ENVIRONMENTAL ASSESSMENT REPORT – IMPORT OF SPECIFIC PATHOGEN FREE *Penaeus monodon* INTO AUSTRALIA

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Contents

List of Tables and Figures

Abbreviations and Acronyms

AFFA	Australian Government Department of Agriculture, Fisheries and Forestry
AFMA	Australian Fisheries Management Authority
AHPND	Acute hepatopancreatic necrosis disease
ALOP	Appropriate level of protection
BP	*Baculovirus penaei* (tetrahedral baculovirosis)
BMC	Broodstock multiplication centre
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMNV	Covert mortality nodavirus
EHP	*Enterocytozoon hepatopenaei*
EMS	Early mortality syndrome
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
F0	Founder population – first generation of animals brought into quarantine
F1	First generation of animals produced in quarantine from founder population
F2	Second generation of animals produced from founder population
GAV	Gill associated virus
GMO	Genetically Modified Organism
HDOA	Hawaii Department of Agriculture
HPV	Hepatopancreatic parvovirus
ICES	International Council for the Exploration of the Sea
IHHNV	Infectious hypodermal and hematopoietic necrosis virus
IMNV	Infectious myonecrosis virus
LPV	Lymphoid organ parvo-like virus
LSNV	Laem-Singh virus
MBV	*Monodon* baculovirus
MoV	Mourilyn virus
MrNV	*Macrobrachium rosenbergii* nodavirus
NHP	Necrotizing hepatopancreatitis
NHPB	Necrotizing hepatopancreatitis bacterium (*Hepatobacter penaei*)
NBC	Nucleus breeding facility
NPF	Northern Prawn Fishery
NSW	New South Wales
NT	Northern Territory
OCVO	Office of the Chief Veterinary Officer of AFFA
OIE	Office International des Epizooties, the world organisation for animal health
PL	Post larvae
PvNV	*Penaeus vannamei* nodavirus
QLD	Queensland
qPCR	Quantitative PCR
QSF	Quarantine spawning facility
RA	Risk analysis
RFLPs	Restriction fragment-length polymorphisms in mitochondrial DNA
SMV	Spawner isolated mortality virus
SPF	Specific pathogen free
TOR	Terms of reference
TS	Taura syndrome
TSV	Taura syndrome virus
WA	Western Australia
WSD	White spot disease
WSSV	White spot syndrome virus
WTD	White tail disease
YHD	Yellowhead disease
YHV1	Yellowhead virus genotype 1
YHV6	Yellowhead virus genotype 6
YHV7	Yellowhead virus genotype 7

Non – technical summary

This document is provided to accompany an application by ProAqua Pty Ltd to amend the *List of Specimens taken to be Suitable for Live Import* (Live Import List) to include specific pathogen free (SPF) black tiger prawns *Penaeus monodon* (also known as the giant tiger prawn) for the purposes of prawn aquaculture development in Australia. A recent disease incursion has allowed entry of the exotic OIE listed White Spot Disease (WSD) into Moreton Bay, which is a key prawn hatchery supply and prawn aquaculture growout region for eastern Australia. WSD is caused by White Spot Syndrome Virus (WSSV), a highly pathogenic disease agent that threatens the viability of prawn farming in Australia if it enters the wild fisheries from which broodstock prawns (mainly *P. monodon*) are sourced. In order to avoid the possibility of WSSV entering prawn hatcheries in Australia via domestic wild caught broodstock, it is desirable to increase hatchery biosecurity by developing "clean" *P. monodon* broodstock lines that are free from specific pathogens such as WSSV and all other nationally and internationally significant disease agents of prawns.

The proposed commodity (SPF *P. monodon*) would be sourced from commercial suppliers of specific pathogen free broodstock prawns located in Thailand or Hawaii. The prawns would be certified by the competent authority of the exporting country to be free of all OIE listed diseases of crustaceans as well as any other crustacean diseases on Australia's National List of Reportable Diseases of Aquatic Animals. The proposed translocations would operate under best practice protocols as outlined by the International Council for the Exploration of the Sea (ICES) for introductions and transfers of marine organisms (ICES 2005, 2012, OIE 2018). Live *P. monodon* (F0 generation) would be imported into a biosecure Quarantine Spawning Facility (QSF) and never leave that facility. The F1 generation of prawns, once tested by the Australian competent authority as free from all relevant diseases, would be released into Broodstock Multiplication Centres (BMCs), and/or into aquaculture ponds as high health prawns for growout for human consumption. Alternatively, a more disease risk-averse option would see only F2 generation postlarvae from BMCs released into aquaculture ponds.

This document provides information that fulfils the terms of reference (TOR) for preparing a draft environmental assessement report, specifically in terms of information relating to:

1. The taxonomy of the species, including any subspecies that occur naturally outside Australia.

2. The status of the species under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the *Environment Protection and Biodiversity Conservation Act 1999*.

3. The possible impacts that imported specimens could have on the native population of the same species, and on other components of the Australian environment.

4. The origin of the live specimens proposed for importation.

5. A summary of the proposed purpose of import.

6. What conditions or restrictions could be applied to the import of the species to reduce any potential for negative environmental impacts, and

7. State/territory controls on the species.

1.0 Introduction

In late November 2016, an outbreak of the exotic, OIE listed White Spot Disease (WSD) occurred in black tiger prawns (*Penaeus monodon*) aquacultured in prawn farms on the Logan River in Moreton Bay, SE QLD (Diggles 2017, Scott-Orr et al. 2017). Recent surveillance results from March 2018 have confirmed the persistence of White Spot Syndrome Virus (WSSV) infections in wild prawns and crabs in Deception Bay, in northern Moreton Bay, around 70km north from the affected aquaculture farms (Biosecurity QLD 2018). The persistence of WSSV in these wild crustacean populations within the White Spot Disease Biosecurity Zone (QLD Biosecurity Act 2017) suggests that the virus may have established in wild populations of crustaceans in Moreton Bay, resulting in ongoing (possibly permanent) damage to the significant prawn aquaculture industry on the Logan River as well as prawn and baitworm fisheries in the affected zone.

Once introduced, the spread of diseases into the aquatic environment in new regions is, with few exceptions (Ferguson 2000), irreversible and can have significant ongoing economic and ecological implications for biodiversity, conservation of threatened native species as well as threaten food security by interfering with commercial and recreational fisheries and the aquaculture industry (Lightner 1996, 2003, 2011, Lightner et al. 1997, Dove 1998, Nunan et al. 1998, Durand et al. 2000, Gaughan 2002, Hasson et al. 2006, Flegel 2006a, 2006b, Baumgartner et al. 2009, Stentiford 2009, Stentiford et al. 2012). Given the extreme consequences that would arise if WSSV entered prawn hatcheries in Australia via domestic wild caught broodstock, the recent WSD incursion has highlighted an urgent need for the prawn farming industry in Australia to pursue the current state-of-the-art in prawn stock domestication through development of Specific Pathogen Free (SPF) broodstock lines.

SPF prawns originate from populations that have had at least two years of documented historical freedom from a certain list of disease agents, during which time they have been subjected to routine diagnostic testing (disease surveillance) while being cultured in biosecure facilities under conditions where the listed disease agents would have produced recognizable disease if any were present (Wyban 1992, 2009, Lotz 1997, Lightner 2005, 2011, Moss et al. 2012). At the time of publication there are two suppliers of SPF *P. monodon* in the Asia-Pacific region (Table 1).

Table 1. International suppliers of live SPF *P. monodon* (data from CP Foods, Moana Tech. 2018)

Supplier	Location	Products	Competent Authority	SPF lines certified free from	Genetic source
Moana Technologies	Hawaii, USA	Adults, nauplii, PL (F12-F14 generation)	State of Hawaii, Depart. of Agriculture (HDOA)	IHHNV, WSSV, MBV, HPV, YHV, GAV, TSV, MoV, LSNV, IMNV, PvNV, NHP, AHPND, CMNV, EMS/*Vibrio parahaemolyticus*, EHP, pathogenic protozoa, metazoan parasites, lymphoid organ spheroids	Vietnam, South China Sea, Andaman Sea, Bay of Bengal, Indian Ocean (143 families, none new since 2005)
CP Foods	Thailand	Adults, PL	Thailand Dept. of Fisheries	IHHNV, WSSV, MBV, HPV, YHV, GAV, TSV, MoV, LSNV, IMNV, NHP, AHPND, EHP and other microsporidians	WA, Thailand PNG, Noumea, Madagascar (none new since 2004)

The proposed translocation of the commodity would incorporate pre-border and post-border biosecurity risk mitigation measures that represent world's best practice, incorporating only SPF prawns translocated under International Council for the Exploration of the Sea (ICES) protocols for introductions and transfers of marine organisms (ICES, 2005, 2012). The proposal involves importation of live sub-adult or adult SPF *P. monodon* (F0 generation) sourced from approved commercial suppliers (Table 1) that have met the minimum standards established by Australia's competent authority (Office of the Chief Veterinary Officer (OCVO) in the Department of Agriculture, Fisheries and Forestry, AFFA). The prawns would need to be certified by the competent authority of the exporting country to be free of all OIE listed diseases infecting prawns, as well as any other diseases of prawns listed on Australia's National List of Reportable Diseases of Aquatic Animals (Table 2), prior to being introduced into a biosecure Quarantine Spawning Facility (QSF) in Australia.

Table 2. List of specific pathogens from which live SPF *P. monodon* would be certified free.

	Disease	Pathogen	OIE Aquatic Animal Health Code (2018)	Australian National List of Reportable Diseases of Aquatic Animals 2018
1	Acute hepatopancreatic necrosis disease (AHPND)/ Early mortality syndrome (EMS)	Infection with *Vibrio parahaemolyticus* (*Vp*AHPND)	✓	✓
2	Infection with *Enterocytozoon hepatopenaei*	*Enterocytozoon hepatopenaei* (EHP)	✓	✓
3	Infection with infectious hypodermal and haematopoietic necrosis virus	Infectious hypodermal and haematopoietic necrosis virus (IHHNV)	✓	✓
4	Infection with infectious myonecrosis virus	Infectious myonecrosis virus (IMNV)	✓	✓
5	Mid crop mortality syndrome	Gill- associated virus (GAV / YHV2)		✓
6	*Monodon* slow growth syndrome (MSGS)	Leam-Singh nodavirus (LSNV)		✓
7	Necrotizing hepatopancreatitis (NHP) (Infection with *Hepatobacter penaei*)	Candidatus *Hepatobacter penaei*	✓	✓
8	Spherical baculovirosis	*Penaeus monodon*-type baculovirus (MBV)	✓	
9	Taura Syndrome (Infection with Taura syndrome virus)	Taura syndrome virus (TSV)	✓	✓
10	Tetrahedral baculovirosis	*Baculovirus penaei* (BP)	✓	
11	White spot disease (WSD)	White spot syndrome virus (WSSV)	✓	✓
12	White tail disease (WTD)	*Macrobrachium rosenbergii* nodavirus (MrNV)	✓	✓
13	Yellowhead disease (Infection with yellowhead virus genotype 1)	Yellowhead virus genotype 1 (YHV1)	✓	✓

Once introduced into the biosecure QSF, the imported SPF *P. monodon* would never leave that quarantine facility (ICES 2005, 2012, OIE 2018) and would instead be euthanased, tested for disease then autoclaved once they have reached the end of their working lives. The F1 generation bred within the quarantine spawning facility would be tested by the relevant Australian competent authority as free from all 13 relevant diseases on the OIE and Australian National List of Reportable Diseases (Table 2). Once the F1 generation are certified as free from these specific pathogens, they would then be allowed to exit quarantine to be released into Broodstock Multiplication Centres (BMCs) and /or the environment of aquaculture ponds as high health prawns for growout for human consumption (OIE 2018). Alternatively, a more disease risk-averse option would involve the F1 generation being certified as free from the specific pathogens then distributed only into Broodstock Multiplication Centres (BMCs), to be utilised to produce a F2 generation (with the F1 generation being euthanased and autoclaved once they have reached the end of their working lives). In the latter lower disease risk scenario, only the F2 generation postlarvae (PL) from the BMCs would be permitted to be released into the environment of aquaculture ponds as high health prawns for growout for human consumption. In both scenarios, regardless of whether F1 or F2 generation are used for release into the environment of aquaculture ponds, sufficient genetic diversity will be required within the family lines which comprise the F0 generation to effectively mitigate the probability of deleterious inbreeding of the F1 or F2 generations.

We understand that submission of the appended application form together with this draft assessment report is the first step in a process which aims to add *P. monodon* to the Department of the Environment's List of specimens suitable for live import (http://www.agriculture.gov.au/biosecurity/risk-analysis/guidelines). Once this is done, an assessment of the biosecurity risks associated with import of live SPF *P. monodon* may be required to determine import conditions for live SPF *P. monodon*. As this proposal also represents a new market access request, Australia’s Federal Government will also require the Government(s) of the exporting country(ies) to make a formal market access request for these commodities.

2.0 Terms of Reference

The *Guidelines for preparing a draft assessment report and application to amend the List of Specimens taken to be Suitable for Live Import* require answers to the following questions:

1. Provide information on the taxonomy of the species, including any subspecies that occur naturally outside Australia.

2. Provide information on the status of the species under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and its conservation status under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

3. Provide information on the possible impacts that imported specimens could have on the native population of the same species, and on other components of the Australian environment. This may include an assessment of:

    3.1 any possible phenotypic or behavioural changes that may have occurred in these specimens as compared to those naturally occurring in Australia

    3.2 any adaptations to differing climatic conditions in the country of export.

    3.3 any possible parasites or pathogens that these specimens may carry as compared to those naturally occurring in Australian populations.

4. Provide information on the origin of the live specimens that you propose to import.

5. Provide a summary of the proposed purpose of import.

6. What conditions or restrictions, if any, could be applied to the import of the species to reduce any potential for negative environmental impacts (e.g. desexing specimens).

7. State/territory controls on the species.

Answers to these questions that represent the terms of reference are provided in Section 3.

3.0 The Environmental Assessment

3.1 Provide information on the taxonomy of the species, including any subspecies that occur naturally outside Australia.

The taxonomy of the black tiger prawn (also known as giant tiger prawn) is as follows (data from Holthuis 1949, Martin and Davis 2001, Zhang 2011).

Phylum: **Arthropoda** von Siebold, 1848

Subphylum: **Crustacea** Brünnich, 1772

Class: **Malacostraca** Latreille, 1802

Order: **Decapoda** Latreille, 1802

Family: **Penaeidae** Rafinesque, 1815

Genus: ***Penaeus*** Fabricus 1798

Species: ***Penaeus monodon*** Fabricus 1798

Penaeus monodon is the type species of the genus *Penaeus* and was described by Fabricus (1798) when establishing the genus *Penaeus* from specimens collected from south east India by Danish marine officer I.K. Daldorff. This species occurs in tropical coastal waters throughout the Indo-West Pacific region from northern Australia throughout Asia as far north as Taiwan, as far east as Fiji and the Pacific Islands, and west throughout the coastal Indian Ocean to East Africa (Holthuis 1980, FAO 2018). There are no recognised sub-species of *P. monodon*, however genetic analysis shows some genetic structure in wild populations of *P. monodon* within this region with phylogeographic history likely to form the basis of most of the genetic differences observed. For example, *P. monodon* on islands in the South Pacific appear to have originated from Southeast Asia and eastern Australia relatively recently during the Pleistocene period over 60,000 years ago when land bridges were more expansive and linked these regions more closely (Waqairatu et al. 2012). However, genetic sequence divergence data from populations sampled from 17 localities across the Indo-West Pacific identified several widespread clades which in some cases included *P. monodon* populations from both northern and southern hemispheres (e.g. one clade included *P. monodon* from Thailand, Taiwan and eastern Australia, see Waqairatu et al. 2012). These data suggest dispersal of *P. monodon* to its present range may not have been through a simple eastward radiation from east Africa as previously hypothesized (Benzie et al. 2002). Instead, a more prolonged and/or more complex dispersal may have occurred originating from a progenitor *P. monodon* with ancestral origins restricted to tropical and subtropical coastlines of the eastern Gondwana supercontinent (Waqairatu et al. 2012). Then, as Gondwanaland fragmented, the *P. monodon* resident to newly formed coastlines of east Africa, India, and Australia could have dispersed to their present distribution through continental drift and subsequent low sea level periods during ice ages (Waqairatu et al. 2012). In recent times, there is evidence that aquaculture and pollution have also significantly influenced genetic diversity in this species (Xu et al. 2001, Rumisha et al. 2017).

Is the species a Genetically Modified Organism (GMO) ? No. Populations of captive SPF *P. monodon* available from commercial suppliers have been selected from wild populations based firstly on their freedom from various diseases. Once disease free individuals were identified, subsequently selective breeding has focused on domesticating individuals that are not only specific pathogen free, but also display desired traits such as improved growth, survival or food conversion in captivity. However, no artificial genetic modification of the genome has been undertaken by any commercial supplier of SPF *P. monodon*.

3.2 Provide information on the status of the species under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and its conservation status under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

No species of *Penaeus* are listed as endangered under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Nor is any species of *Penaeus* listed by the International Union for the Conservation of Nature (IUCN). In Australia, no species of the genus *Penaeus* are listed as threatened or endangered under the EPBC Act. For general information on the fisheries and aquaculture activity for *P. monodon* in Australia, see Section 2 of Biosecurity Australia (2009).

3.3 Provide information on the possible impacts that imported specimens could have on the native population of the same species, and on other components of the Australian environment. This may include an assessment of:

3.3.1 *Any possible phenotypic or behavioural changes that may have occurred in these specimens as compared to those naturally occurring in Australia.*

There is an extremely low to negligible likelihood that imported SPF *P. monodon* would have any detectable negative phenotypic or behavioural impacts on native Australian *P. monodon* or other components of the Australian marine environment. This is because prawns are important components of the lower trophic levels of the natural food chain in the wild of northern Australia and are subject to high predation pressure (Salini et al. 1990). If they escaped from aquaculture farms, they would pose negligible biosecurity risk through their pathogen free status (see Section 3.3.3), and would then become a food source for higher trophic levels (e.g fish). For these reasons, the presence of SPF *P. monodon* in the wild of northern Australia would have no forseeable detrimental impacts on the environment over and above those presented by existing prawn aquaculture establishments.

Given the existence of significant genetic population structure in *P. monodon* from different parts of its range (You 2008, Waqairatu et al. 2012), the only forseeable risk to local populations of *P. monodon* and the Australian environment might be one of potential genetic dilution of Australian domestic *P. monodon* stocks if SPF *P. monodon* escaped from aquaculture farms, evaded predation and established breeding populations. Benzie et al. (1992) found significant geographic variation in allozyme frequencies of populations of *P. monodon* from WA compared to *P. monodon* sampled from Australia's eastern and northern coasts. The allozyme results were supported by data from mitochondrial DNA restriction fragment-length polymorphisms (RFLPs) which again found only the WA population was significantly distinct (Benzie et al. 1993). They considered this was most likely due to a founder effect and/or bottleneck event, resulting from changing sea levels and a temporary land bridge between Indonesia, New Guinea and Australia during the last ice age

(Benzie et al. 1992). Later, Brooker et al. (2000) used more variable microsatellite markers (non-coding gene sequences) to attempt to discriminate between *P. monodon* stocks from Australia's northern and eastern coasts. Again, the microsatellite loci demonstrated that *P. monodon* from WA were a separate genetic stock exhibiting reduced genetic variation relative to the other populations, but the microsatellites could not differentiate consistent significant differences in genetic variation between *P. monodon* collected from Townsville, Cairns, Weipa or Melville Island (Brooker et al. 2000). These data suggest that the waters of WA were colonized by *P. monodon* sometime after the last ice age (7000 yr ago) during sea level rise when sea links between Indonesia, New Guinea and Australia were restored (Brooker et al. 2000).

However, more recent evidence from microsatellite genotyping of *P. monodon* sampled from 17 locations throughout its range (Waqairatu et al. 2012) found that *P. monodon* populations from northern Australia grouped within a distinct clade containing *P. monodon* from Papua New Guinea, Palau and Fiji. In contrast, the population of *P. monodon* from Australia's east coast grouped in a clade that included *P. monodon* from Taiwan and Vietnam, while the population from WA remained distinct (Waqairatu et al. 2012). Nevertheless, these data also indicated that while populations of *P. monodon* from WA were unique, *P. monodon* from Australia's northern and eastern coastlines had more pairwise genetic distance between them (0.091 - 0.155) than occurs between the WA and northern Australian (0.116) or eastern Australian (0.032) populations. Furthermore, these differences were around the same magnitude of genetic distance found between north or eastern Australian *P. monodon* populations and those sampled from Fiji, Palau, Papua New Guinea, Taiwan or the Philippines (Table 1 in Waqairatu et al. 2012), a result which mirrored the findings of You et al. (2008) for *P. monodon* from Australia, Taiwan, the Phillippines, Vietnam and east Thailand.

Waqairatu et al. (2012) used bayesian structure analysis which segregated the *P. monodon* from 17 locations into 8 clusters, with one "Pacific Ocean cluster" comprising prawns from Thailand, Palau, Papua New Guinea, Taiwan, Western Australia, eastern Australia, Philippines and Vietnam. The Bayesian analysis of microsatellite data therefore suggested that genetic divergence between different populations of *P. monodon* in Australia is around the same magnitude as that observed between *P. monodon* populations found throughout much of the western Pacific Ocean, a result which agrees with the conclusions of You et al. (2008). As noted in Section 3.1, these data suggest dispersal of *P. monodon* to its present range occurred via a prolonged and complex process originating from a progenitor *P. monodon* with ancestors restricted to tropical and subtropical coastlines of the eastern Gondwana supercontinent (Waqairatu et al. 2012).

These data together suggest that the potential risk of genetic dilution of Australian domestic *P. monodon* stocks (if SPF *P. monodon* sourced from the western Pacific Ocean (Table 1) escaped from aquaculture farms and established breeding populations) would be around the same as that currently tolerated under state legislation through existing domestic translocations of *P. monodon* broodstock from northern Australia (NT) to Australia's east coast (DAF QLD 2015, 2018, New South Wales Department of Primary Industries 2018).

3.3.2 *Any adaptations to differing climatic conditions in the country of export.*

This would be extremely unlikely, as the commercially available SPF broodstock lines are all sourced from tropical inshore marine environments similar with respect to physiochemical water quality parameters (temperature, salinity, turbidity, pH, etc.) to areas of northern Australia where domestic strains of *P. monodon* naturally occur.

3.3.3 *Any possible parasites or pathogens that these specimens may carry as compared to those naturally occurring in Australian populations.*

Wild populations of *P. monodon* in Australia are host to a wide variety of disease agents including viruses such as Gill Associated Virus (GAV, also known as yellowhead virus genotype 2 or YHV2), yellowhead virus genotypes 6 and 7, infectious hypodermal and haematopoietic necrosis virus (IHHNV), Mourilyn virus (MoV), Spawner Isolated Mortality Virus (SMV), *Penaeus monodon* type baculovirus (MBV), and others; bacteria such as *Vibrio harveyi*, *Vibrio alginolyticus*, and *Vibrio* spp.; and parasites including bopyrid copepods, gregarines, microsporidians, ciliates and other assorted epicommensal microbial biofouling organisms (Table 3). The proposed commodity would be free from all of the disease agents listed by the OIE and in Australia's National List of Reportable Diseases of Aquatic Animals (Table 2), prior to being introduced into Australia. Furthermore, having been reared in high biosecurity facilities for their entire lives, under conditions that would produce recognizable disease if any significant disease agents were present (Wyban 1992, Lotz 1997, Lightner 2011), the proposed commodity is also highly likely to be free from a wide variety of other non-listed disease agents, facultative pathogens and parasites normally found in wild-caught *P. monodon* broodstock in Australia and elsewhere, as well as new emerging diseases such as Shrimp Haemocyte Iridescent Virus (SHIV) (Qiu et al. 2017). However, the translocated prawns would likely still harbour some ubiquitous epicommensal bacteria as part of their normal bacterial flora (Table 1). Nevertheless, it would be reasonably anticipated that the proposed commodity would represent a negligible biosecurity threat to Australian crustacean fauna and the Australian environment.

3.4 Provide information on the origin of the live specimens that you propose to import

This proposal describes importation of live sub-adult or adult SPF *P. monodon* (F0 generation) sourced from approved commercial suppliers in Thailand or Hawaii (Table 1) that have met the minimum standards established by Australia's competent authority (Office of the Chief Veterinary Officer (OCVO) in the Department of Agriculture, Fisheries and Forestry, AFFA). The prawns would be obtained from biosecure compartments (OIE 2017a, 2017b) within the exporting country that are certified by the competent authority of that exporting country to be free of all OIE listed diseases infecting prawns, as well as other diseases of prawns listed on Australia's National List of Reportable Diseases of Aquatic Animals (Table 2).

MOANA Technologies LLC in Hawaii was established in 1999 as a Genetic Improvement Company with its principal business being the selective breeding and genetic improvement of prawns. Founder stocks of SPF *P. monodon* from MOANA Technologies were originally sourced between 2001 and 2005 comprising 1484 prawns from 143 families sampled from seven locations throughout Asia from Vietnam, South China Sea, Andaman Sea, Bay of Bengal, and the Indian Ocean (Moana Tech 2018). Today, the stocks of *P. monodon* at Moana have been under domestication continuously for twelve (F12) to fourteen (F14) generations (Moana Tech 2018). Under a selective breeding program focussing on improving growth and survival, the Moana populations now encompass 300 families and remains SPF for all the OIE listed penaeid prawn disease agents other specific pathogens (Table 1). The Moana population is independently sampled twice yearly by the Hawaii Department of Agriculture (HDOA) and Moana's NBC Facility is currently listed on the HDOA's SPF Shrimp Facility approved list. The University of Arizona Aquaculture Pathology Laboratory is used by the HDOA for disease diagnostic testing (Moana Tech 2018, W. Coppens, email communication, 13 June 2018).

Table 3. Disease agents recorded from populations of *P. monodon* in Australia. ✓= yes, x = no, ? = possible.

Pathogen recorded in Australia	OIE Aquatic Animal Health Code (2018)	Australian National List of Reportable Diseases of Aquatic Animals 2018	Present in proposed commodity
Viruses			
Gill- associated virus (GAV / LOV/ YHV Genotype 2)		✓	x
Hepatopancreatic parvovirus (HPV)			x
Infectious hypodermal and haematopoietic necrosis virus (IHHNV)	✓	✓	x
Lymphoid organ parvo-like virus (LPV)			x
Mourilyn virus (MoV)			x
Penaeid Haemocytic Rod-Shaped Virus (PHRV)			x
Penaeus monodon-type baculovirus (MBV)			x
Spawner isolated mortality virus (SMV)			x
White Spot Syndrome Virus (WSSV)	✓	✓	x
YHV Genotype 6 (YHV6)			x
YHV Genotype 7 (YHV7)			x
Bacteria			
Aeromonas sp.			?
Planctomycete bacteria			x
Rickettsia/chlamydia-like organisms (RLOs)			x
Vibrio alginolyticus			?
Vibrio harveyi			?
Vibrio parahaemolyticus			x
Vibrio sp.			?
Epicommensal bacteria (*Leucothrix* sp, *Thiothrix* sp, *Flavobacterium* sp., *Cytophaga* sp.)			?
Mycoplasma sp.			x
Fungi			
Actinomyocete-like fungus			x
Atkinsiella spp., *Lagenidium* spp.			x
Microsporidians *Agmasoma penaei*, *Ameson* sp., *Thelohania* sp., *Vavraia* sp.			x
Protozoa			
Epicommensal ciliates (*Cothurnia*, *Epistylis*, *Vorticella*, *Zoothamnium*)			x
Metazoa			
Bopyrid copepods (*Epipenaeon* sp.)			x
Gregarines (*Nematopsis* sp., *Cephalolobus* sp., *Paraophioidina* sp.)			x

Information from Lester and Paynter (1989), Owens et al. (1991, 1992, 1998, 2003), Lightner (1992, 1996), Paynter et al. (1992), Owens (1993), Spann et al. (1995, 1997, 2000), Fraser and Owens (1996), Ghadersohi and Owens (1999), Cowley et al. (1999, 2000a, 2000b, 2002, 2005, 2009, 2012, 2015), Callinan et al. (2003), Krabsetsve et al. (2004), Munro and Owens (2007), Biosecurity Australia (2009), Oanh et al. (2011), Munro et al. (2011), Mohr et al. (2015), DAF Queensland (2017), Diggles (2017).

Founder stocks of SPF *P. monodon* from Thailand were originally sourced in 2003and 2004 by CP Foods from Madagascar, Kenya, Thailand, PNG, Noumea and Western Australia. After 4 generations in primary and secondary quarantine facilities, pathogen free *P. monodon* were placed into a Nucleus Breeding Centre (NBC) at Chanthaburi under strict quarantine. The stocks have been held in the NBC for around 10 years now with full decontamination of all intake water, full water recirculation in the broodstock holding tanks, and strict quarantine protocols (including shower-in and clothes change requirements for all staff), resulting in over 39,000 negative diagnostics test for all OIE listed penaeid prawn diseases and other specific pathogens since 2011 (Mr Chalor, CP Foods, personal communication, 18 June 2018, Table 1). In total the SPF *P. monodon* at Chanthaburi have been under domestication continuously for 15 years and twelve (F12) generations with recent selective breeding focussing on improving growth and survival (Mr Chalor, CP Foods, personal communication, 18 June 2018). The Chanthaburi population is independently sampled twice yearly for disease diagnostic screening by the Thailand Department of Fisheries (DoF) (competent authority) and both DoF, and the CP in-house shrimp diagnostic laboratory at Mahachai participate in external diagnostics ring testing with the University of Arizona Aquaculture Pathology Laboratory. The NBC at Chanthaburi is not currently recognised by the DoF as a separate biosecure compartment (OIE 2017a, 2017b) free from the OIE listed diseases of penaeids that are known to occur in Thailand, however at the time of publication the process of being officially recognised by the competent authority as a biosecure compartment is underway.

3.5 Provide a summary of the proposed purpose of import

The importation of specific pathogen free (SPF) *P. monodon* would be for the purposes of development of SPF broodstock lines to improve biosecurity throughout the prawn aquaculture industry in Australia to a level equivalent to current world’s best practice. A recent disease incursion has allowed entry of the exotic OIE listed White Spot Disease (WSD) into Moreton Bay, which is a key prawn hatchery supply and prawn aquaculture growout region for eastern Australia. WSD is caused by White Spot Syndrome Virus (WSSV), a highly pathogenic disease agent that threatens the viability of prawn farming in Australia as it enters the wild fisheries from which broodstock prawns (mainly *P. monodon*) are sourced. In order to avoid the possibility of WSSV entering prawn hatcheries in Australia via domestic wild caught broodstock, it is desirable to increase hatchery biosecurity by developing *P. monodon* broodstock lines that are free from specific pathogens such as WSSV and all other nationally and internationally significant disease agents of prawns.

Given the extreme consequences that would arise if WSSV or other internationally notifiable diseases (DAWR 2017) entered prawn hatcheries in Australia via domestic wild caught broodstock, the recent WSD incursion has resulted in an urgent need for the prawn farming industry in Australia to migrate to the current state-of-the-art in prawn stock domestication through development of SPF broodstock lines. Development of SPF prawns from domestic *P. monodon* broodstock is not feasible in Australia at present due to funding constraints bought about by the prolonged period (usually 6 to 10 years) of disease screening and multi-generational selection that would be required to develop domestic SPF *P. monodon* lines. Importation of SPF *P. monodon* from overseas commercial suppliers as a F0 generation from which to generate F1/F2 SPF or high health lines for domestic growout appears to be the only way of achieving a commercially feasible outcome for the Australian prawn industry within a realistic budget and timeline (within the next 3-5 years).

3.6 What conditions or restrictions, if any, could be applied to the import of the species to reduce any potential for negative environmental impacts.

The proposed translocations would operate under worlds best practice protocols as outlined by the International Council for the Exploration of the Sea (ICES) for introductions and transfers of marine organisms (ICES 2005, 2012, OIE 2018a). Live *P. monodon* (F0 generation) would be imported into a biosecure Quarantine Spawning Facility (QSF) and never leave that facility and would instead be euthanased, tested for all relevant diseases (Table 2) then autoclaved once they have reached the end of their working lives. The most risk-averse translocation protocol would allow the F1 generation of prawns (once tested by the Australian competent authority as free from all relevant diseases), to be released into Broodstock Multiplication Centres (BMCs), and only F2 generation postlarvae from BMCs would be released into aquaculture ponds for growout for human consumption. Alternatively, the F1 generation could be tested by the relevant Australian competent authority as free from all relevant diseases prior to release into aquaculture ponds for growout for human consumption.

Additional conditions that could be applied over and above the ICES best practice protocols, if deemed necessary by Australia's competent authority after assessment of the biosecurity risks associated with import of live SPF *P. monodon*, could include washing of external surfaces of F0 generation prawns prior to their introduction into the QSF using an iodine and/or formalin bath to reduce/eliminate populations of epicommensal bacteria which are part of the normal flora. A second option could be implementation of a minimum biosecurity standard to all farms which stock F1 or F2 generation SPF *P. monodon* to reduce the risk of their escape into the environment. A third option could be to implement a time limit (say, 3-5 years) during which SPF prawns could be imported into Australia in order to develop a viable local SPF breeding programme, after which importations would cease.

3.7 State/territory controls on the species

Fisheries for *P. monodon* in coastal waters of Australia less than 3 nautical miles from shore are managed by various state and territory fisheries authorities in WA, NT and QLD (e.g. QLD East Coast Otter Trawl Fishery[1]), while the Federal Government is responsible for management of *P. monodon* caught in the Northern Prawn Fishery (NPF) in Federally managed waters (3-200 nautical miles offshore) covering an area of 880,000 square kilometres along 6000 km of Australia's northern coastline[2]. The NPF is managed by the Australian Fisheries Management Authority (AFMA)[3] and is also certified as sustainable against the Marine Stewardship Council criteria.

Black tiger prawns are the predominant species farmed by the Australian prawn farming industry. Interstate movements of wild caught broodstock *P. monodon* for the aquaculture industry are controlled by state and territory fisheries management and biosecurity authorities. For example, in QLD aquaculture of *P. monodon* is controlled by various State fisheries, environmental and biosecurity legislations (DAF QLD 2015). These requirements have been adjusted recently to increase biosecurity following the White Spot Disease incursion into Moreton Bay (DAF QLD 2017, 2018, QLD Biosecurity Act 2017). For movements of broodstock *P. monodon* from the NT into QLD, broodstock must be kept isolated from not only other prawns originating

[1] https://www.daf.qld.gov.au/business-priorities/fisheries/monitoring-our-fisheries/commercial-fisheries/data-reports/sustainability-reporting/queensland-fisheries-summary/east-coast-otter-trawl-fishery
[2] http://npfindustry.com.au/the-northern-prawn-fishery/
[3] http://www.afma.gov.au/fisheries/northern-prawn-fishery/

from the QLD east coast, but also other shipments of NT broodstock (e.g. must not share water or be held in the same tank or be grown out in the same ponds), in order to assist tracing back of disease origin should a disease outbreak occur (DAF QLD 2015). Water and equipment used during transport must be adequately disinfected following translocation, in accordance with methods stipulated in the application to translocate (DAF QLD 2015, 2018). Similarly, the translocation of *P. monodon* broodstock into NSW from QLD or the NT requires disease sampling and treatment regimes to minimise the risk of transmission of any diseases that may impact crustacea or other fish in NSW (New South Wales Department of Primary Industries 2018).

In QLD following detection of WSSV in wild populations of crustaceans in northern Moreton Bay in March 2017, all prawn products, including *P. monodon*, which originate from White Spot Biosecurity Area 1 in Moreton Bay (Figure 1), are not permitted to be moved from that area unless they are cooked or subjected to gamma irradiation (QLD Biosecurity Act 2017). New South Wales, Western Australia and South Australia also enacted specific legislation preventing import of uncooked or non-gamma irradiated prawns from the same region (Government of SA 2016, Government of WA 2016, Government of NSW 2017). The various prawn translocation protocols are based on biosecurity measures and farm management practices that meet Australia's domestic Appropriate Level of Protection (ALOP) and which aim to minimise the risk of interstate movements of WSSV or other diseases of concern (DAWR 2017). The Australian Prawn Farmers' Association (APFA) recommends that every prawn farm in Australia has a biosecurity plan[4], and has drafted national biosecurity plan guidelines, which set industry standards for biosecurity planning and management of biosecurity risks.

[4] http://apfa.com.au/prawn-farming/biosecurity-know-farms/

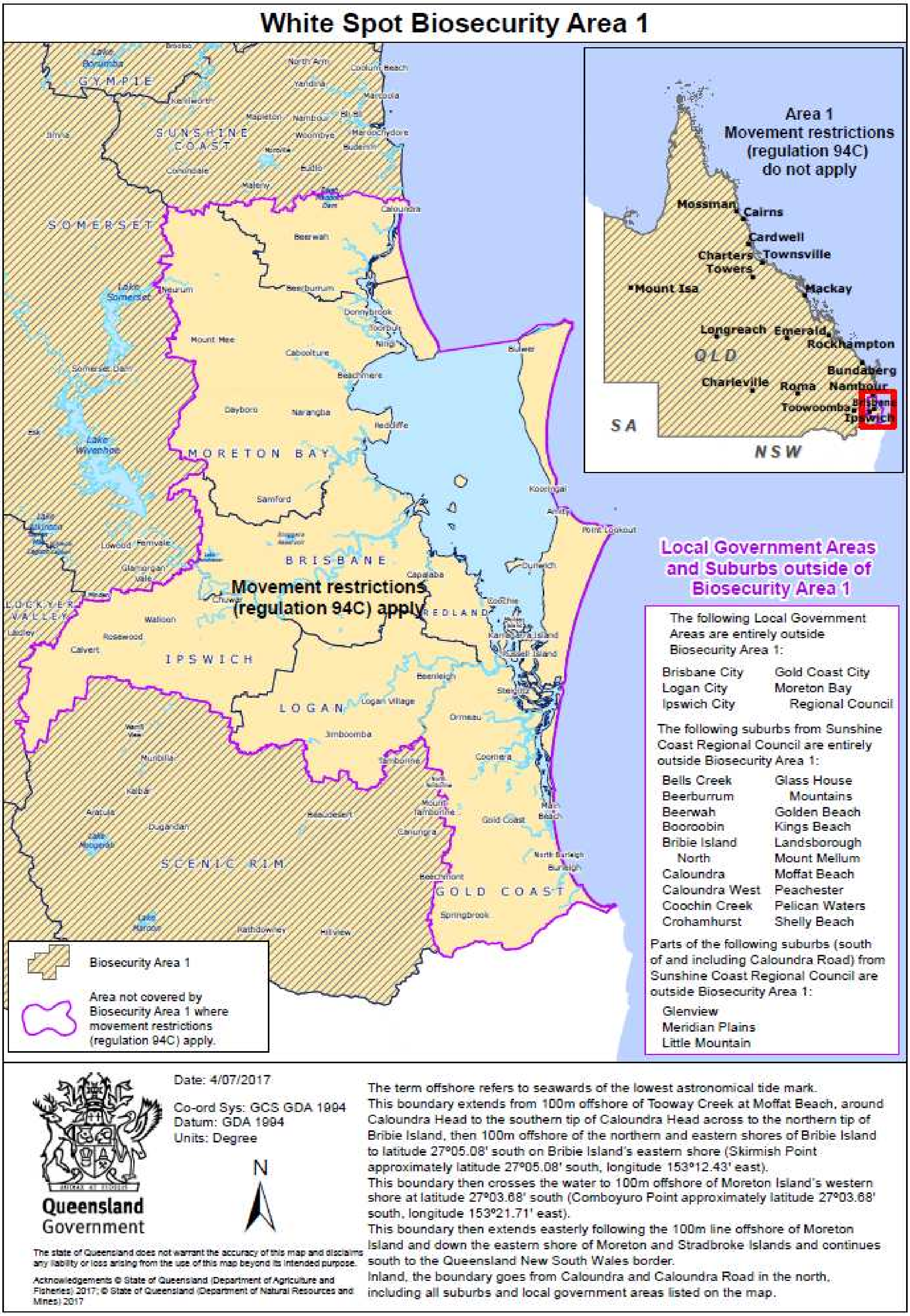

Figure 1. White Spot Biosecurity Area 1 in Moreton Bay, South East Queensland. Movement of all uncooked prawn products, including *P. monodon*, from this region is not permitted.

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