SUBMISSION TO THE AUSTRALIAN SENATE

The environmental, social and economic impacts of large-capacity fishing vessels commonly known as 'Supertrawlers' operating in Australia's Marine Jurisdiction

The role of underwater acoustics in mitigation of dolphin bycatch/depredation associated with trawls in the small pelagic fishery.

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Terms of Reference of this Review in relation this submission

The Terms Of Reference that I will discuss are highlighted (in bold).

The environmental, social and economic impacts of large-capacity fishing vessels commonly known as 'Supertrawlers' operating in Australia's Marine Jurisdiction

a. The effect of large fishing vessels on the marine ecosystem, including
   i. impacts on fish stocks and the marine food chain, and
   ii. **bycatch and interactions with protected marine species**;
b. **current research and scientific knowledge;**
c. social and economic impacts, including effects on other commercial fishing activities and recreational fishing;
d. the effectiveness of the current regulatory framework and compliance arrangements;
e. any other related matters.

This submission

My submission will be presented in the following manner,

- To note what is known internationally about mitigation of dolphin interactions with fishing gear in general, and trawlers more specifically.
    - This Submission is not a scientific document yet it can be shown it is based upon them, and over 40 years spent working with the fishing industry.
    - This Submission introduces the concept of acoustic bycatch mitigation techniques in fisheries excluding fish trawls, then moves to acoustic depredation mitigation techniques in fish trawls, primarily to demonstrate a similarity in acoustic methodology bias or negativity by many non-fishery supportive sectors that could have helped FV *Geelong Star* meet biodiversity targets..
    - This Submission is primarily based on the FRDC *Small Pelagic Research Coordination Program: Technical workshop to explore options for mitigating marine mammal interactions in the Small Pelagic Fishery (Melbourne June 2015)* (http://frdc.com.au/research/Final_reports/2014-046-DLD.pdf) and specifically a slightly longer version of (http://frdc.com.au/research/Final_Reports/McPherson%202015%20FRDC%20Workshop%20Minimising%20fish%20trawl%20interactions%20.pdf) given at the FRDC meeting – a few slides were truncated by allowable time.
- I ask the question why did it take so long for FV *Geelong Star* to be made aware of specific acoustic methods for dolphin trawl mitigation,
    - noting that it was the initiative of Fisheries Research & Development Corporation to develop the initiatives for FV *Geelong Star* to enter a new phase of fishing operations utilisation and FRDC is to be congratulated.
    - Why did other fishery agencies not advise FV *Geelong Star* in time to potentially mitigate a greater number of dolphin mortalities particularly as they were well aware of them.

Personal qualification for providing this submission

To qualify for providing science based data for this submission I wish to indicate,

1. I was a Fisheries Biologist with Fisheries Queensland Government 38 years primarily working on life history and stock assessment of coastal, reef and oceanic fish species.
    - I did work in some stock assessment areas but primarily age structured modeling of demersal and pelagic fish stocks.
    - I will not comment on South East Trawl issues as I believe stock assessment has been addressed by appropriate specialists.
2. For twenty six years of the above period I increasingly worked on the role of underwater acoustical physics and psychoacoustics in marine mammal interactions with fishing gear.
3. I am now Principal Adjunct Research Fellow, Intelligent Systems, Information & Modelling, College of Science, Technology & Engineering, James Cook University specialising on the impacts of underwater noise in marine and freshwater ecosystems.
4. Acoustic aspects of fisheries bycatch and depredation mitigation with commercial fisheries and government research agencies of Japan (Japan Fisheries Research Agency, Far Seas Tuna Lab and Japan Fisheries Acoustics) and the USA (acoustic specialist as Member Marine Mammal Advisory Committee Western Pacific Fishery Management Council) each for 8 years.
5. I was a Member of the Bioacoustics Technical Committee of the American Acoustical Society for two years.
6. Since departing Fisheries Queensland I have been engaged on fish and marine mammal acoustic interactions with fishing gear as well as the impacts of noise mainly from shipping activities on marine ecosystems.

Relevant, most significant, fisheries projects,

1. FRDC (its forerunner) funded an all northern state Northern Pelagic Programme developed to in-part investigate 14,000 dolphins taken by Taiwanese Fisheries off NW Australia in 3 years in the mid 1980's. This heralded the beginning of acoustic bycatch mitigation for marine mammals in Australia, but few would acknowledge it
2. NHT Projects in northern Australia (two) developing bycatch mitigation acoustic alarms for dugongs and dolphins despite strong behind the scenes interference from marine mammal scientists.
3. Shark Control bycatch of marine mammals. Whale bycatch is still significantly down on projections yet not always the results sought due to limited funding and intervention by environmental / political sectors hamper Government business.
4. FRDC2003/016 Toothed whale mitigation project 2003-8. *Phase I developing acoustic localisation techniques for toothed whales (basically large dolphins) around fishing gear and acoustic depredation pingers to mitigate depredation*.
5. Japan Fisheries Research. 8 years working on depredation mitigation in oceanic Pacific and Japanese coastal fisheries.

6. NZ trawl fishery on small pelagic fishery development of acoustic depredation mitigation pingers over a 4 year voluntary consultancy to the pinger manufacturer (to attain a good product).

Current activity

I am currently engaged on projects involving acoustic impact on marine animals in marine ecosystem soundscapes or on marine animals (humpback whales) that are representative of the GBR.

1. Mitigating humpback whale entanglements on West Australian rock lobster gear.
    - Assessing most appropriate bycatch mitigation acoustic alarms (federally funded).
2. Mitigating dolphin interactions with South Australian shark nets.
    - Using sonar interference techniques to maintain playful dolphins from the immediate vicinity of nets.
3. Examining shipping noise impacts on Great Barrier Reef marine soundscape.
    - Using available use densities of ships transiting Great Barrier Reef waters off Townsville (Live Ships AIS shipping densities for May 2014 shown in Figure below) and generating cumulative noise densities based on known and validated shipping sound Source Levels.

- A short consultancy on dolphin bycatch mitigation to Seafish Tasmania using acoustic methods following the FRDC *Technical workshop to explore options for mitigating marine mammal interactions in the Small Pelagic Fishery* in Melbourne June 2015.

THE USE OF ACOUSTIC METHODS IN FISHERIES BYCATCH AND DEPREDATION MITIGATION

Development of acoustic methods to mitigate marine mammal bycatch

Acoustic methods to mitigate the accidental bycatch of marine mammals such as porpoise/dolphins and baleen whales were developed respectively by the Japanese Fisheries Agency and University of Newfoundland (Canada) from the mid 1980's. The original devices were of low amplitude sound and were intended to warn marine animals of the sounds and the gear to which they would be attached to provided,

- the signal strength of the alarms were high enough to propagate the required distances to alert animals in time and,
- the signal frequency were within the hearing capability of the intended targets (*ie* the interacting marine mammals – this not always having been the case in the past).

The rationale for the bycatch mitigation function of the acoustic alarms was based on animal hearing psychoacoustic detection of single and multiple noise sources in marine soundscapes.

- The basis for acoustic bycatch mitigation alarms, alerting alarms, is that marine mammals had to be alerted to the operation of the alarms and then to the fishing gear that the warning devices had been deployed on such as gillnets.
- It should be noted that no dolphin would not be aware of the close presence of a 100 m fishing trawler and any net towed by it.
- A land-based and visual-based analogy would be how humans respond to flashing lights indicating dangerous road edges for motorists, and the calculation of the appropriate flashing rate and between light spacing given the in between areas presented undetectable dangers.

Success of any such bycatch mitigation alerting alarm system was usually judged in a variety of ways including by their capability of reducing the mammal mortality rate, sometimes reducing gear damage costs and sometimes lost catch.

Failure of these systems was usually judged in a variety of ways including by their inability to achieve a biologically impossible statistical significance level interaction mitigation, cost of the system and indeed its reliability.

Competing interests in the success of the devices ranged from,

- device manufacturers who saw financial advantage in their use while offering a product with an acoustic output and resultant animal psychoacoustic function, neither of which they understand in the first place,
- fishing interests that wished to reduce bycatch and to meet biodiversity guidelines for lowest costs and
- marine mammal scientists who wished for reduced fishing choosing to focus criticism toward any device that allowed fishermen to achieve biodiversity targets
    - to initially prevent their application in a fishery and
    - with the long term goal of maintaining publicly unacceptable marine mammal catch in order to secure a fishery closure.

A common tactic by marine mammal scientists not interested in fishing activities to denigrate the success of acoustic devices included,

- unilaterally suggesting that acoustics devices should alarm or scare marine mammals spatially from gear (when all available real world evidence clearly demonstrated they were not) and in testing show spatial deterrence was not achieved and this 'result' used as 'evidence' that the devices were ineffective.
- testing associations between the acoustic devices and the fishing net to which the gear was attached and could be 'seen' by the mammals visually or acoustically on heightened interrogation, yet not including any net material in the 'simulated net'.
    - Subsequent mammal movement through the 'simulated net' composed of a totally unconstrained volume of water was claimed as a failure for the devices as mammals swam into their unilaterally declared 'simulated net'!!!!
    - The fine print describing a 'simulated net' as being nothing was rarely ever read unfortunately.
- Not mention any success of the progress of acoustic systems to mitigate bycatch systems and lobby Government accordingly.

By 1990 the International Whaling Commission considered that issues relating to fisheries bycatch of marine mammals would soon be eclipsed by issues relating to depredation on fishing catches by marine mammals (and sharks for that matter), causing

- product loss,
- gear damage and
- negative interactions with animals that at times would be considered with protected species under national legislation for biodiversity or charismatic megafauna reasons..

Irrespective of the reasons it has always been an objective of the fishing industry to minimise the interactions with marine mammals or sharks.

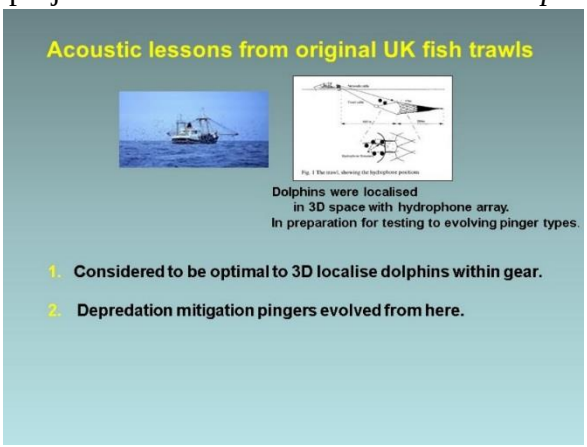
Development of enhanced acoustic methods to mitigate marine mammal depredation and sometimes associated bycatch

Depredation is a standard agricultural term used to describe usually wild animals predating on entrained/confined farm animals/crops or constrained wild animals hooking on fishing lines or in gillnets. Depredation in fisheries usually refers to animals removing fish from hooks and fish from nets, but as a special case or slight variant, would include opportunistic feeding of fish from trawls as discarded or escaping fish. Taking the special case a little further dolphins swimming into nets full of constrained fish and feeding on these fish also becomes a special case of depredation.

While depredation is always a stock resource issue it often may become a perceived biodiversity or legislative problem when individuals of charismatic megafauna species become entrapped or constrained by the fishing gear.

By 1998 UK fisheries had developed a three dimensional dolphin biosonar localisation system for dolphin whistles/clicks intended to monitor dolphin movement inside fish trawl nets within the significant volume of water around and inside trawl openings. The project intention was to utilise the localisation technique under experimental test while developing acoustic biosonar degradation systems, effectively specialised bycatch mitigation pingers now known to be more like acoustic depredation mitigation pingers designed to reduce the acoustic capability of dolphins in the nets.

- This UK Seafish project is summarised from FRDC *Small pelagic meeting*



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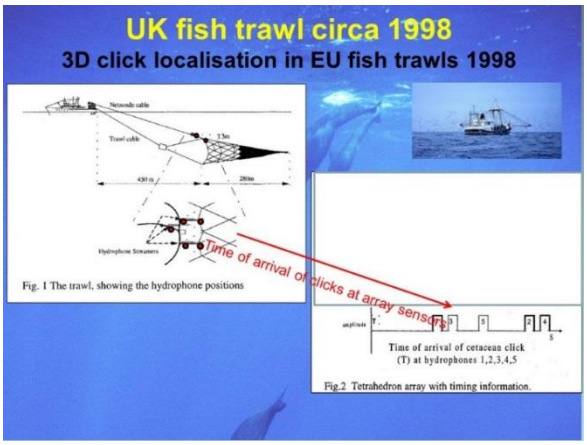
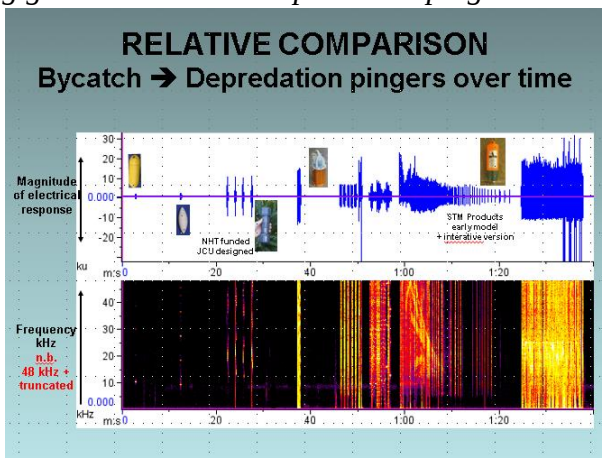


Then and now it was believed that no battery powered system would ever cause any hearing loss, no matter how temporary, to dolphins.

The project was a direct inspiration for FRDC 2003/016 *Reduction of interactions by toothed whales with fishing gear. Phase 1. Development and assessment of depredation mitigation devices around longlines.* from which a 2D and 3D tracking system was developed following development work with AFMA funding.

Unfortunately the UK project was never continued, in part due to the untimely death of one of the principal researchers. The 2D and 3D tracking system from FRDC 2003/016, actually two different systems, were never utilised by Australian fisheries authorities but has found other fisheries uses.

A schematic comparison of bycatch to depredation migration pingers is shown from the time series (upper panel; indicative of electrical/acoustic power) and frequency series (lower panel; showing frequency output over time. The first two pingers on the left would be considered bycatch mitigation pingers and the remaining three versions of depredation mitigation pingers developed with association to an NHT2 project and FRDC 2003/016 *Phase I developing acoustic localisation techniques for toothed whales (basically large dolphins) around fishing gear and acoustic depredation pingers to mitigate depredation*s



Dolphins are by nature obligate echolocators often relying on acoustic interrogation of a target in perfect sight conditions, not just low light and turbid conditions, to navigate and hunt and that does include around and within fishing gear. Basic acoustic interrogation rates can be as short as 0.04 of a second in clear water conditions (shown below).

An example of obligate navigational (or spatio-temporal) clicks as well as hunting clicks of false killer whales (a dolphin) in clear oceanic waters (from FRDC 2003/016 *Phase I developing acoustic localisation techniques for toothed whales (basically large dolphins) around fishing gear and acoustic depredation pingers to mitigate depredation.* In the example below toothed whale navigational clicks are replaced by focused targeted echolocation clicks on fish/diver targets.

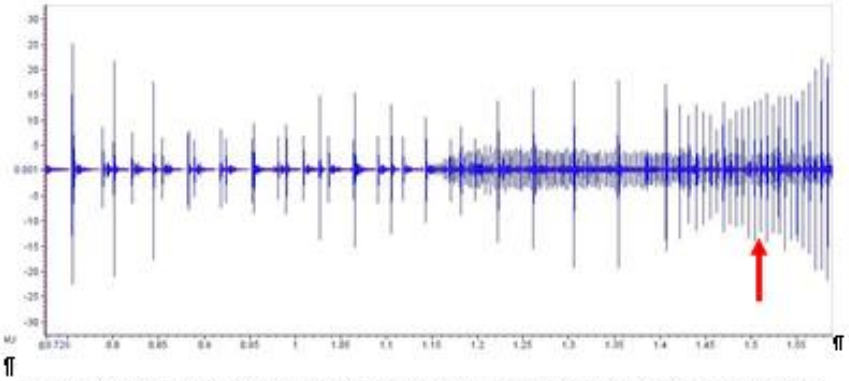


Figure 17. Time series view of the terminal echolocation run of a false killer whale on a floating fish, with probable overlap of clicks on a camera and diver behind the floating fish. Arrow indicates the time of the visual image shown in video captures below. (x-axis: time, y-axis: signal strength measured as voltage).

Figure 18. Echolocation run of a false killer whale on a floating fish, with another whale swimming on a parallel course. Coincidence of this frame of the visual approach with the audio trace is shown as ↑ in Figure 17 above. (Image - - Greenpeace Australia).

Figure 19. A false killer whale taking the floating bait. Echolocation clicks had ceased approximately 100 msec prior to this image being sampled. (Image - - Greenpeace Australia).

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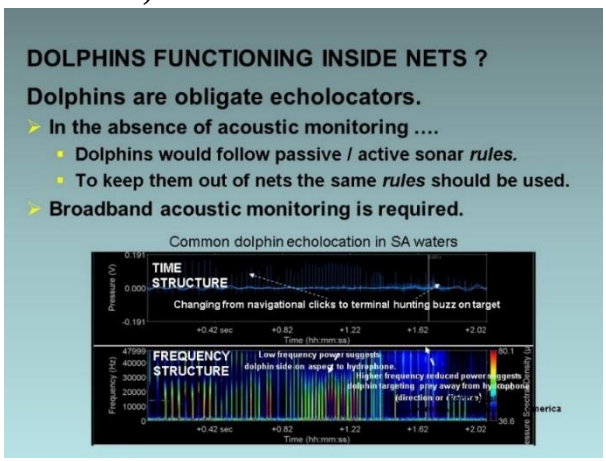
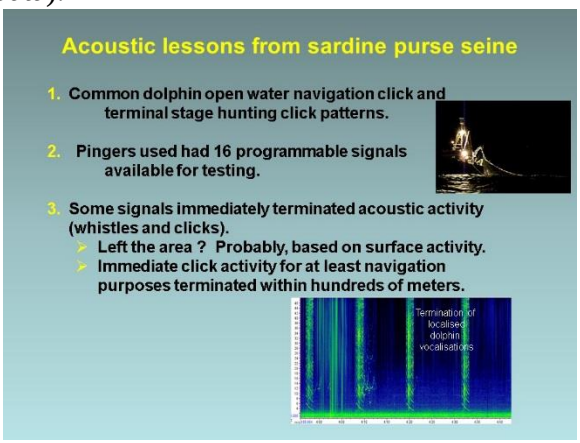
In general if a dolphin has reduced sensory acuity especially from sonar it would not chase a target and would hold back entering an area. Examples include around night squid jigging operations and detecting hooks inside longline caught tuna.

Common dolphin engaged in depredation type behaviour around South Australian sardine purse seine nets demonstrate strong echolocation click activity for navigation and hunting and social whistling (from private data).



When common dolphin were exposed to specific moderate level sounds (no louder than that of a dolphin at 1 m range at least) around South Australian sardine purse seine nets there were obvious changes to echolocation click activity for navigation and hunting and social whistling (from private data).

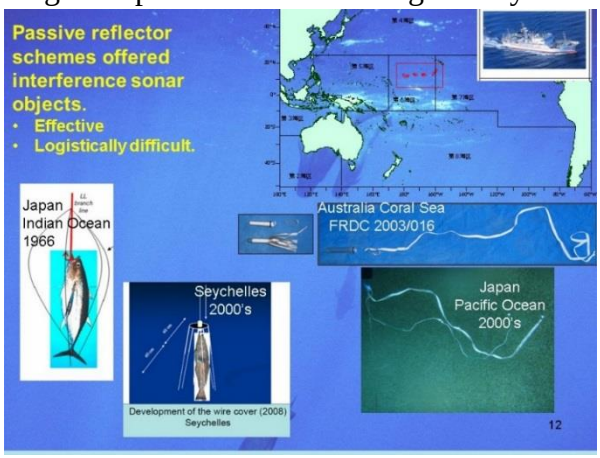


Over an eight year period I worked with Japan Fisheries Research, Far Seas Tuna and Fisheries Acoustics divisions to develop passive reflector and active acoustics systems to reduce depredation on Japanese oceanic fisheries including negative interactions with dolphins. There still is uncertainly as to how the active acoustic pingers functioned,

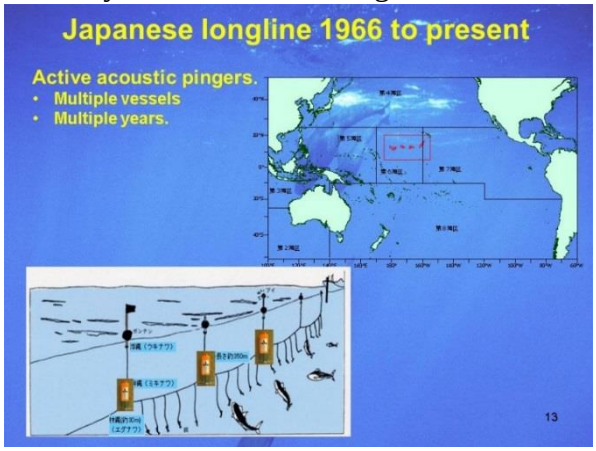
- It is most likely in reducing the clarity of returning echoes from a targets.
- Initial devices were randomised duty cycle, variable frequency tones through the peak hearing sensitivity of most toothed whale hearing where softer sonar returning echoes would not be detected.
- Later versions included randomised broadband dolphin sonar like signals that would reduce the clarity of the echoes.

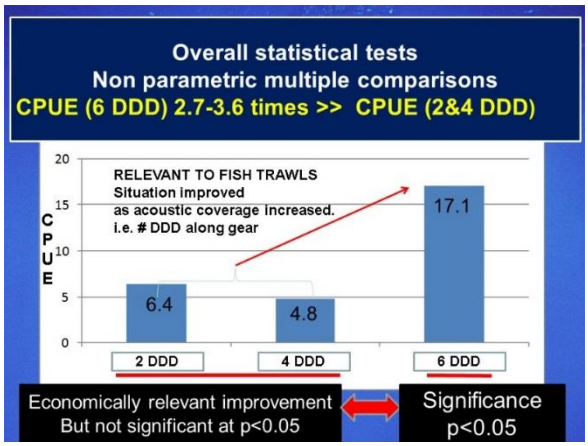
Overall results for the Japanese Fisheries Research Agency (a not so insignificant fisheries agency) assessment of passive reflectors and active acoustic pingers to mitigate dolphin depredation for oceanic longline fisheries included,

- Passive acoustic reflectors made of gear components with acoustic Target Strength reflectivity did mitigate depredation but were logistically difficult.



- Use of acoustic depredation mitigation pingers to mitigate dolphin depredation and bycatch in oceanic longline fisheries did mitigate depredation.

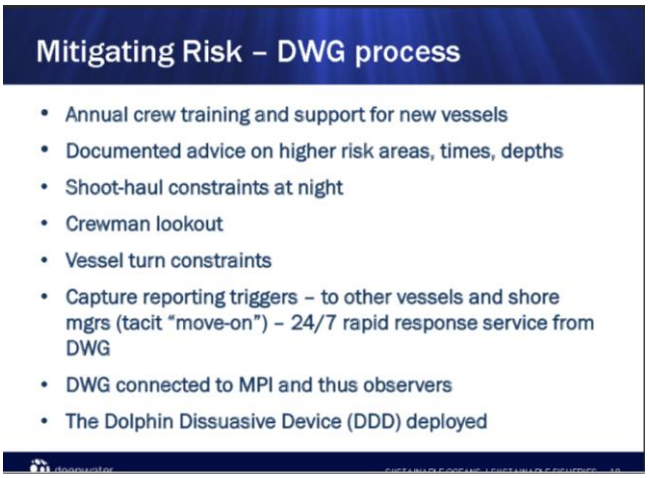




Of greatest significance to this Senate Hearing was that a comparable NZ trawl fishery to the SE Trawl fishery where up to 6 vessels of comparable and sometimes larger size (and notably with larger nets, over double the size) had essentially mitigated common dolphin bycatch issues in that fishery. Perhaps some would say it wasn't entirely solved but dramatic dolphin bycatch in fish trawl nets had been achieved using a variety of techniques including a specific acoustic depredation mitigation pinger used over many years by Japanese Fisheries Research.

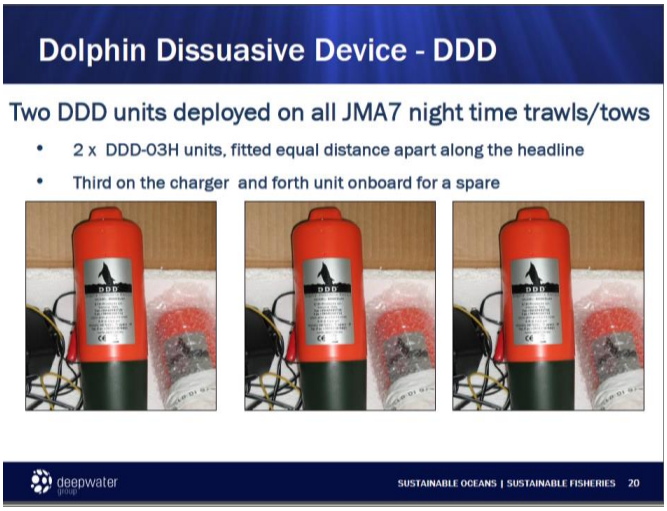
To provide an indication of the scale of the New Zealand fishery an image from the fish deck of a trawler is provided (much larger than that on the FV *Geelong Star*) as taken from a presentation at the FRDC *Small Pelagic Research Coordination Program: Technical workshop to explore options for mitigating marine mammal interactions in the Small Pelagic Fishery (Melbourne June 2015)*
http://frdc.com.au/research/Final_Reports/Richard%20Wells%20FINAL%20-%20Marine%20Mammal%20Captures%20in%20the%20JMA%20Fishery.pdf

The package of dolphin mitigation techniques used in the NZ trawl fishery presented at FRDC's *Small Pelagic Research Coordination Program: Technical workshop to explore options for mitigating marine mammal interactions in the Small Pelagic Fishery (Melbourne June 2015)* is summarised below,

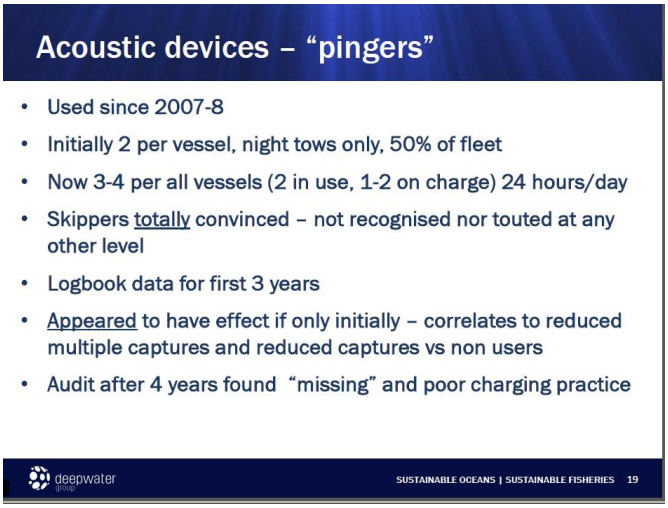


Summary of the pinger results included the following but it should noted that the acoustic output had changed dramatically since their first use in 2007/8 when the logbook data was restricted to pingers with different output,

- The DDD pinger that demonstrated success in Japanese longline fisheries and appear to have success in trawl fisheries despite the NZ application commencing with earlier version pingers.

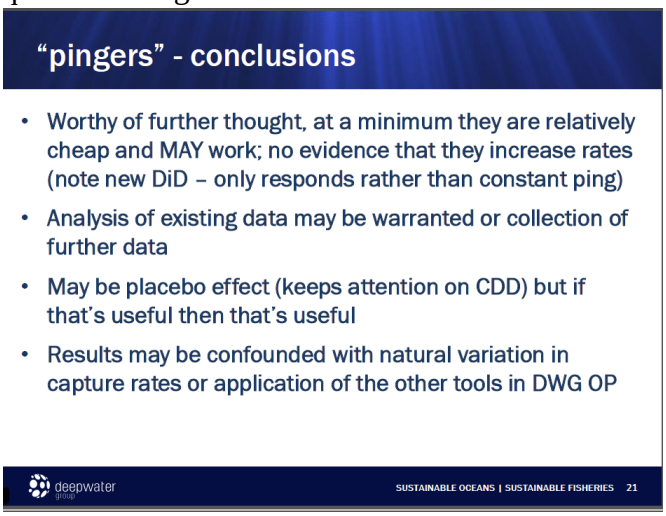


- Initial DDD deployments were often less than 2 per net.
- The trawl nets in NZ were larger than the depredation mitigation pingers were developed for so considerable efficiency acoustic modeling is still required to optimise performance.
- There are continued uncertainties about effective pinger battery charge levels over time. Suggestions were made to address this although the FRDC meeting saw that as the responsibility of the maker. Given the manufacturers loss of engineering skills over the recent year I am not certain this will occur in the near future and recommend it should be accomplished independently as should a map of the sound field from devices on nets.

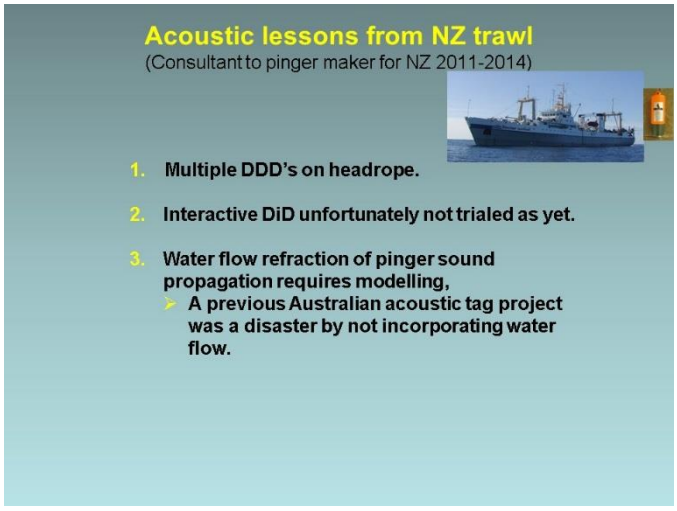


- The interactive version depredation mitigation pinger also assessed in Japanese longline fisheries, the dolphin sonar or gear self-noise activated DiD pinger, is more like a dolphin signal with direct sonar jamming potential.

- The DiD showed more effectiveness in longline fisheries although it is not fully understood how it would function in a mass water flow situation such as in a fish net.
- It would seem that it would show most potential in a package of mitigation techniques including acoustic reflectors.



It should be noted that the NZ commercial trawl fishery unilaterally embarked on an acoustic bycatch mitigation strategy using informal acoustic expertise of the pinger manufacturer rather than associating with local NZ marine mammal negative advice. The decision appears to have been worthwhile.



At the FRDC hosted *Small Pelagic Research Coordination Program: Technical workshop to explore options for mitigating marine mammal interactions in the Small Pelagic Fishery (Melbourne June 2015)* it was indicated that the skippers of the NZ vessels would not go to sea without functioning trawl mitigation pingers.

- This was clearly an indication of confidence in the system though not necessarily an indication of a misleading statistical significance in the success of a system.
- The positive attitude of vessel skippers was worth considering noting that their opinion would have been just as noteworthy if the opposite opinion had been voiced.

By way of example Queensland fishermen had trailed a US 10 kHz bycatch mitigation pinger in the Gulf of Carpentaria under an NHT project 1999-2004 and had declared it ineffective as it attracted dolphin aggression to its device specific sound. Our Fisheries Queensland acoustic scientists accepted the gillnetters recommendation for their lack of confidence in the system despite Fisheries Queensland forcing the use of these ineffective pingers in the Shark Control Programme with clear negative dolphin bycatch.

- The opinion of commercial fishery operators should be valued in data poor situations until better data, not necessarily that of deceptively prepared scientific experiments.

Recent bycatch mitigation developments of FV *Geelong Star* since being made aware of depredation pingers.

The FV *Geelong Star* and Dutch net makers had already been developing a mechanical barrier with a degree of passive acoustic reflection capability (still requiring far more work in an acoustic sense). Yet the FV *Geelong Star* and Seafish Tasmania established a DDD pinger strategy immediately on learning of depredation mitigation pingers from the FRDC workshop in association with a subsequent temporary pre trawl passive detection system.

Without being in a position to follow the depredation/bycatch achievements with the full suite of acoustic and mechanical systems, the FV *Geelong Star* (and Seafish Tasmania) was able to recommence fishing without dolphin interactions.

- The FV *Geelong Star* was not aware of the acoustic systems used around the world until it was so clearly, and perhaps at the time from some begrudgingly, informed of them at the FRDC *Small Pelagic Research Coordination Program: Technical workshop to explore options for mitigating marine mammal interactions in the Small Pelagic Fishery (Melbourne June 2015).*

My observation for this Submission is the why was FV Geelong Star not informed of better acoustic depredation mitigation developments? FV *Geelong Star* should have been given better Australian fisheries advice well before dolphin bycatch had begun.

- Why had acoustic advice deliberately not provided by various administrative or academic sectors?
- Australian Fisheries Management Authority had been made aware of acoustic depredation mitigation pinger developments in the NZ fish trawls by September 2013.
- Was it simply to see the FV *Geelong Star* founder in its attempts to meet its biodiversity targets.

CONCLUSIONS FOR DOLPHIN BYCATCH MITIGATION IN THE SMALL PELAGIC FISHERY

There are published and anecdotal information that suggests acoustic sound generators known as depredation (and trawl) mitigation pingers demonstrate biologically relevant and sometimes statistically significant (whatever the latter means in real world situations) mitigation of dolphin mortality in fish trawls.

- How the dolphin mitigation results are accomplished is not clear but it may be associated with a reduction of the clarity of returning dolphin echoes from sonar.
- Dolphins are obligate echolocators and when faced with poor or negligible returning sonar signals may avoid further acoustic interrogation and interaction with objects in a volume of water.

Human logic at least would suggest that such acoustic devices would function more effectively in concert with other mitigation systems, whether acoustic, mechanical or based on gear deployment timing.

I am highlighting that when FV *Geelong Star* was afforded the opportunity to utilise better standard depredation mitigation pingers it did immediately as part of a package of bycatch mitigation systems.

- It is likely that if FV *Geelong Star* had been made aware of the pinger availability and usage in EU and in NZ waters, the early dolphin mortalities may not have occurred.
- The initial dolphin mortalities should never had occurred.
- Why the usable dolphin mitigation equipment was withheld from FV *Geelong Star* is not known.

Significant enhancement may still be made to acoustic depredation and bycatch mitigation techniques within the soundscape of the FV *Geelong Star* net.

Research work is required to further enhance acoustic mitigation approaches.

- It would most likely be psychoacoustic assessment of dolphin sonar
- It would have to be conducted on contract internationally.

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