IN THE MATTER of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012

AND

IN THE MATTER of a Decision-Making Committee appointed by the Environmental Protection Authority to consider a marine consent application by Chatham Rock Phosphate Ltd to undertake activities in the Chatham Rise restricted by the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012

STATEMENT OF EVIDENCE OF DR JOHANNA PATRICIA PIERRE (COMMERCIAL FISHERIES)

12 September 2014

Environmental Protection Authority
Te Mana Rauhī Taiao

Counsel: **Myregel Carambas**, Solicitor / **Morgan Slyfield**, Barrister
Email: Myregel.Carambas@epa.govt.nz
Tel: 64-4-474 5439
Environmental Protection Authority
Grant Thornton House, 215 Lambton Quay
Private Bag 63002, Wellington 6140

INTRODUCTION

1. My name is Johanna Patricia Pierre.

2. I am a Consultant and Director employed by Johanna Pierre Environmental Consulting Ltd (JPEC Ltd).

3. I have been engaged by the Environmental Protection Authority ("EPA") to:

    (a) prepare a review report of the application information provided by Chatham Rock Phosphate Limited in terms of the information principles under section 61 of the EEZ Act in relation to commercial fisheries;

    (b) prepare, at a later date, at the direction of the Decision-Making Committee, a report that critically appraises the application information in terms of the assessment of effects of the activity on commercial fisheries considering submissions, further information received, the EPA staff report, applicant's evidence; and

    (c) participate in expert conferencing, and the hearing of the marine consent application, if directed to do so by the Decision-Making Committee.

4. I have prepared:

    (a) a report entitled Review of Technical Reports on Commercial Fisheries, 23 May 2014; and

    (b) a further report entitled Assessment of the Effects on Commercial Fisheries from the CRP Marine Consent Application 11 September 2014.

5. A link to the first report is provided in **Annexure A** to this statement of evidence.

6. The second report is provided as **Annexure B** to this statement of evidence.

QUALIFICATIONS AND EXPERIENCE

7. I have the following qualifications and experience relevant to the evidence I have provided:

   (a) PhD (Ecology and Environmental Biology), University of Alberta, 2001;

   (b) BSc (Honours I, Zoology), University of Canterbury, 1996;

   (c) In my present role at JPEC Ltd, my work is focused at the interface of industry and the marine and freshwater environments. I lead and manage all projects the company undertakes. The scope of projects ranges from research, through management and policy. I am currently, and have recently, been engaged in a number of projects of relevance to this application and commercial fisheries more broadly.

   (d) I was an assessor during the second reassessment of the New Zealand hoki fishery's Marine Stewardship Council (MSC) certification and have been involved with subsequent audits of that certification. I was peer-reviewer for the assessments of the New Zealand hake and ling fishery certification processes. All of these assessments include Chatham Rise fisheries. I have also audited the New Zealand southern blue whiting fishery in the context of MSC certification.

   (e) I have undertaken assessments of commercial fisheries for Monterey Bay Aquarium's (USA) Seafood Watch Program. This Program assesses the sustainability of seafood sourced globally.

   (f) Other projects involving commercial fisheries that I am currently or have recently been involved with include electronic monitoring of the New Zealand Snapper 1 fishery (with Archipelago Marine Research, Canada), transitioning South Australian fishers from gillnet to longline fishing methods (with Fishwell Consulting, Australia), characterising and reducing the impacts of commercial fishing on protected species (with Dragonfly Science, New Zealand), and developing measures to reduce the impact of trawl fishing on seabirds (with Clement and Associates, New Zealand).

   (g) Projects I have worked on that involved evaluation and review with a policy and management focus include leading the review of New Zealand's marine management regime (for the Natural Resources

Sector agencies of the New Zealand Government, contracted by Ministry for the Environment), State of the Environment reporting (for Auckland Council), and identifying options for the management of longfin eels (for Department of Conservation).

(h) Prior to starting JPEC Ltd, I was employed at the Ministry for Science and Innovation (MSI), where my role focused on developing international science policy with Asian partner countries; and

(i) Prior to MSI, I was employed as the Manager of the Marine Conservation Services Programme (Department of Conservation). This programme focused on addressing the impacts of commercial fishing on protected species. This role included extensive international engagement with Regional Fisheries Management Organisations and other multilateral agreements operating in the marine area. Engagement encompassed science, policy, and management issues.

(j) During my time as a post-doctoral fellow, a public servant and as part of my international engagement, I have in excess of 15 years' experience working with experts to develop solutions for environmental issues resulting from industrial activities. This includes conferences, workshops, formal working groups and extensive informal engagements.

(k) I have authored in excess of 20 peer-reviewed primary publications in the scientific literature, 30 technical reports, and presented at scientific and industry conferences and meetings over a period of two decades.

CODE OF CONDUCT

8. I confirm that I have read, and agree to comply with, the Code of Conduct for Expert Witnesses as contained in the Environment Court Consolidated Practice Note 2011.

9. In particular, unless I state otherwise below, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

SCOPE OF EVIDENCE

10. When authoring the reports described at paragraph [4] above, I relied upon:

(a) the marine consent application and environmental impact assessment,

(b) further information provided by the applicant and received from the EPA,

(c) selected reports commissioned by the EPA under s 44 of the EEZ Act,

(d) the EPA staff report,

(e) submissions made on the consent application, and,

(f) the applicant's evidence; and,

(g) the list of references cited in both reports.

11. My expertise is in commercial fisheries and the effects of, and integration of, industrial activities and the environment. My expertise is not in the biology or sensory ecology of fish.

Johanna Pierre

12 September 2014

ANNEXURE A

REPORTS PREPARED FOR THE EPA

1. Review of Technical Reports on Commercial Fisheries, 23 May 2014

   http://www.epa.govt.nz/eez/EEZ000006/EEZ000006_Commercial_Fisheries_Technical_Postlodgement_Review_JPEC_23_05_2014.pdf

ANNEXURE B

2. Assessment of effects on commercial fisheries from the CRP marine consent application

ASSESSMENT OF EFFECTS ON COMMERCIAL FISHERIES FROM THE CRP MARINE CONSENT APPLICATION

Date 11 September 2014

Review by Dr Johanna Pierre

Executive Summary

The Chatham Rise has been described as New Zealand's most important and productive fishing ground. Commercial species caught on the Rise include hoki (*Macruronus novaezelandiae*), hake (*Merluccius australis*), ling (*Genypterus blacodes*), orange roughy (*Hoplostethus atlanticus*), black and smooth oreos (*Allocyttus niger, Pseudocyttus maculatus*), and scampi (*Metanephrops challengeri*).

Chatham Rock Phosphate Limited has applied for a marine consent to mine phosphorite on the Chatham Rise. The proposed mining activity would take place in an area covering 5,207 km^2, and involves removing on average the top 0.35 m of the seabed from approximately 30 km^2 per year, within this area. After processing aboard the mining vessel, sediment removed from the seafloor would be redeposited as tailings, on average 10 m above the sea floor. The consent is sought for a period of 35 years.

This report assesses the effects of the proposed activity on commercial fisheries. Levels of commercial catch and fishing effort reported from the marine consent area have been low over the past 10 years. However, beyond any exclusion of fishing effort, mining may potentially affect the value of fishing quota in relevant Quota Management Areas, the integrity of the fisheries management regime given the overlap of the consent area and the Mid-Chatham Rise Benthic Protection Area, sustainability accreditations for Chatham Rise fisheries, and the perceived safety of Chatham Rise seafood.

In addition, the proposed mining activity may affect commercial species at all life history stages, due to the entrainment of non-motile stages, the disturbance of benthic habitats, the release of a sediment plume, the sedimentation of tailings on the seabed, the noise, vibration, and light associated with the mining operation, and the creation of oil spill and biosecurity risks. Mining also contributes to the risk of cumulative impacts of anthropogenic disturbances affecting commercial species on the Chatham Rise.

Where the effects of the proposed mining activity on commercial fisheries can be assessed, they are considered low to moderate. However, the assessment of effects is constrained by considerable uncertainties and knowledge gaps. The most important of these include the timeframe elapsing before commercial species resume their utilisation of mined areas, the response to the fisheries management regime to mining in a Benthic Protected Area, the sensitivities of commercial species of all life stages to sedimentation and suspended sediment, the distribution of commercial species' larvae and spawning activity, and the cumulative effects of anthropogenic disturbances.

Given the nature of the mining operation and the extensive knowledge gaps relating to commercial species, opportunities to mitigate mining impacts are few. Further, an adaptive management approach is not considered possible in the absence of key baseline information and when appropriate, species-relevant thresholds that would serve as triggers for remedial actions are unknown. Should the marine consent be granted, conditions are considered necessary to clearly specify the requirements of the mining operation, where these relate to impacts on commercial fisheries and commercial species. Conditions should also provide clarity around the scope of baseline monitoring, which is necessary to address key knowledge gaps relevant to the assessment of mining effects.

Glossary

1. List of acronyms

ACE	Annual Catch Entitlement
BPA	Benthic Protection Area
CRP	Chatham Rock Phosphate Limited
EEZ	Exclusive Economic Zone
EEZ Act	Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
EPA	Environmental Protection Authority
FMA	Fisheries Management Area
MARPOL	International Convention for the Prevention of Pollution from Ships
MP	Mining Permit
MPL	Minerals Prospecting Licence
MSC	Marine Stewardship Council
PP	Prospecting Permit
QMA	Quota Management Area
QMS	Quota Management System

Table of Contents

Introduction

2. This report relates to Chatham Rock Phosphate Limited's (CRP) application, submitted to the Environmental Protection Authority (EPA), to mine submarine deposits of phosphorite on the Chatham Rise. CRP's application describes the use of a novel mining approach and a custom-fitted vessel to remove material from the seabed for on-board processing to separate phosphate-containing particles > 2 mm in size from other benthic material collected. Following processing, waste material would be piped underwater from the vessel for discharge on average within 10 m of the seabed in mined areas (Golder (Associates) New Zealand Ltd (GANZ) 2014).

3. The spatial extent of the marine consent application was originally 10,192 km^2. This included (i) a 4,726 km^2 area comprising Minerals Prospecting Licence (MPL) 50270 granted in 2010 (and of which 1,019 km^2 is under offer of relinquishment), (ii) 820 km^2 inside MPL 50270, for which a mining permit was granted in 2013 (MP 55549), and two areas that are subject to prospecting permit applications, (iii) 1,501 km^2 PP 55971 located to the west of MP 55549 and MPL 50270, and, (iv) PP 55967, covering 4,985 km^2 to the east of MPL 50270 (Figure 4, GANZ 2014).

4. Subsequent to lodging the marine consent application, PP 55967 was removed from the consent area (Simpson Grierson 2014). The updated marine consent area of 5,207 km^2 and excluding PP 55967 is considered in this report.

5. CRP seeks a marine consent to conduct mining over a period of 35 years (GANZ 2014).

6. This report provides an assessment of CRP's proposed mining activity on commercial fisheries. It is prepared in accordance with the provisions of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (the EEZ Act). Sections of that Act that have particular relevance to the purpose and content of this report include s 59, s 60, s 61, s 63 and s 64.

7. Specifically, the report builds on Pierre (2014) by providing a critical appraisal of the information provided in the CRP application and assesses the effects of the proposed mining activity on commercial fisheries. In addition, the report includes an assessment of the residual effects of the mining activity after mitigation measures have been applied. Finally, the application of adaptive management to the effects of the proposed activity is considered.

8. The report takes into account information relevant to commercial fisheries that was available in:

    a. the marine consent application and environmental impact assessment,

    b. further information provided by the applicant and received from the EPA,

    c. reports commissioned by the EPA under s 44 of the EEZ Act,

d. the EPA staff report,

e. submissions made on the consent application, and,

f. the applicant's evidence.

Description of proposal

Description of existing environment

9. The Chatham Rise has been described as New Zealand's most important and productive fishing ground[1]. Elevated biological productivity on the Rise results from the existence of the subtropical front, and this provides for a rich and diverse ecosystem that includes numerous fish species of commercial importance (Pinkerton 2011, and references therein; Ministry for Primary Industries 2014a, b, c).

10. Commercial fisheries harvesting middle-depth and deepwater species on the Chatham Rise predominantly utilise the trawl and bottom longline methods and target species such as black and smooth oreos (*Allocyttus niger, Pseudocyttus maculatus*), hoki (*Macruronus novaezelandiae*), hake (*Merluccius australis*), ling (*Genypterus blacodes*), orange roughy (*Hoplostethus atlanticus*), and scampi (*Metanephrops challengeri*) (Baird et al. 2011; Horn and Ballara 2012; Ministry for Primary Industries 2014 a, b, c).

11. Commercial species caught on the Chatham Rise that are generally considered bycatch of these target fisheries include dark and pale ghost sharks (*Hydrolagus bemisi, H. novaezelandiae*), giant stargazer (*Kathetostoma giganteum*), lookdown dory (*Cyttus traversi*), ribaldo (*Mora moro*), Ray's bream (*Brama brama*), sea perch (*Helicolenus percoides*), and white warehou (*Seriolella caerulea*) (MacGibbon and Hurst 2011; MacGibbon et al. 2012; Ministry for Primary Industries 2013a, 2014a, b, c).

12. Some commercial species are harvested as both target species and bycatch, such as alfonsino (*Beryx splendens*) (MacGibbon 2013), hake (Ministry for Primary Industries 2014a), and silver warehou (*Seriolella punctata*) (Ministry for Primary Industries 2014c).

13. More broadly, in excess of 200 commercial and non-commercial fish species have been identified from the Chatham Rise (Pinkerton 2013), including more than 100 species or species groups in the marine consent area (O'Driscoll and MacGibbon 2014).

[1] http://www.fish.govt.nz/en-nz/Environmental/default.htm

14. Amongst the commercial fisheries landing catch from the Chatham Rise, the hoki fishery is currently certified as sustainable by the Marine Stewardship Council (MSC). In addition, the hake, ling, oreo and orange roughy fisheries are progressing through the assessment processes associated with this certification[2]. The certification of fisheries as sustainable by the MSC may lead to market advantages such as increased demand and price premiums (MSC 2009; Roheim et al. 2011). Many major international seafood retailers have committed to focusing seafood supply on sustainably-sourced products over time[3].

15. Beyond the eastern extent of the marine consent area, commercial fisheries operating around the Chatham Islands target species such as bluenose (*Hyperoglyhe antarctica*), blue cod (*Parapercis colias*), häpuku/bass (*Polyprion oxygeneios*, *P. americanus*), paua (*Haliotis iris*), kina (*Evechinus chloroticus*), and rock lobster (*Jasus edwardsii*) (Ministry for Primary Industries 2013b, 2014a, b).

16. In the (revised) marine consent area, Ministry for Primary Industries' data shows that commercial fisheries landings have been relatively limited over time (O'Driscoll and MacGibbon 2014). Using the longline method, total catches across the 10-year period of fishing years ending in 2004 to 2013 were 34 t (PP 55971), 4 t (MP 55549), and 61 t (MPL 50270). Landings of species included in the Quota Management System (QMS) comprised ling, spiny dogfish (*Squalus acanthias*), ribaldo, sea perch and smooth skate. In all areas, the majority of longline catches by weight were of ling (O'Driscoll and MacGibbon 2014).

17. Using the trawl method, total catches across the 10-year period of fishing years ending in 2004 to 2013 were 54 t (PP 55971), 11 t (MP 55549), and <1 t (MPL 50270). Landings of commercial species comprised hoki, ling, pale ghost shark, silver and white warehou, and smooth oreo (*Pseudocyttus maculates*). In areas PP 55971 and MP 55549, where total trawl catches were >1 t from 2004 - 2013, the majority of catch by weight comprised hoki (O'Driscoll and MacGibbon 2014).

18. Commercial harvest of the hagfish (*Eptatretus cirrhatus*) was also reported in 2006/07. One pot was reported inside the consent area (O'Driscoll and MacGibbon 2014). This species is not currently included in the QMS but its introduction was considered this year due to sustainability concerns and the potential for development of a hagfish target fishery (Guy 2014; Ministry for Primary Industries 2014d).

19. The Chatham Rise is a key habitat area for fish at different life stages, including species caught commercially there and in other parts of New Zealand's Exclusive Economic Zone. For example, species such as black and smooth oreo, hake, ling, orange roughy, ribaldo, and silver and white

[2] www.msc.org

[3] e.g., http://seafoodinternationaldigital.com/are-the-worlds-retailers-and-restaurants-delivering-on-their-sustainable-seafood-promises/

warehou spawn there (O'Driscoll et al. 2003; O'Driscoll et al. 2014). Further, juveniles of species including black cardinalfish (*Epigonus telescopus*), bluenose, dark and pale ghost sharks, hake, häpuku, hoki, ling, lookdown dory, orange roughy, Ray's bream, ribaldo, smooth oreo, smooth skate (*Dipturus innominatus*), and silver and white warehou have been recorded (Paul 2002; O'Driscoll et al. 2003; O'Driscoll et al. 2014).

20. Providing an update to work published in 2003 (O'Driscoll et al. 2003), O'Driscoll et al. (2014) reported the occurrence of spawning and spent hake and spiny dogfish in the (revised) marine consent area. Spent hoki, lookdown dory, and sea perch were also found. Outside the boundaries but in the proximity of the consent area, O'Driscoll et al. (2014) reported evidence of potential spawning by dark and pale ghost sharks, häpuku, ling, ribaldo, silver and white warehou, and giant stargazer, as well as several non-QMS species.

21. Approximately 59% of the Mid-Chatham Rise Benthic Protected Area (BPA) is co-located with the original marine consent area (GANZ 2014). Around 90% of the revised marine consent area overlaps with this BPA (Environmental Protection Authority (EPA) 2014).

22. The BPA initiative was proposed to "*set aside a broadly representative sample of benthic habitats, in essentially pristine condition, to avoid any future adverse effects of fishing on the seabed*" (Helson et al. 2010; Wood 2014). Regulations applicable to BPAs (Fisheries (Benthic Protection Areas) Regulations 2007) preclude bottom trawling and dredging for fish while permitting bottom longlining and midwater trawling activity.

23. The potential effects of the proposed mining operation on commercial fisheries include:

    a. reduced commercial catch landings, due to:

        i. altered habitat utilisation by commercial species in mined areas,

        ii. population-level impacts of mining on commercial fish species,

        iii. ecosystem changes resulting from mining affecting commercial species, and,

        iv. cumulative impacts of anthropogenic disturbances on commercial species;

    b. changes to fishery sustainability, both actual and perceived, due to:

        i. displaced fishing effort targeting a different component of commercial stocks and bycatch species (including protected species), and,

        ii. the utilisation of a BPA for mining;

    c. changes to the economic characteristics of fisheries, due to:

        i. reduced catch landings (see above),

ii. negative effects on quota value resulting from the permitted occurrence of mining where previously commercial fishing was the only existing economic use,

iii. the redistribution of fishing effort needed to maintain catch levels during and/or after mining, and,

iv. actual or perceived changes in the safety of landed product for consumption, due to the trace elements or radioactive material disturbed during mining.

24. Key information gaps and uncertainties affecting the assessment of the effects of the proposed mining activity on commercial fisheries include the following:

a. Utilisation of habitat by commercial species after mining

There is a paucity of information available to support an assessment of the potential changes in habitat utilisation by commercial species after mining, including the timeframe for any recolonization of mined areas to occur.

b. Impacts of mining on the fisheries management regime

Mining will occur in a BPA, thereby removing some characteristics for which the BPA was initially protected. If considered necessary to retain the integrity of the fisheries management regime, establishing seabed protection in another area with analogous values would potentially displace additional commercial fishing effort.

c. Sensitivities of commercial species at all life stages to sedimentation and suspended sediment

No quantitative information is available on the sensitivities of commercially-fished New Zealand species to sedimentation or suspended sediments.

d. Distribution of commercial species' larvae and spawning activity

The best available information has been presented, but minimal information is available on larval distribution and spawning information available is subject to sampling constraints.

e. Cumulative impacts of anthropogenic disturbances on the Chatham Rise

Globally, scientific understanding of cumulative impacts of marine disturbances is minimal, but developing. It is unknown how mining will affect commercial fisheries, in combination with other anthropogenic disturbances occurring on the Rise.

25. Additional (less important) uncertainties or information gaps that preclude a robust assessment include the following.

a. Noise of the mining operation

No specific information is available on the noise associated with the mining operation. In addition, no information is available on the sensitivities of New Zealand commercial species to noise.

b. Entrainment of biota by the jet pump intake

No quantitative information is available on the likelihood of entrainment of non-motile biota in the jet pump's 2-m zone of influence.

c. Light on the drag-head

The details of lights to be deployed on the drag-head remain to be confirmed. Further, information is not available on the sensitivities of New Zealand commercial species to light.

Information used to assess effects

26. Information on which the assessment of the effects of the proposed activity on commercial fisheries was based was derived from a variety of sources:

    a. the marine consent application and environmental impact assessment,
    b. further information provided by the applicant and received from the EPA,
    c. reports commissioned by the EPA under s 44 of the EEZ Act,
    d. the EPA staff report,
    e. submissions made on the consent application,
    f. the applicant's evidence,
    g. published material in the public domain,
    h. primary literature, and,
    i. grey literature.

Specific documents that reported material is drawn from are referred to in the text.

27. Numerous approaches have been utilised in New Zealand and internationally to identify the effects and risks of economic and industrial activities on the environment or ecosystem (or components of that ecosystem). Typically, assessment processes encompass some consideration of the context, nature and extent of effects, the likelihood of effects occurring, and their potential consequences in terms of severity. Uncertainties in the assessment and approaches to the mitigation of effects may also be included (e.g., Department of Conservation,

undated; Standards Australia and Standards New Zealand 2009; Hobday et al. 2011; MacDiarmid et al. 2012a; Rowe 2013). However, the specifics and efficacy of approaches vary with the objectives and contexts of the assessment being conducted, and the amount and type of information available.

28. The assessment undertaken in this report broadly follows the impact assessment approach presented in EPA (2014), and uses the methods described in MacDiarmid et al. (2012b). This involves an initial determination of whether effects are positive, neutral, or negative, an assessment of the likelihood and consequence of impacts, and an emergent level of risk. The likelihood and consequence of potential effects are assessed in relation to the attribute of the mining operation from which they result (following the approach captured in Table 1 of EPA (2014)). That is, adverse effects of the following are considered:

    a. The drag-head: extraction of non-living and living natural material, sediment resuspension

    b. The discharge of tailings: sedimentation, total suspended sediments, mobilisation of potentially toxic elements

    c. Noise and vibration

    d. Lighting and vessel structures

    e. Oil and fuel spills and biosecurity incursions

29. Further, possible overall impacts of the mining operation are assessed, including cumulative, economic, and sustainability impacts and impacts on the fisheries management regime.

30. The approach presented in this report considers the proposed activity in its entirety, in contrast to GANZ (2014) who evaluated impacts "*generally….on a per mining block basis, rather than considering the mining proposal as a whole over the proposed 35 year term of the marine consent*"(Taylor 2014). This may contribute to differences in the results of assessments.

Assessment of effects on commercial fisheries

31. The marine consent application and environmental impact assessment developed for the original consent area (GANZ 2014) and evidence delivered after the revision of the consent area (Taylor 2014) concludes that the potential impact of mining on fisheries resources is a low environmental risk. This assessment is based on the conclusion that the potential impacts of the mining activity are unlikely to occur, whilst impacts are adverse, near-source confined, short-term (< 6 months) in duration, and reversible. The potential consequence of impacts is identified as medium. Off the main crest of the Chatham Rise and within short distances of the mining activity, no significant impacts on key spawning, juvenile or young fish habitats were identified (GANZ 2014).

32. Impacts on existing interests (including commercial fishers) are neutral to adverse, near-source confined, short-term and reversible. Their potential consequence is medium and likelihood is unlikely. The potential impact is considered a low environmental risk (GANZ 2014; Taylor 2014).

33. Further, the assessment as applied to the original consent area concluded that mining will contribute to cumulative impacts on benthic resources on the crest of the Chatham Rise (GANZ 2014). The extent of this impact is identified by GANZ (2014) as being very small compared to the area affected by bottom trawling. In addition, the intensity of the impacts is identified as different for fishing, in which case habitats may be trawled more than once, compared to mining, in which case any area will be mined once (GANZ 2014; CRP 2014b). Further consideration of cumulative impacts within the marine consent area beyond those described in the original application led to the conclusion that any additional effects identified are minor (CRP 2014c).

Effects of the drag-head

Entrainment of biota

34. GANZ (2014) conclude that as the drag-head will sit firmly on the seabed, the entrainment of motile fish is unlikely; animals should be "*pushed*" out of the path of the drag-head. However, biota are expected to be entrained in the entirety of the drag-head footprint (except for material in excess of 150 mm, which is screened at the drag-head and so does not enter the riser) (GANZ 2014). The passage of the drag-head will result in the complete disruption of benthic habitats and biota to an estimated average depth of 0.35 m. Beyond the footprint of the drag-head, the zone of influence is estimated at 0.25 – 0.5 m (GANZ 2014).

35. The possibility of entrainment of non-motile biota in the jet pump intake is identified in GANZ (2014). The zone of influence of the jet pump intake is estimated at 2 m (GANZ 2014).

36. GANZ (2014) note that entrained biota are not expected to survive. Losses of eggs and larvae of some commercial fish species would therefore be expected through entrainment in the drag-head and jet pump intake. Further, as a burrowing species, the entrainment of scampi by the drag-head is expected (GANZ 2014). Given the lack of survival expected amongst entrained biota, the occurrence of commercial species at all life stages in mined areas is critical to an assessment of effects.

37. GANZ (2014) do not specifically assess the effects of entrainment on commercial fisheries. However, in his evidence, Kennedy (2014a) considers the loss of biota through the drag-head and jet pumps "*is not likely to result in differential mortality of any component of the near seabed system*".

38. In the marine consent area, scampi occurs (GANZ 2014) but has not been reported as part of the landed commercial catch (O'Driscoll and MacGibbon 2014). This suggests that the risk of entrainment affecting commercial fisheries for this species is minimal.

39. Whilst noting the restricted temporal distribution of sampling for spawning fish reported by O'Driscoll et al. (2014), the preponderance of spawning activity in areas outside the consent area (Hurst et al. 2000; O'Driscoll et al. 2003; O'Driscoll et al. 2014) suggests that the effects of egg entrainment by the drag-head on commercial fisheries would not be significant at a Chatham Rise or EEZ scale.

40. The effects of the entrainment on larvae on commercial fisheries are largely inestimable, given the paucity of knowledge about larval distribution amongst these species (except hoki, see references in O'Driscoll and Ballara 2014) (Page 2014a).

41. Similarly, information available does not allow the extent of entrainment of non-motile life stages of commercial species in the jet pump intake to be effectively assessed.

Disturbance of benthic habitats

42. The passage of the drag-head and discharge of tailings will result in significant changes to the characteristics of benthic environments, e.g., removing biogenic habitat and resulting in sedimentation in adjacent areas (GANZ 2014). Some resuspension of discharged mined sediments at the seabed may also occur (GANZ 2014), though this is not expected beyond 48 h after discharge (Lescinski 2014).

43. The importance of specific benthic habitat characteristics to commercial fish species is poorly known. Consequently, the effects of mining-induced changes to benthic habitats in mined areas on commercial fish species are unknown, both in terms of the occurrence of these species in mined areas, and their habitat utilisation patterns (e.g., for spawning). Further, the duration of any effects of benthic disturbance on fish occurrence or habitat use is unknown.

44. For scampi, benthic habitat disturbance due to mining will have profound effects, given the burrowing habit of these animals. Similar to other commercial species, the extent to which scampi would recolonize mined habitat and the associated timeframe for recolonization is unknown. However, their physical capabilities for movement allow for recolonization (Cryer and Stotter 1999), should the post-mining habitat be suitable.

45. The lack of scampi catch in the marine consent area (O'Driscoll and MacGibbon 2014) suggests that benthic disturbance caused by mining is unlikely to significantly affect existing commercial fisheries for this species.

46. For other commercial species, if mining results in the avoidance of disturbed areas, a complete lack of future catch from those areas (assuming comparable fishing patterns and the potential for

landings of the extent reported in O'Driscoll and MacGibbon 2014) appears insignificant at the scale of the relevant QMAs and the EEZ.

47. For commercial species identified as spawning in the consent area, the loss of spawning habitat due to mining does not appear especially significant given the level of utilisation of the consent area and the known extent of spawning areas outside that area (Hurst et al. 2000; O'Driscoll et al. 2003; O'Driscoll et al. 2014). Given the paucity of information on larval distribution of most commercial species (Page 2014a; O'Driscoll and Ballara 2014), the effects of potential habitat loss on larvae cannot be empirically assessed.

48. Impacts on juveniles of commercial species are not clear. For species occurring in greater densities in the consent area compared to elsewhere on the Chatham Rise (e.g., hake, ling, white warehou (O'Driscoll 2014; O'Driscoll et al. 2014)), effects of habitat disturbance may be greater than for species occurring in comparable densities across the Rise, given the apparent importance of, or preference for, the habitat in the consent area.

49. Beaumont and Rowden (2013) note that few studies are available describing the recovery of benthic communities following physical disturbances including mining. Further, no studies have been done in environments similar to the Chatham Rise (in terms of depth, or habitat). Based on what is known, Beaumont and Rowden (2013) conclude that the timeframe for benthic habitats and biota to recover from mining disturbance should be expected to be longer term – from years to decades – and that where the nodules that habitat-forming organisms require are lost, recovery of habitat characteristics present prior to mining is not possible.

50. Therefore, it is reasonable to expect that if the changes in benthic habitat and biotic characteristics are significant in terms of influencing the occurrence and habitat utilisation of commercial species, mining effects may remain for timeframes up to decades, and possibly in perpetuity.

Comparison with effects of bottom trawling

51. It should be noted that bottom trawling also effects benthic habitat disturbance, and that this is well-known to reduce habitat complexity and biodiversity over time (Ministry for Primary Industries 2012a, and references therein). Key differences between trawling and the proposed mining activity include that mining is expected to result in the mortality of all entrained biota (GANZ 2014) in contrast to the partial mortality effected by trawling (e.g., Mormede and Dunn 2013), and that the vertical and horizontal extent of disturbance of benthic habitat by trawl gear differs to that of mining activity (Foden 2011; Parsons et al. 2013; GANZ 2014).

52. However, given that commercial species recolonize trawled areas to at least some degree (as demonstrated by ongoing commercial catches in previously trawled areas (e.g., for hoki, Akroyd

et al. (2012), and references therein), some capacity for recolonization after mining should not be discounted. Further information is required to understand recolonization dynamics of mined areas.

53. The effects of the drag-head on commercial fisheries are considered negative. Using the classifications of MacDiarmid et al. (2012b), adverse effects of the drag-head are assessed as minor/moderate, likely, and presenting a low/moderate risk.

Discharge of tailings

54. The assessment of effects of mining activities on commercial fisheries as presented in this report does not include an analysis of the sediment modelling described as part of the CRP application, or the available reviews or statements evidence relating to that modelling (Hadfield 2013; CRP 2014d, 2014e; Deltares 2014; GANZ 2014; Lescinski 2014; Mead et al. 2014; Spearman 2014). This report is undertaken on the basis that the extent of the plume has been predicted appropriately.

55. The nature and extent of the sediment plume resulting from mining activities are both of relevance to commercial fish species. Characteristics of the plume that are expected to affect fish species include the particle size and type, concentration of sediments and the duration of exposure (e.g., Wilber and Clarke 2001).

Sensitivity of fish to sediments

56. Sensitivities to suspended sediments for non-New Zealand species vary widely, for example, with the effects on fish eggs and larvae becoming apparent at low (e.g., 3 mg/L) to high levels (e.g., 1,000 mg/L) (reviewed in Page 2014a, c). As well as differing amongst species (Page 2014a, c), the sensitivities of different life stages of fish to suspended sediments are expected to differ. Amongst New Zealand species, hake, hoki, barracouta and ling eggs show some surface adhesion. In contrast, the silver warehou eggs were not sticky (Patchell et al. 1987; Page 2014a).

57. Compared to eggs and larvae, juvenile and adult fish are highly motile and therefore are expected to be physically able to avoid the waterborne sediment plume and areas in which sedimentation occurs. However, the existence of such responses amongst New Zealand species has not been confirmed, and the consequences of avoidance may include greater survival risk, e.g., due to predation.

58. Page (2014a, c) highlights the paucity of available information relating to sensitivity to suspended sediments and sedimentation that is directly relevant to fish species occurring on the Chatham Rise, including the different life stages of these species. Page (2014c) suggests that a concentration of total suspended solids of 2 mg/L could be used as a threshold, at which no effects on fish eggs and larvae would be expected to occur, and notes that demersal fish are likely to avoid concentrations of total suspended solids greater than 3-5 mg/L.

59. However, ambient sediment levels on the Chatham Rise have been reported at 0.55 mg/L (Nodder 2013). CRP (2014g) raise the possibility that given ambient concentrations, Chatham Rise fish species may be particularly adapted to low levels of suspended sediment.

60. Given the lack of information on New Zealand species, the effects of the sediment plume on fish (at all life stages) are impossible to predict with any confidence. An alternative to the 2mg/L trigger, and a more precautionary approach, would be to assume possible negative effects where and when suspended solids and sedimentation are at levels higher than would occur in the absence of mining.

61. Given the effects of the sediment plume on fish cannot be predicted empirically, considering effects at the scale of the sediment plume is one reasonable approach.

Impacts on commercial catch

62. On that basis, given the limited commercial catch reported from the area predicted to be affected by the plume and sedimentation, direct impacts on commercial catch landings are not expected to be significant.

63. The work of Dunn and Hurst (2014) explores the impact of the proposed mining activity on three commercial finfish: hoki, hake and ling, on the scale of the Chatham Rise and in the context of existing stock assessment models. Their work considers two scenarios – firstly, in which the sediment plume ($\geq$ 3 mg/L) is avoided by fish and avoidance results in 100% mortality, and secondly, in which benthic habitat disturbance (including sedimentation $\geq$ 1 cm/year) reduces spawning and long-term recruitment.

64. Dunn and Hurst (2014) conclude that under the first scenario, the predicted effects on modelled fish stocks were considered low or negligible. Under assumptions of larger plume sizes, effects increased proportionately. Under the second scenario, the effect is on ling was considered low.

65. The assumptions used in this modelling are important. For example, if the 2 mg/L threshold proposed by Page (2014b) had been used, the effects of the sediment plume would be expected to be greater. Similarly, if ling are assumed to be more sensitive to sedimentation, the size of effects may have increased.

Impacts on other life stages

66. Given the available information on the spawning, the effects of the sediment plume and sedimentation are not expected to be significant on the eggs of commercial species at a Chatham Rise or EEZ scale (Dunn and Hurst 2014; O'Driscoll et al. 2014).

67. However, O'Driscoll et al. (2014) note important constraints on spawning records. That is, research trawls have only been conducted in January. Government fisheries observers are

deployed throughout the year, but the limited fishing effort in the consent area restricts data collection further.

68. Impacts of the sediment plume and sedimentation on juveniles of commercial species are less clear. Juveniles of some commercial species occur in greater densities in the consent area compared to elsewhere on the Chatham Rise (e.g., hake and ling (O'Driscoll 2014; O'Driscoll et al. 2014)). Impacts on these species of juvenile fish may be greater, given the apparent importance of, or juvenile preference for, the consent area habitat.

69. Finally, the effects of the plume and sedimentation on the larvae of commercial species are largely unknown (Page 2014a; O'Driscoll and Ballara 2014) and so cannot be assessed with confidence.

Comparison with the effects of bottom trawling

70. It is appropriate to note that bottom trawling also produces sediment plumes and sedimentation in benthic habitats. To some degree, commercial species are able to recolonise areas affected by sedimentation and sediment plumes, as evidenced by bottom trawling landing catch in previously trawled areas (e.g., for hoki, Akroyd et al. (2012), and references therein). The characteristics of sediment plumes and sedimentation resulting from bottom trawling and mining may be expected to differ (e.g., Parsons et al. 2013). However, further information is required to understand habitat use patterns in areas affected by plumes and sediment deposition, including with respect to commercial species.

Noise and vibration

71. No specific information is available on the noise associated with the operation of the vessel, drag-head, riser, sinker, and pump unit to be used in the proposed mining operation (GANZ 2014; HR Wallingford 2014). Further, no specific information is available on the ambient noise environment on the Chatham Rise (HR Wallingford 2014), or the hearing sensitivities of commercial species occurring there (Pierre 2014).

72. In the absence of information specifically relevant to the consent area and species within it, modelling has been conducted using proxy values (HR Wallingford 2014). This concludes that "*above ambient*" sound resulting from the mining operation will propagate across the Chatham Rise and reach the New Zealand mainland and the Chatham Islands, before becoming indistinguishable from ambient sound (HR Wallingford 2014; Jones 2014). The extent of propagation is dependent on a number of factors in addition to the characteristics of the sound, e.g., temperature, salinity, depth (HR Wallingford 2014).

73. HR Wallingford (2014) compared the modelled sound of the proposed mining operation with the existing sound environment relating to fishing vessel activity on the Chatham Rise. The sound profiles of multiple vessels were not modelled, however HR Wallingford (2014) concluded that

given the presence of fishing vessels, the Chatham Rise already experiences some sound pollution comparable to that which would be produced by the mining vessel. A key difference would result from the dredge pumps that would be used during mining (HR Wallingford 2014).

74. Popper (2014) considers that fish will not be physically harmed or killed by sound generated during the mining proposed. He also concludes that temporary threshold shifts will not occur.

75. Further, Popper (2014) considers that where sounds are at or below ambient levels, these will mask the dredging sounds and reduce the likelihood of behavioural responses. However, HR Wallingford (2014) concludes that sound above ambient levels will extend across the Chatham Rise. If behavioural effects do occur, Popper (2014) concludes "*these are likely to be transient, lasting only minutes or seconds, and would not result in substantial shifts in behaviour that could impact fitness*".

76. In the view of Popper (2014), sound levels "*are likely to be far too low to damage eggs and larvae*". Similarly, while referring to the broad lack of knowledge of invertebrate hearing, Popper (2014) considers that "*sounds from dredging are likely to be below the hearing capabilities of invertebrates at any distance from the source of the noise*", unless invertebrates are "*on or in the substrate*". In that case, where substrate vibration is "*very high and does not attenuate before reaching the invertebrates*", there may be an effect although this is considered unlikely (Popper 2014).

77. Popper (2014) considers that if fish are affected by sound on the Chatham Rise, this sound is much more likely to arise from fishing vessels.

78. The effects of noise on fish responses may include behavioural disturbance, masking of ambient noises, temporary hearing loss, physical damage, fish moving towards vessels, and fish leaving an area (Popper et al. 2006 and reviewed in De Robertis and Handegard 2013). Responses to noise differ amongst different species of marine fish (De Robertis and Handegard 2013).

79. In assessing the impact of noise on commercial species, key information gaps are the characteristics of the noise that the mining operation will generate, the hearing sensitivities and responses of commercial species, and the levels of ambient noise occurring in the consent area and on the Chatham Rise more broadly.

80. A robust assessment of the environmental risk that noise presents to commercial species is not possible given current information. However, noise may have adverse effects (given noise has been modelled at higher than ambient levels), the likelihood of which is considered possible, and of minor consequence, leading to a low risk given the approach of MacDiarmid et al. (2012b).

Lighting and vessel structures

81. It is assumed that while mining is underway, fishing activities will be excluded from the areas being mined and some distance around those areas (e.g., as determined by maritime safety requirements).

82. Given the relatively limited commercial fishing effort reported from the marine consent area and restrictions on bottom trawling resulting from the existence of the BPA, this short-term direct spatial exclusion of fishing resulting from the mining activity is considered extremely unlikely to significantly affect fisheries.

83. The details of lighting arrangements to be used on the drag-head during mining remain to be confirmed. Lights may be attached to the drag-head to facilitate observations (recorded by camera) undertaken for periods of 1 - 8 hours, for an anticipated maximum of 1 - 2 days of any mining cycle, particularly in the first few years of the operation (GANZ 2014). Lighting is expected to be sufficient to illuminate the area approximately 2 – 5 m around the drag-head (GANZ 2014; van Raalte 2014). Kennedy (2014a) notes that "*areas exposed to lighting will be subject to more significant impacts*", i.e., the removal of the seabed by the drag-head.

84. Fish abundance could potentially be negatively or positively impacted by light associated with the mining operation (e.g., Marchesan et al. 2005; Stoner et al. 2008), and effects will relate to the sensitivities and responses of species encountered (e.g., Jones et al. 2004; Rich and Longcore 2006 (cited in Huber et al. 2014)). GANZ (2014) consider that lights are unlikely to attract fish. Huber et al. (2014) note that without additional information, an assessment of the effects of lighting cannot be made.

85. Based on the information available, lighting is not expected to affect fishing activity as fishing will not occur when the drag-head, and therefore the lights, are present. However, the lack of information on the lighting approach precludes a robust assessment and the effects of lighting on commercial species cannot be predicted with confidence. Given the information available, the effects of vessel structures and lighting together are evaluated as adverse, occasional, and minor, resulting in a low risk using the scoring of MacDiarmid et al. (2012b).

Oil and fuel spills and biosecurity incursions

86. GANZ (2014) assess the impact of oil spills on seabirds but not on commercial fisheries. Given the intent to conform with the regulatory framework associated with vessel waste discharges, GANZ (2014) considers the environmental risk these represent is neutral.

87. To mitigate risks associated with incursions of non-indigenous marine organisms, van Raalte (2014) states that the mining vessel will re-ballast en route to New Zealand, and that ballast water discharged on the Chatham Rise will be from New Zealand ports. However, Kennedy (2014a) states that the vessel will either re-ballast en route or demonstrate that ballast water is adequately

treated. Clarifying which is the case is important for a robust assessment of the details of the mining operation and associated risks.

88. Further, visible biofouling of the hull would not occur and the vessel's hull would be cleaned appropriately if it was to pass through a port known to harbour "*unwanted marine organisms or marine pests*" (van Raalte 2014). GANZ (2014) concludes that with these provisions in place, there is no biosecurity risk associated with the mining vessel, and the impact of mining on marine biosecurity is neutral.

89. The effects of mining-related oil spills and biosecurity incursions on commercial fisheries would be highly dependent on where and when these occur, and what invasive species were involved. Both types of unplanned events have the potential to affect commercial fisheries, e.g., altering habitats supporting harvested species, causing fatalities due to exposure of commercial species to spilled material, and negative economic impacts due to loss of brand value (Forrest and Taylor 2002; McCrea-Strub et al. 2011; Upton 2011; Lubchenco et al. 2012), although biosecurity issues are generally considered to be a greater risk for natural rather than economic values (Dodgshun et al. 2007; Hewitt et al. 2009).

90. In accordance with the framework developed by MacDiarmid et al (2012b), these unplanned events are assessed as having adverse effects, that are unlikely, and severe, with an associated risk level of moderate for commercial fisheries.

Cumulative impacts

Ecosystem modelling

91. Pinkerton (2013) addresses trophic connections and non-trophic transfers of organic carbon. Beyond trophic connections and carbon transfer, organism functions are not considered in the model. For example, the overall ecological importance of biogenic habitat-forming organisms such as corals is not evaluated (e.g., Costello et al. 2005; D'Onghia et al. 2011).

92. Commercial fish species prevail in the demersal fish group included in the model. This group is supported by six middle-trophic level groups, which provide 82% of demersal fish prey overall. These prey were arthropods, small demersal fish, mesopelagic fish, squid, krill and salps (Pinkerton 2013). Significant changes in the biomass of these key prey groups could reasonably be expected to have some effect on the biomass of their commercial fish predators.

93. Amongst commercial fish species, hoki showed the highest trophic importance in the Pinkerton (2013) model. On that basis, changes in hoki biomass would be expected to have substantial flow-on ecosystem effects through trophic linkages.

94. Taking into account its assumptions and constraints (Pinkerton 2013), the model provides an informative resource describing the structure of the Chatham Rise food web. However, Pinkerton (2014) notes that it is not appropriate to use it to estimate the ecosystem effects of mining.

Cumulative impacts of mining

95. GANZ (2014) consider the cumulative impacts of the proposed mining activity in relation to human impacts on seabirds and marine mammals, non-benthic fisheries bycatch and benthic fishing impacts. The assessment focuses on bottom trawling. GANZ (2014) conclude that mining will result in cumulative impacts on benthos in addition to those caused by bottom trawling, but that the cumulative impacts of mining will be small in contrast to fishing. This conclusion is based on the area of mining (450 km^2 over the first 15 years), and the operation of a single-pass system.

96. Cumulative impacts considered beyond those discussed in GANZ (2014) are reported by CRP (2014c) to be minor. This conclusion is based on about 0.2% of the marine consent area being subject to mining and fishing impacts (for fishing occurring 2008/09 – 2012/13, but note that this may be an artefact of the mapping method, Tuck 2014), and considers bottom longlining, noting that 0.5% of the ling longline catch occurring in this area in the same period (CRP 2014c).

97. Tuck (2014) and Parsons et al. (2013) provide additional information on sediment disturbance by trawling and mining. They report that the estimated amount of sediment discharged at or near the seabed as a result of the proposed mining activity is considerably greater than that suspended by fishing per unit area. However, fishing occurs over more of the Chatham Rise. Estimates are 74,375 tonnes/km^2 of sediment (over an area of about 240 km^2 annually) for mining, compared to 1,180 – 2,405 tonnes/km^2 (over an area of 17,791 km^2, using the average annual trawl footprint for the five fishing years ending in 2012/13). Both activities disrupt benthic organisms and communities.

98. Cumulative impacts are the totality of all anthropogenic impacts over time. In the marine environment, knowledge and understanding of cumulative impacts is extremely limited (e.g., Mullan Crain 2008; Ban et al. 2011), including in relation to the cumulative impacts of fishing and mining (e.g., Foden 2011).

99. While the spatial overlap of past fishing and proposed mining activities may be limited, mining will result in additional anthropogenic disturbance on the Chatham Rise. In excess of 1,050 km^2 of seabed may be disturbed over 35 years (i.e., the spatial extent of the mining blocks), plus the surrounding areas affected by sedimentation of tailings, and any additional area that may be mined to meet CRP's annual production target of 1.5 million tonnes of phosphorite (GANZ 2014).

100. Based on current knowledge, whether the contribution resulting from mining to the cumulative impacts of anthropogenic disturbances on the Chatham Rise will have significant effects on commercial fish species, or fisheries, cannot be predicted with confidence. While impacts are

likely (e.g., in accordance with the conclusions of Mullan Crain et al. (2008)), their scale is unknown. Consequently, potential cumulative impacts on commercial fisheries are assessed using MacDiarmid et al. (2012b) as adverse, occasional or likely, of moderate consequence, and therefore a moderate risk.

Economic and sustainability impacts

Food safety

101. An assessment of whether toxic or radioactive material would be assimilated or accumulated by commercial species as a result of mining is beyond the scope of this report. However, the evidence of Bull (2014), Hermanspahn (2014) and Kennedy (2014b), and the conclusions of EPA (2014) are noted in this regard.

102. If commercial species were to assimilate toxic or radioactive material, this would naturally be expected to affect the saleability of seafood products. Further, in the absence of real issues with food safety or quality, changes in public perceptions of New Zealand seafood as a safe and healthy product may occur due to an awareness of the properties of the materials extracted and the nature of the sediments disturbed during the mining activity.

103. While the context is clearly very different, an example of the impacts of perceived contamination of seafood is provided by the Deepwater Horizon oil spill in the USA. There, fishery closures were implemented and government monitoring programmes assessed the safety of seafood for human consumption. Although monitoring programmes were in place and no contaminated seafood was reported to reach the market (Lubchenco et al. 2012), scepticism around food safety was ongoing and seafood sales were reported to be depressed including after the well was capped (Upton 2011)[4]. For example, a survey commissioned by Louisiana's Seafood Promotion Board reported that 70% of consumers were concerned about seafood safety following the Deepwater Horizon spill (McGill 2011, cited in Upton 2011). Further, 59% of US consumers surveyed by McKendree et al. (2013) reported that they were likely to avoid seafood from the Gulf, despite their general preference for US-sourced seafood.

104. Similarly, a consumer survey conducted in the USA following Japan's Fukushima nuclear accident found that 63% of respondents considered that the quality of seafood from "*Asian countries*" was lower than prior to the accident (McKendree et al. 2013). Further, 67% felt that Asian seafood posed a risk to consumers and 33% reported seeking to avoid Asian seafood due to the nuclear accident.

---

[4] http://www.eoearth.org/view/article/163046/

105. The likelihood and extent of economic impacts on commercial fisheries due to public perceptions of compromised food safety are difficult to assess. However, examples from outside New Zealand show that such effects are possible.

Fishing patterns

106. Within QMAs 3 and 4, current commercial fishing interests reported by CRP based on their request to FishServe included 221 entities holding either quota and/or ACE (CRP 2014a). Details of approximately 900 fishers holding quota or ACE and operating in FMA4 were provided by the Ministry for Primary Industries to the EPA (EPA 2014). Clarifying the reason for the large difference between these figures describing existing interests would be valuable.

107. While mining is occurring and until commercial species are known to have recolonized mined areas in which fishing is permitted, fishing effort is expected to be displaced to other focal areas within QMAs. While catch volume may be able to be maintained through the relocation of fishing effort, the sustainability and economics of fisheries may change, e.g., due to fishing effort targeting a different component of the stock or landing different bycatch species, and the potential for changes in fishing efficiency including catch per unit effort (Hiddink et al. 2006; Powers and Abeare 2009; Bastardie et al. 2010; van de Geer et al. 2013, Campbell et al. 2014).

108. Given the low volume of catch and effort recorded inside the consent area, the effects of displacing fishing activity are not expected to be significant. An assessment of negligible/minor and rare results in a low risk.

Quota value

109. In addition to potential changes in fishing patterns, the potential value of fishing quota may be negatively affected by any actual and/or perceived loss in fishable area. Given the extent of fishing effort and landings in the QMAs in which the marine consent area is located, this change would not be expected to be significant. However, if mining disrupts fisheries at a broader scale (e.g., due to the sediment plume travelling further than expected), effects on quota value may result.

110. The likelihood of changes to fishing quota value are difficult to assess in advance of the mining application proceeding. However, in the context of marine farming, this potential is formally recognised for proposed farms, by the "Undue Adverse Effects" test (Ministry for Primary Industries 2012b).

111. Clough et al. (2014) consider that given mining is a transient disturbance, "*unless the mine footprints do not recover rapidly the disturbance on bottom long-lining should be much less than the permanent exclusion from the sea-bed*". Where recovery periods are prolonged (e.g., as described in Beaumont and Rowden 2013), effects on fishing would therefore be expected to be

greater than accounted for Clough et al. (2014), within the context of fishing effort deployed in the consent area.

112. The likelihood and extent of impacts on quota value are difficult to assess. However, such effects are considered possible.

Sustainability accreditation and the fisheries management regime

113. Commercial fisheries on the Chatham Rise that are certified as sustainable by the Marine Stewardship Council (MSC) or in assessment for certification include hoki, hake, ling, oreo and orange roughy (see paragraph 14).

114. The MSC principles underlying certification relate to the sustainable utilisation of the target fish stocks, maintenance of the ecosystem on which the fishery depends, and implementation of an effective management system (MSC 2010). An evaluation of the impacts fisheries have on benthic habitats and ecosystems is integral to the MSC assessment and accreditation process (e.g., MSC 2011). MSC have recently reviewed their requirements of fisheries that cause benthic impacts and a new standard is in development for release in October 2014[5].

115. In the most recent reassessment of the hoki fishery (Akroyd et al. 2012), a condition was raised in relation to the fishery's impacts on benthic habitats on the Chatham Rise. This condition was met in 2013 (Akroyd and Pierre 2013).

116. Spatial protection measures, including BPAs, have been identified as important components of the framework for managing the impacts of bottom trawling in New Zealand (Ministry for Primary Industries 2012a). The value of BPAs against the intent described by Helson et al. (2010), including the representativeness of areas protected, has been questioned (Leathwick et al. 2008). A review of BPAs was planned for 2013 (Akroyd and Pierre 2014).

117. Beyond any considerations of BPA representativeness on an EEZ-scale, the Mid-Chatham Rise BPA has value as a substantial area of seabed that has been relatively lightly impacted by anthropogenic disturbances over time. If this area is considered important for the management of bottom fishing impacts in New Zealand waters (Ministry for Primary Industries 2012a), it's modification by mining activities will be of concern to fisheries managers. The possibility of setting a permissive precedent for the occurrence of destructive activities in other BPAs should also be of concern, as this undermines spatial protection initiatives designed to maintain benthic habitats.

118. If the Mid-Chatham Rise BPA is mined, protection of an another area demonstrating the characteristics described by Helson et al. (2010) would presumably be considered, in order to

---

[5] http://improvements.msc.org/database/benthic-impacts

meet the objectives of spatial approaches as a component of New Zealand's fisheries management regime.

119. The Marine Environment Classification (MEC, Snelder et al. 2005) was used to support the selection process that identified BPAs (Helson et al. 2010). More recently, the impacts of bottom fishing in the New Zealand EEZ have often been considered using the Benthic-Optimised Marine Environment Classification (BOMEC, Leathwick et al. 2009) (Akroyd et al. 2012; Ministry for Primary Industries 2014e). While it has strengths and weaknesses, the BOMEC tool has been recognised as the best currently available (e.g., Akroyd et al. 2012; Akroyd and Pierre 2014) and performs better than its predecessor – the MEC – at predicting benthic habitat classes on and around the Chatham Rise (Ministry for Primary Industries 2012a).

120. The Mid-Chatham Rise BPA is classified as BOMEC class 8 (or H, Ministry for Primary Industries 2012a; Ministry for Primary Industries 2014e) or MEC class 63 (Snelder et al. 2005). Bottom trawling for deepwater commercial species has covered 49% of BOMEC 8 from 1989/90 to 2009/10 (Ministry for Primary Industries 2014e). Given the distribution of BOMEC 8 (and MEC 63) in the EEZ, the creation of another BPA with maximally similar characteristics that also captures biodiversity value may be expected to have greater impacts on existing commercial fisheries activities (in terms of the exclusion of fishing effort) than the current BPA.

121. The impact on brand value of mining in a BPA has been raised by some submitters on the proposed mining activity. Citing work that sought to examine the value of New Zealand's clean green brand, Clough et al. (2014) suggest that there is very little likelihood of this occurring.

122. More systemic potential impacts on brand value may result from challenges to MSC certification, and consequent threats to the potential for access to premium markets (MSC 2009; Roheim et al. 2011).

123. The likelihood of commercial fisheries being affected by challenges to sustainability accreditation or the integrity of the fisheries management regime is considered possible.

Other issues

124. GANZ (2014) identified the subsidised provision of unprocessed rock phosphate to farmers on the Chatham Islands as a component of the package developed as compensation for the environmental impacts of the mining project. This proposal has subsequently been amended, such that now, instead of providing fertiliser, CRP through the proposed Chatham Islands Trust, will support the investigation and facilitate the development of opportunities for the Island's farming community. This does not preclude the acquisition of fertiliser (CRP 2014e).

125. The application of a significant amount of additional fertiliser may result in increased nutrient loadings on the Chatham Islands. Some level of run-off would be expected into the islands'

freshwater waterways and ultimately to the coastal waters, which may reduce coastal water quality.

126. The Chatham Islands Annual Plan (2013/14) notes the importance of the coastal environment to the Islands, including for commercial fishing and marine farming (Chatham Islands Council 2013) and commercial fisheries around the Islands target species such as paua, rock lobster, and blue cod (see paragraph 15). Considering the possible effects of increased fertiliser application in the terrestrial environment on the marine environment, including characteristics of that environment that support commercial fisheries, would be necessary in order to develop a thorough understanding of the effects of the proposed mining activity.

127. Commercial fisheries for rock lobster around the Chatham Islands are considered "*highly unlikely*" to be affected by the proposed mining activity, based on the location of mining activity, predictions of the extent of the sediment plume, past catch of rock lobsters in research trawls, and models of larval drift (MacDiarmid 2013, 2014). Commercial fisheries for this species are not considered further in this report.

128. Eels also form the basis for commercial fishing activity, and migrate from freshwater through marine habitats to their breeding area. Due largely to the probable distribution of these animals at various life stages away from the mining area, mining was assessed as unlikely to have any impacts and these species were not considered further (GANZ 2014). That mining is not expected to impact migrating eels is supported by Patrick (2013, in CRP 2014b), however, the opposing views of Hokotehi Moriori Trust (2014) are noted. It appears that currently available information tends towards the proposed mining activity not affecting migrating eels. On that basis, effects are not considered further.

Mitigation of effects

Mitigation proposed by the Applicant

129. Where mitigation is proposed by the applicant, this is described below in accordance with the headings of the previous section. Note that monitoring in isolation of a defined response (e.g., as described in CRP 2014f and GANZ 2014) to reduce effects is not considered mitigation.

Effects of the drag-head

130. No mitigation is proposed for the entrainment of biota by the drag-head, except the use of a screen for material greater than 150 mm diameter (GANZ 2014).

131. With the goal of reducing seabed disturbance and sedimentation around the drag-head, CRP will:

- make the drag-head as narrow as possible without adversely affecting the rate of production

- use a multi-jet drag-head comprising a series of lower pressure jets, rather than fewer high pressure jets, and,
- minimise leakage around the drag-head and maximise the retention of mobilised material for transport to the vessel (GANZ 2014).

132. An evaluation of habitat creation options (also referred to as hard substrate trials) is proposed. Habitat creation is identified as a possible, and experimental, mitigant of the effects of the disturbance of benthic habitats. This proposal involves assessing the viability and value of adding hard substrate to the seabed after mining for enhancing biodiversity recovery. If hard material can be returned to the seabed in a cost effective manner, trials will proceed in consultation with the Environmental Reference Group (GANZ 2014, Taylor 2014).

133. CRP proposed to not mine a set of "*mining exclusion areas*" to address seabed disturbance (Taylor 2014). The existence of high conservation values was a key factor cited as guiding the selection process for these areas, in addition to the existence of iceberg furrows and distribution of four Marine Environment Classification classes (Snelder et al. 2006; Rowden et al. 2014).

134. CRP proposes to explore the establishment of a legal mechanism for the mining exclusion areas and other areas identified outside the marine consent area (GANZ 2014, Taylor 2014).

135. Taylor (2014) notes that rock outcrops greater than 2 km^2 will not be mined.

136. For the first five years of the mining operation, it is proposed that mining blocks "*are sufficiently separated such that sedimentation impacts between the mining blocks are minimised in any given year*" (GANZ 2014).

Discharge of tailings

137. The use of a "*diffuser or similar technology"* is proposed at all times. This will that tailings are deposited at low velocity. Sediment is to be deposited within 10 m of the seabed, on average, per mining block (GANZ 2014, Taylor 2014).

138. Monitoring of the level of total suspended solids is proposed, with exceedances of identified thresholds ultimately requiring assessment of any responses that would avoid, remedy or minimise suspended solids associated with mining operations (GANZ 2014; Taylor 2014).

139. Mining operational procedures are to include controls for the range of conditions under which the returns of non-phosphatic material are to be discharged, including location, water depth, etc. (GANZ 2014). Details of these controls are not described.

Noise

140. No mitigation measures were considered necessary by CRP to protect fish from the potential adverse effects of noise (GANZ 2014), although controls on noise are mentioned are a part of

"*standard operational procedures*" to minimise the potential impacts of noise on marine life. Noise reduction techniques, operating times, and frequency limits are identified, but not described.

Oil and fuel spills and biosecurity incursions

141. With respect to mitigating biosecurity risk, the applicant has clear intent to comply with the requirements of the Biosecurity Act (CRP 2014f; GANZ 2014). As noted in paragraph 87 however, some clarification is required on the details of the management approach. Further, the applicant has agreed to meet the voluntary Biofouling Risk Management Standard (Taylor 2014).

142. To mitigate the risk of oil spills, the applicant intends to comply with New Zealand regulations and rules, and Annexures I, IV, and VI or MARPOL (GANZ 2014).

Economic and sustainability impacts

143. While selected using a different approach to BPAs, CRP's proposed mining exclusion areas are considered to be of particular sensitivity or value within a broader area of the crest of the Chatham Rise (GANZ 2014). (Note paragraphs 133 and 134 above).

Additional mitigation measures

144. Mitigation of adverse effects on commercial fisheries resulting from the proposed mining activity is inherently challenging because of the nature of the operation. That is, the seabed must be destroyed to extract phosphorite nodules and, post-processing, the sediment is to be released back into the mined environment.

145. The extent of entrainment in the jet pump intake is unknown. However, screening the jet pump intake may reduce the entrainment of non-motile biota from the water column. Further, Newell and Woodcock (2013, cited in CRP2014e) refer to the use of recycled water in parts of the mining process. Using recycled water and reducing the amount of seawater taken in through the jet pump intake would reduce the extent of entrainment. The operational feasibility of these measures for the proposed CRP activity is unknown.

146. Restricting mining temporally such that the likelihood of entraining the eggs and larvae of commercial species is minimised may reduce entrainment mortalities. This approach is constrained by a lack of information on larval distribution. Amongst commercial species that are demersal spawners and are known to spawn in the consent area (ling, giant stargazer (Page 2014b)), June – December encompasses known spawning activity. Amongst species that spawn in the water column, hake spawn from September to January and silver warehou from September to December.

147. Potential impacts of perceived food safety issues resulting from the disturbance of trace elements and radioactive material may be mitigated by the implementation of a robust monitoring

programme that established the safety of seafood harvested from the mined areas and within the extent of associated sediment plumes over time.

148. The applicant has stated an intent to comply with regulatory frameworks relating to biosecurity and oil spills. This reviewer would defer to experts in those areas to evaluate the adequacy of mitigation as applied to these risks. Mitigation approaches considered adequate for other large vessels, as well as pertaining to ballast water, hull, any submerged equipment, and waste discharges should be adequate for the mining activity.

149. Notifying fishing interests of the location of mining activities would contribute to mitigation of the direct disturbance of fishing activities. Fishing interests could then plan their activities with knowledge of areas likely to be affected by mining.

150. Mitigation of the destruction of seabed habitats in the Mid-Chatham Rise BPA would require the protection of seabed with the same characteristics in another area. This action would mitigate the loss of the BPA in terms of maintaining benthic protection and delivering on the intent of the fisheries management regime. However, this would be more likely to increase the impact of mining on commercial fisheries than reduce it, due to the likelihood of displacing more fishing effort than has been affected by the location of the existing BPA.

151. An alternative approach that would maintain the BPA and minimise effort displacement would be to amend the proposed consent area to exclude mining (and associated sediment plumes) from the BPA.

152. Effects for which known mitigation measures are not able to be identified, because effects are integral to the mining operation, or the nature of effects is unknown, include:

a. Benthic disturbance, however, monitoring recolonization of mining-affected areas by commercial species over time would improve understanding of the effects of mining.

b. The sediment plume, however monitoring the occurrence of commercial species at all life stages in areas affected by plumes and sedimentation would facilitate an understanding of the plume's effects over time. Reducing the extent of the plume would reduce effects on commercial species. CRP (2014e) notes that best practice mitigation would primarily involve reducing the amount of sediment released.

c. Noise, however characterising noise emerging from the mining operation and exploring the responses of New Zealand species to noise would facilitate an understanding of the effects of noise and whether mitigation is required.

d. Light, however as for noise, characterising light associated with the mining operation and exploring the responses of New Zealand species would support an understanding of the effects of light and whether mitigation is required.

e. Cumulative impacts

153. Overall, the mitigation approaches above cannot be considered to reduce the adverse effects of the mining operation comprehensively or with confidence in most cases.

154. EPA (2014) refer to the case of *Sustain our Sounds Inc vs New Zealand King Salmon Company Ltd*, in which the Supreme Court determined that it would have to be satisfied that any endorsement of an adaptive management approach would have to follow four criteria being met (taken from EPA 2014):

a. there will be good baseline information about the receiving environment

b. the conditions provide for effective monitoring of adverse effects using appropriate indicators

c. thresholds are set to trigger remedial action before effects become overly damaging

d. effects that might arise can be remedied before they become irreversible.

155. With that in mind, it is not considered likely that a robust adaptive management strategy can be developed for managing the effects of the activity proposed by CRP on commercial fisheries. In particular, this is because of the lack of baseline information in a number of areas affecting fisheries and the lack of information available to inform the development of appropriate triggers. The approach presented in GANZ (2014) does not address the criteria identified by the Supreme Court.

156. Four detailed sets of conditions have been made available during the marine consent process to date. These were provided by CRP (GANZ 2014), The Crown (2014), the EPA (EPA 2014), and an updated set on behalf of CRP as provided in Taylor (2014). The conditions proposed to date consider some aspects of the mining operation that determine its effects on commercial fisheries, e.g., issuing advance notification of the location of mining activity and monitoring the extent of the sediment plume.

157. The specific approach to the development of conditions that is presented in EPA (2014) is preferred, given the clarity this establishes. Conditions should include a clear specification of the requirements of the mining operation. Conditions should also provide clarity around the scope of baseline monitoring. Developing monitoring is considered essential, such that key knowledge gaps relating to effects of the mining operation can be addressed.

Discussion

158. The Chatham Rise is a critical area supporting New Zealand commercial fisheries, such as those targeting hoki, hake and ling. Commercial catch and fishing effort deployed in the consent area have been low over the past 10 years (O'Driscoll and MacGibbon 2014). However, the area

is a known spawning site for some commercial species. It also holds densities of juvenile fish of some commercial species that are higher than elsewhere on the Chatham Rise (O'Driscoll et al. 2014). Further, the BPA that the consent area overlaps with is an important part of the New Zealand fisheries management regime (Ministry for Primary Industries 2012a). Five target fisheries on the Rise are certified as sustainable or are in assessment for accreditation by the Marine Stewardship Council.

159. Mining may affect commercial fish species by:

a. entraining non-motile life stages,

b. disturbing benthic habitats important to fish,

c. releasing a sediment plume, and triggering sedimentation, that results in deleterious effects on fish (including eggs, larvae) or excludes fish from affected areas,

d. emitting noise, vibration and light,

e. creating a risk of oil spills and biosecurity incursions, and,

f. contributing to anthropogenic disturbances on the Chatham Rise, which may have cumulative effects.

160. Beyond effects on fish themselves, mining may affect commercial fisheries through:

a. economic impacts due to perceived food safety issues, reduced quota value, and challenges to sustainability accreditation, and,

b. destroying part of a BPA and therefore challenging the integrity of New Zealand's fisheries management regime.

161. This assessment identifies the effects of the proposed mining activity on commercial fisheries as Low to Moderate. Limited mitigation options are available to address these effects and key information gaps introduce significant uncertainties into this assessment.

162. The most important information gaps and uncertainties these relate to are:

a. the timeframe elapsing before commercial species' utilisation of mined habitats is restored,

b. the response of the fisheries management regime to mining impacts in a BPA,

c. the sensitivities of commercial species at all life stages to sedimentation and suspended sediment,

d. the distribution of commercial species' larvae and spawning activity, and,

e. the cumulative impacts of anthropogenic disturbance on the Chatham Rise.

163. An inadequate information base introduces additional uncertainties in assessing the effects of noise and light on commercial species, and the entrainment of biota at the jet pump intake. However, these are considered less important than those listed in paragraph 162 (a-e), above.

164. Under s 60 of the EEZ Act, the extent of adverse effects on existing interests must be evaluated. While mining is occurring, fishing will be excluded from the consent area. Given the limited catch taken from the consent area in recent years, catch landings can most likely be taken from other parts of the relevant QMAs. Beyond short-term exclusions, mined areas may be unsuitable for fishing for extended periods after the cessation of mining if commercial species do not recolonize mined areas. The timeframe for recolonization is unknown.

165. Further, approximately 90% of the marine consent area overlaps with the Mid-Chatham Rise BPA. While addressed under different components of the marine management regime, mining will destroy the seabed characteristics that the Mid-Chatham Rise BPA was designed to protect. Creating a new BPA with these characteristics would probably result in greater displacement of fishing effort than the existing BPA.

References

166. Akroyd, J.M., Pierre, J.P. 2013. Surveillance report: New Zealand hoki fishery. Certificate No.: MML-F-030. February 2013. Intertek Fisheries Certification Ltd. Available at: www.msc.org/track-a-fishery/fisheries-in-the-program/certified/pacific/new-zealand-hoki/second_reassessment-downloads-1/82085_HOK_surveillance_report_120213.pdf

167. Akroyd, J.M., Pierre, J.P. 2014. Surveillance report: New Zealand hoki fishery. Certificate No.: MML-F-030. April 2014. Intertek Fisheries Certification Ltd. Available at: www.msc.org/track-a-fishery/fisheries-in-the-program/certified/pacific/new-zealand-hoki/second_reassessment-downloads-1/20140429_SR_HOK78.pdf

168. Akroyd, J., Pierre, J., Punt, A. 2012. NZ Hoki Fisheries: 2nd Reassessment. Public Certification Report v5. Ref: MML-F-030. Intertek Moody Marine. Available at: www.msc.org/track-a-fishery/fisheries-in-the-program/certified/pacific/new-zealand-hoki/second_reassessment-downloads-1/20120925_PCR.pdf

169. Baird, S.J., Wood, B.A., Bagley, N.W. 2011. Nature and extent of commercial fishing effort on or near the seafloor within the New Zealand 200 n. mile Exclusive Economic Zone, 1989-90 – 2005-05. New Zealand Aquatic Environment and Biodiversity Report no. 73. Ministry of Fisheries, Wellington.

170. Ban, N.C., Alidina, H.M., Ardron, J.A. 2011. Cumulative impact mapping: advances, relevance and limitations to marine management and conservation, using Canada's Pacific waters as a case study. Marine Policy 34: 876-886.

171. Bastardie, F., Nielsen, J.R., Andersen, B.S., Eigaard, O.R. 2010. Effects of fishing effort allocation scenarios on energy efficiency and profitability: an individual-based model applied for Danish fisheries. Fisheries Research 106: 501-516.

172. Beaumont, J., Rowden, A.A. 2013. Potential for recolonisation and recovery by benthic communities following mining disturbance on the Chatham Rise. Report prepared by NIWA for Chatham Rock Phosphate Limited, January 2013 (Updated June 2013). Appendix 30. Chatham Rock Phosphate Limited. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/CRP_application_documents/Pages/CRP_application_docs.aspx

173. Bull, D. 2014. Statement of evidence of Dr David Bull for Chatham Rock Phosphate Limited. Dated: 28 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

174. Campbell, M.S., Stehfest, K.M., Votier, S.C., Hall-Spencer, J.M. 2014. Mapping fisheries for marine spatial planning: gear-specific vessel monitoring system (VMS), marine conservation and offshore renewable energy. Marine Policy 45: 293-300.

175. Chatham Islands Council. 2013. Chatham Islands Annual Plan 2013/14. Available at: www.cic.govt.nz/documents/2013/06/chatham-islands-annual-plan-201314.pdf

176. Chatham Rock Phosphate Ltd. 2014a. QMA 3 and 4 quota and/or annual catch entitlement holders (from FishServe). Appendix 34. Chatham Rock Phosphate Limited. Available at: epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/CRP_application_documents/Pages/CRP_application_docs.aspx

177. Chatham Rock Phosphate Ltd. 2014b. Marine Consent Application and Environmental Impact Assessment. Response to Request for Further Information (Part 1). June 2014. Available at: www.epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/Pages/Further-information-from-CRP.aspx

178. Chatham Rock Phosphate Ltd. 2014c. Marine Consent Application and Environmental Impact Assessment. Response to Request for Further Information (Request No. 37). August 2014. Available at: www.epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/Pages/Further-information-from-CRP.aspx

179. Chatham Rock Phosphate Ltd. 2014d. Marine Consent Application and Environmental Impact Assessment. Response to Request for Further Information – Request No. 6. July 2014. Available at: www.epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/Pages/Further-information-from-CRP.aspx

180. Chatham Rock Phosphate Ltd. 2014e. Marine Consent Application and Environmental Impact Assessment. Response to the Decision Making Committee's Request for Further Information (Part 2). August 2014. Available at: www.epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/Pages/Further-information-from-CRP.aspx

181. Chatham Rock Phosphate Ltd. 2014f. Draft environmental management and monitoring plan. Appendix 35(i). Volume 2. May 2014. Chatham Rock Phosphate Limited. Available at: epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/CRP_application_documents/Pages/CRP_application_docs.aspx

182. Chatham Rock Phosphate Ltd. 2014g. Marine Consent Application and Environmental Impact Assessment. Response to Request for Further Information (Request Nos. 14, 15, 35, 36 and benthic fauna). August 2014. Available at: www.epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/Pages/Further-information-from-CRP.aspx

183. Clough, P., Schilling, C., Zuccollo, J. 2014. Economic assessment of Chatham Rock Phosphate: Input to the Environmental Impact Assessment. Updated report to Chatham Rock Phosphate Ltd, March 2014. Appendix 6. Available at: www.epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/CRP_application_documents/Pages/CRP_application_docs.aspx

184. Costello, M., McCrea, M., Freiwald, A., Lundalv, T., Jonsson, L., Bett, B.J., van Weering, T.C.E., de Haas, H., Roberts, J.M., Allen, D. 2005. Role of cold-water *Lophelia pertusa* coral reefs as fish habitat in the NE Atlantic. Pages 771-805 in: Cold-water Corals and Ecosystems. Freiwald, A., Roberts, J.M. eds. Erlangen Earth Conference Series. Springer, Berlin.

185. Cryer, M., Stotter, D.R. 1999. Movement and growth rates of scampi inferred from tagging, Alderman Islands, western Bay of Plenty. NIWA Technical Report 49. NIWA, Wellington.

186. D'Onghia, G., Maiorano, P., Sion, L., Giove, F., Capezzuto, F., Carlucci, R., Tursi, A. 2010. Effects of deep-water coral banks on the abundance and size structure of the megafauna in the Mediterranean Sea. Deep Sea Research Part II: Topical Studies in Oceanography 57: 397-411.

187. De Robertis, A., Handegard, N.O. 2013. Fish avoidance of research vessels and the efficacy of noise-reduced vessels: a review. ICES Journal of Marine Science 70: 34-45.

188. Deltares. 2014. Modeling investigations on mine tailing plume dispersion on the Chatham Rise. Report prepared for Chatham Rock Phosphate Limited, March 2014. Appendix 25. Available at: www.epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/CRP_application_documents/Pages/CRP_application_docs.aspx

189. Department of Conservation. Undated. The guide to preparing your environmental impact assessment (EIA) for concessions applications. Available at: www.doc.govt.nz/Documents/about-doc/concessions-and-permits/concessions/guide-to-environmental-impact-assessments.pdf

190. Dodgshun, T., Taylor, M.D., Forrest, B.M. 2007. Human-mediated pathways of spread for non-indigenous marine species in New Zealand. DOC Research, Science and Development Series 266. Department of Conservation, Wellington.

191. Dunn, A., Hurst, R.J. 2014. Stock assessment impacts in the Chatham Rock Phosphate consent area. Prepared for Chatham Rock Phosphate Limited, August 2014. NIWA Client Report: WLG2014-63. Available at: http://www.epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/Pages/Further-information-from-CRP.aspx

192. Environmental Protection Authority. 2014. EPA staff report: EEZ000006 Chatham Rock Phosphate Limited Marine Consent Application. August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/reports/Pages/default.aspx

193. Foden, J. 2011. Integrated spatial assessment of human pressures and impact on UK seabed habitats. Thesis submitted for the degree of Doctor of Philosophy, School of Environmental Sciences, University of East Anglia, UK.

194. Forrest, B.M., Taylor, M.D. 2002. Assessing invasion impact: survey design considerations and implications for management of an invasive marine plant. Biological Invasions 4: 375-386.

195. Golder and Associates NZ Ltd. 2014. Chatham Rock Phosphate Limited: Proposed Mining Operation, Chatham Rise. Marine Consent Application and Environmental Impact Assessment. Volume 1: May 2014.

196. Guy, N. 2014. Sustainability measures and other management controls for 1 October 2014: Decision letter B14-059. Office of Hon Nathan Guy, Minister for Primary Industries.

197. Hadfield, M. 2013. Ocean model simulations of sediment plume behaviour. Report prepared by NIWA for Chatham Rock Phosphate Limited, April 2013. Appendix 23. Available at: www.epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/CRP_application_documents/Pages/CRP_application_docs.aspx

198. Helson, J., Leslie, S., Clement, G., Wells, R., Wood, R. 2010. Private rights, public benefits: industry-driven seabed protection. Marine Policy 34: 557-566.

199. Hermanspahn, N. 2014. Statement of evidence of Dr Nikolaus Hermanspahn for Chatham Rock Phosphate Limited. Dated: 29 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

200. Hewitt, C.L., Everett, R.A., Parker, N. 2009. Examples of current international, regional and national regulatory frameworks for preventing and managing marine bioinvasions. Pages 335-352 in: Biological Invasions in Marine Ecosystems: Ecological, Management and Geographic Perspectives. Ecological Studies 204. Rilov, G., Crooks, J.A. eds. Springer, Berlin.

201. Hiddink, J.G., Hutton, T., Jennings, S., Kaiser, M.J. 2006. Predicting the effects of area closures and fishing effort restrictions on the production, biomass, and species richness of benthic invertebrate communities. ICES Journal of Marine Science 63: 822-830.

202. Hobday, A.J., Smith, A.D.M., Stobutzki, I.C., Bulman, C., Daley, R., Dambacher, J.M., Deng, R.A., Dowdney, J., Fuller, M., Furlani, D., Griffiths, S.P., Johnson, D., Kenyon, R., Knuckey, I.A., Ling, S.D., Pitcher, R., Sainsbury, K.J., Sporcic, M., Smith, T., Turnbull, C., Walker, T.I., Wayte, S.E., Webb, H., Williams, A., Wise, B.S., Zhou, S. 2011. Ecological risk assessment for the effects of fishing. Fisheries Research 108: 372 – 384.

203. Hokotehi Moriori Trust. 2014. Submission to the Environmental Protection Authority Application from Chatham Rock Phosphate (EEZ000006). Available at: www.epa.govt.nz/EEZ/chatham_rock_phosphate/submissions/Pages/Submissions-received.aspx

204. Horn, P., Ballara, S.L. 2012. A descriptive analysis and CPUE from commercial fisheries for ling (*Genypterus blacodes*), in Fishstocks LIN 2, 3, 4, 5, 6 and 7 from 1990 to 2009. New Zealand Fisheries Assessment Report 2012/13. Ministry of Agriculture and Forestry, Wellington.

205. HR Wallingford. 2014. Chatham Rock Phosphate Underwater Sound Modelling. DLM7241-RT004-R02-00. August 2014. HR Wallingford Ltd. Available at: http://www.epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/Pages/Further-information-from-CRP.aspx

206. Huber, M., Yeates, M., Probst, T., Taylor, G. 2014. Review of technical reports relating to CRP marine consent application: marine science (marine mammals, fish and plankton, and benthic ecology). Jacobs SKM. Available at: http://www.epa.govt.nz/EEZ/chatham_rock_phosphate/reports/Pages/Independent-review-reports.aspx

207. Hurst, R.J., Stevenson, M.L., Bagley, N.W., Griggs, L.H., Morrison, M.A., Francis, M.P. 2000. Areas of importance for spawning, pupping or egg-laying, and juveniles of New Zealand coastal fish. Final Research Report prepared by NIWA for Ministry of Fisheries Research Project ENV 1999/03 Objective 1. December 2000. NIWA, Wellington.

208. Jones, D. 2014. Statement of evidence of Dr Diane Jones for Chatham Rock Phosphate Limited. Dated: 28 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

209. Jones, E., Glass, C., Milliken, H. 2004. The reaction and behaviour of fish to visual components of fishing gears and the effect on catchability in survey and commercial situations. International Council for the Exploration of the Sea. WGFTFB Working Paper. Available at: http://www.imr.no/ftfb/Jones%20et%20al%20%28File%206%29.pdf

210. Kennedy, R. 2014a. Statement of evidence of Paul Cameron Kennedy for Chatham Rock Phosphate Limited on assessment of environmental impacts. Dated: 29 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

211. Kennedy, R. 2014b. Statement of evidence of Paul Cameron Kennedy for Chatham Rock Phosphate Limited on sediment and chemistry. Dated: 29 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

212. Leathwick, J., Moilanen, A., Francis, M., Elith, J., Taylor, P., Julian, K., Hastie, T., Duffy, C. 2008. Novel methods for the design and evaluation of marine protected areas in offshore waters. Conservation Letters 1: 91-102.

213. Leathwick, J.R., Rowden, A., Nodder, S., Gorman, R., Bardsley, S., Pinkerton, M., Baird, S.J., Hadfikeld, M., Currie, K., Goh, A. 2009. Benthic-optimised marine environment classification for New Zealand waters. Final Research Report for BEN2006-01. Ministry of Fisheries, Wellington.

214. Lescinski, J. 2014. Statement of evidence of Jamie Lescinski for Chatham Rock Phosphate Limited. Dated: 29 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

215. Lubchenco, J., McNutt, M.K., Dreyfus, G., Murawski, S.A., Kennedy, D.M., Anastas, P.T., Chu, S., Hunter, T. 2012. Science in support of the Deepwater Horizon response. Proceedings of the National Academy of Sciences of the United States of America 109: 20212-20221.

216. MacDiarmid, A., McKenzie, A., Sturman, J., Beaumont, J., Mikaloff-Fletcher, S., Dunne, J. 2012a. Assessment of anthropogenic threats to New Zealand marine habitats. New Zealand Aquatic Environment and Biodiversity Report 93. Ministry of Agriculture and Forestry, Wellington.

217. MacDiarmid, A., Beaumont, J., Bostock, H., Bowden, D., Clark, M., Hadfield, M., Heath, P., Lamarche, G., Nodder, S., Orpin, A., Stevens, C., Thompson, D., Torres, L., Wysoczanski. 2012b. Expert risk assessment of activities in the New Zealand Exclusive Economic Zone and Extended Continental Shelf. Prepared for the Ministry for the Environment. NIWA Client Report WLG2011-39. NIWA, Wellington.

218. MacDiarmid, A. 2013. Briefing report: possible impacts of phosphorite nodule mining on red rock lobsters around the Chatham Islands. Report prepared by NIWA for Chatham Rock Phosphate Limited, September 2012 (updated April 2013). Appendix 31. Chatham Rock Phosphate Limited. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/CRP_application_documents/Pages/CRP_application_docs.aspx

219. MacDiarmid, A. 2014. Statement of evidence of Dr Alison MacDiarmid for Chatham Rock Phosphate Limited. Dated: 25 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

220. MacGibbon, D.J. 2013. Fishery characterisation and standardised CPUE analyses for alfonsino, *Beryx splendens*, (Lowe, 1834) (Berycidae), 1989-90 to 2009-10. New Zealand Fisheries Assessment Report 2013/30. Ministry for Primary Industries, Wellington.

221. MacGibbon, D.J., Hurst, R.J. 2011. Fishery characterisation and standardised CPUE analyses for ribaldo, *Mora moro* (Risso, 1810) (Moridae), 1989-90 to 2008-09. New Zealand Fisheries Assessment Report 2011/25. Ministry of Fisheries, Wellington.

222. MacGibbon, D.J., McGregor, V., Hurst, R.J. 2012. Fishery characterisation and standardised CPUE analyses for lookdown dory, *Cyttus traversi* (Hutton, 1872) (Zeidae), 1989-90 to 2008-09. New Zealand Fisheries Assessment Report 2012/07. Ministry of Agriculture and Forestry, Wellington.

223. Marchesan, M., Spoto, M., Verginella, L., Ferrero, E.A. 2005. Behavioral effects of artificial light on fish species of commercial interest. Fisheries Research 73: 171-185.

224. Marine Stewardship Council. 2009. Net benefits: the first ten years of MSC certified sustainable fisheries. Marine Stewardship Council. Available at: www.msc.org/documents/email/Net-Benefits-report.pdf.

225. Marine Stewardship Council. 2010. MSC Fishery Standard: Principles and Criteria for Sustainable Fishing. Version 1.1 – 1st May 2010. Available at: www.msc.org/documents/scheme-documents/msc-standards/MSC_environmental_standard_for_sustainable_fishing.pdf

226. Marine Stewarship Council. 2011. MSC Certification Requirements. Version 1.1, 24 October 2011. Marine Stewardship Council, London.

227. McCrea-Strub, A., Kleisner, K., Sumaila, U.R., Swartz, W., Watson, R., Zeller, D., Pauly, D. 2011. Potential impact of the Deepwater Horizon oil spill on commercial fisheries in the Gulf of Mexico. Fisheries 36: 332-336.

228. McKendree, M.G.S, Ortega, D.L., Widmar, N.O., Wang, H. H. 2013. Consumer perceptions of seafood industries in the wake of the Deepwater Horizon oil spill and Fukushima Daiichi Nuclear Disaster. Staff Paper 2013-03. August 2013. Department of Agricultural, Food and Resource Economics, Michgan State University, East Lansing. Available at: http://ageconsearch.umn.edu/bitstream/155582/2/StaffPaperOrtega2013-03.pdf

229. Mead, S., Grerre, D., McClary, D. 2014. A technical review on information provided in Chatham Rock Phosphate Ltd's (CRP) impact assessment and technical reports in relation to sediment mobilisation and transport. Gardline Marine Sciences Pty Ltd. Available at: www.epa.govt.nz/EEZ/chatham_rock_phosphate/reports/Pages/Independent-review-reports.aspx

230. Ministry for Primary Industries. 2012a. Aquatic Environment and Biodiversity Annual Review 2012. A summary of the environmental interactions between fisheries and the aquatic environment. Ministry for Primary Industries, Wellington.

231. Ministry for Primary Industries. 2012b. The Undue Adverse Effects Test on Fishing. November 2012. Ministry for Primary Industries, Wellington. Available at:

www.fish.govt.nz/NR/rdonlyres/17E57D68-19DA-40E9-82C6-7C7DCED03E89/0/UndueadverseeffectstestonfishingFSweb.pdf

232. Ministry for Primary Industries. 2013a. Fisheries Assessment Plenary November 2013, Stock assessment and yield estimates. Volume 1: Introductory sections to Ray's bream. Ministry for Primary Industries, Wellington.

233. Ministry for Primary Industries. 2013b. Fisheries Assessment Plenary November 2013, Stock assessment and yield estimates. Volume 2: Rock lobster to yellowfin tuna. Ministry for Primary Industries, Wellington.

234. Ministry for Primary Industries. 2014a. Fisheries Assessment Plenary May 2014 – 30th Anniversary. Stock assessments and stock status. Volume 1: Introductory sections to jack mackerel. Ministry for Primary Industries, Wellington.

235. Ministry for Primary Industries. 2014b. Fisheries Assessment Plenary May 2014 – 30th Anniversary. Stock assessments and stock status. Volume 2: John dory to red gurnard. Ministry for Primary Industries, Wellington.

236. Ministry for Primary Industries. 2014c. Fisheries Assessment Plenary May 2014 – 30th Anniversary. Stock assessments and stock status. Volume 3: Red snapper to yellow-eyed mullet. Ministry for Primary Industries, Wellington.

237. Ministry for Primary Industries. 2014d. Proposed introduction of the common halgfish (*Eptatretus cirrhatus*) into the Quota Management System on 1 October 2014. Final Advice Paper. July 2014. MPI Information Paper No: 2014/21. Ministry for Primary Industries, Wellington.

238. Ministry for Primary Industries. 2014e. Annual review report for deepwater fisheries for 2012/13. MPI Technical Paper no: 2014/06. Ministry for Primary Industries, Wellington.

239. Mormede, S., Dunn, A. 2013. An initial development of spatially explicit population models of benthic impacts to inform Ecological Risk Assessments in New Zealand deepwater fisheries. New Zealand Aquatic Environment and Biodiversity Report 106, Ministry for Primary Industries, Wellington.

240. Mullan Crain, C., Kroeker, K., Halpern, B.S. 2008. Interactive and cumulative effects of multiple human stressors in marine systems. Ecology Letters 11: 1304-1315.

241. Nodder, S.D. 2013. Natural sedimentation on the Chatham Rise. Report prepared by NIWA for Chatham Rock Phosphate Limited, August 2012 (updated April 2013). Appendix 12. Chatham Rock Phosphate Limited. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/CRP_application_documents/Pages/CRP_application_docs.aspx

242. O’Driscoll, R.L. 2014. Statement of evidence of Richard O’Driscoll for Chatham Rock Phosphate Limited. Dated: 28 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

243. O'Driscoll, R.L., Ballara, S.L. 2014. The Chatham Rise and hoki: role in hoki biology and distribution. Report prepared by NIWA for Chatham Rock Phosphate, April 2014. Appendix 18. Chatham Rock Phosphate Limited. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/CRP_application_documents/Pages/CRP_application_docs.aspx

244. O'Driscoll, R.L., Booth, J.D., Bagley, N.W., Anderson, O.F., Griggs, L.H., Stevenson, M.L., Francis, M.P. 2003. Areas of importance for spawning, pupping or egg laying, and juveniles of New Zealand deepwater fish, pelagic fish and invertebrates. NIWA Technical Report No. 119. NIWA, Wellington.

245. O’Driscoll, R.L. and MacGibbon, D.J. 2014. Estimated commercial catches in the Chatham Rock Phosphate consent area 2003/04 to 2012/13. Prepared for Chatham Rock Phosphate Limited. July 2014. NIWA Client Report WLG2014-57. NIWA, Wellington.

246. O’Driscoll, R.L., Bagley, N.W., Baird, S.J. 2014. Spawning areas of fish on the Chatham Rise 2001 – 2014. Prepared for Chatham Rock Phosphate Limited. August 2014. NIWA Client Report WLG2014-58. NIWA, Wellington.

247. Page, M. 2014a. Phosphorite prospecting on the Chatham Rise: Effects of total suspended solids (TSS) on fish eggs and larvae. Report prepared by NIWA for Chatham Rock Phosphate Limited, April 2014. Appendix 27. Chatham Rock Phosphate Limited. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/CRP_application_documents/Pages/CRP_application_docs.aspx

248. Page, M. 2014b. Statement of evidence of Mike Page for Chatham Rock Phosphate Limited. Dated: 28 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

249. Page M. 2014c. Effects of total suspended solids on marine fish - Pelagic, demersal and bottom fish species avoidance of TSS on the Chatham Rise. Report WLG2014-7 prepared by NIWA for Chatham Rock Phosphate Limited, April 2014. Appendix 28. Chatham Rock Phosphate Limited. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/CRP_application_documents/Pages/CRP_application_docs.aspx

250. Parsons, D., Tuck. I., Jones, E., Baird, S., Bagley, N., Neil, H. 2013. Potential for sediment suspension from trawl activity on the Chatham Rise. Prepared for Chatham Rock Phosphate Limited, November 2013. NIWA Client Report: WLG2013-61. Available at:

http://www.epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/Pages/Further-information-from-CRP.aspx

251. Patchell, G., Allen, M., Dreadon, D.J. 1987. Egg and larval development of the New Zealand hoki *Macruronus novaezelandiae*. New Zealand Journal of Marine and Freshwater Research 21: 301-313.

252. Paul, L.J. 2002. A description of the New Zealand fisheries for two groper species, hapuku (*Polyprion oxygeneios*) and bass (*P. americanus*). New Zealand Fisheries Assessment Report 2002/13. Ministry of Fisheries, Wellington.

253. Pierre, J.P. 2014. Review of technical reports on commercial fisheries. JPEC Ltd. Available at: http://www.epa.govt.nz/EEZ/chatham_rock_phosphate/reports/Pages/Independent-review-reports.aspx

254. Pinkerton, M. 2011. A balanced trophic model of the Chatham Rise, New Zealand. Available at: www.niwa.co.nz/sites/niwa.co.nz/files/chatham-model_32.pdf

255. Pinkerton, M.H. 2013. Ecosystem Modelling of the Chatham Rise. Report prepared by NIWA for Chatham Rock Phosphate Limited, April 2013. Appendix 22. Chatham Rock Phosphate Ltd. Available at: www.epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/CRP_application_documents/Pages/CRP_application_docs.aspx

256. Pinkerton, M. 2014. Statement of evidence of Dr Matt Pinkerton for Chatham Rock Phosphate Limited. Dated: 29 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

257. Popper, A. 2014. Statement of evidence of Professor Emeritus Arthur Popper for Chatham Rock Phosphate Limited. Dated: 28 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

258. Popper, A., Carlson, T., Hawkins, A., Southall, B. 2006. Interim criteria for injury of fish exposed to pile driving operations: a white paper. Available at: www.wsdot.wa.gov/NR/rdonlyres/84A6313A-9297-42C9-BFA6-750A691E1DB3/0/BA_PileDrivingInterimCriteria.pdf

259. Powers, J.E., Abeare, S.M. 2009. Fishing effort redistribution in response to area closures. Fisheries Research 99: 216-225.

260. Rowden, A., Lundquist, C., Baird, S., Woelz, S. 2014. Developing spatial management options for the crest of the Chatham Rise. Report prepared by NIWA for Chatham Rock Phosphate Limited, May 2014. Appendix 32. Chatham Rock Phosphate Ltd. Available at: www.epa.govt.nz/EEZ/chatham_rock_phosphate/the_application/CRP_application_documents/Pages/CRP_application_docs.aspx

261. Rowe, S.J. 2013. Level 1 risk assessment for incidental seabird mortality associated with fisheries in New Zealand's Exclusive Economic Zone. DOC Marine Conservation Services Series 10. Department of Conservation, Wellington.

262. Roheim, C.A., Asche, F., Insignares Santos, J. The elusive price premium for ecolabelled products: evidence from seafood in the UK market. Journal of Agricultural Economics 62: 655-668.

263. Simpson Grierson. 2014. Second Memorandum of Counsel for the Applicant: Request for Extension to Timeframes Pursuant to Section 159 of the Act and Notice of Change of Application Area.

264. Snelder, T.H., Leathwick, J.R., Dey, K.L., Weatherhead, M.A., Fenwick, G.D., Francis, M.P., Gorman, R.M., Grieve, J.M., Hadfield, M.G., Hewitt, J.E., Hume, T., Richardson, K.M., Rowden, A.A., Uddstrom, M.J., Wild, M., Zeldis, J.R. 2005. Development of an ecological marine classification in the New Zealand region. Environmental Management 39: 12-29.

265. Snelder, T.H., Leathwick, J.R., Dey, K.L., Weatherhead, M.A., Fenwick, G.D., Francis, M.P., Gorman, R.M., Grieve, J.M., Hadfield, M.G., Hewitt, J.E., Hume, T., Richardson, K.M., Rowden, A.A., Uddstrom, M.J., Wild, M., Zeldis, J.R. 2006. The New Zealand Marine Environment Classification. Ministry for the Environment, Wellington.

266. Spearman, J. 2014. Statement of evidence of Dr Jeremy Spearman for Chatham Rock Phosphate Limited. Dated: 28 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

267. Standards Australia and Standards New Zealand. Joint Australian New Zealand International Standard. Risk Management – Principles and Guidelines. AS/NZS ISO 31000: 2009. Superseding AS/NZS 4360:2004. Standards Australia, Sydney; Standards New Zealand, Wellington.

268. Stoner, A.W., Ryer, C.H., Parker, S.J., Auster, P.J., Wakefield, W.W. 2008. Evaluating the role of fish behavior in surveys conducted with underwater vehicles. Canadian Journal of Fisheries and Aquatic Sciences 65: 1230-1243.

269. Taylor, C. 2014. Statement of evidence of Carmen Taylor for Chatham Rock Phosphate Limited. Dated: 29 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

270. The Crown. 2014. Submission 110189 on Chatham Rock Phosphate Limited marine consent application. Available at: www.epa.govt.nz/EEZ/chatham_rock_phosphate/submissions/Pages/Submissions-received.aspx

271. Tuck, I. 2014. Statement of evidence of Dr Ian Tuck for Chatham Rock Phosphate Limited. Dated: 28 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

272. Upton, H.F. 2011. The Deepwater Horizon Oil Spill and the Gulf of Mexico Fishing Industry. Congressional Research Service 7-5700. CRS Report for Congress. Available at: http://fpc.state.gov/documents/organization/159014.pdf.

273. Van de Geer, C., Mills, M., Adams, V.M., Pressey, R.L., McPhee, D. 2013. Impacts of the Moreton Bay Marine Park rezoning on commercial fishermen. Marine Policy 39: 248-256.

274. Van Raalte, R. 2014. Statement of evidence of Gerard van Raalte for Chatham Rock Phosphate Limited. Dated: 28 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx

275. Wilber, D.H., Clarke, D.G. 2001. Biological effects of suspended sediments: a review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management 21: 855-875.

276. Wood, R. 2014. Statement of evidence of Raymond Allen Wood for Chatham Rock Phosphate Limited. Dated: 28 August 2014. Available at: http://epa.govt.nz/EEZ/chatham_rock_phosphate/evidence/Pages/Applicants_evidence.aspx