Monterey Bay Aquarium
Seafood Watch

Environmental sustainability assessment of wild-caught New Zealand Cockle (*Austrovenus stutchburyi*) from New Zealand caught using hand dredges, hand implements, and mechanized dredges

Species:	New Zealand Cockle (*Austrovenus stutchburyi*)
Location:	New Zealand: Southwest Pacific
Gear:	Hand dredges, Hand implements, Mechanized dredges
Type:	Wild Caught
Author:	Seafood Watch
Published:	Published July 10, 2017, Reviewed April 13, 2020 – see Appendix A for more information
Report ID:	844

Assessed using Seafood Watch Fisheries Standard v3

Table of Contents

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 Watch Assessment. Each assessment 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." This ethic is operationalized in the Seafood Watch standards, available on our website here. In producing the assessments, 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 assessments 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 Watch assessments in any way they find useful.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard. 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 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

This report assesses the sustainability of the New Zealand cockle *(Austrovenus stutchburyi;* formerly *Chione stutchburyi)* hand gear and mechanical dredge fisheries operating in two management areas in New Zealand. There is recreational and customary harvest across New Zealand, but commercial harvest only occurs at Otago Peninsula (COC 3) and Tasman and Golden Bays (COC 7A). The Whangarei Harbour commercial fishery has been closed since 2012 and is no longer rated in this report.

The New Zealand cockle is a marine bivalve that is found on protected beaches and shores around the North and South Islands, Stewart Island, the Chatham Islands, and the Auckland Islands in New Zealand. It is found in shallow, sandy, intertidal habitats and can be the dominant species in these habitats.

Each management area is considered a separate population of cockles and all are managed as such. Population assessments by the Ministry for Primary Industries as well as independent researchers have occurred at all three management areas. Cockle populations have remained relatively stable and are thought to be at healthy levels at Golden and Tasman Bays (COC 7A) and Otago Peninsula (COC 3). But the most recent assessment at Whangarei Harbour (through 2009) showed a decline in biomass for unknown reasons.

The majority of commercial catch has been from Otago Peninsula, where catches have remained relatively stable since 2002–2003, when cockle entered the Quota Management System. Landings in Whangarei Harbour (COC 1A) at Snake Bank have not occurred since 2012 due to low biomass levels from unknown causes.

Cockle is managed by the Ministry for Primary Industries of New Zealand and entered the Quota Management System in 2002. At each management area, the fishery is managed under a total allowable catch, with a certain level of cockles allocated for commercial, recreational, and customary fishing as well as a small portion for other fishing-related mortality. Since cockle entered the Quota Management System, harvest has remained well below the total allowable catch in each management area.

Cockles are caught with hand gear in Otago Peninsula and mechanical dredges in Golden and Tasman Bays. With both gear types, bycatch is considered low, and any other captured species (typically undersized cockle or other invertebrates) are returned to the water.

The cockle fisheries have an overall moderate impact on the ocean habitat and ecosystem. Because cockles are found in the top portion of sandy sediment, there are moderate impacts on the benthos and bottom habitat. In each management area, harvest is restricted to certain sites, so ecosystem impacts are spatially limited.

Overall, the cockle hand gear and dredge fisheries in New Zealand are rated Green, or "Best Choice."

Final Seafood Recommendations

SPECIES | FISHERY	CRITERION 1: Impacts on the Species	CRITERION 2: Impacts on Other Species	CRITERION 3: Management Effectiveness	CRITERION 4: Habitat and Ecosystem	OVERALL RECOMMENDATION
New Zealand cockle | Otago Peninsula (COC 3) New Zealand/Southwest Pacific | Hand dredges | New Zealand | Otago Peninsula (COC 3)	Green (3.413)	Green (5.000)	Yellow (3.000)	Yellow (2.739)	**Best Choice (3.441)**
New Zealand cockle | Otago Peninsula (COC 3) New Zealand/Southwest Pacific | Hand implements | New Zealand | Otago Peninsula (COC 3)	Green (3.413)	Green (5.000)	Yellow (3.000)	Yellow (2.739)	**Best Choice (3.441)**
New Zealand cockle | Tasman and Golden Bays (COC 7A) New Zealand/Southwest Pacific | Mechanized dredges | New Zealand | Tasman and Golden Bays (COC 7A)	Green (3.413)	Green (5.000)	Yellow (3.000)	Yellow (2.739)	**Best Choice (3.441)**

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 >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no

Critical scores

- **Avoid/Red** = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern 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).

Introduction

Scope of the analysis and ensuing recommendation

This report covers the New Zealand cockle *(Austrovenus stutchburyi;* formerly *Chione stutchburyi).* New Zealand cockle is fished by handpicking with the use of a hand sorter and with dredges.

Species Overview

The New Zealand cockle is a shallow-burying shellfish that is found in intertidal estuarine environments across the North and South Islands, Stewart Island, and Chatham Island in New Zealand (Morton and Miller 1973) (Spencer et al. 2002). Cockle can be found typically from the lowest high water line to the lowest edge of the shore and has been found as deep as 20 meters, although it prefers shallow habitats. In the upper limit of its habitat, cockle only experiences around 3.5 hours of submergence daily (Larcombe 1971). New Zealand cockle is a fast-growing species, with growth rate dependent on environmental factors such as temperature and salinity (Marsden 2004). Cockle reaches sexual maturity at around 18 mm in length and 2 years of age (Larcombe 1971) and may live to 20 years of age (Owen 1992). Cockle is mobile when it is small, but once it reaches 25 mm in size, it becomes fairly sedentary and is an easy target for fishers.

Across New Zealand there are commercial, recreational, and traditional Maori fisheries that target the New Zealand cockle. Commercial fishing for the New Zealand cockle occurs in two main areas: Papanui and Waitati Inlets, Otago Peninsula (COC 3); and at Pakawau Beach, Ferry Point, and Tapu Bay in Tasman and Golden Bays (COC 7A). Commercial fishing previously occurred at Snake Bank in Whangarei Harbour (COC 1), but no landings have been reported since 2012. Little is known about the population structure of the New Zealand cockle, so in the absence of information, each fishing area is managed as a discrete population (MPI 2016f). The fisheries are managed by the Minister of Primary Industries (MPI) under the Fisheries Act of 1996 (MPI 2016a). The New Zealand cockle entered the Quota Management System on October 1, 2002 and has since been managed under a total allowable catch each year, with separate catch limits set for each fishery management area. There is no minimum size limit, but in general fishers do not catch cockle until it reaches 28–30 mm in length (MPI 2016f).

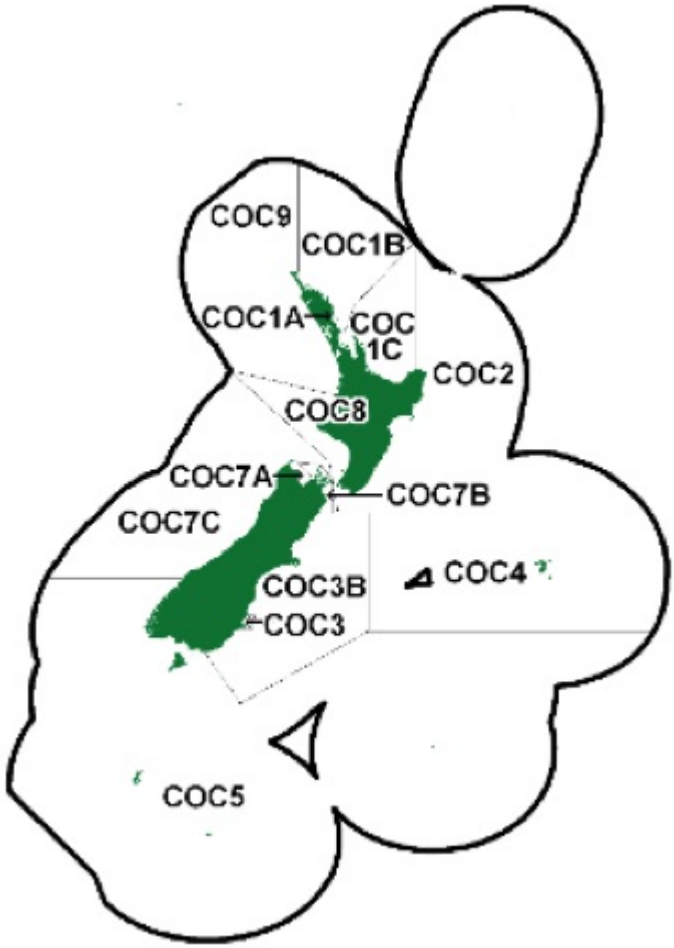

Figure 1 The cockle fishing management areas in New Zealand. Commercial fishing occurs at Snake Bank in Whangarei Harbour (COC 1A); Papanui and Waitati Inlets, Otago Peninsula (COC 3); and at Pakawau Beach, Ferry Point, and Tapu Bay in Tasman and Golden Bays (COC 7A). Figure from (MPI 2016f).
.}

Production Statistics

Total commercial landings of the New Zealand cockle have declined some since the early 2000s but have remained stable in recent years, averaging 1,100 metric tons (MT) (2,425,000 lb) from 2011 to 2015. Most of the catch is taken in Otago Peninsula (800 MT/year during 2011–2015), followed by Tasman and Golden Bays (280 MT/year during 2011–2015). Catches in Whangarei Harbour are low and declining. No commercial catch has occurred in Whangarei Harbour since 2012 (MPI 2016b).

In Otago Peninsula, fishing has historically been restricted to handpicking, but in recent years some catches have been taken with hand-pushed dredges. In Tasman and Golden Bays, fishing occurs with mechanical dredges.

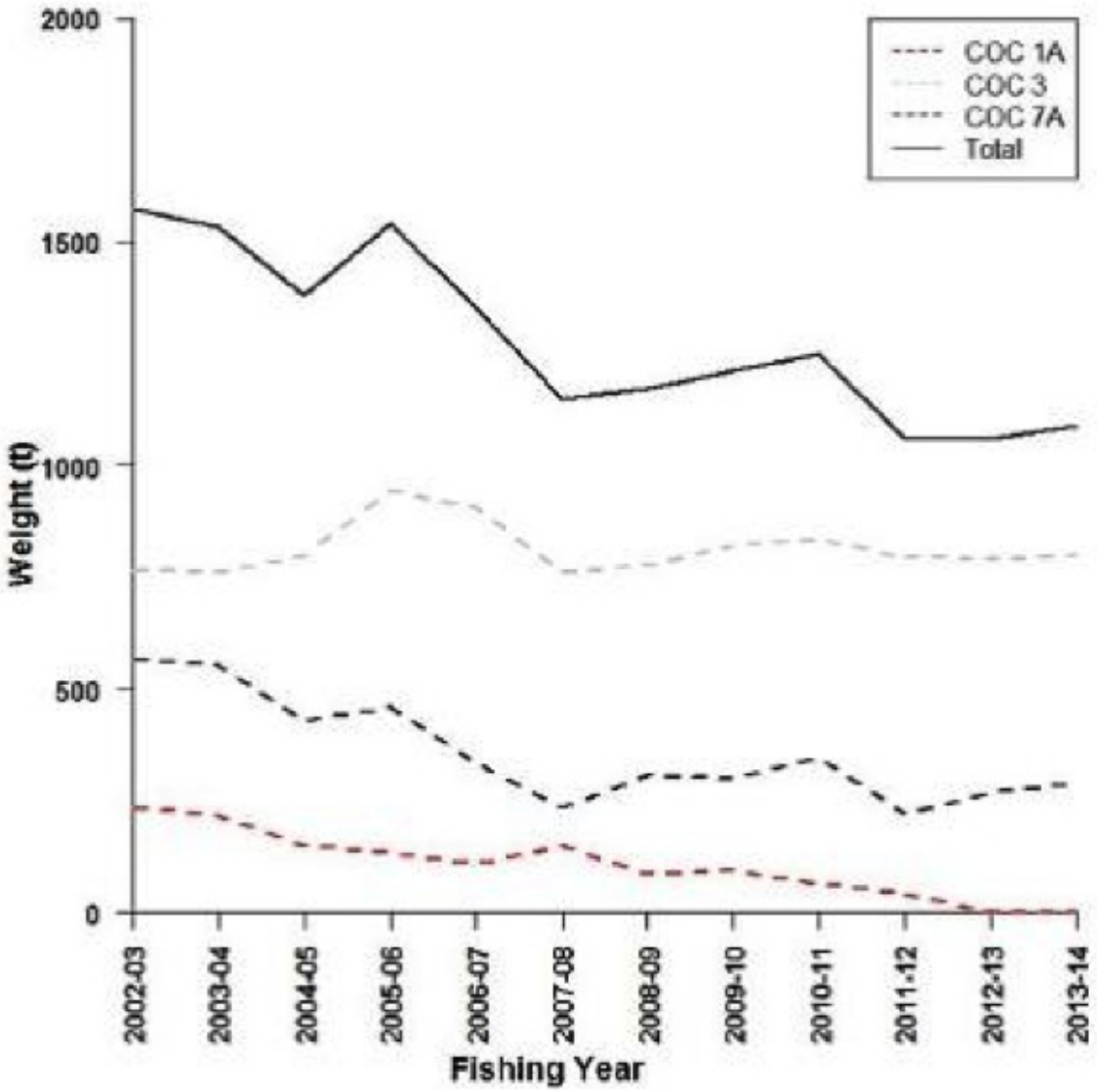

Figure 2 Commercial landings of New Zealand cockle in Whangarei Harbour (COC 1A), Otago (COC 3), and Tasman and Golden Bays (COC 7A), as well as the total commercial landings. Figure from (MPI 2016b).
.}

Importance to the US/North American market.

The New Zealand cockle is an economically important shellfish species and has been exported to the United States. From 2002 to 2009, New Zealand reported exporting 100–400 MT (220,000–882,000 lb) of cockle to the United States (MPI 2017a). Export values for more recent years are not available.

Total clam imports (all species, including cockle) to the United States were 23,356 MT (51 million lb) in 2014 and 28,384 MT (63 million lb) in 2015. The top exporter was China, followed by Canada and Vietnam. Imports of unspecified clams from New Zealand were 517 MT (1,140,000 lb) in 2014 and 440 MT (970,000 lb) in 2015 (NMFS 2016).

Common and market names.

The New Zealand cockle is commonly referred to as littleneck clam and its native names, tuaki and tuangi. The acceptable market names, as identified by the Food and Drug Administration, are "clam" and "Venus" (FDA 2015).

Primary product forms

New Zealand cockle is typically sold fresh (alive), frozen, and occasionally canned (Seafood Source 2011).

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the Species Under Assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. 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

Guiding Principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*

Criterion 1 Summary

NEW ZEALAND COCKLE			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
New Zealand/Southwest Pacific | Hand dredges New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)	2.33: Moderate Concern	5.00: Low Concern	Green (3.413)
New Zealand/Southwest Pacific | Hand implements New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)	2.33: Moderate Concern	5.00: Low Concern	Green (3.413)

NEW ZEALAND COCKLE			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
New Zealand/Southwest Pacific | Mechanized dredges New Zealand | Tasman and Golden Bays (COC 7A) | Tasman and Golden Bays (COC 7A)	2.33: Moderate Concern	5.00: Low Concern	Green (3.413)

The three management areas where commercial fishing for New Zealand cockle occurs are Whangarei Harbour (COC1), Otago Peninsula (COC3), and Tasman and Golden Bays (COC 7A). In the absence of specific information on the population structure of the New Zealand cockle, each fishing management area is treated as an independent population. In all areas, abundance relative to target abundance goals is not known, but no populations are considered overfished. Fishing in most areas is believed to be sustainable, with catches well below the established catch limits. The majority of the commercial catch comes from Otago Peninsula, followed by Tasman and Golden Bays. No commercial catch has occurred in Whangarei Harbour (COC 1A) since 2012, but catches may occur here again in the future and it is still considered a harvest zone.

Because of the limited recent abundance information and the lack of defined target abundance reference points for the regions evaluated in this assessment, the Productivity-Susceptibility Analysis (PSA) Scoring tool was used to evaluate the vulnerability of New Zealand cockle and to score abundance. According to the PSA, New Zealand cockle has a "low" vulnerability. See below for additional details on cockle abundance across the three management sites.

Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: $S = [(s1 * s2 * s3 * s4) - 1/40] + 1$.

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: $V = \sqrt{(P2 + S)2}$

Vulnerability Score Range

- < 2.64 = Low vulnerability
- ≥ 2.64 and ≤ 3.18 = Medium vulnerability
- > 3.18 = High vulnerability

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)	Source
Average age at maturity	2 years	1	{Larcombe 1971}
Average maximum age	10 years	2	{Owen 1992}
Fecundity	High	1	N/A
Reproductive strategy	Broadcast spawner	1	{MPI 2016f}
Trophic level	Second trophic level < 2.75	1	{MPI 2007}
Density dependence (invertebrates only)	Compensatory dynamics at low population size demonstrated or likely	1	{MPI 2007}

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	Unknown level of fishing on species concentration	3
Vertical overlap (Considers all fisheries)	Unknown degree of overlap between fishing depths and depth range of species	3
Selectivity of fishery (Specific to fishery under assessment)	Species is targeted and is not likely to escape the gear	2
Post-capture mortality (Specific to fishery under assessment)	Evidence of some (33%–66%) individuals released and survive post-capture.	2

The PSA score for cockle is 2.23, which corresponds to a low vulnerability.

Criterion 1 Assessment

SCORING GUIDELINES

Factor 1.1 - Abundance

Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.*
- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

NEW ZEALAND COCKLE | OTAGO PENINSULA (COC 3)

Factor 1.1 - Abundance

NEW ZEALAND/SOUTHWEST PACIFIC
Hand Dredges | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)

Moderate Concern

Cockle is found at various locations around the Otago Peninsula but is only commercially fished from Waitati Inlet, Papanui Inlet, and Otago Harbour (under a current special permit). Population surveys have been conducted periodically since 1984 to estimate cockle abundance at these three fished sites (MPI 2016h). The most recent abundance estimates are from 2011–2012. Since fishing began at Waitati Inlet, the biomass of adult cockles (>19 mm) has remained stable around the virgin or unfished biomass level (B_0) (Figure 3) (MPI 2016h). At Papanui Inlet, there has been a gradual decline in estimated biomass since the commencement of fishing in the 1980s, to around 70% of the virgin or unfished biomass (Figure 3). But no fishing has occurred at Papanui Inlet since 2006-2007. Recruited biomass estimates at Otago Harbour indicate that biomass declined prior to the start of commercial fishing in 2009, and has declined further since (Figure 3) (MPI 2016h).

There is no abundance estimate for New Zealand cockle in Otago Peninsula and no target abundance reference point has been defined. But the Ministry for Primary Industries (2016h) states that it is highly likely that the population is above the limit reference point (20% B_0) and not overfished. Abundance is therefore considered to be of "moderate" concern.

Justification:

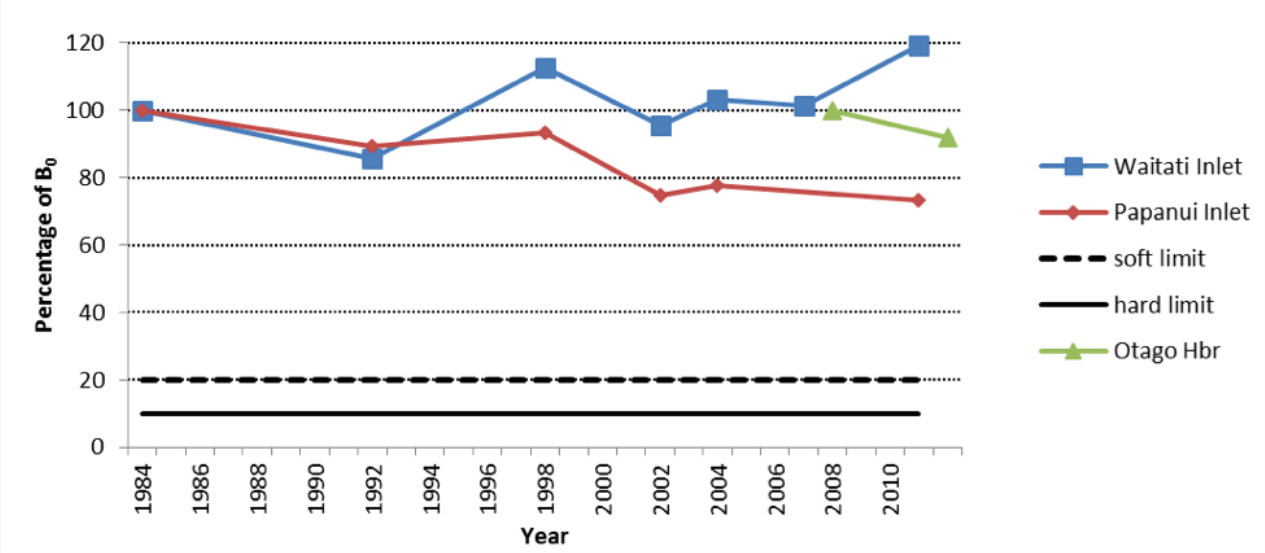

Figure 3 Cockle biomass (> 19 mm) as a proportion of virgin or unfished biomass (B0) for Waitati and Papanui Inlets. No catch has been taken from Papanui Inlet since 2006–2007. Figure from (MPI 2016h).

NEW ZEALAND/SOUTHWEST PACIFIC
Hand Implements | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)

Moderate Concern

Cockle is found at various locations around the Otago Peninsula but is only commercially fished from Waitati Inlet, Papanui Inlet, and Otago Harbour (under a current special permit). Population surveys have been conducted periodically since 1984 to estimate cockle abundance at these three fished sites (MPI 2016h). The most recent abundance estimates are from 2011–2012. Since fishing began at Waitati Inlet, the biomass of adult cockle (>19 mm) has remained stable around the virgin or unfished biomass level (B_0) (Figure 3) (MPI 2016h). At Papanui Inlet, there has been a gradual decline in estimated biomass since the commencement of fishing in the 1980s to around 70% of the virgin or unfished biomass (Figure 3). But no fishing has occurred at Papanui Inlet since 2006–2007. Recruited biomass estimates at Otago Harbour indicate that biomass declined prior to the start of commercial fishing in 2009, and has declined further since (Figure 3) (MPI 2016h).

There is no abundance estimate for New Zealand cockle in Otago Peninsula and no target abundance reference point has been defined. But the Ministry for Primary Industries (2016h) states that it is highly likely that the population is above the limit reference point (20% B_0) and not overfished. Abundance is therefore considered to be of "moderate" concern.

Factor 1.2 - Fishing Mortality

NEW ZEALAND/SOUTHWEST PACIFIC
Hand Dredges | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)

Low Concern

Since 2002, the New Zealand cockle fishery in Otago Peninsula has been managed under a total allowable catch (TAC) of 1,500 MT, which includes a total allowable commercial catch of 1,470 MT, a recreational catch

allowance of 10 MT, a customary catch allowance of 10 MT, and an allowance for other fishing-related mortality of 10 MT (MPI 2016h). Total allowable catch limits are set based on estimates of the sustainable fishing levels (MPI 2016e).

Commercial fishing for New Zealand cockle has occurred since 1983 at two principal sites in Otago Peninsula: Papanui Inlet and Waiti Inlet (MPI 2016h). Commercial fishing at these sites is restricted to handpicking. Catches were around 90 MT in Papanui Inlet in the 1990s to early 2000s but have since declined, and no catch has been taken there since 2006–2007 because of water quality issues (MPI 2016h). Catches in Waiti Inlet ranged from 500 to 900 MT from 2000 to 2009 but have declined in recent years to 200–400 MT. Since 2009, commercial catches have also been taken in Otago Harbour under a special permit to investigate the ecosystem effects of fishing for cockle in the harbor (MPI 2016h). Catches at this site are taken with hand-pushed dredges and have been around 400–600 MT in recent years. Total commercial catches in Otago Peninsula have remained relatively stable since 2002 and well below the total annual commercial catch limit (MPI 2016h). Additionally, the exploitation rate (landings/biomass) for mature cockle ≥19 mm has been less than 7% at all three fished sites (Figures 9 and 10). Small recreational and customary catches of cockle occur in other areas, but these are poorly estimated. Overall, it is considered very unlikely (<10% probability) that overfishing is occurring (MPI 2015e). Fishing mortality is therefore considered "low" concern.

Justification:

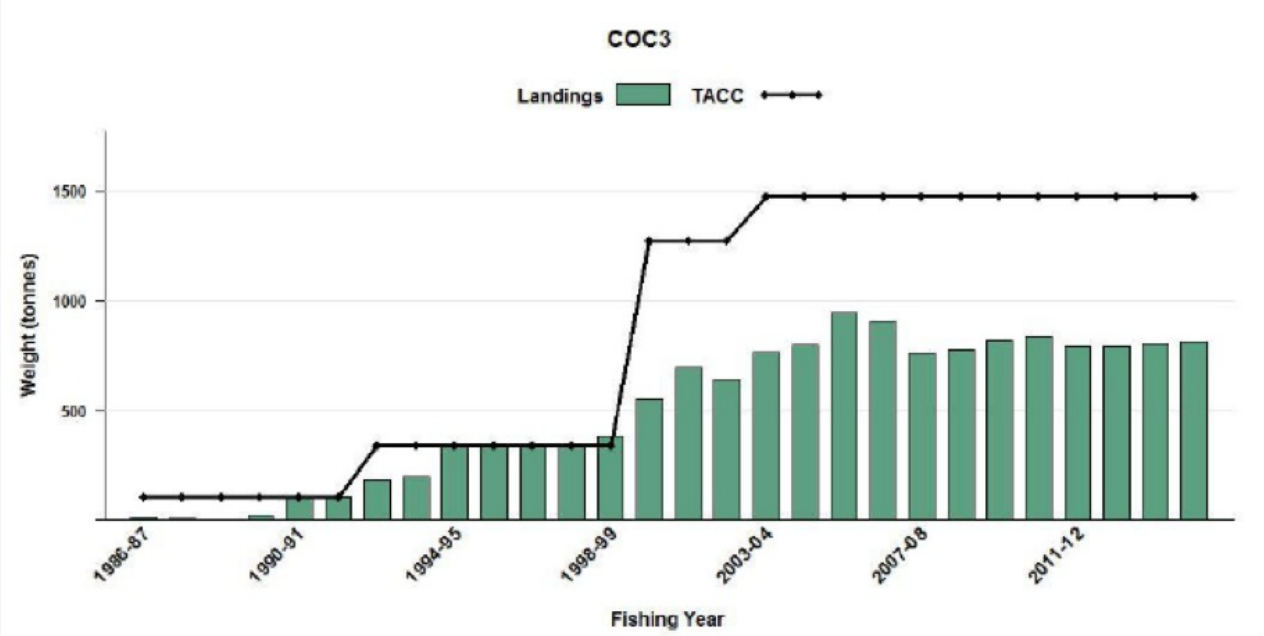

Figure 4 The reported commercial landings (in pounds) compared to the total allowable commercial catch (TACC) from 1986–2016. Figure from (MPI 2016h).

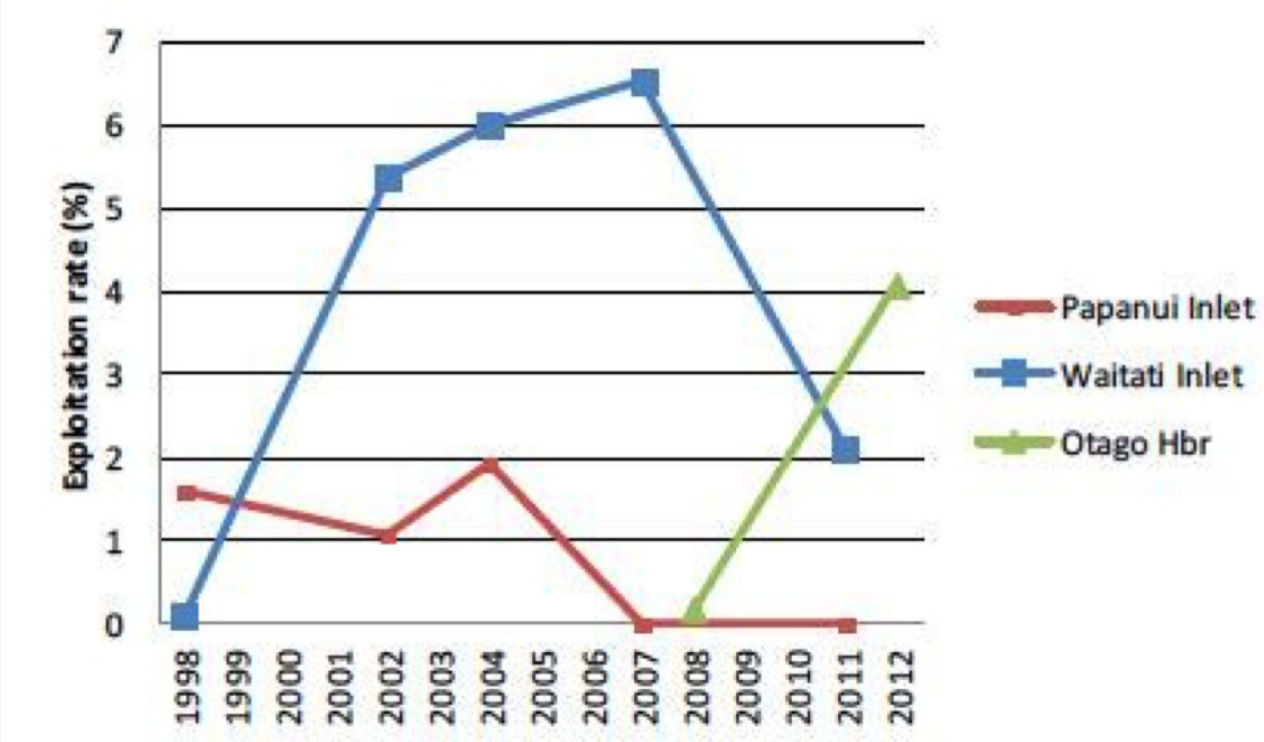

Figure 5 Exploitation rates (landings divided by biomass) for the three commercially fished sites. No commercial catch has occurred at Papanui Inlet since 2006–2007. Figure from (MPI 2016b).

NEW ZEALAND/SOUTHWEST PACIFIC

Hand Implements | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)

Low Concern

Since 2002, the New Zealand cockle fishery in Otago Peninsula has been managed under a total allowable catch (TAC) of 1,500 MT, which includes a total allowable commercial catch of 1,470 MT, a recreational catch allowance of 10 MT, a customary catch allowance of 10 MT, and an allowance for other fishing related mortality of 10 MT (MPI 2016h). Total allowable catch limits are set based on estimates of the sustainable fishing levels (MPI 2016e).

Commercial fishing for New Zealand cockle has occurred since 1983 at two principal sites in Otago Peninsula: Papanui Inlet and Waiti Inlet (MPI 2016h). Commercial fishing at these sites is restricted to handpicking. Catches were around 90 MT in Papanui Inlet in the 1990s to early 2000s but have since declined, and no catch has been taken there since 2006–2007 because of water quality issues (MPI 2016h). Catches in Waiti Inlet ranged from 500 to 900 MT from 2000 to 2009 but have declined in recent years to 200–400 MT. Since 2009, commercial catches have also been taken in Otago Harbour under a special permit to investigate the ecosystem effects of fishing for cockle in the harbor (MPI 2016h). Catches at this site are taken with hand-pushed dredges and have been around 400–600 MT in recent years. Total commercial catches in Otago Peninsula have remained relatively stable since 2002 and well below the total annual commercial catch limit (MPI 2016h). Additionally, the exploitation rate (landings/biomass) for mature cockle ≥19 mm has been less than 7% at all three fished sites (Figures 9 and 10). Small recreational and customary catches of cockle occur in other areas, but these are poorly estimated. Overall, it is considered very unlikely (<10% probability) that overfishing is occurring (MPI 2015e). Fishing mortality is therefore considered "low" concern.

Factor 1.1 - Abundance

NEW ZEALAND/SOUTHWEST PACIFIC
Mechanized Dredges | New Zealand | Tasman And Golden Bays (COC 7A) | Tasman And Golden Bays (COC 7A)

Moderate Concern

Cockle is widely distributed across Tasman and Golden Bays and managed as a single population in this area (MPI 2016f). There are three sites open for commercial fishing: Pakawau Beach, Tapu Bay-Riwaka, and Ferry Point (MPI 2016f), although Pakawau Beach is the main area fished. Surveys to estimate abundance are conducted by harvesters with funding from MPI and have been conducted at these commercially fished sites, with the most recent population assessment in 2014 (Osborne 2010) (pers. comm., Anonymous 2017). Cockle biomass at Pakawau Beach has fluctuated with variable recruitment, but declined as the virgin stock was fished down. But the abundance of young cockle at Pakawau Beach has increased, and recent surveys have shown stable recruited biomass (pers. comm., Anonymous 2017). Limited abundance surveys at Riwaka and Ferry Point show that abundance has declined some since the onset of commercial fishing (Figure 9) (MPI 2016f).

There are no estimates of abundance relative to target reference points, such as biomass at maximum sustainable yield (B_{MSY}), but managers believe it is unlikely that the cockle population in Tasman and Golden Bays is overfished (MPI 2016g). Consequently, abundance is considered of "moderate" concern.

Justification:

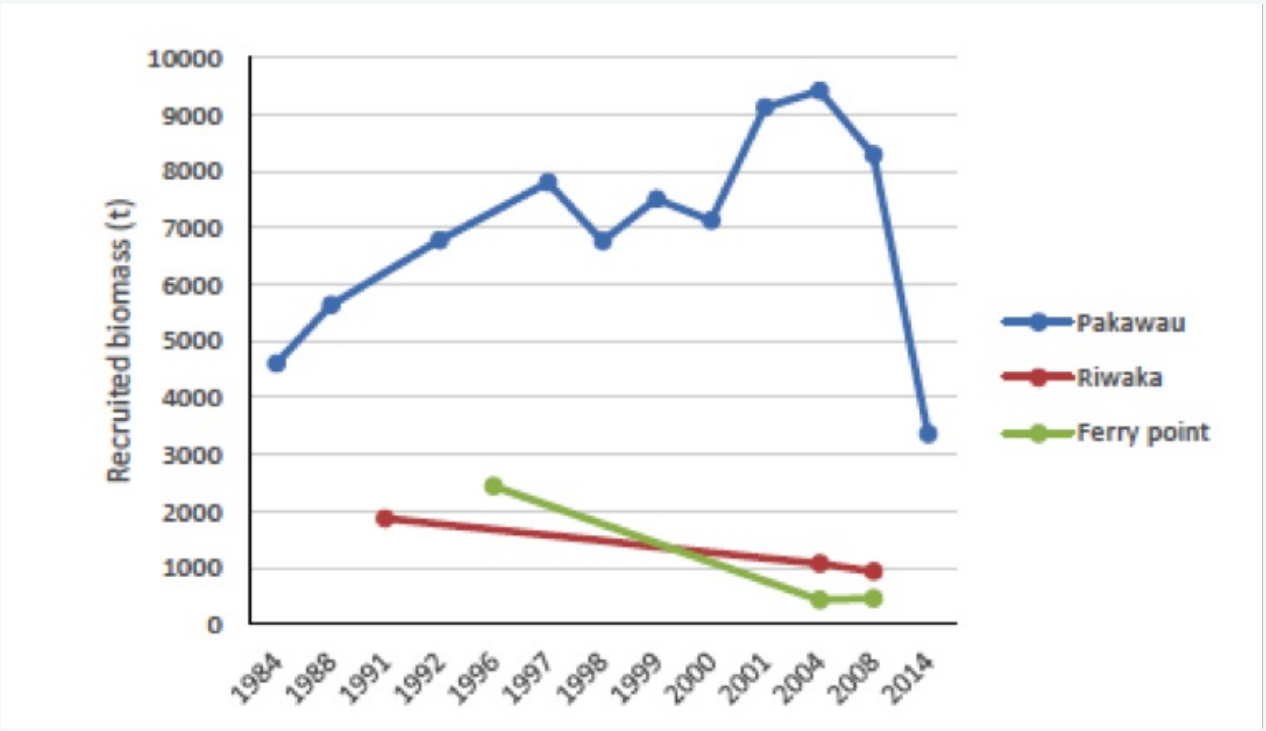

Figure 6 Recruited biomass (= 30 mm shell length) of New Zealand cockle at the three commercial fished sites in Tasman and Golden Bays. Commercial fishing began in Pakawau in 1984, Riwaka in 1990–1991, and Ferry Point in 1998–1999. Notably, the area surveyed over time has changed and decreased at the last time of survey (compared to previous occasions) at all three sites. Figure from (MPI 2016g).

Factor 1.2 - Fishing Mortality

NEW ZEALAND/SOUTHWEST PACIFIC
Mechanized Dredges | New Zealand | Tasman And Golden Bays (COC 7A) | Tasman And Golden Bays (COC 7A)

Low Concern

The New Zealand cockle fishery in Tasman and Golden Bays is managed under a total allowable catch (TAC) of 1,510 MT, which includes a total allowable commercial catch (TACC) of 1,390 MT, a customary allowance of 25 MT, a recreational allowance of 85 MT, and an allowance for other fishing related mortality of 10 MT. Total allowable catch limits are set based on estimates of sustainable fishing levels (MPI 2016e) (MPI 2016f) (MPI 2016g).

Commercial fishing for cockle in Tasman and Golden Bays primarily occurs at Pakawau Beach. Commercial fishing began there in 1984. Some commercial fishing also has occurred at Tapu Bay-Riwaka beginning in 1992–1993 and Ferry Point beginning in 1998–1999. But no commercial landings have been reported at Ferry Point since 2004, and landings have been low at Tapu Bay-Riwaka in recent years due to poor water quality. The sites where commercial fishing occurs are quite small with respect to the total resource, and landings have remained well below the total allowable commercial catch (Figure 6). Commercial landings since 2004–2005 have been at an intermediate level compared to past levels and have fluctuated with no real trend between 220 and 460 MT (485,017–1,014,000 lbs) (MPI 2016g). The commercial yield at Pakawau Beach is being maintained below maximum allowable levels to preserve a stock of large cockles to serve a market niche. In COC 7A, there are currently only three quota holders who fish, and as of 2017, only one is actively fishing. The current fisher in COC 7A harvests cockle at a level lower than the MSY to help maintain large cockles in the area (pers. comm., Anonymous 2017). There are also some recreational and customary catches of New Zealand cockle in other areas of Tasman and Golden Bays, but these are not well estimated. Overall, scientists and managers consider it very unlikely (<10% probability) that overfishing is occurring (MPI 2015e). Fishing mortality is therefore considered "low" concern.

Justification:

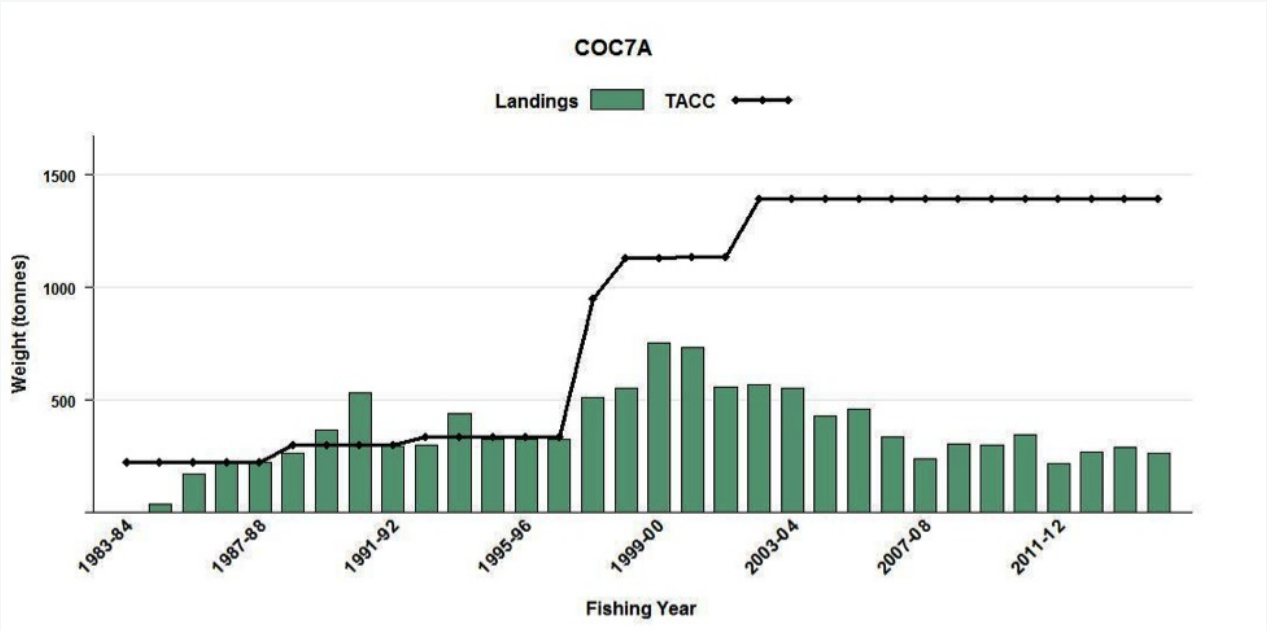

Figure 7 Total reported commercial landings of New Zealand cockle in Tasman and Golden Bays. Figure from (MPI 2016g).

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. 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. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait 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 is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Guiding Principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*
- *Minimize bycatch.*

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 A.

NEW ZEALAND COCKLE New Zealand/Southwest Pacific | Hand Dredges | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)					
Subscore:	**5.000**	**Discard Rate:**	**1.00**	**C2 Rate:**	**5.000**
Species | Stock	**Abundance**	**Fishing Mortality**	**Subscore**		
No other main species caught					

NEW ZEALAND COCKLE New Zealand/Southwest Pacific | Hand Implements | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)					
Subscore:	**5.000**	**Discard Rate:**	**1.00**	**C2 Rate:**	**5.000**
Species | Stock	**Abundance**	**Fishing Mortality**	**Subscore**		
No other main species caught					

NEW ZEALAND COCKLE
New Zealand/Southwest Pacific | Mechanized Dredges | New Zealand | Tasman And Golden Bays (COC 7A) | Tasman And Golden Bays (COC 7A)

Subscore:	5.000	Discard Rate:	1.00	C2 Rate:	5.000

Species | Stock	Abundance	Fishing Mortality	Subscore
No other main species caught			

In the New Zealand cockle fishery, harvest is direct and there is little to no bycatch or other main species landed with either hand gear or dredges. Other species that are found near cockles are other bivalves such as mussels and oysters, which grow in patches and are avoided by fishers (pers. comm., Southern Clams Limited 2016). According to MPI experts, the harvested beds are typically cockle monocultures and bycatch is minimal. Any bycatch that is caught is returned to the beach at the subsequent harvest in COC3 and COC7A (pers. comm., MPI 2017). Cockle is mainly harvested by hand with the use of sorters, which allow for selected harvest of cockle, have zero to little bycatch, and allow for small undersized cockles to be discarded alive (Wilson et al. 1988). Hand harvest may also be done with a steel basket that is pulled through the sand, lifted, and the contents sorted to allow for the handpicking of species (Irwin et al. 2003). Cockle is also harvested with the use of mechanical dredges in Golden and Tasman Bays (COC7A) (MPI 2016f). The mechanical dredges used are low-pressure dredges that remove the top 5–10 cm of sand, which is then passed over a sorting grid and the desirably sized cockles are retained (Schmechel 2001). This mode of dredging also tends to have low bycatch and allows for small cockles to be discarded alive (Wilson et al. 1998). At Otago Harbour, a portion of catch is harvested with "body dredges" by Southern Clams Limited, a small fishery in Otago Harbour. A body dredge is a small, light dredge with a basket that is pulled by a harvester. All bycatch, undersized cockles, and other materials that are brought in with the dredge are returned to the sediment. The process was designed by Southern Clams Limited (Southern Clams Limited 2017).

For all gear types, there are no known interactions with protected species within this fishery, and the bycatch of other invertebrates during the harvest of New Zealand cockle is considered low (Wilson et al. 1998) (MPI 2007). The most common bycatch species is pipi *(Paphies australis)*, but the levels of bycatch are thought to be low (Wilson et al. 1988). In addition, small (<30 mm) New Zealand cockles are commonly collected and discarded in this fishery, but it is likely that discards survive (Osborn 2010). Because bycatch is low and bait is not used in the New Zealand cockle fishery, a score of 5 is awarded for the impacts on other species.

2.4 - Discards + Bait / Landings

NEW ZEALAND/SOUTHWEST PACIFIC
Hand Dredges | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)

< 100%

With the body dredges, all bycatch, undersized cockles, and other materials that are brought in with the dredge are returned to the sediment alive. Therefore, the discard rate/landings is less than 100%.

NEW ZEALAND/SOUTHWEST PACIFIC
Hand Implements | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)

< 100%

Cockle is mainly harvested by hand with the use of sorters, which allow for selected harvest of cockle, have zero to little bycatch, and allow for small undersized cockles to be discarded alive (Wilson et al. 1988).

Therefore, the discard rate/landings is less than 100%.

NEW ZEALAND/SOUTHWEST PACIFIC

Mechanized Dredges | New Zealand | Tasman And Golden Bays (COC 7A) | Tasman And Golden Bays (COC 7A)

< 100%

The mechanical dredges used are low-pressure dredges that remove the top 5–10 cm of sand, which is then passed over a sorting grid and the desirably sized cockles are retained (Schmechel 2001). This mode of dredging also tends to have low bycatch and allows for small cockles to be discarded alive (Wilson et al. 1998). Therefore, the discard rate/landings is less than 100%.

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective,' 'moderately effective,' 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- *5 (Very Low Concern) — Meets the standards of 'highly effective' for all five factors considered.*
- *4 (Low Concern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.*
- *3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.*
- *2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'*
- *1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'*
- *0 (Critical) — Management Strategy and Implementation is 'critical'.*

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 = Red or High Concern*

Rating is Critical if Management Strategy and Implementation is Critical.

GUIDING PRINCIPLE

- The fishery is managed to sustain the long-term productivity of all impacted species.

Criterion 3 Summary

Fishery	Management Strategy	Bycatch Strategy	Research and Monitoring	Enforcement	Stakeholder Inclusion	Score
Fishery 1: New Zealand/Southwest Pacific | Hand dredges | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Highly Effective	Yellow (3.000)
Fishery 2: New Zealand/Southwest Pacific | Hand implements | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Highly Effective	Yellow (3.000)

Fishery 3: New Zealand/Southwest Pacific | Mechanized dredges | New Zealand | Tasman and Golden Bays (COC 7A) | Tasman and Golden Bays (COC 7A)	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Highly Effective	Yellow (3.000)

Criterion 3 Assessment

Factor 3.1 - 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? Do manages follow scientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.

NEW ZEALAND/SOUTHWEST PACIFIC
Hand Dredges | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)
NEW ZEALAND/SOUTHWEST PACIFIC
Hand Implements | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)
NEW ZEALAND/SOUTHWEST PACIFIC
Mechanized Dredges | New Zealand | Tasman And Golden Bays (COC 7A) | Tasman And Golden Bays (COC 7A)

Moderately Effective

All marine life in New Zealand waters is managed by the New Zealand Ministry of Primary Industries through the Fisheries Act of 1996 (MPI 2016a). The goal of management is to maintain populations above the levels necessary to produce the maximum sustainable yield (MSY). In all regions where fishing occurs, cockle is managed by the Ministry under the Quota Management System (QMS) (MPI 2016e). Under the Quota Management System, each Fishery Management Area is assigned a total allowable catch (TAC), which is divided into a commercial catch limit, a recreational allowance, a customary allowance, and an other mortality allowance (MPI 2007). The TAC levels are based on Maximum Constant Yield (MCY) and Current Annual Yield (CAY) levels determined by the population assessments (Mace et al. 2014) (MPI 2016i). Table 1 shows the TAC levels, which are based on a minimum harvest size of 30 mm for COC1 and COC7A and a size of 19 mm for COC3 (MPI 2016b) (MPI 2016h). The current TACs have been in place since 2002 and are based on estimates of sustainable fishing levels. But there is some indication that current TACs are too high for the COC1 management area and need to be updated (Williams et al. 2009).

There is also a mandatory shellfish program in place for all bivalves caught for human consumption in New Zealand, with procedures in place to monitor the water quality, biotoxins, and chemical contaminants (MPI 2016c).

Management has defined limit abundance reference points for cockle populations, but target abundance reference points, such as the biomass at maximum sustainable yield, have not been estimated.

Although the total allowable catch limit is supposed to be set based on the maximum sustainable yield (MSY),

the most recent assessment of Snake Bank cockle at Whangarei Harbor indicated that the current total allowable commercial catch may not be sustainable in the long-term, given the large fluctuations in cockle abundance that have occurred at Snake Bank (Williams et al. 2009). Commercial fishing has not occurred there since 2012, but there is uncertainty as to whether the current commercial catch limit is sustainable. The fisheries at COC3 and COC7A are small and currently only have one active fishery that is managed closely with the Ministry. In COC7A, the single harvester manages the take within the limits determined by management and conducts annual biomass surveys to ensure the most appropriate decisions are made for harvest. In COC3, there is also only one active harvester and they monitor catch per unit effort (CPUE) and conduct occasional biomass surveys (pers. comm., Anonymous 2017). Overall, management measures that are likely to be effective are in place, but more precaution may be needed. Because of this, a score of "moderately effective" is awarded.

Justification:

	Whangarei Harbour (COC 1A)	Otago (COC 3)	Tasman and Golden Bays (COC 7A)
Commercial TAC	346 tons (762,799 lbs)	1470 tons (3,240,795 lbs)	1390 tons (3064425 lbs)
Recreational TAC	25 tons (55,116 lbs)	10 tons (22,046 lbs)	85 tons (187,393 lbs)
Customary TAC	25 tons (55,116 lbs)	10 tons (22,046 lbs)	25 tons (55,116 lbs)
Other Mortality	4 tons (8,818 lbs)	10 tons (22,046 lbs)	10 tons (22,046 lbs)
Total TAC	400 tons (881,848 lbs)	1500 tons (3,306,934 lbs)	1510 tons (3,328,980 lbs)

Figure 8 The total allowable catch (TAC) for New Zealand cockle management areas as of 2016. Data from (MPI 2016b).

Factor 3.2 - Bycatch Strategy

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

NEW ZEALAND/SOUTHWEST PACIFIC
Hand Dredges | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)
NEW ZEALAND/SOUTHWEST PACIFIC
Hand Implements | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)
NEW ZEALAND/SOUTHWEST PACIFIC
Mechanized Dredges | New Zealand | Tasman And Golden Bays (COC 7A) | Tasman And Golden Bays (COC 7A)

Highly Effective

The New Zealand cockle fishery has very low (<5%) bycatch and no species of concern are caught (MPI 2007a) (Wilson et al. 1988). Because bycatch is very low, the bycatch management strategy is rated "highly effective."

Factor 3.3 - Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

NEW ZEALAND/SOUTHWEST PACIFIC
Hand Dredges | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)
NEW ZEALAND/SOUTHWEST PACIFIC
Hand Implements | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)
NEW ZEALAND/SOUTHWEST PACIFIC
Mechanized Dredges | New Zealand | Tasman And Golden Bays (COC 7A) | Tasman And Golden Bays (COC 7A)

Moderately Effective

Where commercial fishing occurs, catches are monitored by management and there have been periodic population assessments to evaluate abundance and determine appropriate fishing levels (MPI 2016g) (MPI 2016h) (MPI 2016i). Studies also have been completed by the government as well as independent researchers to investigate the biology of the cockle and fishing impacts on the cockle population, other species, and the habitat (Irwin 1999) (Watson et al. 2005) (Osborn 2010) (Griffins and Eyre 2014) (Williams et al. 2006). Although biomass surveys have been frequently conducted at some major fishing sites, they have been infrequent at other sites, so the status of some populations is uncertain (MPI 2016g) (MPI 2016h) (MPI 2016i). Additionally, information on noncommercial catches is lacking. Because there are some data related to stock abundance and health in all management areas but in some cases data may be insufficient to adequately ensure the long-term sustainability of the cockle populations, scientific research and monitoring is deemed "moderately effective."

Factor 3.4 - 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 ZEALAND/SOUTHWEST PACIFIC
Hand Dredges | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)
NEW ZEALAND/SOUTHWEST PACIFIC
Hand Implements | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)
NEW ZEALAND/SOUTHWEST PACIFIC
Mechanized Dredges | New Zealand | Tasman And Golden Bays (COC 7A) | Tasman And Golden Bays (COC 7A)

Moderately Effective

A permit is required for commercial fishing, and permit holders must report catch and effort information to the Ministry, typically within 7 days. Permit holders are required to land their catch to Licensed Fish Receivers, and both permit holders and Licensed Fish Receivers must supply monthly reports to the Ministry on the landed weights of all species (MPI 2017c). The catch effort reports and monthly reports are cross-checked to ensure accurate reporting and tracking of quotas (MPI 2016e). Each year, Annual Catch Entitlement (ACE) is generated on the basis of the total allowable commercial catch (TACC) and issued to holders of quota. All commercial fishers must obtain ACE to cover the quota management fish they catch in a fishing year (Telesetsky 2016) (MPI 2017b).

The enforcement of fishing rules and quotas is policed by Fishery Officers around New Zealand (MPI 2010).

Fishery officers patrol New Zealand's coastline to ensure all fishers comply with the rules (MPI 2016d). The ministry also monitors compliance by checking landed cockle returns, matching sales and inventory records (pers. comm., Anonymous 2017). For all New Zealand Fisheries within the Quota Management System, the Ministry closely monitors the amount of catch within each individual fisher's limits and levies financial penalties on commercial fishers who exceed their limits (MPI 2016d) (MPI 2017b). There was some evidence of significant illegal fishing taking place in Whangarei Harbour in the 1990s, including reports of fishers exceeding their catch limits and taking catches from closed areas. But current quantitative information on the level of illegal catch is unavailable (MPI 2016f). Enforcement of management regulations is deemed "moderately effective" because of the uncertainty about possible illegal catch.

Factor 3.5 - 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, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

NEW ZEALAND/SOUTHWEST PACIFIC
Hand Dredges | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)
NEW ZEALAND/SOUTHWEST PACIFIC
Hand Implements | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)
NEW ZEALAND/SOUTHWEST PACIFIC
Mechanized Dredges | New Zealand | Tasman And Golden Bays (COC 7A) | Tasman And Golden Bays (COC 7A)

Highly Effective

In New Zealand, it is stated by the Ministry that all stakeholders have rights and responsibilities related to the use and management of fisheries resources. Goals and conditions are in place to undertake effective engagement with stakeholders through the development of various advisory groups, workshops, and forums (MPI 2010). Historically, the Ministry has interacted with its stakeholder groups and other government agencies involved in fisheries-related issues, and stakeholder inclusion is deemed "highly effective."

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 (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 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*

GUIDING PRINCIPLES

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Region | Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Score
New Zealand/Southwest Pacific | Hand dredges New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)	2	+0.5	Moderate Concern	Yellow (2.739)
New Zealand/Southwest Pacific | Mechanized dredges New Zealand | Tasman and Golden Bays (COC 7A) | Tasman and Golden Bays (COC 7A)	2	+0.5	Moderate Concern	Yellow (2.739)
New Zealand/Southwest Pacific | Hand implements New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)	2	+0.5	Moderate Concern	Yellow (2.739)

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate

Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- *5 - Fishing gear does not contact the bottom*
- *4 - Vertical line gear*
- *3 - 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. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*
- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - 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.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*
- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management

Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles*

and ecosystem functioning.

- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*
- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate

NEW ZEALAND/SOUTHWEST PACIFIC
Hand Dredges | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)

2

At Otago Harbour, a portion of the catch is harvested with "body dredges" by Southern Clams Limited, a small fishery in Otago Harbour. A body dredge is a small, light dredge with a basket that is pulled by a harvester. All bycatch, undersized cockle, and other materials that are brought in with the dredge are returned to the sediment. A body dredge is less damaging to the shellfish and the habitat than a mechanical dredge. The process was designed by Southern Clams Limited (Southern Clams Limited 2017). Body dredges are small and are not mechanical, so damage to the bottom habitat is likely less significant than that of mechanical dredges, but they are still dragged/pushed along the bottom habitat. Because the body dredge is deployed over resilient mud/sand habitats, the impact is considered of "moderate" concern and a score of 2 was awarded.

NEW ZEALAND/SOUTHWEST PACIFIC
Hand Implements | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)

2

In Whangarei Harbour (COC 1A) and Otago (COC3), harvest is restricted to hand gathering of cockles, and fishers typically use hand sorters to separate cockles by size and from sediment (Williams et al. 2006) (MPI 2016f). The sorters used for hand harvest typically are made of a steel basket that is pulled through the sediment, then lifted and shook onto a sorting tray to sort cockles (Irwin et al. 2003). The use of hand sorters to pick and harvest cockles can affect the bottom habitat, but because the cockles are found just below the sediment, the impact is not large. There are no known studies that evaluate the impact of hand sorters specifically, but the gear is similar to hand rakes, hoes, or shovels that are used in many areas to dig for clams, which can have negative impacts on bottom habitat. A study was conducted on the impacts of digging for clams in soft-bottom habitats in Maine and found that digging may have a cumulative negative impact on the bottom community, reducing the overall species diversity in areas that are dug (Brown and Wilson 1997). When digging for clams, if the hole created is not refilled and if the beach is not exposed to high-energy waves and tides, the pile of sediment left on the beach may damage many other types of intertidal species (WDFW 2012). Hand sorters that are used to gather cockles use a similar method, but only contact the top 5–10 cm of sand where the cockles are found (Schmechel 2001). The research conducted at Otago Harbour examined the differences in habitat substrate where harvest was occurring. In the most recent survey, there were no significant differences found among sediment cores from treatment and control areas (Stewart 2013).

Because the hand gear contacts the bottom but is not fished on sensitive habitats, the impact is considered of "moderate" concern and a score of 2 was awarded.

NEW ZEALAND/SOUTHWEST PACIFIC
Mechanized Dredges | New Zealand | Tasman And Golden Bays (COC 7A) | Tasman And Golden Bays (COC 7A)

2

In Tasman and Golden Bays (COC7A), cockle is harvested with a mechanical dredge over the sandy intertidal sediments (MPI 2016g) (Schmechel 2001). The sand habitat in this area changes frequently due to storms and benthic fauna and is relatively resilient to disturbance from cockle harvesting on a 2-year rotation (pers. comm., Anonymous 2017). The mechanical dredges used are low-pressure and remove the top 5–10 cm of sand where cockles are found. The sand is then passed over a sorting grid where the cockles are sorted and the desirably-sized ones are retained (Schmechel 2001). A study was conducted to determine the physical effects of tractor-towed cockle dredges (similar to those used in New Zealand) on the seabed and bottom communities in the Bury Inlet, England. The study determined that this method of fishing can have significant negative impacts on nontarget invertebrates in intertidal areas (Ferns et al. 2000). The level of significance depends on the size of area harvested and pressure of the fishing (Ferns et al. 2000). A population survey is taken of the wading bird population three times yearly to monitor for any significant changes in the ecosystem function in the fishery. There has been no evidence to suggest a declining bird population, and some surveys show populations have increased (pers. comm., Anonymous 2017). Because dredges can cause significant damage to bottom habitats but fishing occurs over resilient sand habitats, the impact to the habitat is considered of "moderate" concern and a score of 2 was awarded.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

NEW ZEALAND/SOUTHWEST PACIFIC
Hand Dredges | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)
NEW ZEALAND/SOUTHWEST PACIFIC
Hand Implements | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)

+0.5

Cockles are present at various locations throughout the Otago Peninsula, but only have been commercially fished from Papanui Inlet, Waitati Inlet, and in recent years from Otago Harbour under a special permit (MPI 2016h). The three areas open to commercial fishing only account for a small portion of cockle habitat (MPI 2016h). Although commercial fishing is restricted, there are no known areas in Otago Peninsula that are fully protected from the gear. Under the special harvest permit at Otago Harbour, fishing with hand-pushed dredges occurs in an experimental area that makes up 0.69 square miles (180 hectares), and only half the area is fished while the other half is left untouched as a control. From the half that is fished, 10% of the cockle biomass is to be removed every year. Overall, mitigation is considered "moderately effective" and 0.5 points are awarded.

Justification:

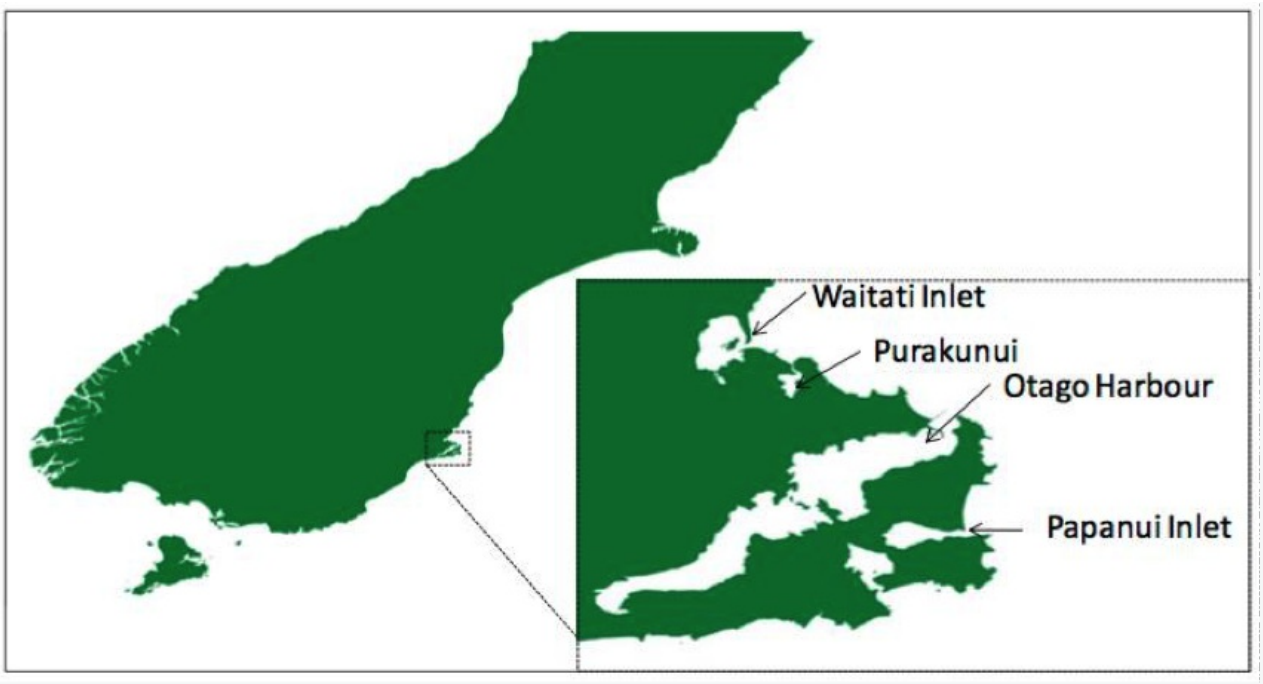

Figure 9 The regions where commercial harvest occurs at a large scale in Otago Peninsula. Figure from (MPI 2016h).

NEW ZEALAND/SOUTHWEST PACIFIC

Mechanized Dredges | New Zealand | Tasman And Golden Bays (COC 7A) | Tasman And Golden Bays (COC 7A)

+0.5

Mechanical harvesting can cause chemical changes in the sediments that can inhibit recolonization of certain species and negatively impact eelgrass beds (Schmechel 2001). The areas of commercial fishing for cockle in Golden Bay and Tasman Bay represent a small portion of the available resource in this region, and fishing for cockle is prohibited where eelgrass beds are present (MPI 2016g). In addition, cockle harvest is prohibited within Tasman and Golden Bay adjacent to Farewell Spit and other areas of the bays (MPI 2016g). Commercial harvest occurs at Pakawau Beach, Ferry Point, and Tapu Bay within the COC7A management area (Figure 11). Because fishing only occurs in a small area, a substantial proportion of all representative cockle habitats are protected from this gear type. Gear modifications are expected to be effective at protecting bottom habitat, but there is no scientific evidence to support this. Therefore, a score of "moderately effective" is given for mitigation of gear impacts and 0.5 points are awarded.

Justification:

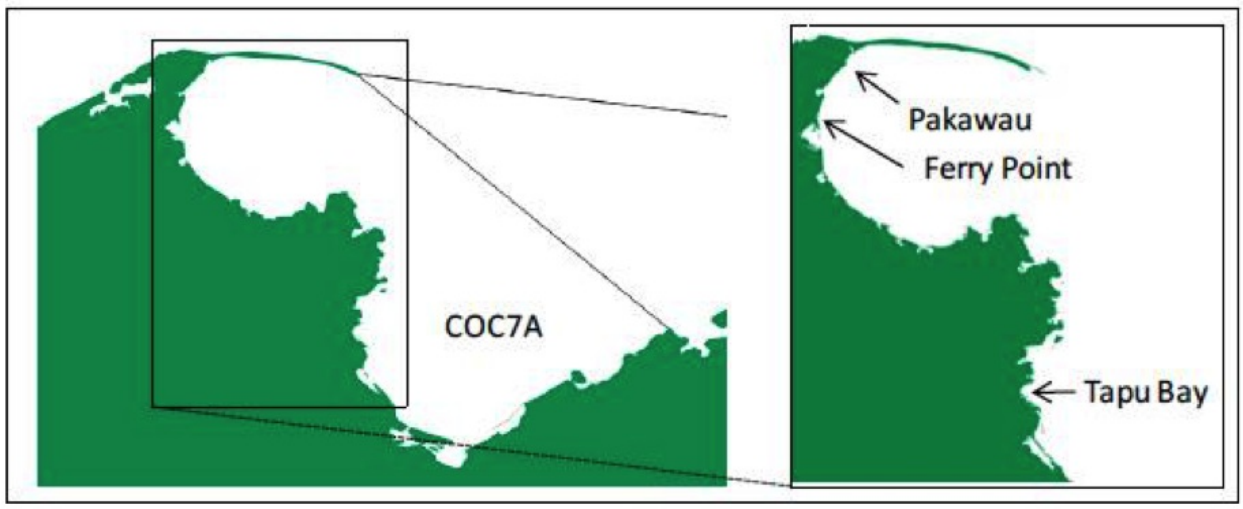

Figure 10 The regions where mechanical harvest occurs at a large scale. Figure from (MPI 2016g).

Factor 4.3 - Ecosystem-Based Fisheries Management

NEW ZEALAND/SOUTHWEST PACIFIC
Hand Dredges | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)
NEW ZEALAND/SOUTHWEST PACIFIC
Hand Implements | New Zealand | Otago Peninsula (COC 3) | Otago Peninsula (COC 3)
NEW ZEALAND/SOUTHWEST PACIFIC
Mechanized Dredges | New Zealand | Tasman And Golden Bays (COC 7A) | Tasman And Golden Bays (COC 7A)

Moderate Concern

New Zealand cockle is a suspension feeder that filters large volumes of water each tidal cycle and feeds on organic matter that can come from red algae, sea lettuce, or micro algae (Leduc et al. 2006). Because cockle helps to clean the water by filtering out materials, a large reduction of cockle could negatively affect water quality (Larcombe 1971) (MPI 2007) (MPI 2007). Cockle is an important food source for various fish and crustacean species as well as various shore birds (Schechel 2001). New Zealand cockle is a major prey species for oystercatchers (Baker 1969), so changes in the abundance of cockle are likely to affect the oystercatcher's food supply. Research conducted in Golden and Tasman Bays showed that, after fishing in areas with high densities of cockle, foraging by shorebirds including the protected variable oystercatcher declined (Schmechel 2001). The ongoing study under the special research commercial harvest permit at Otago Harbour evaluates the changes in the plant and animal community structure where fishing occurs compared to control sites. The study so far has found no significant differences in the community structure between control and fished sites (Stewart 2013).

Historically, fisheries management in New Zealand has been conducted on a species-by-species basis; however, there is an effort to shift toward a more ecosystem-based model for fisheries management (MPI 2007). The purposes of the New Zealand Fisheries management system include the assessment (based on scientific information) of fishing effects on bycatch and mortality of other species, the effects of bottom fisheries on the benthic diversity and habitat, the effects on biodiversity, changes to the ecosystem structure and function, and the effects of fishery enhancement on the environment and on fishing (MPI 2014). But limited studies have been conducted so far to investigate the ecological impacts of the New Zealand cockle fisheries.

There are some measures in place to protect sensitive and important cockle habitats such as eelgrass beds; overall, the sites where New Zealand cockle is commercially fished are small with respect to the total resource (MPI 2016g) (MPI 2016h)(MPI 2016i). Because there are some efforts to protect the ecological role of New Zealand cockle but more robust policies are needed, management of the ecosystem and food web impacts is deemed of "moderate" concern.

Acknowledgements

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

Seafood Watch would like to thank Gabe Andrews for graciously reviewing this report for scientific accuracy.

References

Annala, J.H., Sullivan, K.J., O'Brien, C.J., Smith, N.W.McL. and Grayling, S.M. (2003). Report from the Fishery Assessment Plenary, May 2003: stock assessments and yield estimates. Ministry for Primary Industries.

Baker, A.J. 1969. The comparative biology of New Zealand oystercatchers. MSc thesis, University of Canterbury, Christchurch, New Zealand.

Berkenbusch, K., Neubauer, P. 2015. Intertidal shellfish monitoring in the northern North Island region, 2014–15. New Zealand Fisheries Assessment Report 2015/59. 110 pp.

Food and Drug Administration (FDA). 2015. The Seafood List, Austrovenus stutchburyi. Updated 2015. Available at: http://www.accessdata.fda.gov/scripts/fdcc/?set=seafoodlist&id=Austrovenus_stutchburyi.

Ferns, P.N., Rostron, D.M., Siman, H.Y. 2000. Effects of mechanical harvesting on intertidal communities. Journal of Applied Ecology: 37; p. 464-474.

Griffins, R., and Eyre, R. 2014. Population and Biomass Survey of Cockles (Austrovenus stutchburyi) in Whangarei Harbour 2014. Northland Regional Council.

Irwin, C. 1999. The effects of harvesting on the reproductive and population biology of the New Zealand littleneck clam (Austrovenus stutchburyi) in Waitati Inlet. Thesis submitted for the free of Master of Science at the University of Otago, Denedin, New Zealand. 101 pp.

Larcombe, M.F. 1971. The ecology, population dynamics, and energetics of some soft shore molluscs. Thesis (PhD Zoology), The University of Auckland.

Leduc, D., Probert, P.K., Frew, R.D. and Hurd, C.L. 2006. Macroinvertebrate diet in intertidal seagrass and sandflat communities: a study using C, N and S stable isotopes. New Zealand Journal of Marine and Freshwater Research 40:615-629.

Mace, P.M., Sullivan, K.J., and Cryer, M. 2014. The evolution of New Zealand's fisheries science and management systems under ITQs. ICES Journal of Marine Science, 71: pp. 204-215.

Marsden, I. 2004. Effects of reduced salinity and seston availability on growth of the New Zealand little-neck clam Austrovenus stutchburyi. Mainer Ecology Progress Series Vol. 266: 157-171.

McKinnon, J.K. 1996. Studies of the Age, Growth and Shell Increment Patterns in the New Zealand Cockle (Austrovenus stutchburyi). M.Sc. at the University of Otago, Denedin (unpublished).

Morton, J., Miller, M. 1973. The New Zealand Sea Shore. Collins, London. 653 p.

Ministry for Primary Industries (MPI). 2007. Fisheries Plan North-East Shellfish. Ministry for Primary Industries. Ministry for Primary Industries. 28 p.

Ministry for Primary Industries (MPI). 2010. Statement of Intent 2010 to 2015. Available at: http://www.fish.govt.nz/NR/rdonlyres/83158FCC-A9D4-46A2-BC67-F9A45B0C3E95/0/SOI20102015.pdf.

Ministry for Primary Industries (MPI). 2014. Fisheries Assessment Plenary, May 2014: stock assessments and stock status. Fisheries Science Group, Ministry for Primary Industries, Wellington, New Zealand. 1381 p. (pp 200-225.)

Ministry for Primary Industries (MPI). 2015e. November 2015 Stock Status. Available at: http://fs.fish.govt.nz/Doc/24003/Stock%20Status%20Table%20Nov%202015%20symbols.pdf.ashx.

Ministry for Primary Industries (MPI). 2016a. Fisheries Act of 1996: Public Act No. 88. August 13, 1996; Reprint May 1, 2016.

Ministry for Primary Industries (MPI). 2016b. Cockle (COC). Accessed May 1, 2016. Available at: http://fs.fish.govt.nz/Page.aspx?pk=7&sc=COC.

Ministry for Primary Industries (MPI) 2016c. Travel and Recreation: Shellfish biotoxin alerts. Accessed October 14, 2016. Available at: https://www.mpi.govt.nz/travel-and-recreation/fishing/shellfish-biotoxin-alerts/.

Ministry for Primary Industries (MPI) 2016d. Law and Policy: Sustainable Fisheries Management and Allocation. Accessed October 14, 2016. Available at: http://www.mpi.govt.nz/law-and-policy/legal-overviews/fisheries/sustainable-fisheries-management-and-allocation/.

Ministry for Primary Industries (MPI). 2016e. Quota Management System. Accessed October 17, 2016. Available at: http://fs.fish.govt.nz/Page.aspx?pk=81&tk=400.

Ministry for Primary Industries (MPI). 2016f. Cockles (COC) (Austrovenus stutchburyi) Tuangi. Ministry for Primary Industries. 5 p.

Ministry for Primary Industries (MPI). 2016g. Cockles (COC7A) Tasman and Golden Bays. (Austrovenus stutchburyi) Tuangi. Ministry for Primary Industries. 10 pp.

Ministry for Primary Industries (MPI). 2016h. Cockles (COC3) Otago Peninsula (Austrovenus stutchburyi) Tuaki. Ministry for Primary Industries. 10 pp.

Ministry for Primary Industries (MPI). 2016i. Cockles (COC1A) Snake Bank (Whangarei Harbour) (Austrovenus stutchburyi) Tuangi. Ministry for Primary Industries. 10 pp.

Ministry for Primary Industries (MPI). 2017a. Foreign Trade- All Species. Online Publication. Accessed January 5, 2017. Available at: http://fs.fish.govt.nz/Page.aspx?pk=9&tk=34.

Ministry for Primary Industries (MPI). 2017b. Fisheries Management. Accessed January 16, 2017. Available at: http://fs.fish.govt.nz/Page.aspx?pk=13&tk=348.

Ministry for Primary Industries (MPI). 2017c. Quota Management System - Reporting. Updated January 25, 2017. Accessed May 10, 2017. Available at: http://fs.fish.govt.nz/Page.aspx?pk=81&tk=425.

National Marine Fisheries Service (NMFS). 2016. Commercial Fisheries Statistics Cumulative Trade Data by Product. Available at: https://www.st.nmfs.noaa.gov/commercial-fisheries/foreign-trade/applications/trade-by-product.

Osborne, T.A. 2010. Biomass Survey and Stock assessment of cockles (Austrovenus stutchburyi) in area COC7A: Tapu Bay, Ferry Pointe, and Pakawau. New Zealand Fisheries Assessment Report 2010/44. 37 pp.

Owen, S.J. 1992. A biological powerhouse: the ecology of the Avon-Heathcote Estuary, pp. 30-63. In: S.J. Owen (ed) The estuary: where our rivers meet the sea. Parks Unit, Christchurch City Council, Christchurch.

Pawley, M.D.M. 2012. The distribution and abundance of pipis and cockles in the Northland, Auckland and Bay of Plenty regions, 2012. New Zealand Fisheries Assessment Report 2012/45. 69 p.

Richardson, J R; Alridge, A E; Main ,W. 1979. Distribution of the New Zealand cockle, Chione stutchburyi at Pauatahanui Inlet. NZOI Oceanographic Field Report 14. 10 p.

Schmechel, F. 2001. Potential impacts of mechanical cockle harvesting on shorebirds in Golden and Tasman Bays, New Zealand. DOS Science Internal Series 19. 51 p.

Seafood Source. 2011. Cockle. Published June 9, 2011. Available at: http://www.seafoodsource.com/seafoodhandbook/shellfish/cockle.

Southern Clams Limited. 2016. Sustainability. Accessed Nov. 7, 2016. Available at: http://www.nzclams.com/sustainability.php#research.

Southern Clams Limited. 2017. Southern Clams Limited: About Us. Accessed January 16, 2017. Available at: http://www.nzclams.com/aboutus.php.

Spencer, H. G., Willan, R. C., Marshall, B. A., and Murray, T. J. 2002. Checklist of the Recent Mollusca described from the New Zealand Exclusive Economic Zone.

Steward, B. Investigations into the Effects of Commercial Harvest of Clams (Austrovenus stutchburyi) in Otago Harbour (COC3), Otago: Report on Phase II Harvesting, 2012. Prepared for the Ministry for Primary Industries on behalf of Southern Clams Ltd. by Ryder Consulting Ltd.

Stewart, B. 2010. Investigations into the Effects of Commercial Harvest of Clams (Austrovenus stutchburyi) on Infauna and Substrate in Otago Harbour (COC3), Otago: Report on Phase 1 Harvesting. Prepared for the Ministry for Primary Industries on behalf of Southern Clams Ltd by Ryder Consulting.

Telesetsky, A. 2016. Fishing for the Future: Addressing Fisheries Discards and Increasing Export Value for New Zealand's Sustainable Fisheries. Fulbright New Zealand. August 2016.

University of Waikato (UW). 2009. Cockles. Published October 8, 2009. Available at: http://sciencelearn.org.nz/Contexts/Life-in-the-Sea/Looking-Closer/Cockles.

Watson, T.G., Cryer, M., Smith, M.D., MacKay, G., and Tasker, R. 2005. Biomass survey and stock assessment of cockles on Snake Bank, Whangarei Harbour, 2004. New Zealand Fisheries Assessment Report 2005/15. 36 pp.

Williams, J.R.; Smith, M.D.; Mackay, G. 2006. Biomass survey and stock assessment of cockles (Austrovenus stutchburyi) on Snake Bank, Whangarei Harbour, 2006. New Zealand Fisheries Assessment Report: 38. 21 p.

Williams, J.R.; Smith, M.D.; Mackay, G. 2009. Biomass survey and stock assessment of cockles (Austrovenus stutchburyi) on Snake Bank, Whangarei Harbour, 2009. New Zealand Fisheries Assessment Report 2009: 29. 23 p.

Wilson, N., Stevens, J., Alspach, P. and Butler, D. 1988. Environmental impact assessment, effects of mechanical harvesting of cockles from the Pakawau/Puponga intertidal area. Report prepared by Department of Scientific and Industrial Research (DSIR), Division of Horticulture and Processing, Fish Technology Section, Nelson, for Westhaven Shellfish Co., Ltd.

Appendix A: Updates to New Zealand Cockle Report

This report was reviewed for any significant stock status and management updates to the fishery on April 13, 2020. None were found that would indicate the final rating is no longer accurate. However, the Whangarei Harbour commercial fishery has been closed since 2012. Therefore, the rating for this fishery has been removed from the report.

Appendix B: Review Schedule

It is expected that there will be a peer reviewed stock assessment of COC7A in 2018 which will include analysis of a series of five consecutive annual surveys and population modeling to determine reference biomass levels. This stock assessment will be conducted by Dr. Tracey Osborne with Osborne Research Company.