PRESENTATION
TO THE SENATE SELECT COMMITTEE
ON WIND TURBINES

THE INCONSISTENT ACCEPTACE OF INDUSTRIAL WIND TURBINE NOISE IMPACTS.

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THIS SUBMISSION

I am not in a position to make a detailed submission on the detection and impact of infrasound noise from Industrial Wind Turbines of land based animals. However, I have recently been afforded the opportunity to provide an individual submission to UNESCO on the impact of noise from industrial shipping on aquatic crustaceans, fish and marine mammals. There are some striking similarities of both the science and the blocking tactics of organisations that should be documented.

TERMS OF REFERENCE OF THIS REVIEW IN RELATION THIS SUBMISSION

The application of regulatory governance and economic impact of wind turbines, with particular reference to:

i) any related matter.

My submission will be presented purely as an observation that anthropogenic noise impacting animals in air and aquatic environment is universally accepted as having some impact at some level, yet when IWTs are involved miraculously there is no impact or the impact that is observed is semantically twisted to be "no adverse impact".

PERSONAL QUALIFICATION FOR PROVIDING THIS SUBMISSION

I do not for one moment consider myself any kind of expert on the Industrial Wind Turbine acoustics. My association with IWT's has been while travelling in Hawaii, North America and Europe.

I am not associated with any environmental NGO, resource industry nor do I like within any area threatened by Industrial Wind Turbines.

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

1. I functioned as Fisheries Biologist with Fisheries Queensland Government 38 years primarily on life history and stock assessment of mostly coastal, reef and oceanic fish species.
2. For twenty six years of that 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 on marine and freshwater ecosystems.
4. Acoustic aspects of fisheries with commercial fisheries and government research agencies of Japan (Japan Fisheries Research Agency, Far Seas Tuna Lab Shimizu Japan) 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 and member of the Australian Acoustical Society for 10 years.
    a. I am no longer a member of the Australian Acoustical Society.
    b. I was offended by the impact individuals had on the Queensland Government when establishing new guidelines for noise exposure, particularly the active ignorance of submissions on low frequency noise irrespective of the medium involved.
    c. I was offended at the active support of wind industry corporations and denigration of researchers daring to voice an opinion that about IWT noise impact on nearby people as being offensive to the process, and integrity of science.
    d. There are some wonderful scientists in Australian Acoustics but the clear institutional denigration of individual questioning aspects of IWT acoustics I find offensive, and lacking in professional integrity and ethics.
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.
7. I was asked to provide evidence on underwater noise impact for the Senate Hearing on the Great Barrier Reef in 2014.

I am currently engaged on three 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.

The inconsistent acceptance of Industrial Wind Turbine noise impacts.

INTRODUCTION

I have been a Fisheries Biologist of over 40 years. Since mid 1980s I began working in the impact of low intensity noise on modifying the behaviour of primarily marine mammal in order to reduce accidental bycatch in fishing gear and deliberate depredation.

Over recent years I have been looking at the anthropogenic noise impacts on marine ecosystems, the soundscapes, and the reactions and perceptions of all the animals within it. My current interest is the noise propagation modeling of anthropogenic sounds in shallow Great Barrier Reef waters and their capability to mask social and feeding sounds. That permits me to have a thorough exposure to the scientific literature that involves noise impact on animals, including humans.

Since the 1982 UN Commission for the Law of the Sea input of energy into any environment or aquatic soundscape was pollution, and noise being energy, was accepted as a pollution type.

US Fisheries management has recently moved from management of fish stocks from a *overfishing* perspective to an ecosystem approach where stocks may be *depleted* with fishing impacts and habitat impacts considered to be contributory factors in what had previously been overfishing where primarily fishermen were to blame. What was significant for the US ecosystem approach to this Industrial Wind Turbine debate was that anthropogenic noise pollution was ranked as a factor.in ecosystem health.

There is general acceptance in US and European administrations (barely in Australia), backed up with legislation, where most acoustic energy introductions into sound scapes must be both modeled and validated with some examples of shutdowns. While seismic resource exploration is a significant complication at times it should be noted what acoustic monitoring of offshore renewable energy systems has achieved where underwater regulators, environmental NGOs and individuals all take notice.

- Special mention should be given to the total shutdown of a marine underwater turbine system that was having a catastrophic impact on larvae stocks of a major commercial and recreational fish in New Zealand.
- Offshore IWTs have been shown to cause behaviour modifications of the marine mammal, the harbor porpoise, harbour porpoise, up to 20 kilometres away and Underwater IWTs are quietly chopping up marine mammals in the northern hemisphere and its quite likely in time that they will have far greater mitigation systems or will be totally phased out.
- Just because a system was seen as renewable did not mean that it was exempt from causing ecosystem impact underwater

How is it that such disparate views about the impact of noise can be generated by different sectors of communities subjected to Industrial Wind Turbine (IWT) deployments. Ostensibly the same published data, scientific reports and medical histories are available to all yet the perceptions differ depending if one refuses to suffer anthropogenic noise impact or one wants others to suffer anthropogenic noise impact on their behalf.

Opinions range from the industry perspective where vast amounts of tax incentives could be made by foreign corporations increasing as IWTS encroach further on unwilling neighbours while at the other end of the scale are small landholders in country areas with IWTs rapidly encroaching on their once peaceful lifestyle. Regarding the latter even when a highways goes

through an unwilling suburb there is at least some kind of mitigation to counter the ‘greater good’ of a public used highway.

In between the above positions are opinions that range from armchair renewable energy zealots who maintain a rage to force people in small communities to suffer so they can have renewable power to make them fell pure, to supporters and families of IWT sufferers who perhaps do not experience the same negative symptoms to the same degree as others.

The reality is that a certain % of people within and undefined radius of IWT’ show signs of distress. The fact that those people showing signs of distress are often in the minority is the mainstay of the pro industry argument that individuals are making symptoms up and are standing in the way of industry making more money with close sited turbines. The word ‘spin’ imply preventing any type of damage to a client’s or processes reputation often comes up to malign the sufferers.

I am not going to repeat the acoustical science that clearly demonstrates that infrasound and low frequency sound from IWT’s does exist at high levels as a host of great acousticians can do that well.

- I will focus on what we know of underwater impact of low frequency noise on animals in general where the effect is real with no likelihood of fish reading English language newspapers giving them an idea it would be good to complain about an issue, what we have learnt and could assist air based research.
- I will also comment briefly on how I see support for closed sited IWT is twisted scientifically (acoustically and medically)
- I will note some acoustic/vibration science literature from other disciples that has seriously been ignored in this IWT debate arguable with understandable reasons. Note some extremely recent and ground breaking published research that clearly demonstrates via objective brain monitoring (EEG) no NOCEBO effect but that rather the sound energy causes physiological impacts directly on brain function

COMMENTS

How analysis of impact of infrasound/low frequency noise on aquatic animals is relevant to noise impact on human animals in air

I mentioned in the Introduction that there was some uncertainty about impact of noise from seismic survey. I think that is an understatement but I will not address that here.

I will introduce some historical and current work on impacts of noise on marine animals that are relevant to indicate that the concept of noise/vibration impact on animals, the science of psychoacoustics is seemingly totally unreported in the wind farm debate, and offers not only indicative research methods but simple confirmation of the impact of anthropogenic noise on animals in a soundscape.

Playback of variable tones to dolphins

As early as 1980 US Navy marine mammal veterinarians were playing back signals to various dolphin species wired for sound (non-invasive EEGs looking at incoming brains stem responses from the ears). They determined that different signals could evoke up to four times the electrical brain response than others, namely frequency modulated and impulsive signals generated four times greater signal voltage than constant signals.

- No arbitrary human interpretation were made 'trust me I know marine mammals' but the signals have been utilised in a range of devices to warn marine mammals of obstacles or to detect signals most effective in being recognised and utilised for various process to mitigate mammal interactions with fishing gear.
- It was not the perceived signal level that generated the great brain response, it was the type of signal.

At INTERNOISE 2014 in November in Melbourne Professor Hideki Tachibana (an acoustical engineer from Tokyo Uni and regular visitor to Australia) noted "serious complaints had arisen in Japan from residents near IWT's since 2000". This was an interesting observation clearly contradicting Simon Chapman's claims that opposition to wind turns was a recent English speaking phenomenon and that symptoms were spread by "scaremongers" (https://theconversation.com/new-study-wind-turbine-syndrome-is-spread-by-scaremongers-12834). Professor Tachibana also noted a 2010-2013 project funded by the Ministry of the Environment, Japan, including looking at auditory experiments on the human response to noises containing low frequency components.

Japanese researchers working at a wind farm in Japan noted that workers were complaining about low frequency noise. Inagaki *et al*. (2015), included with this submission noted

> *A local resident has the right to live quietly within the limits of the environmental standards (Japanese-Government). Therefore, maintaining the working environment quietly is especially important for health maintenance of the technicians who work in close proximity to the wind turbine.*
> *This is a problem which cannot be bypassed when conquering an environmental problem.*

While wiring those workers to examine their responses to the sound of turbines was possible in the same way as the Navy did for dolphin (now perhaps AUD$1,500 per unit), a comparable playback experiment was conducted using a similar encephalogram as the physiological evaluation. Inagaki *et al. (2015)* will be published next month and I congratulate them on their work.

The study clearly indicated that workers exposed to playbacks of the sounds 300 Hz (low frequency) to 20 Hz (borderline infrasound) of the wind turbines. The turbines used for playbacks were tiny 600 kWatt units with relatively low intensity and higher frequency output compared to the 3.5 MWatt units on Australian wind farms. The playbacks demonstrated changes to their brainwave patterns specifically,

- ***alpha*** $_1$ **rhythm** is the resting state for the brain at 8-12 Hz. They aid overall mental coordination, calmness, alertness, mind/body integration and learning.
    - playbacks began at 400 Hz and reduced to 20 Hz interference with the brain wave indicating a relaxed state.
    - at 20 Hz restricted the test subjects to maintain a relaxed state or concentrate.
- ***beta*** $_1$ **rhythm** shows a musing or strain state at 12-15 Hz. They dominate our normal waking state of consciousness when attention is directed towards cognitive tasks and the outside world
    - Highest vales, highest mental strain, was achieved at the infrasound 20 Hz.
    - after the sound stimulus with the frequency band of 20 Hz, showed the highest value among the other cases.
- Clearly exposure of subjects to the sound of these small, low intensity and relatively higher frequency IWT's impacted their resting and strain states during the day raisin the question what would be the effect on them at night when they were trying to rest.
    - In the absence of any data it would not seem too difficult to make an educated assumption.
    - The technology is available to accomplish it.

The significance of this study was that the infrasound (borderline in air infrasound at 20 Hz) and traditionally regarded as inaudible for human hearing was considered to be an annoyance to the test subjects.

- Of great relevance was that the test subjects were workers at a Japanese wind farm who would directly benefit from the wind turbines.
    - I worked with Japan Fisheries for 8 years and often visited their fisheries sonar lab near to that wind farm.
    - I would be confident in saying that the test workers had not been bombarded by English language accounts about infrasound exposure to colour the r opinion.

This study clearly flies in the face of assertions of Simon Chapman's constant media assertions that that wind farm effects result from scaremongering i.e. "the NOCEBO effect ". https://theconversation.com/new-study-wind-turbine-syndrome-is-spread-by-scaremongers-12834

But why stop there. Mikołajczak *et al.* (2013), included with this submission, in the Polish Journal of Veterinary Science (in English) described a study documenting a negative effect on Polish geese of the immediate vicinity of a wind turbine. Geese gained less weight and had a higher concentration of cortisol in blood and demonstrated some disturbing changes in behaviour. In other words there was clear objective evidence of a physiological stress effect. This is consistent with the Japanese research which also showed physiological stress although in humans.

My very good friend who I cycle with was Polish and returns to his ancestral home on regular basis and actually can pronounce all the names in Mikołajczak *et al*. (2013). Although he is not a 'twitcher' he informs me that it is unlikely that Polish geese would be insufficiently aware of English literature discussing the impact of wind turbines so he believes the geese's response would be pretty much indicative of their internal response to wind turbine noise and not based on Simon Chapman's NOCEBO hypothesis, which is so useful for the wind industry's commercial interests, achieved at the expense of the health of the neighbours.

Playback of very low frequency vibrations to fish and frog embryos

The science of cytology is the study of cells in terms of structure function and chemistry. It includes the early developmental stages of cells in sexual a cell division (meiosis) and a-sexual cell division (mitosis).

- My Honours Thesis was on the sexual cell division in a fish species that changes sex.
- I have some experience in this area of science.

It is worth noting that as the chromosomes split /replicate/divide and move to separate poles of a dividing cell there is a stage in division where the chromosomes move along a delicate protein-based track called a spindle. The science of cytology recognises that at various combinations of events, including low frequency vibration, damage may occur to some cells. The timing of the division and the type of cell involved would have a degree of impact.

Over the 2011 to 2012 period a number of cytological studies examined the effect of low intensity vibration on embryonic development of fish and frogs (Vandenberg *et al*. 2012). The units of intensity of vibration were not presented but the frequency of vibration ranged from 7 to 200 Hz. I contacted the authors to note that the intensity of vibration was akin to a gentle movement of ones hand as the developing embryos were delicate that strong agitation would be counterintuitive.

A few hours of gentle vibration at the critical embryonic development stage generated extremely serious spinal malformations. If they had developed past embryos there is no indication of how serious the malformations would be nor how viable the animal would be.

I note from the work of Stephen Cooper that the same vibration frequencies resonate in some of the homes of nearby residents at Cape Bridgewater. There are similar reports of perceptions of vibration from other locations including Waterloo and Macarthur, and also residents impacted by noise and vibration from other noise sources, including a coal fired power station and an underground coal mine extractor fan at Lithgow where one of the residents has observed deformities in her chickens which she incubates inside her home.

- One can't be sure at this stage how this vibration would affect the humans.
- It is highly likely that animals in water around the house examined by Steven Cooper at Cape Bridgewater may have been subjected to a vibratory sensation with potentially fatal implications.

Given the horrendous malformations that occurred in fish and frog embryos occurred over a few hours one immediately must consider the sudden and highly dramatic events around the dramatically changed behaviour, mass miscarriages (1600 over 4 months) and malformations at a mink farm in Denmark immediately after a wind turbine commenced operation nearby. The mortality events with vet report are given (http://wcfn.org/documents/documents-re-mink-farm-tragedy/).

- Social websites in Denmark are saying as of mid April 2015 that permitting for Danish wind farms has been put on hold. Danish legislation defines low frequency noise as 10 – 160Hz.
- Unfortunately the turbines are still operating, perhaps so as not to admit the problem, and mortalities are still occurring unabated when there is no other potential source for the problem than the IWT's. The courageous vet who highlighted the mortalities has now passed away from cancer and the Government of Denmark is not investigating the problem.

Playback of low frequency shipping sounds to fish

For the purpose of this presentation infrasound impact on fish is still under investigation.

There is however, sufficient evidence over the past few decades to suggest that marine animals (prawns, rock lobster, fish) respond differentially to the pulses and tones of low frequency noise including shipping noise <200 Hz. Marine animals are able to differentiation anthropogenic noise from ships (with its distinctive sound characteristics) with natural noise and artificial noise at the sound levels (Filiciotto *et al.* 2013). Stress impacts such as blood chemistry, stress associated proteins (as often stress hormones are too transient) and even immune response have been detected and published in various zoology, acoustics and marine pollution journals.

Some sounds annoy more than others. In 2004 as part of an Natural Heritage Trust funded study reducing bycatch of dolphins in northern Australian gillnet fisheries I used a 10 kHz pulsed tone generator to warn dolphins of nets that had worked well in other locations for northern dolphin species. However, when a new model with the 20 and 30 kHz harmonics were suppressed was used the dolphins immediately began to attack the device often being caught by the nets (McPherson *et al.* 2004). Obviously that device was withdrawn yet the Qld Government slavishly maintained its use in the Queensland Shark Control Programme with continued mortality while the devices still remained functional.

In May 2015 Parmentier *et al*. (2015) demonstrated that fish larvae in coral reef waters can detect differences in reef sound made by animals from at least 4 different microhabitats within a coral reef complex. Incoming fish larvae are differentially attracted /repelled from reef sounds and therefore settle on the area of reef that they should, as indicated by a reef sound signature.

The single point that I wish to make is that as invertebrates, fish etc can detect differences in sound characteristics and make non emotive responses then there should be no reason why humans can detect different sounds and respond differently to them. For the wind industry to suggest that as various natural or anthropogenic noises are the same sound levels as turbines and there would be no reason to be impacted by turbine noise is utter rubbish. The science of psychoacoustics clearly dictates that animals respond differentially to different sounds.

Ioannidou *et al*. (2015) from a Danish University looking at wind turbine noise impact will present "Annoyance of wind-turbine noise as a function of amplitude modulation parameters" at the upcoming Spring 2015 Acoustical Society of America meeting. There is no doubt that the amplitude modulation noise of the turbines is detected by experimental subjects, but the power of the paper is that the time variation of the signal, the pulsation effect, will be shown to be the dominant part of the signal that causes annoyance, including amplitude modulation. Leventhall (2006) while now currently trying to suggest that infrasound is not a factor in wind turbine annoyance did admit "time varying sound is more annoying than a steady sound of the same average level".

How the public have been provided erroneous data -on the margins of scientific fraud.

Withholding research material results

One of the more comment public statements made by individuals decrying the concern of IWT impact is usually along the lines that "17 Reviews have conclusively shown no impact ….".

Is a Review something special that it should be listened to? Are reviews that good that they can be held up as final arbiters in an argument? Certainly not!

Caution is required when interpreting any 'scientific' document irrespective of who writes it. Scientific fraud is indeed rare, although most notable in the medical literature but it can extend to the Nobel Prize level.

- For underwater NGO's for example, disclosures exist for underhand payments to editors of journals to omit or delay publications while journals have often been established to only one a single point of view in order to promote that point of view, or delay publishing of others first.
- Many a scientist can point to a conference where their work was relegated to a poster session instead of a presentation as their topic did not agree with that of the dominant paradigm of the session convenor.

Sugden 2002 as editor for Science noted in a comparison of papers versus reviews that reviews generally have a more diffuse objective namely to document and interpret the developments and state of the art in a given field (http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2002_02_01/nodoi.18257848507005478043 Accessed 11th May 2015). Simply put reviews don't contain original research nor new results. They reflect the personal or commercial responsibility of an editor who commissions a review or the individual views and commercial reality of the writers. The comments in no way suggest that all Reviews are bad or that excellent ones do not abound and that Reviews often identify original research papers well worth reading than an author may not have noticed by independent searching.

So lets look at Australian most recent Review on wind turbine noise, one of the "legendary 17 Reviews", the Australian National Health and Medical Research Council commissioned review for wind farms. My submission to the Australian Medical Association Position Statement on Wind Farms and Health concerning the Draft NHMRC Review is included with this submission.

How did the Adelaide University investigative group came up with a review of the literature for the NHMRC that gave them the capability to start relegating so many historical to current papers to that "background" status? The investigators outlined how their literature search was conducted using what most people would call keywords (listed) for a Google search though a tad more intricate.

> *The Draft NHMRC Review Table 2 Search strategy and criteria for selecting evidence to inform Background included the keywords noise/adverse effects, systematic, noise injury, clinical trial, controlled clinical trial, controlled study, longitudinal study, prospective study, randomized controlled trial, humans and English.*
>
> *The NHMRC Review Table 3 Search terms to identify evidence to inform the systematic review questions included keywords wind, turbine, farm, tower, energy, technology, energy generating resources, electric power supplies, wind turbine syndrome and wind power.*

However, if medical, psychoacoustic or acoustic type keywords relevant to turbine impact on definable proportions of the population of close sited humans would have also been included, in other words find out of there were data to suggest that IWTs impacted people such as stress, annoyance, heart (with qualifiers), disease, misophonia (the selective sound sensitivity syndrome which is now being accepted as a current psychiatric disorder), psychoacoustic (integrating the pulsing sounds that annoy people), headaches, nausea, dizziness, nosebleeds and sleep disturbances/deprivation etc then the result would have been totally different. The inclusion of the keyword English may have stifled acceptance of even more relevant information usually in English. Keywords about language such as Dutch, German, Swedish, Danish, Polish, Japanese and Korean would also have been more instructive given that literature exists in those languages, sometimes with English Abstracts and certainly readable with the benefit of basic translators to get a general idea..

The Draft NHMRC Review authors apparently went out of their way to **no**t encounter many research articles dealing with wind turbine induced annoyance leading to impacts. It is somewhat of a miracle that anything indicating any mechanistic, direct or parallel evidence relating to wind turbines and health was stumbled upon, only to then be relegated to "background" status. Despite this, the Draft NHMRC Review determined that there were findings that wind turbines were detrimental to human health, using words such as quality of life, sleep deprivation etc. ***The Draft NHMRC Review findings did not say the concerns did not exist, or that there was no evidence.***

The Draft NHMRC Review included many documents that were completed as reviews and were assigned "Background" status and were duly buried. However, if the Draft NHMRC Review was really serious about obtaining information about the impacts of turbine noise they would have considered the original research articles specifically referenced in the reviews with journal titles including the keywords research, brain, hearing, health, sleep deprivation etc. Potentially such a more thorough approach may have found the information that was required. Accidental? I doubt it!

Using inappropriate acoustic units to compare to observed health issues

Arguably the greatest single bone of contention between all parties in IWT are the appropriate metrics utilised by which the observed sickness can be gauged. Where different sides can establish a metric as the most appropriate they can derive entirely opposing impact results with the same data. This scientific subterfuge causes great confusion in the interested and indeed the impacted public. Science should do way better if science was really supposed to be functioning as it should.

The Acoustical Society of America Accredited Standards Committee S3/SC 1 Animal Bioacoustics Committee has established a number of standards, accredited by the American National Standards Institute, for the assessment of acoustic impact on a variety of animals including marine mammals, fish, sea turtles. In general most standards include a range of different standards (including instantaneous, cumulative, impulsive and continuous) to suit different animals and different ranges to the noise source. Mortality, hearing impairment and behavioural modification are all appropriate.

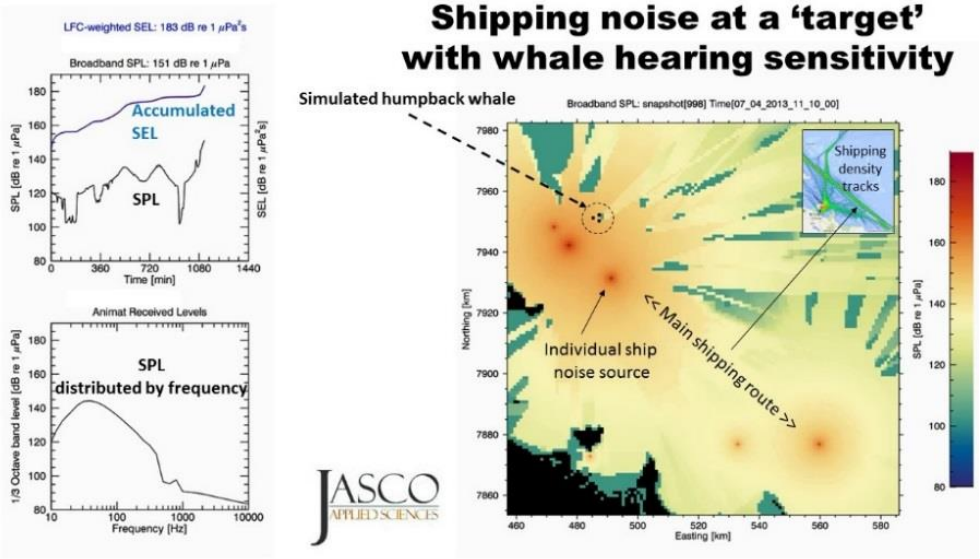
Acoustic standards for underwater noise impact may look different to air units but become similar when the mathematical basis is compared. It is enough to say that impulsive and cumulative noise parameters are considered in underwater standards.

International Standards Organisation acoustical standards have been established on how to measure the noise from shipping in deep water. An equivalent standard is being developed for measuring ships in shallow water.

As recently as last week a study looking at the applicability of pulses, amplitude modulating sonar at well outside the peak hearing range of northern hemisphere toothed whale has resulted in calls for existing standards to be modified. Underwater standards for noise impact on animals should be at least considered to be dynamic.

For marine invertebrates, fish and mammals the instantaneous, averaged and cumulative metrics are often recorded and utilised as appropriate. Marine animals have often been shown to be able to determine the differences between anthropogenic, natural and biologically meaningful sounds for the same standardised noise level. It is likely that they are detecting nuances in the sounds suggesting they do have their own metrics that they respond to. We just haven't worked it out yet suggesting it is advisable to record all available metrics in the first instance.

By way of example a figure presented to the 2014 Senate Hearing on the Great Barrier Reef an example of shipping noise cumulative impact on marine organisms is shown indicating ship noise propagation received by a 'target' with whale hearing capability.



Ship noise propagation as instantaneous Sound Pressure Levels and accumulated Sound Exposure Levels, received by a modelled humpback whale target in GBRWHA waters off Townsville.

The 'target' is shown receiving shipping noise that could have potential in causing hearing impact, generate communication masking effects or behavioural stress effects.

The pulsed component of wind turbine noise has been documented in the literature for some time. It was earlier noted by Ioannidou *et al.* (2015) for May 2015 that the time variation of the signal, the pulsation effect, will be shown to be the dominant part of the signal that causes annoyance, including amplitude modulation. This further highlights the inappropriateness of averaging on sound from wind turbines which arguably reaches a height of absurdity with the recent Qld conditions for the Mt Emerald Wind Development that features a night time LAeq metric which means the noise is averaged over the entire 8 hour night time period.

- If ever a metric was developed to not find a sound component in a signal this would have to be a strong contender.
- Averaging a loud sound and a 'silence' sound to assess annoyance from sound is farcical

CONCLUSIONS

To attain the most appropriate use of renewable energy systems those parameter must be determined. Impacts of low frequency noise on marine animals from invertebrates, fish, turtles and marine mammals have demonstrated that there is an adverse impact. The world is variously developing standards to mitigate the adverse impacts. The lessons from underwater noise are appropriate for in air use with the siting of IWT's. We should consider some of those methods.

The entire wind turbine noise debate is buried within a mire of inconsistency.

Environmental groups, political parties and individuals all so enthusiastic in expressing concern about the impact of low frequency noise on marine ecosystems (whether from military sonar - never normal sonar, seismic survey and drilling, pile driving and shipping of all types) suddenly become missing in action when people suffering closed proximity to IWT's begin complaining. The noise from IWT's seems to become acceptable because some people think they will save the planet, and also consider it is acceptable that other people must suffer – so called "collateral damage". Why should rural residents living near wind developments be discriminated against on the basis of noise pollution?

Humans are animals in their ecosystem and they deserve every right just as Inagaki et al (2015) noted, namely that "*A local resident has the right to live quietly within the limits of the environmental standards (Japanese-Government)*

Others have commented how the wind industry has effectively set their own acoustic standards to which the wind industry claim they comply with, and government regulatory authorities appear to be complicit with this approach. Science is increasingly showing that these standards are a deliberate attempt to not see what is really happening.

Yet the reason a percentage of people are impacted more than others within a given radius of IWTs is still not fully understood. Drug administration clearly has demonstrates that where contraindications exist for new drugs, sometimes with symptoms including headaches or dizziness, the product is often removed from the markets. The contraindications rates are often at least an order of magnitude lower than those cited for IWT impact on humans so why are the health impacts of IWT's basically non-existent?.

Stephen Cooper and others have provided the acoustic metric upon which to base further experiments to establish why some people are impacted more. Japanese and NZ researchers are clearly demonstrating the appropriateness of wiring people for sound to better understand the physiological impacts of IWT noise in all its forms.

What is now required is the full spectrum acoustic testing inside the homes of the worst affected people, together with detailed physiological assessment via EEG's and other physiological and biomarkers for stress to see what dose of sound energy is required as a threshold to protect people from these impacts. Good objective science will help solve this problem – bad science and industry inspired propaganda "science" will not.

ATTACHMENTS

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Geoff McPherson. COMMENT ON AMA Position Statement on Wind Farms.

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