Review of proposed L-DEO seismic surveys in SE Asia (FR 78294) 28.1.09

Contents

Note 1. Focus on marine mammals in this review

The concerns raised here specifically focuses on marine mammals but do not imply that impacts on other marine organisms such as marine reptiles, fish, etc. are insignificant but rather that the expertise of this reviewer is with marine mammals. Sincere consultation with experts on other marine organisms of the region is needed as there are also considerable socio-economic issues with fisheries and aquaculture.

Note 2. Noise impacts on cetaceans

- according to NMFS, to avoid permanent physiological damage, cetaceans should not be exposed to received pulsed underwater noise levels of 180 dB re 1μPam (rms) or more.
- This would be 'Level A Harassment' whereas received levels above 160 but lower than 180 dB re 1μPam (rms) would be considered 'Level B Harassment'.
- The predicted distances of where 180 dB re 1μPam (rms) will be received varied between 710m and 3,694m from the source (36-airgun array) depending on the depth at which the array will be towed and the depth of water.
- A deeper tow depth and over shallower water will increase the distance of exposure.
- For the 160 dB re 1μPam (rms) level, the distances varied from 4,670 to 8,000m from source.

1. Lack of data but numerous threats for marine mammal species and populations in SE Asian waters

- There is little knowledge available for most of the species that inhabit the waters of SE Asia. Even the most basic knowledge about the presence/absence of species is incomplete.
- Only a small proportion of the large expanse of sea in the region (and mostly coastal waters) has been surveyed systematically for marine mammals.
- Few estimates of abundance or distribution exists for SE Asian marine mammals and in most cases, this information is for a limited region, often bounded by political rather than biological borders.
- What little is known clearly shows the region to be an area with a high diversity of marine mammal (and other marine) species.
- However, it is also a region where marine mammals are facing a myriad of serious threats that have made the continued existence of several marine mammal populations and possibly some species uncertain (note: some of the same threats and activities have resulted in the recent 'functional extinction' of the baiji (Turvey et al., 2007), which is endemic to the Yangtze River of China).
- All small cetaceans in Taiwanese waters are threatened by fishermen using hand-harpoons, bycatch in fishing gear and noise. Those that inhabit coastal waters of western Taiwan also face habitat degradation, pollution and possibly prey reduction.
- Some marine mammals have been reduced to numbers so low that even minimal 'takes'

will have a large impact on the remaining population.

- A number of marine mammals are discussed below based on what is known about their biology, conservation status and threats in the region. This does not imply other marine mammals that are not specifically discussed in detail are 'safer' from the seismic surveys; in most cases, too little information is available to understand the impacts, which may be as great as or greater than the marine mammals discussed in detail below.

2. Threats to particular species and populations- odontocetes

2.1 Certain overlap of survey tracklines with distribution of critically endangered Eastern Taiwan Strait (ETS) Indo-Pacific humpback dolphins (*Sousa chinensis*) (west coast of Taiwan)

2.1.1 Potential threat from LDEO seismic surveys:

With the exception of a very small area where the proposed tracks take the *Langseth* to the mainland Chinese coast and back to western Taiwan, the *Langseth* will operate in waters within 1 km from the shore of Taiwan and right through the middle (longitudinally) of almost the entire linear coastal distribution of the ETS population, i.e. the proposed trackline almost completely overlaps with entire distribution of the ETS population. At this distance from shore, the *Langseth* will subject the entire population to noise levels >>180dB.

2.1.2 Background

- STATUS: The species *Sousa chinensis* is listed as 'near threatened' under the IUCN red list and is listed under CITES Appendix I. The ETS population is listed as Critically Endangered under the IUCN red list. The species is given the highest level of legislative protection by Taiwan's Wildlife Conservation Act (WCA); distinct (Wang et al., 2008a)
- ABUNDANCE: Population size <100 (Wang et al., 2007a)
- DISTRIBUTION: Thus far, the ETS humpback dolphin population has been recorded in waters from shore out to about 3 km and in water depths that vary from 1.4 to about 25m deep (see Wang et al., 2007a; Chou 2006). The species has not been reported in waters greater than about 25-30m (Jefferson and Karczmarski, 2001) but can be found much further offshore if shallow water exists (Corkeron et al., 1997). Jefferson (2000) showed that humpback dolphin sightings drop off considerably beyond a perpendicular distance of about 400-500m and none were observed beyond a perpendicular distance of about 1500m.
- The ETS population is resident year-round (J.Y. Wang, unpublished data) in a very restricted (<200km) stretch of shallow coastal waters (to about 3km from shore) along western Taiwan (=eastern Taiwan Strait) (Wang et al., 2007b).
- THREATS: noise, bycatch in fisheries, loss of habitat due to land reclamation, decrease of freshwater to river estuaries, pollution (Wang et al., 2007b).
- HUMPBACK DOLPHINS AND BOAT NOISE: In general the species are usually indifferent towards boats but can be curious and approach boats occasionally. Noise from boat traffic (being much lower in intensity than airguns) can affect the acoustic behaviour of humpback dolphins, with mother-calf pairs being the most disturbed (van Parijs and Corkeron, 2001); Boat

traffic can also affect the diving and swimming behaviour of humpback dolphins (Ng and Leung, 2003).

2.1.3 No escape from noise

Sousa chinensis is considered a slow swimmer and unlikely to sustain high speed swimming for more than a few minutes, and therefore unlikely to be able to outrun the *Langseth* (while towing airguns) for extended periods. Even if they were able to outrun the *Langseth*, there would be no escape within their distribution because:

a) the tracklines covers nearly the entire longitudinal length of the ETS population's total distribution and beyond; and
b) no safe acoustic shelters exist.

2.1.4 Poor/no tolerance of additional stress

Mortality (by human causes) of even a single individual per year from this population may not be sustainable, and unless effective mitigation measures are taken immediately to reduce the threats to this population, it is unlikely that the population will continue to exist (Wang et al., 2004, 2007b). Any single threat has the potential to be the final cause of extinction for this small population of dolphins.

2.1.5 Unacceptably high proportion of ETS humpback dolphin population to be impacted

68.7% of the ETS population was predicted to be impacted by the proposed surveys. This high proportion in itself is a severe underestimation of the population being impacted as the *Langseth* will transect the entire distribution of the ETS population, which has no acoustic shelters in these waters and the dolphins can not escape to other waters. Therefore, nearly the entire population will be exposed regardless of where the dolphins are in their distribution. Even at 68.7%, the proportion of this critically endangered population to be impacted is unquestionably far too high.

2.1.6 Proposed impact mitigation measures

Predicted RMS distances

- Even staying >= 2km from the coastline (a proposed mitigation measure to reduce the impact on the ETS humpback dolphin population) does absolutely nothing to reduce the noise exposure to these critically endangered dolphins.
- Even at 8-10km from shore will still expose all animals to >160dB and an unknown number would still be exposed to >180dB.
- The above statements are conservative because they are based on the predicted RMS distances for different levels of exposure (Table 1 in the Federal Register (FR) notice), which
  a) underestimates actual exposure levels in shallow waters* (FR) and
  b) does not consider
     - ◆ reverberations that are likely to occur as a result of the solid concrete sea walls that are found along much of the central western coast of Taiwan,

- the very shallow water depths of western Taiwan (also, tidal fluctuation is up to about 5-6m and can affect the depth in which the dolphins are found during exposure); or
- the many sandbars that may force animals to be further offshore from the solid shoreline during lower tides.

* The grouping of exposures into the very broad category of 'shallow' water (being <100m) is not sufficient to understand the exposure level for a species that occupies water depths at the lowest end of the 'shallow' water category. It is expected that the exposure levels will be much higher at any given distance from source than the predicted values in the tables. The distance to reduce exposure to noise levels of 160dB or greater is unknown for dolphins in water depths less than 25m and could be much greater.

2.1.7 Previous recommendation for buffer zone for ETS humpback dolphins

In December 2008, the Eastern Taiwan Strait *Sousa* Technical Advisory Working Group (ETSSTAWG, an international working group established in early 2008 to provide scientific guidance and advice to all interest groups) recommended that a buffer for noise threats to be out to at least 5km from shore for the ETS population after reviewing a proposal for designation of Major Wildlife Habitat for the ETS population (review letter to Wild At Heart Legal Defense Association – dated 29 December 2008).

Calculations of how far the *Langseth* should be to prevent the ETS population from being exposed to levels >160dB should be based at least on the recommended 5km buffer boundary (i.e., the waters from shore to 5km offshore should not be exposed to levels >160dB). However, given the population's critical status and the fact that table 1 underestimates the actual exposure levels in shallow water, the recommended distance should be even more precautionary, i.e. greater than 13 km from shore based on the values presented in table 1 of the FR notice.

Consideration of cumulative noise impacts

The exposure of these dolphins to total cumulative noise has not been considered. The ETS dolphins live in an environment which is already very noisy (e.g., pile driving and other noise-generating activities during coastal construction, shipping, other seismic surveys (oil and gas, local researchers, etc.). The cumulative impact of all noise sources needs to be examined in context of the contributions by the intense sounds source of the airguns.

2.2 Overlap of survey tracklines with distribution of Jiulong River estuary (JRE) Indo-Pacific humpback dolphins (*Sousa chinensis*) (east coast of China)

2.2.1 Potential threat from LDEO seismic surveys

If the *Langseth* approaches to within 10km from shore, dolphins using waters east of the Chinmen islands may be exposed to levels greater than 160dB and some may be be exposed to 180 dB or

more depending on where the dolphins are found in their distribution and how close the *Langseth* is to the 25-30m isobath.

2.2.2 Background

- STATUS: The species *Sousa chinensis* is listed as 'near threatened' under the IUCN red list and listed under CITES Appendix I. The JRE population likely to meet the IUCN Red List criteria for "critically endangered". *Sousa chinensis* is afforded the highest level of legal protection in China and Hong Kong. JRE humpback dolphins are distinct from ETS humpback dolphins (Wang et al., 2008a); the level of exchange (if any) with other provisional populations along the mainland Chinese coast is uncertain. The JRE population is less well understood than ETS population
- ABUNDANCE: Population size <90 (Chen et al., 2008a)
- DISTRIBUTION The shallow water which *Sousa chinensis* inhabit is more expansive on the western side (i.e. JRE side) of the Taiwan Strait than on the eastern side (ETS side) with the 25-30m isobath which likely marks the boundary of their distribution being further offshore.
- THREATS: main threats are bycatch, habitat degradation, reduction of freshwater to the Jiulong River estuary, increasing pollution, prey reduction and noise. Some JRE dolphins were also killed recently by blasting during coastal construction activities (Wang et al., 2003).

2.2.3 Note on lack of data

Although the JRE dolphins' distribution near Xiamen, PRC has been studied, their distribution in the adjacent waters of the Chinmen islands and further east are completely unknown and were not surveyed by Chen et al. (2008) due to political border issues. Not enough is known about this population to estimate what proportion of dolphins in this small population will be impacted but it is clear that some will be impacted and with such a small population size, even minimal disturbance can have a large impact on the population.

Note on other provisional populations of *Sousa chinensis* along the coast of China:

Far less is known about *Sousa chinensis* in other regions so the impact on these dolphins can not be estimated. However, given the proposed trackline which meets the mainland Chinese coast perpendicularly and closest near the area of Xiamen/Chinmen Islands and near Pingtan (where records of *Sousa chinensis* also exist – see Wang, 1999; Zhou, 2004), dolphins of these coastal waters would be expected to be impacted most.

2.2.5 Summary for populations of Indo-Pacific humpback dolphins in the EEZs of Taiwan and China:

The proposed tracklines for the LDEO survey

a) overlap completely with the distribution of the ETS population, and

b) are directly in line with the heart of the JRE population's distribution at their closest approach to the mainland Chinese coast

The tracklines proposed have the maximum possible impact on these two very small populations, one of which is listed critically endangered, while the other has an even lower abundance.

Given the confirmed critically endangered status of the ETS population and the small population size of the JRE provisional population, a higher level of precaution must be given to avoid negative impacts of human activities on these dolphins. Until the affects of seismic surveys on these shallow water dolphins and in the context of the cumulative impacts of all threats already present can be better understood, a 'safe' exposure level cannot be estimated as all contributions have the potential to be the 'final straw'.

2.2.6 Threats of lower noise levels

Even lower thresholds of exposure than those discussed above may increase the risks to these dolphins by altering dolphin behaviour. Increasing ambient noise levels that can 'mask' biologically important sounds as well as sounds that allow the detection of other threats (e.g., the sound of water flowing past gillnets, approaching boats, etc.).

2.2.7 Reviewer's recommendations for mitigation for *Sousa chinensis*

It is recommended that activities that would increase the risk of extinction of these populations, including physiological and behavioural impacts, not be permitted.

2.3 Beaked Whales, Ziphiidae

2.3.1 Potential threat of LDEO seismic surveys

- The tracklines of proposed seismic survey overlap much of the waters that are known or suspected to be important habitat for beaked whales.
- Waters along the edge of the continental shelf (especially where the strong Kuroshio Current meets the shelf edge) are particularly productive and appear to attract cetaceans, including beaked whales.
- Tracklines that run near and parallel to the edge of the continental shelf around Taiwan will have the greatest impact on cetaceans, being particularly damaging to beaked whales.

2.3.2 Background on beaked whales in SE Asian waters

- Beaked whales are given level two protection under the Wildlife Conservation Act of Taiwan and are listed under CITES Appendix II
- Three species of beaked whales occurring in this area are listed as "data deficient" in the IUCN Red List while Cuvier's beaked whale is 'least concern'.
- Threats to beaked whales in Taiwanese waters include large-mesh pelagic driftnet entanglement (Perrin et al., 2005), direct hunting, vessel collisions (large volume of commercial shipping occurs all around Taiwan) and noise from vessels, live-fire military exercises, naval sonar and seismic surveys (research and commercial).

- Four species of three genera of beaked whales are known from Taiwanese waters:
    - Cuvier's beaked whale (*Ziphius cavirostris*),
    - Longman's beaked whale (*Indopacetus pacificus*),
    - Blainville's beaked whale (*Mesoplodon densirostris*) and
    - ginkgo-toothed beaked whale (*Mesoplodon ginkgodens*);
- Taiwan qualifies as a 'key area' for beaked whales based on the criteria of MacLeod and Mitchell (2006).
- Abundance: Almost nothing is known about the abundance of any species of beaked whales in SE Asian waters; however, recent systematic surveys of the waters of SE Taiwan (J.Y. Wang, unpublished data) revealed much higher beaked whale sightings per unit effort than in Hawaiian waters (Baird et al., 2006), a recognized beaked whale 'key area' (MacLeod and Mitchell, 2006). Beaked whales have been recorded in the waters off the entire eastern coast of Taiwan and strandings have also been recorded in SW Taiwan and several places along western Taiwan (see Wang et al., 1995; Wang, 1999; Zhou, 2004; Wang and Yang, 2006; Yang et al., 2007).
- Although the waters off western Taiwan are usually considered shallow and not the preferred habitat of beaked whales, in NW and SW Taiwan, adjacent deep water is present.
- Of note, *M. ginkgodens* has not been observed alive at sea and <25 specimens are known (see MacLeod et al., 2006).
- There are at least 10 (likely more) stranding and catch records of this species from Taiwan (J.Y. Wang, unpublished data) since the early 1990s.
- Recent surveys off SE Taiwan resulted in multiple sightings (and many photographs) of an unknown species of mesoplodont, which almost certainly was *M. ginkgodens* (the only other species recorded from this region is *M. densirostris*, which clearly was not the species observed). It was the most frequently encountered species in the waters surveyed (J.Y. Wang, unpublished data) and probably not as rare as once believed.
- There is evidence that at least some species of beaked whales exhibit strong site fidelity (e.g., Gowans et al., 2000; McSweeney et al., 2007)

2.3.3 Note on military exercises in waters near Taiwan and unusual stranding events

Military exercises of all forms and by many nations are common in and around Taiwanese waters and recently the Taiwan navy purchased four US-made Kidd-class destroyers that possess the 53-C mid-frequency active sonar, which has been implicated in the mortality of beaked whales in the Bahamas (Balcomb and Claridge, 2001; Evans and England, 2001). The waters around Taiwan are also one of the few places in the world where the US Navy can use their powerful low frequency active (LFA) sonar.

In 2004 and 2005, unusual multiple stranding events of several deep-diving species were recorded (Wang and Yang, 2006; Yang et al., 2008). Shattered tympanic bones and massive injuries to internal structures associated with diving and acoustics were reported for a *M. ginkdogens* that stranded in SW Taiwan (Wang and Yang, 2006). Yang et al. (2008) also reported finding "bubble

lesions" in two beaked whale carcasses that stranded in NE Taiwan.

2.3.4 Need for cetacean surveys before seismic surveys

- Clearly, all tracklines over or near the shelf edge will likely impact many cetaceans. However, without more cetacean survey information, it is uncertain if
  a) just moving tracklines away from the shelf edge would be effective in reducing impacts on beaked whales; or
  b) if the relocation of tracklines would harm different species in waters further offshore.
- Recent multiple sightings of *M. ginkgodens* during dedicated cetacean surveys of waters off SE Taiwan demonstrate the importance of such studies.
- Cetacean surveys in the waters off SW Taiwan where the important deep Penghu Channel exists are limited. This channel has a steep eastern wall that borders against the SW shores of Taiwan and helps to funnel a branch of the Kuroshio Current or the South China Sea Current to the northern tip of the channel ending in an important area of complex seasonal mixing with the cold China Coastal Current (Jan et al., 2002).

2.3.5 Reviewer's recommendations

- Systematic cetacean surveys of the waters of the Penghu Channel are needed before seismic surveys are conducted, to help reduce the impact on beaked whales and other cetaceans.
- Cetacean surveys are needed in the waters off eastern Taiwan (particularly in waters beyond 20km from shore where almost no cetacean survey effort exists) to determine if and what concentrations of beaked whales exist.

2.4 Sperm Whale, *Physeter macrocephalus*

2.4.1 Background on sperm whales in Taiwanese waters

- STATUS: This species is given the highest level of legislative protection by the Wildlife Conservation Act of Taiwan and is listed under CITES Appendix I
- The sperm whale is listed as "vulnerable" in the IUCN Red List
- DATA: Little is known about the sperm whales in Taiwanese waters.
- ABUNDANCE: The population size is unknown
- DISTRIBUTION: It is the most frequently sighted large cetacean in Taiwanese waters and is not 'uncommon' as stated in table 2 of the Federal Register notice. Most sightings occur in eastern Taiwanese waters (they have been observed along most of eastern Taiwan) but strandings have also occurred along the shores of the Taiwan Strait. Past whaling indicates that the deeper waters off SW Taiwan were also inhabited by sperm whales and sightings are still reported by fishermen.
- THREATS: Sperm whales in Taiwanese waters are threatened by the same human activities that harm beaked whales (see above) with the possible exception of direct hunting.

2.5 Finless Porpoises, *Neophocaena* spp.

2.5.1 Potential threat from LDEO seismic surveys

- During the period of proposed seismic surveys, many female finless porpoises in the region will be accompanied by neonatal calves. These will be most vulnerable individuals as they will be less able to maintain swimming speeds that will allow them to escape the range of the airguns.

2.5.2 Background on finless porpoises

- STATUS: The species is given the highest level of legislative protection by the Wildlife Conservation Act of Taiwan and is listed under CITES Appendix I. Finless porpoises are listed as "vulnerable" in the IUCN Red List but some populations are being threatened more seriously (e.g., the Yangtze River population is listed as 'endangered')
- There is recent evidence that more than one species exists (Wang et al., 2008b)
- ABUNDANCE: the population size is unknown but as a group, finless porpoises are probably the most abundant coastal cetaceans

2.5.3 Comments on detection by MMVOs as mitigation measure

- This is one of the most difficult species to detect at sea even in calm conditions because of its small size, lack of dorsal fin, brief surface time and usually occurring individually or in small groups. Depending on the behaviour of the animal, it can be near impossible to detect.
- Jefferson et al. (2002) reported that during calm sighting conditions, finless porpoises were observed primarily within 300m from the trackline (perpendicular distance) and none were observed beyond about 700m.
- In low light conditions or even slight seas, detecting finless porpoises is challenging even for researchers experienced with the species.
- MMVOs will be ineffective at detecting animals within the predicted distance where exposure in shallow waters can be greater than 190dB.

2.5.4 Comments on PAM as mitigation measure

- In shallow water, PAM is unlikely to be effective in detecting finless porpoises.
- Finless porpoises are not always vocalizing and the high frequency sounds produced by finless porpoises attenuate quickly.

2.5.5 Swimming speed

- Finless porpoises are generally slow-swimmers but are capable of high-speed bursts.
- However, it is unlikely that such speeds can be maintained for more than a few minutes.

2.6 Other Odontocetes

2.6.1 Melon-headed whale

Recent mass strandings of melon-headed whales (*Peponocephala electra*) may have been related to the use of naval sonar (Hawaiian waters) and seismic surveys (Madagascan waters) so there is

concern about the potential impact such activities may have on this species as well. Melon-headed whales, although not a commonly-observed species, have been sighted on several occasions in the waters of eastern Taiwan and SW Taiwan and harpoon captures and two mass stranding events have been recorded from NE Taiwan and western and southern Taiwan, respectively (Wang et al., 2001a).

2.6.2 Short-finned pilot whale

Although the short-finned pilot whale (*Globicephala macrorhynchus*) has not been a species of concern in other parts of the world, four unusual stranding events (with two being mass strandings) involving short-finned pilot whales occurred at several places in and near Taiwan over a short period and coincided spatially (accounting for the direction and strength of local currents) and temporally with large-scale military exercises in the region (Wang and Yang, 2006).

2.6.3 Deep diving cetaceans

Deep diving cetaceans such as Risso's dolphins (*Grampus griseus*), dwarf and pygmy sperm whales (*Kogia sima* and *K. breviceps*, respectively) are also species of concern. Risso's dolphins are very common in all waters off eastern Taiwan (Yang et al., 1999; Wang et al., 2001b; Chen, 2001; Yeh, 2001) and SW Taiwan (Huang, 1996) and appear to be concentrated along and near the steep slope of the continental shelf. Dwarf sperm whales are also seen quite often at sea (Wang et al., 2001b) and appear to have a similar distribution to Risso's dolphins. Nothing is known about the distribution of the pygmy sperm whale in Taiwanese waters as none have ever been seen at sea; the only records are from strandings but comparisons of stomach contents of both *Kogia* spp., Wang et al., (2002) suggested the pygmy sperm whale had a more offshore distribution than that of the dwarf sperm whale. Many *Kogia* (both species) were involved in unusual mass stranding events of multiple species in Taiwan that were linked to intense energy sources (Wang and Yang, 2006; Yang et al., 2008).

Very little is known about most cetacean species in SE Asia. Studies in other regions suggest that some populations of species such as the false (*Pseudorca crassidens*) and pygmy killer (*Feresa attenuata*) whales, common bottlenose dolphin (*Tursiops truncatus*) and spinner dolphin (*Stenella longirostris*) may comprise small isolated groups that are associated with oceanic islands (see Karczmarski et al., 2005; Baird et al., 2008a,b; Baird et al., in press; McSweeney et al., in press).The conditions along eastern Taiwan may have similar characteristics (i.e., oligotrophic waters with considerable nutrient input from land sources and is distant from other such sources of nutrients) that encourages such populations with high site fidelity. Small isolated populations are more vulnerable to local extirpation. These species have been seen throughout the waters of eastern Taiwan and parts of the Taiwan Strait but nothing is known about population structuring of these species in Taiwanese and nearby waters. Several mass stranding events of pygmy killer whales have occurred in SW Taiwan and at least one individual exhibited internal haemorrhage deep in the melon (Wang and Yang, 2006).

3. Threats to particular species and populations - mysticetes

3.1 Background

Little is known about baleen whales in this region. The western gray (*Eschrichtius robustus*), north Pacific right (*Eubalaena japonica*) and western north Pacific blue (*Balaenoptera musculus*) whales have been depleted to such low numbers that their future is precarious. The humpback whale (*Megaptera novaeangliae*) in the western north Pacific is also not as numerous as before commercial whaling with at least one wintering population (southern Taiwan) being extirpated and a small population that over-winter in the northern waters of the Philippines, particularly the Babuyan Islands. Little is known about the other species that have been recorded from these waters: minke whale (*Balaenoptera acutorostrata*), sei whale (*Balaenoptera borealis*), fin whale (*Balaenoptera physalus*), Bryde's whale (*Balaenoptera brydei*)and the newly described Omura's whale (*Balaenoptera omurai*).

3.2 Western Gray Whale, *Eschrichtius robustus*

3.2.1 Potential threat of LDEO seismic surveys

- The proposed L-DEO surveys from March 21 to July 14, which overlaps with the period during which western gray whales are expected to be either in their wintering grounds or are undergoing their northward migration through the Taiwan Strait, are an additional threat to these highly threatened gray whales. The shallow water preference of gray whales also increases the distance greatly for exposure thresholds. Even the take of a few individuals is projected to cause a continuing decline in the population towards extinction (Cooke et al., 2006).

3.2.2 Background

- STATUS: This species is given the highest level of legislative protection by the Wildlife Conservation Act of Taiwan, is listed under CITES Appendix I, and is listed as "critically endangered" under the IUCN Red List
- ABUNDANCE: ~100 individuals (Cooke et al., 2006)
- DISTRIBUION: Generally found in fairly shallow (i.e., continental shelf) waters
- summers in the Okhotsk Sea (mainly off northeastern Sakhalin Island), off eastern Kamchatka, Russia (Weller et al., 1999); wintering grounds (yet undiscovered) are believed to be somewhere in the waters of southern China, possibly around Hainan Island (northern part of the South China Sea) (Wang, 1984). Migration between summering and wintering grounds is unknown but records exist along more or less the entire Chinese coast (Omura, 1988; Zhu and Yue, 1998) so is likely through the Taiwan Strait; migration likely occurs as with other baleen whales during the spring (northwards) and autumn/winter (southwards) periods.
- THREATS: The western Gray whale faces many threats including: direct hunting, incidental mortality caused by fishing gear, coastal industrialization and shipping and activities associated with oil and gas development (for a review, see Weller et al., 2002).

3.2.3 Reviewer's recommendations

- Only with more dedicated cetacean surveys of the region's waters can this population be better understood. Better coverage of the region's waters by cetacean surveys can also allow fine tuning of spatial and temporal avoidance of gray whales by seismic surveys.
- Simple strategic scheduling of seismic surveys can eliminate or at least greatly reduce the impacts on this population.

North Pacific Right Whale, *Eubalaena japonica*

3.3.1 Background

- STATUS: This species is given the highest level of legislative protection by the Wildlife Conservation Act of Taiwan and is listed under CITES Appendix I, and is listed as "endangered" in the IUCN Red List.
- ABUNDANCE: No more than a few hundred
- DISTRIBUTION: The distribution of this species is unknown, especially the wintering grounds where calving and nursing occurs; the wintering grounds may be as far south as the East China Sea.
- NOTES: Very little is known of the species.

3.4 Western North Pacific Blue Whale, *Balaenoptera musculus*

3.4.1 Potential threat of LDEO seismic surveys

- If small numbers of western north Pacific blue whales still exist in the region's waters, seismic surveys can have a large impact on the few remaining individuals (even if only a very few whales are disturbed).

3.4.2 Background

- STATUS: The species is given the highest level of legislative protection by the Wildlife Conservation Act of Taiwan, is listed under CITES Appendix I; the blue whale is listed as "endangered" in the IUCN Red List. The north Pacific stock was listed as 'lower risk/conservation dependent' by the 1996 IUCN Red List based mainly on the numbers and evidence of increase from a small part of the stock's distribution (i.e., in Californian waters); a reassessment of this stock using the revised criteria (version 3.1) is needed as the 'lower risk/conservation dependent' category no longer exists and the western north Pacific stock should probably be assessed as a separate entity. There is evidence that supports the western north Pacific stock of blue whales being separate from blue whales elsewhere (for review, see NMFS, 1998).
- ABUNDANCE: The population size is unknown but none has been seen in recent times from Taiwan to southern Japan where hunting once occurred (Clapham et al., 2008); this suggests that the population maybe greatly depleted or possibly extirpated (see NMFS, 1998; Clapham et al., 2008).

3.5 Western North Pacific Humpback Whale, *Megaptera novaeangliae*

3.5.1 Potential threat of LDEO seismic surveys:

The timing of the L-DEO surveys overlaps greatly in space and time with the whales wintering in the Babuyan Islands and coincides spatially and temporally with the northward migration of mothers with neonatal and other young calves from the calving/nursing grounds of the Babuyan waters.

3.5.2 Background

- STATUS: This species is given the highest level of legislative protection by the Wildlife Conservation Act of Taiwan and is listed under CITES Appendix I. Although the humpback whale is listed as "least concern" in the IUCN Red List (mainly because many populations have recovered greatly from past commercial whaling), there are still great concerns about some stocks of humpback whales, including the western North Pacific stock which has shown no signs of recovery contrasting greatly with the eastern North Pacific stock.
- ABUNDANCE: The population size for the western North Pacific is estimated to be about 1000 (Calambokidis et al., 2008), which is low and does not indicate recovery from past hunting.
- DISTRIBUTION: There are several wintering populations of humpback whales in the north Pacific Ocean. One population found in the waters of southern Taiwan was decimated (Darling and Mori, 1993) and almost certainly extinct as there have been no sightings of the species in these waters in recent years (Wang and Yang, 2007) even though past records show whales were observable from shore and the waters are fairly extensively utilized by fishing boats presently. Another small wintering population was recently discovered in the waters of the Babuyan Islands in the northern Philippines (Yaptinchay, 1999; Acebes et al., 2007). The sightings data indicates that the humpback whales are present in Babuyan waters from November to May/June but peaking from February to March/April (Acebes et al., 2007). These waters are a calving and nursing area. Records of humpback whales exist for the waters of almost the entire eastern Taiwan and a few records also exist for the Taiwan Strait. At least for some individuals, migration between summering and wintering grounds is through Taiwanese waters, mainly along the east coast of Taiwan (=Philippine Sea) but also some records from the shallow waters of the Taiwan Strait also exist (J.Y. Wang, unpublished data). Records of humpback whales exist for the waters of almost the entire east coast of Taiwan.
- THREATS: Mother-calf pairs of humpback whales appear to be more sensitive to loud noises and have reacted to impulsive noise levels of as low as 140dB (McCauley et al., 2000). The wintering population of the Babuyan Islands is small and vulnerable to threats faced by the whales along their migration route. Incidental mortality of whales in net fisheries along the east coast of Taiwan has been recorded. In the waters of both the west and east coasts of Taiwan, the volume of commercial shipping is a threat to whales because of increased risks of vessel collisions, oil and chemical spills and increased noise. The additional threat of loud noises from seismic surveys has the potential to mask other important sounds or displace humpback whales from their migration routes, which in turn, may increase the risk of other threats (e.g., increase

entanglement as a result of a reduced ability to detect nets in the water; increased vessel collisions because of reduced ability to detect and avoid approaching vessels; movement into waters with a larger amount of net fisheries, etc.). The lack of recovery, the extirpation of the southern Taiwan wintering population and the small size of the Babuyan population are indicative of the need for better protection from impacts caused by human activities.

3.5.3 Reviewer's recommendations

- Better coverage of the region's waters by cetacean surveys can also allow fine tuning of spatial and temporal avoidance of humpback whales by seismic surveys.
- Simple strategic scheduling of seismic surveys can eliminate or at least greatly reduce the impacts on this population.

3.6 Other mysticetes

3.6.1 Background

- STATUS: All other baleen whales species are given the highest level of legislative protection under the Wildlife Conservation Act of Taiwan and listed under CITES Appendix I. Both the sei (*Balaenoptera borealis*) and fin (*B. physalus*) whales are listed as 'endangered' under the IUCN Red List. Little is known of both species in this region but it is believed that a distinct population of fin whales exists in the East China Sea (Fujino, 1960). The common minke whale (*B. acutorostrata*) is under the 'least concern' category of the IUCN Red List. However, the 'J-stock', which inhabits waters that include the East China Sea, is believed to be distinct from other minke whales (evidenced by a reproductive cycle that is out of phase with the others) and has been reduced by >50% by whaling (Reeves et al., 2003). The J-stock of minke whales continues to be hunted or caught by nets by Japanese and Korean whalers/fishermen and is of conservation concern. Furthermore, bycatch of minke whales appear to be common in Chinese waters but this has not been quantified. Although both Omura's (*B. omurai*) and Bryde's (*B. brydei*) whales are listed as 'data deficient' by the IUCN Red List, considerable confusion with regards to taxonomy and nomenclature remains amongst whales that resemble the Bryde's whale. Very little is known about the biology of these whales in the region including how many species exists.
- ABUNDANCE: An estimate of 137 was reported for the East China Sea stock (IWC, 1996). These whales were also captured in Taiwanese waters but none have been seen in recent years. Bryde's whales of the East China Sea stock may have been depleted by whaling (Omura, 1977).

4. Regions of Particular Importance

4.1 Western Taiwan (inshore of about 5km)

- There are three main coastal small cetaceans that inhabit these waters:
  - the endemic and critically endangered ETS population of humpback dolphin
  - Indo-Pacific bottlenose dolphin and the

- finless porpoise.

- Only the waters inshore of about 5km have been surveyed extensively. Most of the Taiwan Strait remains unstudied for cetaceans.
- These waters are effectively a large river delta that is formed by complex of many river systems and are highly productive as there is considerable nutrient input from several of the largest river systems in Taiwan. These coastal waters comprise many estuaries, wetlands, salt marshes, mangrove forests and extensive mud flat areas (resulting from large tidal fluctuations). Intrusions of the warm, clear oceanic waters of the Kuroshio Current also occur fairly regularly.

4.2 Southwestern Taiwan and the Penghu Archipelago

- The Penghu Channel and adjacent waters are important structures that funnel both the South China Sea and strong Kuroshio currents into a narrow area where an important productive upwelling results between the Penghu Islands and Taiwan's west coast.
- There are reports of oceanic cetaceans along and near the steep walls/shelf edge of the channel (Huang, 1996) and deep-diving cetaceans are known to exist in an around the mouth (southern portion) of the Penghu Channel where deeper water exists (as evidenced by past sperm whale whaling records).
- The waters around the Penghu Islands are rich in marine diversity and have substantial coral reefs. There are important fishing grounds to the north and east of the islands that are likely due to the complex bathymetry and mixing of water in this region (Jan et al., 2002).

4.3 Southern Taiwan

- There is great complexity in ocean bathymetry in southern Taiwan and a
- great diversity of cetacean species (>20 species) have been found (see Wang et al., 2001b).
- Wang et al. (2001) also found that the highest occurrence of cetaceans occurred in April and June (the proposed seismic surveys span these months).
- Several sensitive species have been recorded in these waters: Cuvier's beaked whale,Longman's beaked whale (although reported as 'tropical bottlenose whale' in Wang et al. (2001b)), ginkgo-toothed beaked whale, sperm whale, humpback whale (migrants), other baleen whales, dwarf sperm whale, short-finned pilot whale, melon-headed whale, Risso's dolphin and Indo-Pacific bottlenose dolphin.

4.4 Southeastern Taiwan

- This region is mainly occupied by oceanic and deep-diving species (Yeh, 2001; J.Y. Wang, unpublished data). There are minimal shelf waters and the edge of the shelf is very close to shore. The bathymetry is very complex with three small oceanic islands being located more than 30km from Taiwan: Green Island, Orchid Island and Little Orchid Island.

Green and Orchid islands are inhabited and there have been several reports of beaked whale strandings.

- There is a deep water canyon between Green Island and Orchid Island and several upwelling areas between Green Island and Taiwan that is the result of the Kuroshio Current flowing past areas where the water depth decreases quickly. These upwelling areas are important waters for local fisheries targeting large oceanic fish. These islands, being in the path of the Kuroshio Current, also generate areas where deeper water is brought to the surface.
- Recent surveys of some of waters showed high diversity of cetaceans but relatively low abundance of each. Of note is that all four beaked whale species known from Taiwan have been recorded from these waters. There are also frequent sightings of large whales (sperm and humpback). Other oceanic species such as pygmy killer, false killer and killer whales, short-finned pilot whale, dwarf sperm whale, Risso's dolphin, common bottlenose dolphin, striped dolphin, Fraser's dolphin, spinner dolphin and pantropical dolphin have also been recorded.
- In these waters, bycatch mortality by large-mesh, pelagic driftnets are suspected to be very large, on the order of several thousand cetaceans per year and >100 beaked whales per year maybe captured (Perrin et al., 2005).

4.5 Central Eastern Taiwan

- This region has a very narrow shelf so the shelf edge is very close to shore.
- Large concentrations of cetaceans are found along and near the edge of the shelf (Yang et al., 1999) and are the targets of one of the fastest growing cetacean-based tourism industries in the world. Cetaceans are easy to find quickly (with little search effort) and marine conditions during the summer tourism season are generally calm. Although delphinids comprise the main species observed, beaked, sperm and baleen whales have also been reported from these waters. Humpback whales have been recorded migrating through these waters in both spring and autumn.
- As in SE Taiwan, large-mesh pelagic driftnets are abundant and there is a sizeable bycatch.

4.6 Northeastern Taiwan

- This is the only region along eastern Taiwan where the continental shelf is more than a narrow sliver. The bathymetry is complex with a geo-thermally active oceanic island being located <10km from Taiwan.
- An important upwelling exists in NE Taiwan and is the site of a major fishing ground where large purse-seine boats are used to catch schooling fish such as scads and mackerel, which are also consumed by several cetaceans.
- A large cetacean-based tourism industry exists and focuses mainly on spinner dolphins. However, 11 species have been recorded from these waters (Chen, 2001) including the

long-beaked common dolphin (Delphinus capensis), which has only been recorded from these waters thus far. Most of the species observed were delphinids but sperm whales and *Kogia* were also recorded. Of the delphinids observed, the short-finned pilot and pygmy killer whales are suspected to be impacted most by intense noise generated by activities such as seismic surveys.

- There is still a fairly substantial but illegal take of cetaceans by the hand-harpoon fishery, which should be targeting large pelagic fish and fisheries bycatch (especially in purse-seines and entanglement in longlines) are suspected to be considerable as well.
- With the exception of some inshore (<5km from shore) waters, no marine mammal surveys have been conducted in the waters of northern and northwestern Taiwan. The limited surveys of inshore waters in NW Taiwan revealed a single sighting of Indo-Pacific bottlenose dolphins. However, strandings and near strandings of many species have been recorded from the shores of NW and N Taiwan. There are anecdotal reports that a feeding area for baleen whales exists in the waters off northern Taiwan but there is no information to confirm these reports and it is unknown if it still exists. Research on the cetaceans in these waters is needed.

5. Concerns regarding timing of the proposed seismic surveys

5.1 Survey dates and locations

- 21 March to 19 April: seismic surveys will be conducted mainly in the South China Sea.
- 20 April to 07 June: the *Langseth* will survey the waters of the Luzon Strait and Philippine Sea.
- 21 June to 14 July: seismic surveys of the waters around Taiwan will be conducted.

5.2 Concerns:

5.2.1 Western gray whale

- The route(s) and months when western gray whales may undertake their migration from a suspected wintering ground(s) in the South China Sea are unknown. However, it is likely that the period for the migration is in the spring.
- Scheduling the seismic surveys in the South China Sea to be conducted in March and April will likely coincide with at least some migrating gray whales.
- L-DEO did not address this possibility and have not proposed any mitigation measures to avoid this likely overlap of seismic surveys and migrating gray whales.

5.2.2 Humpback whale

- The schedule for surveying the Luzon Strait and the Philippine Sea overlaps completely with the period when humpback whales are still in the area (and includes the latter portion of the peak period (April) for humpback whale concentrations in the Babuyan Islands). Therefore it is unclear how the timing of the surveys reduces the impacts on humpback whales as claimed by L-DEO.

- A large proportion of this population of humpback whales will also be migrating through the Philippine Sea to northern waters at the same time as the proposed surveys Although the exact migratory routes of most humpback whales are unknown, it is clear that at least some will follow a path that is parallel and fairly close to the shores of eastern Taiwan. One of the proposed survey tracklines of the *Langseth* also follows this course.
- Many females undertaking the migration at this time will also be accompanied by neonatal calves and these are the most sensitive individuals of the population (McCauley et al., 2000).

5.2.3 Calving/nursing (general)

- Calving for most cetacean species in this region is likely in the spring to early summer as evidenced by sightings of many females with young calves during cetacean surveys that have been conducted in Taiwan and the examination of hundreds of carcasses (J.Y. Wang, unpublished data).
- The proposed survey schedule overlaps greatly with the calving seasons of many species or will occur as females are accompanied by and nursing young calves.
- This proposed period for the seismic surveys is probably the worst choice of seasons if minimizing the impacts of this activity on marine mammals in this region is a sincere goal.

5.2.4 Timing (ETS humpback dolphins and general)

- The ETS population of humpback dolphins is found in the coastal waters western Taiwan throughout the year. Seismic surveys in June and July (as well as any other time of the year) will have a serious impact on this critically endangered population. Given their year-round residency, there is no season that will reduce the serious impacts of seismic surveys in inshore waters on this population.
- In June and July, large numbers of cetaceans are found along and near the shelf edge of eastern Taiwan. Conducting seismic surveys close to the shores of Taiwan risks greatly impacting on these cetaceans.

6. Concerns regarding particular mitigation measures

The mitigation measures proposed by L-DEO would be ineffective or have limited effectiveness at best; below is a list of concerns regarding these mitigation measures:

6.1 Timing (delay)

- The claim is that surveys will be delayed as late as possible to avoid humpback whales, But the timing of the surveys overlap the presence of humpback whales greatly and during a time when newborn calves will be accompanying mothers. The surveys will also occur during or near the calving season for most species in the region; this is when females and calves are the most vulnerable

  The Federal Register notice states that *"The Langseth will attempt to avoid these wintering*

areas at the time of peak occurrence, by surveying the lines near the Ryuku Island and Babuyan Islands as late as possible during each leg of the cruise."

- Given that the entire period of the proposed survey overlaps with humpback whale concentrations in the Babuyan Islands and during the migration period, there is no attempt to avoid this area, and surveying the lines near the Ryuku and Babuyan islands as late as possible within the scheduled period of the surveys does nothing but delay the impact on the animals to a slightly later period because the whales will still be in the area. As such, this measure does not mitigate anything.

6.2 Distance offshore (ETS humpback dolphins)

- The critically endangered ETS population of humpback dolphins will be subjected to >>180dB received levels even if mitigation measures are taken (i.e., to remain offshore of 2km from shore).
- Even if the mitigation measures proposed by L-DEO are fully implemented, there will likely be 'level A harassment' to the ETS population that could have serious and likely irreversible impacts on this population.
- Based on the tabled predicted RMS distances for different received levels and accepting the recommendations of the ETSSTAWG (see above) for this population that for noise issues an additional (i.e., additional to the 3km-from-shore distribution that is known presently for the ETS population) 2km buffer should be considered, the *Langseth* should not be within 13 km of western coast of Taiwan to avoid exposing dolphins to >160dB levels.
- However, the model underestimates the actual levels at different distances.
- Further compounding the underestimation of levels is the fact that the shallow water category is <100m but the ETS population lives in waters less than 25m. Much better predicted RMS distances for different received levels are needed for very shallow waters.

The Federal Register notice states that *"Due to the conservation status of the Indo-Pacific humpback dolphins in Taiwan Strait, seismic operations will not occur in water depths less than 20m and within at least 2 km from the Taiwanese shore. Also, when possible, seismic surveying will only take place at least 8-10km from the Taiwanese coast (approximately from Taixi to Tongshiao), to minimize the potential exposing these threatened dolphins to SPLs greater than 160dB re 1 μPa (rms)."*

- Being 2km from shore puts the *Langseth* in the middle of the distribution of the ETS population and does absolutely nothing to reduce the exposure level to any dolphin.
- The only reduction of noise is possibly with the statement that surveying will only take place 8-10km from shore but the condition of "when possible" is not acceptable because this can be a subjective determination by someone not concerned about the impacts on critically endangered populations of cetaceans.

- Furthermore, as discussed above, 8-10km from shore still may not be sufficient to reduce exposure of the animals to >160dB and the distribution for the ETS population is further south than Taixi (Wang et al., 2007b). Chou (2006) also believes that some of the waters south of Taixi are an important breeding/nursing area for the ETS population.
- These mitigation measures are not effective and still poses unacceptable risks to the dolphins of being exposed to >180dB.

NMFS states that: *"Cetaceans need to be closer than between 950 and 3694m (depending on conditions) to the source to be exposed to levels that can cause PTS (180dB)."*

- The proposed seismic surveys will expose almost the entire ETS population of humpback dolphins to levels >180dB.

NMFS states that: *"Cetaceans need to be closer than between 6000 and 8000m (depending on conditions) to be exposed to levels that may cause TTS (160dB)."*

- As such, all or almost all ETS humpback dolphins will be exposed to >160dB levels even if the *Langseth* remains 8-10km from shore.

6.3 MMVOs

- Based on the table of predicted RMS distances for different received levels, MMVOs may be completely ineffective for detecting small cetaceans in shallow coastal waters because the distance from source will be great even for the 190dB received level (1600 to 2182m); for 180dB, the distances can be 2761 to 3694m from source and for 160dB, the distances are 6227 to 8000m.
- Again, these distances must be considered underestimates because the coastal waters of western Taiwan in which some cetaceans inhabit are much shallower than 100m (e.g., the critically endangered ETS humpback dolphins are in waters from 1.5 to 25m deep; finless porpoises and Indo-Pacific bottlenose dolphins are often commonly observed in waters shallower than about 50m).
- Finless porpoises are difficult to detect even if they are within several hundred metres and sighting is during excellent conditions and by experienced observers (note: excellent weather conditions for sighting cetaceans in the waters around most of Taiwan, especially western Taiwan, are very limited).
- Nighttime visual detection of these coastal species is impossible at the distances shown above even with night-vision equipment.
- MMVOs have limited effectiveness in detecting many deep-diving species such as beaked whales and *Kogia* spp. These are all difficult species to observe and study by experienced researchers. Barlow (1999) reported that very few beaked whales are detected even in prime sighting conditions by cetacean researchers. Barlow and Gisiner (2006) estimated that less than 2% of the beaked whales are likely to be observed by typical mitigation monitoring

(this estimation did not account for observer experience, which will greatly affect detection).

- With such a low detection rate, other mitigation measures dependent upon detection and tracking will be compromised.
- None of the mitigation measures takes into account sighting conditions. This is important as several of the mitigation measures are dependent upon observers sighting marine mammals.

LDEO claims that "Marine mammal detection by MMVOs is high at the short distances from the source [the short distances are the ones mentioned earlier]."

- With the possible exception of 180dB at 950m for deep water, the distances mentioned above (especially for operations in shallow waters) are not short for sighting cetaceans (small or large). Detection of most species drops off beyond 1km from a ship. Even 25x binoculars may have limited use in a region with high humidity and smog in coastal regions (e.g., western Taiwan), which can reduce the clarity of high power optical aids.
- The detection of finless porpoises at distances beyond 1 km is poor. At 3694m, detection of small cetaceans is limited and maybe questionable (especially for finless porpoises) when sighting conditions are sub-optimal.
- In no way can the detection of small cetaceans in shallow water at distances of several kilometers be considered high.
- For beaked whales, only a small proportion of the animals are detected by experienced observers in good sighting conditions (Barlow, 1999). As such, beaked whale detection cannot be considered to be high either.
- Because detection of both shallow water small cetaceans and beaked whales were wrongly concluded to be high, take by injury or death cannot be dismissed and the potential for temporary or permanent hearing impairment is not low and (as discussed above) cannot be avoided by implementing the inadequate mitigation measures proposed.

6.4 PAM

- In shallow water, PAM would be almost completely ineffective at detecting (never mind locating or tracking) cetaceans especially at the predicted RMS distances for the different exposure levels (listed in bullet 3 above).
- Furthermore, PAM is only capable of detecting cetaceans when they are vocalizing. Some species have been known to reduce vocalizations during seismic surveys while other species do not vocalize much at or near the surface (e.g., beaked whales).
-

6.5 Shut down

- Shut down of 30 minutes was proposed. This is clearly not sufficient as several species of concern can stay submerged for more than an hour and remain undetected.

6.6 Ramp up

- There are uncertainties about the effectiveness of ramp-up procedures and no data was presented to show that this was indeed useful in reducing impacts

6.7 Additional concerns: masking; displacement; impact of any level of take on small or vulnerable populations; inappropriate use of data from other areas; impacts on prey; assumption that animals will move away from noise source; variability and uncertainty in TTS threshold information; and need for greater local consultation and research

In all cases, animals can face other issues related to loud noise sources.

6.7.1 Masking

- Masking of not only biologically important sounds but also masking of the noises made by threats, hindering detection of the threats and increasing the impact of the existing threats (e.g., water rushing past a gillnet, commercial shipping) and the chances of mortality.

6.7.2 Displacement

- The impacts on cetaceans due to displacement into other waters may not be trivial for populations with low numbers, restricted distributions and in areas where threats are abundant (e.g., large number of net fisheries).
- Displacement may increase energy expenditures by the animals already compromised energetically (such as mothers with calves, individuals that are thin due to interrupted feeding, etc.) and increase exposure to other threats (e.g., changes in migration routes may result in animals using waters with higher densities of fishing nets or lines and thus increase their risk of mortality due to entanglement). Mothers with calves are most vulnerable.

6.7.3 Impact of any level of take on small or vulnerable populations

- Several cetaceans are in critically low numbers that even minimal 'takes' can contribute greatly to the demise of these populations.
- Most of the values in Table 3 do not make any sense to those who have experience with local marine mammal populations in the region
- (e.g., the take of 64 Cuvier's beaked whales compared with 168 Blainville's beaked whales; a take of 189 killer whales compared with only 68 finless porpoises). These numbers are little better than random guesses.

The Federal Register notice states that: *"…the number of potential harassment takings is estimated to be small, less than a few percent of any of the estimated population sizes, and has been mitigated to the lowest level practicable through incorporation of the measures mentioned..."*

- This statement is incorrect. L-DEO estimated that 68.7% of the critically endangered ETS population of humpback dolphins will be impacted.
- Even although this is a serious underestimate (explained earlier), it is already a very high proportion of this distinct population and the mitigation measures proposed do not minimize the exposure level to these dolphins.
- The taking is also expected to include level A harassment rather than just level B as claimed by L-DEO.
- The taking (both level A and B) of such a large proportion of the ETS dolphins could have an irreversible impact on the continued survival of the population.

6.7.4 Inappropriate use of data from other areas

- The use of data from the Eastern Tropical Pacific for estimating the densities and number of individuals impacted by the proposed seismic survey is completely inappropriate as there is no evidence that the two sides of the Pacific Ocean are comparable. Such extrapolation would not be acceptable to most cetacean scientists. This should be re-examined carefully.

6.7.5 Potential impacts on prey (fish)

- The impact on the prey of coastal species such as the ETS population of humpback dolphins, finless porpoises and Indo-Pacific bottlenose dolphin are of concern. A large proportion of the diet of these species consists of sciaenids (croakers, drums, etc.) that are highly acoustic fish. How intense noise from seismic surveys will affect their prey is unknown.
- For the ETS population, this is of particular concern because there are already indications some dolphins are nutritionally stressed (J.Y. Wang, unpublished data).

6.7.6 Assumption that animals will move away from noise source

NMFS states that: *"Animals will move away from noise source that is annoying before it can potentially become injurious."*

This assumption is flawed for slow swimming species and those with restricted distributions.

- This is the case for the ETS population of humpback dolphins, which would be exposed to sound levels >180dB for many pulses and result in PTS
- Finless porpoises and Indo-Pacific bottlenose dolphins may also be as restricted in their movements.
- Furthermore, for cetaceans that inhabit the waters near or on the shelf edge, where the shelf edge is close to shore (e.g., waters of much of Taiwan), it is not clear that cetaceans fleeing an approaching seismic survey vessel will always choose to flee offshore. If an error is made and dolphins flee inshore, they will be trapped and be exposed for a much longer duration and potentially higher levels.

6.7.7 Variability and uncertainty in TTS threshold values

- Furthermore the TTS threshold is based on limited information from only a few species of cetaceans.
- Most of the species of concern (e.g., baleen whales, beaked whales, humpback dolphin, finless porpoises, etc.) have not been examined and there appears to be greatly variability amongst individual cetaceans tested so interspecific extrapolations need to be considered cautiously (for a review, see Weilgart, 2007).

6.7.8 General recommendation for greater local consultation and research

- Extensive consultation with experts on these regions and more studies to better understand the biology of cetaceans in this region can provide expert guidance to greatly reduce the impacts of the seismic surveys.

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