.

² Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Table of Contents

About The Safina Center	2
About Seafood Watch®	3
Guiding Principles	4
Summary	5
Introduction	9
Criterion 1: Impacts on the species under assessment	11
Criterion 2: Impacts on Other Species	22
Criterion 3: Management effectiveness	33
Criterion 4: Impacts on the habitat and ecosystem.....	55
Acknowledgements.....	63
References	64
Appendix A: Review Schedule.....	72
Appendix B: Main Species Considered in the Assessment	73

Introduction

Scope of the analysis and ensuing recommendation

This report evaluates blue swimmer crab, *Portunus armatus* (formerly *Portunus pelagicus*), caught with pots in Queensland, New South Wales, South Australia, and Western Australia, as well as blue swimmer crab caught in the Western Australia Shark Bay prawn trawl fishery. Small amounts of blue swimmer crabs are caught in other trawl fisheries and in mesh or hoop net fisheries that are not evaluated in this report.

Overview of the species and management bodies

Blue swimmer crab is a large crab in the Portunidae family that can reach a carapace width (CW) of 25 cm (10 in) and have a claw span up to 80 cm (31.5 in) (Department of Fisheries WA 2011). It has flat, disc-shaped hind legs that are used like paddles for swimming (Department of Fisheries WA 2011). It is a tropical species found in estuaries and inshore marine waters throughout the Indo-Pacific region and in all Australia States except Tasmania.

In Australia, blue swimmer crab is an important species for both the recreational and commercial fisheries. Blue swimmer crab is managed differently in each state. In Queensland, the Department of Agriculture and Fisheries is the management body, and in New South Wales, the Department of Primary Industries Fishing and Aquaculture is responsible for fisheries management. In South Australia, blue swimmer crab is managed by Primary Industries and Regions South Australia. In Western Australia, it is managed by the Government of Western Australia's Department of Fisheries. Management of blue swimmer crab fisheries in Australia is much better than in the surrounding Indo-Pacific countries.

Production Statistics

In 2011, global reported catches of blue swimmer crab totaled 183,445 metric tons (MT). The largest producing countries were China (70,165 MT), Indonesia (42,411 MT), Philippines (29,497 MT), Thailand (20,582 MT), Taiwan (7,623 MT), Australia (4,176 MT), Saudi Arabia (4,076 MT), and Bahrain (3,042 MT) (FAO 2013).

In Australia, the commercial fisheries in Queensland and Western Australia have historically been the largest, but in both of these states, catches have declined in recent years (Johnston et al. 2012) (see Figure 1). In 2012 and 2013, South Australia had the highest blue swimmer crab catch. In Western Australia Shark Bay, blue swimmer crabs are caught with both pots and trawls (Fletcher and Santoro 2014). In all other areas, pots are the predominant gear used to catch blue swimmer crabs. There are also significant recreational catches of blue swimmer crabs in most areas, with an estimated 3.9 million crabs caught each year (Henry and Lyle 2003).

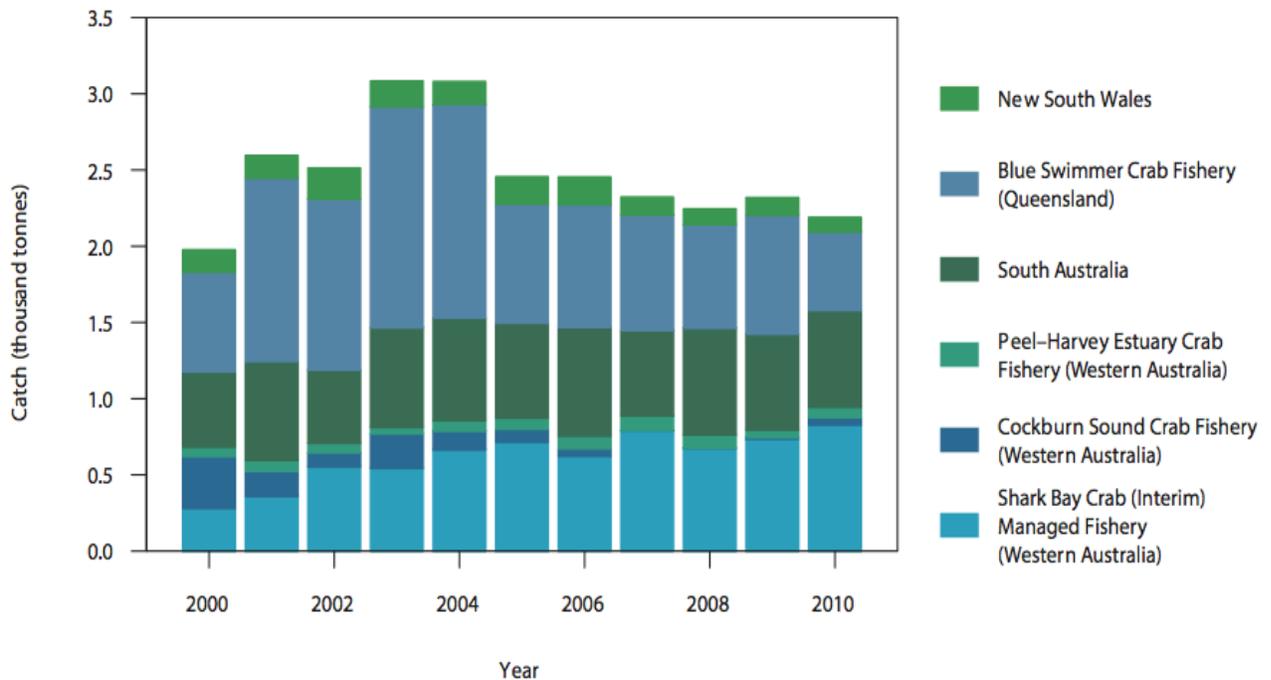


Figure 1: Commercial catch of blue swimmer crab in Australian waters, 2000–2010 (Johnston et al. 2012).

Importance to the U.S./North American market

All species of crabs imported from Australia to the United States are lumped together. 2,999 kg of frozen crab, 881 kg of live/fresh/salted/brine crab, 146 kg of frozen crabmeat, and 749 kg of crabmeat with other preparations were imported to the United States from Australia in 2013. It is unclear if any of this is swimmer crab (NMFS 2014a). Currently, only the Western Australia crab fisheries are reported to have an export market (Johnston et al. 2014a).

Most swimmer crab imported into the United States comes from Indonesia, China, Philippines, Thailand, and Vietnam (NMFS 2014b); all of these blue swimmer crab fisheries are rated “Red/Avoid.”

Common and market names

Other common names include blue crab, blue manna, or blueys (Department of Fisheries WA 2013b).

Primary product forms

The primary product forms are pasteurized lump meat, special meat, and claw meat, which can be canned, in pouches, or frozen.

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Criteria for Fisheries, available at <http://www.seafoodwatch.org>.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- Score >3.2=Green or Low Concern
 - Score >2.2 and <=3.2=Yellow or Moderate Concern
 - Score <=2.2=Red or High Concern
- Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.*

Criterion 1 Summary

BLUE SWIMMER CRAB				
Region / Method	Factor 1.1. Inherent Vulnerability	Factor 1.2 Abundance	Factor 1.3 Fishing Mortality	Criterion 1 Score
New South Wales South Pacific Pot	Low	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)
Queensland South Pacific Pot	Low	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)
South Australia Gulf St Vincent Pot	Low	2.00:High Concern	2.33:Moderate Concern	Red (2.159)
South Australia Spencer Gulf Pot	Low	4.00:Low Concern	3.67:Low Concern	Green (3.831)
Western Australia Cockburn Sound Pot	Low	2.00:High Concern	2.33:Moderate Concern	Red (2.159)
Western Australia Peel-Harvey Estuary Pot	Low	4.00:Low Concern	2.33:Moderate Concern	Yellow (3.053)
Western Australia Shark Bay Pot	Low	2.00:High Concern	2.33:Moderate Concern	Red (2.159)
Western Australia Shark Bay Trawl, Bottom	Low	2.00:High Concern	2.33:Moderate Concern	Red (2.159)

In both Queensland and New South Wales, there is believed to be a single blue swimmer crab population. Blue swimmer crab abundance and fishing levels in Queensland and New South Wales are uncertain because there have been limited assessments of these populations. In South Australia, three separate biological populations of blue swimmer crab have been identified: Spencer Gulf, Gulf St. Vincent, and West Coast. Nearly all (99%) blue swimmer crab fishing occurs in Spencer Gulf and Gulf St. Vincent. The Spencer Gulf population is being sustained at an appropriate level. Abundance of blue swimmer crabs in the Gulf St. Vincent is low, but managers have taken appropriate action to limit fishing. In Western Australia, the biological structure of blue swimmer crabs is uncertain, but there is some evidence of distinct separation between the three management units in this region: Cockburn Sound, Peel-Harvey Estuary, and Shark Bay. Blue swimmer crab abundance is low in both Cockburn Sound and Shark Bay, and these populations have been classified as environmentally limited. Fishery managers have taken measures to limit fishing on these populations. Blue swimmer crab abundance in Peel-Harvey Estuary is believed to be healthy, but further assessment of this population is needed.

Criterion 1 Assessment

BLUE SWIMMER CRAB

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing (*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*
- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make it particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator).*

Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.

New South Wales South Pacific, Pot
 Queensland South Pacific, Pot
 South Australia Gulf St Vincent, Pot
 South Australia Spencer Gulf, Pot
 Western Australia Cockburn Sound, Pot

Western Australia Peel-Harvey Estuary, Pot
Western Australia Shark Bay, Pot
Western Australia Shark Bay, Trawl, Bottom

Low

The blue swimmer crab can live up to 4 years and grow to 25 cm in carapace (shell) width (CW) (Johnston et al. 2012) (Department of Fisheries WA 2011). The age and size at which blue swimmer crabs reach sexual maturity varies by location, but typically 50% of crabs reach sexual maturity between 6 and 14 months old and 8.6–9.8 cm CW (Johnston et al. 2012). A female crab can produce 180,000 to 2,000,000 eggs during each spawning and may spawn more than once in a season (Department of Fisheries WA 2011). When the fertilized eggs are laid, they attach to hairs under the female’s abdomen. The female crab incubates the eggs until the embryos are mature, about 18 days. Then, the female shakes the eggs off her abdomen and they hatch into free-floating larvae called “zoëa” (Department of Fisheries WA 2011). Blue swimmer crabs typically feed on small fish, mollusks (e.g., snails), worms, and small crustaceans (e.g., shrimp, crabs). Predators of blue swimmer crabs include fishes, birds, and other blue swimmer crabs (Department of Fisheries WA 2011). The life-history attributes of the blue swimmer crab indicate that it has a “low” inherent vulnerability to fishing.

Rationale:

Table 1: Results from Seafood Watch fish vulnerability rubric (criteria document, pg. 4). Attribute scores can range from 1–3 with higher scores signifying more resilient life-history attributes.

Vulnerability attribute	Category	Score
Average age at maturity	< 5 years	3
Average maximum age	< 10 years	3
Fecundity	> 100 eggs	N/A
Reproductive strategy	Demersal egg layer or brooder	2
Density dependence	No depensatory or compensatory dynamics demonstrated or likely	2
Average Score	Low Vulnerability	2.5

Species with average attribute scores between 2.46 and 3.00 are deemed to have a “low” vulnerability.

Factor 1.2 - Abundance

Scoring Guidelines

- *5 (Very Low Concern)—Strong evidence exists that the population is above target abundance level (e.g., biomass at maximum sustainable yield, BMSY) or near virgin biomass.*
- *4 (Low Concern)—Population may be below target abundance level, but it is considered not overfished*
- *3 (Moderate Concern) —Abundance level is unknown and the species has a low or medium inherent vulnerability to fishing.*
- *2 (High Concern)—Population is overfished, depleted, or a species of concern, OR abundance is unknown and the species has a high inherent vulnerability to fishing.*
- *1 (Very High Concern)—Population is listed as threatened or endangered.*

New South Wales South Pacific, Pot

Moderate Concern

In New South Wales, there is a single blue swimmer crab population. There is little biological information available for this population and no abundance targets or conservation goals have been established. Catches and catch rates of blue swimmer crab have declined in recent years. The reasons for these declines are being investigated (NSW I&I 2010) (Johnston et al. 2012) (Johnston et al. 2014a). Since the current abundance of blue swimmer crabs in New South Wales is unknown and this species has a low vulnerability to fishing, this factor is rated “moderate” concern.

Queensland South Pacific, Pot

Moderate Concern

In Queensland, scientists and managers determine the status of the blue swimmer crab population by examining various fishery performance measures, such as whether catches and catch rates are increasing or decreasing. Since 2003, catches and catch rates of blue swimmer crabs in the commercial pot fishery have been declining and in recent years have dropped to below average levels. The reported catch in 2013 was the lowest since 1997 (Johnston et al. 2014a). The declining trend has led to concerns about the sustainability of the population (Holmes et al. 2013). The population is not yet believed to have declined to the point where reproduction would be impaired, but no abundance goals/reference points have been established (Johnston et al. 2014a).

Further work is underway to more accurately determine abundance. The catch rate data are not considered particularly reliable, especially since commercial fishing effort is only measured by the period (day), rather than the number of pot hauls. A scientific survey was started in 2006 to better monitor the abundance of blue swimmer crabs, and a formal population assessment is in progress (Johnston et al. 2014a).

Because there are signs that blue swimmer crab abundance is declining in Queensland and estimates of abundance in relation to abundance conservation goals are not available, this factor is awarded a “moderate” concern score.

South Australia Spencer Gulf, Pot

Low Concern

In South Australia, three separate biological populations of blue swimmer crab have been identified: Spencer Gulf, Gulf St. Vincent, and West Coast. Nearly all (99%) blue swimmer crab fishing occurs in Spencer Gulf and Gulf St. Vincent. Scientists have conducted pot surveys in these two areas since 2002

to estimate the relative abundances of blue swimmer crabs (Johnston et al. 2012). Limit and upper abundance reference points or goals have been defined for these populations in the South Australian Blue Crab Fishery Management Plan.

In 2012, the abundance of legal-sized blue swimmer crabs in Spencer Gulf (9.3 crabs per pot lift) was above the limit abundance goal (5.0 crabs per pot lift), as well as the upper abundance goal (9 crabs per pot lift). The relative abundance of young crabs or pre-recruits (8.7 crabs per pot lift) was also above the limit abundance goal (2.0 crabs per pot lift) and slightly below the upper abundance goal (9 crabs/pot lift). Since the abundance of blue swimmer crabs in Spencer Gulf is above the limit abundance goals and near the upper abundance goals, the population is considered “sustainable” (Dixon et al. 2013) (Noell et al. 2014). This factor is awarded a “low” concern score.

South Australia Gulf St Vincent, Pot

High Concern

In South Australia, three separate biological populations of blue swimmer crab have been identified: Spencer Gulf, Gulf St. Vincent, and West Coast. Nearly all (99%) blue swimmer crab fishing occurs in Spencer Gulf and Gulf St. Vincent. Scientists have conducted pot surveys in these two areas since 2002 to estimate the relative abundances of blue swimmer crabs (Johnston et al. 2012). Limit and upper abundance reference points or goals have been defined for these populations in the South Australian Blue Crab Fishery Management Plan.

In the Gulf St. Vincent, abundance of blue swimmer crabs has declined to low levels in recent years. In 2013, the abundance of legal-sized crabs in Gulf St. Vincent declined to 1.45 crabs/pot lift, which is just below the limit abundance goal (1.5 crabs/pot lift) and well below the upper abundance goal (4 crabs/pot lift). The abundance of young crabs or pre-recruits in 2013 was also low (1.2 crabs/pot lift) and below the limit abundance goal (1.5 crabs/pot lift). But the abundance of pre-recruits did increase slightly from the very low 2012 level (0.78 crabs/pot lift) (Noell et al. 2014). Since the abundance of blue swimmer crabs in the Gulf St. Vincent is below the limit abundance reference points, the population is considered to be in an overfished/depleted state. Thus this factor is rated “high” concern.

Western Australia Cockburn Sound, Pot

High Concern

In Western Australia, the biological structure of blue swimmer crabs is uncertain, but there is some evidence of distinct separation between the three management units in this region: Shark Bay, Cockburn Sound, and Peel-Harvey Estuary.

In Cockburn Sound, the catch and abundance of blue swimmer crabs significantly declined in the early 2000s. The decline was thought to be a result of high fishing pressure combined with poor environmental conditions, leading to reduced survival of young crabs. In response to the low blue swimmer crab abundance, managers closed the fishery in December 2006. Scientific surveys of blue swimmer crabs in 2009 indicated the population had recovered enough to allow for a limited re-opening of the fishery in 2010 (Fletcher and Santoro 2014). However, catches of blue swimmer crab remained low during the 2010, 2011, and 2012 seasons and catch rates declined throughout each season. Research surveys conducted during 2012 and 2013 indicated low numbers of spawning female crabs and low numbers of young crabs. It is believed that the population is once again depleted. Because of the low blue swimmer crab abundance, the fishery in Cockburn Sound closed early for the 2013–2014 season. There is some evidence that the low abundance is due to a lack of growth and moulting by a large number of crabs during the summer of 2011–12, and that the crabs may be in a poor nutritional state due to a lack of prey. The Cockburn Sound population has been classified as “environmentally limited” (Johnston et al. 2014a). Since the abundance of blue swimmer crabs in Cockburn Sound is low, this factor is rated “high” concern.

Western Australia Peel-Harvey Estuary, Pot

Low Concern

In Western Australia, the biological structure of blue swimmer crabs is uncertain, but there is some evidence of distinct separation between the three management units in this region: Cockburn Sound, Peel-Harvey Estuary, and Shark Bay.

Blue swimmer crabs in Peel-Harvey Estuary and outside adjacent areas (Mandurah Estuary and Comet Bay) are believed to be part of a common population. Most fishing for blue swimmer crabs occurs within Peel-Harvey Estuary, but there is a developing crab pot fishery in these adjacent outside areas (Mandurah to Bunbury developing crab fishery) and some crabs are also caught in trawl fisheries in Comet Bay (Johnston et al. 2014b).

Catch rates (amount of crabs caught per unit of fishery effort) in the Peel-Harvey Estuary pot fishery are used to provide an index of crab abundance. From 1996 (when the fishery converted from a net fishery to a pot fishery) until 2011, catch rates have varied from 0.9–1.5 kg/pot lift. In 2012, the catch rate increased to 1.68 kg/pot lift, which was the highest observed catch rate since 1996 (Fletcher and Santoro 2014), and the catch rate remained high in 2014 (1.4 kg/pot lift) (Johnston et al. 2014a) (Johnston et al. 2014b). These catch rates are above the proposed threshold abundance level (1 kg/pot lift). Scientific research surveys have also been conducted within this estuary in recent years to monitor abundance. Comparisons of recent scientific research surveys to historical surveys suggest that abundance has remained relatively stable over the last decade (Johnston et al. 2014b). Catch rates in the Mandurah to Bunbury blue swimmer crab pot fishery have generally increased since the

commencement of exploratory fishing in 2002. Monitoring of commercial catches in this fishery indicates that a high proportion of the catch is females (Johnston et al. 2014b).

The available information indicates that the Peel-Harvey Estuary blue swimmer crab population has remained stable over the last decade and is unlikely to be depleted (Johnston et al. 2014b). Abundance is therefore rated a “low” concern.

Western Australia Shark Bay, Pot

Western Australia Shark Bay, Trawl, Bottom

High Concern

In Western Australia, the biological structure of blue swimmer crabs is uncertain, but there is some evidence of distinct separation between the three management units in this region: Cockburn Sound, Peel-Harvey Estuary, and Shark Bay.

Blue swimmer crab abundance in Shark Bay began rapidly declining during 2011, and catch rates in the fishery fell below the established limit abundance reference level of 1.0 crab/pot lift. It is thought that a marine heatwave in the summer of 2010–11 along with two major flood events in 2010–11 contributed to the abundance decline, but fishing may have also played a part (Harris et al. 2014) (Fletcher and Santoro 2014). Due to the low crab abundance in this area, the fishing industry agreed to halt fishing activities on this population from April 2012 to June 2013 to allow for rebuilding, and only limited commercial fishing has been allowed since (Johnston et al. 2014a) (Fletcher and Santoro 2014). There was some evidence of a partial recovery of the blue swimmer crab population during 2012 and 2013, but it is likely that abundance remains below the limit abundance goal. The population has been classified as “environmentally limited” (Johnston et al. 2014a). Since the abundance of blue swimmer crabs in Shark Bay is low, this factor is rated “high” concern.

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible ($\leq 5\%$ of a sustainable level of fishing mortality).*
- *3.67 (Low Concern)—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing*

mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).

- *2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.*
- *1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.*
- *0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.*

New South Wales South Pacific, Pot

Moderate Concern

The blue swimmer crab is an important commercial and recreational species in New South Wales. In 2010, the total commercial catch of blue swimmer crab in New South Wales was 113 MT (Johnston et al. 2012) (NSW I&I 2010). Five estuaries account for 95% of the commercial catch, with Wallis Lake being the most important (NSW I&I 2010). The biological data collected on blue swimmer crabs in Wallis Lake indicate that fishing pressure is high in this area and that fishing mortality is greater than natural mortality (NSW I&I 2010). Recreational catches of blue swimmer crab are believed to be greater than commercial catches in New South Wales but are poorly quantified (Johnston et al. 2014a). Recreational catches are estimated to range from 150 MT to 310 MT (NSW I&I 2010). No fishing mortality targets or conservation goals have been determined for this species in New South Wales, but scientists have classified the population as “fully fished,” meaning there is no room for any increase in fishing levels (NSW I&I 2010). Therefore, this factor is rated “moderate” concern.

Queensland South Pacific, Pot

Moderate Concern

Blue swimmer crabs are found in coastal and estuarine waters along the entire Queensland coast but are fished mainly in the southern part of Queensland. The annual commercial catch of blue swimmer crabs decreased from 537 MT in 2010 to 354 MT in 2011 (Holmes et al. 2013). Between 2010 and 2011, fishing effort also decreased, with fishing effort days dropping 21% in pot fisheries (Holmes et al. 2013). The recent decline in catches and catch rates in the blue swimmer crab fishery has led to some concern about the sustainability of the population (Holmes et al. 2013). The recent decline is believed to be a result of environmental factors rather than fishing; however, no data are available to quantify the impact of environmental factors on blue swimmer crab mortality in recent years (Johnston et al. 2014a). There are several management measures in place, including spatial closures, a prohibition on taking females, and a minimum size limit for males, that should ensure that a large proportion of the blue

swimmer crab population is protected from fishing, but fishing mortality has not been estimated (Holmes et al. 2013) (Johnston et al. 2014a). Since there is some concern that the population is in decline and no fishing mortality estimates are available, this factor is rated “moderate” concern.

South Australia Spencer Gulf, Pot

Low Concern

Since 1996, South Australia fishery managers have set total allowable commercial catch limits for the blue swimmer crab pot fisheries in Spencer Gulf and Gulf St. Vincent (Johnston et al. 2012). The purpose of the catch limits is to ensure that catches of blue swimmer crabs remain within ecologically sustainable limits.

In Spencer Gulf, the total allowable catch limit has remained constant since the early 2000s, and for the past 9 years the fishery has taken nearly all of its allotted catch. During this time, the population has remained above the limit abundance reference point/goal and is currently near the upper abundance goal (Noell et al. 2014). This suggests that fishing levels on this population are likely sustainable. This results in a “low” concern score.

South Australia Gulf St Vincent, Pot

Moderate Concern

Since 1996, South Australia fishery managers have set total allowable commercial catch limits for the blue swimmer crab pot fisheries in Spencer Gulf and Gulf St. Vincent (Johnston et al. 2012). The purpose of the catch limits is to ensure that catches of blue swimmer crabs remain within ecologically sustainable limits.

During the 2012–2013 fishing season, it became evident that blue swimmer crab abundance in the Gulf St. Vincent was declining (Dixon et al. 2013) (Noell et al. 2014). As a result, fishers purposefully caught less than their allocated catch limit during the season to help protect the population (Noell et al. 2014). For the 2013–2014 season, in response to the low estimated blue swimmer crab abundance, managers reduced the commercial catch limit for the Gulf St. Vincent blue swimmer crab fishery by 20% and the daily allowed recreational catch by 50%. Also, fishers proposed a closure to fishing in this area from July 2013 to January 2014 to provide protection for spawning crabs and young blue swimmer crabs (PIRSA Fisheries 2013d). The effect that these measures had on promoting recovery of the population will not be fully known until a new blue swimmer crab assessment is completed in 2015. However, there is evidence of an increase in the abundance of young or pre-recruit blue swimmer crabs (Noell et al. 2014). The reduced commercial and recreational catch restrictions for blue swimmer crab remain in effect for the 2014–2015 fishing season (Johnston et al. 2014a). This results in a score of “moderate” concern.

Western Australia Cockburn Sound, Pot

Moderate Concern

In Cockburn Sound, the blue swimmer crab fishery was previously closed from 2006–2009 because of low blue swimmer crab abundance. By 2010, abundance had increased to an adequate level to allow for a limited re-opening of the fishery. The 2010 season was restricted to only 3.5 months, and the 2011 and 2012 seasons were restricted to 6 months (Fletcher and Santoro 2014). But in 2013, the population was once again found to be depleted and the fishery was closed early for the 2013–14 season. The low abundance is believed to be a result of environmental changes rather than overfishing, since fishing effort was being restricted (Johnston et al. 2014a).

Since managers have responded appropriately when abundance has fallen to low levels, but the level of fishing that this population can support remains unclear, fishing mortality is rated a “moderate” concern.

Western Australia Peel-Harvey Estuary, Pot

Moderate Concern

Commercial catches of blue swimmer crab in Peel-Harvey Estuary have remained relatively stable since 1996, ranging from 50 MT to 100 MT. But recreational catches contribute to a significant proportion of the catch in this area and are poorly quantified. There is also a developing crab pot fishery (Mandurah to Bunbury crab fishery) in areas outside the estuary, which are believed to be part of the same population. There are only two vessels currently participating in the Mandurah to Bunbury crab fishery, with catches ranging from 0 MT to 20 MT (Johnston et al. 2014b).

Fishing levels on the Peel-Harvey Estuary blue swimmer crab population are believed to be sustainable, since evidence suggests that abundance has remained relatively stable over the last decade. Additionally, the population is thought to be well protected because the minimum size limit for both the commercial and recreational fisheries is well above the size at which crabs sexually mature, ensuring that the crabs can reproduce at least once before they are caught. However, there are some indicators of concern. There has been a decline in catch rates of males and increasing catches of females. Also, the fishing level by the recreational sector is unknown (Johnston et al. 2014b). This factor is rated “moderate” concern.

Western Australia Shark Bay, Pot**Western Australia Shark Bay, Trawl, Bottom****Moderate Concern**

The Shark Bay fishery for blue swimmer crab expanded rapidly between 2000 and 2010 and became Australia's highest producing fishery, with catches around 800 MT. But in late 2011, the abundance of blue swimmer crab was found to be low. This rapid decline was believed to be a result of environmental changes, but declining catch rates and declines in the size of crabs caught could suggest high exploitation (Harris et al. 2014). The Shark Bay fishery closed from April 2012 to September 2013 to allow for the blue swimmer crab population to recover. A partial recovery of the blue swimmer crab population was observed in 2012 and 2013 (Fletcher and Santoro 2014). This provided some confidence to allow for limited commercial fishing for the 2013–14 season. Based on scientific research, a catch limit of 400 MT was set, with 66% allocated to the pot fishery and 34% to the prawn trawl fishery. It is believed that this level of fishing will allow for continued recovery (Johnston et al. 2014a). Until a new assessment is conducted, this remains somewhat uncertain. This results in a score of “moderate” concern.

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. Seafood Watch® defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. The Criterion 2 rating is determined as follows:

- Score >3.2=Green or Low Concern
 - Score >2.2 and <=3.2=Yellow or Moderate Concern
 - Score <=2.2=Red or High Concern
- Rating is Critical if Factor 2.3 (Fishing Mortality) is Critical.

Criterion 2 Summary

Only the lowest scoring main species is/are listed in the table and text in this Criterion 2 section; a full list and assessment of the main species can be found in Appendix B.

Blue swimmer crab				
Region / Method	Factors 2.1-2.3		Factor 2.4 Discard Rate Modifying Score ((Discards+Bait)/Retained Catch)	Criterion 2 Score
	Lowest Scoring of Other Species	Lowest Species Subscore		
New South Wales South Pacific, Pot	No Other Main Species Caught	5.000	0.90 (40-60%)	Green (4.500)
Queensland South Pacific, Pot	Green Sea Turtles	2.159	0.95 (20-40%)	Red (2.051)
South Australia Gulf St Vincent, Pot	Rough Rock Crab and Spider Crab	3.318	0.95 (20-40%)	Green (3.152)
South Australia Spencer Gulf, Pot	Rough Rock Crab and Spider Crab	3.318	0.95 (20-40%)	Green (3.152)
Western Australia Cockburn Sound, Pot	No Other Main Species Caught	5.000	0.95 (20-40%)	Green (4.750)
Western Australia Peel-Harvey Estuary, Pot	No Other Main Species Caught	5.000	0.95 (20-40%)	Green (4.750)
Western Australia Shark Bay, Pot	No Other Main Species Caught	5.000	0.95 (20-40%)	Green (4.750)
Western Australia Shark Bay, Trawl, Bottom	Sea Turtles	1.526	0.75 (>100%)	Red (1.145)

The pot fisheries for blue swimmer crab generally catch low amounts of non-target species. In the New South Wales and Western Australia pot fisheries, bycatch is low and no other species are considered to be caught in significant numbers (Fletcher and Santoro 2013) (Johnson 2007). In the South Australia pot fishery, the primary bycatch species are rough rock crabs (>80% of the total bycatch) and spider crabs (7% of the total bycatch). All other species accounted for <5% of the bycatch. The impact of the South Australia blue swimmer crab pot fishery on these other crab species is low (Government of South Australia 2009). In the Queensland blue swimmer crab pot fishery, three-spot crabs are the main bycatch species and the fishery is considered to have a moderate impact on their population size (Hill and Garland 2009). However, the Queensland blue swimmer crab pot fishery also incidentally catches endangered green sea turtles, which is driving the “high concern” rating for this criterion (Hill and Garland 2009).

In Western Australia, blue swimmer crabs are also caught in the Shark Bay prawn trawl fishery, so this fishery was assessed in this report. The western king prawn and the Australian tiger prawn account for most of the retained catch in this fishery. Bycatch and discards in this fishery are quite high, and include dead wire weed, small fish, small blue swimmer crabs, and other crustaceans. The specific species composition of the bycatch is not reported, but a study that investigated the impacts of trawling on non-target species in Western Australia Shark Bay found that even though the total number of species caught in bottom trawls is high, only about 20 invertebrates and 20 fish contribute to most of the catch. We have grouped the potential bycatch species into “unknown benthic invertebrates” and “unknown finfish.” Due to the limited information on the catches and status of these species, we have scored these groups based on the Seafood Watch unknown bycatch matrix. This matrix is based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type (see Appendix 3 in the Seafood Watch Wild Fisheries Assessment Criteria). Additionally, some species of concern are caught in this fishery, including protected sea snakes and occasionally endangered or vulnerable sea turtles (Fletcher and Santoro 2013); these species limit the score for this fishery.

Criterion 2 Assessment

GREEN SEA TURTLE

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Queensland South Pacific, Pot

High

Green sea turtles can live up to 80 years and reach a carapace length of over 1 m. An average adult green sea turtle weighs 150 kg. Females reach sexual maturity between 30 and 40 years old (Queensland Government 2013a). Females can lay between 1 and 7 clutches in a season, with each

clutch containing approximately 110 eggs. Although immature green sea turtles are carnivorous, the adults typically feed on seaweeds, seagrass, and mangrove fruits (Queensland Government 2013a). Sea turtles are considered to have “high” inherent vulnerability to fishing.

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Queensland South Pacific, Pot

High Concern

Green sea turtles are listed as vulnerable under Australia’s Environment Protection and Biodiversity Conservation Act and under Queensland’s Nature Conservation Act (Department of the Environment 2015f) (Queensland Government 2013a). The International Union for Conservation of Nature (IUCN) lists the green sea turtle globally as Endangered, but it was last assessed in 2004 (Seminoff, J.A. 2004). A recent global study that looked at the risks to marine sea turtle populations indicates that the green sea turtle population in the Southwest Pacific off the Australia coast is at low risk (Wallace et al. 2011). This factor is rated “high” concern based on the Australia listing for green sea turtles.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Queensland South Pacific, Pot

Moderate Concern

According to the Queensland Parks and Wildlife Services (QPWS) stranding and mortality database, out of all turtle species, the green sea turtles have the most interactions with the blue swimmer crab fishery in Queensland due to their high abundance in the fishing area (Hill and Garland 2009). Green sea turtles are at risk of mortality by entanglement in float lines or direct capture in crab pots (Hill and Garland 2009). They are also at risk of capture in various other fisheries. A recent global study that looked at the risks and threats to marine sea turtle populations indicates that the green sea turtle population in the Southwest Pacific off the Australia coast is at low risk but faces high threats (Wallace et al. 2011).

In 2009, an ecological risk assessment of the Queensland blue swimmer crab investigated the impacts on green sea turtles and concluded that the fishery poses a moderate threat to green sea turtles. The assessment indicated that in most areas where fishing occurs, mortalities of green sea turtles are expected to be low, but in areas with high fishing effort, impacts to green sea turtles may be more severe. There is also the potential for green sea turtle entanglements to occur in pot gear that is lost at

sea; this is known as “ghost fishing” (Hill and Garland 2009). To help reduce interactions with sea turtles, some crab fishers are now using modified, protected-species–friendly gear. Managers have created a “responsible crabbing” brochure and it is expected that the number of fishers using protected-species–friendly gear will continue to increase (Queensland Government 2011). There was only one reported interaction with a green sea turtle during the 2013 fishing season (Queensland Government 2014h), but it is unclear how well interactions are monitored since there is no scientific observer program for this fishery. This factor is scored a “moderate” concern based on the 2009 ecological risk assessment.

ROUGH ROCK CRAB

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Low

Rough rock crab (*Nectocarcinus integrifrons*) is a carnivorous crustacean that can grow to a carapace width of 8 cm (3.1 in) (Taylor and Poore 2011). There is little biological information available for the rough rock crab in South Australia. It was assumed that the rough rock crab has similar life-history characteristics to the blue swimmer crab, so it was given an inherent vulnerability to fishing score of “low.”

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Moderate Concern

Little information on the rough rock crab is available and their abundance is unknown. Rough rock crab is not listed on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN 2013) (Taylor and Poore 2011). Because their abundance is unknown and they are assumed to have a “low” vulnerability to fishing, this is scored as “moderate” concern.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Low Concern

There is no directed fishery for rough rock crabs in South Australia. According to fishery independent surveys, rough rock crabs are the most abundant bycatch species in the South Australia blue swimmer crab pot fishery (Svane and Hooper 2004). It is legal for blue swimmer crab license holders to retain rough rock crabs; however, they are not retained because they have little to no market value. Most rough rock crabs are likely returned to the water alive and unharmed (PIRSA Fisheries 2009). The blue crab fishery is considered to have a low, but not negligible, impact on rough rock crab populations (PIRSA Fisheries 2009), so this factor is scored “low” concern.

SEA SNAKES (UNSPECIFIED)

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Western Australia Shark Bay, Trawl, Bottom

High

Sea snakes are generally long-lived, slow growing, and produce few offspring. They give birth to live young (Department of the Environment 2015b) (Department of the Environment 2015c) (Department of the Environment 2015d) (Department of the Environment 2015a). Sea snakes are considered to have a “high” vulnerability to fishing.

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Western Australia Shark Bay, Trawl, Bottom

High Concern

It is unclear which species of sea snakes are caught in the Shark Bay prawn trawl fishery. Some examples of sea snakes that occur in this region include the short-nosed sea snake (*Aipysurus apraefrontalis*), Shark Bay sea snake (*Aipysurus pooleorum*), elegant sea snake (*Hydrophis elegans*), and olive-headed

sea snake (*Disteira major*). The short-nosed sea snake is listed as critically endangered under Australia’s Environmental Protection and Biodiversity Conservation Act and under Western Australia’s Wildlife Conservation Act (Department of the Environment 2015a). It is also listed as Critically Endangered by the International Union for the Conservation of Nature (IUCN) (Lukoschek et al. 2010). However, this species mostly associates with coral reefs and is not believed to be commonly caught as bycatch in trawl fisheries (Department of the Environment 2015a) (Lukoschek et al. 2010). No other sea snake species found in this region are listed as endangered, but they are listed as protected marine species under Australia’s Environmental Protection and Biodiversity Conservation Act (Department of the Environment 2015b) (Department of the Environment 2015c) (Department of the Environment 2015d) (Department of the Environment 2015e). Since sea snakes are protected species in Australia and highly vulnerable to fishing, this factor is rated “high” concern.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Australia Shark Bay, Trawl, Bottom

Moderate Concern

Sea snakes are regularly caught in the Shark Bay prawn trawl fishery, but most are returned to the sea alive (90%). In 2013, 363 sea snakes were reported as caught with 351 released alive (Fletcher and Santoro 2014). However, it is unknown if there is additional post-release mortality of sea snakes. The specific species of sea snakes that are caught are not reported. Unfortunately, there is limited information on sea snake populations within Shark Bay or on the impact of the fishery on these populations. Bycatch reduction devices have not effectively reduced the capture of sea snakes in this fishery, though they may be helping to increase the survival of sea snakes by reducing the weight of the total catch in the net. Identifying the specific species of sea snakes that are caught in the fishery and assessing the impact of the fishery on their populations has been identified as priorities in the Shark Bay Prawn Fishery Bycatch Action Plan for 2014–2019 (Department of Fisheries WA 2014c). Since the fishery’s impact on sea snakes is currently uncertain, this factor is rated “moderate” concern.

SEA TURTLE (UNSPECIFIED)

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Western Australia Shark Bay, Trawl, Bottom

High

Sea turtles are long-lived and do not reproduce until late in life. Sea turtles are considered to have “high” inherent vulnerability to fishing.

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Western Australia Shark Bay, Trawl, Bottom

Very High Concern

The specific species of sea turtle that are caught in the Shark Bay prawn trawl fishery are not reported. Sea turtle species that occur in this area include the leatherback, loggerhead, green, hawksbill, and flatback. The leatherback turtle is listed as endangered under Australia’s Environmental Protection and Biodiversity Conservation Act, and vulnerable under Western Australia’s Wildlife Conservation Act (Department of the Environment 2015h). The loggerhead turtle is listed as endangered under both Australia’s Environmental Protection and Biodiversity Conservation Act and Western Australia’s Wildlife Conservation Act (Department of the Environment 2015g). The other sea turtle species are listed as vulnerable (Department of the Environment 2015f) (Department of the Environment 2015i) (Department of the Environment 2015j). This factor is rated “very high” concern since some sea turtles are listed as endangered.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Australia Shark Bay, Trawl, Bottom

Moderate Concern

The implementation of bycatch reduction devices in the Shark Bay prawn trawl fishery since 2002 is believed to have greatly reduced the capture of sea turtles in the nets. Studies have indicated that the reduction devices reduce sea turtle captures by 95%–100% (Department of Fisheries WA 2014c). In 2012, six sea turtles were reported caught in the nets and were released alive. In 2013, 36 sea turtles were reported caught in the nets, and 35 were released alive (Fletcher and Santoro 2014). The specific species of sea turtles caught are not reported. There is currently no scientific observer program to verify the accuracy of these fisher-reported sea turtle catches, but this has been proposed as part of the new bycatch action plan (Department of Fisheries WA 2014c). Since management measures have been implemented to reduce the capture of sea turtles in the trawl nets, but the fishery’s impact on sea turtles remains somewhat uncertain due to limited monitoring, this factor is rated a “moderate” concern.

SPIDER CRAB

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Low

Spider crabs (*Leptomithrax gaimardii*) can grow to a carapace width of 16.5 cm (6.5 in) (Griffin 1963). There is little biological information available for the spider crab in South Australia. It was assumed that the spider crab has similar life-history characteristics to the blue swimmer crab, so it was given an inherent vulnerability to fishing score of “low.”

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Moderate Concern

There is no information on the abundance of spider crabs in South Australia and they are not listed on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN 2013). Since abundance is unknown and the species has a low inherent vulnerability to fishing, this factor was rated “moderate” concern.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Low Concern

There is no directed fishery for spider crabs in South Australia. According to fishery-independent surveys, spider crabs are the second-most abundant bycatch species in the South Australia blue swimmer crab pot fishery (Svane and Hooper 2004). It is legal for blue swimmer crab license holders to retain spider crabs; however, they are not retained because they have little to no market value.

Most spider crabs are likely returned to the water alive and unharmed (PIRSA Fisheries 2009). The blue swimmer crab fishery is considered to have a low, but not negligible, impact on spider crabs (PIRSA Fisheries 2009), so this factor is rated “low” concern.

ALL SPECIES

Factor 2.4 – Modifying Factor: Discards and Bait Use

Scoring Guidelines

The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

Ratio of bait + discards/landings	Factor 2.4 score
<20%	1
20-40%	0.95
40-60%	0.9
60-80%	0.85
80-100%	0.8
>100%	0.75

New South Wales South Pacific, Pot

40-60%

During the 2002/2003 season, it was estimated that 385,988 blue swimmer crabs were retained, 183,653 blue swimmer crabs were discarded, and 5,686 of other species were discarded in the Wallis Lake crab pot fishery. Discarded species were reported to be in good condition when returned to the wild (Johnson 2007). If we conservatively assume that 50% of all discarded species suffer mortalities, the dead discard to retained catch ratio is 25%. As well, blue swimmer crab pots are baited with fish. The amount of bait used in this fishery is not reported, so to account for bait use, we have increased the discard plus bait score to 40-60%.

Queensland South Pacific, Pot

20-40%

According to the 2003 blue swimmer crab assessment, the proportion of the blue swimmer crab catch

that is discarded is usually less than 50% (Sumpton et al 2003). The mesh size of the pots and the location where they are used makes catching juvenile blue swimmer crabs uncommon. In addition, experiments suggest that the mortality rate of discarded crabs is less than 2% due to the efficient sorting practices used by Queensland crabbers (Sumpton et al. 2003). Bycatch of other species is also reported to be low relative to the targeted catch. Given the high survival rate of discarded blue swimmer crabs and low bycatch of other species, dead discards in the fishery are likely <20% of the retained catch. However, bait is also collected and used in this fishery. The amount of bait used in the fishery is not reported (Hill and Garland 2009). To account for bait use, the discard plus bait score is increased to 20%–40%.

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

20-40%

According to the 2009 risk assessment completed on the blue swimmer crab fishery in South Australia, the level of discarding in the fishery is quite low and most bycatch captured in crab pots is released alive (PIRSA Fisheries 2009). Bycatch in the fishery is recorded during fishery-independent surveys of the blue swimmer crab population. The most common bycatch species is rock crabs. They account for around 80% of the total bycatch. Total bycatch in this region is estimated to be around 200,000 individuals per year, which is low compared to the total blue swimmer crab catch (Currie and Hooper 2006).

Fishers do use fish to bait their pots. It is reported that they get most of their bait from the Marine Scalefish fishery, but the amount of bait used is not reported (PIRSA Fisheries 2009). Although dead discards in the fishery are likely low (<20% of the retained catch), the discard plus bait score is increased to 20%–40% to account for bait use in this fishery.

Western Australia Cockburn Sound, Pot

Western Australia Peel-Harvey Estuary, Pot

Western Australia Shark Bay, Pot

20-40%

There is very little bycatch in Western Australia's blue swimmer crab pot fisheries. The pots are designed to minimize the capture of non-target species and most fish are able to escape through the entrance gaps. Only small numbers of fish are captured in the pots, and this infrequent capture is considered to have a negligible effect on their population status and the overall ecosystem. Also, any undersized crabs caught are typically placed back in the water alive (Fletcher and Santoro 2014). We therefore assume that the dead discard to retained catch/landing ratio is likely less than 20 percent. However, blue swimmer crab pots are baited with fish. The amount of bait used is not reported. To account for bait

use, we have increased the discards plus bait score to 20-40%.

Western Australia Shark Bay, Trawl, Bottom

> 100%

The bycatch taken by the Shark Bay prawn fishery that catches blue swimmer crab is considered moderate compared to other subtropical trawl fisheries. However, the bycatch is still estimated to be four to eight times that of the prawn catch. The bycatch consists of dead wire weed, small fish, small blue swimmer crabs, and other crustaceans (Fletcher and Santoro 2014). The discard to retained catch/landing ratio is considered greater than 100% for this fishery.

Criterion 3: Management effectiveness

Management is separated into management of retained species (harvest strategy) and management of non-retained species (bycatch strategy).

The final score for this criterion is the geometric mean of the two scores. The Criterion 3 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and <=3.2=Yellow or Moderate Concern*
- *Score <=2.2 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern*
Rating is Critical if either or both of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) ratings are Critical.

Criterion 3 Summary

Region / Method	Factor 3.1 Harvest Strategy	Factor 3.1 Bycatch Strategy	Criteria 3 Score
New South Wales South Pacific Pot	3.00: Moderate Concern	4.00: Low Concern	Green(3.464)
Queensland South Pacific Pot	3.00: Moderate Concern	3.00: Moderate Concern	Yellow(3.000)
South Australia Gulf St Vincent Pot	3.00: Moderate Concern	5.00: Very Low Concern	Green(3.873)
South Australia Spencer Gulf Pot	4.00: Low Concern	5.00: Very Low Concern	Green(4.472)
Western Australia Cockburn Sound Pot	3.00: Moderate Concern	5.00: Very Low Concern	Green(3.873)
Western Australia Peel-Harvey Estuary Pot	3.00: Moderate Concern	5.00: Very Low Concern	Green(3.873)
Western Australia Shark Bay Pot	3.00: Moderate Concern	5.00: Very Low Concern	Green(3.873)
Western Australia Shark Bay Trawl, Bottom	3.00: Moderate Concern	3.00: Moderate Concern	Yellow(3.000)

Factor 3.1: Harvest Strategy

Scoring Guidelines

Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations,

Management Track Record, and Inclusion of Stakeholders. Each is rated as ‘ineffective,’ ‘moderately effective,’ or ‘highly effective.’

- 5 (Very Low Concern)—Rated as ‘highly effective’ for all seven subfactors considered.
- 4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated ‘highly effective’ and all other subfactors rated at least ‘moderately effective.’
- 3 (Moderate Concern)—All subfactors rated at least ‘moderately effective.’
- 2 (High Concern)—At minimum, meets standards for ‘moderately effective’ for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated ‘ineffective.’
- 1 (Very High Concern)—Management exists, but Management Strategy and/or Recovery of Species of Concern rated ‘ineffective.’
- 0 (Critical)—No management exists when there is a clear need for management (i.e., fishery catches threatened, endangered, or high concern species), OR there is a high level of illegal, unregulated, and unreported fishing occurring.

Factor 3.1 Summary

Factor 3.1: Harvest Strategy							
Region / Method	Management Strategy and Impl.	Recovery of Species of Concern	Scientific Research & Monitoring	Record of Following Scientific Advice	Enforcement of Regs.	Track Record	Stakeholder Inclusion
New South Wales South Pacific Pot	Moderately Effective	N/A	Moderately Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective
Queensland South Pacific Pot	Moderately Effective	N/A	Moderately Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective
South Australia Gulf St Vincent Pot	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective
South Australia Spencer Gulf Pot	Highly Effective	N/A	Highly Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective
Western Australia Cockburn Sound Pot	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Moderately Effective	Moderately Effective
Western Australia Peel-Harvey Estuary Pot	Moderately Effective	N/A	Moderately Effective	Highly Effective	Highly Effective	Moderately Effective	Moderately Effective
Western Australia Shark Bay Pot	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Moderately Effective	Moderately Effective
Western Australia Shark Bay Trawl, Bottom	Highly Effective	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Moderately Effective	Moderately Effective

Factor 3.1 Assessment

Subfactor 3.1.1 – Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? To achieve a highly effective rating, there must be appropriate management goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.

New South Wales South Pacific, Pot

Moderately Effective

The commercial blue swimmer crab fishery in New South Wales is managed as part of the Estuary General Fishery by the New South Wales Department of Primary Industries Fishing and Aquaculture. Management strategies that are used to help the long-term sustainability of the Estuary General Fishery include a limit on the number of fishers authorized to operate in the fishery, temporal and spatial closures, gear restrictions, and minimum size limits (NSW DPI 2014b). The current size limit for blue swimmer crabs in this fishery is a carapace width of 6 cm (2.4 in), which is above the size at which 50% of blue swimmer crabs reach sexual maturity in this area (NSW I&I 2010). Therefore this size limit should ensure that most crabs are able to spawn or reproduce before being caught. Unfortunately, there is only limited research and monitoring of the blue swimmer crab population in New South Wales, and no target abundance or fishing level goals have been determined. As a result, it remains unclear whether the current management strategy in place is sustaining the blue swimmer crab population (NSW I&I 2010) (Johnston et al. 2012).

The management system for commercial fishing in New South Wales is currently being reformed. As part of this reform, there will be some changes to the management of the Estuary General Fishery. The new system will give each fisher a set share of the available fishing resource, by regulating either the amount they are allowed to catch, the amount of gear they can use, or the number of days they are allowed to fish (NSW DPI 2014a). These changes are just starting to be implemented, so it remains to be seen if they will improve the sustainability of the blue swimmer crab resource. Also, to ensure the sustainability of blue swimmer crab, conservation goals and further monitoring of the population are needed. For these reasons, this factor is deemed “moderately effective.”

Queensland South Pacific, Pot

Moderately Effective

The Queensland blue swimmer crab fishery is managed by Fisheries Queensland under the Queensland Fisheries Act 1994 and in accordance with the Queensland Fisheries Regulation 2008 (Queensland Government 2011). Management strategies include a minimum size limit, a prohibition on taking female

crabs, numerous spatial closures, restrictions on the number of pots that can be fished, and a limit on the number of available licenses. The current management strategies should protect a large proportion of the blue swimmer crab population from fishing (Queensland Government 2013b) (Queensland Government 2011). However, there is evidence that the population has declined in recent years, following a period of fishery expansion (Johnston et al. 2014a). Abundance conservation goals and target fishing levels have not been determined for this population. The Queensland Government is undertaking a wide review of their current fisheries management system to determine how it can be improved (Queensland Government 2014i). Management strategy is deemed “moderately effective.”

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Highly Effective

Primary Industries and Regions South Australia (PIRSA) Fisheries and Aquaculture follows the Fisheries Management Act 2007 in order to manage South Australia’s fisheries. PIRSA is viewed as a national leader in fisheries management (PIRSA Fisheries 2013b). Management measures for the South Australia Gulf St. Vincent and Spencer Gulf blue swimmer crab fisheries include total allowable commercial catch limits (which are divided and allocated among individual fishers), daily catch limits for recreational fishers, seasonal closures, a minimum size limit, and a prohibition from taking egg-bearing females (PIRSA Fisheries 2012) (Dixon et al. 2013). The goals of the harvest strategy for the blue swimmer crab fishery in South Australia are to implement a precautionary approach to managing the fishery and set the catch limit at a level that ensures the sustainability of the population. Specific abundance goals/reference levels are outlined in the management plan. The abundance goals were set based on the observed blue swimmer crab abundance during the reference period 2002–2010, when the population was considered sustainable. If abundance drops below the limit reference level, this triggers a review of the catch limits for the fishery (PIRSA Fisheries 2012) (Dixon et al. 2013). Since successful management strategies are in place in South Australia, this factor is deemed “highly effective.”

Western Australia Cockburn Sound, Pot

Western Australia Peel-Harvey Estuary, Pot

Western Australia Shark Bay, Pot

Moderately Effective

In Western Australia, fisheries are managed by the Government of Western Australia’s Department of Fisheries. In unison with commercial and recreational fishing effort restrictions, the main management measure for the blue swimmer crab fisheries to ensure adequate abundance is a minimum size limit that is well above the size at which blue swimmer crabs reach sexual maturity. This ensures that blue swimmer crabs are able to spawn at least once before they are caught. Fishing effort regulations include limits on the number of fishing vessels and pots in the fishery, seasonal closures, area closures, gear restrictions, and daily bag/catch limits for recreational fishers (Department of Fisheries WA 2011). Additionally, for the Shark Bay fishery, a total allowable catch limit was recently established, and

allocations were made to the pot and trawl sectors. A management plan is currently in development for this fishery and it will be transitioning to an individual transferable quota system, in which each fisher will be allotted a certain amount of the blue swimmer crab catch limit (Johnston et al. 2014a). Abundance conservation goals/reference levels have been established for each of the three blue swimmer crab management units (Shark Bay, Cockburn Sound, and Peel-Harvey Estuary) and harvest control rules have been developed or are in development to ensure that the blue swimmer crabs are maintained at target levels (Johnston et al. 2014b) (Department of Fisheries WA 2014a) (Johnston et al. 2011). Managers have a history of closing fisheries when abundance falls below the reference level (Fletcher and Santoro 2014).

Although several management strategies are in place, two of the three Western Australia blue swimmer crab populations are currently at low abundance. It is expected that some of the new management initiatives mentioned above will help to improve the sustainability of the fisheries, but up to this point, management is considered to have been only “moderately effective” at achieving sustainability goals.

Western Australia Shark Bay, Trawl, Bottom

Highly Effective

In Western Australia, fisheries are managed by the Government of Western Australia’s Department of Fisheries. Some blue swimmer crabs are taken in the Shark Bay prawn trawl fishery. A robust management plan/harvest strategy has been developed for the Shark Bay prawn trawl fishery, which defines abundance targets or performance indicators for prawns, blue swimmer crabs, and other retained species (Department of Fisheries WA 2014b). Management measures for this fishery include limits on the number of fishery participants, gear restrictions, and various seasonal and area closures that protect nursery areas and breeding areas for prawns. The fishery is monitored in-season to determine when to open and close certain areas, so that the breeding populations of all prawn species are maintained at adequate levels (Fletcher and Santoro 2014). For blue swimmer crabs, a minimum size limit is in place to ensure that blue swimmer crabs are able to spawn at least once before they are caught, and a catch limit was also recently established (Johnston et al. 2014a). The management strategy is deemed “highly effective.”

Subfactor 3.1.2 – Recovery of Species of Concern

Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/ endangered species or to limit fishery’s impact on these species and what is their likelihood of success? To achieve a rating of Highly Effective, rebuilding strategies that have a high likelihood of success in an appropriate timeframe must be in place

when needed, as well as measures to minimize mortality for any overfished/threatened/endangered species.

New South Wales South Pacific, Pot

N/A

In New South Wales, there are currently no overfished, depleted, endangered, or threatened species targeted or retained in the blue swimmer crab fishery. Therefore, this factor is rated N/A.

Queensland South Pacific, Pot

N/A

In Queensland, there are currently no overfished, depleted, endangered, or threatened species targeted or retained in the blue swimmer crab pot fishery. Therefore, this factor is rated N/A.

South Australia Gulf St Vincent, Pot

Moderately Effective

The 2013 assessment of blue swimmer crab in the Gulf St. Vincent indicated that the population was overfished/depleted (Dixon et al. 2013). This triggered a review of the current catch limits for the fishery. To help the population rebuild, managers decided to reduce the commercial catch limit by 20% and the daily allowed recreational catch by 50% for the 2013–2014 season. Fishers also proposed a closure to fishing in this area from July 2013 to January 2014 to provide protection for spawning crabs and young blue swimmer crabs, to further help the population recover (PIRSA Fisheries 2013d). The effect of these measures on promoting recovery of the population will not be fully known until the 2015 assessment of the blue swimmer crab is completed. However, there is evidence of an increase in the abundance of young or pre-recruit blue swimmer crabs (Noell et al. 2014). The reduced commercial and recreational catch restrictions for blue swimmer crab remain in effect for the 2014–2015 fishing season and it is believed that the current level of fishing will promote continued recovery (Johnston et al. 2014a). This factor is awarded a “moderately effective” score.

South Australia Spencer Gulf, Pot

N/A

In the South Australia Spencer Gulf blue swimmer crab fishery, there are currently no overfished, depleted, endangered, or threatened species that are targeted or retained. Therefore, this factor is

rated N/A.

Western Australia Cockburn Sound, Pot

Moderately Effective

Abundance of blue swimmer crabs in Cockburn Sound has fluctuated and is currently at a low level. The Cockburn Sound fishery was closed from 2006–2009 due to low blue swimmer crab abundance. The fishery was re-opened in 2010, after research surveys indicated that the population had increased enough to support some commercial fishing again. In 2010, the fishing season was limited to 3.5 months while in 2011 and 2012 the season was limited to 6 months. However, in 2013, scientists found that the population was once again at a low level, and the fishery was closed early for the 2013–2014 season. The population has been classified as “environmentally limited,” since it is believed that the latest population decline is the result of environmental changes rather than overfishing (Johnston et al. 2014a). An acceptable target catch level for this fishery is currently under review (Department of Fisheries WA 2014a). Because managers have taken appropriate actions to limit fishing on this population, but it has not yet recovered, this factor is rated “moderately effective.”

Western Australia Peel-Harvey Estuary, Pot

N/A

There are currently no overfished, depleted, endangered, or threatened species that are targeted or retained in this fishery. Therefore, this factor is rated N/A.

Western Australia Shark Bay, Pot

Western Australia Shark Bay, Trawl, Bottom

Moderately Effective

In 2011, the blue swimmer crab population in Shark Bay was found to be at a low abundance. The population has been classified as “environmentally limited” because the rapid decline of the population is believed to be a result of environmental changes rather than overfishing. However, scientists did observe declining catch rates and declines in the size of crabs caught, which could be suggestive of high exploitation (Harris et al. 2014).

To allow the Shark Bay population to recover, managers negotiated a voluntary fishing closure with blue swimmer crab pot fishers from April 2012 to September 2013, as well as a voluntary non-retention of blue swimmer crabs in the Shark Bay prawn trawl fishery (Fletcher and Santoro 2014). For the 2013–2014 season limited commercial fishing was allowed. A catch limit of 400 MT was set, with 66% allocated to the trap fishery and 34% to the prawn trawl fishery. Scientists have been conducting research surveys in this area to monitor the recovery of the population. A partial recovery of the blue

swimmer crab population was observed in 2012 and 2013, and it is believed that current fishing levels will allow for continued recovery (Johnston et al. 2014a). A management plan/harvest strategy for this fishery is in development. Therefore this factor is rated “moderate concern.”

Subfactor 3.1.3 – Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery’s impact on the species? To achieve a Highly Effective rating, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.

New South Wales South Pacific, Pot

Moderately Effective

Little data on the blue swimmer crab fishery is being collected and analyzed in New South Wales. Commercial fishery catch and effort data are collected and catch rate data are used to provide an index of blue swimmer crab abundance. Also, some of the commercial catches are sampled to monitor crab size (NSW II 2010). The available information is insufficient to determine the status of the New South Wales blue swimmer crab population (Johnston et al. 2012). Therefore, this factor is deemed “moderately effective.”

Queensland South Pacific, Pot

Moderately Effective

In the Queensland blue swimmer crab fishery, catch and fishing effort data are collected. Catch rate data are used to provide an index of blue swimmer crab abundance and assess the status of the population. However, the reliability of this data is not great. A scientific survey to better monitor blue swimmer crab abundance began in 2006, but data from this survey have not yet been analyzed (Queensland Government 2011). However, a formal population assessment is in progress to better determine the abundance of blue swimmer crab (Johnston et al. 2014a). This factor is rated “moderately effective.”

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Highly Effective

To monitor and estimate the abundance of the blue swimmer crab in South Australia, scientists conduct fishery-independent surveys of young or pre-recruit crabs and legal size crabs. They also monitor catch

rates (amount of crabs caught per unit of fishing effort) in the commercial fishery. This data is used in annual population assessments of blue swimmer crab, and the fishery is assessed against performance/conservation goals identified in the management plan. This information is then used to make management decisions and determine the total allowable commercial catch limit (TACC) (PIRSA Fisheries 2013a) (Noell et al. 2014). Therefore, this factor is deemed “highly effective.”

Western Australia Cockburn Sound, Pot

Western Australia Peel-Harvey Estuary, Pot

Western Australia Shark Bay, Pot

Moderately Effective

Western Australia uses various scientific data to monitor the populations of blue swimmer crabs. For most populations, catch rates from the commercial fishery (amount of crabs caught per unit of fishing effort) are the primary data used to monitor abundance. These data come from catch and effort reports from fishermen and onboard catch monitoring by scientists. In addition, scientific research surveys of the blue swimmer crab population in Cockburn Sound have been conducted for 10 years, and these data are used in the population assessment to provide a more reliable estimate of abundance (Fletcher and Santoro 2014). Scientific research surveys to monitor blue swimmer crab abundance have also been conducted for 5 years in Peel-Harvey Estuary, and were recently initiated in Shark Bay to monitor the recovery of this population. But because these efforts are new, there is not yet a reliable time-series of abundance estimates. Several research projects have also been conducted to learn more about the biology of blue swimmer crabs and their population dynamics (Department of Fisheries WA 2013d). Since, in most areas, fishery data are currently the main source of information used to assess blue swimmer crab abundance, this factor is rated “moderately effective.”

Western Australia Shark Bay, Trawl, Bottom

Moderately Effective

Western Australia uses various scientific data to monitor the populations of prawns and blue swimmer crabs in Shark Bay. Catch rate data from the commercial fishery (amount of prawns/crabs caught per unit of fishing effort) are used to provide an index of abundance. For the main prawn species caught in the fishery (king and tiger), scientific research surveys are also conducted to monitor abundance and are used to complement the fishery data (Fletcher and Santoro 2014). For the Shark Bay blue swimmer crab population, a 3-year scientific research project was initiated in 2012 to help better understand this population, and research surveys are now being used to monitor the recovery of the population (Department of Fisheries WA 2013d). For other retained species in the Shark Bay prawn trawl fishery, catches are closely monitored (Department of Fisheries WA 2014b). This factor is rated “moderately effective.”

Subfactor 3.1.4 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g. do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

New South Wales South Pacific, Pot

Highly Effective

There appears to be little scientific advice given that is specific to the management of blue swimmer crabs. However, the New South Wales (NSW) Department of Primary Industries (DPI) does consult various scientific advisory committees when developing new commercial fisheries policies and management plans (NSW DPI 2013a). In 2012 an independent review team completed a review of the New South Wales fishery management system and made several recommendations for improving the decision-making process, stakeholder involvement, and the allocation of fishing shares. The government has agreed to make the majority of the recommended changes. Several changes have already been implemented and others are underway (NSW DPI 2014a). Therefore this factor is rated “highly effective.”

Queensland South Pacific, Pot

Highly Effective

In the 2003 blue swimmer crab assessment in Queensland, recommendations on reducing the minimum legal size, changing the method of measuring the minimum size, and modifications to gear were given (Sumpton et al. 2003). Management listened to this advice and changed the minimum size from a 15 cm (5.9 in) carapace width to 11.5 cm (4.5 in) notch to notch. Managers also followed the recommendation to develop a responsible crabbing code of conduct that outlines gear modifications to reduce impacts on other species and the ecosystem (Queensland Government 2011). In addition, a Crab Review Working Group, which includes fisheries managers and researchers, was formed in 2011 to consider management options, participate in discussions regarding the future of the blue swimmer crab fishery, and to provide relevant advice to Fisheries Queensland (Queensland Government 2011). Therefore, this factor is deemed “highly effective.”

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Highly Effective

The current management plan for the South Australia blue swimmer crab fisheries was established in 2012 and followed the most up-to-date scientific advice at that time. The harvest strategy is designed to implement a precautionary approach to managing the fishery and to set the total allowable commercial

catch limit (TACC) at a level that promotes ecological sustainability (PIRSA Fisheries 2012). The current management plan allows for a decrease in the catch limit if evidence is provided that it is not sustainable (PIRSA Fisheries 2012). Recently, it was shown that the Gulf St. Vincent blue swimmer crab population was being depleted, so managers reviewed and decreased the catch limit to promote recovery. Since managers appear to nearly always base management decisions on scientific advice, this factor is deemed “highly effective.”

Western Australia Cockburn Sound, Pot

Western Australia Peel-Harvey Estuary, Pot

Western Australia Shark Bay, Pot

Western Australia Shark Bay, Trawl, Bottom

Highly Effective

In Western Australia, managers seem to always make management decisions and determine harvest strategies based on the most up-to-date scientific data available (Department of Fisheries WA 2013d) (Fletcher and Santoro 2014). They have also adjusted management strategies based on scientific advice. For instance, a recent evaluation of the Shark Bay crab fishery indicated that the current strategy was not sufficient to sustainably manage the fishery and that management arrangements that would allocate a share of the catch among fishers would be useful. Managers listened to this advice and the fishery is now transitioning to an individual quota system (Harris et al. 2014). This factor is deemed “highly effective.”

Subfactor 3.1.5 – Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

New South Wales South Pacific, Pot

Highly Effective

Fisheries compliance managers from the New South Wales (NSW) Department of Primary Industries (DPI) help develop strategies to combat illegal, unregulated, and unreported fishing (IUU). NSW managers also contribute to the Australian Fisheries Law Enforcement Conference and the National Fisheries Compliance Committee (NFCC). The Australian Fisheries National Compliance Strategy 2010–2015, which emerged from the NFCC, outlines the objectives that Australian fisheries agencies will pursue to promote voluntary compliance and to deter illegal fishing activity. The strategy also includes key elements such as education, advisory and extension programs, and prosecution of offenders where appropriate (NSW DPI 2013b). In NSW, commercial fishers are required to report logbooks of their catch and effort that must be submitted within 28 days of the end of each calendar month (NSW DPI 2013c).

During the 2012–2013 fishing year, NSW fisheries officers exercised their power more than 49,000 different times. A total of 6,284 offenses were committed by commercial and recreational fishers, and over 52,000 fish and invertebrates were seized due to non-compliance. Also, over 3,100 items of fishing gear/equipment were seized, including 770 crab traps (NSW DPI 2013d). Since there is regular enforcement of regulations, this factor is deemed “highly effective.”

Queensland South Pacific, Pot

Highly Effective

In Queensland, all commercial fishers are required to complete daily logbooks detailing their catch and effort (Queensland Government 2013c). In addition, it is required for licensed fishing vessels in certain fisheries to use a vessel monitoring system (VMS) (Queensland Government 2014a). The Queensland Boating and Fisheries Patrol (QBFP) is charged with enforcing Queensland’s fisheries and boating safety laws, providing educational outlets, and monitoring surveillance (Queensland Government 2013c). During 2013, they inspected 1,206 units (118 commercial fishing vessels; the rest were recreational and charter boats) in the Queensland blue swimmer crab fishery and a total of 69 offenses were detected. The compliance rate for the commercial fishery was 92%. In addition, 883 incorrectly marked crab pots were seized from tidal waters in 2013 (Queensland Government 2014h). The Queensland government provides a Fishwatch hotline, which the public may report illegal fishing activity to (Queensland Government 2014c). Because regulations are regularly enforced, this factor is deemed “highly effective.”

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Highly Effective

South Australia has appropriate enforcement and compliance checks in place to ensure that goals of the blue swimmer crab fishery are met. Every year a report is prepared that assesses the compliance status of the blue swimmer crab fishery. This report gives an overview of the previous year’s compliance activities, describes how voluntary compliance and effective deterrence were achieved, analyzes the compliance status, and makes suggestions for the future. Quarterly reports are also provided to the industry to capture any emerging compliance trends (PIRSA Fisheries 2012). Vessel monitoring systems are used in various fisheries and are being tested in the blue swimmer crab fishery (PIRSA Fisheries 2013b). In addition, a demerit point system was introduced in 2009 as a deterrent to fisheries offenses. Under this system, if a person commits an offense, they receive a certain number of demerit points (depending on the degree of the offense). If a person accrues 200 points in 5 years, a penalty is given, such as losing a fishing permit (PIRSA Fisheries 2013c). South Australia has also initiated a 24-hour fishwatch service that the public can report illegal fishing activities to (PIRSA Fisheries 2013e). Therefore, this factor is deemed “highly effective.”

Western Australia Cockburn Sound, Pot
 Western Australia Peel-Harvey Estuary, Pot
 Western Australia Shark Bay, Pot
 Western Australia Shark Bay, Trawl, Bottom

Highly Effective

Several enforcement measures in Western Australia are in place in order to ensure that management goals are successfully met. In accordance with the Fish Resources Management Act 1994 and the PEARLING Act 1990, the Department of Fisheries is responsible for covering statewide fisheries compliance and community education (Department of Fisheries WA 2013e). At-sea and aerial patrols are used to ensure that closed seasons, closed areas, and other regulations are being followed. Vessel monitoring systems are also used in many commercial fisheries in Western Australia to allow officers to monitor vessel locations and adherence to fishing closures (Fletcher and Santoro 2014). Therefore, this factor is deemed “highly effective.”

Subfactor 3.1.6 – Management Track Record

Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels? A Highly Effective rating is given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.

New South Wales South Pacific, Pot

Moderately Effective

Management measures, such as size limits and area closures, are in place for the New South Wales blue swimmer crab fishery. However, little information is collected to evaluate the status of the blue swimmer crab population, so it is uncertain if these management measures have been effective at sustaining blue swimmer crab (Johnston et al. 2012). A reform of New South Wales commercial fishery management is underway, which will result in several changes to the current management system for the Estuary General Fishery that blue swimmer crabs are caught in. Under the new system, shares of the available fishing resource will be allocated among fishers (NSW DPI 2014a). It remains to be seen if these changes will improve the sustainability of the blue swimmer crab resource. This factor is rated “moderately effective.”

Queensland South Pacific, Pot

Moderately Effective

Several management measures are in place to ensure the protection of a large proportion of the Queensland blue swimmer crab population. But in recent years there has been concern about the sustainability of the blue swimmer crab because of observed declines in catches and catch rates (Holmes et al. 2013). It is believed that these declines are likely a result of environmental factors rather than fishing, but no data are available to quantify the impact of environmental factors on blue swimmer crab mortality in recent years (Johnston et al. 2014a). Due to the current concerns regarding the sustainability of this blue swimmer crab population, the management track record is rated “moderately effective.”

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Moderately Effective

The current management plan for South Australia’s blue swimmer crab fisheries was implemented in January 2012. Management measures include a minimum size limit, prohibition on taking egg-bearing females, area closures, and total allowable commercial catch (TACC) limits. The management plan also defines abundance conservation goals and stipulations for reviewing catch limits if abundance drops below the limit abundance level. While the current management system is sustaining the blue swimmer crab population in Spencer Gulf, it was recently determined that the blue swimmer crab population in the Gulf St. Vincent is at a low abundance (Johnston et al. 2012) (Dixon et al. 2013). To allow the Gulf St. Vincent population to recover, managers reduced the allowed catches of blue swimmer crab in both the commercial and recreational fisheries (PIRSA Fisheries 2013d). The effect of these measures on promoting recovery of the population will not be fully known until the 2015 assessment of the blue swimmer crab is completed, but there is some evidence that recovery is occurring (Noell et al. 2014). Because the management track record for South Australia’s blue swimmer crab fisheries is mixed and uncertain, this factor is given a “moderately effective” rating.

Western Australia Cockburn Sound, Pot

Western Australia Peel-Harvey Estuary, Pot

Western Australia Shark Bay, Pot

Western Australia Shark Bay, Trawl, Bottom

Moderately Effective

Management measures for Western Australia blue crab fisheries include size limits, area and seasonal closures, and gear restrictions (Department of Fisheries WA 2013d). Unfortunately, two of the three blue swimmer crab populations in Western Australia (Shark Bay and Cockburn Sound) are currently depleted. Managers have a history of taking appropriate actions when populations become depleted and of closing fisheries (Johnston et al. 2014a); however, since current management strategies have not always been able to sustain blue swimmer crab populations, the track record is rated “moderately effective.”

Subfactor 3.1.7 – Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent and includes stakeholder input.

New South Wales South Pacific, Pot

Highly Effective

The New South Wales (NSW) Department of Primary Industries consults with various advisory councils, committees, and working groups on the development of regulations and management plans (NSW DPI 2013a). The Ministerial Fisheries Advisory Council (MFAC) provides advice on strategic policy issues, and includes representatives from the commercial, recreational, indigenous, aquaculture, and conservation sectors. The Structural Adjustment Review Committee (SARC) is an independent committee that oversees the commercial fisheries reform program, and various working groups are established to provide advice on specific issues (NSW DPI 2013e). The interests of commercial fishers are represented by a Peak Industry Body (NSW DPI 2013a). In addition, the preparation and assessment of fishery management strategies (including the one established for the estuary general fishery that the blue swimmer crabs are caught in) require stakeholder and public input to ensure compliance with State and Commonwealth legislation (NSW DPI 2013f) (NSW DPI 2014b). Therefore, this factor is deemed “highly effective.”

Queensland South Pacific, Pot

Highly Effective

When a comprehensive review of the blue swimmer crab management arrangements is undertaken, Fisheries Queensland collaborates with other states (particularly New South Wales) on determining the potential for implementing complementary management arrangements for the species (Queensland Government 2011). Other Australian states have the opportunity to comment on the Crab Review during a consultation period (Queensland Government 2013b). Fisheries Queensland also encourages stakeholders to participate in developing new fishing rules to help conserve fisheries habitats and resources. The stakeholders that are consulted include the fishing industry, fisheries management agencies, research scientists, and the general public (Queensland Government 2014b). In 2011, a number of industry meetings were held as part of the blue swimmer crab management review process. This factor is deemed “highly effective.”

South Australia Gulf St Vincent, Pot**South Australia Spencer Gulf, Pot****Highly Effective**

The current blue swimmer crab management plan included the consultation of various stakeholders and was subject to a public review. In 2009, a workshop was conducted with the industry and broader stakeholders to conduct an Ecological Risk Assessment of the fishery in preparation for the management plan (PIRSA Fisheries 2009) (PIRSA Fisheries 2012). In addition, South Australia is currently considering the implementation of a co-management policy, in which responsibilities and obligations for sustainable fisheries management are negotiated, shared, and delegated at appropriate levels between government, industry, and other stakeholders (PIRSA Fisheries 2012). Therefore, this factor is deemed “highly effective.”

Western Australia Cockburn Sound, Pot**Western Australia Peel-Harvey Estuary, Pot****Western Australia Shark Bay, Pot****Western Australia Shark Bay, Trawl, Bottom****Moderately Effective**

The Western Australia Department of Fisheries works closely with the Western Australian Fishing Industry Council (a peak industry body representing commercial fishing) and RecFishWest (a peak industry body representing recreational fishing) when making management decisions. The Western Australia Fishing Industry Council was created by the fishing industry more than 40 years ago to work cooperatively with the Department of Fisheries in identifying annual priorities and to ensure the sustainability of the fisheries. Traditionally, fisheries management consultations have primarily been between government and the commercial and recreational sectors. In recent years, due to public demand, the seafood consumer has also entered the consultation process (WAFIC 2010b) (WAFIC 2010c). The Western Australia Department of Fisheries also works with several research organizations (Department of Fisheries WA 2014d). However, it remains unclear if there is significant stakeholder input outside the industry. Additionally, there is sometimes a lack of transparency. For instance, the most recent Ecological Risk Assessments for the Shark Bay prawn trawl fishery were conducted internally and only a summary of the results has been made publicly available (Department of Fisheries WA 2014c). This factor is considered “moderately effective.”

Factor 3.2: Bycatch Strategy

Scoring Guidelines

Four subfactors are evaluated: Management Strategy and Implementation, Scientific Research and Monitoring, Record of Following Scientific Advice, and Enforcement of Regulations. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.' Unless reason exists to rate Scientific Research and Monitoring, Record of Following Scientific Advice, and Enforcement of Regulations differently, these ratings are the same as in 3.1.

- 5 (Very Low Concern) — Rated as 'highly effective' for all four subfactors considered.
- 4 (Low Concern) — Management Strategy rated 'highly effective' and all other subfactors rated at least 'moderately effective.'
- 3 (Moderate Concern) — All subfactors rates at least 'moderately effective.'
- 2 (High Concern) — At minimum, meets standards for 'moderately effective' for Management Strategy but some other factors rated 'ineffective.'
- 1 (Very High Concern) — Management exists, but Management Strategy rated 'ineffective.'
- 0 (Critical)— No bycatch management even when overfished, depleted, endangered or threatened species are known to be regular components of bycatch and are substantially impacted by the fishery.

Factor 3.2 Summary

Factor 3.2: Bycatch Strategy				
Region / Method	Management Strategy and Impl.	Scientific Research & Monitoring	Record of Following Scientific Advice	Enforcement of Regs.
New South Wales South Pacific Pot	Highly Effective	Moderately Effective	Highly Effective	Highly Effective
Queensland South Pacific Pot	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective
South Australia Gulf St Vincent Pot	Highly Effective	Highly Effective	Highly Effective	Highly Effective
South Australia Spencer Gulf Pot	Highly Effective	Highly Effective	Highly Effective	Highly Effective
Western Australia Cockburn Sound Pot	Highly Effective	Highly Effective	Highly Effective	Highly Effective
Western Australia Peel-Harvey Estuary Pot	Highly Effective	Highly Effective	Highly Effective	Highly Effective
Western Australia Shark Bay Pot	Highly Effective	Highly Effective	Highly Effective	Highly Effective
Western Australia Shark Bay Trawl, Bottom	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective

Factor 3.2 Assessment

Subfactor 3.2.1 – Management Strategy and Implementation

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and how successful are these management measures? To achieve a Highly Effective rating, the primary bycatch species must be known and there must be clear goals and measures in place to minimize the impacts on bycatch species (e.g., catch limits, use of proven mitigation measures, etc.).

New South Wales South Pacific, Pot

Highly Effective

The blue swimmer crab pot fishery in New South Wales is a highly selective fishery and has little impact on non-target species. The only significant bycatch associated with this fishery appears to be undersized blue swimmer crabs, which are likely returned to the water alive (Johnson 2007). We have therefore rated the bycatch management strategy as “highly effective.”

Queensland South Pacific, Pot

Moderately Effective

Bycatch in the Queensland blue swimmer crab pot fishery is low, but incidental catches of green sea turtles in this fishery are of moderate concern. To help reduce impacts on sea turtles, a “responsible crabbing brochure” was introduced by Fisheries Queensland in 2010 to promote the use of environmentally sound fishing practices (Queensland Government 2011). Several crabbers are now using protected-species–friendly gear such as trotlines and weighted gear to reduce turtle interactions. Also, they are using biodegradable components in their crab pots to reduce the longevity of ghost fishing if pots are lost (Queensland Government 2011). Fisheries Queensland anticipates that the percentage of crab fishers using environmentally friendly fishing gear will increase over time, but since these mitigation strategies are currently voluntary, this factor is ranked “moderately effective.”

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Highly Effective

Bycatch in the South Australia blue swimmer crab pot fishery is low and mainly consists of other crab species that can be returned to the water alive. Strategies to mitigate bycatch, such as minimum mesh sizes and escape panels, are in place in the South Australia blue swimmer crab fishery. Currently, the minimum mesh size for crab pots is 75 mm (3.0 in); however, most commercial crabbers used mesh of 90 mm (3.5 in) (PIRSA Fisheries 2009). Research has shown that the use of larger mesh sizes has

significantly reduced the capture of bycatch species. Also, since gear modifications were implemented in 1995–1996, there have been no recordings of interactions with threatened, endangered, or protected species (PIRSA Fisheries 2009). Therefore, this factor is deemed “highly effective.”

Western Australia Cockburn Sound, Pot

Western Australia Peel-Harvey Estuary, Pot

Western Australia Shark Bay, Pot

Highly Effective

The hourglass pots used in the Western Australia blue swimmer crab pot fishery are designed to minimize the capture of undersized crabs and non-target species. The majority of non-target fish are able to escape through the entrance gaps, and bycatch that is captured is returned to the water. Onboard sampling by fisheries scientists indicates that bycatch is low and consists of finfish (e.g., snappers) and other invertebrate species (starfish, cephalopods, and other crabs). The low and infrequent capture of these species is considered to pose a negligible risk to their populations and the overall ecosystem (Fletcher and Santoro 2014). There is little chance of the crab pots interacting with any protected, threatened, or endangered species. Because bycatch is very low, the bycatch management strategy is considered “highly effective.”

Western Australia Shark Bay, Trawl, Bottom

Moderately Effective

Bycatch in the Western Australia Shark Bay prawn trawl fishery that catches blue swimmer crabs is considered moderate relative to other sub-tropical trawl fisheries, but is still four to eight times the targeted catch. Bycatch includes small blue swimmer crabs and other crustacean species that are typically returned to the water alive, as well as small-size fish species (Fletcher and Santoro 2014). There is also some bycatch of sea snakes and occasionally sea turtles. Effective measures to reduce bycatch of small fish, such as grid and square mesh panel bycatch reduction devices, have been fully implemented since 2002. Turtle excluder devices have also been fully implemented in the fishery and have greatly reduced the capture of sea turtles, though 36 turtles were reported caught in 2013 (Fletcher and Santoro 2014). Other measures have been implemented to reduce fishing effort and several spatial closures are in place, which have helped to protect sea turtles, marine mammals, and other vulnerable species. More than 50% of the trawlable area in Shark Bay is protected (Kangas and Morrison 2013). But some bycatch concerns remain. Bycatch of sea snakes has not been effectively reduced and the impacts on their populations are uncertain. It has been suggested that further studies and monitoring are needed to ensure that the fishery is not having a significant effect on sea snakes or any other species. A bycatch action plan has been developed for this fishery for 2014–2019. Investigating the fishery’s impact on sea snakes and improving bycatch monitoring have been identified as priorities (Department of Fisheries WA 2014c). Since managers have taken several actions to reduce bycatch, but

some bycatch concerns remain, the bycatch management strategy is rated “moderately effective.”

Subfactor 3.2.2 – Scientific Research and Monitoring

Considerations: Is bycatch in the fishery recorded/documented and is there adequate monitoring of bycatch to measure fishery’s impact on bycatch species? To achieve a Highly Effective rating, assessments must be conducted to determine the impact of the fishery on species of concern, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are being met.

New South Wales South Pacific, Pot

Moderately Effective

A research study was conducted on the blue swimmer crab fishery in Wallis Lake in New South Wales during the 2002–2003 fishing season. This study recorded and quantified the catches of non-target or bycatch species caught in the fishery, and found bycatch levels to be low (Johnson 2007). However, no further studies have been conducted. Therefore, this factor is rated “moderately effective.”

Queensland South Pacific, Pot

Moderately Effective

There is some information available on bycatch in the blue swimmer crab Queensland pot fishery. Managers and scientists conducted an Ecological Risk Assessment for the fishery in 2009, which included an evaluation of the impacts of the fishery on non-target or bycatch species. They determined that the impact on most non-target species is low, but that the impact on endangered green sea turtles is moderate (Hill and Garland 2009). An updated Ecological Risk Assessment has not been conducted. Although the Queensland government does have effective at-sea observer coverage for other fisheries to monitor fishery catches, observer coverage in the blue swimmer crab pot fishery does not currently exist (Queensland Government 2011). This factor is deemed “moderately effective.”

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Highly Effective

South Australia effectively monitors and analyzes the impacts of the blue swimmer crab fishery on bycatch species. Since 2002, annual fishery-independent surveys have been conducted that provide detailed information on the composition and abundance of bycatch in the fishery (PIRSA Fisheries 2009). These surveys use small mesh pots with mesh size coverings that are smaller than the ones used in

commercial pots. Therefore, the bycatch taken using the survey pots is significantly higher than what is taken in the commercial fishery. This provides a conservative method of estimating bycatch (PIRSA Fisheries 2009). Scientists conducted an Ecological Risk Assessment for this fishery in 2009 and found the impact on most bycatch species to be negligible (PIRSA Fisheries 2009). This factor is deemed “highly effective.”

Western Australia Cockburn Sound, Pot

Western Australia Peel-Harvey Estuary, Pot

Western Australia Shark Bay, Pot

Highly Effective

The Department of Fisheries’ research staff conducts onboard catch sampling in each of the blue swimmer crab pot fisheries. This onboard sampling has indicated that bycatch is low and consists of finfish (e.g., snappers) and other invertebrate species (starfish, cephalopods, other crabs) (Fletcher and Santoro 2014).

Western Australia Shark Bay, Trawl, Bottom

Moderately Effective

Bycatch monitoring in the Shark Bay prawn trawl fishery is monitored through fishers’ reported daily logbooks, with a focus on detailing interactions with endangered, threatened, or protected species, and also through scientific research surveys. A research survey conducted in 2002–2003 found no significant difference in the abundance or diversity of invertebrates and finfish between trawled and untrawled areas (Fletcher and Santoro 2014). Studies have also been conducted to investigate the effectiveness of bycatch excluder devices. However, the lack of a formal, ongoing bycatch monitoring program has been identified as an issue in this fishery. Another issue is the lack of information about the fishery’s impact on sea snake populations. A newly developed bycatch action plan for this fishery focuses on these issues. The plan outlines several ways that bycatch will be collected moving forward, including: scientific monitoring of the fishery to validate bycatch reports by fishers and to improve species identification, and regular fishery-independent surveys to evaluate bycatch species composition (Department of Fisheries WA 2014c). This factor is rated “moderately effective.”

Subfactor 3.2.3 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g., do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

New South Wales South Pacific, Pot
 Queensland South Pacific, Pot
 South Australia Gulf St Vincent, Pot
 South Australia Spencer Gulf, Pot
 Western Australia Cockburn Sound, Pot
 Western Australia Peel-Harvey Estuary, Pot
 Western Australia Shark Bay, Pot
 Western Australia Shark Bay, Trawl, Bottom

Highly Effective

Managers of these fisheries appear to nearly always follow scientific recommendations. See Factor 3.1 in Harvest Strategy for details.

Subfactor 3.2.4 – Enforcement of Management Regulations

Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen’s compliance with regulations? To achieve a Highly Effective rating, there must be consistent enforcement of regulations and verification of compliance.

New South Wales South Pacific, Pot
 Queensland South Pacific, Pot
 South Australia Gulf St Vincent, Pot
 South Australia Spencer Gulf, Pot
 Western Australia Cockburn Sound, Pot
 Western Australia Peel-Harvey Estuary, Pot
 Western Australia Shark Bay, Pot
 Western Australia Shark Bay, Trawl, Bottom

Highly Effective

Enforcement of regulations is considered highly effective. See Factor 3.1 in Harvest Strategy for details.

Criterion 4: Impacts on the habitat and ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment.

The final score is the geometric mean of the impact of fishing gear on habitat score (plus the mitigation of gear impacts score) and the Ecosystem Based Fishery Management score. The Criterion 2 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and <=3.2=Yellow or Moderate Concern*
- *Score <=2.2=Red or High Concern*
Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Region / Method	Factor 4.1 Impact of Gear on Habitat Score	Factor 4.2 Mitigation of Gear Impacts Modifier	Factor 4.3 Ecosystem Based Fisheries Management Score	Criterion 4 Score
New South Wales South Pacific Pot	3.00:Low Concern	0.50:Moderate Mitigation	4.00:Low Concern	Green (3.742)
Queensland South Pacific Pot	3.00:Low Concern	0.50:Moderate Mitigation	4.00:Low Concern	Green (3.742)
South Australia Gulf St Vincent Pot	3.00:Low Concern	0.50:Moderate Mitigation	4.00:Low Concern	Green (3.742)
South Australia Spencer Gulf Pot	3.00:Low Concern	0.50:Moderate Mitigation	4.00:Low Concern	Green (3.742)
Western Australia Cockburn Sound Pot	3.00:Low Concern	0.50:Moderate Mitigation	4.00:Low Concern	Green (3.742)
Western Australia Peel-Harvey Estuary Pot	3.00:Low Concern	0.50:Moderate Mitigation	4.00:Low Concern	Green (3.742)
Western Australia Shark Bay Pot	3.00:Low Concern	0.50:Moderate Mitigation	4.00:Low Concern	Green (3.742)
Western Australia Shark Bay Trawl, Bottom	1.00:High Concern	0.50:Moderate Mitigation	4.00:Low Concern	Yellow (2.450)

Criterion 4 Assessment

Factor 4.1 – Impact of Fishing Gear on the Habitat/Substrate

Scoring Guidelines

- 5 (None)—Fishing gear does not contact the bottom
- 4 (Very Low)—Vertical line gear
- 3 (Low)—Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom occasionally (
- 2 (Moderate)—Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand
- 1 (High)—Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)
- 0 (Very High)—Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)

Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

New South Wales South Pacific, Pot

Queensland South Pacific, Pot

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Western Australia Cockburn Sound, Pot

Western Australia Peel-Harvey Estuary, Pot

Western Australia Shark Bay, Pot

Low Concern

The crab pots/traps used in the blue swimmer crab fishery throughout Australia have a low impact on the physical and biological structures of the seafloor. There is minimal dragging of the pots on the bottom during trap retrieval. Blue swimmer crabs live in sandy and muddy habitats, which are resilient habitat types (Johnston et al. 2012) (PIRSA Fisheries 2009). In addition, the large mesh size on blue swimmer crab pots prevents sand and benthic organisms from being brought up to the surface with the pot (Fletcher and Santoro 2014). Occasionally small amounts of seagrass may be brought up, if pots are set near seagrass areas, but overall the fishery is considered to pose a low risk to seagrass (Fletcher and Santoro 2014) (PIRSA Fisheries 2009). Therefore, this factor is deemed “low concern.”

Western Australia Shark Bay, Trawl, Bottom

High Concern

Bottom trawls are dragged along the seafloor during fishing and can negatively affect the physical and biological structures of the seafloor. In this fishery, trawling is primarily considered to occur over sand/shell habitats, which are considered more resilient to trawl damage compared to rocky or coral habitats (Fletcher and Santoro 2014). However, the habitats in the area where the trawl fishery occurs have not been well-studied. The habitats and species that occur in Shark Bay are known to be quite diverse and may include some sensitive structural organisms. Soft-sediment substrates can contain various sponge and soft coral species, and may have once been highly populated with these species. Soft sediments are typically unsuitable habitats for most hard corals, but a small number of coral patches are scattered irregularly throughout these habitats in Shark Bay (Kangas et al. 2007). Because the habitat where trawling occurs has not been well studied and trawling may occur over some sensitive habitat features, we have conservatively awarded a score of “high concern.”

Factor 4.2 – Mitigation of Gear Impacts

Scoring Guidelines

- *+1 (Strong Mitigation)—Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage to seafloor and modifications shown to be effective at reducing damage, or an effective combination of ‘moderate’ mitigation measures.*
- *+0.5 (Moderate Mitigation)—20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.*
- *+0.25 (Low Mitigation)—A few measures are in place (e.g., vulnerable habitats protected but other habitats not protected); there are some limits on fishing effort/intensity, but not actively being reduced.*
- *0 (No Mitigation)—No effective measures are in place to limit gear impacts on habitats.*

New South Wales South Pacific, Pot

Moderate Mitigation

In New South Wales, vulnerable habitats are strongly protected through Marine Protected Areas. There are several different types of Marine Protected Areas including 6 multiple use Marine Parks, Commonwealth Marine Reserves, 12 Aquatic Reserves, and 62 National Parks and Reserves with marine components (NSW Government 2013). These areas cover more than one-third of New South Wales coastal waters. Managers regulate activities in each of these marine protected areas. Fishing is

permitted in some places within these marine protected areas and prohibited in others. There are also Intertidal Protected Areas, which are designed to help protect the biodiversity and structure in intertidal communities, to protect species' breeding areas so exploited areas nearby can be recolonized or sustained, and to help ensure sustainable harvesting of intertidal invertebrates (NSW DPI 2013g). The blue swimmer crab fishery is managed as part of the Estuary General Fishery. There are various location closures that pertain directly to the Estuary General Fishery, and the Fisheries Management (General) Regulation 2010 outlines fishing gear provisions (NSW DPI 2013h). As part of the New South Wales fishery reform process, there are also efforts to reduce the number of commercial fishery participants (NSW DPI 2014a). Due to the various measures in place to reduce the fishery's spatial footprint and fishing effort, this factor is given a score of "moderate mitigation."

Queensland South Pacific, Pot

Moderate Mitigation

In Queensland, there are several spatial closures and Marine Parks to help protect vulnerable habitats and the ecological community. Inshore juvenile blue swimmer crab habitats such as seagrass beds and sand and mud banks are protected by fisheries and marine park closures (Queensland Government 2011). There are three Marine Parks in Queensland: Great Barrier Reef Marine Park, Great Sandy Marine Park, and Moreton Bay Marine Park. In each park, there are different zones that provide different levels of protection (Queensland Government 2014f). In the Great Barrier Reef Marine Park, the largest of the Marine Parks, fishing with crab pots is not allowed in approximately one-third of the park area (GBRMPA 2011). Also, the lightweight and stable structure of the crab pots reduces their impact on the seafloor, and there are limits on the number of pots that can be used per fisher. A number of commercial fishers are using biodegradable components in their crab pots to reduce the risk on the marine ecosystem if they become lost or abandoned (Queensland Government 2011). Due to the various measures in place to reduce the fishery's spatial footprint and fishing effort, this factor is given a score of "moderate mitigation."

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Moderate Mitigation

In South Australia, blue swimmer crabs are found in the waters of Gulf St. Vincent, Spencer Gulf, and the west coast bays off the upper western Eyre Peninsula. Fishing for blue swimmer crabs primarily occurs in Gulf St. Vincent and Spencer Gulf. In Spencer Gulf there are three closed fishing areas, and in both regions there are seasonal fishing closures (PIRSA Fisheries 2009). And, 16 aquatic reserves have been established in South Australia's marine and estuarine waters, many of which are within Spencer Gulf and the Gulf St. Vincent (PIRSA Fisheries 2013f). Fishing with crab pots is not allowed in the aquatic reserves. Also, 12 Marine Parks have recently been established in South Australia's waters. Fishing is not permitted in "sanctuary zones" within the Marine Parks but is permitted in other areas. The "sanctuary

zones” account for 6% of the state’s marine habitat (Department of Environment, Water, and Natural Resources 2014). In the blue swimmer crab fishery, access to the fishery is limited and each fisher is restricted to a certain number of pots and to catching their allotted amount of the total annual catch limit (PIRSA Fisheries 2009). Since there are various measures in place to reduce fishing effort, intensity, and the spatial footprint, this factor is given a score of “moderate mitigation.”

Western Australia Cockburn Sound, Pot

Western Australia Peel-Harvey Estuary, Pot

Western Australia Shark Bay, Pot

Moderate Mitigation

In Western Australia, effective measures are being taken to protect bottom habitats from the impacts of fishing gear. There are a variety of marine protected areas in Western Australia to ensure sustainable marine environments and high aquatic biodiversity. These protected areas include marine natural reserves, marine parks, marine management areas, and fish habitat protection areas (Department of Fisheries WA 2013h) (Department of Fisheries WA 2013g). Sensitive habitat areas are strongly protected and there are restrictions on the level of impacts that can occur in less sensitive areas. Also, fishing intensity in the blue swimmer crab pot fishery is actively controlled through limits on the number of pots that can be fished, seasonal closures, and gear restrictions (Fletcher and Santoro 2014). This factor is given a score of “moderate mitigation.”

Western Australia Shark Bay, Trawl, Bottom

Moderate Mitigation

In Western Australia, effective measures are being taken to protect bottom habitats from the impacts of fishing gear. There are a variety of marine protected areas in Western Australia to ensure sustainable marine environments and high aquatic biodiversity. These protected areas include marine natural reserves, marine parks, marine management areas, and fish habitat protection areas (Department of Fisheries WA 2013h) (Department of Fisheries WA 2013g). In Shark Bay, 62% of the area is closed to trawling. Additionally, fishing typically only occurs within 40%–50% of the trawlable area each season, which represents 14%–18% of the total area. Habitats closed to trawling include seagrass beds, corals, and shell communities, as well as important nursery areas for young prawns. There are also some rolling closures to protect prawn spawning areas. Other measures in place to limit overall fishing effort include a limited number of licenses (18) and a seasonal closure from November to March each year, with the aim of a maximum of 175 total fishing days each year (Department of Fisheries WA 2014b). Although a large proportion of Shark Bay habitats are protected from trawling, it is unclear if greater than 50% of prawn and blue swimmer crab habitats are protected. This results in a score of “moderate mitigation.”

Factor 4.3 – Ecosystem-Based Fisheries Management

Scoring Guidelines

- *5 (Very Low Concern)—Substantial efforts have been made to protect species’ ecological roles and ensure fishing practices do not have negative ecological effects (e.g., large proportion of fishery area is protected with marine reserves, and abundance is maintained at sufficient levels to provide food to predators).*
- *4 (Low Concern)—Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. Measures are in place to minimize potentially negative ecological effect if hatchery supplementation or fish aggregating devices (FADs) are used.*
- *3 (Moderate Concern)—Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the ecological role of these species, OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts.*
- *2 (High Concern)—Fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.*
- *1 (Very High Concern)—Use of hatchery supplementation or fish aggregating devices (FADs) in the fishery is having serious negative ecological or genetic consequences, OR fishery has resulted in trophic cascades or other detrimental impacts to the food web.*

New South Wales South Pacific, Pot

Low Concern

In New South Wales, various marine reserves, marine parks, aquatic reserves, and intertidal protected areas have been established to protect marine species and their habitats (NSW Government 2013) (NSW DPI 2013g) (NSW DPI 2013h) (NSW DPI 2013i). In these areas, managers regulate what marine activities are allowed and where they can occur. These areas cover more than one-third of New South Wales’ coastal waters.

An Environmental Impact Assessment of the Estuary General Fishery that blue swimmer crabs are caught in was completed in 2001. This assessment evaluated the total impacts of fishing on all potentially affected species and habitats. These assessments are undertaken to ensure that the fishery management strategies for each fishery are sufficient to sustain species and protect the environment. However, an updated environmental impact assessment of the fishery has not been conducted (NSW DPI 2013f).

Managers have established numerous marine protected areas, there have been efforts to evaluate the impacts of the fishery on affected environments, and the fishery does not catch any species of exceptional ecological importance, therefore this factor is rated “low concern.”

Queensland South Pacific, Pot

Low Concern

The blue swimmer crab fishery does not catch species of exceptional ecological importance, and scientific assessment and management efforts to account for species’ ecological roles are underway. In 2009, an Ecological Risk Assessment of the Queensland blue swimmer crab fishery was conducted. This assessment investigated the fishery’s impact on the target species, other species, and the environment. It also considered other non-fishing factors that might affect the ecosystem (Hill and Garland 2009). The fishery was found to have a moderate impact on blue swimmer crabs, three-spotted crabs, and green sea turtles. The fishery was found to have only a low or negligible impact on all other species and on the physical environment. In Queensland, several Marine Parks have been established including the Great Barrier Reef Coast Marine Park, Great Sand Marine Park, and Moreton Bay Marine Park (Queensland Government 2014f). These Marine Parks are managed by creating different zones in the park and each allows for different activities. This zoning technique ensures that each marine park remains a diverse, resilient, and productive ecological system while allowing people access to its resources (Queensland Government 2014g). This factor is deemed “low concern.”

South Australia Gulf St Vincent, Pot

South Australia Spencer Gulf, Pot

Low Concern

The blue swimmer crab fishery in South Australia does not catch species of exceptional ecological importance, and scientific assessment and management efforts to account for species’ ecological roles are underway. An objective of the Fisheries Management Act 2007 is to protect and conserve aquatic habitats and maintain ecosystem diversity (PIRSA Fisheries 2009). The Fisheries Management Act 2007 requires fishery management plans to describe the biological, economic, and social characteristics of a fishery. They also must include a risk assessment of the impacts of the fishery on relevant ecosystems (PIRSA Fisheries 2009). In 2009 an Ecological Risk Assessment of the blue swimmer crab fishery was performed to examine the fishery’s impact on the target species, other species, habitats, and the broader environment (PIRSA Fisheries 2009). This assessment identified areas where specific management might be needed to meet ecosystem goals. Overall, the fishery was found to have a low impact on the ecosystem (PIRSA Fisheries 2009). Managers have also established several Marine Parks and Aquatic Reserves within South Australia to protect species and their habitats (PIRSA Fisheries 2013f) (Department of Environment, Water, and Natural Resources 2014). This factor is

rated “low concern.”

Western Australia Cockburn Sound, Pot

Western Australia Peel-Harvey Estuary, Pot

Western Australia Shark Bay, Pot

Western Australia Shark Bay, Trawl, Bottom

Low Concern

The Department of Fisheries in Western Australia was one of the first fishery management agencies in the world to introduce Ecosystem-Based Fisheries Management (Department of Fisheries WA 2013f). To manage their coastal ecosystems, they have divided the area into “bioregions.” Comprehensive assessments of each bioregion and each major fishery in the bioregion are completed each year, which aim to examine the impacts on target species, bycatch species, habitats, and food webs (Fletcher and Santoro 2014). All activities affecting the bioregion (e.g., fishing, aquaculture, oil and gas exploration, and tourism) are also described (Fletcher and Santoro 2014). A number of marine protected areas exist in Western Australia (Department of Fisheries WA 2013g) (Department of Fisheries WA 2013h), and more than 90% of the Western Australia coastline is protected from trawling (Department of Fisheries WA 2013f). This factor is scored as “low concern.”

Acknowledgements

Scientific review does not constitute an endorsement of The Safina Center and Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. The Safina Center and Seafood Watch® are solely responsible for the conclusions reached in this report.

The Safina Center and Seafood Watch® would like to thank the following individuals for graciously reviewing this report for scientific accuracy and clarity:

Kerrod Beattie of the Queensland Department of Agriculture and Fisheries, Tooni Mahto of the Australia Marine Conservation Society, Trevor Ward of the University of Technology, Sydney, and three other anonymous reviewers.

References

Currie, DR. and G.E. Hooper. 2006. Blue Swimmer Crab (*Portunus pelagicus*) Fishery 2004/05. Fishery Assessment Report for PIRSA. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. RD 03/0274-3.

Department of Environment, Water, and Natural Resources. 2014. About Marine Parks. Government of South Australia, Department of Environment, Water, and Natural Resources. Available online <http://www.environment.sa.gov.au/marineparks/About>.

Department of Fisheries WA. 2014a. Annual report to parliament 2013/14. Government of Western Australia, Department of Fisheries. Available online at <http://www.fish.wa.gov.au/Pages/Home.aspx>.

Department of Fisheries WA. 2014b. Shark Bay Prawn Managed Fishery Harvest Strategy 2014 – 2019. Government of Western Australia, Department of Fisheries, Fisheries Management Paper No. 267. November 2014.

Department of Fisheries WA. 2014c. Shark Bay Prawn Managed Fishery bycatch action plan 2014 – 2019. Government of Western Australia, Department of Fisheries, Fisheries Management Paper No. 268.

Department of Fisheries WA. 2014d. Partnerships. Government of Western Australia, Department of Fisheries. Available online at <http://www.fish.wa.gov.au/Education-and-Partnerships/Partnerships/Pages/default.aspx>.

Department of Fisheries WA. 2013a. Crab commercial fishing. Government of Western Australia, Department of Fisheries. Available online at <http://www.fish.wa.gov.au/Species/Blue-Swimmer-Crabs/Pages/Blue-Swimmer-Crab-Commercial-Fishing.aspx>

Department of Fisheries WA. 2013b. Blue Swimmer Crabs. Government of Western Australia, Department of Fisheries. Available online at <http://www.fish.wa.gov.au/species/blue-swimmer-crabs/Pages/default.aspx>

Department of Fisheries WA. 2013c. Prawn. Government of Western Australia, Department of Fisheries. Available online <http://www.fish.wa.gov.au/Species/Prawn/Pages/default.aspx>

Department of Fisheries WA. 2013d. Crab Management. Government of Western Australia, Department of Fisheries. Available online at <http://www.fish.wa.gov.au/Species/Blue-Swimmer-Crabs/Pages/Blue-Swimmer-Crab-Management.aspx>

Department of Fisheries WA. 2013e. About Us. Government of Western Australia, Department of Fisheries. Available online at <http://www.fish.wa.gov.au/About-Us/Pages/default.aspx>

Department of Fisheries WA. 2013f. Sustainable Fisheries Management. Government of Western Australia, Department of Fisheries. Available online at <http://www.fish.wa.gov.au/Sustainability-and-Environment/Sustainable-Fisheries/Pages/Sustainable-Fisheries-Management.aspx>

Department of Fisheries WA. 2013g. State Marine Parks and Reserves. Government of Western Australia, Department of Fisheries. Available online at <http://www.fish.wa.gov.au/Sustainability-and-Environment/Aquatic-Biodiversity/Marine-Protected-Areas/Marine-parks-and-reserves/Pages/default.aspx>

Department of Fisheries WA. 2013h. Marine Protected Areas. Government of Western Australia, Department of Fisheries. Available online at <http://www.fish.wa.gov.au/Sustainability-and-Environment/Aquatic-Biodiversity/Marine-Protected-Areas/Pages/default.aspx>

Department of Fisheries WA. 2011. Fisheries Fact Sheet: Blue Swimmer Crab. Government of Western Australia, Department of Fisheries. 4 pp.

Department of the Environment 2015a. *Aipysurus apraefrontalis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Tue, 21 Apr 2015.

Department of the Environment. 2015b. *Aipysurus pooleorum* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Tue, 21 Apr 2015.

Department of the Environment. 2015c. *Hydrophis elegans* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Tue, 21 Apr 2015.

Department of the Environment. 2015d. *Disteira major* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Tue, 21 Apr 2015.

Department of the Environment. 2015e. EPBC Act List of Threatened Fauna. Available from: <http://www.environment.gov.au/sprat>. Accessed Tue, 21 Apr 2015.

Department of the Environment. 2015f. *Chelonia mydas* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Wed, 22 Apr 2015.

Department of the Environment. 2015g. *Caretta caretta* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Wed, 22 Apr 2015.

Department of the Environment. 2015h. *Dermochelys coriacea* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Wed, 22 Apr 2015.

Department of the Environment. 2015i. *Natator depressus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Wed, 22 Apr 2015.

Department of the Environment. 2015j. *Eretmochelys imbricata* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Wed, 22 Apr 2015.

Dineshbabu, A.P., B. Sreedhara, and Y. Muniyappa. 2007. Fishery and stock assessment of *Portunus sanguinolentus* (Herbst) from south Karnataka coast, India. *Journal of the Marine Biological Association of India* 49:134-140.

Dixon, C.D., C.J. Noell, G.E. Hooper, and T.M. Ward. 2013. Blue Crab (*Portunus armatus*) Fishery 2011/12. Fishery Assessment Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000729–9. SARDI Research Report Series No. 689. 70pp.

Food and Agriculture Organization (FAO). 2013. FishStatJ Version 2.0.

Fletcher, W.J. and K. Santoro (eds). 2014. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2013/14: The State of the Fisheries. Department of Fisheries, Western Australia.

Froese, R. and D. Pauly. Editors. 2011. FishBase. World Wide Web electronic publication.

GBRMPA 2011. Zoning guide to using the Marine Park: Interpreting Zones. Australia Government, Great Barrier Reef Marine Park Authority. Available online at <http://www.gbrmpa.gov.au/visit-the-reef/zoning/zoning-guide-to-using-the-marine-park/interpreting-zones>

Griffin, D.J.G. 1963. Redescriptions of the Australian Majid Spider Crabs *Leptomithrax Gaimardii* (H. Milne Edwards) and *Paramithrax Barbicornis* (Latreille). *Records of the Australian Museum*. Vol. 26, No.4: Pages 131-143.

Harris, D., D. Johnston, E. Sporer, M. Kangas, N. Felipe, and N. Caputi, N. 2014. Status of the Blue Swimmer Crab Fishery in Shark Bay, Western Australia. Fisheries Research Report No. 233. Department of Fisheries, Western Australia. 84p.

Henry G.W. and J.M. Lyle. 2003, The national recreational and Indigenous fishing survey, Fisheries Research and Development Corporation project 1999/158, Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, http://eprints.utas.edu.au/2526/1/Henry_Lyle_Nationalsurvey.pdf.

Hill, F. and A. Garland. 2009. Ecological risk assessment of Queensland's Blue Swimmer, Spanner and Mud Crab Fisheries. Queensland Government, Queensland Primary Industries and Fisheries. 17 pp.

Holmes, B., M. Leslie, M. Keag, A. Roelofs, M. Winning and B. Zeller. 2013. Stock status of Queensland's fisheries resources 2012. Queensland Government, Department of Agriculture, Fisheries and Forestry. 120 pp.

IUCN 2013. The IUCN Red List of Threatened Species. Version 2013.2. . Downloaded on 21 November 2013.

Johnson, D. 2007. Fisheries and biological data for management of the blue swimmer crab fisheries of New South Wales. School of Environmental Science and management. Lismore, NSW, Southern Cross university. m.App.Sci. Thesis

Johnston, D., S. Wesche, C. Noell, and D. Johnson. 2014a. Status of Key Australian Fish Stocks 2014: Blue Swimmer Crab, *Portunus armatus*. Fisheries Research and Development Corporation. Available online at http://www.fish.gov.au/reports/crustaceans/crabs/Pages/blue_swimmer_crab.aspx

Johnston, D., A. Chandrapavan, B. Wise, and N. Caputi. 2014b. Assessment of blue swimmer crab recruitment and breeding stock levels in the Peel-Harvey Estuary and status of the Mandurah to Bunbury Developing Crab Fishery. Fisheries Research Report No. 258. Department of Fisheries, Western Australia. 148pp.

Johnston, D., C. Dixon, M. Leslie and K. Rowling. 2012. Status of Key Australian Fish Stocks 2012: Blue Swimmer Crab, *Portunus armatus*. Fisheries Research and Development Corporation. Available online at http://www.fish.gov.au/reports/crustaceans/crabs/Pages/blue_swimmer_crab.aspx

Johnston, D., D. Harris, N. Caputi, S. de Lestang, and A. Thomson. 2011. Status of the Cockburn Sound Crab Fishery. Fisheries Research Report No. 219. Department of Fisheries, Western Australia. 104pp.

Kangas M. and C. Dixon. 2012. Status of Key Australian Fish Stocks: Western King Prawn *Melicertus latisulcatus*. Fisheries Research and Development Corporation. Available online at http://www.fish.gov.au/reports/crustaceans/prawns/Pages/western_king_prawn.aspx

Kangas, M. and S. Morrison. 2013. Trawl impacts and biodiversity management in Shark Bay, Western Australia. *Marine and Freshwater Research* 64: 1135–1155.

Kangas, M.I., S. Morrison, P. Unsworth, E. Lai, I. Wright and A. Thomson. 2007. Development of biodiversity and habitat monitoring systems for key trawl fisheries in Western Australia. Final report to Fisheries Research and Development Corporation on Project No. 2002/038. Fisheries Research Report No. 160, Department of Fisheries, Western Australia, 334p.

Lukoschek, V., M. Guinea, and D. Milton. 2010. *Aipysurus apraefrontalis*. The IUCN Red List of Threatened Species. Version 2014.3. . Downloaded on 21 April 2015.

NMFS. 2014a. Imports 2013 Australia. National Marine Fisheries Service Fisheries Statistics and Economics Division. Accessed February 2014.

NMFS. 2014b. Imports 2013 Swimming Crab. National Marine Fisheries Service Fisheries Statistics and Economics Division. Accessed April 2014.

Noell, C.J. C.L. Beckmann, and G.E. Hooper. 2014. Blue Crab (*Portunus armatus*) Fishery 2012/13. Fishery Assessment Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000729–10. SARDI Research Report Series No. 757. 77pp.

NSW DPI. 2014a. Reform program for NSW commercial fishing. New South Wales Government, Department of Primary Industries, Fishing and Aquaculture. Online at <http://www.dpi.nsw.gov.au/fisheries/commercial/reform>

NSW DPI. 2014b. Estuary General Fishery. Fishing and Aquaculture. New South Wales Government, Department of Primary Industries, Fishing and Aquaculture. Available online at <http://www.dpi.nsw.gov.au/fisheries/commercial/fisheries/egf#Managing-the-fisheryThe>

NSW DPI. 2013a. Consultation. New South Wales Government, Department of Primary Industries, Fishing and Aquaculture. Available at <http://www.dpi.nsw.gov.au/fisheries/commercial/consultation>

NSW DPI. 2013b. Fisheries Compliance. New South Wales Government, Department of Primary Industries, Fishing and Aquaculture. Available online <http://www.dpi.nsw.gov.au/fisheries/compliance#Fisheries-Compliance-Enforcement>

NSW DPI. 2013c. NSW Commercial Fishing Catch and Effort Reporting. New South Wales Government, Department of Primary Industries, Fishing and Aquaculture. Available online at <http://www.dpi.nsw.gov.au/fisheries/commercial/catch-effort>

NSW DPI. 2013d. Fisheries Compliance Enforcement 2012-13. New South Wales Government, Department of Primary Industries, Fishing and Aquaculture. Available online at <http://www.dpi.nsw.gov.au/fisheries/compliance/fisheries-compliance-enforcement-2012-13#Images-of-Fisheries-Officer-compliance-activity>

NSW DPI. 2013e. Structural Adjustment Review Committee. New South Wales Government, Department of Primary Industries, Fishing and Aquaculture. Available online at <http://www.dpi.nsw.gov.au/fisheries/commercial/reform/sarc>

NSW DPI. 2013f. Environmental assessments. New South Wales Government, Department of Primary Industries, Fishing and Aquaculture. Available online at <http://www.dpi.nsw.gov.au/fisheries/commercial/ea>

NSW DPI. 2013g. Intertidal protected areas. New South Wales Government, Department of Primary Industries, Fishing and Aquaculture. Available online at <http://www.dpi.nsw.gov.au/fisheries/info/closures/ipa>

NSW DPI. 2013h. Estuary General Fishery closures. New South Wales Government, Department of Primary Industries, Fishing and Aquaculture. Available online at <http://www.dpi.nsw.gov.au/fisheries/info/closures/commercial/eg>

NSW DPI. 2013i. Protecting habitats. New South Wales Government, Department of Primary Industries, Fishing and Aquaculture. Available online at <http://www.dpi.nsw.gov.au/fisheries/habitat/protecting-habitats>

NSW DPI. 2010. Structural Reform Program: Estuary General Fishery Historical Fishery Data January 2010. Available online <http://www.dpi.nsw.gov.au/fisheries/commercial/reform/program>

NSW Government. 2013. Marine Parks. New South Wales Government. Available online at <http://www.mpa.nsw.gov.au/>

NSW II 2010. Status of Fisheries Resources in New South Wales, 2008/09 Blue Swimmer Crab. New South Wales Government, Industry and Investment, Wild Fisheries Research Program.

PIRSA Fisheries. 2013a. Blue Crab Fishery. Government of South Australia, Primary Industries and Regions South Australia. Available online at http://www.pir.sa.gov.au/fisheries/commercial_fishing/commercial_fisheries/blue_crab_fishery

PIRSA Fisheries. 2013b. Fisheries Management. Government of South Australia, Primary Industries and Regions South Australia. Available online at http://www.pir.sa.gov.au/fisheries/commercial_fishing/fisheries_management

PIRSA Fisheries. 2013c. Demerit points. Government of South Australia, Primary Industries and Regions South Australia. Available online at http://www.pir.sa.gov.au/fisheries/commercial_fishing/licensing__and__registration/demerit_points

PIRSA Fisheries. 2013d. Reduction in blue swimmer crab fishing limits to aid recovery. Government of South Australia, Primary Industries and Regions South Australia. Media release, May 24, 2013.

PIRSA Fisheries. 2013e. Fishwatch. Government of South Australia, Primary Industries and Regions South Australia. Available online at <http://www.pir.sa.gov.au/fisheries/fishwatch>

PIRSA Fisheries. 2013f. Closures and aquatic reserves. Government of South Australia, Primary Industries and Regions South Australia. Available online at <http://www.pir.sa.gov.au/fisheries/closures>

PIRSA Fisheries. 2012. Management Plan for the South Australian Commercial Blue Crab Fishery. Government of South Australia, Primary Industries and Regions South Australia. 90 pp.

PIRSA Fisheries. 2009. Ecologically Sustainable Development (ESD) Risk Assessment of the South Australian Commercial Blue Crab Fishery. Government of South Australia. Primary Industries and Regions South Australia. 88 pp.

Queensland Government. 2014a. VMS requirements in Queensland. Business and Industry Portal. State of Queensland.

Queensland Government. 2014b. Basic fisheries management methods. Department of Agriculture, Fisheries and Forestry. State of Queensland.

Queensland Government. 2014c. Queensland Boating and Fisheries Patrol. Department of Agriculture, Fisheries and Forestry. State of Queensland.

Queensland Government. 2014d. Protection and management of marine plants. Department of Agriculture, Fisheries and Forestry. State of Queensland.

Queensland Government. 2014e. Fish habitat policies. Department of Agriculture, Fisheries and Forestry. State of Queensland.

Queensland Government. 2014f. Marine Parks. Department of National Parks, Recreation, Sport, and Racing. State of Queensland.

Queensland Government. 2014g. Managing Marine Parks. Department of National Parks, Recreation, Sport, and Racing. State of Queensland.

Queensland Government. 2014h. Blue Swimmer Crab Fishery: 2013 Fishing Year Report. Department of Agriculture, Fisheries and Forestry. State of Queensland.

Queensland Government. 2014i. Fisheries Management Review. Department of Agriculture, Fisheries and Forestry. State of Queensland.

Queensland Government. 2013a. Green Turtle. Department of Environment and Heritage Protection. Queensland Government.

Queensland Government. 2013b. Blue Swimmer Crab Fishery: 2011 Fishing Year Report. Department of Agriculture, Fisheries and Forestry. State of Queensland.

Queensland Government. 2013c. Licensing, catch reporting and enforcement. Department of Agriculture, Fisheries and Forestry. State of Queensland.

Queensland Government. 2011. Annual Status Report 2011: Blue Swimmer Crab Fishery. The State of Queensland, Department of Employment, Economic Development and Innovation.

Roach, J., M. Kangas, and M. Winning. 2012. Status of Key Australian Fish Stocks: Tiger Prawns *Penaeus esculentus*, *P. semisulcatus*. Fisheries Research and Development Corporation. Available online at http://www.fish.gov.au/reports/crustaceans/prawns/Pages/tiger_prawns.aspx

Seminoff, J.A. (Southwest Fisheries Science Center, U.S.) 2004. *Chelonia mydas*. In: IUCN 2013. IUCN Red List of Threatened Species.

Sumpton, W., S. Gaddes, M. McLennan, M. Campbell, M. Tonks, N. Good, W. Hagedoorn, and G. Skilleter. 2003. Fisheries Biology and Assessment of the Blue Swimmer Crab (*Portunus pelagicus*) in Queensland. The State of Queensland, Department of Primary Industries, and the Fisheries Research and Development Corporation.

Sumpton, W.D., G.S. Smith, and M.A. Potter, M.A. 1989. Notes on the biology of the Portunid crab, *Portunus sanguinolentus* (Herbst), in subtropical Queensland waters. *Australian Journal of Marine and Freshwater Research* 40:711-717.

Svane, I. and Hooper, G.E. 2004. Blue Swimmer Crab (*Portunus pelagicus*) Fishery. Fishery Assessment Report to PIRSA for the Blue Crab Fishery Management Committee. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. RD 03/0274-2.

Taylor, J. and G.C.B. Poore. 2011, Rough Rock Crab, *Nectocarcinus integrifrons*, in Taxonomic Toolkit for marine life of Port Phillip Bay, Museum Victoria. Available online at <http://portphillipmarinelife.net.au/species/3994>

WAFIC. 2010a. Crabs. Western Australian Fishing Industry Council inc. Available online at <http://www.wafic.org.au/crabs>

WAFIC. 2010b. What We Are. Western Australian Fishing Industry Council inc. Available online at <http://www.wafic.org.au/about-wafic/what-we-are>

WAFIC. 2010c. Sustainability. Western Australian Fishing Industry Council inc. Available online at <http://www.wafic.org.au/about-the-industry/sustainability>

Wallace, B.P., A.D. DiMatteo, A.B. Bolten, M.Y. Chaloupka, B.J. Hutchinson, et al. 2011. Global Conservation Priorities for Marine Turtles. *PLoS ONE* 6(9): e24510. doi:10.1371/journal.pone.0024510

Appendix A: Review Schedule

New blue swimmer crab assessments are expected to be completed in 2015 and a management plan is in development for the Shark Bay Blue Swimmer Crab fishery. This report will be updated when this information becomes available.

Appendix B: Main Species Considered in the Assessment

Summary of all main species considered in the assessment

Blue swimmer crab: New South Wales South Pacific, Pot				
Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
BLUE SWIMMER CRAB	Low	3.00: Moderate Concern	2.33: Moderate Concern	2.644

Blue swimmer crab: Queensland South Pacific, Pot				
Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
GREEN SEA TURTLE	High	2.00: High Concern	2.33: Moderate Concern	2.159
BLUE SWIMMER CRAB	Low	3.00: Moderate Concern	2.33: Moderate Concern	2.644
KUAHONU CRAB	Low	3.00: Moderate Concern	2.33: Moderate Concern	2.644

Blue swimmer crab: South Australia Gulf St Vincent, Pot				
Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
BLUE SWIMMER CRAB	Low	2.00: High Concern	2.33: Moderate Concern	2.159
ROUGH ROCK CRAB	Low	3.00: Moderate Concern	3.67: Low Concern	3.318
SPIDER CRAB	Low	3.00: Moderate Concern	3.67: Low Concern	3.318

Blue swimmer crab: South Australia Spencer Gulf, Pot				
Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
ROUGH ROCK CRAB	Low	3.00: Moderate Concern	3.67: Low Concern	3.318
SPIDER CRAB	Low	3.00: Moderate Concern	3.67: Low Concern	3.318
BLUE SWIMMER CRAB	Low	4.00: Low Concern	3.67: Low Concern	3.831

Blue swimmer crab: Western Australia Cockburn Sound, Pot				
Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
BLUE SWIMMER CRAB	Low	2.00: High Concern	2.33: Moderate Concern	2.159

Blue swimmer crab: Western Australia Peel-Harvey Estuary, Pot				
Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
BLUE SWIMMER CRAB	Low	4.00: Low Concern	2.33: Moderate Concern	3.053

Blue swimmer crab: Western Australia Shark Bay, Pot				
Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
BLUE SWIMMER CRAB	Low	2.00: High Concern	2.33: Moderate Concern	2.159

Blue swimmer crab: Western Australia Shark Bay, Trawl, Bottom				
Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
SEA TURTLE (UNSPECIFIED)	High	1.00: Very High Concern	2.33: Moderate Concern	1.526
BLUE SWIMMER CRAB	Low	2.00: High Concern	2.33: Moderate Concern	2.159
SEA SNAKES (UNSPECIFIED)	High	2.00: High Concern	2.33: Moderate Concern	2.159
BENTHIC INVERTS	Medium	3.00: Moderate Concern	2.33: Moderate Concern	2.644
FINFISH	Medium	3.00: Moderate Concern	2.33: Moderate Concern	2.644
AUSTRALIAN TIGER PRAWN	Low	4.00: Low Concern	3.67: Low Concern	3.831
WESTERN KING PRAWN	Low	4.00: Low Concern	3.67: Low Concern	3.831

Assessment of main species not included in body of report

AUSTRALIAN TIGER PRAWN

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Western Australia Shark Bay, Trawl, Bottom

Low

Tiger prawns can live up to 2 years and grow to a carapace (shell) length of 5.5 cm (2.2 in). On the west coast of Australia, tiger prawns reach sexual maturity at around 6 months and a carapace length of 2.7–3.5 cm (1.1–1.4 in) (Roach et al. 2012). Tiger prawns typically spawn during spring and summer months. Female prawns spawn more than once a year and release hundreds of thousands of eggs during each spawning. Prawns feed on plant material, decaying organic matter, microorganisms, small shellfish, and worms. Prawns are preyed on by squid, cuttlefish, and demersal fish (Department of Fisheries WA 2013c). Based on the life-history attributes of the tiger prawn, they are considered to have a “low” inherent vulnerability to fishing.

Rationale:

Table 1: Results from Seafood Watch fish vulnerability rubric (criteria document, p. 4). Attribute scores can range from 1–3 with higher scores signifying more resilient life-history attributes.

Vulnerability attribute	Category	Score
Average age at maturity	< 5 years	3
Average maximum age	< 10 years	3
Fecundity	>100 eggs	N/A
Reproductive strategy	Broadcast spawner	3
Density dependence	No depensatory or compensatory dynamics demonstrated or likely	2
Average Score	Low Vulnerability	2.75

Species with average attribute scores between 2.46 and 3.00 are deemed to have a “low” vulnerability.

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Western Australia Shark Bay, Trawl, Bottom**Low Concern**

There are several populations of tiger prawn in Western Australia, but the Shark Bay population is the only one assessed in this report because the Shark Bay prawn trawl fishery is the only one that catches blue swimmer crab in significant quantities. In Shark Bay, scientific surveys of tiger prawn are conducted to estimate their abundance. Also, catch rates in the commercial fishery are monitored from year to year to look at changes in the population. The abundance of the breeding adult population in Shark Bay in 2013 was slightly below the target level of 25 kg/hr. But the abundance of new recruits to the population in 2014 was average, suggesting that the breeding population in 2013 was adequate. Further investigation indicated that the adult population shifted their distribution well south of the typical survey breeding grounds in 2013, which may explain the low estimated abundance of the adult population (Fletcher and Santoro 2014). Abundance surveys are now being conducted in an additional area to better estimate tiger prawn abundance. Although abundance was below the target level, the population is not considered depleted. This factor is rated “low” concern.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Australia Shark Bay, Trawl, Bottom

Low Concern

In Shark Bay, catches of tiger prawn in 2013 were 660 MT, which is within the target catch range for the species (400–700 MT). The fishery is managed in-season using spatial and temporal closures to ensure that the breeding population is maintained at an adequate level (Fletcher and Santoro 2014). Since fishing is closely controlled and likely occurring at a sustainable level, this factor is awarded a “low” concern score.

BENTHIC INVERTS

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Western Australia Shark Bay, Trawl, Bottom

Medium

In the Western Australia Shark Bay prawn trawl fishery that catches blue swimmer crabs, several non-target species of benthic invertebrates may be caught. In a study that evaluated trawling impacts on non-target species in Shark Bay, 360 different invertebrate species were recorded; however, most of these were caught in small numbers. Of the recorded species, 20 accounted for 88% of the total invertebrates caught. These species included coral prawns, endeavour prawns, swimmer crabs, scallops, lobster, sea slugs, sea squirts, and sea cucumbers (Kangas and Morrison 2013). Due to the diversity of species that may be caught in the Western Australia trawl fishery, the inherent vulnerability factor is rated as “medium.”

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Western Australia Shark Bay, Trawl, Bottom

Moderate Concern

For the majority of benthic invertebrates caught as bycatch in this fishery, there is little information available on their biology or abundance (Kangas and Morrison 2013). This factor is rated as “moderate” concern based on the unknown bycatch (see Appendix 3 in the Seafood Watch Wild Fisheries Assessment Criteria).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Australia Shark Bay, Trawl, Bottom

Moderate Concern

A research study on trawled vs. lightly or non-trawled areas in Western Australia Shark Bay suggests that fishing effects on non-target species (bycatch) are low (Fletcher and Santoro 2014). However, further studies are needed (Department of Fisheries WA 2014c). Several regulations are in place to reduce impacts on non-target species. These include the mandatory use of bycatch reduction devices, fishing effort restrictions, and a number of closed areas to trawling (Kangas and Morrison 2013) (Department of Fisheries WA 2014c). This is scored as “moderate” concern based on the unknown bycatch matrix (see Appendix 3 in the Seafood Watch Wild Fisheries Assessment Criteria).

FINFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Western Australia Shark Bay, Trawl, Bottom

Medium

In the Western Australia Shark Bay prawn trawl fishery that catch blue swimmer crabs, several non-target species of finfish may be caught. In a study that evaluated trawling impacts on non-target species in Shark Bay, over 241 different finfish were recorded; however, most of these were caught in small numbers. Of the recorded species, 20 accounted for 80% of the total finfish caught. These species included leatherjackets, goatfish, toadfish, scorpionfish, emperor, trumpeter, stinkfish, butterfly, lizardfish, whiting, and flounder (Kangas and Morrison 2013). Due to the diversity of species that may be caught in the Western Australia trawl fishery, inherent vulnerability is rated as “medium.”

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Western Australia Shark Bay, Trawl, Bottom

Moderate Concern

For most of the finfish species caught as bycatch in this fishery, there is little information available on

their biology or abundance (Kangas and Morrison 2013). This factor is rated as “moderate” concern based on the unknown bycatch matrix (see Appendix 3 in the Seafood Watch Wild Fisheries Assessment Criteria).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Australia Shark Bay, Trawl, Bottom

Moderate Concern

A research study on trawled vs. lightly or non-trawled areas in Western Australia Shark Bay suggests that fishing effects on non-target species (bycatch) are low (Fletcher and Santoro 2014). However, further studies are needed (Department of Fisheries WA 2014c). Several regulations are in place to reduce impacts on non-target species. These include the mandatory use of bycatch reduction devices, fishing effort restrictions, and a number of areas closed to trawling (Kangas and Morrison 2013) (Department of Fisheries WA 2014c). This is scored as “moderate” concern based on the unknown bycatch matrix (see Appendix 3 in the Seafood Watch Wild Fisheries Assessment Criteria).

KUAHONU CRAB

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Queensland South Pacific, Pot

Low

Kuahonu crab (or three-spotted crab) can grow up to 17 cm (6.7 in) in carapace (shell) length and are thought to live for around 2.5 years (Dineshababu et al. 2007). In Australia, male kuahonu crabs reach sexual maturity at around 8.3 cm (6.4 in) and females reach sexual maturity at around 7.4 cm (2.9 in) (Sumpton et al. 1989). This species can produce a high number of eggs and, like other crabs, it carries its eggs under the abdomen. Given these life-history attributes, this species is considered to have a “low” inherent vulnerability to fishing.

Rationale:

Table 1: Results from Seafood Watch fish vulnerability rubric (criteria document, pg. 4). Attribute scores can range from 1-3 with higher scores signifying more resilient life history attributes.

Vulnerability attribute	Category	Score
Average age at maturity	< 5 years	3
Average maximum age	< 10 years	3
Fecundity	>100 eggs	N/A
Reproductive strategy	Broadcast spawner	3
Density dependence	No depensatory or compensatory dynamics demonstrated or likely	2
Average Score	Low Vulnerability	2.75

Species with average attribute scores between 2.46 and 3.00 are deemed to have a “low” vulnerability.

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Queensland South Pacific, Pot

Moderate Concern

Little information on the kuahonu (or three-spotted crab) is available and their abundance in Queensland, Australia is unknown. This species is not listed on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN 2013). Since abundance is unknown and this species has a low inherent vulnerability to fishing, this factor is rated “moderate” concern.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Queensland South Pacific, Pot

Moderate Concern

There is no directed fishery for kuahonu crab (or three-spotted crab) in Queensland, Australia. This species is caught as bycatch in the blue swimmer crab pot fishery and several other fisheries (Hill and Garland 2009). The impact of the blue swimmer crab pot fishery on the kuahonu crab and other bycatch through direct capture is considered minor. However, gear loss in the fishery and continued fishing of the lost pots (known as “ghost fishing”) is a concern and could affect the kuahonu crab. The impact of the blue swimmer crab pot fishery on the kuahonu crab due to gear loss is considered moderate (Hill and Garland 2009). Given the limited information about fishing levels on kuahonu crab and some concern about the impact of the blue swimmer crab fishery on this species, this factor is rated “moderate” concern.

WESTERN KING PRAWN

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Western Australia Shark Bay, Trawl, Bottom

Low

In Western Australia, king prawns can live up to 4 years. Males can reach a carapace or shell width of 4.8 cm (1.9 in) and females can reach 6.3 cm (2.5 in). They reach sexual maturity between 6 and 8 months of age and a carapace width between 2.3 and 2.7 cm (0.9 and 1.1 in) (Kangas and Cameron 2012). King prawns typically spawn throughout the year and a single prawn can spawn more than once a year. A female prawn can release hundreds of thousands of eggs during each spawning. King prawns feed at night on plant material, decaying organic matter, microorganisms, small shellfish, and worms. They are preyed upon by squid, cuttlefish, and demersal fish (Department of Fisheries WA 2013c). Based on these life-history attributes, the inherent vulnerability of king prawns in Western Australia is deemed “low.”

Rationale:

Table 1: Results from Seafood Watch fish vulnerability rubric (criteria document, pg. 4). Attribute scores can range from 1-3 with higher scores signifying more resilient life history attributes.

Vulnerability attribute	Category	Score
Average age at maturity	< 5 years	3
Average maximum age	< 10 years	3
Fecundity	>100 eggs	N/A
Reproductive strategy	Broadcast spawner	3
Density dependence	No depensatory or compensatory dynamics demonstrated or likely	2
Average Score	Low Vulnerability	2.75

Species with average attribute scores between 2.46 and 3.00 are deemed to have a “low” vulnerability.

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Western Australia Shark Bay, Trawl, Bottom

Low Concern

There are several populations of king prawn in Western Australia, but the Shark Bay population is the

only one assessed here because the Shark Bay prawn trawl fishery is the only one that catches blue swimmer crab in significant quantities. In Shark Bay, catch-and-effort data from the 1970s–1990s shows no evidence that the population of king prawns was ever below a sustainable level (Kangas and Cameron 2012). Abundance fluctuates from year to year, likely as a result of environmental factors. Scientific surveys indicate that current mean abundance of the western king prawn breeding adult population catch rate is 49.4 kg/hr, which is above the historical abundance range for this species (16–29 kg/hr) (Fletcher and Santoro 2014). Current abundance is considered adequate (Fletcher and Santoro 2014). This factor is therefore rated “low” concern.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Australia Shark Bay, Trawl, Bottom

Low Concern

Commercial catches of king prawns in 2013 were 1,139 MT, which is within the target range for this species (950 MT to 1,350 MT) (Fletcher and Santoro 2014). The fishery is managed in-season using spatial and temporal closures to ensure the breeding population is maintained at an adequate level (Fletcher and Santoro 2014). Since fishing is closely controlled and likely occurring at a sustainable level, we have awarded a “low” concern score.