Identifying and addressing the biosecurity risks to Australia associated with imported prawns and seafood products

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A submission to the Parliamentary Inquiry into the biosecurity risks associated with the importation of seafood and seafood products (including uncooked prawns and uncooked prawn meat) into Australia

For the attention of:

The Senate Rural and Regional Affairs and Transport References Committee

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Introduction

I thank the Committee for their invitation to make a submission to the Parliamentary Inquiry into the biosecurity risks associated with the importation of seafood and seafood products (including uncooked prawns and uncooked prawn meat) into Australia. By way of introduction I am an independent aquatic animal health specialist with honours and doctoral degrees in the field of aquatic animal health and 25 years international experience working on various aspects relating to research, prevention and control of diseases of fish and shellfish. I have worked for Government in both Australia and New Zealand and for the last 14 years have directed my own independent consultancy DigsFish Services Pty Ltd, through which I have undertaken research, development and analysis for the fisheries and aquaculture industries as well as Governments throughout Australasia. My core business area of direct relevance to this inquiry is the work I have done on pathogen and pest Import Risk Analysis for fish and shellfish products, as well as aquatic biosecurity work I have done for industries and Governments not only in Australia but also for other countries such as New Zealand, Brunei Darussalam, and Saudi Arabia. For more information see Table 1 and www.digsfish.com/publications.html.

Table 1. Aquatic animal risk analysis documents developed by Dr Ben Diggles.

Risk Analysis Jurisdiction	Date	Commodity	Risks	Number of Hosts / hazards / assessments
New Zealand	2002	Juvenile Kingfish from Australia to NZ	Diseases	1/ 42 / 9
New Zealand	2005	Ornamental fish and invertebrates into NZ	Diseases	394 / 500 / 35
New Zealand	2006	Aquatic pathogens important to NZ – hazard identification and RA	Diseases	>500 / 92 / 92
New Zealand	2006	*Macrobrachium* from Hawaii to NZ	Diseases	1 / 76 / 6
Australia	2007	Menhaden from USA to Australia	Diseases	1 / 42 / 1
Australia	2007	Pacific Oysters from Tasmania to NSW	Pests + diseases	1 / 18 / 13
Several	2008	Pathogen risk analysis – 9 case studies – Invited keynote paper	Pests + diseases	Summary of 9 IRA studies
Brunei	2010	Crustaceans into Brunei Darussalam	Diseases	54 / 125 / 17
Australia	2011	Hazards due to domestic bait translocation	Diseases	>500 / 80 / 44
Australia	2011	Abalone translocations in Tasmania	Diseases	1 / 1 / 1
Australia	2012	Abalone translocations in South Australia	Diseases	2 / 9 / 7
New Zealand	2012	North / South Island shellfish biosecurity assessment	Diseases	27 / 39 / 20
New Zealand	2012	Environmental assessment report Salmon farming – disease risks	Diseases	1 / 20 / 4
Saudi Arabia	2012	Technical assessment of RA – Imported prawns (live *P. vannamei*)	Diseases	1 / 30 / 30
Australia	2014	Abalone translocations in Tasmania	Diseases	1 / 1 / 1
Australia	2017	Northern Australia Biosecurity Review	Pests + diseases	>100 / 15 / 15
Australia	2017	State aquaculture centre Biosecurity risk assessment	Diseases	8 / TBA / TBA

Submission

a. Management of the emergency response and associated measures implemented to control the outbreak of White Spot Syndrome Virus.

My observations relating to the management of the response to the outbreak of White Spot Disease (WSD) due to an incursion of White Spot Syndrome Virus (WSSV) in the prawn aquaculture farms on the Logan River in SE QLD were documented in Diggles (2017) (Appendix 1). Biosecurity QLD certainly were faced with a very difficult task which was exacerbated by their lack of awareness of the situation at the international border with Operation Cattai investigating quarantine breakdowns involving uncooked prawn commodities. If Federal authorities had communicated the increased risk to state authorities, Biosecurity QLD may well have been better prepared and/or surveillance for exotic diseases may have been more effective. Furthermore, if the pathway of introduction of WSSV was recent use of imported green prawns as bait by anglers, it's even possible the whole incident could have been avoided if prawn farmers and recreational anglers were promptly made aware of the heightened risks associated with such high (> 50-70+%) prevalence of infected prawns at the retail counter. Notwithstanding these important considerations, my observations (outlined in Diggles 2017) were as follows:

- It is important to consider the potential for an exotic disease incursion in any differential diagnosis list (mentioned in relation to advice to farmers allowing options for pond flushing). In view of the situation at the international border with quarantine breakdowns involving uncooked prawn commodities, preparedness and heightened surveillance for exotic diseases could have been facilitated if Federal authorities had communicated the increased risk to state authorities.

- Decisions made at the earliest stages of an incursion response may have significant impacts on the ultimate outcomes and chances of eventual eradication success. A rule of thumb may be (unless proven otherwise) to imagine or assume the worst case scenario and attempt to cater for it, while hoping for the best. This is mentioned in relation to the decision to block 1IP outlet canal at the exit of the settlement pond instead of where it enters the Logan River. If the outlet canal was blocked where it enters the river, it may have reduced the risks of any concentrated virus particles released from pond flushing entering the river.

- Restricting activities of people and movements of animals in the control zone surrounding affected farms is important (mentioned in relation to unrestricted movements of recreational fishers in the inlet canals for at least one week after WSSV was known to be present, and failure to erect signage advising no movements of crustaceans for more than 3 weeks). Enforcement is necessary and useful for preventing movements of potentially infected animals and materials, as well as for gathering information, as shown by the subsequent detections of recreational fishers using WSSV positive imported prawns as bait near the infected farms.

- Availability of biosecurity field staff with specialist aquatic animal training is limited. Water bodies which hide the animals within them can be very hard to "read" without some sort of specialist training. Lack of training for personnel on the ground may hinder information transfer to decision makers – meaning important decisions may have to be made by people who are remote from the situation on the ground and/or who may not have even visited the area where the incident/incursion is occurring. Having more aquatic trained decision makers on the ground on farms and scanning the wider area for potential biosecurity leaks (e.g. local bait from the river being sold in tackle shops) would have been advantageous, allowing more precise decision making and more rapid adaptation to changing situations.

- Similarly, from the coalface the response structure appeared unwieldy at times. While managing biosecurity responses through traditional response structures utilizing State and local control centres may be entirely appropriate for some of the highly contagious diseases of terrestrial animals (think Foot and Mouth Disease), for aquatic animal diseases the need to have decision makers so remote from the affected area/farms may not be so critical, given the different pathways of disease spread (usually water related).

- In part because of the various different layers of the response structure, communication with farmers was lacking in some instances. This was evident when BKD first arrived at 2IP, 3IP and 4IP and met with farmers who had not received any information from authorities and hence felt they were operating in an information vacuum. Prompt advice to all farmers in the area about basic biosecurity precautions (e.g. potential risks of disease introduction from intake water) at the earliest stages may have reduced their risks of infection.

- It is important for authorities to recognize that industry peak bodies may not have sufficient resources to manage the quantum of communication and meetings – this capacity needs to be recognized and addressed earlier in the response process.

- Interpersonal interactions at the farm were also identified as problematic. Several farmers complained about BQ staff turnover – they never knew when their site controller would change. Just when they may have "inducted" one person onto the farm and gained some proficiency in working with them, that person would be replaced by another and the whole process would have to be repeated. Even acknowledging the unprecedented scale of the response (for an aquatic event), a more stable roster process may have been able to reduce/prevent these problems.

- A large amount of stress for farmers arose due to the fact that many instructions to them were verbal and not backed up by written documentation. Indeed, several farmers did not receive any written documentation regarding testing results or even documents outlining why their whole farm was being chlorinated until half or most of it was already wiped out. The only thing worse than no information is misinformation, which often happened when verbal instructions dominated and the response strategy appeared to vary from day to day or hour by hour. Clearly this is not satisfactory and in the future it is important that relevant documentation is provided to farmers as promptly as possible and written (hard copy) situation updates are also provided to farmers on a regular, predictable basis. The urgency for eradication should in no way be used as an excuse to keep farmers in the dark.

- A fundamental of disease surveillance is that the chain of custody of samples should be complete to ensure that samples are collected from sites that are properly identified. Sampling should also be biased towards collecting diseased or suspect animals first, followed by random samples if no suspect animals are available. Sampling of prawns from feed trays biases samples towards healthy feeding prawns, which is at odds to the objective of disease surveillance. Cast net sampling (ideally with a single cast net per pond to minimise risk of cross contamination), appears a good compromise in this regard, but all pond edges should always be observed first for animals exhibiting unusual behaviour or other signs of disease, and if present those animals should be sampled first before random sampling commences.

- Eradication strategies for disease incursions in prawn farms should always be flexible enough to allow emergency harvest to cooking on the infected property for any disease agent that is inactivated by heat (such as WSSV). During eradication whether the disease agent is inactivated by physical (heat) or chemical means (e.g. chlorine) should be irrelevant, it is the inactivation that matters, and indeed any method of inactivation which allows removal of biomass from ponds as part of the process (e.g. emergency harvest to cooking on site) will make the treatment of the pond water more effective and subsequent management of the pond contents far easier (e.g. carcass disposal occurs through normal processes).

- Control of birds or other mobile predators is absolutely necessary to reduce the chances of rapid movement of exotic diseases from infected premises to uninfected areas. There were several instances where scare ammunition was used when birds were actually in WSSV positive ponds, leading to spread of the virus rather than containment. It was clear at the coalface that live ammunition should always be available and bird control officers need to be prepared to use it when necessary to prevent disease spread whenever birds physically enter infected ponds.

- During a response to an exotic disease, access for BQ staff to all farms in the area at all times should not be negotiable. It is possible that failure to place bird control officers on 8IP during harvesting there and the inability of BQ staff to oversee the emergency harvest at 8IP ultimately lead to infection of 7ARP when hundreds of birds gained access to drain harvested WSSV positive ponds at 8IP, which were only 600-750 meters away from the then last remaining WSSV free farm on the Logan River.

b The effectiveness of biosecurity controls imposed on the importation of seafood and seafood products, including, but not limited to, uncooked prawns and prawn meat into Australia, including the import risk analysis process concluded in 2009 that led to these conditions being established.

While the original source of the WSSV in this incursion may never be known with absolute 100% certainty, the apparent absence of WSSV in crustaceans sampled from the Brisbane River to date, despite intensive sampling (DAF QLD 2017) suggests that the pathway of entry into the Logan River and/or Moreton Bay was not likely to be via introduction by ballast water discharge or biofouling of shipping at the Port of Brisbane. Nor does it appear likely that the virus was introduced via infected broodstock prawns or aquaculture feed (Diggles 2017). The fact that WSD has never been reported in prawn farms on the Logan River prior to November 2016 suggests that WSSV was not present in the Logan River prior to when the last prawns of the 2015/16 season were harvested, which was sometime around April 2016. This suggests that sometime between April 2016 and November 2016, WSSV was introduced into the Logan River system. In the absence of prawn farming elsewhere in Moreton Bay (and its associated active and intensive disease surveillance), it is impossible to determine the timing of introduction of WSSV into other parts of northern Moreton Bay (e.g. Redcliffe, Deception Bay). However such a patchy distribution of WSSV could be explained by separate introductions of the virus at multiple locations via the bait and burley pathway. Indeed, there is a strong possibility that the disease incursions in the Logan River and Moreton Bay were caused by use of imported uncooked prawns as bait or burley by recreational anglers. This is because of a number of factors, including:

- It appears between 50% and 70+% of supermarket prawns sold in the lead up to Christmas/New Year 2016/17 were positive for WSSV (Diggles 2017, Senate Estimates 2017, Future Fisheries Veterinary Service 2017), and surveys by Biosecurity QLD field officers in December 2016 allegedly found 6 groups of recreational anglers fishing with imported green prawns near the affected prawn farms on the Logan River. Two of the 6 bait samples (33%) were allegedly tested as "strongly positive" for WSSV;

- Viable WSSV has been recovered from crustacean tissues (including commodity prawns) frozen at both -20 and -70°C after months to several years storage and used to successfully infect susceptible crustaceans (Wang et al. 1998, Durand et al. 2000, McColl et al. 2004, Hasson et al. 2006, Biosecurity Australia 2009, Bateman et al. 2012, RM Overstreet, personal communication, Nov 2009);

- Viral loads of between 10^{8}-10^{10} viral copy units/g tissue typically occur in infected imported green prawns (Oidtmann and Stentiford 2011). This level of virus has been proven to be more than sufficient to infect naïve hosts after consumption of less than 50 milligrams (mg) of infected tissue (Bateman et al. 2012, Tables 2a, 2b);

- Removal of the head section does not reduce WSSV viral load on a per weight basis, as viral load in prawns is similar in either heads (49% of total virus) or tails (51% of total virus) (Durand et al. 2003). The viral load of the peeled shell represents c. 55% of the total viral load remaining in the tail (Durand et al. 2003). Hence full processing of green prawns as specified in the 2009 prawn import risk analysis (Biosecurity Australia 2009) only reduces viral load by around half, which is not sufficient to prevent establishment of infections in susceptible species (Bateman et al. 2012, Tables 2a, 2b); and

- The evidence that the number of recreational anglers fishing with imported green prawns purchased as seafood from supermarkets was increasing in the early 2000s (Kewagama Research 2002, 2007, Table 3) and has continued to increase to become "routine practice" as imports of green prawns have increased in volume (Fishraider.com.au 2013, Fishing Victoria 2016, Figure 1). Recent phone surveys conducted by Biosecurity QLD suggest that the prevalence of anglers using supermarket purchased imported prawns as bait may now exceed 50% (Biosecurity QLD 2017 - unpublished data).

The strong possibility that this disease incursion was caused by use of imported prawns as bait or burley signals an urgent need to revise the 2009 prawn IRA (Biosecurity Australia 2009) and reassess this and other potential pathways of aquatic animal disease introduction into Australia. The IRA has now not only failed, it is simply out of date. The risk profiles for diversion of prawns and other imported seafood products to bait and burley have either changed or were not properly identified in the first place, and they were certainly never "negligible" as suggested by the Interim Inspector General of Biosecurity (Dunn 2010). Regardless, new sanitary information is now available on risks related to WSSV and many other emerging (post-2009) diseases (Table 4) in imported prawn commodities (see papers by Overstreet et al. 2009, Ma et al. 2009, Stentiford et al. 2009, Oidtmann and Stentiford 2011, Reddy et al. 2011a, 2011b, Bateman et al. 2012, Stentiford et al. 2012, Stentiford 2012, Jones 2012, Shields 2012, Behringer 2012, Lightner et al. 2012, Tran et al. 2013a, 2013b, Reddy et al. 2013, Nunan et al. 2014, De La Pena et al. 2015, Cowley et al. 2015, Li et al. 2016, Thitamadee et al. 2016, Bateman and Stentiford 2017, amongst many others).

The reason why Australia has not yet got some of these new diseases may be pure luck. For example, the toxin related components of the bacterium that causes Acute Hepatopancreatic Necrosis Disease (AHPND) appear to be inactivated by freezing, which is fortunate otherwise Australia could be included in the estimated $5 billion US annual global losses experienced by overseas prawn producers due to AHPND (Tran et al. 2013a, 2013b, Chamberlain 2013, Thitamadee et al. 2016). Unfortunately, while freezing may stop transmission of AHPND, it may not prevent release of the genes responsible for toxin formation.

The fact that some States (Western Australia and South Australia), quickly moved to protect their environment and valuable fisheries and aquaculture industries by implementing controls on movements of uncooked prawn products from the Logan River area to try to prevent WSSV incursions into their own waters, highlights a remarkable inconsistency in what is considered an Appropriate Level of Protection (ALOP) by State Governments in Australia, compared to the Federal Governments previous (pre-interim closure) position on imported prawn products. Having stricter controls requiring cooking of wild caught Australian prawns moved domestically from WSSV positive regions, yet still allowing uncooked imported farmed prawns entry at the border from WSSV positive regions overseas is an extraordinary situation that highlights exactly where the real risks lie (hint: the real risks are not domestic).

Table 2a. WSSV minimum infective doses based on data from the EU (Oidtmann and Stentiford 2011, Bateman et al. 2012).

	Carrier state viral load in commodity prawns	Typical viral load in infected prawns	Emergency harvest viral load in muscle	Minimum dose to initiate infection (*per os*)	Minimum lethal dose	LD50% dose
P. vannamei	4.6×10^{1} to 5×10^{2} viral copies/ng DNA[a]= 4.6×10^{7} to 5×10^{8} viral copies/g tissue*	1×10^{9} to 7×10^{10} viral copies/g tissue[b]	3.65×10^{5} viral copies/ng DNA[a] = 3.65×10^{11} viral copies/g tissue*	c. 100 viral copies[b]		
P. monodon		1×10^{9} to 1×10^{10} viral copies/g tissue[b]	1.5×10^{9} viral copies/g tissue[b]			
P. stylirostris			5.7×10^{11} viral copies/g tissue[b]			
European Lobster[a]				$<2 \times 10^{6}$ viral copies[a]	c. $>1 \times 10^{8}$ viral copies ?[a]	1.82×10^{10} viral copies[a]
	Equivalent commodity prawn dose – carrier state			4 – 43.5 mg	0.2 – 2.2 g	36.4 – 395 g
	Equivalent commodity prawn dose – typical infection			0.028 – 2 mg	0.0014 – 0.1 g	0.26 -18.2 g
	Equivalent commodity prawn dose – emergency harvest			0.003- 0.13 mg	0.17 – 66.7 mg	0.03 -12.1 g

* Assumes that virus copy numbers reported per g of tissue are roughly 1000·x the number of virus copies reported per µg of DNA [b]

[a] Bateman KS, Munro J, Uglow B, Small HJ, Stentiford GD (2012). Susceptibility of juvenile European lobster *Homarus gammarus* to shrimp products infected with high and low doses of white spot syndrome virus. *Diseases of Aquatic Organisms* 100: 169-184.

[b] Oidtmann B, Stentiford GD (2011). White Spot Syndrome Virus (WSSV) concentrations in crustacean tissues – A review of data relevant to assess the risk associated with commodity trade. *Transboundary and Emerging Diseases* 58: 469–482.

Table 2b. Summary of experimental results from Bateman et al. (2012)

Treatment	Commodity shrimp #1	Commodity shrimp #2	Commodity shrimp #3	Positive control
Source of virus	Ecuador	Vietnam	Honduras	Lab – Emergency harvest
Viral load in muscle	4.68×10^{1} viral copies/ng DNA	1×10^{2} viral copies/ng DNA	5.16×10^{2} viral copies/ng DNA	3.65×10^{5} viral copies/ng DNA
Viral load per mg muscle	4.68×10^{4} viral copies/mg	1×10^{5} viral copies/mg	5.16×10^{5} viral copies/mg	3.65×10^{8} viral copies /mg
Viral dose in 50 mg ration	2.34×10^{6} viral copies	5×10^{6} viral copies	2.58×10^{7} viral copies	1.82×10^{10} viral copies
% lobsters infected	30%	45%	70%	94%
% lobster mortality	20%	22%	0%	55% (after 6d. at 22°C)

Table 3. Temporal trends in use of supermarket green prawns as bait by recreational fishers in Australia using WSSV as an example of risk.

	A	B	C	D[+]	E	F	G[++]	H
Date	% of fishers using prawns sold as seafood as bait	Weight of seafood prawns used as bait (tonnes)	% of seafood prawns used as bait that are imported	Quantity of imported prawns used as bait	% increase in weight of imported prawns used as bait	% prevalence of WSSV in retail prawns	Quantity of WSSV +tve prawns used as bait	% increase / decrease in WSSV +tve bait by weight since 2002
2001/2002[1]	6%	50.5 t	4%	2020 kg	-	50% (est)	1010 kg	-
2006[2]	7.9% (+33%)	59.6 t (+18%)	11%	6556 kg	324%	50% (est)	3278 kg	+324%
2012 (est)	10.5% (est)	70.3 t (est)	18% (est)	12654 kg	626%	5%*[4]	632.7 kg	-38%
2017 (est)	14% (est)	82.9 t (est)	25% (est)	20725 kg	1025%	5%*[4]	1036 kg	+2.6%
2017[3] actual	>50%[3]	82.9 t (est)	>50%[5] (est)	>41450 kg	>2051%	50-83.6%[6]	>20725 – 34652 kg	>+2051 to 3430 %

* 5% prevalence based on "as designed" testing program from 2009 IRA (65 prawns per shipment sampled at border assuming 100% test sensitivity /specificity)[4]

[+] Quantity of imported prawns used as bait calculated D = B x (C/100) x 1000 [++] Weight of WSSV+tve prawns used as bait calculated G = D x (F/100)

(est) = 5 year growth estimates for years 2012 and 2017 based on linear extrapolation of % growth trends documented between surveys done in 2001 and 2006. Actual % increase in imported bait use may far exceed this[3] hence actual quantities now used (2017 actual) are likely to be underestimates.

[1] Kewagama Research (2002). National survey of bait and berley use by recreational fishers. Report to Biosecurity Australia, AFFA. December 2002. Kewagama Holdings, Pty. Ltd., Noosaville, Queensland, Australia. 137 pgs.

[2] Kewagama Research (2007). National survey of bait and berley use by recreational fishers: a follow-up survey focussing on prawns/shrimp. Report to: Biosecurity Australia, AFFA.

[3] Biosecurity QLD (2017). Online Survey. (Unpublished).

[4] Biosecurity Australia (2009). Generic Import Risk Analysis Report for Prawns and Prawn Products. Final Report. Biosecurity Australia, Canberra, Australia. 7 October 2009, 292 pgs.

[5] FRDC (2017). Australian Seafood Trade Database. http://frdc.com.au/trade/Pages/Crustacean-Full.aspx

[6] Future Fisheries Veterinary Service (2017). Assessing compliance and efficacy of import conditions for uncooked prawn in relation to White Spot Syndrome Virus (WSSV). FRDC Project 2016-066 Report to Australian Prawn farmers Association. 103 pgs.

Table 4. List of some of the diseases of prawns that were not included in, or have emerged since the 2009 Import Risk Assessment (data collated only from Thitamadee et al. 2016, Li et al. 2016, Bateman and Stentiford 2017 and is not an exhaustive list).

Disease name	Date emerged	Disease agent	Mitigated by existing sanitary measures?
AHPND	2009 (China)	Bacterium w. toxic plasmid	Yes*
Secret Death Disease	?	Possibly AHPND or mixed aetiology	?
Empty Stomach Disease	?	?	?
Aggregated transformed microvilli (ATM)	2009 (China)	Vermiform gregarine-like bodies	?
Covert Mortality Disease (CMD)	2009 (China)	Nodavirus	?
Hepatopancreatic microsporidiosis	2009 (Thailand)	Microsporidian (*Enterocytozoon hepatopenaei*)	?
Hepatopancreatic haplosporidosis	2009 (Indonesia)	Unnamed haplosporidian	?
New strains of YHD	2013 (China)	*Okavirus*	?
Pandalus montagui bacilliform virus	2007 (North Sea)	*Nudivirus*	?

* Existing sanitary measures may prevent direct transmission of AHPND, but may not prevent release and establishment of the plasmids and genes responsible for toxin formation.

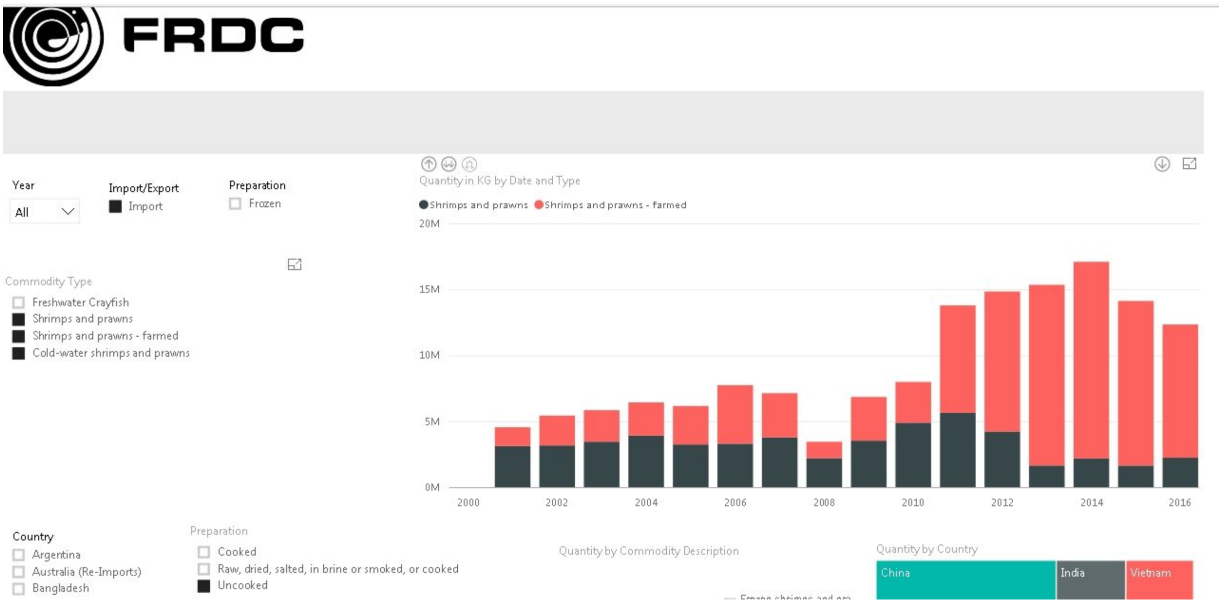

Figure 1. Quantities of uncooked prawns imported between 2001 and 2016. The quantity of farmed uncooked prawns more than tripled between 2009 and 2013-16. Data from FRDC (2017).

While a risk analysis has been done to assess the risk of domestic bait translocation (Diggles 2011), its terms of reference meant that it did not consider risks associated with use of imported fish or shellfish products as bait. Any risks of use of imported products via the bait and burley pathway were supposed to be considered and mitigated in the appropriate IRAs for the imported commodities. It appears when that is not done properly, these risks "fall through the cracks" and Australia is left vulnerable to aquatic disease incursions. Given the scale of the biosecurity breaches that have been recently revealed at the international border in Operation Cattai, and the potentially severe consequences of introduction of exotic diseases to Australia's environment, fisheries and aquaculture industries and food security, it is clear that the biosecurity controls imposed on the importation of seafood and seafood products including (but presumably not limited to) uncooked prawns and prawn meat into Australia have been, to put it politely, ineffective. As pointed out above, for these commodities in recent times it seems Australia has basically been relying on luck, and in November 2016 we found that our luck had run out.

Clearly, relying on luck is simply not good enough. Only a comprehensive review and full update of the IRAs for prawns and other seafood products (and the resulting biosecurity protocols implemented at the international border) is acceptable, so that Australia's environment, seafood industries, and food security for future generations are given the full consideration and attention the people of Australia deserve and demand.

c. The adequacy of Commonwealth resourcing of biosecurity measures including Import Risk Assessments.

Because of the Federal Government's choice to use higher risk sanitary measures (e.g. reliance on a testing program for imported uncooked prawns), increased resources are required to enforce biosecurity at the international border and post-border. In a perfect world, even assuming a significant increase in resources was granted to allow disease testing of each consignment of prawns to a more rigorous standard closer to Australia's ALOP for non-seafood commodities (for example: test to a 1% prevalence level requiring samples of 300 prawns from each consignment in a random fashion), the chance of human error would remain, and tests are not always 100% reliable. Furthermore, new diseases continue to emerge in prawn farms for which there are no tests available, sometimes for many years, and it is well known that many important diseases of crustaceans were spread widely before their cause was identified and tests became available (Lightner 1999, Jones 2012). Furthermore, if disease testing programs are chosen, to keep risks within the ALOP the import risk assessments underpinning the testing programs need to be updated very regularly, probably every year or 2 years given the high rate of emergence of new disease syndromes in cultured prawns (Table 4).

In fact, the requirement for effective testing is at odds with the high volumes of imported prawns that are now traded into Australia. You can have one, but not the other. It is easy to test low volumes of commodities thoroughly for the diseases you know of, but as trade volumes increase (imports of farmed green prawns more than tripled between 2009 and 2014, see Figure 1), either resources required for testing must also increase to meet demand, dramatically increasing (tripling ?) costs over time, or else errors begin to be made and risks of incursions skyrocket, like we have seen in Australia recently with Operation Cattai. And under such circumstances, when a new disease emerges, unless we are very lucky, it may become established in Australia before the IRA is updated and a reliable test becomes available. In either case, as trade volumes increase, propagule pressure increases and without increased funding for more rigorous testing procedures and more frequent reviews of IRAs, biosecurity breaches become inevitable, which is unacceptable to many Australians including Australia's fishing and aquaculture industries.

However, there are other options. Implementation of more appropriate sanitary measures (e.g. cooking of prawns and crabs) would reduce risks of introduction of not only WSSV, YHV and TSV, but also the many new diseases that continue to emerge in crustaceans farmed overseas (Table 4). Cooking is a simple, cheap and effective sanitary process that inactivates most pathogens that threaten animal and human health and/or the environment (Torgersen and Hastein 1995, Tacon 2017). Indeed, cooking eliminates the risk of introduction of WSSV (Maeda et al. 1998b, Nakano et al. 1998, Chang et al.1998, Biosecurity Australia 2009) especially if the cooked prawns are subsequently frozen (Reddy et al. 2011a, 2011b 2013). If appropriate sanitary measures are employed (i.e. all imported prawns are cooked), costs associated with compliance testing are much reduced, as is the need for constant updating of import risk assessments. Clearly the costs associated with inappropriate selection of sanitary measures are significant, not only in monetary terms, but also in their toll on industries, the environment, food security and people when things go wrong. So the adequacy of the Commonwealth's resourcing of biosecurity measures depends on the choices it makes. Selecting the right sanitary measures the first time around can avoid spiraling escalation of the ongoing costs involved with protection at the border and trying to control impacts post-border when things go wrong.

d. The effectiveness of post-entry surveillance measures and "end use" import conditions for seafood products including, but not limited to, uncooked prawns and uncooked prawn meat into Australia, since the import conditions implemented in 2010 were put into place.

These are simply not effective. Clearly the post-entry surveillance measures chosen by DAWR after the 2009 Prawn IRA have proven inadequate for preventing incursions of exotic diseases, resulting in Australia's first outbreak of WSD. Despite biosecurity protocols requiring testing of 100% of shipments of frozen green prawns imported into Australia, WSSV-infected frozen green prawns were transiting through border quarantine resulting in >50-73.6% of imported green prawns sold at the retail counter at supermarkets in Australia in November/December 2016 being WSSV positive. Furthermore, there was no testing required for other risky products like marinated prawns or soft shelled crabs, all of which have similar risks of containing viable WSSV given the large host range of the virus, which affects all decapod crustaceans.

The root of the problem is that Federal biosecurity authorities have not only underestimated risk and failed to deliver an effective testing program, they also have no control over end use once these risky products clear quarantine and/or are sold at the retail store. It is well known that recreational anglers commonly use supermarket bought seafood (including prawns) for bait and burley. Upon asking some of them why, I have found that besides being cheaper and more convenient (as reported by Kewagama Research 2007), anglers assume that whatever is sold in supermarkets is safe to eat and use however they see fit. They say "*if the risk to Australia was so great from these imported products, why would authorities let these products be sold in the first place* ?" Unfortunately it was well known by aquatic animal health professionals that imported prawn products carried viable viruses, yet it was technically not illegal to use them as bait. Indeed in all the supermarkets I visited leading up to Christmas/New Year 2016/17, not one of them were selling imported prawns over the delicatessen counter with warnings to customers that they should not be used as bait (Figure 2). In some supermarkets, bait freezers were actually located within the seafood section, encouraging consumers to relate the two together (Figure 3).

Certainly, since introduction of WSSV into Australia much effort has been made to recall imported green prawns and educate anglers not to use supermarket products as bait. However, the correct way to control risk along a supply chain is to apply appropriate mitigation at appropriate critical control points. It makes no sense to try to apply risk mitigation after the retail sale is made, and to rely on people being educated and "doing the right thing", as after the point of sale the routes of entry to high risk pathways are too numerous and widely dispersed, making enforcement impossible. And without adequate enforcement, there is no incentive for people to educate themselves or "do the right thing". Clearly the only proper way to control risk in this supply chain is either pre border, or at the border. Once these products clear quarantine, and enter the retail chain, all control of the end use is lost.

Once WSSV was introduced into SE QLD, the fact that other States (WA and SA in particular), quickly moved to protect themselves by implementing controls on movements of uncooked crustaceans and other WSSV carriers from the Logan River to try to prevent WSSV incursions into their own waters, highlights a remarkable inconsistency in what is considered an Appropriate Level of Protection (ALOP) by State Governments in Australia, compared to the Federal Governments previous (pre-interim closure) position on imported prawn products. Having stricter controls requiring cooking of Australian prawns moved domestically from WSSV positive regions, yet still allowing uncooked imported prawns entry at the international border from WSSV positive regions overseas is an extraordinary situation that highlights exactly where the real risks lie. It makes no sense whatsoever to have stricter quarantine requirements domestically than at the international border. All that does is discriminate against Australian businesses while hastening the spread of the disease to other areas of the country via imported products. Clearly the only safe solution within Australia's ALOP is to require all imported products to be cooked as well to ensure a consistent ALOP across the board.

As a final observation of the effectiveness (or lack thereof) of end use import conditions, despite all the effort put into education programs with anglers and consumers to try to prevent disease spread from imported seafood products, what is often not talked about in risk analyses are the real risks of deliberate introductions and even industrial sabotage (Jones 2012).

Figure 2. Assorted uncooked imported prawns being sold at supermarkets on the Gold Coast in December 2016. At none of the dozens of supermarkets in SE QLD I visited were there any signs or information informing consumers not to use these products as bait or burley.

Figure 3. In some SE QLD supermarkets examined, bait freezers (arrow) were located within the seafood section, encouraging consumers to relate the two together.

Not everyone wants to "do the right thing", and why would Australian investors want to invest 10's or 100's of millions of dollars into new prawn farms to open up economic opportunities in northern Australia if they knew that anyone so inclined could ruin their investment by purchasing $30 worth of imported green prawns from their local supermarket and introducing them into the waters next to their farm intake, or into the farm itself ?

In the real world, the unfortunate but real risk of industrial sabotage of our local seafood production industries is a significant threat to Australia's food security. The findings of Operation Cattai demonstrate that some people are very willing to deliberately break the law, hence the risk of industrial sabotage must also be considered as real, providing yet another reason why strong border controls are necessary, including requiring cooking of imported prawn products to reduce the risks of such activities occurring.

e. The impact of the outbreak on Australia's wild and farm prawn sectors.

In other areas of the world where WSSV has been introduced, aquaculture industries based on prawns and other crustaceans (e.g. crayfish) have suffered significant cumulative production and economic losses of up to $15 billion USD (Stentiford et al. 2012), and though some adaptation to the disease agent may occur over time, in Australia the presence of the virus represents a significant obstacle to industry competitiveness and profitability. Production in many WSD affected countries overseas eventually recovered, however much of the recovery was due to switching to the faster growing *Penaeus vannamei* (see Flegel 2006, Stentiford et al. 2012), a species which is exotic to Australia and hence this recovery option is not available to the Australian prawn aquaculture industry. There are no commercially available methods of control of WSD (vaccines etc.) at present, although filtering water and covering of production ponds with mosquito netting may provide protection (Thitamadee et al. 2016). However, under Australian economic conditions, the required changes to infrastructure and husbandry practices (filtration of water, lining of ponds, carrier and vector exclusion, minimal/zero water exchange production cycles, development of pathogen free or pathogen resistant prawns lines, see Lightner 2005, Moss et al. 2012) would impart additional production costs that would greatly reduce industry profitability to marginal levels, at least in the short term. The reduced profitability would discourage investment in prawn farming in Australia, posing a risk to Australia's future food security (Stentiford 2012, Stentiford et al. 2012). The likely impacts of introduction of WSD on the prawn aquaculture industry in Australia are therefore considered to be extreme.

Infections of WSSV in wild crustaceans are generally sub-clinical - infected crustaceans carry the virus but it usually does not kill them (Lo et al. 1996), a situation which may aid the transmission and spread of the disease agent throughout local crustacean populations. Adverse impacts at the population level have not been previously reported in wild crustaceans in areas where WSSV has been introduced (Maeda et al.1998a, De La Pena et al. 2007, Baumgartner et al. 2009, Flegel 2009). However, because sub-clinical WSSV infections can revert to the disease state in susceptible species after periods of stress (Lo et al. 1996), this suggests that populations of wild crustaceans adversely affected by environmental stressors (e.g. floods or other adverse environmental conditions, rapid drops in water temperature or exposure to pollutants such as pesticides and herbicides) may experience reduced resilience or “silent mortalities” (Behringer 2012, Stentiford et al. 2012, Shields 2012) due to WSSV infection, as has been reported for some other viral pathogens of prawns (Couch and Courtney (1977).

Indeed, any absence of evidence of impacts on populations of wild crustaceans in areas where WSSV has been introduced overseas is not evidence of likely absence of such impacts in Australia, as impacts of new diseases in wild populations of crustaceans are likely to go unnoticed in countries without proper baseline ecological data (Shields 2012) and effective fisheries management. As effects of disease in wild populations vary greatly due to factors such as environmental characteristics, host susceptibility and host densities (Burge et al. 2016), it is possible that impacts of WSD introduction into Australia could be more severe due to our unique environment, isolated fauna and effective environmental and fisheries management arrangements that tend to keep host population levels relatively high. Any adverse effects could result in ecological harm to aquatic environments, potentially resulting in significant cultural and socio-economic harm to regional communities in Australia and elsewhere in the country.

As WSSV is a listed disease agent notifiable to the OIE and NACA, there are significant trade implications following its introduction into Australia. Indeed, as shown in the Logan River and Moreton Bay, establishment of WSD in a region of Australia necessitates intervention by government authorities and disruption to normal trade in crustacean commodities by commercial fisheries and crustacean gathering by recreational fishers as attempts are made to try to prevent anthropogenic movements of crustaceans to limit potential spread into uninfected areas. As shown in the Logan River, if the disease spreads to areas where bait prawns are commercially gathered, not only commercial fishers but recreational fisheries may be disrupted due to loss of bait supplies. Under such circumstances the commercial fishers can be more heavily impacted than aquaculturists, as while the aquaculturists can (given enough financial investment) revise their farms and improve biosecurity to try to prevent the virus from entering the farm, commercial fishers cannot do this. Although the virus does not kill their wild catch outright, because of the risk of spreading the infection commercial fishers may not be able to sell their product (prawns, crabs, lobsters, crayfish) into their usual markets, effectively a situation commercially equivalent to having all of the animals dying from the virus anyway, as they are no longer saleable. The likely impacts of introduction of WSD on the commercial crustacean fisheries in Australia are also, therefore, considered to be extreme.

f. The economic impact on Australian wholesalers and retailers.

I have little to comment on this topic except to point out that if importation of uncooked green prawns and other crustacean products was prohibited based on these disease risks, wholesalers and retailers can now (and could into the future) still import and sell unlimited quantities of cooked or irradiated prawns and crustaceans to satisfy market demand without endangering Australia's environment and primary industries and without causing seafood shortages or increased costs to consumers. Indeed, the cooking option in particular is not only "least risk", cost-wise it is also “least cost” as it would greatly reduce processing complexity and hence costs pre-border (prawns could be imported essentially unprocessed provided they were cooked prior to entry), and this would also reduce costs associated with disease testing post-border, potentially <u>reducing</u> retail costs to consumers for imported prawns and other crustacean commodities.

g. Domestic and foreign trade implications for Australian industries resulting from the suspension of importation of seafood and seafood products, including, but not limited to, uncooked prawns and uncooked prawn meat in Australia.

With the liberalization of international trade through the General Agreement on Tariffs and Trade (GATT) in 1947, and the subsequent establishment of the *Agreement on the Application of Sanitary and Phytosanitary Measures* (SPS Agreement) in 1994 (WTO 1994), World Trade Organization member countries are required to use the risk analysis (RA) process as a means to justify any restrictions on international trade beyond those specified by the Aquatic Animal

Health Code (OIE 2016a) based on risks to human, animal or plant health (WTO 1994, Rodgers 2004). Risk analysis is thus an internationally accepted science based method for assessing whether trade in a particular commodity (e.g. uncooked seafood, including prawns) poses a significant risk to human, animal or plant health, and if so, what measures could be adopted to reduce that risk to an acceptable level.

The general framework for import risk analysis for aquatic animals and their products is laid out in the World Organization for Animal Health's (OIE) Aquatic Animal Health Code (OIE 2016a). Australia, as a member of both the OIE and the WTO, is obligated to follow OIE and WTO procedures. The 2009 prawn risk analysis (Biosecurity Australia 2009) went through a process of identifying risks to Australia via imported prawn commodities in a manner consistent with WTO and OIE regulations. The IRA was mostly fit for purpose at the time it was published, although in my professional opinion the risk profiles for the pathways involving diversion of prawns and other imported seafood products to bait and burley were underestimated at that time, and even fraudulently misrepresented in subsequent incidents (Dunn 2010). In any case, since 2009 there is evidence that the risks of introduction and establishment of many known diseases of prawns have increased with increasing volumes of trade, several new diseases have emerged (Table 4), and new sanitary information is now available on risks related to WSSV and many other diseases (see Sections b and c above). A comprehensive review of these new hazards and full updates of the risk assessments for prawns and other seafood products are therefore needed.

Indeed, the OIE code (OIE 2016b) requires that Australia reviews <u>and modifies</u> import measures following an outbreak of exotic disease and prior to any subsequent claim for freedom from that disease. See point c. below from the relevant article relating to country freedom.

Article 9.7.4 (OIE 2016b)

4. it previously made a *<u>self-declaration of freedom</u>* from WSD and subsequently lost its *<u>disease</u>* free status due to the detection of WSD but the following conditions have been met:
   a. on detection of the *<u>disease</u>*, the affected area was declared an *<u>infected zone</u>* and a *<u>protection zone</u>* was established; and
   b. infected populations have been destroyed or removed from the *<u>infected zone</u>* by means that minimise the *<u>risk</u>* of further spread of the *<u>disease</u>*, and the appropriate *<u>disinfection</u>* procedures (as described in Chapter <u>4.3.</u>) have been completed; and
   c. previously existing *<u>basic biosecurity conditions</u>* have been reviewed and modified as necessary and have continuously been in place since eradication of the *<u>disease</u>*; and
   d. *<u>targeted surveillance</u>*, as described in Chapter <u>1.4.</u>, has been in place for at least the last two years without detection of WSD.

   In the meantime, part or all of the non-affected area may be declared a free *<u>zone</u>* provided that such a part meets the conditions in point 3 of Article <u>9.7.5.</u>

Of course, the process of revising the prawn IRA not only has to identify where things went wrong, it also has to identify any new risks under current trading conditions, properly assess those risks, and identify options for mitigating those risks to within what Australia considers its Appropriate Level of Protection (ALOP). Australia's ALOP reflects community expectations through government policy, and is expressed as providing a high level of sanitary or phytosanitary protection whereby risk of introduction of exotic diseases is reduced to a very low level, but not to zero. Until such time as the IRA is fully reviewed and updated, Australia is within its rights to uphold the current suspension of imports of uncooked prawns.

However, given evidence of increasing use of imported seafood commodities through the bait and burley pathway in Australia (see Sections b, c and Table 3), and the fact that the only existing analysis of disease risks via that pathway in Australia (Diggles 2011) is now itself 6 years old and did not consider risks associated with use of imported fish or shellfish products (as they were outside the terms of reference), the risks posed by other imported products besides prawns if they were introduced into the environment via the bait and burley pathway may also have been underestimated. The risks posed by use of other imported seafood products (crabs, lobsters, fish and molluscs) as bait or burley therefore also need to be reviewed to assess whether the risk profile for these other seafood commodities was also underestimated, or has changed.

h. Matters to be satisfied in the management of biosecurity risk before imports of seafood and seafood products, including, but not limited to, uncooked prawns and uncooked prawn meat into Australia could recommence

These requirements will only become clear once the relevant risk analyses have been reviewed and updated to reflect the current situation. In the case of imported prawns, it is possible that a fully revised and updated prawn risk analysis may find that today, the risks posed by uncooked prawns can no longer be reduced below Australia's ALOP due to the much larger volumes of products imported, the changed risk profiles of these products due to new and emerging diseases of cultured prawns overseas, better modern understanding of the epidemiology of the known diseases, and the persistence of multiple pathways which move these products (and viable exotic pathogens within these products) into our waterways.

Education of anglers has been considered to be one way of potentially mitigating the risk of introduction of diseases such as WSSV via the bait and burley pathway. However, it is always difficult to engage all recreational fishers in educational campaigns and there is evidence that compliance will decline over time unless the educational message is followed up with strong enforcement. Given that it appears inevitable that if green imported prawns are made available for retail sale as seafood that some will be diverted into the bait and burley pathway, other risk mitigation methods will be required if the risk of introduction of diseases such as WSSV are to be reduced to within the ALOP consistent with the sanitary risk reduction methods employed by Australia for other non seafood products, for example pork. Indeed, it is notable that compulsory cooking is required for pork products imported into Australia from countries with foot and mouth disease and several other important diseases of pigs (see Commonwealth of Australia 2004a, b).

Certainly the current risk reduction methods used for imported green prawns such as freezing and processing to removing the head, shell and alimentary canal decrease the risks of introduction of some prawn diseases (YHV1, AHPND, NHP, *Enterocytozoon hepatopenaei*), but some of these processes may actually increase the risk of establishment of other diseases infecting prawn muscle such as WSSV, TSV or IMN, given that removal of the shell may allow potential hosts (e.g. prawns, shrimps, crabs) to eat a larger ration of muscle tissue if they encountered an imported prawn used as bait or burley. Recent data from Europe suggest that a ration of less than 50 mg of muscle tissue of supermarket prawns is sufficient to establish WSSV infection in susceptible hosts (Bateman et al. 2012, Tables 2a, 2b), and it could be that removing the shell may allow that host to eat more of the prawn that it otherwise would, potentially increasing the overall dose of virions via the *per os* route and increasing chances of infection (Oidtmann and Stentiford 2011, Bateman et al. 2012).

Indeed, in the case of WSSV in imported prawns, replacement of uncooked frozen prawn products with cooked products may be the only way to reduce risks to within the ALOP consistent with the sanitary risk reduction methods employed by Australia for other non seafood products imported for human consumption (Commonwealth of Australia 2004a, b). Sanitary conditions allowing entry of only cooked prawns (processed or whole unprocessed) would not only reduce the risk of introduction and establishment of WSSV to within Australia’s ALOP (as evidenced by Commonwealth of Australia 2004a, b), it would also be consistent with domestic biosecurity arrangements currently implemented for crustacean products originating from SE QLD under the current WSD incursion (DAF QLD 2017). Allowing entry of only cooked prawns would also reduce the risk of introduction and establishment of new and emerging diseases (Thitamee et al. 2016, Li et al. 2016, Bateman and Stentiford 2017) for which, in the absence of identification and suitable diagnostic tools, there may be high risks of introduction (Lightner 1999, Gaughan 2002), without any currently available means of testing at-risk commodities at the border. There may be other sanitary treatment options that could provide equivalent risk reduction, such as irradiation, however the radiation dose rates required for WSSV and other prawn diseases have not been established, and radiation processes or certification processes may not be foolproof and/or subject to human error. Indeed, cost-wise the cooking option would not only be "least risk", it is also likely to be “least cost” as it would reduce processing costs pre-border (in the case of unprocessed prawns), and reduce testing costs post-border, potentially reducing retail costs to consumers for imported prawn commodities. Pre-border cooking of imported prawns may also be the only practical way to significantly reduce the risks of post-border industrial sabotage (Jones 2012).

Quarantine conditions requiring cooking of imported meat products are permissible within WTO and OIE rules and are widely accepted by consumers in Australia as necessary to protect our local cattle, pig and sheep industries (and hence our food security with regard to terrestrial meat products from species susceptible to foot and mouth). Why then, are the fishing and aquaculture industries of Australia being treated any differently? By requiring cooking prior to entry, the processes of inspection at the border would be simplified, additional costs of testing for diseases would be eliminated, and other risk mitigations like processing (removal of heads/peeling /deveining) may no longer be required, resulting in a more streamlined inspection process at the border and potentially a cheaper product to the end consumer. Furthermore, the technology required to cook seafood is virtually no cost, imposing little burden on exporting countries, and we would no longer have this ridiculous situation whereby uncooked commodities enter

Australia from WSSV positive overseas countries, while commercial fishers and aquaculturists in SE QLD have to cook their commodities prior to sending them interstate or up to North QLD. Such are the many advantages of compulsory cooking as a "least cost, high effectiveness" sanitary process, that was identified back during the 2009 IRA, but, unfortunately, was not fully implemented at the time.

i. Any related matters.

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