Recommendations of Marine Seismic Survey Regulatory Laws for the Oil and Gas Industry in Malaysia

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ABSTRACT

Malaysia's marine sector contributes a significant portion to the economic development of the country. The offshore petroleum industry has significant benefit to the economy, however, the downside of seismic exploration has left detrimental effects on marine mammals. In seeking the equilibrium between economic growth and ecological safeguard, Malaysia has to cope with stringent measures in seismic and geophysical exploration to abide with world standards in marine mammal conservation. Oil and gas seismic survey employs sound-producing seismic techniques and relies heavily on sound waves which penetrate through, and are reflected from, seabed structures prospecting for oil reserves. For discovering, evaluating and producing crude and gas, there are no realistic alternatives other than seismic exploration, however there may be other alternatives to further ameliorate the technical aspects of seismic survey and mitigation procedures. Scientific knowledge of the impacts of seismic sound has expanded significantly in the last two decades as the issue has gained public attention and research prioritization, however it is not practiced in Malaysia. This thesis intends to present information on seismic survey regulating guidelines to propose on the improvement to PETRONAS seismic geophysical exploration by examining critical International Laws / National Laws and Policies together with in-depth interviews with stakeholders from PETRONAS Dalak Project benefiting both PETRONAS and the community at large.

In this epistemological research, it was found that PETRONAS should demonstrate a regulatory approach that includes a prudent balance of prescriptive and performance-based regulations that are developed using the best practices of geophysical survey with international benchmarks while enhancing and continuously improving the petroleum industry's environmental performance towards marine mammal mitigation preparedness.

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ABBREVIATIONS

ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
ASEAN	Association of Southeast Asian Nations
ATOC	Acoustic Thermometry of Ocean Climate
BIMP-EAGA	Brunei-Indonesia-Malaysia-Philippines East ASEAN Growth Area
BOEMRE	Bureau of Ocean Energy Management, Regulation & Enforcement
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species
CTI	Coral Triangle Initiative
DCE	Offshore Seismic Surveys in Greenland
DOC	Department of Conservation, New Zealand
DOE	Department of Environment, Malaysia
DOF	Department of Fisheries, Malaysia
DWNP	Department of Wildlife and National Parks Peninsular Malaysia
ECO	Environment and Conservation Organisations, New Zealand
EEZ	Exclusive economic zone
EIA	Environmental Impact Assessment
ESA	Environmentally sensitive areas
EPA	Environment Protection Agency
EQA	Environmental Quality Act
GEF	Global Environment Facility
HELCOM	Baltic Marine Environment Protection Commission - Helsinki Commission
HSE	Health and Safety in Employment
IAGC	International Association of Geophysical Contractors
IUCN	International Union for Conservation of Nature

IOES	Institute of Ocean and Earth Sciences
JIP	Joint Industry Programme
JNCC	Joint Nature Conservation Committee
MEXCOE	Meeting of Ministers of the Environment (Malaysia)
MIMA	Maritime Institute of Malaysia
MMO	Marine mammal observer
MMPA	Marine Mammal Protection Act
MNS	Malaysian Nature Society
MOSTI	Malaysian Ministry of Science, Technology and Innovation
MPA	Marine Protected Area
MSFD	Marine strategy framework directive
NBC	National Biodiversity Council
NBR	National Biodiversity RoundTable
NBSAP	National Biodiversity Strategies and Action Plans
NEPA	National Environment Policy Act
NERC	Natural Environment and Rural Communities
NGO	Non-Governmental Organizations
NOAA	National Oceanic & Atmospheric Administration
NOD	National Oceanographic Directorate
NPBD	National Policy on Biodiversity Conservation
NPP	National Physical Plan
NPOA	Malaysian National Plan of Action
NRE	Ministry of Natural Resource and Environment
NSC	National Steering Committee
OGP	International Association of Oil and Gas Producers
OSPAR	Oslo and Paris Conventions
PAM	Passive Acoustic Monitoring
PCSB	PETRONAS Carigali Sdn Bhd
PEPANZ	Petroleum Exploration and Production Association of New Zealand
PETRONAS	Petroliam Nasional Berhad
RMA	Resource Management Act (New Zealand)

PSSE	Prime Scientific Sailing Expedition
SMRU	Sea Mammal Research Unit
SSC	State Steering Committee
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNMC	University of Nottingham Malaysian Campus
WHC	World Heritage Convention

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CHAPTER ONE – INTRODUCTION

1.1 Research background and problem area

Malaysia has one of the largest continental shelve and a distance of 200 nautical miles of the exclusive economic zone (EEZ), to a country which is ample in various marine resources, considering for the most part oil and gas reserves. The three business sectors in petroleum industry are the upstream, midstream and downstream activities. The upstream processes comprise of exploration, development and production of hydrocarbon resources, while the midstream and downstream processes extent from refining and processing through to marketing, transportation and trading of its by-products. These resources have fuelled the country's economic development and conduced about 20 percent of the Nations GDP. Malaysia aims by the year 2020, is to acquire a more diversified petroleum business sector to boost the nation's economic development (Maizatun et al., 2012).

Nevertheless, concordant to the ecological point of view, the constant concern over the adverse effects of seismic survey activities on the ocean environment that can occur at the upstream phases of exploration is the focus on this thesis.

For the upstream activities, referring to the phase in the industries from exploration to production, their environmental concerns are varied, which include negative biodiversity impressions from, noise pollution, oil spills accidents, and water contamination. For seismic survey activities, noise pollution is detrimental to marine environmental mainly to marine mammals and to their surrounding natural habitat itself (NPC, 2011).

With the constant growing concern of environmental deterioration due to the speedy economic growth (Mazlan, 2005), Malaysia need to seek and implement strategies that can accomplish an equilibrium amidst the fast development needs and the preservation of the ecology.

The setting and imposition of the EIA regulations is treated as the key towards to derogate the probable ecological impact. The strategies also is the answer for obtaining sustainable development through the equilibrium amongst economic growth and sustainable utilization of natural reserves (Maizatun et al., 2011).

The EIA studies are divided into two categories that is the Normal-EIA and Special-EIA[1].For the upstream activity, seismic survey extends beyond geographical boundaries, therefore falls in the order of Special EIA, where a comprehensive and elaborated assessment of the primary environmental issues and impacts are required to forge a suitable mitigation and perpetuate a consistent monitoring programme (EIA, 2007).

Ecological systems or natural life systems are among the most sensitive to environmental changes due to human interest through marine activities. Those changes may impact the species of ocean organism through alteration to their habitat and life support system. Malaysia has classified Natural systems as 'environmentally sensitive areas' or 'ESA' that include those that have been described in the National Physical Plan (NPP) as being of priority ranking in sensitivity for Malaysia. In the NPP, there are 'ecologically sensitive areas' which require protection due to their significant environmental contribution for preservation of species, which includes Marine life (EIA, 2007).

Areas identified as important sources of ocean life by the Department of Minerals and Geo-science represent ESA which should be refrained by hydrocarbon developments in view of the their high eco system pollution. Influence of noise and light which is the possible cause of Turtle to move elsewhere, are identified as ESA (EIA, 2010). Dugongs and Turtles are captured in the ESA, however there are other endangered species of marine

[1] Special EIA are conducted for projects having special magnitude and sensitivity regarding the environmental impacts which may extend beyond the geographical boundaries of the project site and/or can adversely affect the welfare of local communities.

mammals in Malaysia such as the fin whale and blue whale, as documented in the International Union for Conservation of Nature and Natural Resources, Red List not identified as critical marine species (IUCN, 2016).

1.1.1 Seismic sound and effects on marine mammal

Sound generated from offshore seismic exploration is acknowledged as a potential effect on marine life, such as fisheries, dolphins, dugongs and whales (NPC, 2011). Research shows cetaceans are the most affected group, as all species can produce and hear an extensive range of sounds and are very dependent on hearing ability for communication, navigation, and food location. Marine mammals embrace all species of cetaceans (whales, dolphins, and porpoises), carnivores (seals, sea otters, and polar bears), and sirenians (manatees and the dugong). Scientific studies of the possible effects of manmade ocean noise on cetaceans was initiated 47 years ago (Payne, 1971), however it has expanded significantly in the most recent two decades to review potential impacts include behavioural changes, masking, auditory injury, physical injury, stranding and other impacts (Richardson et al., 1995).

Malaysia consist of a diversity of marine mammal species and observations were organised during the 2009 Prime Scientific Sailing Expedition (PSSE) (Ponnampalam, 2012). The survey concluded a number of 27 sightings and comprised the spinner dolphin, bottlenose dolphin, pantropical spotted dolphin, unidentified dolphins, an unidentified species of whale and Dugong which is found around mainly in Sabah and in the Strait of Johor (Ponnampalam, 2012).

It is obvious that even though there is a growing body of knowledge illustrating the risks seismic surveys present to marine organism (Richardson et al., 1995), there is still little knowledge of these species that inhibit Malaysia waters and the negative influence anthropogenic noise can impact on them.

Australia, Brazil, Canada, Ireland, New Zealand, The United Kingdom and The United States are the only seven countries in the world that already have mitigation measures for seismic surveys with the intention to abate the effects of seismic blast on cetaceans. Even though there are no formal international 'watchdog' overseeing seismic survey activities, those seven nations participate in conferences that enable sharing of information for cetacean mitigation (North American Resource Development Study, 2011). These international guidelines will be discoursed in this thesis along with comparison case studies of international seismic mitigation procedures in comparison to an EIA seismic survey engagement carried through in an oil and gas project in Malaysia.

1.1.2 A brief background history of EIA in Malaysia

The history of EIA as a legal tool was enacted in 1970 when NEPA (National Environment Policy Act) came into effect in the USA, several nations around the followed suit and adopted the EIA systems (Alm, 1988).

In Malaysia, the Environmental Quality Act (EQA), a Federal Act in 1974 was enacted to ensure restriction, suspension, pollution control and enrichment of the environment, where Environmental Impact Assessment Order of 1987 was among the first subsidiary legislations enacted later in late eighties.

About six years later, the State of Sarawak appended another section to EIA history in Malaysia when the State Legislative Assembly ameliorated the Colonial Natural Resources Ordinance, 1949 to consider the "environment" to transform to the current Natural Resources and Environment Ordinance, 1993. Thenceforth, the State of Sabah became the second State in Malaysia to ordain its State law and named the Conservation of Environment Enactment, 1996 (Sentian, 2004).

Malaysia's EIA policy is derived from a government initiative which was outlined in Chapter XI of the Third Malaysia Plan 1976 -1980. These guidelines are drawn from the Fifth Malaysia Plan 1980 -1986. The Handbook of Environmental Impact Assessment Guidelines. (3rd Ed.) 1987 was the first outlines of relevant legislation (the Environmental Control Act of 1985) and gives a general introduction to EIA (Donnelly et al., 1998).

EIA is essentially a planning mechanism for preventing environmental problems due to human intervention. In Malaysia there are eight distinctive project proponents that requires Government approval so that it does not contravene with National plans, policies and future development. For the Oil and Gas project proponent and the EIA relating to noise pollution such as seismic survey, the DOE's "Guidelines for the sitting and zoning for industries" is used as a guideline. EIA review is the responsibility of the Department of the Environment (DOE) for preliminary assessments under the Ministry of Natural Resources and Environment (EIA, 2007).

1.1.3 PETRONAS

PETRONAS, short for Petroliam Nasional Berhad, is a Malaysian-owned petroleum company that was established on August 17, 1974. It is wholly Government owned, and the industry is empowered with the entire hydrocarbon resources in Malaysia in expanding and contributing economic value to these resources. PETRONAS is stratified amidst Fortune Global 500's most prominent industry in the world. Fortune rated PETRONAS as the 95th largest industry in the world in 2008, 80th largest in 2009 and 69th largest in 2014.It also places PETRONAS as the 13th most productive company in the world and the most lucrative in Asia. (Fortune 500, 2014).

Prior to the launching of PETRONAS in 1974, oil and gas in Sabah and Sarawak boomed in the 1960s with the breakthrough and growth of offshore fields. Shell was nevertheless exclusively operating in the region in 1963, when the Federation of Malaya, merged with Sabah

and Sarawak to become Malaysia. The regime in the two states maintained their links with Royal Dutch Shell, which contributed to Malaysia's first offshore oil field on-stream in 1968 (PETRONAS, 1984).

Meanwhile, the federal government moved to Esso, Continental Oil, and Mobil, licensing exploration off the state of Terengganu where the focus of federal power was until 1974, when Esso only endured. Malaysia scored its first breakthrough of natural gas in that same year and quickly made Terengganu a larger producer than Sarawak or Sabah. By the time PETRONAS came up in existence, four out of the nineteen crude oil fields that had been ascertained were bringing in yield of 90,000 to 99,000 BBD (Billion Barrels a Day). For comparison sake, by 2004 even with the declining reserves, national production was 750,000 BBD (Fred R. von der Mehden, 2007)

1.1.4 Marine seismic survey

Seismic surveys have been conducted out at sea for many decades in order to discover the geological physical composition that are associated with oil and gas deposits. High-energy sound sources are employed to launch echoes in the earth, which are then recorded and analysed to ascertain the geological composition. These good reverberations require accurate, recurring, brief length, high-energy pulses. In the beginning, these origins were explosive charge, using TNT or black powder. This activity has been ceased building upon to more rigorous safety ordinances and the reality that explosive device can cause physiological impairment to cetaceans (Greene, 1985). In contemporary years, many astute types of seismic source have substituted explosives in all instances and these include sparkers, boomers, vibroseis and airguns (Lugg, 1979). The most common sound sources currently used in Malaysia for petroleum seismic surveys are airgun arrays but there are no standards and these can vary in design and size and output characteristics.

1.1.5 Seismic surveys using airguns

This type of surveys uses high-intensity sound to image the earth's crust. It is the primary technique for finding and monitoring reserves of oil and natural gas. Seismic reflection profiling is used by academic and government groups to gather information on crustal structure, for the purpose of understanding the origin and tectonic history of the earth's crust (Dragoset, 1984).

Modern large-scale seismic surveys are supervised using towed arrays of "air-guns" in cylinders of compressed air. Each cylinder consist of a small volume (typically between I0 and I00 cubic inches) at a pressure of about 2000 psi. The array, usually containing some tens of such cylinders, is discharged simultaneously, to generate a pressure pulse which travels downwards into the sea bed (Greene, 1985). Some of this sound energy is discharged into the broader marine environment, however, the designers of air-gun arrays attempt to exploit the transmission of discharge into the sea bed, with the result that the energy dissipated into the broader environment is reduced. As a survey continue, the air-gun array is recharged with air from a compressor on board the towing vessel. The process is repeated at intervals of approximately ten seconds and the timing determine on the objectives of the survey (Weilgart, 2007).

Offshore oil and gas exploration and construction activities occur along continental margins. Currently active areas include northern Alaska and north-western Canada, eastern Canada, the U.S. and Mexican Gulf of Mexico, Venezuela, Brazil, West Africa, South Africa, North Sea, Middle East, north-western Australia, New Zealand, southern China, Vietnam, Malaysia, and Indonesia. New areas of exploration include the deep-water U.S. Gulf of Mexico and deep-water West Africa, both of which have seen activity in the past 5 to10 years (Hildebrand, 2009).

1.2 Problem statement

The oil and gas industry has significant benefaction to the economy, however, the downside can potentially affect marine biodiversity including cetaceans in various ways such as behavioural reactions; hearing loss, and even death.

An environmental footprint is a mathematical calculation of man-made activity altering the air, water or land within its vicinity. In the context of seismic survey, this is essentially adding noise pollution to the ocean affecting marine mammals.

Seismic survey is a high-tech driven technology that requires continuous improvement and high level of human discipline in relation to noise elimination and value addition in its administration and operational guidelines. In most countries, it is an activity hinged on government policies and regulations as well as international bodies and agencies. The problem with seismic noise regulation associated with Malaysian Environmental Impact Assessment is it's devoid in practice and ordinance.

It's a common ideology that this ordinance can be developed easily with the applicability of International seismic mitigation guidelines and transforming original technical fundamentals with some necessary adjustments for possible policy adaptation.

However, in reality a unique adaptation policy will be required to translate international seismic mitigation taking into account Aichi Biodiversity Targets, CITES (Convention on International Trade in Endangered Species), UNCLOS (United Nations Convention on the Law of the Sea), International treaties, and the Nations' very own Biodiversity 2016 Policy.

For seismic survey mitigation guidelines, it must be important to develop a coherent science-policy interface to lead decision making that would benefit from a reliable

evidence base and scientific insights. The underlying theory is in minimising acoustic damaged to marine mammals instead of resolving it entirely.

The scientific community must synthesise and relate scientific discoveries in an easily understood manner to related government agencies and seismic operators ensuring that policy formulation is evidence-based.

This interface between science and policy making will provide the opportunity to fully utilise the various tools identified within the policy to mainstream National Biodiversity NPBD 2016, giving hope for the integration of a seismic survey mitigation guideline in the near future.

The application of seismic scientific tools against marine mammal mitigation has not been capitalised yet for the integration into National Biodiversity policy related to marine noise pollution. Malaysia's seismic survey regulations can be implemented with timely and substantial scientific based decision making.

Due to varying levels of socio-economic, political development and common problems regarding government bureaucracy and environmental regulations problems, it is important to recognise that various stakeholders have differing capacities to contribute in conservation effort towards Malaysian marine mammals. In order for this to conduce, the Government has plans to facilitate numerous biodiversity-related repositories throughout the country and will be coordinated and linked, enabling easy access to information. (Goal 5, NPBD, 2016).

Critical questions rising up of this discourse that are important for this study are:

- ✓ What existing environmental and regulatory framework are used during seismic survey to protect marine mammals in offshore seismic operations by PETRONAS?
- ✓ What are the government environmental policies that can be implemented for seismic survey guidelines in Malaysia?
- ✓ What are the ideal application of seismic scientific tools for marine mammal mitigation in PETRONAS?

1.3 Aim & objectives

The aim of this research is to conduct an exploratory case study on PETRONAS DALAK PROJECT and propose a framework for seismic survey mitigation guideline for marine mammals that PETRONAS can successfully implement in the EIA towards future oil and gas geophysical survey operations. To achieve this aim, the objectives of the research are as follows:

- To ascertain whether application of prescriptive and performance methods, tools and techniques for seismic survey implementation framework and concept can actually be implemented in *PETRONAS Technical Specification* **(PTS)** for *Health, Safety, Security and Environment* **(HSSE)**, *Environmental Impact Assessment* (**EIA**) planning mechanism.
- To compare and analyse various international seismic guidelines, tools and techniques for proposed inclusion into the PTS.
- To examine the government environmental policies for marine noise pollution that can be implemented for seismic survey in the EIA planning mechanism of PETRONAS.

1.4 Thrust and motivation for the research

Seismic methods will remain to be the primary geophysical tool used to discover, evaluate and enable responsible production of fossil fuel but further technological enhancement can constitute current internationally practiced mitigation methods.

Seismic noise is already acknowledged as a negative cognitive factor for marine mammal populations, where these technology and resource development in cetacean mitigation has matured in the developed Nations. Therefore the motivation for implementation of mitigation of risk to cetaceans and continuous improvement in this area in Malaysia is deemed pertinent now.

Scientific understanding of conditions in the Environmental Sensitive Area (ESA) along the coastal habitats and in areas for petroleum exploration must be enhanced to fit the outlook of NPBD 2016 for the Marine Protected Areas (MPA).

For a balanced and perfected process of cetacean protection from seismic noise pollution, there must be an oversight in offshore geo survey and guidelines must be formulated by PETRONAS. Since in Malaysia, seismic survey mitigation is not incorporated yet into the EIA, it is pertinent that PETRONAS HSE involves on risk management for seismic survey, while DOE will mitigate on risk assessment.

The mitigation procedure and technologies that will be formulated to minimize marine mammal impacts would allow prudent development of oil and gas resources consistent with government objectives of NPBD biodiversity protection, National economic growth, and the National Physical Plan (NPP).

The emphasis on sustainable seismic operations involves several technology and policy regulation that must be considered in the **PETRONAS Technical Specification (PTS) for**

Health, Safety, Security and Environment (HSSE), Environmental Impact Assessment (EIA) planning mechanism.

1.5 Significant of the study

1.5.1 Seven Core Topics in Environment Impact for offshore petroleum industry

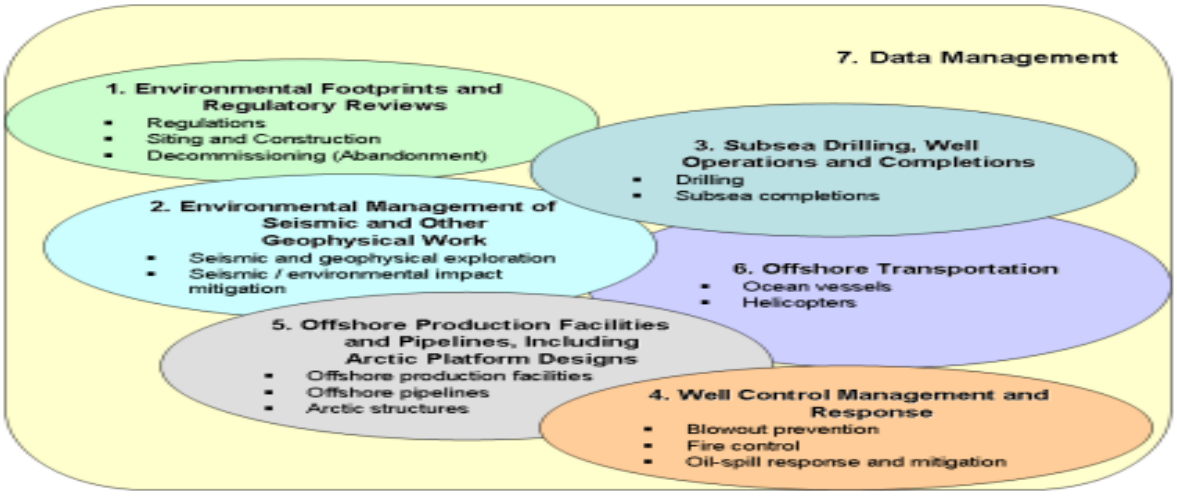


Chart 1: Core Topics in Environment Impact for offshore petroleum industry Source: National Petroleum Council, 2011

Presently there are seven core topics (Chart 1) in the overall environmental impact and concerns for the offshore oil and gas industry. They encompass the four development phases in the petroleum industry which comprise of

(a) Pre-Development Phase (Exploration);

(b) Development Phase (Design and Construction);

(c) Production Phase (Operations);

(d) De-Commissioning Phase (NPC, 2011)

The specific context of this research is centred on the *Pre-development phase* and the *3 Core topics of the pre development phase* which are;

1. Environmental footprint and regulatory reviews (Green)

2. Environmental management of seismic work (Blue)

3. Information (Data) Management (Yellow)

CHAPTER TWO– LITERATURE REVIEW ON SEISMIC SURVEY

2.1 History and background information on anthropogenic noise in marine environment

Sound is a form of energy that occurs naturally in the ocean. It is also introduced intentionally into the oceans through human activities as waves through water, air, or any other motion of fluid particles (Richardson et al., 1995)

For marine seismologists, acoustical oceanographers and minerals explorers, sound is the most potent remote-sensing device obtainable to compute the geo structure of the seabed to unearth fossil fuel reserves deep under the seafloor. Organisations have harvested significant intellectual and sensible benefits from these activities, including engineering science and bottom mapping sonars contributing to the breakthrough of significant offshore oil reserves. (NRC, 2003)

Scientists and the society are also conscious about that sound is a primary means by which plenty marine life discover about their environment. The same sound is also the principle medium of navigating, transmitting, and breeding for most species of marine mammals and fish. The first research of the impacts of anthropogenic noise on ocean environment was conducted in 1971 (Payne, 1971). The study of sounds of cetaceans contributes perceptive into important aspects of their biology. While researchers had been aware for certain period of time about the sounds produced by marine life, after the launching of Acoustic Thermometry of Ocean Climate (ATOC) project (Baggeroer et al., 1998), in which high-intensity, low-frequency noise were broadcast over long ranges, that the public's scrutiny centred on the potential effects of human-generated noise on cetaceans, although noise with potential impacts had been governed since the enactment of the Marine Mammal Protection Act in 1972. From then on, nearly all sources of human-generated

noise came under acute investigation as potential threats to the survival and wellness of marine mammals (NCBI, 2014).

In essence, sound and sound detection would evidently play vital parts of the lives of cetaceans. All cetaceans employ sound for fundamental interaction amongst social unit of their species. But equally important is the idea that probably all of these genus use sound to study in connection with their environment and to survive (Fay et al., 2000). Hence, there should be worry not only about the effects of manmade noise on interaction but also about the influence on general determination of information in the environment (NRC, 2003).

An essential debate is whether the impact of manmade sound on cetaceans and the marine biodiversity is adequately huge to create worry by both the scientific community and the public. The most used framework of the ambient element of ocean noise probably to be the Wenz curves developed by (Wenz, 1962).

The specific hypotheses on the consequences of noise-induced hearing impairment on cetaceans have been depicted and the experiments have revealed that

(1) The noise need not be painful to cause permanent loss;

(2) The impairment is roughly relative to noise energy integrated over time;

(3) high-frequency noise is more dangerous than low-frequency noise;

(4) Narrowband noise is more dangerous than broadband noise; and

(5) There is large intersubjective resistance to noise, even amidst hereditary animals (Liberman, 2001).

Essentially, the impact of noise on the mammal is determined to a degree on the proximity of the mammal to the source and the received degree of the discharge by the mammal. At

close ranges, a loud source may induce serious physical impairment and possible death (NRC, 2003). At farther distance, geometric progression dispersion and sorption cut down the frequency level considerably and may cause hearing impairment and short-term behavioural changes, which can contribute to death under particular circumstances (Evans et al., 2001).

2.2 Technical summary on anthropogenic noise from seismic survey

The quantitative assertion of the acoustic pressure wave to which a mammal is endangered is acquired through the use of the sonar equation (Urick, 1975). Particularly, the received acoustic level (RL) from a source with source level (SL) is given by

$$RL = SL - TL + AG, \qquad (1\text{-}1)$$

Where TL is the transmission loss from source to receiver and AG is the processing gain affiliated with the mammal's signal detection system. All of the elements of the sonar equation are conveyed in decibels (dB). These are relative to the logarithms of the matching linear values. The decibel is utilised largely for convenience, since the individual elements of the equation may span a broad dynamic range. The logarithmic is also used for expressing multiplicative processes in terms of seemingly simpler additive operations. In addition, a logarithmic scale is typically used for sound levels because human perception of loudness increases logarithmically. The decibel is naturally a relative quantity, that is

$$RL\ (dB) = 20 \log^{10} (\text{measured pressure} / \text{reference pressure})$$

$$= 10 \log^{10} (\text{measured pressure} / \text{reference pressure})^{2} \qquad (1\text{-}2)$$

Where the reference pressure level used in underwater acoustics is 1 μ Pa. The SL is determined as the pressure at a unit range, generally 1 m, from the source, while the TL

depicts all of the geometrical scattering and attenuating results of the medium associated with propagation, scattering, and absorption as the signal travels from a position 1 m from the discharge to the position of the mammal. While the AG represents the improvement of the received signal that can occur through the diligence of signal-processing techniques and perhaps multiple sensors in the receiving system. Combining all of these terms, the capacity of the mammal to sense the signal can be interpreted in terms of the animal's hearing sensitivity, that is, the minimum perceptible value of RL, which conveys its lower limit threshold for audible level as a function of frequency (Figure 1) (Wartzok et al., 1999)

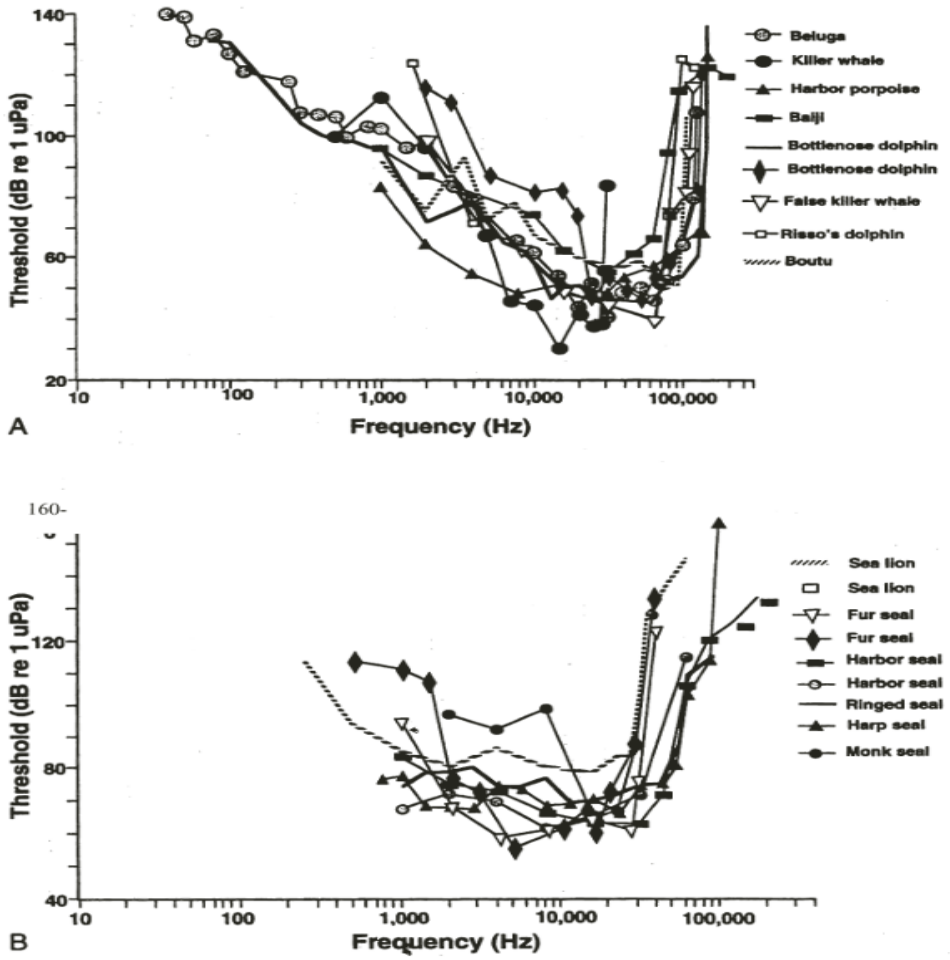


Figure 1: Cetacean hearing sensitivity. Sources: Richardson et al., (1995).

In the ocean environment, an additional term must be introduced into the sonar equation, namely an ocean noise term (NL), which is defined with respect to the same reference pressure and frequency bandwidth as SL and RL . The real surplus signal level (SE) ready to permit signal detection and translating of the signal is given by

$$SE = RL – NL = SL – TL + AG – NL \qquad (1\text{-}3)$$

The animal will be permitted to hear and respond to a signal of a particular frequency only if SE is greater than zero. In other words, in the absence of human noise, the ocean is very quiet for them and they seem to have adapted to the natural noise that surrounds them.

Transmission loss in Equations 1-1 and 1-3 is a complicated function of the source and receiver geometry, frequency, and environmental parameters of the water column and the seabed (Brekhovskikh et al., 1991).

Overall, transmission loss with raising source-receiver threshold is overshadowed by two important effects. Firstly, the sound velocity in the ocean is not fixed but changes with both depth and range; the simple spherical spreading loss model related with a point source in free space is immediately altered. Sound waves interact with both the moving sea surface and the seabed, which is a complicated multi-layered structure that supports acoustic waves. All of these factors combine to generate a channel, for the sound waves that are trapped amongst the top and the lower shoal water or concentrated by the sound speed structure in Deep Ocean as they spread outward from transmitter to receiver. This channelling impressions causes the shape of the frequency to disperse cylindrically, instead of spherically, outbound at distance much larger than the waveguide thickness, D. Secondly, the inherent soaking up attributes of ocean water induce the sound wave to be

even more weakened by high temperature, viscidity, and molecular losses (Medwin et al., 1998). As a result, the transmission loss can be expressed generally as:

TL (dB re 1 m) = 20log 10 r + α r, when r < D (1-4)

TL (dB re 1 m) = 10log 10 r + 10log 10 D + α r – 3, when r > D, (1-5)

Where r is the horizontal distance between transmission and receiver (in m), and the absorption coefficient α (in dB/m) is roughly relative to the square of the frequency (Figure 2) with the shock of absorption shown for an idealized case. Equations 1-4 and 1-5 are justified only for omnidirectional, single-point sources; the vector distribution for other types of transmitters (such as vertical source arrays) may be significantly different.

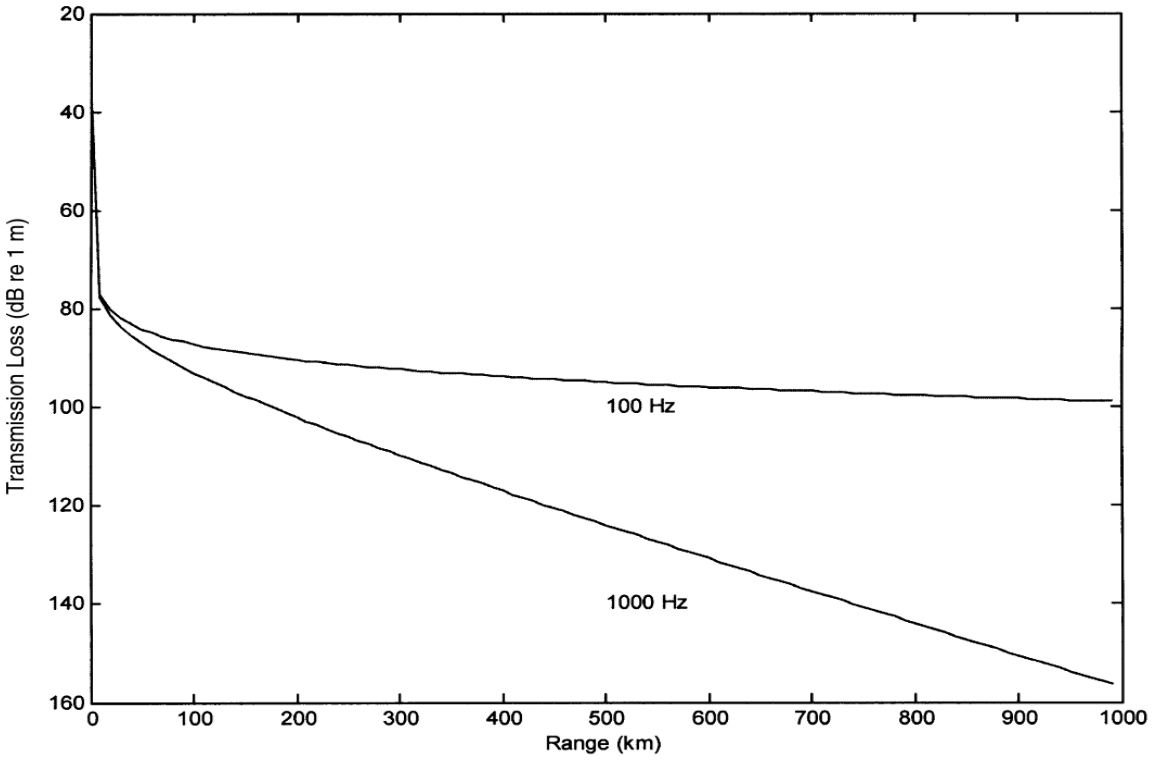


Figure 2: Transmission loss expressed in range and receiver. Source: Frisk, 1994

The major source of naturally occurring noise across the frequencies from

1 Hz to 100 kHz is affiliated with ocean surface waves generated by the wind acting on the sea surface. Nonlinear contacts amongst sea surface waves called microseisms are the prevailing factor below 5 Hz, although thermic noise which are the pressure variations consociated with the thermal excitement of the sea substance itself, is the main exponent factor above 100 kHz. Natural biological sound sources make a noticeable contribution at given times of year, for instance, a frequency about 20 Hz produced by baleen whales is frequently passing in deep sea noise spectra. Groups of whistling and echo locating dolphins can also raise the threshold level while snapping shrimp can raise noise levels from a few kilohertz to above 100 kHz. (NRC, 2003). Figure 3 shows frequency relationship between marine animal sounds and human noise source.

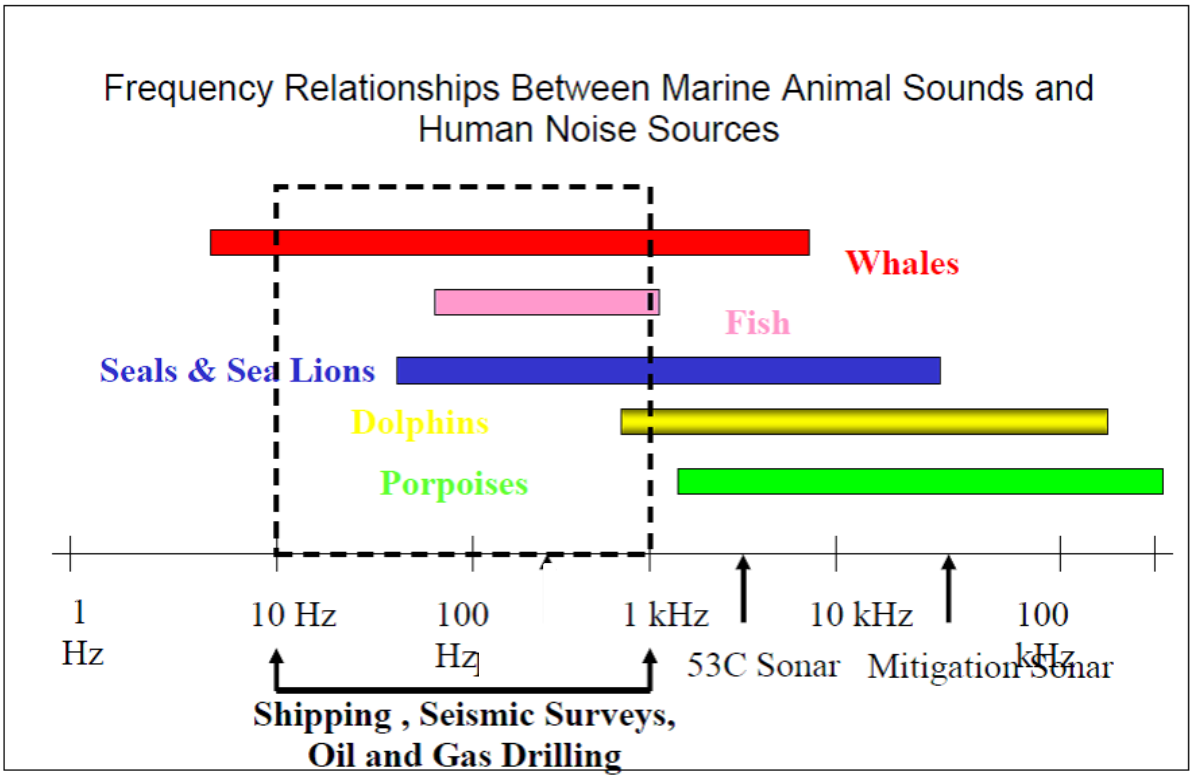


Figure 3: Frequency relationship between marine animal sounds and human noise source. Source: Southall, 2004

2.3 Acoustic injury in cetaceans

Figure 4 illustrates sound intensity in comparison to various noise conditions. Sound moves more effective than light in the sea, therefore many cetaceans, employ sound instead of light to acquire information about their environment (Urick, 1984).

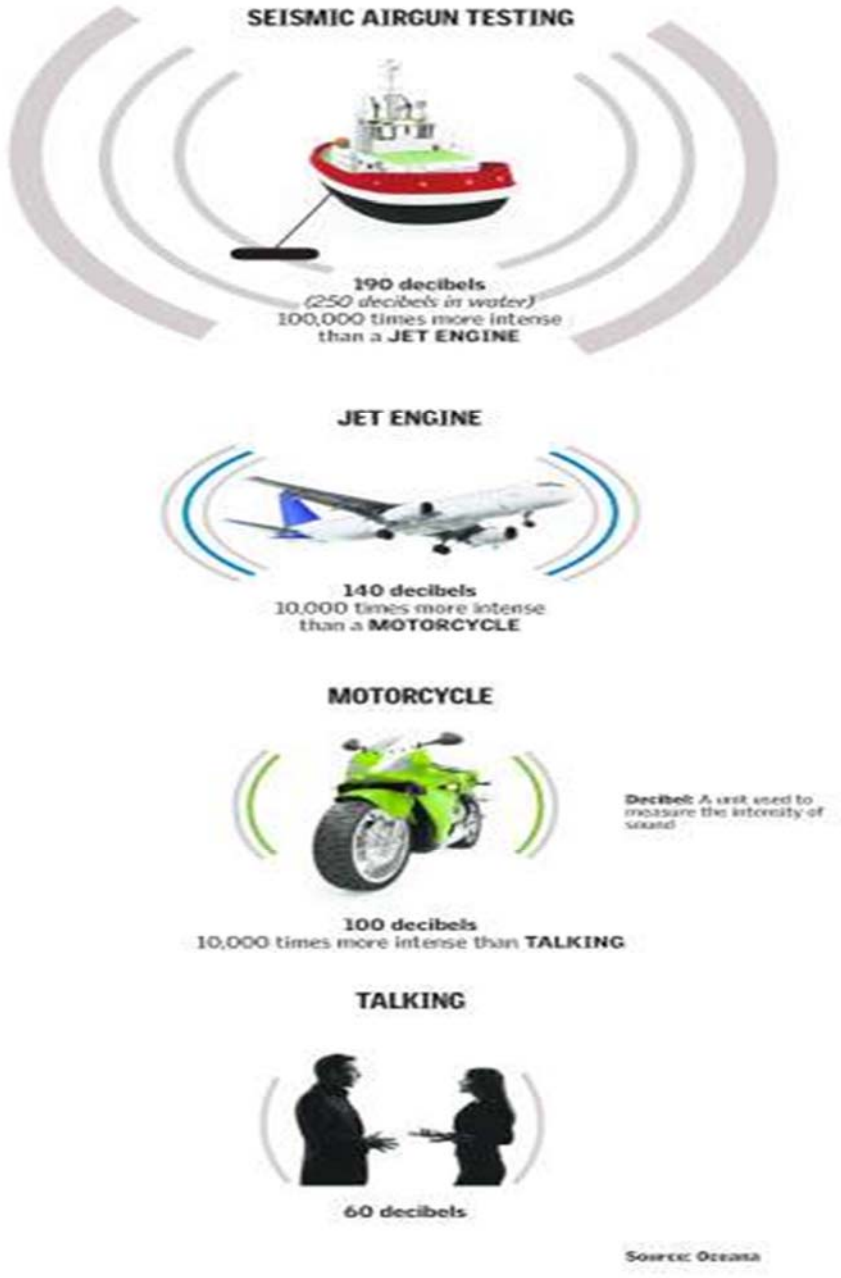


Figure 4: With the force of an explosive charge that's 100,000 times more intense than a jet engine, seismic airgun surveys shoot compressed air every one to twelve seconds, twenty four hours a day for up to weeks on end. Source: Oceana, 2014.

Two independent studies to date that had investigated the physical strain reaction to noise in captive marine mammals. One was conducted by Thomas et al., (1990), who exposed four confined beluga whales (Delphinapterus leucas) to replays of oil production noise but detected no alterations in blood adrenaline and noradrenaline (stress hormones) levels evaluated instantly after replays. The second was Romano et al. (2004) who exposed confined bottlenose dolphins (Tursiops truncatus) to sounds from a seismic air gun for

1s, a 3 kHz pure pulse outburst and observed detrimental changes in hormones in the blood. There seemed to be substantial impingement to seismic blast as compared to drilling.

Beak whales were constantly exposed by a new symptom, consisting of intensive fat and gas bubble emboli, and collection of injures most comparable to decompression sickness in divers (Fernández et al., 2005). Beaked whales have always mass-stranded a few hours to days after naval manoeuvres engaged in midrange frequency sonar exercise (Hildebrand, 2005). A beaked whale workshop was held on April 13-16, 2004, in Baltimore, Maryland to explore subjects pertaining to the health risk of beaked whales associated with seismic blast. Thirty-one scientists participated in a process that included several presentations describing the most current facts presented on the topic. The discussions at the workshop supports the assumption that beaked whales have unique characteristics that appear to make them especially vulnerable to seismic sources, including naval sonars and seismic activities (Advisory Committee on Acoustic Impacts on Marine Mammals, 2004).

2.4 Long term impacts of anthropogenic noise on cetaceans

Most studies conducted have looked at only short term impacts of seismic blast on cetaceans. Repetitive transient behavioural changes of cetaceans have the prospective of

inducing accumulative tension. Even transient behavioural changes due to seismic survey is believed to have caused mother-offspring pairs to be separated and lead to death of the young (NRC, 2003). Pups have known to be trampled by adults speedily imparting to a disturbance often hurt or even killed. The major permeating outcomes of seismic noise on cetaceans, is the decrease in a mammal's cognition to sense relevant sounds in the proximity of other sounds, also known as masking. Long-term effects of masking causes the heaviest impact on cetaceans. This long-term effects of seismic blast can include the transformation of temporary threshold shift (TTS) to permanent threshold shift (PTS) and an increase in occurrence of pathological stress. Stress can induce secretion of corticotrophin releasing factor (CRF) from the hypothalamus. The CRF promotes the discharge of glucocorticoids and catecholamines, which modulate the immune reaction and can cause alterations in the response to infectious, neoplastic, allergic, inflammatory, and autoimmune diseases (Webster et al., 1977). Chronic stress can also suppress reproduction (Rabin et al., 1988), suppress development (Diegez et al., 1988), and change metabolic process (Mizrock, 1995). Selye, recognized effects of chronic stress of the adrenal cortex and medulla that was the hypertrophy and hyperplasia (Selye, 1973). Harbour porpoises that died of chronic causes were more probable to exhibit adrenocortical hyperplasia than were ones that died of acute causes (Kuiken et al., 1993). Geraci researched mass-stranding of Atlantic white sided dolphins which died of stress related exposure had adrenal cysts in post biopsy. (Geraci et al., 1978).

2.4.1 Stranding cases in Malaysia

A pygmy sperm whale record was based on newspaper reports with clearly identifiable photos of an adult female whale stranded in Terengganu in 2009, the pantropical spotted dolphin on a stranding on Langkawi Island in 2007, while the record of the striped dolphin was based on a stranding in Kedah in 2010 (Ponnampalam, 2012). In Sabah, new species records are the blue

whale (*B. musculus*), which, based on newspaper reports with clearly identifiable photos and online videos, had stranded in Kota Kinabalu in 2006, and rough-toothed dolphins (*Steno bredanensis*), which were photographed by divers off Layang-Layang Island in 2010 (Minton et al., 2011).

2.4.2 Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS)

Auditory threshold shifts (hearing loss) can be either temporary (TTS) or permanent (PTS). Marine mammal TTS data have formed the basis for regulation of impulsive sounds in Germany and the USA (Lucke et al., 2009). Noise pollution under certain circumstances can affect the non-auditory systems including the vestibular and nervous systems, which able to cause physical harm to tissues and organs, and lead to concussion, cavitation, and stress. Prolonged stress caused by noise pollution can cause health problems (Erbe, 2013).

Figure 5: Potential zones of bioacoustic impact around a noise source (red star). Source: Centre for Marine science and technology, Curtin University, Perth, Western Australia, 2013

Most discussed effects discussed in the previous sections might be related, since TTS affects audibility of a signal and thus alters the normal behavioural response of an animal

(Figure 5). Furthermore noise received by a diving animal might induce stress leading to a flight response which causes it to surface rapidly resulting in decompression sickness or injury (Cox et al., 2006).

Potentially, seismic blast can have impacts on cetaceans at so many levels, from short-term impacts on individuals to long term effects on populations and even species mortality rate. A decline in foraging rate, may correspond to a year's holdup in reaching sexual maturate leading to lower life span which could make the difference between extinction and survival for cetacean species (Ocean Noise and Marine Mammals, 2003). While there are so much legislation and scientific work focusing on conservation goals, it is also important to recognize that the well-being and welfare of individual marine mammal is also a concern for many members of the public and harassment of any individual marine mammal is prohibited by the Marine Mammal Protection Act (MMPA, Federal Cooperation With States 16 U.S.C. 1379, 2007)

2.5 Anthropogenic noise from various contributors

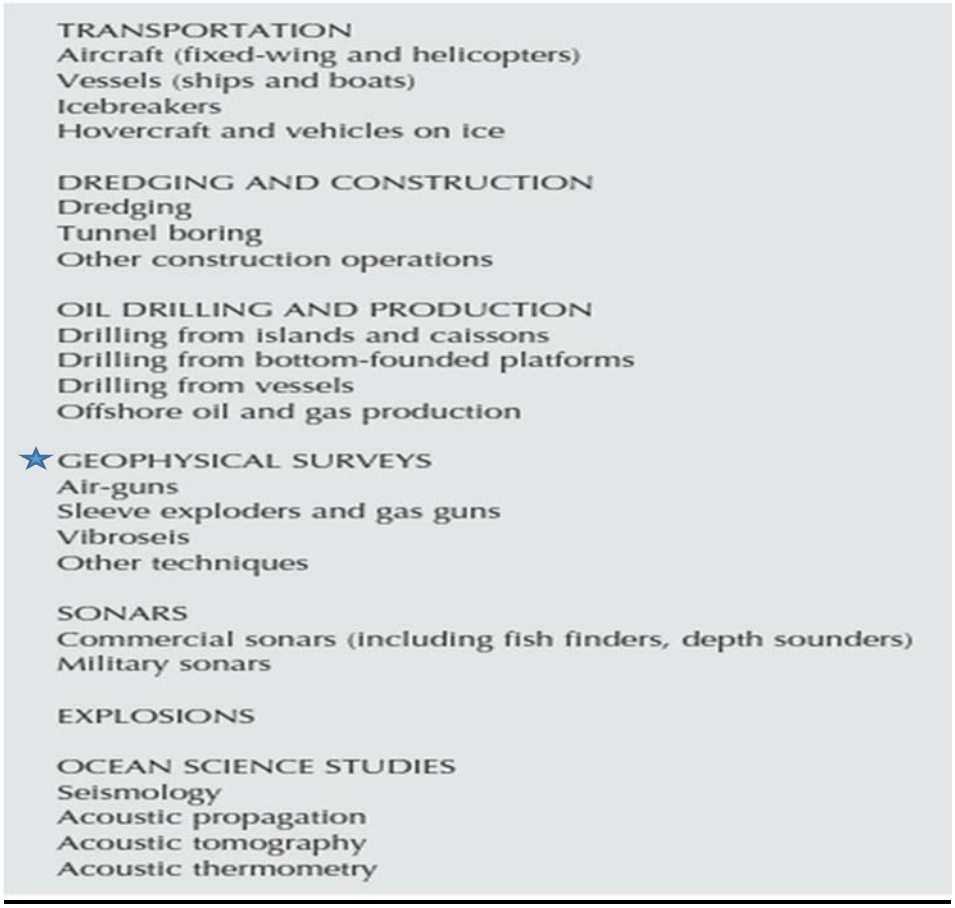


Table 1: Source of anthropogenic noise in the ocean. Source: Richardson et al., 1995. Courtesy of Academic Press. Star denotes subject area of discussion for this study from overall group of anthropogenic noise contributors

Marine anthropogenic noise is man-made noise pollution or excessive noise that may harm the activity of marine life (Hildebrand et al., 2005). Table 1 depicts anthropogenic noise from various sources of contributors in the ocean with reference to directionality, probability and frequency of activity level. Table 2 is explicit reference to various noise contributors showing signal structure, spectral bandwidth and source intensity.

Seismic blast in the ocean is an indispensable element of marine pollution. In seismic survey, frequency blast is a widely used tool for a wide range of marine activities. In

discovery for oil and gas reserves, the structure underlying the seabed is distinguished by using air-guns resonance (National Academy of Sciences, 2003).

Table 3 shows characteristics of ocean noise contributors to marine environment showing signal structure, spectral bandwidth and source intensity. Airgun produce a low frequency impulsive sounds at intervals of 10–15s, with broadband source levels of 220–255dB at 1m (Richardson et al., 1991). The common frequencies of seismic blast range within the 0–120Hz, although the levels of higher-frequency pulse up to 20 kHz can also be discharged by the transmitter. This frequencies coincide with those exerted by baleen whales (10Hz–1 kHz), with the same frequency factor also extending with the frequency range used by many odontocetes (10–150kHz) (Goold, 1998).

Compton explains that these seismic blast causes damaging impacts upon cetaceans from agitation that lead to deracination from foraging and reproduction habitat, to hearing impairment and eventual death (Compton et al., 2008).

SOURCE	SPATIAL VARIABILITY			DIRECTIONALITY	ACTIVITY LEVELS	
	Large Scale Ocean Basin to Global	Mid Scale 10s of km to Ocean Basin	Small Scale <1 km to 10s of km		Number of Regional Sources	Frequency of Activity in Region
Shipping	**Presence is global for all types and limited to the ocean surface**					
Merchant	Shipping lanes transcend ocean basins and are populated continuously				1-2	4-5/hr
Utility		Operations are confined to subocean basins and localized areas such as fishing grounds		All shipping: Generally considerd to be omnidirectional, but shielding is certainly present in the horizontal plane, especially for the higher frequencies; omnidirectional in the vertical plane.	1-30	daily
Military		Operations are military exercises, war zones	Extending down to amphibious assault zones, beach heads		6-10	bi-monthly
Scientific		Specific sites to observe phenomena of limited spatial scales	Down to localized phenomena such as "black smokers"		1-2	monthly
Recreation			Coastal regions, limited range		>10	>5/day
Other	E.g., transoceanic cable laying	Localized operations	E.g., drill site			>monthly
Seismic exploration		Surveys to >100 km	Down to 10s of km	Omnidirectional	1	monthly
Sonars	**Global presence, but variability is defined by sonar use**					
Military						
Surveillance	Ocean basin use	Down to 10s of km		Omnidirectional	1	monthly
Tactical		10s of km and up, conditions permitting		Horizontal plane, Vertical >100°, Vertical plane <20°	2-3	See host platform data above
Weapon/ Counter Weapon			10 m to >10 km	Highly directional in both planes (<5°)	1-2	
Civilian						
Communications		10s of km and up	Down to >1 km	Horizontal plane: omni Vertical plane: <10°	1	

Table 2: Characteristics of anthropogenic contributors to marine noise showing directionality, probability and frequency of activity level. Souce: National Academy of Sciences, 2003

SOURCE	TEMPORAL VARIABILITY			SOURCE CHARACTERISTICS		
	Large Scale wks to mos	Mid Scale hrs to days	Small Scale sec(s) to min(s)	Signal Structure	Spectral Content	Source level dB re 1 µPa at 1 m
Shipping				See Figure 2-1 for example		
Merchant	Constant presence			occasional transient due to operations activity on vessel		160–220
Utility	On site for wks	Down to hrs		numerous transients due to nature of operations	For all shipping, broadband energy from 10 Hz to >1 kHz with spectral lines rising above B/B due to propulsion blades, turbines, generators, etc.	160–200
					Transient additions are broadband and flat from 10 Hz to 1 kHz	160–200
Military		On site for hrs to days		general level up and down with exercise/war fighting requirements		160–220
Scientific		On site for days	Down to min(s)	stop and start behavior driven by data collection schedule		160–200
Recreation Other	Wks	Typically hrs days /hrs	Or less	highly variable		160–190
Seismic exploration		On site for days		Impulsive (see Figure 2-4)	Broadband	>240
Sonars *Military*						
Surveillance	On site for wks	Down to days		Pulsed tones	<1 kHz	>230
Tactical		On site for hrs	Down to min(s)	Pulsed tones	>1 kHz to <10 kHz	200 to 230
Weapon/ Counter Weapon		hrs to ~ a day	Down to min(s)	Pulsed tones / Wideband pulses	>0 kHz to >100 kHz	190 to 220

Table 3: Characteristics of anthropogenic contributors to marine noise showing signal structure, spectral bandwidth and source intensity. Source: National Academy of Sciences, 2003

2.6 Anthropogenic noise from the oil & gas industry

Hydrocarbon industry activities may be divided into five major categories: (1) seismic surveying, (2) drilling, (3) oilrig construction, (4) oilrig deconstruction, and (5) production and process related activities. Offshore seismic surveying, the predominant marine geophysical surveying technique employed by the petroleum industry, uses intentionally created sound as compared to the other categories. Research shows that the noise levels affiliated with petroleum processes and production are typically much lower than of seismic surveying (Richardson et al., 1995).

2.7 Various types of seismic surveying in the Petroleum Industry

Seismic surveying encompasses an assortment of methods, all of them use sound to relay information about geological structure underneath the seabed of the ocean. The oil industry depends on the extensive use of seismic reflection profiling to provide accurate data about the geo structure that extend beneath the seafloor. There are a number of techniques utilised which will be describe here.

In Figure 6 the different geometrics receiver utilized in seismic surveying are illustrated, while Figure 7 provides a variation of surveys. Towed streamer procedures present the bulk of seismic activity, followed by ocean bottom seismic. Shallow water is an intricate seismic operations as it is undertaken in shoal water areas such as tidal zones, river estuaries, marshes and swamplands (OGP, 2011).

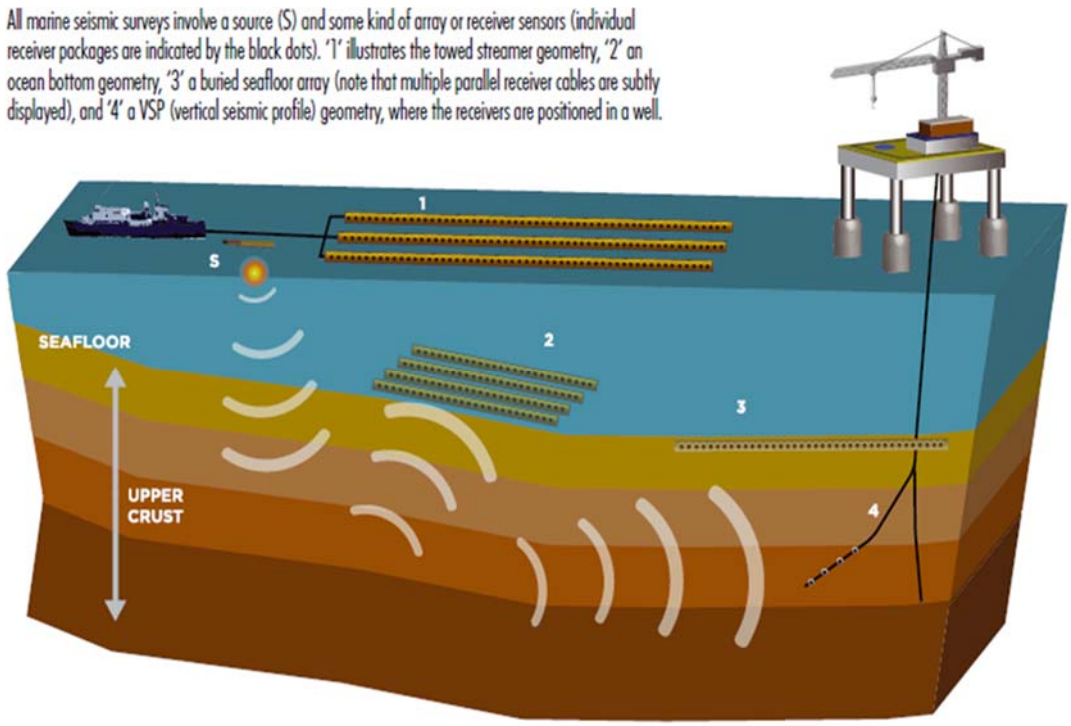


Figure 6: Different geometrics receiver used in marine seismic surveying. Source OGP April 2011- International Association of Oil & Gas Producers.

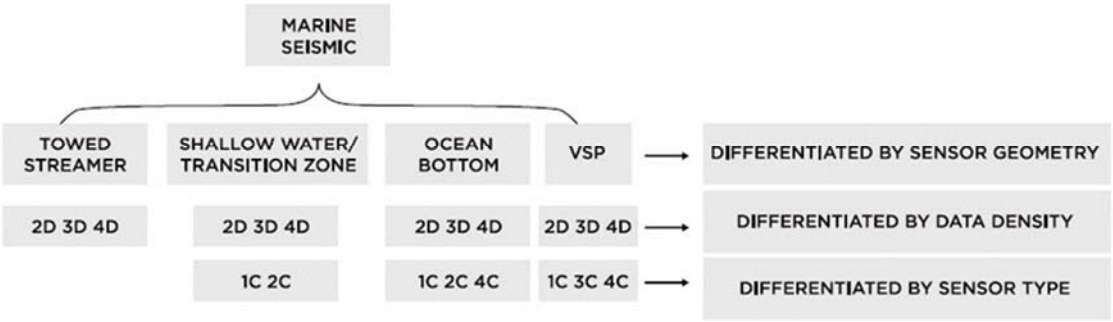


Figure 7: This table summarises the various types of seismic survey. Source OGP April 2011- International Association of Oil & Gas Producers.

In vertical seismic profiling (VSP), a several geophones is brought down into a well and used to decypher information from a receiver.

Seismic surveys may also be distinguished by the density of the data analysis made over a region; 3D surveys have a much denser number of measurements than 2D surveys. There are

also surveys that are required repeatedly above an identical area, the duration between surveys being in the order of months or years. These are known as 4D surveys or time lapse surveys, and consequently the data density is more prominent above the identical area, over a time interval because there are multiple data points above the identical region. Indeed, this rationality of 4D data density is more eminent than 3D, which is in evidently higher than 2D imaging (OGP report 448, 2011).

Finally surveys can be distinguished by the type of sensor that is used. The cables containing the hydrophones, called streamers, is towed or 'streamed' in the stern of a moving vessel. These streamers are generally 3 to 8 kilometres in length, although lengths can be up to 12 kilometres long, considering the depth of field being analyzed. In ocean bottom survey, generally the receiver system is equiped with a hydrophone and a 3- component geophone at each receiver station and the data are analyzed either as a 2-component data, or 4-component data (IAGC, 2011).

2.8 Typical seismic survey

This operation involved in seismic reflection surveying are (1) the seismic vessel, typically about 100 m long by 30 m wide; (2) air-gun arrays towed about 200 m posterior to the seismic vessel; and (3) cables, called streamers, on the order of a few thousand hydrophone sensors towed posterior to the seismic vessel. Current technology uses streamers up to twelve kilometers long to record the echoes returning from the subsurface. Figure 8 shows a typical airgun array in seismic reflection survey profiling.

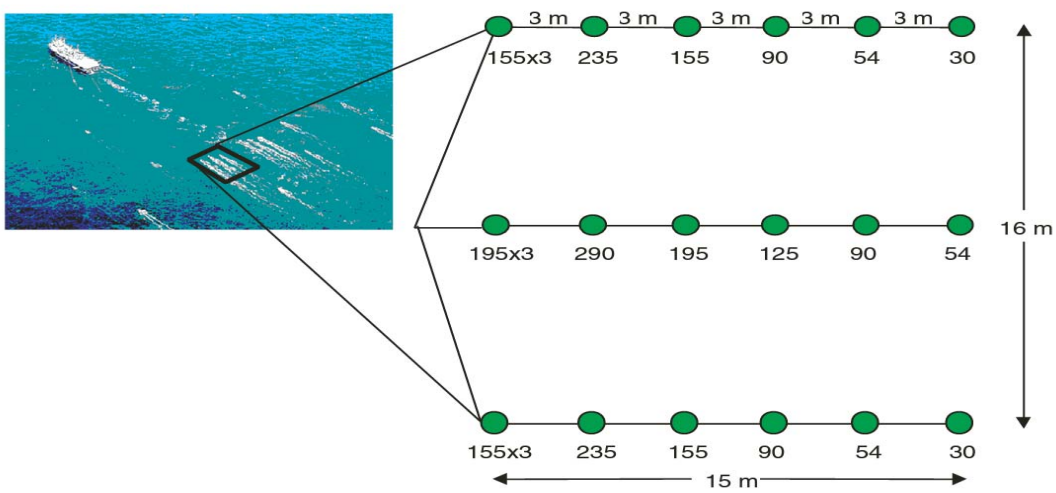


Figure 8: Schematic diagram of an air-gun array. A total volume of 3,397 cu. in. is shown. These array has three subarrays and uses 18 airguns. Each circle represents an air-gun, except for the circles at the head of each array, which represent three-gun clusters. The number represents the air volume expelled by individual air-guns in cubic inches. Source: National Research Council 2003

Seismic survey presently depends on the use of air-guns which have replaced the explosive charges that mentioned previously in section 1.5. Air-guns discharge a volume of high pressure air, creating a sound pressure wave that is able to ascertain the profile of the seabed substrates. A complete air-gun array used in the petroleum industry will typically involve 12-48 individual guns. Most of the petroleum industry uses air-gun arrays with operating pressures of 2,000 psi (equal to 13.8 million Pascals) and are typically about 20 m by 20 m .The acoustic pressure output of a seismic blast is relatively (1) equal to its operating pressure; (2) to the number of air-guns and (3) and to the cube root of the volume. For example, an 8,000 in^3 (0.131 m^3) array has a greater output than a 2,500 in^3 (0.041 m^3) array having an equal amount of airguns. If the signal pressure of the discharge is focused vertically, it is 12-15 dB stronger (Figure 9), as the frequency discharge in the upright way is a summation of the total array in both the forward and-behind plus the side-to-side directions of the blast (Richardson et al., 1991).

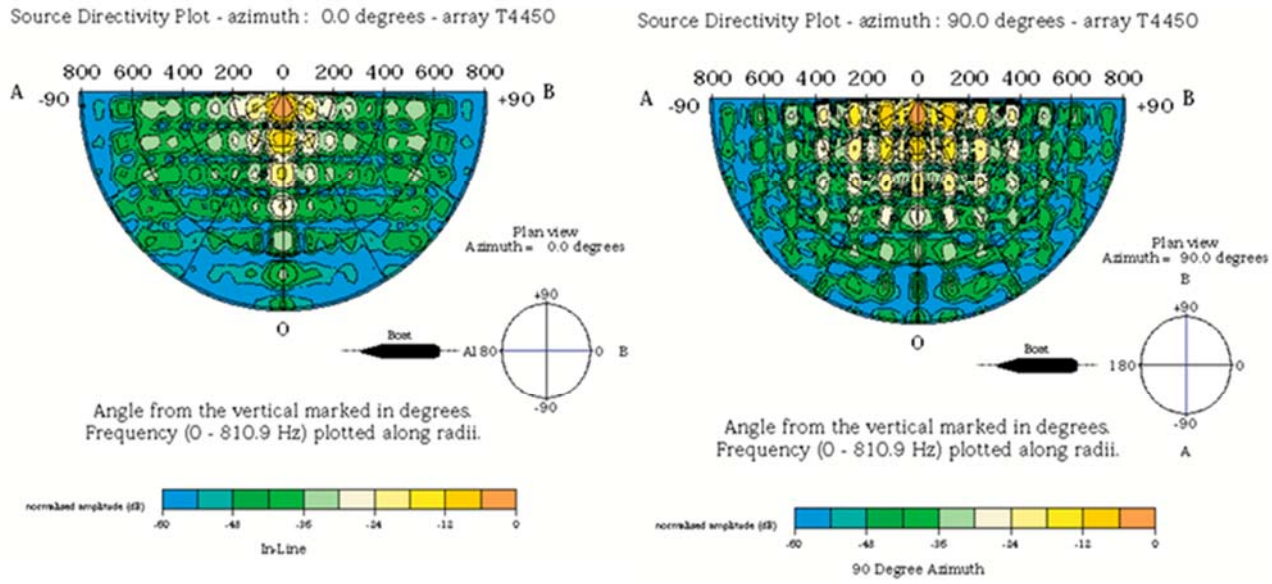


Figure 9: Air-gun array directivity. The magnitude and frequency of blast signals are subject to the downward angle and the horizontal azimuth of the emitted sound. The signal reaction of the blast signal is shown as a function of direction. The radial lines on each figure represents discharge angles from the vertical way (0, 30, 60, 90), and the concentrically half-circle represent increasing frequencies. Cold colours indicate lower amplitudes, and the hot colours indicate higher amplitudes. The figure on the left shows the blast response along the array forward and behind, and the figure on the right shows the blast response side to side. Source: National Research Council 2003

Research shows the highest pressure threshold a marine mammal could withstand from a seismic blast in the current seismic usage, is in the range of 235-240 dB re 1 μ Pa (RMS). The location where this blast is impacted will be upright underneath the source, generally close to its centre. This quantitative data also depends on the type of the array, the ocean depth in which the array is operating, and the physical properties of the seafloor (Dragoset, 2000). The peak amplitude of an air-gun blast is also relative of the frequency (Figure 10). The peak pressure levels emitted from normally utilised seismic blast are in the 5-300 Hz bandwidth. The source are pulled along at a speed around five knots (2.6 m/s) and are discharged around every 10 to 12 seconds.

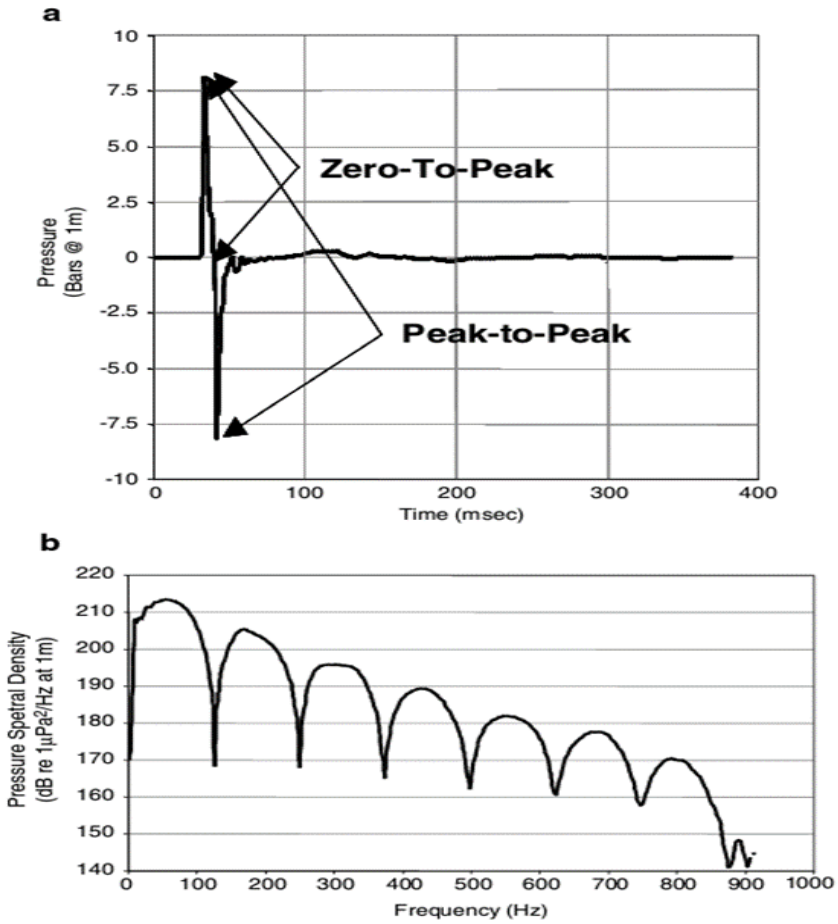


Figure 10: Air gun discharge pressure versus frequency. 10a) Pressure pulse produced by an air-gun discharge. The high-amplitude of the pulse lasts about 20 ms. 10b) An amplitude spectrum of a seismic blast. This plot shows pressure levels as a relation of frequency for a seismic blast of 4,550-cu.-in. air-gun array. Source: National Research Council 2003

In a characteristic seismic survey, a vessel towing air-gun arrays of six to ten streamers makes a series of parallel passes, typically taking about two hours, and then the air-guns are shut down during this turning manoeuvre.

2.9 The implication of seismic survey on marine mammals in Malaysia

Marine mammals' distribution throughout Malaysia is inadequately informed. Knowledge on distribution on cetaceans in this region are provided only in published historical literature (Lydekker, 1901; Bank, 1931; Gibson, 1949; Fraser,1956; Lewin, 1958; Berry et al.,1973; Abdul, 1986), and from coastal inshore regions (Nadarajah, 2000; Bali et al., 2008; Minton et al., 2011) . As of 2004, (Jaaman), there were only 22 species recorded, which were transient or resident mammals.

In the latest report, in 2009 (Table 4), a total of 27 cetacean observations were documented in connection with the Prime Scientific Sailing Expedition (PSSE), coordinated by the National Oceanographic Directorate (NOD) of the Malaysian Ministry of Science, Technology and Innovation (MOSTI). Additional recorded species were 2 mixed-groups of spinner and pantropical spotted dolphins and one species of unidentified whale (Ponnampalam, 2012).

These groups of cetacean, except for the Dugong, are excluded in the ESA in the NPP3, although these mammals are classified as 'ecologically sensitive', and require protection for the role of their important ecological contribution for conservation of species or habitats.

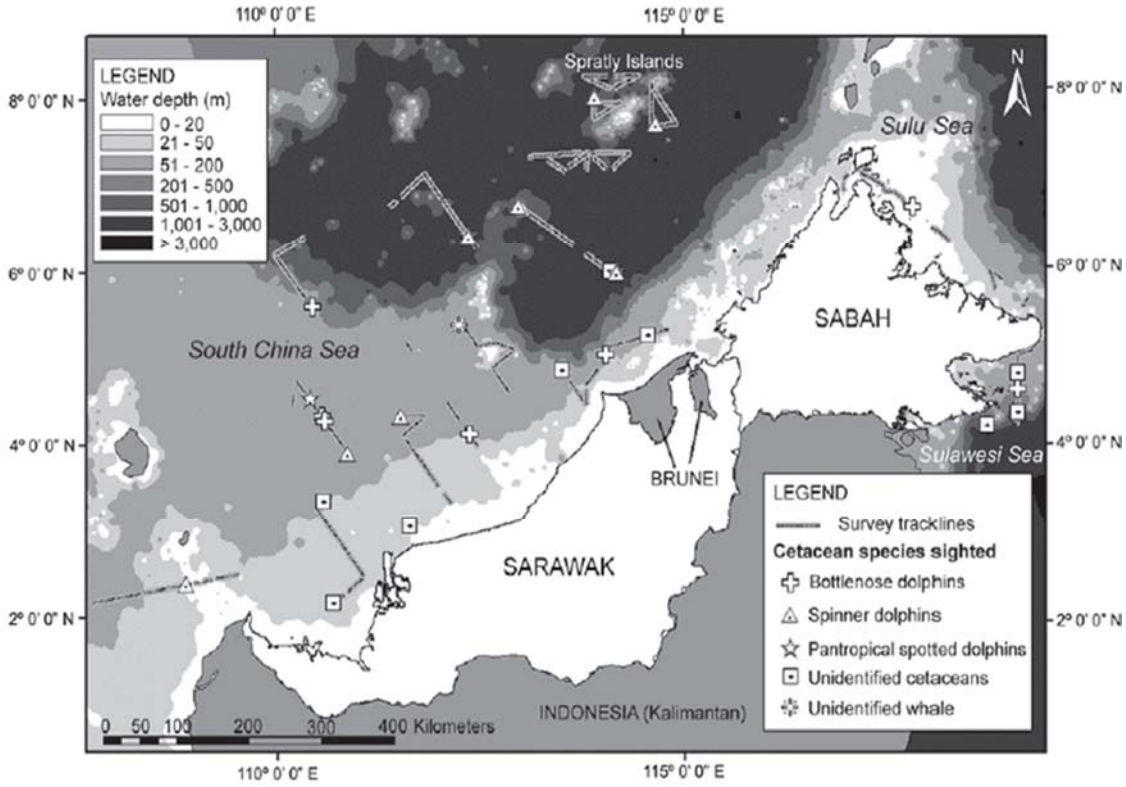
Species	No. of sightings	Encounter rate		Group size			Depth (m)		
		EG/h	EG/100 km	Range	Mean (n)	Std. Dev.	Range	Mean (n)	Std. Dev.
Spinner dolphin (*Stenella longirostris*)	8	0.07	0.36	10-55	27.0 (9)	12.6	30-1250	563.3 (9)	586.7
Bottlenose dolphin (*Tursiops c.faduncus*)	7	0.05	0.28	1-75	29.3 (7)	29.0	32-142	83.1 (7)	35.4
Pantropical spotted dolphin (*Stenella attemuata*)	2	0.02	0.12	35-250	111.7 (3)	120.0	108-1250	852.7 (3)	645.4
Unidentified cetaceans (*excluding large whales*)	9	0.07	0.36	2-50	11.9 (9)	16.0	42-1250	232.5 (9)	392.1
Unidentified whale	1	0.008	0.04	1	1.0 (1)	--	110	110.0 (1)	--
TOTAL	**27**								

Table 4. Sightings recorded during 2009 Prime Scientific Sailing Expedition. Source: Ponnampalam 2012

NOD under MOSTI, organised the 2009, PSSE expedition to gather data on the existence of marine mammals in the areas of the Malaysian South China Sea and Sulu-Sulawesi Sea (Map 1). It was a four leg expedition on-board the 68-meter long Royal Malaysian Navy Hydrographic vessel, KD PERANTAU. The departure was from Port Klang, en-route via the western seaboard of Peninsular Malaysian through South China Sea, and heading north bound towards Sulu Sea off the coast of Sabah, and finally encircling in to Sulawesi Seas (Ponnampalam, 2012). On the 3rd August 2010, Maritime Institute of Malaysia (MIMA), organised a RoundTable Discussion on Establishing a National Marine Mammal Stranding Network in Malaysia. This was a follow-up to the seminar entitled Marine Mammals Conservation in Malaysia: Adopting Sustainable Management Strategies, in 2009. The meeting was a collaboration with the Institute of Ocean and Earth Sciences (IOES), University of Malaya, and the Malaysian Nature Society (MNS). The main theme was the absence of a national marine mammal stranding response network in the country (Ponnampalam, 2010).

Participants attended were from various government agencies, academia as well as non-governmental organisations. Among the stakeholders present were Department of Fisheries Malaysia, Malaysia's Turtle and Marine Ecosystem Centre, National Oceanography Directorate, Malaysian Maritime Enforcement Agency, Royal Malaysian Police, Department of Marine Park Malaysia, Sabah Parks, Sarawak Forestry Corporation, National Fishermen's Association of Malaysia, TRAFFIC Southeast Asia, several local universities as well as marine mammal conservation groups.

It was resolved in the RoundTable Discussion that it is essential to successfully establish a stranding response network which would assist to facilitate accumulation of information from stranded carcasses for succeeding research and conservation plans as many strandings are associated to the effects from seismic survey (Ponnampalam, 2010).

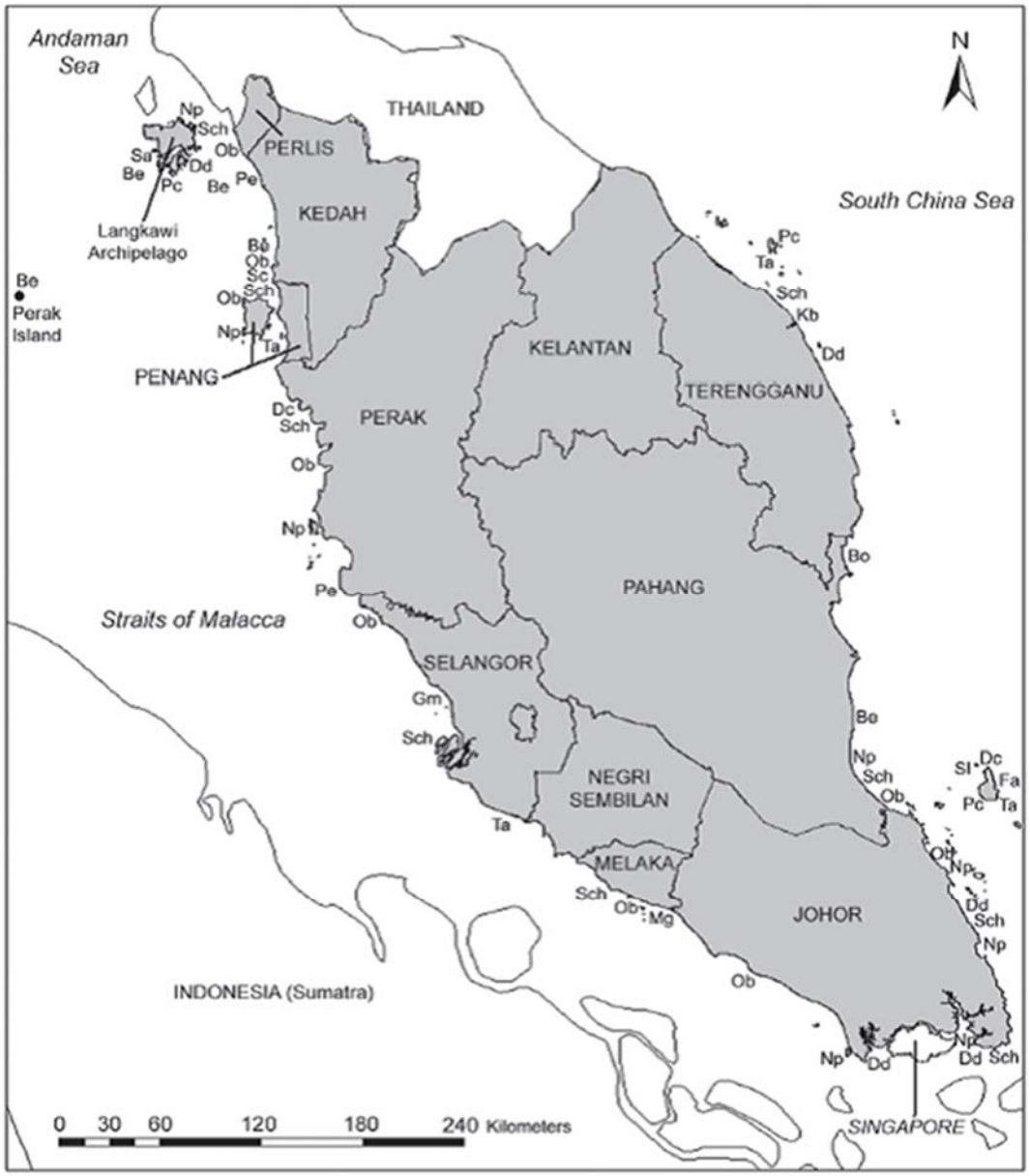


Map 1: 2009 Prime Scientific Sailing Expedition route where cetacean observations were carried out and recorded. Source: Ponnampalam, 2012.

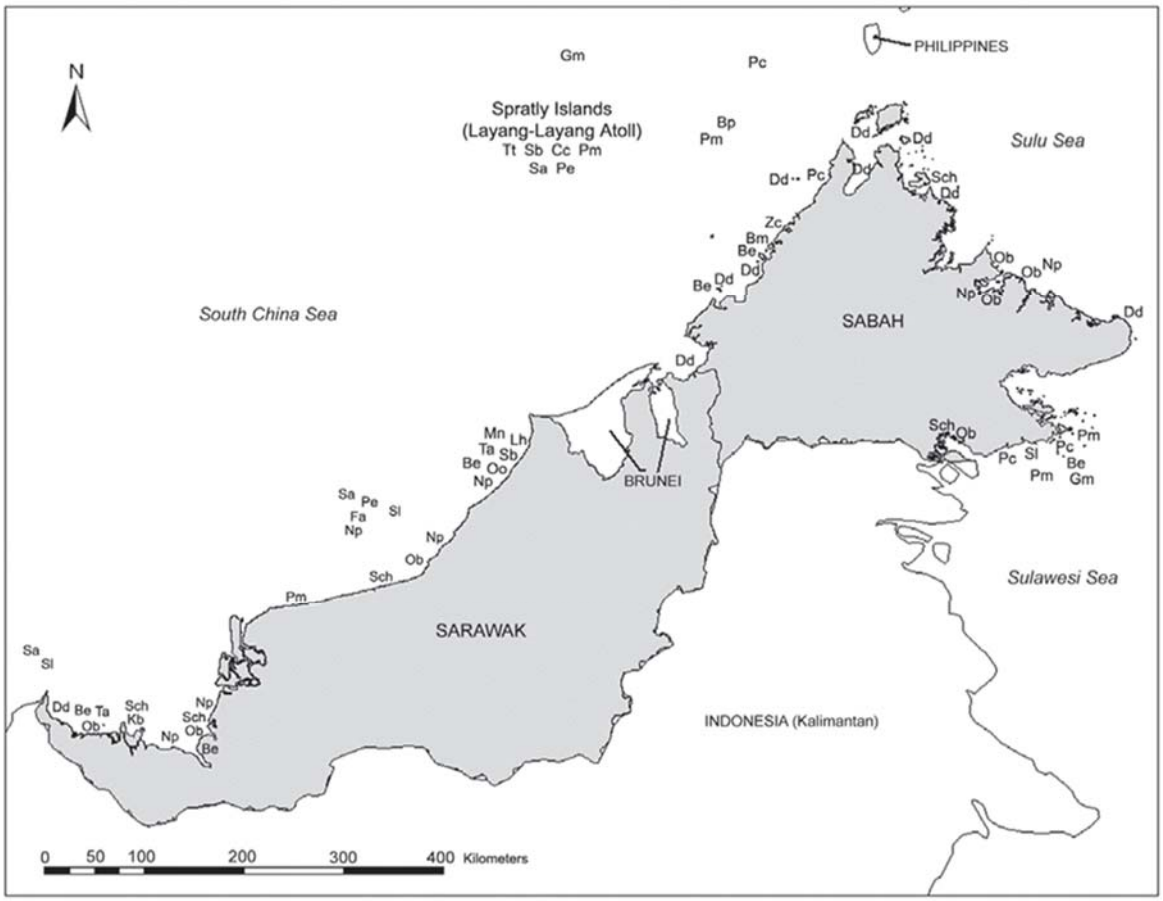
The complete updated checklist of species, along with its source of references, is listed in Table 5. Each species' code on the map is referred to the two-letter abbreviations listed in Map 2 and Map 3.

Species	Peninsular Malaysia		Sarawak		Sabah		Reference(s)
	LS	ST	LS	ST	LS	ST	
Family Dugongidae							
Dugong (Dugong dugon) - Dd	√	√	√	√	√	√	4,14,16,18,20
Family Balaenopteridae							
Omura's whale (Balaenoptera omurai) - Bo		√					20
Bryde's whale (Balaenoptera edeni) - Be	√	√	√	√	√	√	8,14,16,20
Blue whale (Balaenoptera musculus) - Bm						√	20
Fin whale (Balaenoptera physalus) - Bp					√		15
Humpback whale (Megaptera novaeangliae) - Mn			√				18
Family Ziphiidae							
Cuvier's beaked whale (Ziphius cavirostris) – Zc						√	16
Gingko-toothed whale (Mesoplodon ginkgodens) – Mg		√					13
Family Physeteridae							
Sperm whale (Physeter macrocephalus) - Pm				√	√	√	14,15,16
Family Kogiidae							
Pygmy sperm whale (Kogia breviceps) - Kb		√		√			8,9
Family Delphinidae							
Indo-Pacific humpback dolphin (Sousa chinensis) – Sch	√	√	√	√	√		5,6,9,14,17,18,19,20
Irrawaddy dolphin (Orcaella brevirostris) - Ob	√	√	√	√	√		5,6,7,11,14,15,16
Indo-Pacific bottlenose dolphin (Tursiops aduncus) - Ta	√	√	√	√	√	√	16,17,18,20
Common bottlenose dolphin (Turships truncatus) - Tt					√		16
Long-beaked common dolphin (Delphimus capensis) - Dc	√	√					5,13,20
Spinner dolphin (Stenella longirostris) – Sl	√		√		√	√	15,16,17,18,20
Pantropical spotted dolphin (Stenella attemuata) - Sa		√	√		√		15,16,20
Striped dolphin (Stenella coeruleoalba) - Sc		√					20
Fraser's dolphins (Lagenodelphis hosei) –Lh			√	√			6,16
False killer whale (Pseudorca crassidens) Pc	√	√			√	√	15,16,17,20
Pygmy killer whale (Feresa attenuate) - Fa		√	√		√		15,20
Melon-headed whale (Peponocephala electra) - Pe		√	√		√		15,16
Rough-toothed dolphin (Steno bredanensis) - Sb				√	√		16,20
Killer whale (Orcinus orca) - Oo				√	√		5,16
Risso's dolphin (Grampus griseus) - Gg				√			14,16
Short-finned pilot whale (Globicephala macrorhynchus) - Gm		√			√	√	5,16
Family Phocoenidae							
Indo-Pacific finless porpoise (Neophocaena phocaenoides)- Np	√	√	√	√	√		4,5,14,16,17,18,19,20

Table 5: Updated cetacean checklist in Malaysian waters as of 2009 (LS - live sighting record; ST - stranding record). Source: Ponnampalam 2012.



Map 2: Species distribution of sightings in Peninsular Malaysia as listed in the updated checklist in Table 5. Source: Ponnampalam 2012.



Map 3: Species distribution of sightings in East Malaysia as listed in the updated checklist in Table 2. Source: Ponnampalam 2012.

As an endorser to the Convention on Biological Diversity, Malaysia is obligated to protect 10% of representative marine ecosystems within its national boundaries (Ponnampalam et al., 2014). The constitution of this conservation area would extend to meeting the Aichi Biodiversity Targets alongside research methodology is ensuing with the goals and strategies of NPP-3. (CBD. 2015)

2.10 Migratory cetaceans in Malaysia

There are numerous cetacean species that share our common waters with Australian and New Zealand. This information is helpful to expend as references in proposing new guidelines for the

seismic survey in Malaysia. A comparison chart is depicted in Table 6, with red indicating species with high encounter rate and blue indicating the common species compare with Malaysian waters.

From the comparison table, it is clear Australia has more cetaceans in common with Malaysia compared to New Zealand. This information would serve to formulate similar reference guidelines, however a detailed review of international guidelines have to be scrutinised before formulating a regional set of mitigation measures for Malaysia in minimising acoustic disturbance to cetaceans from seismic survey operations.

It was stated in the Malay Medical Science editorial, published by Ponnampalam, 2014, that migratory cetaceans have the acquirement to bio accumulate pollutants and anthropogenic toxicant in the ocean such as polybrominated diphenyl esthers (PBDEs) and polychlorinated biphenyls (PCBs) via a process called bio-magnification. In short, these chemical compounds increasingly travel through the food web and gain in quantities every instant they move into a new trophic level, which signifies that the moment they reach the top (i.e., in marine mammals), their concentrations are generally quite toxic. Cetaceans with their reining emplacement at the peak of the food chain, higher mortality and extraordinary fat storage that have eminent acquisition to keep toxicants are indicants of alteration in the habitat and guardian for community and the well-being of our oceans (Ponnampalam, 2014).

Malaysian Water	Australian water	New Zealand's Water
Omura's whale	Bryde's whale	Killer whale
Bryde's whale	Blue whale	Bottlenose dolphin
Indo-Pacific bottlenose dolphin	Humpback whale	Pilot whale
Common bottlenose dolphin	Fin whale	Blue whale
Spinner dolphin	Sperm whale	Humpback whale
Pantropical spotted dolphin	Pygmy sperm whale	Sperm whale
Fraser's dolphin	Ginkgo-toothed beaked whale	Maui dolphin
False killer whale	Cuvier's beaked whale	Hector's dolphin
Pygmy killer whale	Killer whale	Dusky dolphin
Melon-headed whale	Pygmy killer whale	Common dolphin
Rough-toothed dolphin	False killer whale	Southern right whale
Dugong	Short-finned pilot whale	New Zealand sea lion
Blue whale	Melon-headed whale	New Zealand fur seal
Fin whale	Rough-toothed dolphin	Leopard seal
Humpback whale	Indo-Pacific humpbacked dolphin	Elephant seal
Cuvier's beaked whale	Risso's dolphin	
Ginkgo-toothed whale	Coastal bottlenose (Indo-Pacific) dolphin	
Sperm whale	Pantropical spotted dolphin	
Pygmy sperm whale	Spinner dolphin	
Indo-Pacific humpback dolphin	Striped dolphin	
Irrawaddy dolphin	Fraser's dolphin	
Long-beaked common dolphin	Bottlenose dolphin	
Striped dolphin	Sei whale	
Killer whale	Pygmy right whale	
Risso's dolphin	Antarctic minke whale	
Short-finned pilot whale	Dwarf minke whale	
Indo-Pacific finless porpoise	Southern right whale	
	Dwarf sperm whale	
	Gray's beaked whale	
	Andrews' beaked whale	
	True's beaked whale	
	Hector's beaked whale	
	Shepherd's beaked whale	
	Arnoux's beaked whale	
	Longman's beaked whale	
	Blainville's beaked whale	
	Strap-toothed beaked whale	
	Southern bottlenose whale	
	Long-finned pilot whale	
	Dusky dolphin	
	Hourglass dolphin	
	Common dolphin	
	Southern right whale dolphin	
	Australian snubfin dolphin	
	Spectacled porpoise	

Table 6: The comparison of species of marine mammals in Malaysian marine environment (Ponnampalam, 2012), Australian marine environment (Australian Government Department of Environment) and New Zealand's marine environment (Department of Conservation). Red indicate species with high encounter rate during seismic survey. Blue indicate the common species compare with Malaysian waters.

2.11 Chapter summary

Underwater noise spreads in principle omnidirectional from the source, the zones of noise influences, given as range from the source, indicate a radius rather than a straight line.

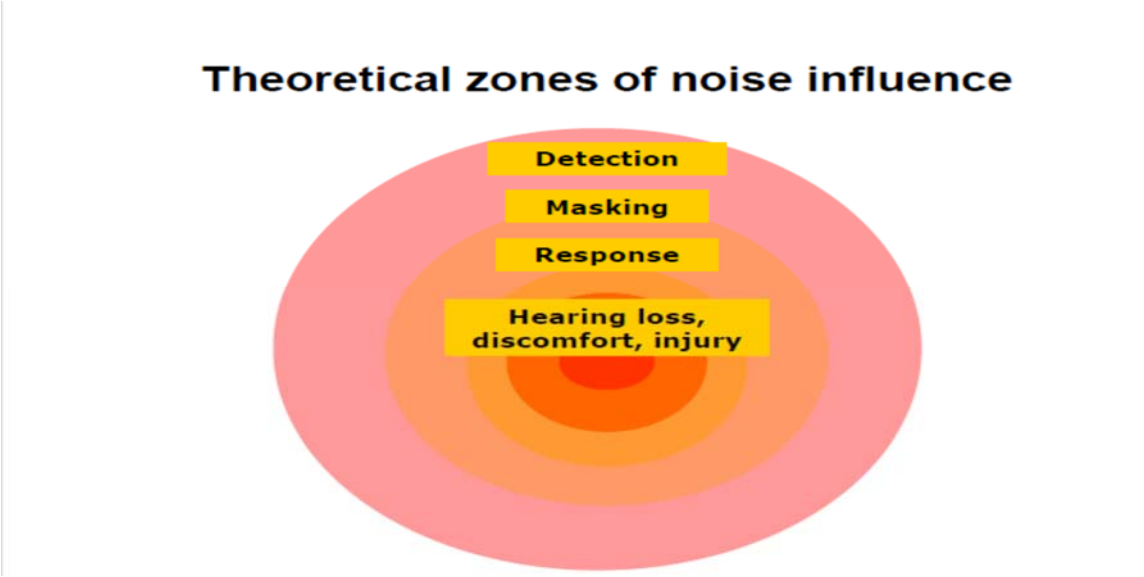


Figure 11: The safety and sustainability "bowtie" model featuring the P-D-M-R elements to be used for seismic survey mitigation tool. (Source: National Petroleum Council, 2011)

It ought to be noted here that Richardson et al.' s 1995 model (Figure 11) gives only a very rough estimate of the zones of influence as ocean noise in the seas is always three-dimensional. The Richardson model is used frequently for noise influences impact assessments where the zones of are ascertained established on noise pressure level measurements and hearing capabilities of the cetaceans.

The interference, refraction and reflection patterns within sound propagation will inevitably lead to much more complex sound fields than those grounded on the model by Richardson et al. 1995. This complexity leads to effects such as increases of received sound energy with distance, especially when multiple sound sources are used simultaneously like seismic airguns.

The quantitative assertion of the sound pressure wave to which a cetacean is endangered is acquired through sonic equation (Urick, 1975).

RL = SL – TL + AG, (1-1)

The decibel is utilised largely for convenience and the logarithmic is applied for demonstrating multiplicative processes for noise levels because mammals' sensing of sound intensity increases logarithmically.

RL (dB) = 20 $\log^{10}$ (measured pressure / reference pressure)= 10 $\log^{10}$ (measured pressure / reference pressure) ^{2} (1-2)

However the real surplus signal level (SE) ready to permit signal detection and translating of the sound pressure is given by

SE = RL – NL = SL – TL + AG – NL (1-3)

Transmission loss in Equations 1-1 and 1-3 is a composite mathematical function of the seismic sound, receiver geometry, environmental parameters and frequency of the water column against the sea floor (Brekhovskikh et al., 1991).

As a result, the transmission diminution can be transmitted generally as:

TL (dB re 1 m) = 20log 10 r + α r, when r < D (1-4)

TL (dB re 1 m) = 10log 10 r + 10log 10 D + α r – 3, when r > D, (1-5)

Where r is the horizontal range between transmission and receiver (m), and the absorption coefficient α (in dB/m) is roughly relative to the square of the frequency.

Whereas,

(RL) Received acoustic Level

(SL) Source Level

(TL) Transmission Loss

(AG) Processing Gain affiliated with the mammal's signal detection system

(NL) Ocean Noise

(SE) Surplus Signal

(D) Wave Thickness

The study revealed that each marine mammal communicates in a different frequency, therefore transmission loss, surplus signal, back ground ocean noise together with other variable factors makes distinguishing marine mammal species even harder. In order to improve and strengthen the efficiency of data administration of the target 27 species transmigrating within our oceans requires Information Management which will be discussed later in Chapter 6.

Progressing from this chapter, in understanding explicitly on the impingements and the risks to marine mammals', the next chapter will show the methodology process towards the aim of this research, which is to conduct an exploratory case study on PETRONAS DALAK PROJECT and propose a framework for seismic survey mitigation for PETRONAS to implement.

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CHAPTER THREE – RESEARCH METHODOLOGY

3.1 Mixed empirical research methodology

This research study applies empirical social science research method coupled with technical and engineering industry knowledge of the petroleum sector. Empiricism is a philosophical term to describe the theory that regards experience as the foundation or source of knowledge. Since experience is perceived through the senses, to sense information or observe, when used the term 'observation' alongside with the term 'experience', implies that 'empirical' is based on direct experience or observation of the world. (Aspin, 1995).

To interpret a question in this study as an empirical question is by receiving direct, observable information from the project. The key concept is 'observable information about the project, or 'direct experience of the project', is research data. The essential idea in this empirical research is to use data as the way of answering questions, and of developing and testing ideas (Punch, 2014), for development in seismic survey mitigation guidelines.

Data for empirical research is subdivided into 2 principal categories:

- Quantitative data – which are data that constitute numbers (or measurements), and
- Qualitative data – which are data not comprised of numbers (mostly, not always, this means words).

This leads to two definitions:

- Quantitative empirical research is a research which involves a collection or cluster of methods, including data in numeral form.
- According to the evolving definition by Denzin et al., 2011, in their *SAGE Handbook of Qualitative Research* conveys the ever-changing nature of qualitative inquiry from social construction, to interpretivism, and on to social justice to the

> world, their latest definition - Qualitative research is a state that places the researcher in a conundrum which consists of a set of interpretive condition and in resolution, the experimenter ingeminate the enigma into a chronological succession of representations, of field notes, interviews, conversations, photographs, recordings, and memos. Qualitative researchers investigate subjects in their innate environments, attempting to sensualize and interpret processes in academic terms of the substances in a naturalistic approach to the world. (Denzin et al., 2011).

The study of cognition is called epistemology, and the epistemological assumptions of qualitative and quantitative approaches to research are radically different. A quantitative research perspective assumes that knowledge is "out there" to be discovered; there is a physical, knowable reality that can be noticed by a trained researcher. Moreover, this reality can be dismantled and its parts extensively examined. A qualitative perspective assumes that data is constructed through communication and interaction: as such, knowledge is not "out there" but within the perceptions and explanations of the person and information is generated by people. A qualitative perspective assumes that you cannot analyse and understand an entity by analysis of its parts; rather, we must examine the larger context in which people and knowledge function. This concept is called the social construction of reality (Vanderstoep et al., 2009).

The term quantitative refers to a research epitome intended to deal with inquiries that theorize affiliations within standards that are measured frequently in numerical ways. The term qualitative refers to a research perspective tailored to discourse interviews for the interpretative thought process in a socially speculated reality (Tashakkori et al., 1998). Therefore, in this research study, the mixed methodology that involves the accumulation and reasoning of both empirical research, using data collection and perspectives of both principles demonstrates distinctive characteristics in this study.

In the classic understanding of methodological triangulation, the research must come into conclusions by using different methods to study the same phenomenon, just as the surveyor sights a point from various angles to confirm its location. Unlike surveying, however, the different processes of research in all probabilities become iterative and cyclical. In this research study, it will exhibit qualitative and quantitative investigations offered in different yet confirmatory angles on the multiple dimensions of research performance (Denzin et al., 2011).

The rudimentary principle behind mixed methods is the combination strengths of qualitative and quantitative research while compensating for the weaknesses of each method (Johnson et al., 2004).

In using this mixed methods approach, it is important that all presumptions of the methodology such as data collection and interview strategies be consistent, maintaining methodological congruence. The major design principles to be considered for mixed method are to (1) recognize the theoretical drive of the objective, (2) recognize the function of the imported component in the information, (3) adhere to the methodological hypotheses of the base method, and (4) work with as few data sets as possible. The research will therefore provide the overall theoretical scheme into which the findings of other data fit to which they complement the aim and objective of the research (Punch, 2014).

Figure 12 below illustrates qualitative and quantitative interactive continuum of research.

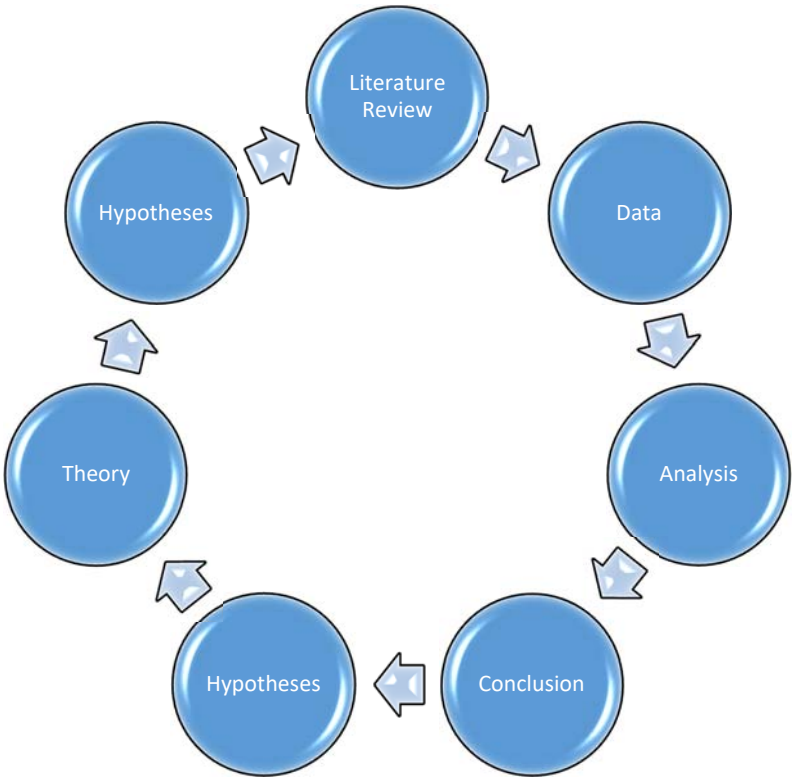


Figure 12: Qualitative- Quantitative Interactive Continuum of Research Source: Newman et al., (1998)

Nearly 40 years ago, (Kerlinger, 1964), a traditional quantitative methodologist, described the researcher's struggle with questions and purpose. As he wrote about social science research, he acknowledged science as process and as product. He was inadvertently endorsing the holistic quality of science and showed that qualitative and quantitative research is not opposite to one another but in the contrary has the elements of both assumptions (Kerlinger, 1964).

All methods of data collection have restrictions and is shaped by several factors. The collection and consolidation of both quantitative and qualitative data in research are progressively available for use in studying social science research problems because the use of multiple methods can nullify some of the disadvantages (Jick, 1979).

3.2 Research methods and procedure

The research method adopted is a PETRONAS project case study with a mix-method approach to data gathering and analysis. It involves the deployment of combination of both quantitative and qualitative techniques for information and data acquisition from respondents within the case study group of respondents. The process involves the use of survey questionnaires, semi structured interview prescriptive and performance based methodology and comparative review.

The method of approach was required for the understanding of whether seismic survey regulations are practised in mitigation for marine mammals in PETRONAS projects. It also explores the organisation's culture and attitude towards seismic regulations; seismic equipment used, methods, procedures; regulatory factors, Government environmental policies to seismic survey mitigation policies and its adaptation into the study organisation

Results obtained were interpreted and discussed in relation to practices of international seismic survey applications in a comparative review used to affirm the research hypotheses.

3.2.1 Statement of hypotheses

To achieve the objectives of this research, the following hypothesis are formulated:

1) By comparing and analyzing various international seismic guidelines, prescriptive tools and techniques, can an improved version of seismic mitigation guideline be introduced in PETRONAS Technical Specification (PTS)
2) To ascertain whether there exist government environmental policies that seismic survey guidelines can be implemented

3.3 The research philosophy

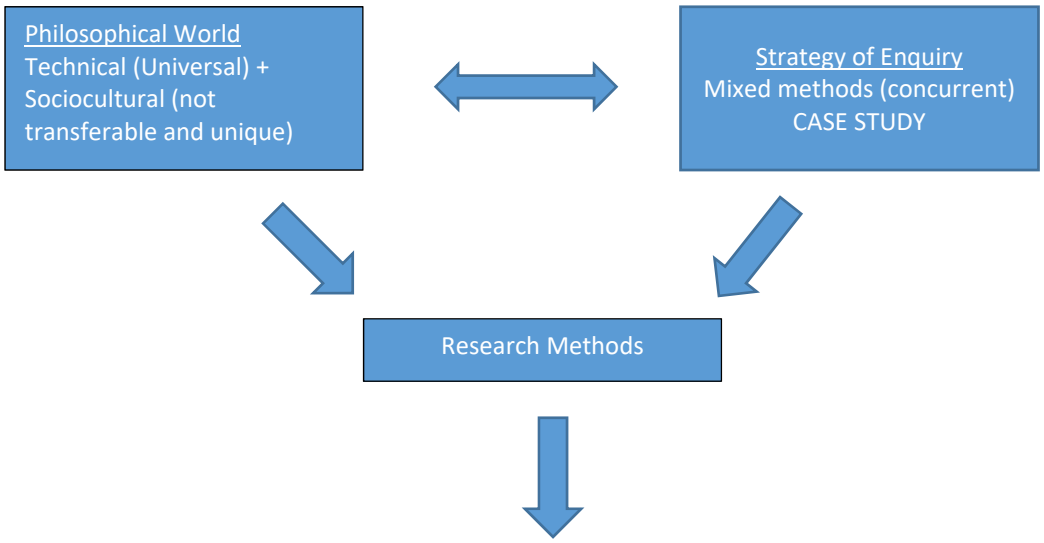
The obvious purpose of research from any epistemological perspective is to answer questions. This is done by dealing with deeper and more perplexed intentions and purposes that go beyond mere "questions." The deeper intention of a research is the reason for doing it. The research question does not provide the explanation for addressing it. The first benefit is to question whether the study is worth pursuing at all as in the formation of seismic survey mitigating guidelines.

When this has a significant purpose, there is a reason for pursuing it out. The purpose for this research study is rooted in the unique conceptualization of global sustainability in the ocean environment for the purpose of collective marine mammal protection and biodiversity conservation. The purpose here is not the question nor a design concept, or data collection. The purpose here is a focus on the reasons why this research is so important for Malaysia to give its full commitment in conserving her mega-diverse ecosystems, including that of the richly endowed seas.

This section ascertains the philosophical position that underlies the design of this research. It defines the philosophical factors that affect the overall arrangement, which enables satisfactory outcomes from the research activity.

The relevance of philosophical issues by Eatserby-Smith, et al,, (2008) is to create understanding in the following ways: Firstly, it is used in classifying the research designs which involves the consideration of the kind of evidence that is required, how can be gathered, interpreted and also the way it will provide answers to basic questions being investigated. Secondly, the knowledge of philosophy enables the researcher to recognise the suitable choice of research design through the exposure and limitations of these particular approaches. Third, it assists the researcher to identify and create design that may

be outside his or her past experience; and as well suggests how to adapt to new research designs according to the constraints of different subject or knowledge structures.



Data Collection and Management (Qualitative and Quantitative)	
Data collection tools (Mixed Methods)	• survey questionnaires • semi-structured interview • interaction • observation
CODING	EXCEL Spreadsheet
Data Analysis (Mixed methods)	Descriptive or Statistical analysis: • mean, • standard deviation • frequencies • Simple linear regression
Data presentation and Interpretation	Percentages, graphs, tables, charts and figures

Figure 13: Framework of Research Design Modified, Source: Creswell, 2009

In the same vain, Creswell, (2003) presents the standard framework for research design consisting of three major elements of inquiry: philosophical assumptions, strategies of inquiry, and methods. The first element is the philosophical assumption that explains the

worldview on which the research design is based, meaning that it defines what constitutes knowledge claims.

The second element is the strategy of inquiry or methodology that provides the choice or the use of methods or the general research procedures e.g. survey research, demography, and case study. The third one is the methods, which are techniques and detailed procedures of data collection, analysis, and writing e.g. questionnaire and interview.

Following this, the choice of pragmatism paradigm or philosophy is considered for this scientific research. Pragmatism is a philosophical position, which argues that knowledge and understanding should be derived from experience (Eatserby-Smith et al., 2008). This choice of worldview or knowledge claim is informed by the nature of the research questions and objectives with the philosophical assumption on which the research design is drafted. In this instance, the research objective is aimed at formulating a framework that can be deployed towards successful implementation of seismic survey mitigation guidelines for PETRONAS. It is therefore relevant that an appropriate choice of paradigm is achieved in-view of the importance of this research to PETRONAS case study and simulate the replicability of the seismic regulatory framework in similar future projects within PETRONAS shared resources and subsidiaries the prescriptive and performance methods in managing the seismic scientific tools.

Mixed model studies or triangulation are therefore employed as a product of the pragmatists' paradigm and supports this research inquiry, which combines qualitative and quantitative approaches within different phases of the research process. The difference between qualitative and quantitative methods is generally described in terms of the type of data collection: the quantitative method involves numerical data and statistical analysis while the qualitative method collects descriptive data from interviews and interaction for

interpretation analysis. The qualitative method focuses on patterns of inter-relationships between a previously unspecified set of concepts, while the quantitative way narrowly looks through a specified set of variables (Brannen, 1992). Three main strategies of inquiry, quantitative, qualitative or mixed methods and their data collection methods are shown in the Table below (John W Creswell et. al, 2004)]:

Quantitative Methods	Mixed- Methods	Qualitative Methods
Pre-determined	Both pre-determined and emerging methods	Emerging methods
Instrument based questions	Both open- and closed-ended questions	Open-ended questions
Performance data, attitude data, observational data. and census data	Multiple forms of data drawing on all possibilities	Interview data, observation data, document data, and audio-visual data
Statistical analysis	Statistical and text analysis	Text and image analysis
Statistical interpretation	Across databases Interpretation	Themes patterns interpretation

After the strategy of triangulation was chosen for this research, the research process is then designed with the aim of answering the research objectives. This research aims for an operational framework to provide PETRONAS with a practical approach to making decisions upon comparative seismic survey guidelines review.

3.4 Sampling Techniques (People sampling)

Eatserby-Smith et al. (2008) believe that "the quality of a sample is as important as its size". Where collection of data from an unknown entire population is not feasible, hence statistical inferences are drawn from the sample and a suitable sampling frame need to be

employed (Saunders et al., 2009). The decision of selecting a suitable sample size plays a significant role in confidence and certainty level which depicts that the characteristics of the data collected are representative of the total population.

With both qualitative and quantitative data, the essential requirement is that the sample is representative of the population from which it is drawn. This is because no study, whether quantitative, qualitative or both, can be based on the whole for large population. Miles et al., (2013), states that "you cannot study everyone everywhere doing everything. Sampling in quantitative research usually means "people sampling", in which the key concept therefore is the population (the total target group) and the sample (the actual group who are included in the study, and from whom the data is collected).

Generally speaking, the purpose of collecting data from a sample is to enable the researcher to make statements about the population that the sample is drawn from. The claims that are made from sample data depend absolutely on the relationship between the sample and the population (Eatserby-Smith et al., 2008).

A general question that often plagues especially novice researchers is the size of samples for the research (Punch, 2014). He further emphasized the there is no clear-cut answer to this issue as the correct sample size depends on the purpose of the study and the nature of the population under scrutiny. Fundamentally, larger sample are better and preferable, as it gives greater reliability and also enables more sophisticated statistics to be used. In addition, the number of variables researchers set out to control in their analysis and the types of statistical tests that they wish to make must inform their decisions about sample size prior to the actual research undertaking (Punch, 2014)

There exist several types of sampling methods, but for the purpose of this study simple random and purposive sampling methods were applied. For the survey questionnaire,

simple random sampling method was used to ensure that a larger part of the respondents gets the chance of participating in the study. In addition, purposive sampling was also used to target PETRONAS, EIA Consultants and Government Agencies. For the semi-structured interview, only the purposive sampling was used to target the seismic contractors, NGO's, the public and some 'critical case' participants who are in key positions who are 'knowledgeable people' about the activities and operations of seismic survey.

3.5 Implementation of Research Design

From the point of organisational management and social research enquiry, the research approach or methods usually would either be by quantitative, qualitative or mixed methods (Creswell, 2009). For this particular study the research design for the data collection method is mixed.

Mixed methods in the sense that a set of questions was structured for interview (qualitative data) with middle, senior and top management level of PETRONAS, EIA Consultant and Government Agencies, to pick data that was largely of their professional opinion based on their wealth of experience. The information or data collected are subjective and professional perspective on how seismic survey guidelines can be applied to PETRONAS.

In addition to that, quantitative data collection was done through the administration of survey questionnaires. Structured questionnaires consisting of both closed and open-ended questions were grouped into the following clusters:

a. Biodata

b. Existing seismic survey concepts and implementation in PETRONAS.

c. Use of prescriptive and performance methods, tools and techniques for improvements, marine mammal safety and industry productivity in PETRONAS.

d. Government environmental policies that can adopt to seismic survey mitigation policies

This was done to ascertain whether seismic survey policies can be applied to PETRONAS and establish whether the tools and techniques of prescriptive and performance based methods are implemented in seismic operations deliberately or unknowingly. The enquiry was further used to unravel the Government National policies that could aid in implementing the regulation of seismic survey mitigation in PETRONAS.

According to Creswell, (2009) and Yin, (2011), this fusion of two methods used to pick data for a research gives it grounding in reliability and validity.

3.6 Reliability and validity

Validity and reliability measures are commonly used to judge the quality of quantitative and qualitative research. Hence, the reliability and validity of the data collected depends largely on the design of the questions, the structure and the rigour of the pilot testing (Saunders et al., 2009). Validity could be internal or external.

The internal validity involves running a pilot test from sample size in order to ascertain the internal coherence and pertinence of results produced (Drucker-godard, 2001). It concerns two aspects of qualitative research; causal links to determine whether event x led to event y; and links made between inferences (Yin, 2011). To accomplish this challenge, Pilot tests were conducted so as to avoid measurement errors and to make sure that the data collected was reliable. The goal was to find out the clarity and unambiguity of the instruction, the time it will take to fill out the questionnaires, conduct the interview, to test if questions were unclear, ambiguous or uneasy to answer. The test revealed that the time for and answering survey questionnaire was about 13 minutes and average of 47 minutes

for the interview session. The universal validity and suitability of the questions were established from administering 30 questionnaires and testing the semi- structured interview questions with 3 persons from the sample drawn from case study. The preliminary analysis of test data was done to establish that data to be collected would allow the investigative questions to be answered.

Since the qualitative research aspect involves the causal links to determine whether event x led to event y; and links made between inferences (Yin, 2011), adjustments were effected in the approach and ways of administering the interview questions. Similarly, the questionnaires were reviewed where required to meet up with above objectives.

External validity is here referred to as the degree to which findings can be generalised across the study environment. Yin (2011); Yin et al., (2007) state that "the question of generalizability in case studies has always been an area that received considerable criticism. This is usually so as the question of validity is raised on how a single case or sample can be used to generalise statistical evidence (Chin, 2011). The generalizability issue of case study brings the strength of sensibility and sensitivity to meaning and to context, local grounded-ness, the in depth study of smaller samples, and great methodological flexibility which enhances the ability to study the seismic survey process. Taking advantage of where the qualitative methods can be strong in those areas where quantitative methods are weak, and similarly that the quantitative methods can be strong in those areas where qualitative methods are weak. Therefore, combining both methods offers the possibility of combining these two sets of strength, and compensating for the weaknesses. Of the assumptions and justification of pragmatism in relation to mixed methods is where the essential ideas of pragmatism is to reject the either /or choices and the meta physical concepts associated with the paradigm, and to focus instead on 'what worked' in getting the research questions answered (Tashakkori et al., 2003).

The question of external validity of data collection in this study is ensured by selecting and drawing a robust sample from the population. The samples are effectively the appropriate respondents for the study based on their demographic background, nature of the institution and other parameters identified in the next section.

3.7 The design of survey questionnaire (Quantitative data collection tool)

The survey questionnaires used is to measure quantitative data and research to gather from a pool of opinions from Government officials, EIA Consultants, NGO's, PETRONAS and seismic contractors. The questionnaire survey was selected as the appropriate method for collecting data for the appraisal of the current management approach to seismic survey mitigation. The objective of this questionnaire survey was aimed at evaluating the degree of understanding of harm that seismic noise cause to cetaceans and to establish if any deliberate measures were mitigated to deter them.

The open-ended segment of the questionnaire is to allow the respondents the liberty to render their views, opinions and understanding from their experience enabling them to provide in their own context without limitations from the pre-set categories. These are useful for investigating complex issues, to which a yes or no will not suffice the query. In order to produce a flow of questions, the research objectives were subdivided into more investigative questions, which were needed to gather data.

Closed-ended question were used in order for respondents to provide information that are specific for technical interpretation to the data collected for analysis.

The designed survey questionnaire is made up of a total of 14 questions with 10 closed-ended and 4 open-ended (please refer to appendix). As earlier mentioned, questions were designed to particularly answer certain objectives. The objective of ascertaining the existence of seismic survey implementation in the case study PETRONAS project in order

to evaluate the possible seismic prescriptive and performance tools, techniques currently practiced by seismic operators and reveal the possible National environmental policies that may aid the implementation of new seismic survey guidelines in PETRONAS.

The questionnaires were intentionally developed for the objectives of the research and formulating on the collected data for subsequent analysis. Each data or information provided has its strengths and weaknesses, which must be cross checked with other responses and must be balanced against each other

3.8 The design of Semi-Structured interview (Qualitative data collection tool)

The second segment of raw data accumulation was by employing semi-structured interview questions where the respondents are largely management cadre who are stakeholders or decision makers. Notifications were channelled to the respondents informing them of the date, time and venue of interview. Preceding the interview, the respondents were advised about the aim and objective of the study, confidentiality and anonymity. They respondents were adequately briefed on the research ethics and were informed that their identity shall be well concealed and during the interview, they are at will to discontinue.

In this mixed research methodology, survey questionnaire and semi-structured interviews, case studies, review of comparative international / country guidelines and prescriptive and performance method will be used for analysis. Interview sections with Government agencies, Consultants, NGOs, PETRONAS, seismic contractors and stakeholders to keep the thought process flow allowing new ideas to be brought up and conjugated. Face-to-face interviews are preferred in this research rather than through telephone or social media as it is characterised by synchronous communication in time and place where the social

cues of respondent can allow interviewer to get extra information by adding survey questions towards the verbal answer from the respondents.

The interviews are conducted in areas of Kuala Lumpur, Putrajaya, and Labuan via any electronic resource information for data collection. This mixed methodology approach is providing related closed and open ended questionnaire to different Government Departments, PETRONAS and NGOs respectively. These primary sources of survey questionnaires will be part of the main analysis framework. The methodology is to compare with another framework of secondary semi structured interview to strengthen the information from the primary. Theses secondary interviews will be utilised to collect opinions and feedback for research analysis using unbiased approach.

The semi-structured questions were disseminated out on a 'case to case' basis, i.e. with participants who are in key positions and who are the 'decision makers' of daily activities and operations. The interview was upheld to comprehend their predisposition of seismic survey and from their perception and to gather understanding into the working mechanism of the jurisdiction and operations systems. Due to limited time scheduled for both survey and interview with officials from the Government, PETRONAS and Consultants, the two data collection processes were concurrently carried out with the help of research assistants.

Clearly, in qualitative research, the interview is perceived as a purposeful discussion between two or more people (Kahn et al., 1957). But it needs to be of real scientific value if it needs to serve more purpose than that. Saunders et al (2000) describes it as a means of gathering valid and reliable data relevant to the research question(s) and objectives of a study.

3.9 The respondent group

Respondents are personnel involved in DALAK Project directly or indirectly. These include the general populous that lives within the project vicinity. Every section has a contribution to make in the general mission of the research and as such, selection of respondents was not limited to management. The study tries to involve every relevant Government agency, PETRONAS, environmental NGO's, environment consultants, Marine mammal scientist, seismic operators, village leaders and fishermen that are germane to the research. Enquiries were made from participants with a view to understanding whether Malaysian seismic guidelines already exists and to what extent it is implemented.

In administering the measuring instrument, (Punch, 2014) believes that two points needed to be kept in mind: First is to ensure that respondents have been approached professionally, and, within limits, fully informed about the purpose and context of the research, about confidentiality and anonymity, and about what use will be made of, and who will make use of, the information they provide. It also helps to point out that this sort of research is not possible without their cooperation, and they should know clearly what they are being asked to do. This is because when it is done properly and professionally, people will usually cooperate, and the quality of the data is improved. In this case face-to-face approach was adopted.

The questions were to obtain from the respondents how they look at seismic survey guidelines, how well they are exposed to seismic survey guidelines, both personally and professionally. Specific representatives were chosen from each group of respondents. Each respondent used about 15 minutes to answer the survey questionnaires and about 45 minutes for the interview questions.

3.10 Data collection on public perception

Social surveys were performed in December 2016 at Kg Lubuk Darat, Kg Naluyan Besar, Kg Mesapol Lama and Kg Sapok Palakat to gauge the local people's perception of the Dalak Pipeline project. A totality of 25 villagers were randomly selected from the 4 settlements mentioned above. The details of respondents interviewed are shown in Table 16 and 17 in Chapter Eight– analysis of data and discussion.

. Outcome of the interview showed that most people are mindful of the project and speculate this to bring more development for the Sabah economy. When asked about the concerns on marine mammals and the possibility of fishing catch deterioration due to seismic operation, the main issue that was highlighted by the villagers is this aspect is mitigated by PETRONAS.

Results from the semi-structured interviews conducted with 53 fishermen along the southern shores of Kuala Padas, the Klias peninsula and on Labuan to provide baseline data on background, fishing methods, catches, value and importance. Interviews also include the on perceptions of fishery trends.

It took about 25 minutes each for the respondents to reply to the questions and others took the questions home to be answered later. Some respondents turned in the interview questionnaires after three weeks due to fishing engagement offshore.

3.11 Methods of Analysis

The analysis methodology used is also mixed, which involves both quantitative and qualitative data.

The qualitative data (largely interview) was transcribed, articulated and consolidated. Classification and categorization of responses were split into technical, regulatory

legislations, environmental concerns and general perception to achieve a conclusive resolution. This qualitative data was then used to support, corroborate and substantiate the quantitative data used in interpreting and discussing the discoveries of the research.

3.11.1 Multiple correlation and regression

Simple correlation and regression has one independent and one dependent variable. Multiple correlation and regression has more than one independent variable, and one dependent variable.

The linear relationship between the population mean of the outcome and the value of the explanatory variable can be postulated by letting y be some outcome, and x be some explanatory variable, then the structural model using the equation

$E(y/x) = ß0+ß1$

where E(), read as expected value of', indicates a population mean; y/x, which is read 'y given x', indicates that we are looking at the possible values of y when x is restricted to some single value; ß0, read 'beta zero', is the intercept parameter; and ß1, read 'beta one' is the slope parameter.

So the structural model says that for each value of x the population mean of y can be calculated using the simple linear expression ß0 +ß1.

Generally, the structural model underlying a linear regression analysis is that the explanatory and outcome variables are linearly related such that the population mean of the outcome for any x value is ß0 +ß1.

For multiple regression with more than one variable is therefore expressed as:

$Y = ß0 + ß1x1 + ß2x2 + ß3x3 + \ldots\ldots\ldots\ldots + ßnx\infty$

Where $x1, x2, x3, x4$ ..... $x\infty$, referred to as the independent variables and ß0, ß1, ß2, ß3 ..... βn = constant coefficients or parameters.

Expressing this in a simpler form, it is convenient to define x as the explanatory variable (or independent) variable and y as the outcome (or dependent) variable. We are concerned with determining how well x can predict y.

Generally expressed as:

$Y = a + bx$I, where i = 1, 2, 3, 4.....∞

Correspondingly, the conceptual framework for multiple linear regression (Punch, 2014), also expresses the above expressions in the form:

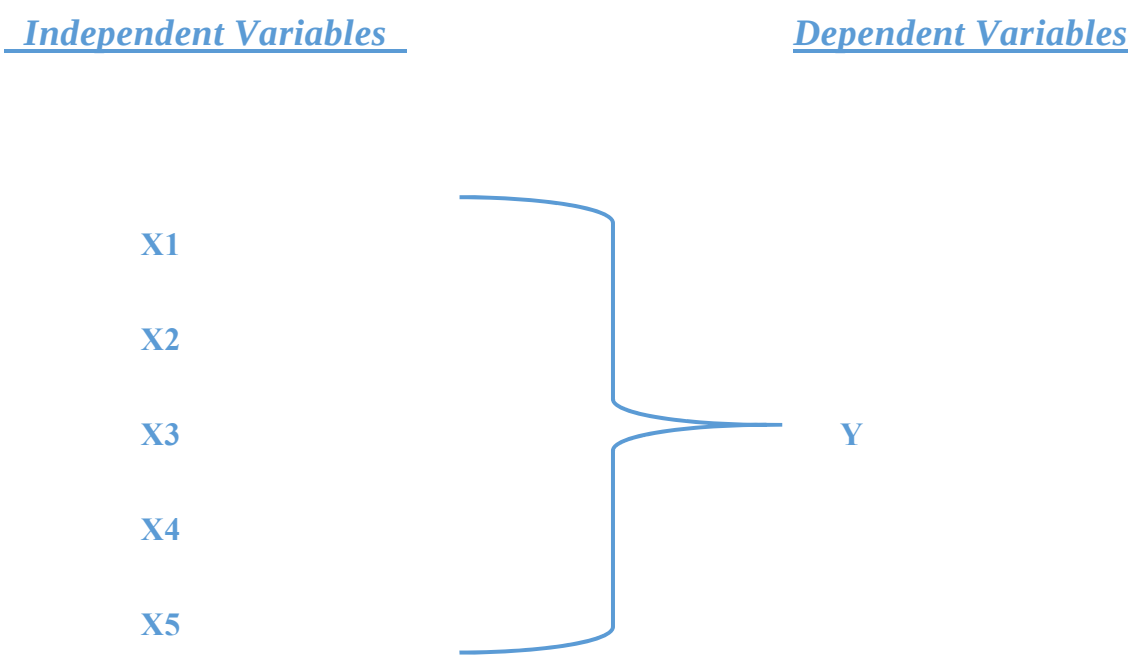


Figure 14: A conceptual framework for multiple linear regression adopted from Punch, 2014

Using the above expressions, the following is the definitions of variable used in the study.

Objectives	Dependent variables (Y)	Independent variables (X)
Objective one is to ascertain respondent awareness level of seismic survey guidelines.	Respondent awareness level of seismic survey guidelines.	$x1$ = Seismic survey equip $x2$ = value of service, $x3$ = Internal customers, $x4$ = external customers, $x5$ = survey processes, $x6$ = Respondent knowledge of seismic survey guidelines, and $x7$ = management's understanding of seismic survey guidelines
The second objective used for answering the hypothesis that "The adoption of seismic survey guidelines would improve the quality, effectiveness and efficiency of EIA in PETRONAS Technical Specification (PTS)"	Commonly used seismic survey methodology or tools,	$x1$ = seismic survey mitigating tools $x2$ = PETRONAS internal regulations used for seismic survey mitigating tools and $x3$ = International regulations used in marine mammal mitigation.
Objective three is meant to answer the hypothesis states that "There exist government environmental policies that seismic survey guidelines can be implemented"	Malaysian environmental policies	$x1$ = Government biodiversity programmes, $x2$ = NGO influence on marine mammal conservation effort, $x3$= Government's efforts in protecting ESA

Larsen (2008), suggests that it is important to know that the hypothesis is about what the relationship is when performing a regression analysis as it is fundamental to the interpretation. In a linear regression statistical hypotheses, the chief null hypothesis is H0:

ß1 = 0, and the corresponding alternative hypothesis is H1: ß1 ≠ 0. If this null hypothesis is true, then, from E(Y) = ß0 +ß1 x, we can see that the population mean of Y is ß0 for every x value, which tells us that x has no effect on Y. The alternative is that changes in x are associated with changes in Y (or changes in x cause changes in Y in a randomized experiment). The two hypotheses postulated for this research is presented as follows:

H1: The adoption of seismic survey guidelines would improve the quality, effectiveness and efficiency of EIA in PETRONAS Technical Specification (PTS).

H0: The adoption of seismic survey guidelines would NOT improve the quality, effectiveness and efficiency of EIA in PETRONAS Technical Specification (PTS).

H1: There exist government environmental policies that seismic survey guidelines can be implemented

H0: There exist NO government environmental policies for seismic survey guidelines to be implemented

3.12 Ethical consideration

The mode of this research is aimed by the University of Nottingham's ethical guidelines. The University's ethical guidelines delivers the researcher with a statement of principles and procedures so as to not transgress from the institutional ethical code of conduct. To consecrate this ethical objective, the researcher presented to the Faculty research ethics committee the completed ethics application forms together with the research data accruement processes and an abstract of the study which were approved before commencing data gathering from participants. Social survey and interview questionnaires were also presented to a free-lance social science researcher to verify and validate even though this isn't a requirement from the University (see appendix).

High ranking officials' names and their positions are not mentioned in the output of this study, including their portfolio were all strictly confidential as specified in the consent form.

3.13 Prescriptive and performance-based methodological

PETRONAS needs to respond instinctually to scientific and natural world changes in seismic regulatory proposition internationally by being a member of JIP which will be discussed in section 4.3.2. Instinctively the two ways to achieve these goals are classified as either "*prescriptive*" or "*performance-based*."

These are not reciprocally individual concepts but rather rudimentary cornerstone of mixed techniques in qualitative and quantitative methodology, redressing for the weaknesses of seismic techniques that can be applied together in a complemented way to accomplish the desired outcomes related to NPBD, 2016 which will be discussed in chapter 5.

Prescriptive and performance-based methodological improves the contributing factor and intensity of the menaces of how seismic pollution constitute, on-going scientific insightfulness and administration of those threats, and the possibility for efficient preservation actions. Consolidating and coordinating from these two methodology, data sharing as well as actively pursuing to update with international seismic standards, these information will be registered in Information Management which will be discussed later in Chapter 6 (Information Management). This methodology puts together social science, technical study, International Laws as it involves choice of pragmatism paradigm for this scientific research. This choice of worldview is the nature of the research questions and objectives with the philosophical assumption on which the research design is built.

This methodology is effective to analyse and understand the wider circumstance in which people and knowledge function of operating seismic equipment combines qualitative and quantitative approaches within different phases of the research process. In concept this methodology diverges in two projections, synergising together with a deeper intention of sustaining marine mammals in Malaysia.

3.14 Prescriptive based methodology

Prescriptive regulations are those that define the minimal prerequisites to permit an activity. In a technically composite evolving petroleum seismic activity, these processes can rapidly get out-of-date and make it unmanageable for oil industry to propose alternative approaches that can best meet technological or environmental conditions (NPC, 2011).

For seismic pollution, pragmatism as a worldview concern arouse out of actions of International organisational through the United Nations, UNCLOS Article 194 where scientific measures to reduce seismic pollution to the marine environment are updated. In this study, prescriptive methodology is used to evaluate and understand PETRONAS organisational readiness if this implementation is enforced. Scientific prescriptive tools such as soft start, vertical survey profiling (VSP), MMO, PAM and other measurement approach were investigated to determine whether seismic survey mitigation is practiced by seismic contractors either formally or unknowingly. Questionnaires are formally administered to establish the current situation about the seismic survey, whether the prescriptive scientific tools and the appropriate strategies are applied. By combining assorted technologies, techniques, tools and pragmatism, a rich data collection of qualitative data were obtained from the technical segment of the interview (Appendix).

The methodology step by step formulates this research through semi structured interview and survey questionnaires followed by review through comparison guidelines and statutes.

The epistemology then approaches prescriptive methodology with pragmatist paradigm to ensure promptly the incessant technological and environmental changes continued growth in regulations because changes in scientific technology will necessitate changes to statutory requirements.

Lastly, in section 3.16 the methodology progresses to case study approach which is not only the form of qualitative research, even though others recognized the case study as being the array of qualitative research choices, it can be based on any mix of quantitative and qualitative evidence (Creswell, 2012).

Prescriptive based methodology can best suit and increase the current level of regulatory balance and marine mammal protection on exclusive zone, soft start, PAM mitigation and other seismic survey scientific tools discussed later in section 4.14.

3.15 Performance-based methodology (Qualitative tool)

Seismic operators are people who do the work. Work sometimes is planned by regulators although it remains the operators who must perform tasks in the geographical region and undertake activities necessary for the carrying out of their functions. To determine the most sensible and efficient unification of policy and technology, feedbacks from seismic operators is significantly relevant in this qualitative data collection.

The performance-based approach provided from interviews renders insights to best application as the operator recounts essential performance that would improve the proficient of the current practice by making it more forthcoming to accomplishment in scientific and environmental changes. Although pragmatism is a philosophical position, which argues that knowledge and understanding should be derived from experience

(Eatserby-Smith et al., 2008), a quantitative model (PDMR) to extract data is also applied to provide the best understanding of the research problem. Pragmatism is not committed to any one system of philosophy and reality. This applies to mixed-methods research in that inquirers draw liberally from both quantitative and qualitative assumptions when they engage in their research (Creswell, 2009).

3.15.1 Performance-based PDMR model (Quantitative tool)

In a realistic scenario, prescriptive-based seismic measurement must be comprised into performance-based mitigation model of P-D-M-R (Prevention, Detection, Mitigation, Recovery) with relative emphasis to cetacean safety-sustainability risk management as per American Petroleum Institute (API) recommended practice as in Figure 15. This is the reason behind the API Recommended Practice (RP) 75, "Development of a Safety and Environmental Management Program for Offshore Operations and Facilities", which was made mandatory by BOEMRE for every seismic operation risk with acoustic noise (NPC, 2011).

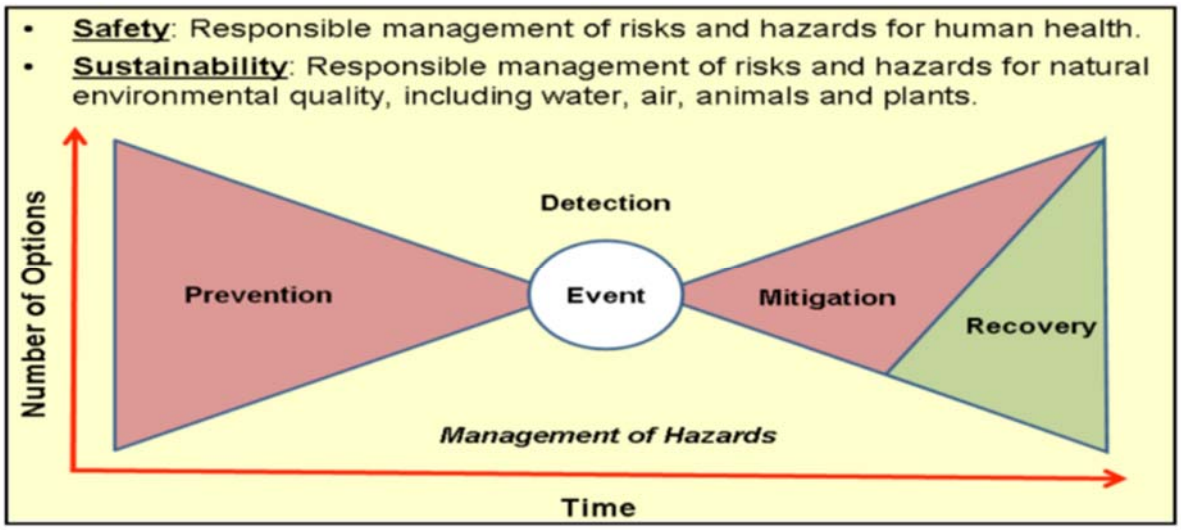


Figure 15: The safety and sustainability "bowtie" model featuring the P-D-M-R elements. Source: National Petroleum Council, 2011

In incorporating each seismic survey in prescriptive seismic measurement followed by performance-based mitigating model, seismic operators can then map step by step via the P-D-M-R categorizations at the project preparation level. By doing so, PETRONAS will then be capable to evaluate every P, D, M or R consideration clearly in their integrated HSSE plan.

Table 7 summarizes one view of how the safety-sustainability elements are incorporated into risk management. P-D-M-R safety-sustainability elements will likely receive different relative proportions of emphasis within different offshore activities, depending on precisely which hazards are being managed. Table 7 suggests different combinations of P-D-M-R emphasis for different intersections of the seven topical areas and the four hazard categories.

Offshore Operational Core Topic Area	**Safety-Sustainability in Offshore Development: Planning Emphasis P= Prevention, D = Detection, M = Mitigation, R = Recovery**			
	Human Health & Safety (Immediate)	**Disturbance of Marine Mammals & Fish**	**Oil & Gas Spills into Marine Environment**	**Other Pollutant Releases into Air or Water**
1. Environmental Footprints and Regulatory Reviews	P, M	P, D, M, R	P, D, M, R	P, D, M, R
2. Environmental Management of seismic and Other Geophysical Exploration Work	P, D, M	P, D, M	P, D, M, R	P, D, M, R
3. Subsea Drilling, Well Operations and Completions	P, D, M, R	P, M	P, D, M, R	P, D, M, R
4. Well-Control Management and Response	P, D, M, R	P, M	P, D, M, R	P, D, M, R
5. Offshore Production Facilities and pipelines, Including Arctic Platform Designs	P, D, M, R	P, M	P, D, M, R	P, D, M, R
6. Offshore Transportation	P, D, M, R	P, M	P, D, M, R	P, D, M, R
7. / Information Management	P, D	P, D, M	P, D, M	P, D, M

Table 7. Safety-Sustainability Elements of Emphasis in Different Offshore Operations. Source: NPC, 2011.

For example, core topic 7 (Information Management) enables the dissemination of essential information used in oil-spill planning, recovery and restoration operations but data management alone cannot implement hazard Recovery measures. Comprehensive planning for safety and sustainability of every offshore operation should include explicit consideration of each of the P-D-M-R elements and documentation of how each one is accommodated. Documentation should further include explanation of whether and why any of the four elements is de-emphasized. Toward that end, there will be a need for a standardized and rigorous process for reviewing and documenting the four elements in every operating plan.

PETRONAS must detail the intensity and substantial effect of the noise pollution and incorporate that in the P-D-M-R bowtie model for performance-based methodology. This ensures the data depicted on risks of detrimental impacts on the specific area of operations, and consideration will be applied to the prescriptive scientific tools.

This model will be useful to depict the related methods of the planned seismic activity and also identify the current environmental condition before seismic activities initiates. The P-D-M-R model will distinguish the existent and possible effect to cetaceans, including any conflicts with existing biodiversity.

This will ensure a comprehensive coverage to risk associated to cetaceans and to define any possible alternatives for taking on the activities to avert, rectify, or extenuate any adverse effects and will be moderated effectively (UNCLOS, Article 194)

3.16 Case study

Since the research objective is aimed at formulating a framework that can be used towards successful implementation of seismic survey guidelines in a typical oil and gas industry, 2 case studies has been chosen for in-depth study, gain insight and understanding of the existing processes of the cases and gather data to answer the research questions.

Case study 1(one) Stone, C J, Cetacean sightings during seismic surveys, 2001 is based on the technical definition of case study by Yin (2013), which states that `a case study is an empirical inquiry to investigate a contemporary phenomenon ("the case") in depth within its real life context especially when the boundaries between phenomenon and context are not clearly evident'. The researcher capitalized on the choice of case study one because of the feasibility of understanding the real-world seismic mitigation case and assumes that such an understanding is likely to involve important conditions pertinent to this research in case study 2 (Yin et al, 2007). In case 2 (two) the unit to be studied is the PETRONAS Dalak Project in Labuan, East Malaysia which requires multiple sources of evidences to benefit the development of theoretical propositions in the data collection and analysis.

Going by the nature of the study with the broad research question to be `How can seismic survey guidelines be successfully applied to the National Oil Company like PETRONAS, means that the first choice of case study must had its methods met in conformity to International standards, as such questions are more exploratory and likely to lead to the use of case study one, Simons (2009) and Yin (2011) further emphasized that it is because such questions deal with operational links needing to be traced over time rather than mere frequencies or incidences. Other justifications for the adoption of case study research methods are enumerated below as presented by (Simons, 2009).

Case study two is the focus in this research where exploring and understanding the process and dynamics of change in policy is required. And it involves closely documenting describing and interpreting seismic processes as they unfold in the 'real project setting', it also can determine the factors that are critical in the implementation of a policy and analyse patterns and gaps between them.

The methodology used for this research is to compare both case studies in various perspectives, mainly in prescriptive of scientific tools applied, exploring contested viewpoints and demonstrate the influence of key factors and interactions between them in telling a story of policy in play. That means it can explain how and why things happened. For case study one in particular this enables the researcher to explore the complexity of policies to be studied in depth and interpreted to suit the Geo-political contexts in which the statutes and policies are going to be enacted, specifically in Malaysia,

Case study two is chosen for this research because it has the potential to engage participants in the research process, in both political and epistemological arena. It signals a potential shift in the power base of who controls knowledge and recognizes the importance of co-constructing perceived reality through the relationships and joint understandings of academics and industry. It also provides an opportunity for future researchers to take a self-reflective approach to this study.

Case study two is adopted for its flexibility, which is neither time-dependent nor constrained by method as a reference case. It can be researched and be written up in different forms however the focus on prescriptive and performance range of methods are the most appropriate in understanding the research objectives.

Case study one is written in simple language, including vignettes of people in the case, direct observation of seismic operators, peculiar incidents and anomalies, public

perception to vicarious experience of what was observed and utilize their knowledge in answering the research questions.

There is no doubt that case study research method cannot exist without such challenges as accumulation of mass data that could be difficult to process, reports that may be too long and detailed for stakeholders to read and narratives that may over persuade.

Albeit bounded by the scope and limitation of this study, experimenting or testing the proposed framework is however limited by the research duration or time frame.

3.17 Chapter summary

This chapter conveyed the step by step process of the various mix methodology used, ranging from design of questionnaire to data collection tools and models, respondent groups, method of analysis and case study selection, Core topic one in the following chapter will show the review in seismic environmental footprint in three review segments; 1) International treaties and conventions 2) Country specific guidelines 3) International joint programmes, and the comparative review of country based regulations for a broader perspective to study the seismic guidelines in depth.

CHAPTER FOUR– CORE TOPIC ONE
SEISMIC ENVIRONMENTAL FOOTPRINT AND REGULATORY REVIEWS

4.1 Segment One: International Treaties and Conventions

4.1.1 UNCLOS - The United Nations Convention on the Law of the Sea (UNCLOS)

UNCLOS is also called the Law of the Sea Convention or the Law of the Sea treaty which took place between 1973 and concluded in 1982, replaced by four 1958 treaties (UNCLOS Treaty, 2014), which resulted from the third United Nations Conference on the Law of the Sea (UNCLOS). It defines the ethical motive and obligations of nations with regard to the ecology, and the governance of ocean's use and resources, establishing regulations for businesses. This is the highest authority for sea pollution control and it presents a legal framework upon which the management of the global oceans should be carried out where nation states should adhere to guidelines when managing the seas of the world. Malaysia ratified UNCLOS on 14 October 1996 and UNCLOS came into force on Malaysia on the 13th November 1996 (Ratifications, 2014)). Overall UNCLOS comprise of 17 parts, 320 articles and nine annexes (UNCLOS Agreement, 2014), however, the primary focus of this study will be on the core of Part XII's provisions to call for States to take "Measures to prevent, reduce and control pollution of the marine environment". These measures are to be taken by nations to prevent marine pollution from all sources on the sea-bed as well as in the marine environment. This emphasis in closing the gaps in implementation of the general provisions in Part XII will be discussed in this study, as Malaysia lacks in regional instrument, knowledge and comprehensive national programme in seismic survey mitigation. In implementing Part XII, Malaysia is demanded to constitute local laws to closely admonish the consequences of marine pollution including public notification, alternative contingency planning and in-depth research to closely monitor the effects of pollution on its marine environment. (UNCLOS Agreement, *see part XII*, 2014).

4.1.2 UNEP - United Nations Environment Programme

Established in 1972, UNEP is the advocate for the environment within the United Nations, acting as an educator and enabler to promote sustainable development of the global environment. As an advocate for the global environment, UNEP sets the global environmental agenda, which promotes the coherent execution of the environmental checks and measures of sustainable development within the United Nations. Within their agenda includes ecosystem management, environmental governance, chemicals & waste pollution, climate change, etc. However so, UNEP does not authorize regulations as these are governed in the individual jurisdictions of area of environmental concern (UNEP, 2014).

4.1.3 (MSFD) - Marine strategy framework directive

The European maritime policy contrived to create a framework for sustainable use of Europe's marine waters. Their commencement considered a myriad of anthropogenic “noises” and their potentially cumulative effects initiating MSFD, which is management of human actions producing impact on the marine environment. Most European legislation and guidelines are supplemented from MSFD including JNCC, where concepts of environmental protection and sustainable use a legislative framework is integrated in the ecosystem management (Oil & Gas UK, 2014)).

The Baltic Sea, the North-east Atlantic Ocean, the Mediterranean Sea and the Black Sea are the four European maritime regions of the Sea Conventions. MSFD is a global resource for policy makers which actively collaborate through Conventions between the Member States which shares the same marine waters, to educate, train marine institutions, contribute economic interests and involve anyone with an interest in the marine environment (MSFD, 2014)).

4.1.4 HELCOM - Baltic Marine Environment Protection Commission - Helsinki Commission

The Helsinki Convention, also known as HELCOM is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, with the Contracting Parties include Denmark, Estonia, the European Union, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden (HELCOM, 2014). HELCOM was established about forty years ago to protect the marine environment of all sources of pollution for a salubrious marine environment to support a variety of sustainable development and social activities. There are five areas within HELCOM, which addresses specific tasks and source of pollution, namely; Monitoring and assessment (MONAS), Land based pollution (LAND), Shipping issues (MARITIME), incidents response (RESPONSE), and Nature protection and biodiversity (HABITAT). These outlined framework for specific tasks is done for UNCLOS and HELCOM is allowed to set environmental standards with respect to most sources of pollution (Schriften zum See-und Hafenreccht, 2006). The Helsinki Convention is therefore adopted not only to preserve the marine environment in the Baltic and but to deal with marine pollution globally as an umbrella convention of UNCLOS (Abhinayan Basu, 2012).

4.1.5 ASCOBAN - Agreement on the Conservation of Small Cetaceans in the Baltic, North East Atlantic, Irish and North Seas.

Under the aegis of the Convention on Migratory Species (Bonn Convention), ASCOBANS entered into force in 1994. Later in February 2008, an annex of the agreement came into force which changed its name to "Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas" (ASCOBANS, 2014).

ASCOBANS recognizes the dangers of underwater noise pollution in its Conservation Management Plan and in 2003 passed a resolution endorsing a commitment to apply the Precautionary Principle to ocean noise. This declaration inaugurated the Scientific Committee to the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and

Contiguous Atlantic Area (ACCOBAMS) to issue a formal recommendation on anthropogenic Noise in 2003. However prior to this event, during the sixth Meeting of the Advisory Committee in April 1999, the Committee have already recommended that other parties should apply similar guidelines developed by JNCC for the UK since it was frequently used by seismic contractors working in other areas. (ASCOBANS Report of 6th, 1999).

4.1.6 ACCOBAMS - Agreement on the Conservation of Cetaceans in the Black Sea Mediterranean Sea and contiguous Atlantic Area

In 1991, an informal group met in Palma de Majorca with the view of drafting an Agreement as a standing Committee against anthropogenic noise. This Agreement resulted from the consultation between the Secretariats of the three Conventions: the Barcelona Convention on the Protection of the Marine Environment and the Mediterranean Coast, the Bonn Convention on the Conservation of Migratory Species of Wild Animals and the Bern Convention relative to the Conservation of European Wildlife and Natural Habitats. The Bucharest Convention on the protection of the Black Sea against noise pollution joined the group later. This bore to the first inter-convention consultations held in Athens on the 26th and the 27th of October, 1992 essentially on the mechanisms of cooperation, coordination and transmission of information on cetaceans between the Secretariats of the three Conventions (Barcelona Convention, Bonn Convention, Bern Convention) and all organizations involved in implementing on the conservation of cetaceans in the Mediterranean and Black Seas (ACCOBAMS, 2014).

On the 2nd meeting of the scientific committee in 2003, ACCOBAMS issued a formal recommendation on Anthropogenic Noise from seismic survey. “Identify problem areas and assess the impact on coastal dolphins of high intensity noise. Determine whether impulsive noise affects bottlenose dolphin distribution and habitat use, and investigate other possible detrimental effects on the animals. The occurrence of impact on the animals which may be relatively subtle or hidden and therefore difficult to measure (e.g. behavioural disruption, stress

etc.) should be evaluated carefully (Richardson et al., 1995)", (ACCOBAMS report of the 2nd, Action 4.6, 2003). This was a pivotal recommendation that enforces a global consensus in marine mammal conservation against seismic survey till today.

4.1.7 OSPAR - OSPAR is so named because of the original Oslo and Paris Conventions ("OS" for Oslo and "PAR" for Paris).

The Oslo Convention with a mandate against ocean dumping extended to cover land-based pollution and to the offshore industry by the Paris Convention in 1974. These two conventions then unified, up-dated and then extended to the 1992 OSPAR Convention. It is a fifteen Government coalition of Europe, together to cooperate to protect the marine environment of the North-East Atlantic. They are Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and The United Kingdom. (OSPAR Commission, 2014)).

OSPAR plays an important role in the knowledge sharing and agreement between other international organisations such as the Marine Strategy Framework Directive (MSFD) and International Maritime Organisation (IMO) for standardisation of guidelines, methodologies and data collection (OSPAR commission, 2009). The OSPAR Convention comprises of a series of conditions requiring the application of the precautionary principle (OSPAR Convention, 1992) such as penalty, that the polluter pays the principle (Article 2 (2) (a)), by showing best available techniques to remedy current practice (BAT) (Article 2 (2) (b)), and by providing best environmental practice (BEP) (Article 2 (3) (b)). By doing so, the legislation provides the participation of the applicant to identify threats to the marine environment and organize programmes and measures to prevent them and ensuring participating member states effectively implement it into their national legislation. This framework allows for accountability of each EU member to acknowledge the provisions and entitlements of UNCLOS and highlights that the General Principles for the Conduct of Marine Scientific

Research demand conformity with all applicable regulations for marine pollution (OSPAR Convention, 2008).

OSPAR's plans to establish a network of Marine Protected Areas by 2016 as an ecologically consistent and a well-established biodiversity strategy. OSPAR defines Marine Protected Area (MPA) as:

"a maritime area for which protective, preservation, recuperative or preventative measures, coherent with international law have been established for the purpose of protecting, conserving species, habitats and ecosystems of the marine environment" (OSPAR Convention, 2003).

The UK has currently identified 244 OSPAR MPAs with the assistance of JNCC in formulating a matrix to appraising the ecological consistency of the OSPAR MPA (OSPAR MPA, 2014).

Summary of International treaties relating to Ocean Noise Pollution:

1. The 1982 UN Convention on the Law of the Sea (UNCLOS) defines noise pollution is likely to cause injurious effects as impairment to living resources of marine life and causes deterioration of quality of sea water. (UNCLOS, Article, 1, (1), (4))
2. ASCOBANS recognizes the dangers of underwater anthropogenic noise in its Conservation Management Plan and passed a resolution endorsing a commitment to apply the Precautionary Principle to ocean noise in 2002 (ASCOBANS report 9th, 2002)
3. The Scientific Committee to ACCOBAMS issued a formal recommendation on anthropogenic noise in 2003 (ACCOBAMS report of the 2nd, 2003).
4. OSPAR recognizes the problem of anthropogenic noise in its "Guidelines for the Management of Marine Protected Areas" and at its 2003 meeting directed the Secretary to prepare a report to further assess noise impacts from offshore activities (OSPAR convention, 2003-18).

4.2 Segment Two: Country specific guidelines

4.2.1 United Kingdom

4.2.1.1 JNCC - Joint Nature Conservation Committee

JNCC was initially established under the Environmental Protection Act 1990, and was later restructured by the Natural Environment and Rural Communities (NERC) Act 2006 (NERC, 2015) as a public body that advises the UK Government and international nature conservation.

Professor Chris Gilligan	Independent Chair(University of Cambridge)
Dr. Hilary Kirkpatrick	Chair, Council for Nature Conservation
Ms Diane McCrea	Chair, Natural Resources Wales
Dr. Madeleine Harvard	Deputy Chair, Natural Resources Wales
Mr. Ian Ross	Chair. Scottish Natural Heritage
Dr Susan Walker	Deputy Chair, Scottish Natural Heritage
Professor Howard Platt	Deputy Chair, Council for Nature Conservation
Dr Joe Horwood	Natural England
Dr Bob Brown	Independent
Mr Guy Duke	Independent
Professor Michel Kaiser	Independent (University of Wales, Bangor)
Professor Colin Galbraith	Independent
Professor Ian Bateman	Independent (University of Exeter)

Table 8: Members of the Joint Nature Conservation Committee as of July 2016.
Source: *http://jncc.defra.gov.uk/page=5349*

The composition of the Joint Committee (Table 8), with its purpose and functions of national and international significance, the fundamental basis for the JNCC is the Natural Environment and Rural Communities (NERC) Act 2006.

As set out in the Offshore Marine Conservation Regulations 2007, JNCC's has precise duties for ocean preservation that are concerned to the activities of the oil and gas commercial enterprise (DECC, 2011).

The UK Government appointed JNCC under the Convention on International Trade in Endangered Species (CITES) as the scientific administrative body on fauna to the corresponding EC Regulation (Joint Nature Conservation Committee, 2014).

JNCC not only provides the framework for UK nature conservation, but also as the legal instruments that defines directives, legal acts and policies that shapes international, European and national conventions (JNCC, 2014).

JNCC performs a dynamic function in execution of Annex V on Biodiversity Strategy by offering recommendation to the UK Government to indorse OSPAR commitments. By taking the head role for OSPAR in the mapping of habitats on the OSPAR MPA's (Marine Protected Area), JNCC has focused on areas of species and habitat protection, ecological biodiversity objectives and appraisal of the impacts of anthropogenic noise on Marine Protected Areas (OSPAR Convention, Annex V, 1992).

JNCC help to formulate policies from investment in research and development in the UK and internationally to facilitate mitigation measures from seismic survey activities by the oil and gas industry, and their 'Guidelines for minimising acoustic disturbance to marine mammals from seismic surveys', will be a model framework for many nations to adopt, which will be discussed later in this study.

4.2.1.2 SMRU - Sea Mammal Research Unit

The Sea Mammal Research Unit (SMRU) is a marine science research organisation in Fife, Scotland established in 1978, when the NERC merged its Seals Research Division and Whale Research Unit. It is located at the Gatty Marine Laboratory, part of the University of St Andrews and provides the UK's with the main scientific field of marine mammal biological study (SMRU Scientific report, 2004).

4.2.2 SMRU Partners Overview

The following are the major partners, stakeholders and sponsors for SMRU:

1. Natural Environment Research Council
2. Oceans 2025
3. National Oceanography Centre
4. Scottish Government
5. Department for Environment, Food and Rural Affairs
6. Scottish Natural Heritage
7. Natural England
8. Environment and Heritage Service Northern Ireland
9. Countryside Council for Wales
10. **Joint Nature Conservation Committee (JNCC)**
11. International Whaling Commission
12. Department for Business, Enterprise and Regulatory Reform
13. International Council for the Exploration of the Seas
14. Seafood Scotland
15. National Oceanographic and Atmospheric Association Fisheries Services (US)
16. IUCN-SSC Cetacean Specialist Group

The SMRU carries out key research on marine mammals in many varied subject areas, however, their main aim is to determine the nature, extent and implication of increasing influence on the marine mammals which are often impacted by human marine activities. The SMRU extends to support policy in fields of marine management and is often called upon to advice on policy issues concerning other countries (Policy, 2014). They were instrumental in drafting the 'Guidelines for minimising acoustic disturbance to marine mammals from seismic surveys' for JNCC which will be discussed later in section 3.3 on the inception of JNCC guidelines.

4.2.3 United States of America

4.2.3.1 NOAA – National Oceanic & Atmospheric Administration

Formally known as the National Marine Fisheries Service, NOAA's dates back to 1807 when the US's first scientific government agency, the Survey of the Coast, was appointed. NOAA

maintains as an international leader on scientific and environmental matters under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA), to protect marine species while allowing economic development (NOAA, 2014). NOAA's significance in the Malaysian legislation falls into the jurisdiction of Marine Mammal Protection Act (MMPA), which is under the watch of NOAA (MMPA Annual report, 2014).

4.2.3.2 MMPA - Marine Mammal Protection Act

On 21st October, 1972, The Marine Mammal Protection Act (MMPA) was enacted specifically to protect marine mammals from man-made noise. It is administrated by the NOAA and was divided between the Secretary of the Interior through the U.S. Fish and Wildlife Service (Service), and the Secretary of Commerce. A third Federal agency, the Marine Mammal Commission (MMC), was constituted to review existing policies and better implement the MMPA. These three Federal agencies are well conformed to provide the best management practices for marine mammal protection (MMPA policy, 2014).

The MMPA was the first statute law to impose anywhere in the world and dictate an ecosystem approach to marine biodiversity management. Its main objective is to maintain the health and stability of the marine mammal ecosystem management, consistent with the preservation of sustainable marine mammal species worldwide (MMPA Legislation, 2014).

4.2.3.3 BOEMRE - Bureau of Ocean Energy Management, Regulation and Enforcement

BOEMRE, formerly known as the Minerals Management Service (MMS), managed the nation's oil and gas and other mineral resources on the outer continental shelf (OCS), is divided into four regions: Alaska, Atlantic, Gulf of Mexico, and the Pacific Ocean (BOEM, 2014).

In May 2010, following the Deepwater Horizon disaster, BOEMRE reorganized under then Secretary of the Interior, Ken Salazar to three new agencies ;

- Bureau of Ocean Energy Management, which is accountable for engaging areas of the Outer Continental Shelf for mainstream and clean energy resources.
- Bureau of Safety and Environmental Enforcement, which is obligated to safety, and environmental protection for all offshore activities.
- Office of Natural Resources Revenue, which is in charge of revenue management, oversee asset management, revenue collection, auditing and conformity (Former MMS, 2014).

JNCC requires Marine Mammal Observers (MMO) to be included on every seismic testing for marine mammals' protection. The Marine Mammal Protection Act (MMPA) requires similar protection for marine mammals for a Protected Species Observer (PSO) to be included during all seismic testing operations (PSO is the US term for MMO).

In the US, BOEM, regulates geophysical activities of seismic surveys of oil and gas exploration consultation within Federal waters with the Outer Continental Shelf Land Act (OCSLA). (NOAA's National Marine Fisheries Service Endangered Species Act, Section 7, 2013)

For surveys conducted outside the US, BOEM has no jurisdiction, however Nations are still mandated to section 7 (a) (2) of the ESA of the Marine Mammal Protection Act (MMPA) including the issuance of MMPA authorizations by any US Federal agency (ESA, 2014).

In essence BOEM and JNCC are two sides of the same coin, administering for the US and the UK standards respectively for seismic survey mitigation on marine mammals. Malaysia is ratified with UNCLOS, Convention on International Trade of Endangered Species (CITES) Act 2008 and other EU treaties for cetacean preservation and at the same time it is also adhering to United States Marine Mammal Protection Act of 1972 as a contracting state.

4.3 Segment Three: International joint programmes

4.3.1 JIP - THE E&P Sound & Marine Life Joint Industry Programme

Founded in 2005 the Joint Industry Programme (JIP) is a diversified group of international oil companies together with the International Association of Geophysical Contractors (IAGC) help to identify and conduct a research programme that improves understanding of the potential impact of oil and gas induced sound on marine mammals (OGP, 2014).

JIP is committed under the endorsement of the International Association of Oil and Gas Producers (OGP), to support research and increase comprehension of the effects of noise on cetaceans by seismic blast. Their research provides much needed knowledge to the people around the world and assist governments to make legislations based on the best practices and effective mitigation strategies for seismic survey.

JIP consists of two principal wing: The Executive Committee (ExCom) and the Technical Management Committee (TMC) to ensure that it is open to expert unbiased opinion for scientific understanding on the effects of seismic survey.

The ExCom approves funding and it is represented by business managers and industry scientists that co-ordinates with every partner member on the ExCom, while the TMC delineates the research projects and reports to the ExCom.

This ensures that all members of the JIP are involved and consensus are made unanimously, addressing key questions on the effects of seismic activity. JIP has already committed USD $31 million to research and development, working systematically with NGOs, international agencies and scientists around the world (Research, 2014).

The development of PAMGuard (a software that processes and analyses sounds made by cetaceans) by IAGC, is part of the research programme to detect the presence of marine mammals and calculate their proximity to the seismic vessel in operation, since their identified

vocal characteristics distinguish specific marine mammal species by their communicative spectrum (IAGC, 2014).The subject on PAM will be elaborated further in section 3.16.5.

JIP plays a pivotal role in increasing the understanding of the effect of noise on marine mammals which is a platform that is advantages for PETRONAS to be a member in contributing technical and scientific expertise and funding research programmes locally for effective solution.

4.3.2 JIP MEMBERS

Malaysia is competent to conduct research programmes in collaboration with PETRONAS and JIP in understanding seismic survey impact on marine mammals under the aegis of the International Association of Oil and Gas Producers (OGP). This can be achieved by developing coordinated partnerships with the private sector organisations, for instance seismic contractors like ASIAN GEO. PETRONAS will be invaluable in transfer technology programmes in association with JIP in seismic survey operations.

PETRONAS co-partnership with the private sector to accomplish technology transfer in enhancing seismic survey mitigation operation would enable sustainability, that can deliver stronger and lasting returns to overall Malaysian marine biodiversity conservation.

In August 30, 2016 JIP launched an industry wide reliability database and expanding its reach. OGP had collected performance data from approximately 200 oil and gas companies worldwide. The data used to help the oil industry identify defects, failure trends and impact on seismic survey system performance (Drilling Contractors, 2018).

Seven drilling contractors, Diamond Offshore drilling, Ensco, Maersk drilling, Noble drilling, Pacific drilling service, Seadrill America, and Transocean participate to input all known seismic survey information into an electronic database.

Ten Oil companies, Anadarko, BP, Chevron, CNOOC, KOSMOS, GE Oil and Gas, Petrobras, Statoil, Shell and National Oilwell Varco also participate in *root cause failure analysis* (RCFA) and determine their own key performance indicators to collaborate on improvements. JIP plans to collect more information and help members' spot common problems by increasing member participation from new oil companies and drilling contractors. JIP firmly believes by examining data from a large population of member components, will lead to seismic technological improvements and better mitigation practice in overall seismic survey operations. Looking at the future, JIP anticipates to refine its seismic survey performance and improve overall safety and reliability for the oil and gas industry and marine mammal biodiversity (Drilling Contractors, 2018).

4.4 Inception of JNCC "Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Surveys"

Seismic surveying in the oil and gas industry have taken place off the coasts of North and South America, Asia, Australia, Africa and Europe, An average of about twenty-five offshore oil exploration operation happens at any one time in the Gulf of Mexico itself, with over 900 seismic surveys each year, having the highest level of oil and gas exploration in the world. Exceptionally high seismic activity are also recorded in the North Sea region, Nigeria, Brazil, Malaysia, Indonesia, India, the north western coast of Australia, and Sakhalin Island (Hildebrand, 2009).

International law holds considerable relevance for anthropogenic noise introduced into the ocean environment. The relevance for substantiating these laws are significant to the activities that produce underwater noise, and the marine mammal species that are impacted by it.

Low-frequency (< 100 Hz) sound, in particular, can cross entire ocean basins (Hildebrand, 2009), travels into neighbouring continental shelf, making it an international concern. Ocean noise can legally be treated as a "trans boundary pollutant" - "trans boundary" because it

crosses boundaries between jurisdictions, and “pollutant”, because it fits the UNCLOS definition of marine pollution (Article, 1, (1), and (4)).

Seismic survey activities is trans boundary in nature. Even though the activity may not be in international waters and restrained within the country’s boundaries, the noise discharge does have significant trans boundary impacts. It is of a country responsibility to mitigate standards to preserve marine environment from anthropogenic noise is mandated by UNCLOS (Article 204-206). Noise produced within a country waters can have impacts beyond its boundaries since sound is transmitted efficiently through water (OSHA, 2014). For this to materialize, International agreements are necessitated to regulate these activities and effective coordination globally for concerted actions by neighbouring countries must be accomplished. Some species migrate between countries utilizing marine corridors to migrate entirely beyond national territory (Kent, 1978). This provides another rational for implementing international law in protection of migratory species that are affected by noise. Many potentially affected species migrate over large distances, and measures adopted by one country would be ineffective if similar measures were not adhered by the other country. For such species that reside temporarily or entirely outside national jurisdiction, international law assumes particular relevance to its conservation and wellbeing.

The general provisos of the UNCLOS Article 194 specifies a complete judicial structure for all uses of the oceans by protection and conservation of the marine environment, where in many aspects it represents conventional international law of the seas, for all Nations to abide.

4.5 International seismic pollution law

Although there may not be regulation in Malaysia to address anthropogenic pollution, international law is still very applicable for marine mammal preservation and mitigation. International law provides general responsibilities for countries to safeguard and conserve the

marine mammals and to mitigate seismic noise pollution. Since noise can effect marine mammals and in the mitigating circumstance the conservation of marine ecosystems and habitats, ocean noise pollution have been regulated as a regional instruments for dealing with seismic survey activities. This problem of ocean noise has only recently received most attentiveness within the framework of governments coping with the conservation of marine mammals (Scott, 2007).

Under the regional Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) of 17 March 1992, much attention was given to anthropogenic noise on cetaceans. Five years later, the Committee addressed the impact caused by seismic activities in two of its resolutions following the Second Meeting of Parties to ASCOBANS, which convened from 17th–19th November 1997. Five months later in the Fifth Meeting of the Advisory Committee in April of 1998, the United Kingdom introduced the "Guidelines for Minimizing Acoustic Disturbance to Marine Mammals from Seismic Surveys." These Guidelines, drawn up in 1994, are attached as mandatory conditions on all new licenses issues by the UK government for seismic surveys (ASCOBANS Report of 5th, 1998). A year into that in April 1999, during the Sixth Meeting of the Advisory Committee, it was highlighted that the UK Guidelines were frequently used by seismic contractors working in other areas in the EU and the Committee recommended that all parties should apply similar guidelines developed by JNCC (ASCOBANS Report of 6th, 1999). This important advisory keynote is to be commented as recommended by the advisory committee since Malaysia is in the ratification committee of UNCLOS Numbering 107th, and ratified with UNCLOS on the 14th October 1996. (Ratification, 2014).

The Committee however stated that the adoption of seismic mitigation guideline would depend on individual regional species abundance, dispersion, and cetacean characteristics and further research to evaluate seasonal and regional variation is needed (ASCOBANS Report of 6th,

1999). In the UK, this Guidelines applies to all cetaceans, and all surveys using higher frequency with the purpose to avoid direct physiological harm to marine mammals and not to cause any permanent effects (JNCC, 2010). In order to prevent injury to marine mammals, the Guidelines allows for a 30 minutes delay before beginning of any use of seismic sources, ensuring vicinity of any marine mammals within 500 meters. The start of seismic sources should be delayed further if cetaceans are spotted, or else, power should be built up slowly to give adequate time for the cetaceans to leave the vicinage. Throughout the survey, the lowest practicable power levels should be used and even though no cetaceans have been sighted, .Soft Start (SS) procedure is applied every time the airguns are used. The UK's 'Guidelines for minimising acoustic disturbance to marine mammals from seismic surveys' produced by JNCC were the first such guidelines to come into effect to mandate a law against acoustic pollution. It is an important international law developed to safe guard the conservation of cetaceans from acoustic pollution initiated by SMRU in 1995, which have been used as a framework by other countries throughout the world for seismic survey mitigation plan.

4.6 Inception of New Zealand Guidelines

The Department of Conservation (DOC) New Zealand, following the recommendation from the Advisory Committee (ASCOBANS Report of 6th, 1999), developed the 2013 'Code of Conduct for minimising acoustic disturbance to marine mammals from seismic survey operations' called "the Code". In February 2006, DOC followed suit incorporating JNCC Guidelines and published the Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations. Subsequently in 2010, DOC with the assistance of Blue Planet Marine, facilitated an appraisal of the Guidelines by engaging discussions with Petroleum Exploration and Production Association of New Zealand (PEPANZ). DOC continued the review process during 2011 and developed what would become the 2012 and

consequently the 2013 Code of Conduct, which has been endorsed as industry's best practice towards conservation of marine mammals in New Zealand (Blue Planet Marine, 2010).

4.7 Other International seismic guidelines

Canada, The United States of America and Brazil have adopted JNCC guidelines in order to implement national and international environmental policies to diminish affective disorder to cetaceans from marine seismic survey. The Brazilian guidelines, adopted a mixed methodology of the UK and US guidelines. There are several criteria's to take into intellection in outlining the framework of this guideline particularly on species distribution, feeding, breeding, calving, pupping and migration, which are significant in determining types of methodology to apply.

4.8 Marine protection guidelines used in Malaysia

The Malaysian marine guidelines are bound by UNCLOS, MMPA and Convention on International Trade of Endangered Species (CITES) Act 2008 and further Malaysian marine mammal protective legislations such as

1. Fisheries Act 1985 (Part VI, Aquatic Animals)

2. Fisheries (Control of Endangered Species) Regulation 1999

These regulations state that no person(s) is to catch, kill, possess, buy, export, import, harm, harass or disturb any marine mammals in Malaysian waters, either deliberately or accidentally, however there are no specific guidelines on mitigation measures against seismic blast on cetaceans.

Malaysian marine environment protective legislation are a mixed guidelines of the United States, United Nations and European law. It is to our advantage to formularise using various legislation for an effective monitoring and control procedure in the EIA.

In the US and in most of the other countries which have JNCC guidelines, the two most common disparities are visually observing a "monitoring zone" around the array and temporarily suspending seismic activities when a endangered species is observed within the zone; and secondly, gradually increasing the blast level from the airgun array, which is called soft-start (SS) or ramp-up, before a survey begins or resumes after an interval of silence. The purpose of a soft-start is to dispel marine animals of seismic operations and to allow ample time for those animals to leave the immediate vicinage. Under normal conditions, it is presumed that cetaceans will find the source sound aversive and will move away before auditory injury or physiological effects occur. These disparities within different country domains dissent in terms of time, distance and frequency for reasons that suit to their environment and geophysical background will be discussed in the next section.

BOEMRE together with JIP and the International Association of Oil & Gas Producers (OGP), funded a large research study on the Australian Humpback Whale Behavioural Response Study which included the testing of the efficacy of the soft-start procedure to find the best effectuation in application. This may not be practical for use in other countries with varied ocean salinity and density (Workshop proceedings, 2009).

BOEMRE has also encouraged the evolution and usage of electronic devices like Passive Acoustic Monitoring (PAM) by computing to detect cetaceans in low visibility conditions where the mammals cannot be seen. PAM systems are capable to discover, classify and situate cetaceans. This system again may be accurate but may not be necessarily required in clear tropical waters.

Even though marine mammal preservation procedures and instruments may differ within various countries, but the principle remains the same, which is for the safeguard of cetaceans. According to UNCLOS Article 194, Section 1, Countries are expected to work

on marine environment programmes from any form of acoustic contamination by using feasible conventional methods concordant with the treaty to harmonise with national policies. Therefore in order for Malaysia to draft its legislation, an in-depth research and consultation with marine conservation groups and academia is compelled to formulate best practice instead of conforming established guidelines.

4.9 Comparison review of various country guidelines

The individual reviews of each guideline from different countries have been made as in the sections below and a comparison chart is produced for simplicity of visualizing the differences.

Table 9 shows the comparison chart of different countries' guidelines.

	UK (JNCC)	Brazil (IBAMA)	New Zealand (DOC)	Australia (DOE)	Greenland (MRA)
Planning stage					
Environmental Impact Assessment	Yes, but details are not included	Not mentioned in guideline	Yes, fundamental for Level 1 & 2 survey; details are included in another document	Yes, but details are not included	Yes, detail criteria are included
Exclusive Zone					
Radius from the centre of air gun array	500m	Safety zone(<500m); Warning zone(500m-1km)	Refer to table 1	3km	500m
Pre-shooting search					
Number of MMO	2	3	2	2	2
Duration of search	30min (water depth<200m) 60min (water depth>200m)	30 min	30 min	30min	30min (water depth<200m) 60min (water depth>200m)
Requirement to commence soft start					
Duration of delay if marine mammal spotted before firing	20 min	30 min	Refer to table 1	30min	20 min
Soft Start					
Duration of soft start	20-40 min	20-40 min	20-40 min	30 min	20-40 min
Shut Down of operation					
Situation that needed to cease air gun firing	No shut down when cetacean enters exclusive zone	Start tracking the marine mammal when it enters warning zone; cease fire when it enters safety zone	Refer to Table 1	Refer to Table 2	Use mitigation gun(Lowest power gun) when marine mammals are observed within 500m
Line Changing Policies	Note: Normally, full soft start has to be carried out when the air guns are restarted				
	Air gun volume (>500in^3): If line change duration is longer than 20min, cease firing; otherwise, keep firing. Air gun volume (<180in^3): If line change duration is longer than 40min, cease firing; otherwise, keep firing but increase Shot Time Interval.	If line change duration is longer than 20 min, cease firing	Need to shut down operation unless exceptional circumstances	Not mentioned	If line change duration is longer than 1 hour, cease fire; shorter than 1 hour, use mitigation gun (If no mammal is observed within 500m after line changed, soft start may be skipped)

Table 9: Comparison Table of different countries' guidelines

4.10 JNCC Guidelines Review (JNCC, 2010)

The mitigation methods introduced by JNCC consider planning stage, pre-shooting stage and the shooting stage.

4.10.1 Planning Stage

During planning stage, the proponent of the seismic activity is recommended to assess whether there is any seasonal consideration such as period of migration, breeding, calving or pupping. Those ecological important periods stated above should be prevented. The environment impact assessment should also be done to evaluate the prospect of disturbing or hurting a European Protected Species. However, the details of the environment impact assessment are not discussed in this document. The lowest possible practical power of the air gun array should be used to minimize the disturbance or injury to the marine mammals.

4.10.2 Pre-shooting stage

During pre-shooting stage, Marine Mammal Observers (MMO) are required to conduce a visual observation around the exclusive zone (500m radius from the centre of the air gun arrays) to ensure there is no marine mammal in sight. MMO is a personnel who has the authorization to postpone the air gun shooting if observed any cetacean within that area. MO must comprehend JNCC guidelines and their duty should be only focus on monitoring the mammals within the mitigation area and giving advices to the crew on how to abide by JNCC guidelines. In normal cases, two MMOs are required on a seismic vessel during the survey period. This is to ensure that both MMOs can interchangeably do their duty in their comfortable and healthy condition.

The Guidelines requires a visual assessment for at least 30 min before beginning the operation. For deeper waters (more than 200m), visual scan should be extended to 60 min as some cetaceans are known to be able to submerge for more than 30 min. If there is any cetaceans on

sight during the pre-shooting scan, a further delay of 20 min on the commencement of air gun shooting should be carried out. After 20 min delay, the pre-shooting search need to be repeated again to ensure that the mammal has left the area. If the mammal has left, then the shooting can be commenced; if the mammal still within the area, another 20 min delay should be carried out.

JNCC also encourages the usage of Passive Acoustic Monitoring (PAM) system to track the vocalizing species of cetacean. PAM is the software that normally used as supplement tool during night time or rough weather conditions. PAM operatives are the individual responsible to monitor the system and they are encouraged to work closely with MMOs.

4.10.3 Shooting stage

During starting the operation, minimum power or smallest air gun is used and gradually increased to its normal operating power. This mitigation procedure is known as 'soft-start'. Soft start's duration should be at least 20 min but not significantly longer than 20 min. Soft start which takes longer than 40 min is considered to be excessive. Soft-start is conducted to ensure that unseen marine mammals have sufficient time to leave the mitigation area with minimal damage to them. After commencement of the air gun shooting, for any reason, if the air gun has stopped firing for more than 10min, then a 30 min pre-shooting search and a 20 min soft start have to be carried out. If the break is shorter than 10 min, soft start is not required to be carried out and MMO only needs to conduct a visual assessment.

During the firing of the air guns, although there is marine mammal being observed in the mitigation area, according to JNCC guidelines, there is no need to shut down the air guns but MMOs are required to continue tracking the mammal.

After finishing a survey line, vessel will turn to another line. The durations of line change are varied for different seismic survey types. For seismic survey with an air gun volume of 500 cubic inches or greater, if the line change duration is longer than 20 min, the air gun shooting

should be terminated during the line change. A pre-shooting search and a 20 min soft start are required when a new line commences. For seismic survey with an air gun volume of 180 cubic inches or less, the process like above should be done only when the line change duration is longer than 40 min. If the line change duration is shorter than 40 min, the air gun firing can be continued during line turn but Shot Point Interval (SPI) should be increased. (But not exceeding 5 min).

4.11 New Zealand Guidelines Review (DOC, 2013)

There is a list of marine animals that listed as Species of Concern by New Zealand Code. The survey needs to avoid any sensitive areas as well as critical biological periods where Species of Concern are likely to calving, breeding, etc. During planning stage, the technical detail and specification of PAM system must be provided along with Marine Mammal Impact Assessment (MMIA) whenever PAM is used as mitigation tool. Geographical extent of the area needed for seismic activities such as area where acoustic equipment is being tested and where soft starts are initiated needed to be specified in MMIA process.

MMO's qualification for New Zealand Code is higher than JNCC, as they require to sustain a minimum of 12 weeks' of field training in continental waters under qualified trainers.

Code of conduct 2013 categorized seismic survey into three: Level 1 survey (>427 cubic inches), Level 2 survey (151-426 cubic inches), Level 3 survey (<150 cubic inches). For level 1 survey, no seismic survey vessel crew can be considered as qualified observer regardless of experience and training. However, for Level 2 seismic vessel, crew member that is trained and experienced may act as qualified observer due to smaller vessel and limitation of space. A qualified observer has the authority to shut down or delay the operating survey. If a crew member onboard observes any possible marine mammal, he or she should report to a qualified MMO and the MMO should try to identify what have been observed and the distance between

vessel and the mammal. In case MMO could not find the animal, crew member will be provided a sighting report. It is MMO's decision to be made whether the mitigation action should be done based on the information provided. Table 10 shows operation of survey in 3 different levels.

	Level 1 Survey	Level 2 Survey	Vertical Seismic Profiling
Observer requirement			
Number of qualified MMO	At least 2	At least 2	Requirements depends on capacity of the air gun array and comply to the requirement of Level 1 or 2 survey
Number of qualified PAM operator	At least 2	Not considered mandatory but if PAM is used, at least 2	
Normal requirement before start of survey			
MMO's observation	No marine mammal in sight for 30 min; no fur seal in sight for 10 min	No marine mammal in sight for 30 min; no fur seal in sight for 10 min	Requirements depends on capacity of the air gun array and comply to the requirement of Level 1 or 2 survey
PAM's observation	No vocalizing cetacean detected for at least 30 min	No vocalizing cetacean detected for at least 30 min	
	Additional requirements for start up in a new location during poor sight condition	Requirement of operation at night or during poor sighting conditions	
MMO's observation	Observations within 20 nautical miles of the startup position for at least the last 2 hours of good sighting conditions and no mammal is observed	No more than 3 marine mammal instigated shut downs and start delays occur in previous 24 hours of active operation in good sighting condition	-
PAM's observation	No Species of Concern being detected in 2 hours; no fur seal detected in 10 min; no other marine mammals detected in 30 min	-	-
Delay starts and shut downs will be carried out when:			
Species of Concern with calves	within a mitigation zone of 1.5 km from the acoustic source	within a mitigation zone of 1 km from the acoustic source	Requirements depends on capacity of the air gun array and comply to the requirement of Level 1 or 2 survey
Species of Concern	within a mitigation zone of 1 km from the acoustic source	within a mitigation zone of 600 m from the acoustic source	
Other mammals	within a mitigation zone of 200 m from the acoustic source	within a mitigation zone of 200 m from the acoustic source	
Delay starts and shut downs can be resumed when:			
Species of Concern with calves	last detected 30 min ago within mitigation zone of 1.5 km and the zone remains clear	last detected 30 min ago within mitigation zone of 1.5 km and the zone remains clear	Requirements depends on capacity of the air gun array and comply to the requirement of Level 1 or 2 survey
Species of Concern	last detected 30 min ago within mitigation zone of 1 km and the zone remains clear	last detected 30 min ago within mitigation zone of 1 km and the zone remains clear	
Other mammals	New Zealand fur seal is last detected 10 min ago within mitigation zone of 200 m; other marine mammal is last detected 30 min ago within mitigation zone of 200 m	New Zealand fur seal is last detected 10 min ago within mitigation zone of 200 m; other marine mammal is last detected 30 min ago within mitigation zone of 200 m	

Table 10: Requirements for operation for New Zealand Code of Conduct 2013

Soft starts are also being implemented under New Zealand Code and the procedures are the same with JNCC guidelines.

The requirement of the seismic survey in New Zealand Code is specifically depends on each different level. The seismic survey operation can only be started when these requirements are achieved.

4.12 Greenland's Seismic Guideline Review (DCE, 2011)

Greenland's template of expected noise propagation and specification of PAM system such as sensitivity and species coverage is not included in their Environmental Mitigation Assessment (EMA). Deliverables and objectives of EMA are elaborated in the Greenland's guideline, not in this study.

During the pre-shooting stage, the mitigation policies such as delay of commencement, soft-start and pre-shooting search used in Greenland are exactly similar to JNCC guidelines. However, some adjustments are made in Greenland's guidelines. For example, according to JNCC 2010, during air gun firing, there is no need to shut down the operation when mammal approaches; while for Greenland's guideline, the firing must be reduced to the smallest air gun (mitigation gun) in the air gun array. Besides, for unintended shut down scenario, Greenland's guideline has a different policy to be followed. If air guns stop for 5 min or shorter, air gun can be resumed at full power immediately; if air guns stop for 5min to 10min, MMO's visual scan should be done to ensure there is no mammals in the 500m exclusive zone, if there is no mammal presents, the full power operation can be resumed; if air guns stop for 10 min and longer, a full 30 in pre-shooting observation and 20 min soft start should be carried out before operating in full power.

Line change policy used in Greenland guideline also differs from JNCC. If line change duration is expected to exceed 1 hour, the air gun firing shall be shut down at the end of the line. A pre-

shooting observation and a full soft start must be undertaken when the new line commences. If line change duration is expected to be shorter than 1 hour, the air gun should be reduced to lower power or mitigation gun should be used during the line change.

4.13 Australia's Seismic guidelines Review (DOE, 2008)

In Australia's guidelines, the ecologically important period, calving location and migration route of the known marine mammal such as Humpback whales have been researched and are clearly stated.

In term of mitigation method, Australia's guideline is quite similar to JNCC except the duration and the size of mitigation area differ (Table 11). Pre-shooting search that carried out in Australia has an exclusive zone of 3 km and the soft start is carried out over a period of 30 min. The whale watch should be started when any whale enters the area of 3 km away from the seismic source. For air gun sound pressure less than 160dBre:1µPa, the seismic source power should be switched into lowest possible power when whales are observed within 1km. For other seismic survey with the sound pressure that larger than 160dBre:1µPa, lowest power should be used when whales are observed within 2km. For any case when whales enter within 500m, the fire should be ceased.

	>160dBre:1μPa	<160dBre:1μPa
Observation Zone	2-3 km from the centre of the source	1-3km from the centre of the source
Low power zone	500m-2km from the centre of the source	500m-1km from the centre of the source
Shut down zone	500m from the centre of the source	500m from the centre of the source

Table 11: Exclusive zone in Australia guideline

4.14 Brazil's Seismic guidelines 2005 Review (IBAMA, 2005)

Mitigation methods mentioned in Brazil's guideline are mostly similar to JNCC's guidelines. Only the different policies implemented by Brazil will be discussed in following summary.

Firstly, Brazil's guideline recommends three MMOs to be used on the seismic vessel so that there are always two MMOs on duty. Area within 500m-1km from the seismic source is defined as warning zone while area within 500 m from seismic source is called safety zone in Brazil's guideline. Marine mammal that enters warning zone must be carefully observed by MMO but the cessation of the air gun is not required; if any mammal enters safety zone, the air gun shooting operation shall be ceased. Other than those, the detail of completing MMO monitoring table and sighting recording table are mentioned in the guideline.

4.15 Prescriptive mitigation methods

Beside the comparison chart, the prescriptive mitigation methods among different countries guidelines has been elucidated below:

4.15.1 Exclusive zone

Exclusive zone is definitely one of the crucial criteria that will directly affect the severity of disturbance and harm on marine mammal. Sound level of 160dB rms has been identified to cause behavioural responses while between 180dB (for cetaceans) and 190dB (for pinnipeds) are likely to induce auditory damage and other physical damage (MMS, 2004; HESS, 1999). Based on different capacity of the seismic source, sound pressure of 180 dB rms is achieved at distance from 200m to over 1km from the sound source (Pierson, 1998). This indicates that the exclusive zone (500m) set by some international guidelines such as JNCC and Greenland is not wide enough to protect the marine mammals from the noise disturbance.

For Australia's guideline, exclusive zone of 3km is certainly beyond the range that sound pressure of 180dB rms can reach. However, the reliability of the detection, identification and the estimation of the range have been questionable for both visual and acoustic assessment due to the longer distance.

New Zealand's guideline implements a very different way compare to others in term of exclusive zone. New Zealand has a different treatment for those mammals which are listed in Species of Concern (SOC) and those SOC with calves. The exclusive zone for those SOC with calves is wider than those without as the consideration of calves are more vulnerable to noise compared to the adult. For SOC with calves, the exclusive zone is set to be 1.5km; for adult SOC, 1km of safety area is being used. 1km radius of exclusive zone is based on the sound pressure level of 180dB re 1 Pa isopleths by assuming a 2000-3000 in3 capacity air gun array being used (DOC, 2013). However, due to different water depth, temperature, salinity etc, the sound pressure level may vary.

Brazil's guideline has a similar effect as JNCC because the air gun operation will only be ceased when marine mammal enters safety zone which is 500m although it has a 1km warning zone.

There is certainly necessary to have a case-by-case calculation of safety radii for different regions' water instead of using an arbitrary 500m exclusive zone. The sound pressure level that will affect the marine mammals the most should be obtained by researching the specific species existing in the region and the safety radii should be calculated by taking consideration of water depth, temperature and salinity.

4.15.2 Soft Start (SS)

Every mitigation Guidelines includes the SS in seismic activity to chase away the undetected cetaceans by using initially low powered noise. The assumption of marine mammals will move away from the area has been made but there are cases that the marine mammal approached the initially low level sound source instead of leaving away. This case is illustrated in Shapiro which shown that sperm whales approach the sound source of 160 dB rms instead of leaving the area (Shapiro, 2006).

Besides, some other considerations such as habituation to the noise may occur. Some seals have been found to change their demeanour by lifting their head out of water to avoid the noise. This may lead to chronic exposure of high level pressure noise and may lead to long-lasting or impermanent auditory damage (Cox, 2001).

The delay of the Soft Start varies within countries**.** It is 20 minutes after the marine mammal is last seen within the Exclusion Zone (EZ) in the UK. This is 30 minutes after a 'whale' is last seen in Australia. In New Zealand the SS commences when the animal is outside the EZ or 30 minutes after the animal is last seen within the EZ (with a special requirement for fur seals, i.e. 10 minute delay).

A 30 minute delay is also implemented in the Gulf of Mexico, Brazil and Colombia for cetaceans and turtles. The JNCC recommends measures for turtles but this is not mandatory. Marine turtles are included in measures of Gulf of Mexico, Brazil, Colombia, Trinidad and Tobago, French Guyana, Surinam, Venezuela and Aruba & Curacao.

Malaysia has lately gazetted its National Plan of Action for Conservation and Management of Sea Turtles, which was prepared by the Department of Fisheries, but there was nothing mentioned on seismic mitigation plan (IOSEA, Marine Turtle MoU, 2013). In Trinidad and Tobago the SS commences after cetaceans or significant movements of fish are outside the EZ or a 30 minute delay applies. The SS also is allowed to commence until a marine turtle is outside the zone. In French Guyana the delay of the SS is 20 minutes after seeing a marine turtle or a shark/ray within a zone of 200m or until a cetacean is out of sight. In Surinam, Venezuela, Aruba & Curacao, a 20 or 30 minute delay applies for marine mammals and turtles (MaMa CoCo Sea Project, 2015).

Every guideline in the world includes soft start but the effectiveness of this procedure is questionable. Further research on the behaviour of cetaceans / sirenians and the response to sound source should be investigated to conclude the effectiveness of this mitigation procedure.

4.15.3 MMO

MMO is the individual that monitor, detect and identify the marine mammals during and before the operation of the seismic activities. Standard procedure of MMO is to keep watching from a good location on vessel that provides clear 360º view over the mitigation area.

MMO's number varies for different guidelines. Most of the guidelines recommend 2 MMOs to be used while Brazil recommends 3 MMOs for the intention of more accurate and fresh visual assessment by preventing excessive fatigue. MMOs under JNCC have to undergo a short training before they go for the observation work. During the MMO training, they are taught the role and responsibilities of a MMO, instruction of data reporting, basic information of detection and recognition of cetaceans and a brief understanding on seismic operation (JNCC, 2010). However, there is no pre-requisite course required and the level of experience of MMO is very dependent on their own background. The lack of field training is one of the main problems in JNCC guideline. Therefore, some real field trainings should be included into the training course in order to improve the reliability of MMO. The training course should be including the appearance of the most common species of cetaceans of the water that the MMO will serve his/her duty as well as the cetacean's natural behaviour such as breeding, duration of diving, feeding ,etc. This should be the only different part from a training course to another because the training courses of different countries should be standardized so that for example MMO from UK is equally qualified in New Zealand.

4.16 Other JNCC guideline special requirements

4.16.1 Vertical Seismic Profiling (VSP)

When receivers are located in well holes and its source is adverted off the well platform, it's called vertical seismic profiling. Whilst it is appreciated that VSP operations may produce lower acoustic output than 2D or 3D surveys it is still considered mandatory to conduct a soft-start procedure to allow for the cetaceans to leave the vicinity.

4.16.2 Seismic surveys with an airgun volume of 500 cubic inches or more

If the line change is anticipated to be greater than 20 minutes, airgun firing should be terminated at the end of the line and a full 20 minute soft-start undertaken before the next line. A pre-shoot search of 30 minutes should also be conducted during the scheduled line change, and if cetaceans are observed within 500 metres, the soft-start procedure should commence.

4.16.3 Seismic surveys with an airgun volume of 180 cubic inches or less

If the line change is anticipated to be more than 40 minutes, the airgun should be terminated at the end of the line and given a full 20 minute soft-start kick-off before the next line intake. Similar pre-shooting search should also be undertaken during the line change, and the soft-start is delayed if cetaceans are spotted within 500 metres of the safety zone. If the line change is anticipated to be less than 40 minutes, then the airgun firing can continue during the turn, however the Shot Point Interval (SPI) should be increased (i.e. longer duration between shots). Ideally, the SPI is not permitted for more than 5 minutes during the line turn.

4.16.4 Undershoot operations

When there are oil rigs or offshore platform, there are hindrance affiliated with seismic survey activities due to the obstruction in way off the survey area. An undershoot operations is executed, where a two-vessel operation is carried out, one acts as a streamer and recording

vessel and the other provides the source energy from the two independent units (Figure 16).The emission of the source from an independent vessel gives greater mobility when it comes to avoiding impediments since the streamers are 3 to 12 kilometres long in length. Typically, the recording vessel will sail on one side of the obstacle while the source vessel on the other. The name ‘undershooting’ comes from the Common Mid-Point (CMP) lines that lie between the two survey vessels and the obstructed area. To effectively monitor the mitigation zone, JNCC recommends to place the MMO on the source vessel.

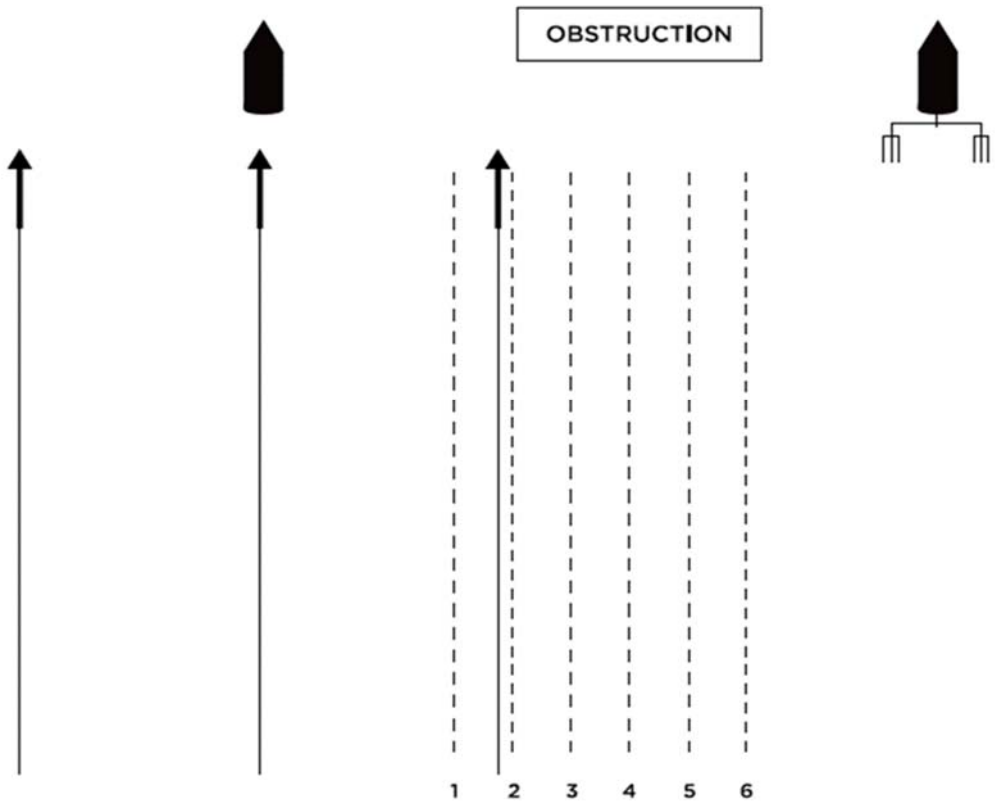


Figure 16: The solid lines indicate the streamers and the dash lines indicate the CMP lines. Towing long streamers (up to 8 KM) around obstruction requires skill and experience from both the marine crew and the seismic crew on board the vessel. Source OGP April 2011- International Association of Oil & Gas Producers.

4.16.5 Use of PAM as a mitigation tool

In poor visual conditions, PAM acoustic monitoring can be a useful appurtenance to visual sightings carried out by MMOs. Even though JNCC promotes the use of PAM as a mitigation tool, in many cases it is not as accurate as visual sightings for determining localization, which literally misinterprets the range precision of the system. For example, if the distant precision of a system is approximated at +/-400 metres, mammals discovered and computed to be within 500 metres could, in reality, be 500 + 400 = 900 metres, and this would lead to a time lag in the soft-start. Although, currently it is not practicable to interpret the accuracy range of most PAM monitors, but this serves to elaborate that it is in the operator's experience to estimate distance, rather than the reliance on the equipment which is accountable in localization of cetaceans (defra.uk.com, 2014).

Some PAM systems do not have a reliable range determination facility or can only calculate the range for some species. In such cases, because of PAM operative's experience gained in differentiating between distant and close vocalisations of the detection of a confirmed cetacean vocalisation, this should still be used to initiate postponement of the soft-start. In the absence of PAM systems capable of range determination, the trained MMOs expert judgement will constitute the best basis for deciding whether an area is free from cetaceans prior to the soft-start. A combined contribution of both roles play a key factors in accurate cetacean detection.

PAM software that analyses cetacean vocalisation has been in rapid development lately. JNCC further enhances to balance proactive implementation of PAM and develop its capability to include other mammal species identification for accurate range detection. Therefore in an effort to enhance PAM acoustic detection, JNCC encourages users to actively include cetaceans native to their maritime sector for refinement for future improvement. (IAGC, 2014).

4.17 Summary of prescriptive mitigation methods that requires further evaluation

4.17.1 Minimising sound output

With a substantial background noise of 1–1000 Hz frequency range, the ocean is a pretty cacophonous environment for cetaceans to inhabit. To limit additional seismic noise, most guidelines accentuate the usage of lowest operable volume. Some recommendations suggest to increase the ratio of energy headed vertically down to reduce high energy output and mitigate impact to cetaceans.

4.17.2 Safety Zones

In order to minimise physiological impairment to marine mammals, safety zones have turn to an instrument to mitigate within established set of guidelines.

The safety radius of 500 m where the marine mammals may be dependably watched is common among Canadian, UK and USA guidelines and regulations, The United States National Marine Fisheries Service (NMFS) has recognized the safety radii of 160 dB for behavioural responses, and between 180 dB for cetaceans and 190 dB for pinnipeds for auditory damage by sound pressure levels.

The NMFS has identified Level A harassment zone at 180 dB, where beyond this pressure level, physiological impairment may take place. However, given the underlying doubt over its diligence to all species, the 160 dB threshold limit acts more to precautionary solution.

4.17.3 Soft-Start

Soft-start denotes to the slow build-up of energy passed from the airgun from the smallest dB in ascending order for 20–45 min to allow cetaceans to displace.

The efficiency of the soft-start procedure may vary in different species and circumstances, and causes a negative stimulus associated to habituation. Habituation leading to prolonged exposure contributes to chronic auditory damage.

Controlled Exposure Experiments (CEEs) must be conducted on a case-by-case basis for determining the reaction of species to seismic frequency and define the real dangers related with Soft-start technique.

4.17.4 Visual Observations

This technique is performed by trained MMO and frequently used procedure in supervising the mitigation zone.

MMO's tally varies between different nations and the requirements of a survey. The JNCC and Marine Mammal Protection Act (MMPA) specify the MMO/Protected Species Observer (PSO) syllabus for the UK and USA, respectively. Each program comprises a summary of operations, relevant legislation, function of a MMO, data transcription and reportage and information about cetacean spotting and recognition.

There is presently no equilateral course for MMO's, therefore the training is often adhoc, and MMOs expertise solely depends upon their cognition resulting in high irregularity. In order to ameliorate and regulate MMO training, the syllabus must be standardised, such that an MMO trained in the US is qualified to operate in the UK for example, since the program and mitigation tools are the similar.

4.17.5 Passive Acoustic Monitoring (PAM)

PAM in most instances isn't as precise as visual observation which literally misinterprets the range accuracy of the system. For example, if the distant is approximated at +/-400 metres, mammals discovered in reality could be 500 + 400 = 900 metres, and this would contribute to a time lag in soft start.

Some PAM systems can only calculate the range for certain species and it is because of the PAM operative's experience in distinguishing between range and confirmed species vocalisation, this could commence deferment of the soft-start.

The use of PAM as a prerequisite in this form promotes seismic operators to rely in its operations and become more dependent to it which in returns widens the operation budget and proven not as effective.

4.17.6 Temporal and Spatial Restrictions

Global research programmes had aided the recognition of MPA's, backed on the presence of marine threatened species, biodiversity, foraging, breeding and migratory patterns.

Temporal and spatial restrictions are generally to monitor seismic operations to cumulate data concerning the localizations of cetaceans with regard to any perceptible alterations in distribution or decline in numbers due to the operations.

To consecrate this, aerial surveys are required to monitor at approximately 300m elevation to prevent commotion to cetaceans', which is a copious cost to bear for MPA's planning.

4.17.7 Voluntary Methods

Since Malaysia has no seismic guidelines in place, some oil company clients operating here are taking the initiative to implement similar mitigation protocols on a freewill basis.

Many clients were willing to use the JNCC guidelines in offshore survey where there are no statutory guidelines for marine mammal mitigation, for example, Amerada Hess working offshore Libya (NPC, 2011).

Similarly, clients working offshore Malaysia have implemented JNCC guidelines amended for the particular conditions of this area, but at times not imposing shutdown procedures of 500m safety zone or Soft-start sequence to avoid production downtime because this was done on a voluntarily basis.

4.18 Chapter summary

In this chapter the study presented seismic environmental footprint in regulatory review to compare and analyse various international seismic guidelines, tools and techniques for proposed inclusion into the PTS (PETRONAS Technical Specification). The review has clearly identified various international conventions, country specific guidelines, International joint programmes, comparative review of various international guidelines and methods formulated which have more similarities than differences between them. For instant, the utilization of soft-start besides being omnipresent, it coheres to virtually similar time constraints between nations.

This is not astounding, given the mutual goal of mitigating disruption to cetaceans during seismic survey. What is astonishing is the ways the safety zones vary.

There are clean-cut motion for distances determined as what is comparatively easy to visually observe for zones established on the distance at which a sound pressure is reached. However,

at this phase in time it is still uncertain which pressure level is most suitable to set as limit, and this is debatable to agree with on suitably sized safety zones.

The study has described numerous domains where further prescriptive methods can be headed, as well as points for discourse in regulatory reviews of seismic environmental footprint.

The specific dynamics of seismic noise pollution measurement is lacking and calls for advance in-depth study and the need for decisive safety zones based on safe seismic survey frequency is essentially imperative.

These prescriptive seismic methods could be improved further by:

- ✓ Standardisation of measurement units;
- ✓ Improvement of mathematical models for seismic sound transmission;
- ✓ Acoustic measurements of pertinent seismic sources i.e. detailed measurements of seismic levels, frequency, and radiated sound field around intense and chronic noise sources;
- ✓ Surrounding ocean noise measurements i.e. systematic measurements of underwater ambient noise to quantify how human activities are affecting the acoustic environment via ambient noise mapping;

The cooperation with academia, environmental NGO and PETRONAS to use data gathered by MMOs and PAM operators from around the world to help analysis to delineate areas suited for management of Malaysian MPAs for marine mammal mitigation is crucial. These gaps will be discussed in Chapter 6 Information Management.

The clear recommendation to emerge from this research objective is that an international unanimity in mitigation techniques must be employed that would be beneficial to all stakeholders. Having clear mitigation procedure grounded on the essence of which do not differ between countries will make it simpler for seismic operators to adhere to. With this assurance,

prescriptive and performance-based decisions will serve best to initiate a new proposed Malaysian Seismic Guidelines in the near future.

The relevance of existing International regulations and treaties for the preservation of marine mammal should be looked into specifically to input where necessary and amendments proposed to suit localised marine mammal transmigration characteristics and foraging habits.

The need to include OSPAR. ASCOBANS and ACCOBAMS regulations when developing this framework on scientific measures to mitigate seismic pollution is important since these guidance includes the description of appropriate mitigation methods that could be deployed.

This framework must also integrate JNCC special requirements and its purpose should be to provide impact criteria and enable more consistent measurement for prescriptive seismic tools, such as Minimising sound output, Safety zones, Soft-start , Visual observations, Passive acoustic monitoring (PAM) and Temporal and spatial restrictions.

The most efficient way to develop seismic mitigation methods is to research geographical and seasonal migration of marine mammal species in Malaysian maritime and to avoid misconstruing data for typical characteristics of endangered species elsewhere. Standards have to be selected and designed on ‘species-to-species’ basis and not generalising. In particular for all those cetacean in Malaysia for which scientific information are not available, the mitigating measures must be the essence customized from a combination of prescriptive and performance based variation.

Following all the consideration of international seismic footprint and cross comparative review so far, in the next section the study will explore if there exist a guidelines for seismic survey in oil and gas exploration work within the Malaysian Biodiversity Policies.

CHAPTER FIVE– CORE TOPIC TWO

ENVIRONMENTAL MANAGEMENT OF OIL AND GAS GEOPHYSICAL EXPLORATION WORK

5.1 National Policy on Biological Diversity (NPBD) 2016

5.1.1 Introduction

Malaysia is recognised as one of 12 mega-diverse countries in the world. The global significance of Malaysia's biodiversity is reflected through the representation of several G200 Ecoregions in East and West Malaysia, including tropical lowlands, mangroves, peat and montane forests as well as its marine ecoregions (the Sulu-Sulawesi Marine Eco-region and the Andaman Sea) (MOSTI, 2010)

Malaysia's marine ecosystem covers highly diverse habitats especially its coral reefs. Most reefs occur in the coastal zones and consequently, making it the most biological diverse area. Malaysia alone is reported to house 612 species of corals. This accounts for 77 percent representation of the world's coral species. The coral reef in Malaysian waters is also home to no less than 700 species of fish. Four (Green Turtle, the Hawksbills, the Olive Ridley and the Leatherback Turtle) out of the seven species of marine turtles are found to be nesting on Malaysian beaches (Chong et al., 2010).

Malaysia sanctioned the Convention of Biodiversity (CBD) in 1994 and formulated the National Policy on Biological Diversity (NPBD) in 1998. Alongside its obligations under the CBD, Malaysia has been integrating biodiversity conservation as an integral part of sustainable development, a consistent policy component of the 5 year development plans of Malaysia. Malaysia advocates a development path that emphasises conservation aspects while striving to achieve socio-economic development goals (Economic planning unit, 2013). Figure 17 illustrates the commitment by the Malaysian Government to conserve our biodiversity through sustainable approach.

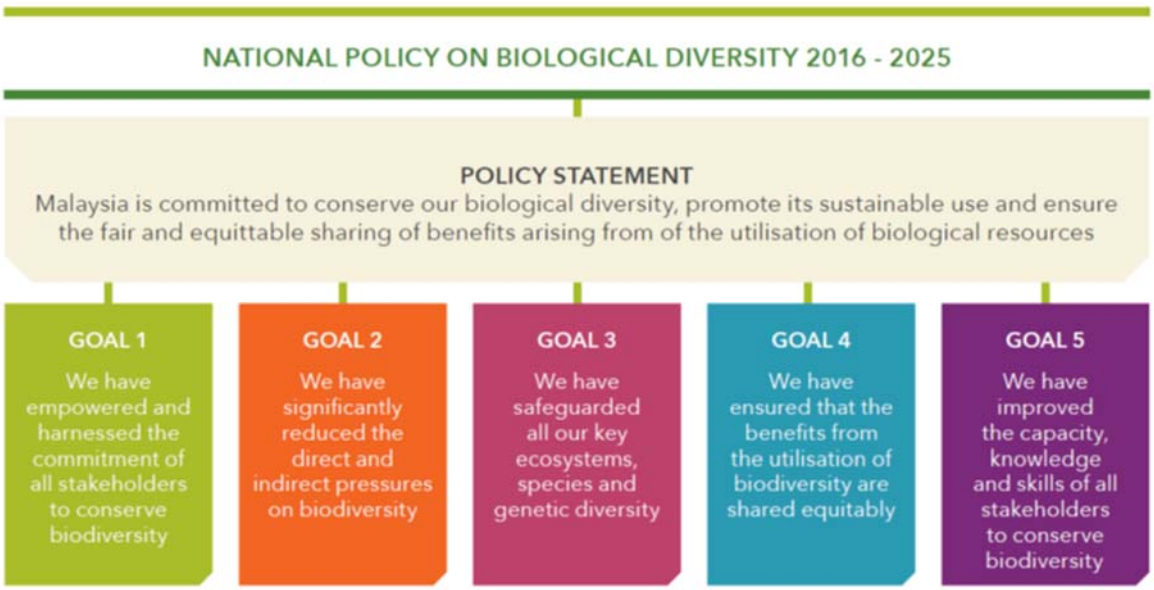


Figure 17: 5 Goals to achieve in the Policy Statement of NPBD 2016. Source: NPBD, 2016

Being the 64th nation to ratify the CBD in June of 1994, Malaysia remains committed in implementing its allegiance under the Convention.

Marine protected areas (MPA) in hectares (1.4%) is relatively minuscule in general compared to Malaysian waters which is about 453,186 km2 overall coverage, is a huge sanctuary for marine biodiversity ranging from coral reefs to marine mammals. The proposed Tun Mustapha Marine Park in Sabah is forecast to boost over 1.0 million hectares of MPA in the country (NRE, 2014).

The National Biodiversity Strategies and Action Plans (NBSAP), otherwise known in Malaysia as the National Policy on Biological Diversity or NPBD 1998 is a mega-level integrated conceptualization in which the document known as the Common Vision on Biodiversity is deployed as a directive for policy makers in relation to biodiversity projection and organization. With regard to development planning and the categorisation of areas.

Though the term biodiversity is not provided for in the Constitution explicitly, recognition of the various components of biodiversity such as forests, fisheries, land and wild animals are present under these various lists. From umbrella institutional view point on biodiversity governance, the previous National Biodiversity-Biotechnology Council is now known as the National Biodiversity Council (NBC) with a more focused function on biodiversity related issues. Specifically the NBC would determine and endorse the direction, policy and strategies for conservation of biodiversity. It is chaired by the Deputy Prime Minister and functions as a mediation and discussion on biodiversity issues between the state and federal government (NRE, 5th National Report, 2014).

For strengthening these procedures and increasing their scope and effectiveness in the EIA, Malaysia plans to adopt the flow process as below in Figure 18.

Acknowledging these demands, the Prime Minister, via the Ministry of Natural Resources and Environment has developed the National Policy on Biological Diversity 2016 – 2025 to aid as our guide for biodiversity management over the next 10 years (NPBD, 2016).

From Figure 18 it can be seen that the goals of achieving seismic survey legislation is rather foretelling and relevant with Target 9 in prevention of extinction by improved and sustained methods on endangered species by the year 2025.

GOALS, TARGETS AND ACTIONS

GOAL 1

We have empowered and harnessed the commitment of all stakeholders to conserve biodiversity

This goal seeks to encourage and empower all stakeholders to conserve our biodiversity.

Target 1: By 2025, more Malaysians are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Target 2: By 2025, the contributions of indigenous peoples and local communities, civil society and the private sector to the conservation and sustainable utilisation of biodiversity have increased significantly.

GOAL 2

We have significantly reduced the direct and indirect pressures on biodiversity

This goal aims to ensure that all sectors of the economy are planned and managed in a manner that does not impose pressures on our biological resources.

Target 3: By 2025, biodiversity conservation has been mainstreamed into national development planning and sectoral policies and plans.

Target 4: By 2025, our production forests, agriculture production and fisheries are managed and harvested sustainably.

Target 5: By 2025, tourism is sustainably managed and promotes biodiversity conservation.

GOAL 3

We have safeguarded all our key ecosystems, species and genetic diversity

This goal aims to ensure the resilience of our key ecosystems, species and genetic diversity and that they are managed in an effective and integrated manner.

Target 6: By 2025, at least 20% of terrestrial areas and inland waters, and 10% of coastal and marine areas, are conserved through a representative system of protected areas and other effective area-based conservation measures.

Target 7: By 2025, vulnerable ecosystems and habitats, particularly limestone hills, wetlands, coral reefs and seagrass beds, are adequately protected and restored.

Target 8: By 2025, important terrestrial and marine ecological corridors have been identified, restored and protected.

Target 9: By 2025, the extinction of known threatened species has been prevented and their conservation status has been improved and sustained.

Target 10: By 2025, poaching, illegal harvesting and illegal trade of wildlife, fish and plants are under control and significantly reduced.

Target 11: By 2025, invasive alien species and pathways are identified, priority species controlled and measures are in place to prevent their introduction and establishment.

Target 12: By 2025, a comprehensive biosafety system inclusive of a liability and redress regime is operational to manage potential adverse impacts of modern biotechnology on biodiversity and human health.

Target 13: By 2025, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives is adequately conserved.

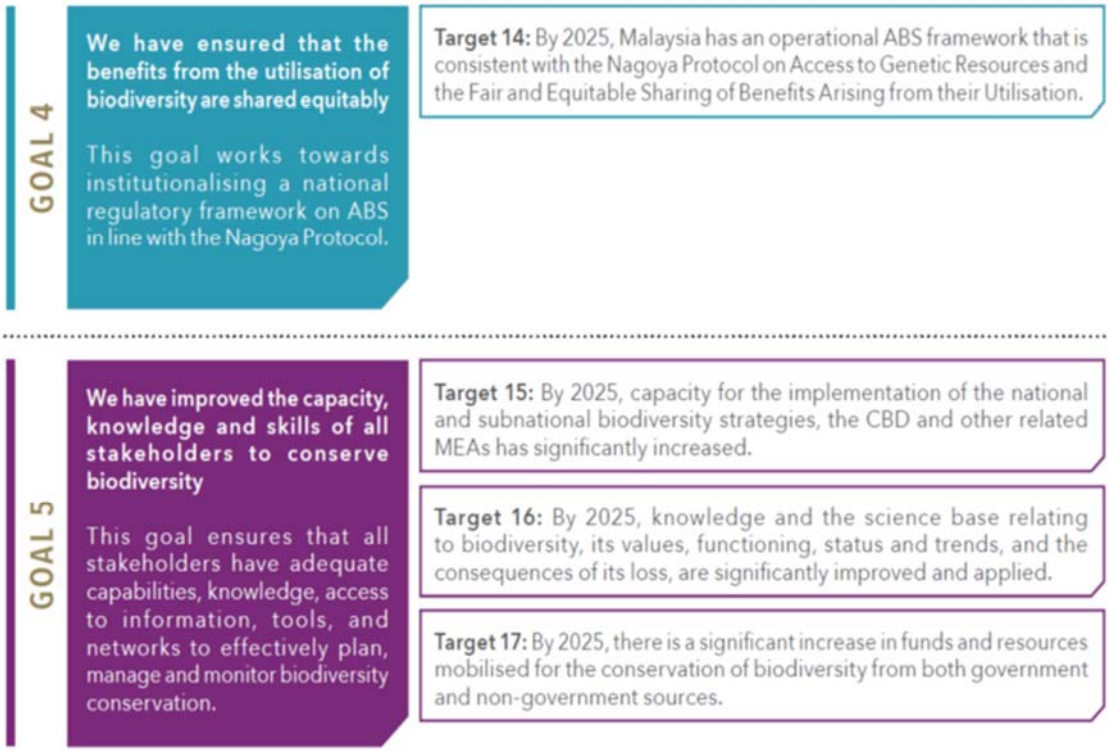


Figure 18: National goals, targets and action for Policy on Biological Diversity 2016 – 2025 (NPBD, 2016)

5.2 A Review of efforts under the Convention on Biological Diversity

Biodiversity is high on the international agenda for nature conservation with particular regard to marine and coastal ecosystems which are an important component of the Earth's biological diversity. Malaysian legislation and national laws have also included references to marine biodiversity based on the CBD and other related international conventions. The conservation of marine biodiversity is a complicated issue requiring consideration of geographic, policy-making, and commercial factors. Marine biodiversity is largely a heterogeneous concept which is a complex smorgasbord of policy agendas and legal frameworks. Malaysia adopted the NPBD in 1998 to carry out and accomplish CBD requirements at the national level by enunciating dictums and to lead government authorities on the preservation and governance of biological diversity in Malaysia. This study examines the health of Malaysian biodiversity in referents to regulations and judicial

attributes under the CBD, discerning knowledge gaps and issues associated with proposing seismic survey mitigation in Malaysia with the need to re-evaluate the NPBD. Among the areas that would have to be addressed include establishing National cetacean stranding network, having greater detail in complete marine mammal database on conservation protocol within the policy and the effectiveness of current mitigation strategies of MPA during seismic survey operations in marine environmental management.

5.3 Marine protected areas (MPA)

The offshore and inshore areas of Malaysia are very rich in biodiversity, where the EEZ overlaps with the Coral Triangle area which possesses an excellent potpourri of marine life in the world amongst its coral reefs and mangrove forests (WWF Global, 2015).

Marine Protected Areas in Malaysia generally are composed of Marine Parks and Fisheries Prohibited Areas and there are currently 42 marine parks with a total area of 248,613 ha governed by various piecemeal legislations. In addition, there are 14 turtle sanctuaries and fisheries prohibited areas covering a further 63,254 ha. Sarawak has seven MPAs covering an area of 207,723 ha. Sabah has five MPAs covering 73,807 ha. The proposed Tun Mustapha Marine Park in northern Sabah will add another close to one million ha to the MPA network (NPBD, 2016). The history of the establishment of MPAs in Malaysia dates back to the 1970s, elaborate in Table 12 below.

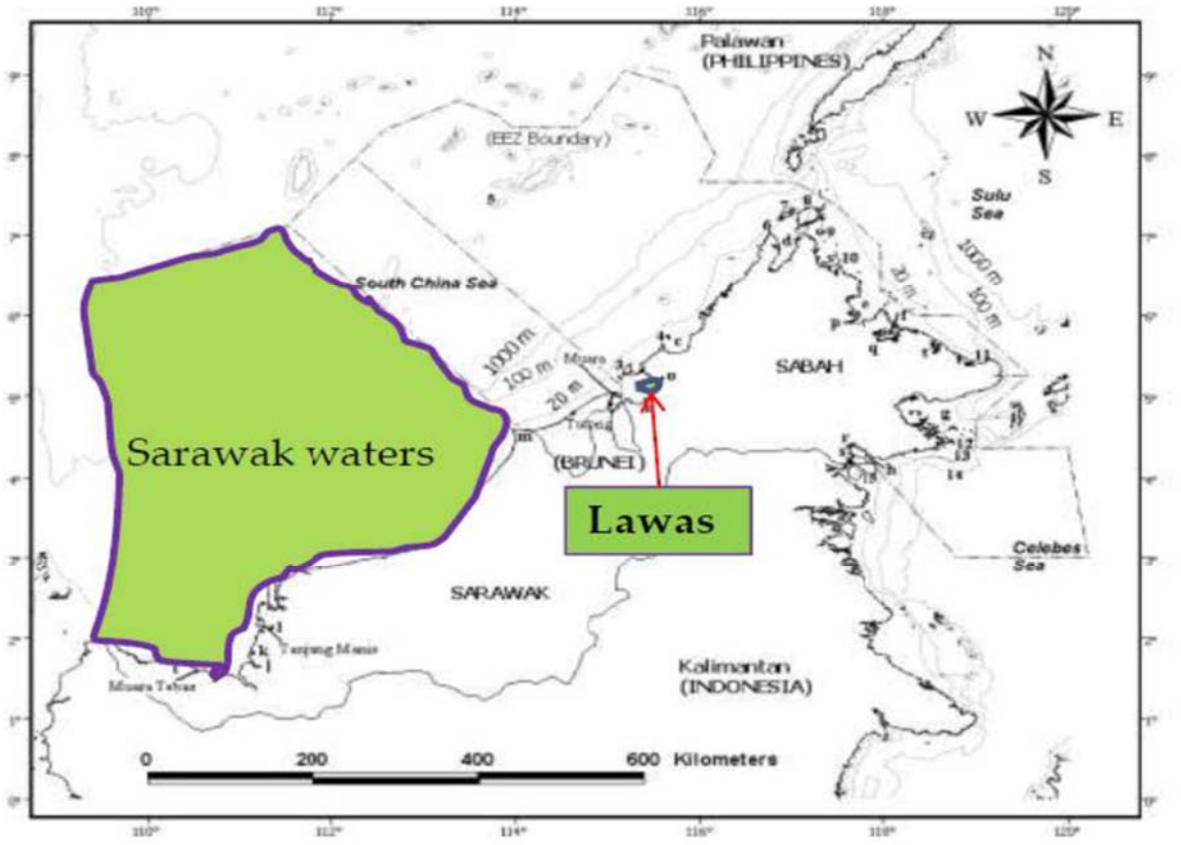
1970s	Establishment of three (3) MPAs in Sabah waters which consist of 11 islands under the management of the Sabah Parks.
1980s	Establishment of 22 islands in states of Kedah, Terengganu, Pahang, Johor and Sarawak as Fisheries Prohibited Areas under the management of Department of Fisheries Malaysia.
1990s	Gazette and re-gazette of 40 Fisheries Prohibited Areas islands in states of Kedah, Terengganu. Pahang, Johor and Federal Territories of Labuan as Marine Parks under the management of the Department of Fisheries Malaysia. Establishment of two (2) MPAs in Sarawak under the management of Forest Department of Sarawak Marine Parks in Terengganu waters. Establishment of Department of Marine Park Peninsular Malaysia under Ministry of Natural Resources and Environment to manage 42 Marine Parks in Malaysia.
2000s	Establishment of three (3) MPAs in Sabah waters which consist of 12 islands under the management of Sabah Parks and the Sabah Wildlife Department. Establishment of two (2) MPAs in Sarawak under the management of Forest Department of Sarawak. Establishment of two (2) Marine Parks in Terengganu waters. Establishment of Department of Marine Park Peninsular Malaysia under Ministry of Natural Resources and Environment to manage 42 Marine Parks in Malaysia.
2010s	Formulation of Management Plans and Zoning Plans for Marine Parks. Department of Marine Park Malaysia forges closer collaborations with local communities by introducing Alternative Livelihood Programmers, and the formation of Community Consultative Committee. Department of Marine Park Malaysia forges closer collaborations with NGO's and local universities in research and monitoring.

Table 12: Key milestones achieved by Malaysia in relation to the establishment and management of MPAs in Malaysia. Source: NPBD, 2016

Apart from the need to preserve ecological systems within marine areas it is also acknowledged that the rich biodiversity, natural resources, ecosystem functions and beauty of these areas bring socio economic benefits to the country. In particular, the country's marine parks contribute considerable revenue to the country through tourism activities. Average number of tourists visiting these MPAs (in Peninsular Malaysia) is around half a million tourists per year. The tourism sector in the Pulau Redang Marine Park was estimated to be worth US$3.16 million in 2003. The Total Economic Value (TEV) of the Pulau Payar Marine Park in Kedah is estimated to be US$54.38 million according to a

study conducted in 2011. The estimated Total Economic Value of Labuan Marine Park in 2012 was US$12.38 million (Ministry of Agriculture and Agro Based Industry, 2013).The State government is striving to gazette the waters of Lawas in the Bay of Brunei as an MPA for the protection of dugongs and seagrass habitat by 2016.

Lawas Bay is recognized as a vital feeding habitat for various species of endangered marine mammals (Map 4). To date, eight (8) species of seagrass (*Thalassiahemprichii*, *Halophila minor*, *Halophila ovalis, Cymodocea rotundata, Halodule pinifolia, Halodule uninervis, Enhalus acoroides and Halophila beccarii*) were confirmed to occur in this area with *Halophila* and *Halodule* as the dominant species. This seagrass meadow is believed to be the largest in Malaysia (DOF, 2008). Seagrass beds are another example of the diversity of marine habitats, with their own complement of specialised species of plants and other marine life. They are critical for the survival of the endangered dugong and sea turtles. Studies have shown that about 100 fish species and 20 prawn species in Malaysia are dependent on seagrass beds for nursing, feeding and breeding (MOSTI, 2010).



Map 4: The Lawas waters in the Bay of Brunei for proposed dugong and seagrass MPA. NPBD, 2016

5.4 A common vision on Biodiversity

A policy document titled 'A Common Vision on Biodiversity' was released by NRE in 2008 and officially adopted by the National Biodiversity and Biotechnology Council of Malaysia in 2009. It serves as a guiding tool for planners, decision makers and practitioners at all level of governments with respect to biodiversity planning and management.

It largely constitutes a three-pronged implementation approach (Figure 19) that consists of:

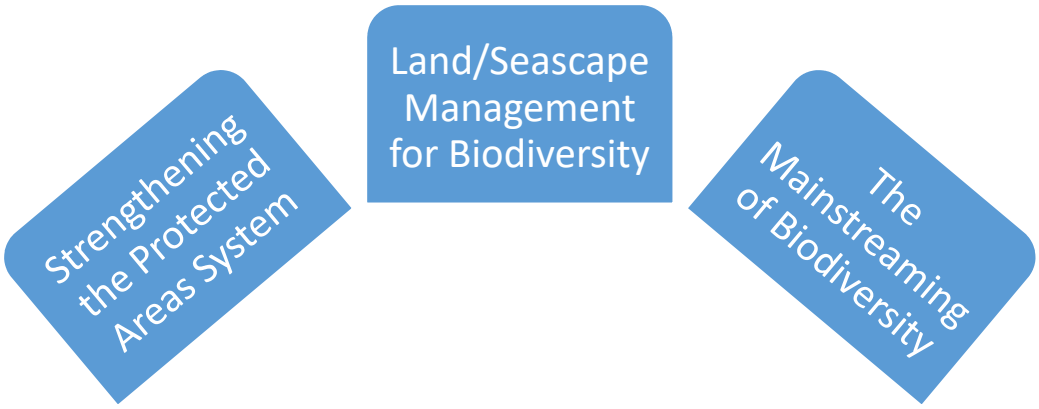


Figure 19: Three-pronged implementation approach- A Common Vision on Biodiversity (NRE, 2014)

With regard to mainstreaming of seismic survey mitigation, the primary short-term goal is to strengthen NRE position as a facilitator to provide support to other agencies in their efforts to extenuate seismic survey activity. The Common Vision also outlines a number of options for mainstreaming biodiversity which include industry standards, codes of conduct, guidelines, biodiversity integration into legal frameworks and certification schemes. The Common Vision also highlights the need to incorporate various economic and financial tools in order to achieve comprehensive biodiversity and sustainable development goals (UNESCO, 2016).

5.5 The Coral Triangle Initiative-Coral Reefs, Fisheries and Food Security (CTI-CFF)

A new fisheries management approach that focuses on ecosystems conservation, resources health and improvement of the fisheries quality is in development in the 2016 Policy. The implementation framework of Ecosystems Approach to Fisheries Management (EAFM) is

guidelines to ensure the conservation of fisheries resources and to formulate regulations, promote and provide incentives for fisheries certification (4.3, NPBD, 2016).

One of the areas of improvement is in promoting research and development of good aquaculture practices including methods to safeguard biodiversity (4.3a, NPBD, 2016). This might be an interesting prospect to start with in application of seismic survey procedures. EAFM is an integrated ecosystem management and Department of Fisheries has ownership and the jurisdiction of marine eco conservation which include marine mammals. The development of a management mechanism, including new legislation for seismic guideline and certification to regulate this activity could be appropriately implemented here.

Malaysian fish stock is under pressure due to pollution and unsustainable fishing practices. Figure 20 shows catch per fisherman has been on a fixed declension from 2010 from degrading mangrove forests, seagrass beds and coral reefs (Hiew et al., 2013). To address this, Malaysia has established a zoning system of coastal waters which prohibits fishing vessels from encroaching marine life nursery and breeding grounds.

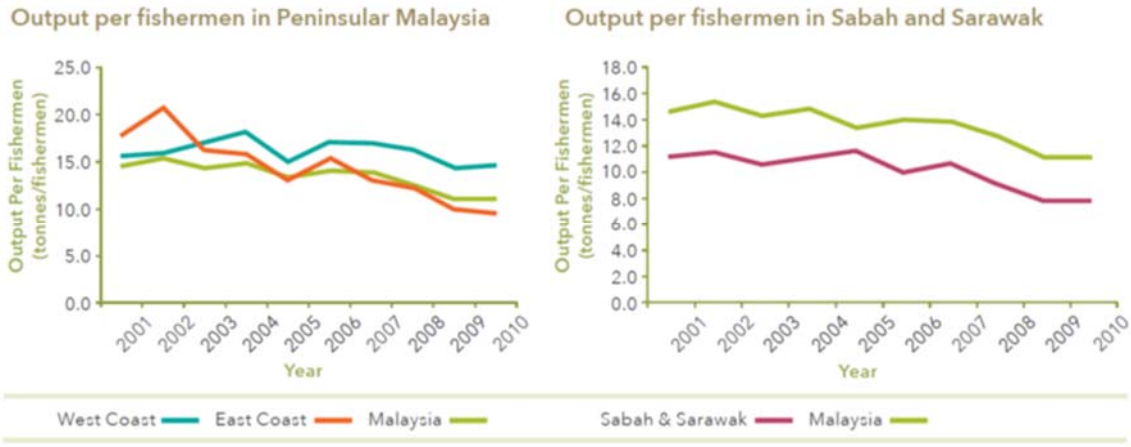


Figure 20: Coral Triangle Initiative: Ecosystem Approach to Fisheries Management – Country Position paper. Source: Hiew et al (2013).

The Prime Minister of Malaysia, The Honourable Dato' Sri Mohd Najib bin Tun Haji Abdul Razak, at Coral Triangle Initiative Summit Manado, Indonesia, 15 May 2009 said "Malaysia is very committed to ensuring that our marine ecosystem remains healthy so that this rich biodiversity can be enjoyed in perpetuity and sustainably utilized for wealth creation in concomitant to our objective to be a first world nation by 2020". It is in that spirit that Malaysia became a part of the 6 nations (CT6) Coral Triangle Initiative in 2009.

Map 5: Coral Triangle region. Source: NPBD, 2016

The boundaries of the Coral Triangle region are defined by coral and reef fish diversity and covering all part of the EEZ of 6 countries, which are Malaysia, Indonesia, Papua New Guinea, Timor-Leste, The Philippines, The Solomon Islands (Map 5). These boundaries encompass only part of Malaysian waters i.e. Malaysian maritime in the Sulu Sea and Sulawesi Sea that is premised mainly in the coasts of Sabah.

Malaysia has performed a dynamic role in the CTI Initiative whereby Malaysia facilitated the endorsement of a Regional Secretariat by four countries and to be the first country to ratify the Agreement on the Establishment of the Permanent Regional Secretariat of the CTI-CFF.

The Malaysian National Plan of Action (NPOA) for the CTI Initiative contains a volume of 12 regulations substantiated into 133 Action Plans disseminated among the five CTI goals. The goals are illustrated in Figure 21.

As clearly elucidated in Goal 5 to undertake the improvement in threatened marine mammals' species status is a positive outlook in implementing seismic survey mitigation procedure for marine mammals in the Malaysian EIA.

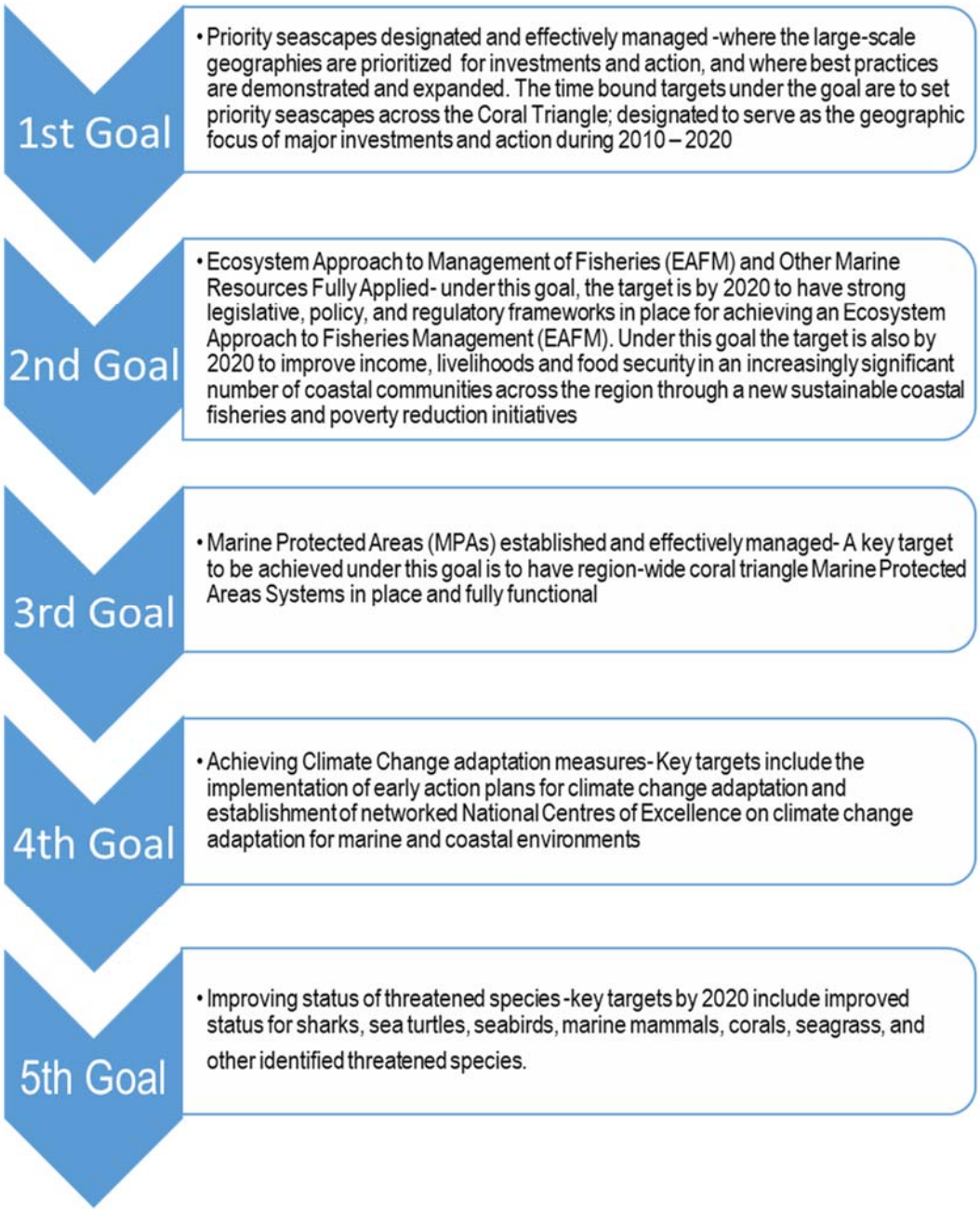


Figure 21: CTI Goals. Source NPBD 2016

5.6 Aichi Biodiversity Targets

Through the revision of the second generation of the National Biodiversity Strategies and Action Plan (NBSAP) for 2011-2020, Government strategies will be developed, agencies

involved will be identified and held accountable, and resource allocation plan for research and development will be prepared.

Malaysia has begun formal work on the updating of the current NBSAP with intention of incorporating the Aichi Biodiversity Targets as part of its national targets. The NPBD 2016 specifies the course and strategies to preserve Malaysia's biodiversity and use it in increasingly complex challenges. In order to achieve this, the Malaysian Government conglomerated with UNDP (United Nations Development Programme) / GEF (Global Environment Facility) on a project entitled "National Biodiversity Planning to Support the Implementation of the CBD Strategic Plan in Malaysia" in 2011 (NRE, Malaysia's 5th National Report to CBD, 2014).

The NPBD 2016 was is implemented due to the major significance role biodiversity plays in Malaysian maritime sector, as well as inadequacy in Government Agencies management abilities and shortage of funding, which are all contributing factors to ascertain that Malaysia's biodiversity is efficaciously preserved (NPBD, 2016).

5.7 Potential for seismic survey mitigation implementation framework

For seismic survey mitigation, it is crucial to develop a coherent science-policy interface to guide decision making that would benefit from a reliable evidence base scientific insights.

NPBD 2016 Policy has established channels of communication between the scientific community and policy-makers and to all levels of government administration (16.4, NPBD, 2016). Research Scientist will synthesise and relate scientific discoveries in seismic survey mitigation to decision-makers and practitioners ensuring that policy formulation is evidence-based. In the next section onwards the study investigates regulations currently practiced in the environmental process flow of the oil industry.

5.8 EIA in marine pollution

In 1985, the Environmental Quality Act 1974 (EQA), which was the principal environmental legislation in Malaysia, was improved to incorporate a pivotal proviso of EIA under section 34A (EQA, 2006). Under this segment, the Minister is authorized to dictate any act, which may have substantial impacts to the environmental.

For any project proponents in planning to present the EIA report, they have to consult to two different types of guidelines. First is the `Handbook of EIA Guidelines', which furnish common EIA guidelines and process (DOE, 1995). The other is a guideline that covers specific project, and meant to supplement the EIA Handbook. In relation to hydrocarbon activities, the specific regulation pertinent is the `Environmental Impact Assessment Guidelines for Petroleum Industries', published by the Department of Environment .This handbook would be used as a recommendation by the project proponent, and as well as oil and gas companies or seismic companies on the selection of alternatives, preparation and mitigation.

For Malaysia and other maritime countries, affairs associating to the preservation of biodiversity are very wide and complex. They include, among others, preservation of biological assets, maintaining pristine sea condition, and conservation of marine resources. Since noise pollution has been considered to be a leading hazards to the ocean, the abatement of seismic blast will be eventually a requirement in the preservation of the ocean biodiversity.

According to UNCLOS pollution of the ocean means "the intromission by human, substances into the ocean environment which consequences is in such destructive outcomes as injury to ocean life form and deterioration of the lineament of the sea". The discharge of seismic blast to the ocean must therefore be controlled effectively as it is

hazardous to marine life, the biodiversity and public wellbeing. In this regard, seismic survey mitigation can be conceived as a significant instrument for inhibiting ocean pollution, as it is confided by many countries in dealing with marine seismic pollution.

Malaysia participated with other maritime nations in enhancing the legal regime in dealing with marine pollution shows that Malaysia does takes pollution issues seriously. Malaysia's has showed tenaciousness towards ocean pollution through governance under the relevant law in enforcing of both national and transnational law (Ariffin, et al., 2011).

In accordance to the EEZ Act 1984, Malaysia holds the privileges and responsibilities to safe guard the marine biodiversity by controlling the discharge of pollutant into the EEZ. If so, then Environmental Quality Act 1974 is the principal statute law ordained to conserve the environment from all forms of pollutant, including marine noise pollution, which includes seismic blast. Besides, Malaysian Enforcement Agency Act 2004 embarked on to corroborate a marine enforcement agency in ensuring protection of the Malaysian waters and biodiversity from pollution covering all maritime areas of Malaysia. This federal agency is answerable directly to the Prime Minister's Department and also have the exclusive rights to enforce law and order under any federal law of Malaysia (Maizatun et al., 2011)

For Malaysia, the governing of seismic noise pollution would inevitably involve both national and global laws. It is possible for seismic noise pollution to extend beyond boundaries of states requiring the intervention of international law, however, Malaysia being a sovereign state has the autonomy to administrate its own law first.

A particular technique implemented by the EQA, is to appraise pollution emission by environmental standards or "acceptable conditions". The term "acceptable conditions" implies an environmental standard which calls for a "natural surrounding", that is an

applied bench mark of the admissibility or limitation stipulated in the EQA. Parameters limits for satisfactory considerations of assorted contaminant activities are furnished in ordinances published through the Environmental Quality Act 1974. Perhaps by virtue of this “acceptable standard” clause, there is potential to introduce an addendum for seismic survey mitigation standard, since the Act (Section 23) stipulates that *"no person shall, emit any noise greater in volume, intensity or quality in contravention of the acceptable conditions"* (EQA, 2006).

5.9 Noise Limit in Environmental Quality Act (EQA)

EQA, Amended (1985) makes it mandatory for an EIA on various activities scheduled by the Ministry and the projects in particular generally permit upper limit allowable noise at the involved regions that must be adapted conformed to throughout the stage of the project.

Noise Limits as outlined by The Planning Guidelines for *Environmental Noise Limits and Control, DOE*, is set based on (a) An absolute demarcation established on the average level of noise which cannot be exceeded in a defined time frame; (b) A comparative bandwidth based on the allowed gain in noise level to the background level and (c) A relative limits in general are not appropriate where the allowable increment in noise over background is substantial, for example 15 dB or more. Examples of suggested maximum tolerable noise levels are generally from road traffic, railroads and other land based noise sources. Such controls are requirement in safeguarding the welfare of the society, however, there are no provision for marine noise pollution in endangerment to cetaceans.

In section 4.4.1.1 of Noise Pollution of the EIA for Dalak Project, stated; “As for noise, the human response to ambiance noise is subjective and varies considerably from person to person. Noise from construction works has often been brought up as a health problem, not in referents of literal physical injury such as hearing disability , but in conditions of

suppressing general wellbeing and contributing to undue stress and annoyance" (Chemsain Konsultant, 2013)

It is clear here that mitigation measures for anthropogenic noise was considered for humans but not for marine mammals. Mitigation measures were to plan and limit noisy activities to day time only especially at nearby settlements. Noisy construction activities at these areas should be minimised during weekend and public holidays to avoid nuisance; again the importance was for such was for human consideration.

5.10 EQA for oil and gas sector

By virtue of section 34A, of the Environmental Quality Act 1974, it is a requirement that all hydrocarbon activities require EIA acceptance from the DG of the DOE before getting the sanctioned for project execution. For the focus of EIA in Malaysia, the sanctioning body is the government agency that has the undertaking of determining, the outcome of the project status. For offshore projects that are beyond the limits of the Malaysian territorial waters, the government agency is the Ministry of Domestic Trade and Consumers Affairs. However, for other types of prescribed activities, the authorities are as follows: The National Development Planning Committee for Federal Government sponsored projects; The respective State Planning Authorities for State Government sponsored projects; The Regional Development Authorities for the of International Trade and Industry, with due reference to the Malaysia Industrial Development Authority (MIDA) for industrial projects (Maizatun et al., 2012).

'Offshore' is defined by the ordinance as the 'ocean from the lowest tide level to 200 nautical mile EEZ'. Petroleum associated activities have been identified as prescribed activities, and all impacts from petroleum exploration until decommissioning is listed apart from impacts advocated on geotechnical marine seismic survey.

It is mentioned in the proposal for mitigation measures (EPD, 2005) that environmental issues must be considered in the scoping phase for ecological threats. These issues that are a threat to animal habitat or causes obstruction of migration or passage way to wildlife and loss of biodiversity including endemic, rare or endangered species, existing environmental guidelines shall be used as reference whenever possible. This clause strengthens the need for mitigating guidelines in seismic survey for marine mammals and other marine anthropogenic noise pollution.

5.11 EIA process flow for oil and gas projects

The overall EIA process for petroleum industry is provided in Table 13 below:

1. Site Selection ⇨	2. Project Scoping ⇨	3. Preparation of EIA: ⇨ - Site selection - Regional Planning - socio-economic - existing environment - public participation - risk management - modelling - environmental management & response procedures	4. Review and approval of EIA ⇨	5. Compliance: - auditing - monitoring

Table 13: EIA Process Flow, Source: Department of Environment Malaysia, 1995

From this table, three most important processes can be derived that enable the identification of possible adverse marine anthropogenic noise that can be included in the environmental impacts of the proposed activity together with their mitigating measures, which are; site selection, project scoping and screening activity.

5.11.1 Site Selection

The first steps within the procedures appropriate in environmental protection is that of site selection, undoubtedly it is a significant precondition in considering environmental impacts. Environmental detrimental effects leading from the petroleum industry are largely dictated by the localization of the project and its associated infrastructure. Henceforth, thorough site selection is essential for diminishing these impacts by excluding ESA and endangered species habitats. Specifically, in order to explicate the EIA, the project proponent must perform an appraisal of marine biodiversity including cetacean group and habitat assessment for each site location. The project proponent must bring in within the site selection matters associated to the probable and residual impacts from seismic survey activities. These depicted subjects would then be evaluated and categorized to produce a list of possible effect for each region before the said impacts can be predicted and evaluated. Specifically, their prediction can follow suit commonly used methodological analysis by JNCC, whereas their evaluation is where the predicted impacts are judged depending on environmental factor, national laws, regulations and acceptable international standards. For Malaysia, under the Environmental Quality Act 1974, in the case of offshore activities, evaluation of impacts on cetaceans and ecosystem would be in conformance with acceptable international standards such as that of the United States MMPA, endangered species of the Convention of International Trade in Endangered Species of Wildlife Fauna and Flora (CITES) and UNCLOS Article 192.

In the case of hydrocarbon activity, its site selection typically come about in the early stages of project and leads to the identification of a preferred site and probably a few options. The criteria for selecting a new site normally include engineering, environmental and economic aspects. Under the EIA procedure, project proponent is urged not to choose a site which is contiguous to ESA, as defined in NPP (EIA, 2010). Unfortunately, for

petroleum projects in Malaysia their sites are usually selected for economic and technical feasibility and less towards marine resource, habitat and ecological importance (Ramli, 1985).

5.11.2 Scoping

Scoping is the process of determining the content and extent of the EIA studies. It is an indispensable step in EIA because it discerns the issues of emphasis in endangered cetaceans and eradicates those of minor risk. By doing so, the process checks that EIAs are concentred on the substantial impacts and not wasting time and resources on unnecessary investigations. In addition to that, project proponents will also receive terms of reference (TOR) from the DG for an elaborated evaluation against anthropogenic noise. This TOR in return, can then provide distinct guidance to the project proponent on the necessary data that needs to be presented to the relevant competent authority. In this manner the TOR can then be administered in a detailed mitigation and list the significant marine seismic impacts and that must be appraised during the detailed evaluation. In a nutshell, scoping can be an essential methodology which sets the boundaries of the EIA for marine seismic survey. It defines the significant issues related to marine environmental effects that needs to be addressed, which is an important step in prompting the need for mitigating measures against oil and gas seismic impacts on the cetaceans.

Scoping involves the connections between site selection, data collection, methodology and risk assessment elements that are excellent concepts for cetacean mitigation in the EIA, since it also involves multi-disciplinary public participation. Public participation pertains to acquiring input from the various stakeholders such as environmental consultants, risk consultants, engineers, NGO's, designers, planners, and affected local community.

5.11.3 Screening

Screening is the procedure by which a conclusion is considered on whether or not an EIA is necessitated for a particular project. For the intention of seismic survey for instance, the only information required is the type of the project and its general location. It should be screened by checking with the required guideline for example JNCC, to review whether it should undergo preliminary assessment. The main objectives of screening are to ascertain that a full EIA is only performed for projects with probable detrimental effects on cetaceans or where impacts are not adequately known.

Screening therefore requires establishing a prelude of the anticipated effect of a project on the environment and its proportional implications. A certain level of fundamental data about the proposal and its location is compulsory as it helps alleviate the screening process by determining for which categories an EIA is required, including projects with significant impacts that require the submission of detailed EIA report (DOE, 1997). For type of projects which are dangerous, diverse, or unprecedented, the submission of Detailed EIA Reports is required. In Malaysia, screening is looked at as a flexible process, which can be stretched out into a preliminary form of an EIA study, as will be discoursed in the PETRONAS Dalak Project (case study two). If a preliminary assessment is undertaken to assist in the screening decision, the information from the preliminary assessment can also be used for scoping and later in the actual EIA process (Maizatun et al., 2012)

Therefore during preliminary assessment, when developing the EIA report, EIA consultants must ascertain that each activity in the marine biodiversity is rationalized into various areas such as baseline data; prognostication; abatement measures; and management plan. Thus, for marine seismic survey for instance, two types of information are expected in the EIA; one of which is the information pertaining to the operational

phases, the other is the environmental information relating to existing environment including geophysical and biological characteristics (EIA, 2010).

EIA for seismic survey should go forward to be relevant not only in mitigation purpose but also in the country's environmental sustainability target. Malaysia is already a party to various treaties that manage marine pollution including UNCLOS (Article 194).These treaties contain provisions affecting obligations of a Nation on matters regarding marine protection. Thus, Malaysia is bound to ensure that these rights and duties are coherent with the essentials of the treaty. Consentaneous to National law of Malaysia, this may call for the legal instrument of a statute by the Parliament, allowing such treaty to become part of the law of Malaysia (Maizatun et al., 2011).

5.12 Environmental Legal framework

The Environmental Quality (Amendment) Act 1985 makes it mandatory for an Environmental Impact Assessment (EIA) on various activities scheduled by the Ministry.

Approval of such EIA and the projects in particular usually include maximum permissible noise limits at the affected areas that must be complied with during the construction phase of the project, and upon completion of the project.

It is however mentioned in Section 23 (EQA, 2006), no person shall, unless licensed, emit or cause or permit to be emitted any noise greater in volume, intensity or quality in contravention of the acceptable conditions. Any person who contravenes this section (Section 23) shall be guilty of an offence and shall be liable to a fine not exceeding one hundred thousand ringgit or to imprisonment for a period not exceeding five years or both and to a further fine not exceeding five hundred ringgit a day for every day that the offence is continued after a notice by the Director General requiring him to cease the act specified therein has been served upon him.

In 2012, the Environmental Quality Act which functions as the main legal framework for the prevention of pollution as well as impacts from development activities was amended with a view to provide the Act with stronger enforcement related prescriptions. The Department of Environment (DOE) which is under the purview of the Ministry of Natural Resources and Environment (NRE) is the administrator and enforcer of this legal framework.

Under the Act, subsidiary legislation is passed containing a range of regulations that deal with multiple sector-based issues. The amendments covered a number of key aspects that include:-

1) Providing the Director General of the DOE with powers to issue stop work or prohibition orders in relation to prescribed activities. Under the Act, an EIA is required to be carried out if a proposed activity is defined under the Act as a prescribed activity under the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987. With the new amendments, the Director General is now empowered to issue these stop work orders if a prescribe activity violates any conditions attached to the approval of an EIA report or in the opinion of the Director General, the activity is carried out in a manner that is likely to cause environmental damage.

2) As a consequence of any violation of the order made by the Director General, a significant penalty is now prescribed. Any person guilty of contravening any orders issued shall be fined a sum not exceeding RM500, 000 or to a term of imprisonment not exceeding 5 years or both.

In order to further enhance the powers of the Director General, the Act provides influences that are akin to police jurisdiction in relation to investigation and arrest.

5.13 Improving judicial oversight in environmental cases

In January 2012, The Honourable Tan Sri Arifin Bin Zakaria, the Chief Justice of Malaysia at the Opening of the Legal Year 2012, stated that Environmental Courts would be established. In less than a year from the time the announcement was made, a Practice Direction was issued to courts across the country where it follows, that effective September 2012, all Magistrate and Sessions Courts are to prioritise environmental cases and must dispense with such cases within 6 months of the accused being first charged in court. The vision for such a court is to address primarily the need for swift adjudication of environmental cases. Under the Practice Direction, almost 38 pieces of legislation will come under the purview of the Environmental Court (Maizatun et al., 2012).

The Wildlife Conservation Act 2010 having the most number of provisions coming under the purview of the Environmental Court, they related to offences ranging from licensing requirements, prohibition of certain acts within wildlife sanctuaries and reserves, hunting, possessing, dealing or keeping of wildlife without lawful authority, the disturbing of salt licks and various other offences involving cruelty to wildlife.

The Environmental Quality Act 1974 now within the jurisdiction of the Environmental Court mostly relate directly to the pollution issues. These apply to chiefly, restrictions in relation to pollution to soil, inland waters, discharge into Malaysian waters and violations of conditions attached to Environmental Impact Assessments.

5.14 Improving legal framework on species protection

In Peninsular Malaysia, for almost 30 years since 1972, the DWNP (Department of Wildlife and National Parks) enforced the Protection of Wildlife Act 1972 as the main protective legal framework on wildlife species. The Protection of Wildlife Act 1972 was repealed and replaced by the Wildlife Conservation Act 2010 which came into force in

2011. The new Act contains significantly stricter provisions on species protection by adding species to the protective status and alleviating the protection of a number of species. In relation to enforcement of wildlife offences, the new Act provides for heftier penalties by way of significantly higher fines as well as mandatory prison sentences for serious crimes. For example, some fines have gone up by almost 33 times for certain offences (Mustapha et al., 2012).

The Act also provides for more punitive measures. For example, any person who has been convicted of an offence under the Act or any of its subsidiary legislation may be barred from holding any license, permit or special permit for a period not exceeding five (5) years from the date proceedings in respect of the conviction concludes.

Another significant change made under the new Act relates to the power to compound offences under the previous Act. As a result, certain offences such as failure to obtain prerequisite special permits in relation to Totally Protected species, the female or the immature of a Totally Protected species will result in prosecution of the offence rather than an offer to compound the offence through a fine. Between in 2011 and 2012, 13% of wildlife cases were prosecuted in court, due to the removal of the prerogative to compound offences being repealed (Mustapha et al., 2012).

Current provision for noise pollution and penalties are already in place, through specific contravention licence application and the need to address and amend policies with regard to ocean noise pollution can be implemented under this clause.

5.15 Maritime enforcement

South China Sea is encountering pollution as an outcome of petroleum activities, considering the vital role petroleum industry plays in the economy, it is subject to direct government control. From an environmental stand point, there exist a haunting anxiety

over the impacts of petroleum activities on the marine environment particularly that of noise pollution (EIA for Petroleum Industries, 1995).

Malaysia enacted an important maritime enforcement legislation, called the Malaysian Maritime Enforcement Agency (MMEA) Act established in 2004, with the sole objective of protecting Malaysian maritime and other national interests. Under this Act, the "Malaysian Maritime Zone (MMZ)" is all-encompassing domain which includes "internal waters, territorial sea, continental shelf, EEZ and the air space over the Zone" and thus it covers all the maritime areas of Malaysia (Kamin, 2010).

While the general objective of this Agency is to improve Malaysia's maritime protection, the Agency is also responsible for the control and prevention of maritime pollution and is given the power under section six of the legislation to enforce law and order under any federal law of Malaysia. It's outstripped imposition of jurisdictions in the MMZ, has a substantial execution in strengthening and imposing all legislation regarding marine pollution (Mustafa et al., 2012).

Being a maritime nation, Malaysia has to take steps to guarantee that her marine protection law continues to be dynamic to cope with the various sources of ocean pollution. Experience has shown that while prevailing laws are adequate to curb ocean pollution, it is however moderated by a dissociated operation (Mustafa et al., 2012). Therefore, the greatest undertaking is in dealing with maritime law enforcement that is sectoral in nature and not uniformed. The constitution of the MMEA is one means for the country to effectively cope with, and coordinate, the enforcement of these piecemeal laws.

Although it is still premature to gauge the end result of the effectuation of seismic survey mitigation planning, crucial developments in this area are nevertheless taking place as previously highlighted in this study in establishing RoundTable discussion with authorities

on cetacean strandings. These developments are reflections of changes that are taking place within the legal regime towards a more comprehensive and effective check of ocean pollution for the betterment in establishing cetacean stranding network which is pathway for establishing seismic survey mitigation guidelines.

This is backed by Ariffin, et al., 2011, stating this implementation indirectly on marine protection law should be continue to be dynamic to cover various sources of ocean pollution and hoping that the management in conservation will get better with sufficient biology and ecology information for future generations. The Government has recently establish a platform for agencies to share resources and carry out joint enforcement activities, particularly on encroachment into protected areas including strengthening the 1Malaysia Biodiversity Enforcement Operation Network (1MBEON) in the NPBD (NPBD, 2016).

The problems lies in no substantive commitment to regional environmental governance although there is a clear provisions in national and global law which provide direction to countries. The rationalities behind this is the deficiency of comprehensive regional environment management framework, interagency conflicts, inappropriate policies that is overlapping and extensive studies on biodiversity. The primary problems are due to lack of biologists and insufficiency of published information on basic biology and ecology of the endangered cetaceans in Malaysia (Mazlan, 2005).

5.16 Chapter summary

Malaysian government recognises the necessity to escalate strives on awareness raising on the importance and significance of cetacean protection, preservation and governance through the launching of NPBD 2016.

Minimizing and managing seismic environmental footprints is the shared purview of technology and regulations, which greatly necessitates multiple Government Regulatory Agency that can quickly establish effective environmental management systems.

The NPBD 2016 is anticipated to meet the nations demanding economic needs aside from environmental eco balance by establishing and effectively managing MPAs and improving the consideration of threatened species as the Nations key goals.

Malaysia's role in managing environmental footprints as detailed in the NPBD 2016, encompasses many steps, however the overall management is anticipated to remain within DOE, which is the ultimately agency responsible for coordinating with other NPBD-derived regulatory authorities associated with the seismic noise pollution. Experience has demonstrated that the outcome of the effectuation of the environmental impact assessment in PETRONAS track record has been positive with DOE (Ramli, 1985).

The untoward impacts of seismic pollution is not comprehended yet and there by its economic, social and environmental importance is poorly recognised. While a greater appreciation of its values is important the motivation to act on it is still not enough.

The proposal for seismic survey mitigation for cetaceans at the current time seems most appropriate than ever before by PETRONAS taking the lead in showing how seismic mitigation plays an important linkage between healthy marine life and healthy living from all segments of our society.

Clearly from this chapter, the Government biodiversity conservation Policy is the current best effective mechanism to push forward seismic survey mitigation as part of the framework in the environmental framework. The Government anticipates that the future national and state policies and programmes will have biodiversity conservation embedded in them and this ought to be mandatory for PETRONAS geophysical exploration. This was

made clear by the Ministry that all national policy levels, programmes will incorporate marine protection of ESAs, mainly in MPA's (Goal 2, NPBD, 2016).

Unlike the NPBD, 1998 Policy, the 2016 Policy recognises that each agency function by their individual mandate and aspirations, however the sectors need to work together, so that marine life preservation and economic growth are integrated. NRE states that all policies are planned and administered systematically that it will not impose ravaging effect on marine life conservation (4.0, NPBD, 2016). This is imperative especially with seismic survey guidelines having various sectors from academia to Governmental agencies and conservation NGO's involved.

The Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations (the Guidelines) were originally founded by the Department of Conservation (DOC) in 2006 in colligation with the Petroleum Exploration and Production Association of New Zealand (PEPANZ, 2016). Similarly PETRONAS needs colligation with DOE in producing Malaysian Seismic Survey Guidelines proposing to the Biodiversity Council.

PETRONAS needs to keep economic development as a fundamental national priority, but this journey must be on a path that utilises geophysical exploration in a more efficient and effective manner. It cannot sustainably manage biodiversity and petroleum development in separate silos. Development depends on having sustained marine life and they in turn will depend on appropriate management of national petroleum development.

The Policy stated companies to dynamically pursue with international institutions and research programmes and support knowledge exchanges on marine life conservation (15.5 c, NPBD, 2016). A sound evidence base and scientific insights are vital to endorse the effective conservation of seismic survey guidelines. PETRONAS will be the forefront of

decision making, to pursue acknowledgment of the worldwide importance of Malaysia's seismic survey mitigation policy by being a member of Joint Industry Programme (JIP).

This will ensure a coherent science-policy interface to guide decision making that would gain insights in Malaysia's policies which can be improved further with Information Management.

The succeeding chapter will review Core Topic Three of this research study and the theoretical model for scientific Information Management of seismic survey mitigation processes for cetaceans.

CHAPTER SIX– CORE TOPIC THREE

INFORMATION MANAGEMENT

6.1 Introduction

Important data are generated in overwhelming volumes from beginning to end of an offshore oil or gas project. The data are indispensable for commercial and economic decisions and also for monitoring and detection to assure compliance with safety-sustainability elements. A data management process to compile, distribute, analyse, store, retrieve, and archive information is an obligation to improve real-time and long-run resolution. The competency to administer data across industry, regulators and other interested groups requires an information management plan

A common issue in data management is that organizations have only recently begun looking at standard information management processes and programs across their own organization. It is common that information management was done at a local level with each office defining their process and technology. The resultant effect is usually many technologies do not share information. Now those organizations are optimizing their information management all around the whole establishment either by introducing common technologies and processes or linking the current systems. In the future, information management should be considered across all regulatory agencies so that common information is easily transferred from the lease operators to the various agencies.

The Microsoft and Accenture Upstream Oil & Gas Computing Trends Survey 2010, which

polled 172 professionals within global oil companies, found that 44 percent of respondents have a vote down on their ability to get their work done. Forty-four percent of professionals surveyed reported a difficult and time engaging search of diverse systems to find information; and data appearing in unstructured forms not well interpreted or archived. Forty-three percent of those reported that information stayed in personal

computer storage and not easily shared was a common challenge across disciplines, and 35 percent reported too much redundant and/or unnecessary data available (NPC, 2011).

6.2 Essentiality in establishing a complete cetacean scientific information database and supervision programme

A comprehensive baseline data is essential for cetacean mapping and supervision. Malaysia's research currently holds a large assemblage of records on the country's marine biodiversity in the category of specimens, samples, germplasm, genetic information and related derivatives. The current collections and information database are by no means complete and much work is necessary to catalogue Malaysia's immense biodiversity as mentioned by the Prime Minister (16.2, NPBD, 2016).

The Government urges for a robust information database to be undertaken on the fisheries stocktaking survey encompassing detailed assessments of seawater and freshwater resources, including their marine species biota. The Policy as stated underline the necessity to conduct periodic national surveys of threatened species in order to enable priorities for interventions (16.2 b, c, NPBD, 2016).

PETRONAS needs to realize the many ways that seismic noise affects marine mammals so that it can incorporate appropriate safeguards to protect this precious resource base. Seismic operators must then achieve credible standards of environmentally-friendly practices to ascertain that marine mammals are well protected.

This requires a comprehensive database of the effects of all forms of seismic pollution on marine mammals, especially those at ESAs and MPAs.

This would complement to streamlining databases values for all 27 species of cetaceans in Malaysia as the key indicants of the policy and enable to monitor them effectively.

This database will then be accessed and shared by scientists, resource managers and other stakeholders in launching a system of species and records for cetacean sightings. By doing so, it ensures all spatial planning processes identify and incorporate ESAs in a coherent manner. (5.1b, NPBD, 2016).

Malaysia also sees pressing demand to develop and follow through administration programs for all fisheries prohibited areas (FPA) to ensure reestablishment of targeted endangered species population. This move could provide a wider and comprehensive database to develop methods, criteria, standards and facts for measuring the effectivity of ESA, MPA and FPA management and governance to the Fisheries Management (6.2c, NPBD, 2016).

In formulating a complete scientific database, including information related to endangered cetacean status, known threats from seismic noise, the Information Management will have a formulated management plans, taking into account international earmark techniques, measures, standards and milestones for evaluating the effectiveness of MPA establishment and seismic mitigation governance worldwide.

6.3 Environmental issues with regards to seismic activity apart from marine mammal

Information Management identifies the resource management affairs affiliated with seismic activity apart from marine mammal conservation. There are a numeral environmental impacts connected with seismic survey operations including vegetation and soil disturbance for shot-hole drilling and geophone placement.

There is also the concern of vibration associated with the sound blast charges and vessel movements (generally minor) which causes potential upwelling and discharge to the environment of groundwater fluid (and subsequent drawdown of groundwater), or upwelling of shallow gas through shot holes (PEPANZ, 2013).

Information management permits traceability conditions on seismic operation and provide solution to deal with the possible environmental impacts.

Vegetation clearance should be minimised, and councils may wish to provide for replanting to offset any considerable vegetation clearance, if needed. Shot holes should be back filled with soil and tamped after the seismic survey operations have been completed.

The effects of vibration on the surrounding environment can be managed by setting appropriate setback distances from structures, which is affected by the sound blast charges.

These information management ensure conditions remain the same prior to seismic survey activity with no disturbance to flora and fauna in marine biodiversity.

The Information management will describe the related methods of the planned seismic survey and also identify the current phase of the local environment before the activities being initiated. The mitigation has to also distinguish the existent and possible impact of the activities on the environment and actual interests, including any conflicts with existing interests. This is to enable a comprehensive coverage of all risk connected with seismic survey and not just for cetaceans. The proponent has to define any potential options for taking on the activities to avert, rectify, or extenuate any adverse effects and measures that the operator plans for (Ministry for the Environment, 2014).

6.4 EAFM Information Management

The implementation framework of Ecosystems Approach to Fisheries Management (EAFM)as mentioned in the previous chapter of NPBD, is a novel fisheries administration approach that focuses on ecosystems conservation information management, resources health and development of the marine environment quality (4.3, NPBD, 2016).

EAFM is an integrated ecosystem governance and the Department of Fisheries has ownership and the jurisdiction of marine eco conservation which include marine mammal information management.

The expansion of this Information Management mechanism, can boosters inclusions of seismic guideline improvement including marine mammal species biodata as mentioned in clause 4.3a, of the NPBD, 2016.

A study published by Offshore Operations Subgroup of the Operations & Environment Task Group in 2004 identified several issues that remain problematical with Information Management (NPC, 2011).

It was discovered in the publishing better processes and practices are required explicit considerations to alleviate information management data and it is necessity to manage and preserve this data for environmental eco system management.

The studies found that, even though technology provides new opportunities to provide information management, but it cannot provide solutions without thoughtful planning and best practices.

The research concluded that information management require to be referenced to be easily located by users in the consideration of emerging needs for long-term management and curation.

Information management, like any other data, should be widely accessible and available at no cost to the community and the key factors of advancement for information management are centred on the utilization of Prescriptive and performance-based methodological approaches to seismic regulations.

6.5 Seismic survey policy and information management concerns

A key issue for example was identified in the review. While many international jurisdictions had implemented mandatory regulations, New Zealand relied on voluntary information management. The stakeholder group agreed that mandatory regulations should be established in New Zealand (NZ publications, 2016).

Due to both scientific uncertainty about the efficiency of soft-starts and the unresolved policy & ordinance for New Zealand's EEZ, it has been decided that some kind of revised information management will remain in place for a period of three year. Only a core group of key stakeholders, including representatives from the oil industry, marine mammal observers, academic and scientific organisations, will work with the DOC on the content of this revised data (DOC, 2013).

Progress monitoring of information management will be done by NRE and adopt the methods of measurement and verification for all key indicators. NRE will collate all the baseline data necessary for tracking the information management at any stage to ensure that the monitoring process is conducted smoothly (NPBD, 2016).

A broader discussion looking into the prospect for corroborating a research information management system dealing with the above mentioned scientific and policy uncertainties is compulsory to ensure a consolidated database.

6.6 Chapter summary

The fundamental components of improved information management are adoption of standards for data administration, formatting and exchange. Even though government regulatory agencies in the NPBD define reporting requirements, development of seismic

data standardization must be led by PETRONAS. This is to assure the efficiency of seismic information management and mitigation systems that requires closer collaboration among government regulatory agencies and also between the Academia are closely supervised by PETRONAS in an information management server database. The need for improved information management programs and systems is simplified in 5 key points below.

6.6.1 Five Key Points

• The necessity to manage and preserve information for seismic survey should be the primary considerations in the scoping and screening phase of EIA

• Better processes are called for to be put in perspective to eliminate Red Tape in obtaining Information for researchers and government agencies

• For EIA prescribed activity in seismic survey, it is crucial to initiate thoughtful planning and application of seismic technologies to be devised in the information management.

• Seismic Data retention (what to archive and for how long) should be addressed in the advance Planning stage of EIA.

• The Seismic Metadata must be optimized for future retrieval, assimilation, and re-use (for research purposes).

In a nutshell scientific-based decision-making and rapid, criteria-based seismic mitigation responses can function only if the required information is readily available; meaning that the underlying data are up-to-date and accessible on demand using prescriptive and performance-based methodology.

This chapter sums up the review of relevant areas necessary of the three Core Topics in the overall seismic environmental footprint, impact and concerns for the petroleum industry, presented by all the supporting evidences and arguments in examining government environmental regulatory policies for marine noise pollution that can be implemented in the EIA. Progressing to the next chapter the review will cover all the implementation of environmental footprint and regulatory reviews, management of seismic work and Information Management in two case studies.

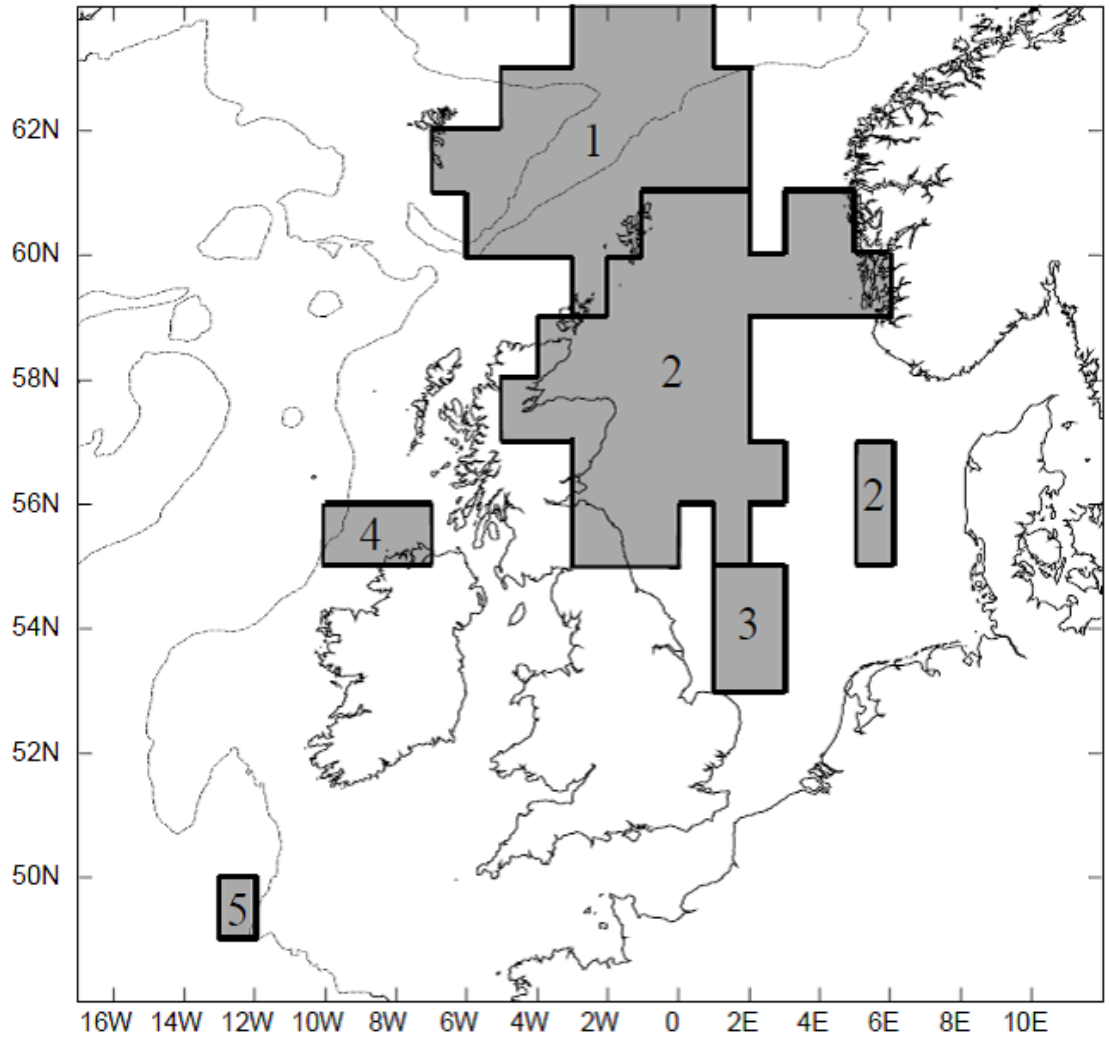
CHAPTER SEVEN – CASE STUDY

7.1 Case study one

This first case study on Stone, C J, Cetacean sightings during seismic surveys, 2001 will be reviewed to look at a systematic method in the 3 core topics discussed in seismic survey mitigation techniques. The area surveyed from seismic survey vessels in 1999, were conducted in West of Shetland, Northern North Sea, Southern North Sea, West of Ireland and South-West Approaches in the UK

There were 501 sightings of cetaceans (13,398 individuals) with total of 14,341 hrs and 19 minutes consumed observing cetaceans during the seismic surveys in UK waters and neighbouring areas in 1999.

The most frequently seen species was the white-beaked dolphin. In moderate frequencies, white-sided dolphins, sperm whales, minke whales and killer whales were also encountered with lesser quantities of observances of other species. There were indicatively more sightings of minke whales and white-beaked dolphins than the previous year. Observations of cetaceans spiked in August, with most taking place in the northern North Sea, west of the Shetlands.



Map 6: Quadrants surveyed for cetaceans from seismic survey vessels in 1999, and areas used in quantitative analysis: 1) West of Shetland; 2) Northern North Sea; 3) Southern North Sea; 4) West of Ireland; 5) South-West Approaches. Source: Stone, C J, 2001 Cetacean sightings during seismic surveys in 1999. Report. No. 316

7.2 A summary of marine mammal sightings and survey effort

Map 6 shows the marine seismic quadrant surveyed done in the United Kingdom. There were 480 sightings of cetaceans (l3, 376 individuals) and 2l sightings of seals (22 individuals) during l999 seismic surveys (Table 14). 60% of sightings were identified to species level, and a further l4% were identified as being one of a pair or group of similar species.

Species	Number of sightings	Number of individuals
Seal sp.	4	4
Grey seal	11	12
Common seal	6	6
Cetacean sp.	11	32
Whale sp.	19	79
Large whale sp.	27[a]	68
Humpback whale	1	1
Fin whale	15[b]	33
Sei whale	4	4
Fin/blue whale	5	13
Fin/sei whale	5	9
Fin/sei/blue whale	2	5
Fin/sei/humpback whale	6	8
Fin/sei/blue/humpback whale	2	4
Minke whale	31	47
Sperm whale	39	79
Humpback/sperm whale	2	2
Medium whale sp.	2	2
Beaked whale sp.	3	3
Pilot whale	13[c]	639
Killer whale	25	197
Dolphin sp.	90[a]	4,226
Dolphin sp.not porpoise	8	24
Risso's dolphin	1	7
Bottlenose dolphin	10[d]	74
Unpatterned dolphin sp.*[1]	1	2
White-beaked dolphin	76[d,e]	783
White-sided dolphin	55[b,c,e]	6,416
Lagenorhynchus sp. *[2]	14	516
Striped dolphin	1	18
Harbour porpoise	19	45
Total	**501**	**13,398**

*[1] unpatterned dolphin = Risso's/bottlenose dolphin

*[2] Lagenorhynchus sp. = white-beaked/white-sided dolphin

a includes 2 sightings of large whale sp. Associated with dolphin sp.

b includes 1 sighting of fin whales associated with white-sided dolphins

c includes 2 sightings of pilot whales associated with white-sided dolphins

d includes 1 sighting of bottlenose dolphins associated with white-beaked dolphins

e includes 1 sighting of white-beaked dolphins associated with white-sided dolphins

Table 14: Summary of cetacean observations from seismic survey vessels in 1999. Source: Stone, C J, 2001 Cetacean sightings during seismic surveys in 1999. Report. No. 316

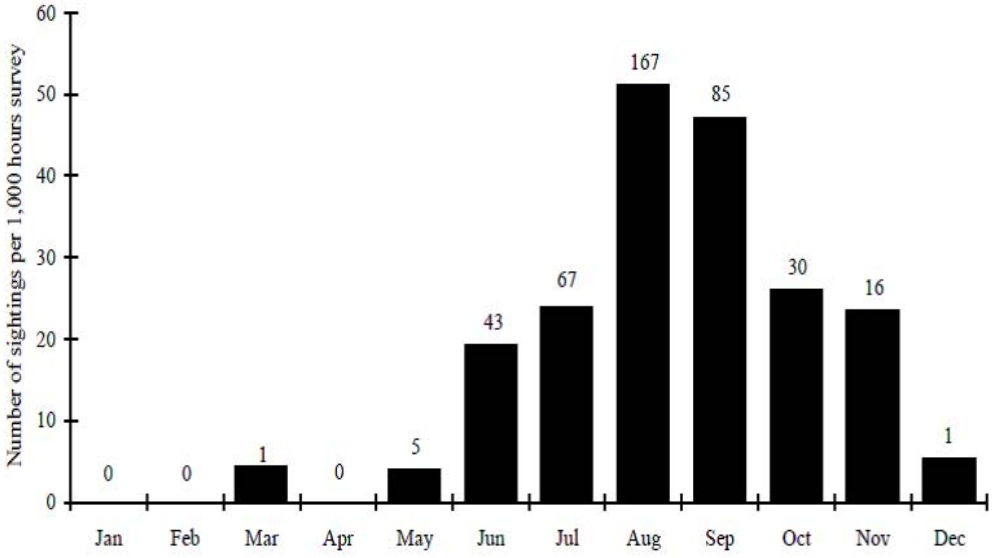
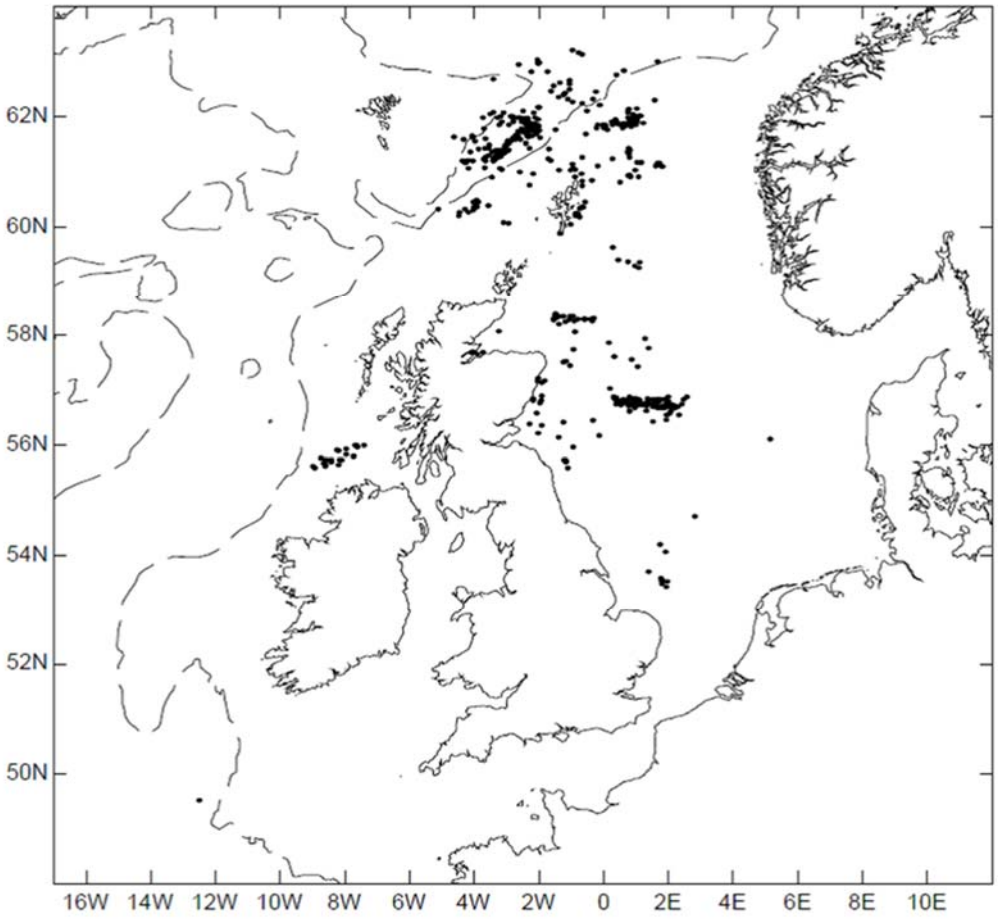


Figure 22 Observation rates of cetaceans per month, with number of observations (only includes surveys where effort was correctly recorded). Source: Stone, C J, 2001 Cetacean sightings during seismic surveys in 1999. Report. No. 316

Dolphins, pilot whales and killer whales were usually seen in groups; these groups could at times be quite large (mean pod size = 49.15 for pilot whales, 7.88 for killer whales, 10.30 for white-beaked dolphins, 116.65 for white-sided dolphins). Baleen whales and sperm whales tended to occur either singly or in small groups (mean pod size = 2.20 for fin whales, 2.03 for sperm whales, 1.52 for minke whales). There was a peak in sightings of cetaceans during the month of August (Figure 22), when more time was spent watching for marine mammals.

Sightings of marine mammals during seismic surveys in 1999 were concentrated in two main areas: north and west of Shetland and in the north-western part of the North Sea (Map 7).



Map 7: Cetacean observations (all species). Source: Stone, C J, 2001 Cetacean sightings during seismic surveys in 1999. Report. No. 316

To the north and west of Shetland there were many sightings in waters deeper than 1,000 m, but there were also a number of observations in ridge waters. In the North Sea there was a cluster of sightings to the east of Aberdeen, near a deep trench known as the Devil's Hole, and a smaller cluster just beyond the outer Moray Firth. Scattered sightings occurred elsewhere off the east coast of Scotland and further offshore in the northern part of the North Sea. There were a few observations in the southern part of the North Sea and a small cluster of sightings to the north-west of Ireland. There was just one sighting in the South-West Approaches. Some species were only seen in relatively restricted geographical areas, while others were more widespread. Sei whales, sperm whales, beaked whales and pilot

whales were concentrated in more northerly waters, with a preference for deeper oceans further than the 1,000 m isobaths, although pilot whales were also witnessed on one occurrence in the South-West Approaches. Fin whales and white-sided dolphins were also found in northern waters, but were seen over the ridge waters and shelf slope and in deep waters. In the the north-west of Shetland, white-sided dolphins were also seen in the North Sea. Some killer whales occurred relatively close inshore around Shetland but more were restricted to northern waters. Risso's dolphins were also seen closer inshore, with one sighting to the north of Shetland. One humpback whale was seen close inshore off the east coast of Shetland.

In comparison to many species, striped dolphins were restricted to more southerly waters. The sole sighting of this species occurred in the southern North Sea. Some species had a more widespread distribution. White-beaked dolphins were seen mostly in the northern North Sea, but were also seen close inshore around Shetland, over the continental shelf to the north of Shetland, and occasionally in deeper waters to the west of Shetland. There were occasional sightings of white-beaked dolphins in the southern North Sea. The distribution of harbour porpoises also ranged from shallow waters in the southern North Sea to deep waters to the north-west of Shetland. Minke whales and bottlenose dolphins were seen in the northern North Sea, sometimes relatively close inshore, and also occasionally further offshore in deeper waters to the north-west of Shetland. All observances of bottlenose dolphins offshore around the North Sea occurred within a 12 day period in late August and early September. Most grey seals seen in the North Sea, were relatively close inshore of Scotland, especially near the Firth of Forth, with one sighting near the Farne Islands. There was one sighting of a grey seal further offshore in the North Sea. Common seals were seen less often, but were seen near to the Farne Islands, close to Shetland and Moray Firth.

These records show a very distinct cetacean distribution by quadrant and species. Maps are plotted showing numerous observance of singular species including numerous observations of certain cetacean associated with other species in categories.

Clearly these recordings were detailed and elaborate, reinforcing the prerequisite for trained MMOs having background experience and knowledge in marine biology and conservation. The minimum qualification of a MMO is a degree in marine biology (MMO qualification, 2015). Although it is not always the practice to employ qualified MMOs, this does affect the quality and consistency of the reporting as it will be seen in the later sections.

7.3 Seasonal abundance and migration of marine mammals

It was recorded in the report that there were no indications from the distribution or direction of travel of marine mammals of any migratory patterns in the species observed. However, there were seasonal peaks of occurrence for some species. Cetacean sightings of many species peaked in August, including the time spent observing these mammals, some differences in the seasonal occurrence of the different species became apparent (Figure 23).

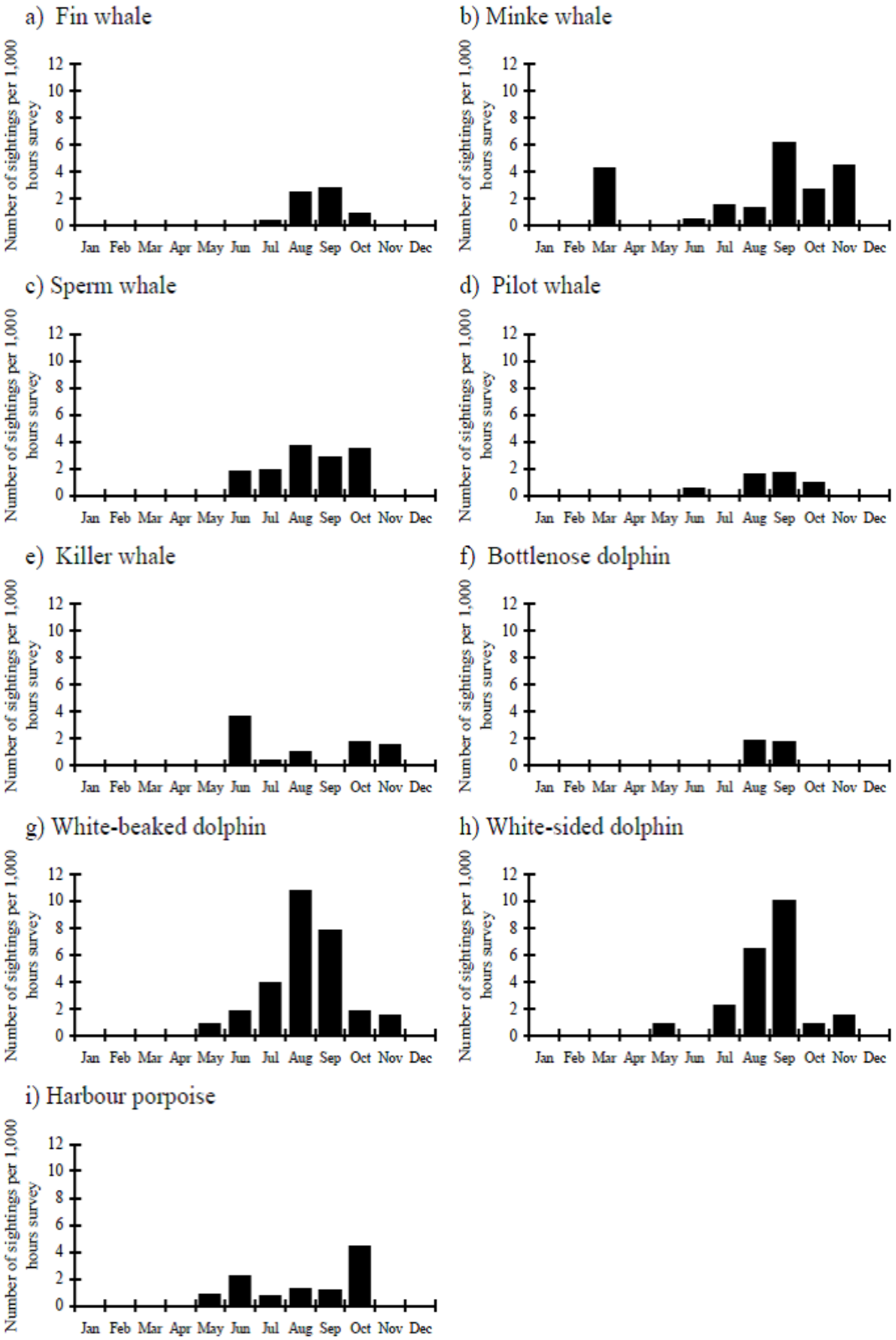


Figure 23: Observation rates of marine mammal per month. Source: Stone, C J, 2001 Cetacean sightings during seismic surveys in 1999. Report. No. 316

To elaborate on this phenomenon, marine mammal distribution and occurrence varies both spatially and temporally, and it is much easier to detect marine mammals in calm weather conditions with good visibility. It is particularly important to account for such factors if the proportion of time spent shooting also varies in relation to them. For example, including data from areas or seasons where marine mammal abundance is naturally low but where a high proportion of time was spent shooting could lead to the erroneous conclusion that sighting rates were reduced due to seismic activity, when the reduction could be adequately explained by natural factors. Therefore when re-calculating sighting rates, subsets of data were extracted corresponding to location and season, using various sources to establish known areas and months of copious species in the region. By doing so, a consolidation of data was used, considering location, season and weather conditions to eliminate various factors that could have influenced these results.

This was precisely done for Stone, C J, where a consolidated data were used, considering location, season and weather conditions for five main species as seen in Figure 24.

Recording and charting the variations in the seasonal changes of various species in Malaysian maritime and observing variations in migratory behaviour must be alligned for conservation towards research approach by DOE.

By doing so we'll be capable to indentify the location and seasonal condition around Malaysian waters in comparison data to various contributing factors, which will be then analysed for seasonal occurance of different species that are in migratory or transient enroute.

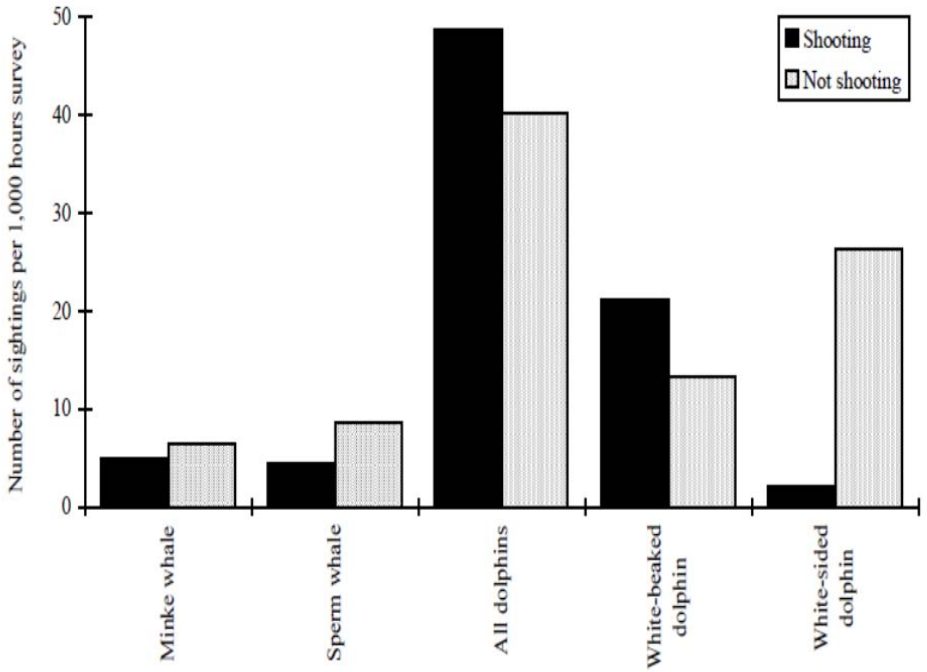


Figure 24: Observation rates of cetaceans taking into account of location, season and weather condition. Source: Stone, C J, 2001 Cetacean sightings during seismic surveys in 1999. Report. No. 316

7.4 Sightings during soft start

There were a total of eight sightings of marine mammals during the soft-start (Table 15), one was first seen prior to the soft-start commencing but was still present as the soft-start commenced, while the remainder were all first detected once the soft-start was underway.

The one sighting that first occurred prior to the soft-start commencing was of a single sei whale. It was at a distance of 600 m from the airguns as the soft-start commenced, and showed no apparent reaction to the commencement of firing, although the soft-start was halted after just four shots when the whale came within 500 m of the airguns. It continued on its course, crossing ahead of the ship, and at its closest point of approach was 400 m from the airguns. The soft-start soon re-commenced, but as the whale was no longer visible it was not possible to observe any reactions. Of the seven sightings that were first seen during the soft-start, only one was heading towards the vessel; in this instance the sighting occurred as the soft-start commenced, so firing would have been at the lowest power level.

Species	*Number of animals*	*Closest distance to airguns (metres)*	*Behaviour*	*Duration of soft-start (mins)*	*Time elapsed since commencement of soft-start when animals sighted (mins)*
Sei whale	1	400	Slow swimming; crossed bow	Four shots, then stopped, then 10 mins	Seen beforehand
Fin/ blue whale	5	5,000	Slow swimming	36	1
Dolphin sp.	1	2,000	Fast swimming	22	15
Dolphin sp.	1	3,500	Jumping, fast swimming	21	13
Dolphin sp. not porpoise	3	5,000	Breaching and jumping	22	9
White-beaked dolphin	8	1,600	Breaching, fast swimming	22	17
Lagenorhynchus sp.	2	1,000	Heading towards ship	17	0
Harbour porpoise	1	1,700	Slow swimming; heading away from ship	24	5

Table 15: Sightings during soft-start. Source: Stone, C J, 2001 Marine mammal observations during seismic surveys in 1999. Report. No. 316

A harbour porpoise reported at a distance of 1,700 m from the airguns (during calm conditions) was recorded as heading away from the vessel, but showing no obvious signs of disturbance, five minutes into a soft-start of 24 minutes duration, when the power level was presumably still relatively low. All dolphins occurring more than one-third of the way into the soft-start were swimming at speed, breaching or jumping.

Both white-beaked dolphins and white-sided dolphins demonstrated avoidance during seismic discharge. These species, like other dolphins, use higher frequencies than those typically emitted by seismic airguns. For example, white-beaked dolphins emit squeals at 8-12 kHz and white-sided dolphins whistle at 6-15 kHz. Malaysian Bottlenose dolphins emit squeals from 3-40 kHz and harbour porpoise around 1- 12 kHz with dugongs on a much lower frequency (Evans et al., 1996). Thorough detail recordings of such accuracy, not only ensures conseravtion to ocean surroundings but a keen study into the characterisitc reactions of cetaceans to their environment might contribute to further research of their response to other

natural occuring disasters like tsunami as an admonitory feedback to coastal community (Earth rangers, 2014).

7.5 Case study two

This section discusses case study two of the Project Proponent PETRONAS Carigali Sdn Bhd (PCSB), where Chemsain Konsultant Sdn Bhd has been appointed as the EIA Consultant for this EIA study for the **Dalak Project** in Labuan, East Malaysia. This Project is to install a new 44.2 km gas pipeline (5.1 km onshore and 39.1 km offshore/ nearshore) to supply 150 MMscd of processed gas from the Tee-Off Point at KP 71.66 of Sabah-Sarawak Gas Pipeline (SSGP) in Sipitang, Sabah to PETRONAS Chemicals Methanol Sdn Bhd, Plant-2 (PCMSB-2) in Labuan (PCSB, 2013).

Under the Amendment Act, 1985, section 34A, PCSB was called for to present to the Director General of the Department of Environment for the EIA approval. The report containing an appraisal of the impact to have on the environment also contain suggested methods to be set about to protect, decrease or handle the probable impingements on the marine environment.

EIA that is mandatory for project proponents to done with and submission of report to PETRONAS is required as EIA within the ambit of the Environmental Quality Act 1974. Under the Act, the upstream petroleum related projects listed involve hydrocarbon exploration and erection of off-shore pipelines is in excess of 50 kilometres in length (PCSB, 2013).

Although the construction is not an imposed task under DOE's requirement (since the total length of the gas pipeline is only 44.2 km), PETRONAS Carigali has taken the initiative to initiate the EIA study mainly for internal usage and environmental conservation purposes. For formality purpose and following discussion with DOE, it was agreed that the EIA be processed administratively and this shall be done by the DOE headquarter in Putrajaya (Chemsain Konsultant, 2012).

The EIA study was undertaken in accordance to all the relevant guidelines and PETRONAS Technical Standards (PTS) published by PETRONAS in the Health, Safety and

Environmental (HSSE) Policy of PETRONAS. Further consultations have also been carried out with all the relevant authorities such as the Forestry Department, the Fisheries Department, the District Council (Sipitang), the Public Works Department, the Marine Department, to identify and document the issues related to the development of the Project.

The EIA forms on the Project site's suitability have been submitted to DOE Sabah and DOE Labuan on December 11, 2012 and December 19, 2012, respectively. These were accepted on January 07, 2013 and January 08, 2013 respectively.

In general, the existing EIA process is applied to predict the consequences of a proposed gas pipeline development on the environment. It is aimed at foreseeing and addressing potential problems at an early stage during project planning and design stages.

This EIA report will specify and prescribe appropriate mitigating and abatement measures for the marine impacts identified together with an environmental management plan (EMP) outlined as a framework of the monitoring programme for the Project.

The DALAK EIA is required to fulfil all prescribed activities with potentially significant residual marine environmental impact and therefore falls in the sector of Special EIA.

Apart from fulfilling the environmental requirements, this report is focused to contribute significantly to the preparation of the project by furnishing environmental information and highlighting key issues. This EIA report will also make recommendations and monitoring plans in order to enhance the quality of the environment in line with the effort all the relevant authorities.

PETRONAS has classified in their prescribed activity in various fields such as standard database, fundamental matters, forecasting and valuation of impacts, mitigation measures, and environmental administrative provision. Further data concerning existing geographic region in the construction area covering geophysical, chemical and biological hazards are also covered.

7.6 Seismic survey processes

Geo-Surveys Sdn Bhd (OGS) a member of Offshore Works Sdn Bhd (OWS) is contracted by PETRONAS Carigali Sdn Bhd (PCSB) Malaysia to perform a seismic survey from PETRONAS Methanol Labuan (PML) to Sipitang, situated within Labuan and Sabah water, Malaysia for PETRONAS Dalak Project Offshore (PCSB, 2013).

The analogue equipment used in seismic surveying comprised of:-

• An Odom Echotrac DF3200 MKIII Single Beam Echo Sounder Frequency

• High band: 100 kHz – 1 MHz

• Low band: 3.5 kHz – 50 kHz Output Power

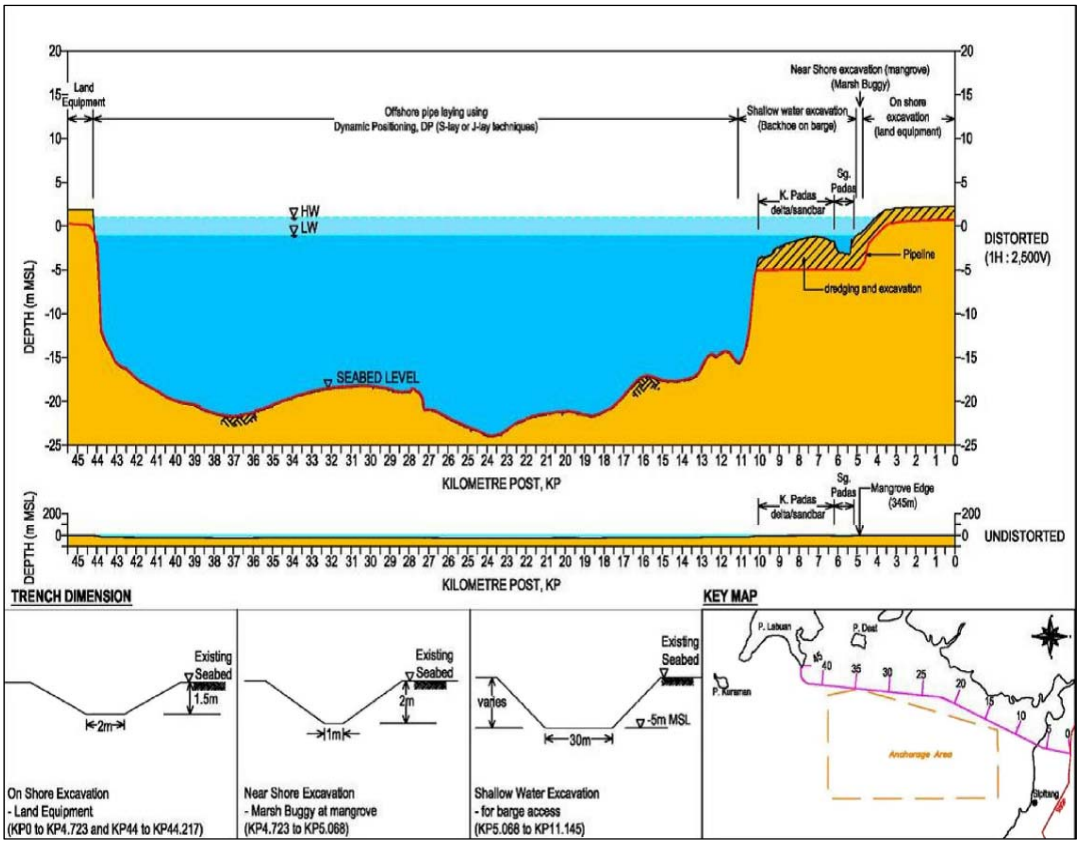
• High: 100 kHz – 1 kW RMS max 200 kHz – 900 W RMS max, 750 kHz – 300 W RMS max

• Low: 3.5 kHz – 2 kHz

• R2 Sonic Multibeam Echo Sounder 200KHz – 400 KHz

• A 159D GeoAcoustics Side Scan Sonar Towfish 114KHz-410 KHz

• A Pinger 1 x 2 Orotech. The output power is continuously adjustable up to 10 kW with a selectable frequency from 2 to 12 kHz (Chemsain Konsultant, 2013).



Map 8: Cross section of pipeline alignment Dalak Project. Source: Dalak Pipeline Project, PCSB 2013.

Mitigation methods were for excavation and pipe laying activities (Map 8) were mentioned such as; excavated material to be beneficially backfilled, excavation and dredging to be carried out during dry season, sediment concentration to be monitored in a quarterly bases, to avoid seabed hazards, work plan to minimize disturbance of soils, particularly clay areas, which could be easily re-suspended (PCSB, 2013).

However there were no seismic survey mitigation measure addressed nor discussed before, after and during seismic activity for marine mammal conservation plan.

There are mitigation measures against small-scale oil spills which may impact marine species. It was mentioned in the report that marine life such as fish and cetaceans have the capability to swim off from a spill by going deeper in the water or farther out to the ocean, decreasing the odds that they will be injured by a spill. The report has also stated marine life that typically

populate closer to land, such as turtles and dugongs, take chances on pollution by oil spill that flows onto beaches or by consuming oil- contaminated forage. In shoal waters, oil spill may scathe sea grasses that are used for feed, refuge, and inhabiting by many marine genus. No turtle nesting sites take place in the vicinage of the planned development, and the existence of large marine fauna such as dugongs and turtles is considered too low to face a substantial impact through a small-scale spill. Although the report has included Dugongs and sea turtles, it does not include any cetacean sightings in survey. While some recent research has been made on more fine-scale studies of cetacean distribution and habitat use in specific coastal areas in Malaysia, such as in Sarawak, Sabah, Langkawi knowledge outside these areas is extremely limited or not mentioned altogether (Ponnampalam et al., 2011).

7.7 No cetacean pre shoot sightings were conducted

According to Ponnampalam, 2012, bottlenose dolphins, spinner and spotted dolphins, together with other unidentified cetaceans and whales are sighted in this regions. This was not considered during the DALAK EIA assessment and no cetacean mitigation plan nor were sightings conducted during the survey.

7.8 Cetacean behaviour recorded on MOSTI PSSE expedition

The 2009 PSSE expedition organised by NOD under MOSTI brought about an aggregate of 27 sightings of cetaceans recorded with a total of 10 sightings of cetaceans that could not be identified to species level, including one unidentified whale that was sighted over the continental shelf of the South China Sea and two sightings comprised of mixed-groups of spinner and pantropical spotted dolphins, (Ponnampalam, 2012). This recording format and detailing were very similar to JNCC recording format as seen in Case study one but not captured in the Case study two (Table 16).

Species	No. of sightings	Encounter rate		Group size			Depth (m)		
		EG/h	EG/100 km	Range	Mean (n)	Std. Dev.	Range	Mean (n)	Std. Dev.
Spinner dolphin (*Stenella longirostris*)	9[a]	0.07	0.36	10–55	27.0 (9)	12.6	30–1250	563.3 (9)	586.7
Bottlenose dolphin (*Tursiops* c.f *aduncus*)	7	0.05	0.28	1–75	29.3 (7)	29.0	32–142	83.1 (7)	35.4
Pantropical spotted dolphin (*Stenella attenuata*)	3[a]	0.02	0.12	35–250	111.7 (3)	120.0	108–1250	852.7 (3)	645.4
Unidentified cetaceans (excluding large whales)	9	0.07	0.36	2–50	11.9 (9)	16.0	42–1250	232.5 (9)	392.1
Unidentified whale	1	0.008	0.04	1	1.0 (1)	—	110	110.0 (1)	—
TOTAL	**27[a]**								

[a]Two sightings were of mixed spinner-spotted dolphin group sightings, hence total sightings is 27 and not 29.

Table 16. Summary of sightings recorded during the survey, including encounter rates, group sizes and depth distributions. EG/h = groups sighted per hour of search effort; EG/100 km = groups sighted per 100 km of search effort. n = sample size. Source: Ponnampalam 2012

During the PSSE expedition, highly evasive behaviour of the dolphins was observed during three of the nine spinner dolphin sightings and two of the seven bottlenose dolphin sightings. During these sightings, the dolphin group generally kept moving away as the vessel sought to nuzzle alongside the group, some darting away without even breaking the ocean's surface. Social and herd mating behaviours were observed in spinner dolphins on two occasions, whereby the dolphin group was very active and most individuals appeared to be harassing and in constant close body contact with a single individual that was in the middle of the group.

A lone bottlenose dolphin was once observed following behind a fishing trawler in the shallow coastal waters of north-eastern Sabah, while spinner dolphins were observed chasing fish on the surface on three occasions.

7.9 Marine mammal standings in East Malaysia

During the National RoundTable Discussion, Maritime Institute of Malaysia (MIMA) emphasised in greater detail, issues pertaining to the marine mammals' survival and the need to conserve them. Strandings are also often indicators of the health of our seas and is the key to understanding the animals' conservation needs. Many strandings are believed to be associated to the effects of man-made activities such as shipping and seismic activity (Ponnampalam, 2010).

Date	Species	Where Found	Source
15 Jan 2014	**Whale**	**Kuala Tatau**	**The Star**
2nd Aug 2012	**Whale**	**Kuala Penyu**	**The Star**
11th Jan 2012	**Pygmy Whale**	**Sabah**	**The Star**
15th Feb 2013	**Dolphin**	**Sepanggar Bay**	**Daily Express**
30th Sept 2014	**Whale**	**Pulau Bangi**	**Daily Express**

Table 17: Newspaper marine mammal stranding summary in Malaysia

There are many cases of marine mammal stranding (Table 17). For example on January 15th, 2014, a whale, which was still alive, was found stranded on the Kuala Tatau beach early Wednesday morning by a family who were out walking on the beach in Bintulu (The Star, 15th January 2014). A 15.8m long whale that beached in Sabah's west coast Kuala Penyu district that died 12 hours after it was first spotted on the 2nd August 2012 (The Star, 2nd August 2012). Staff of a beach resort in Sabah have rescued a pygmy killer whale stranded by the shore during low tide on 11th January 2012 (The Star, 11th January 2012).On the15th February, 2013, an injured female dolphin was found stranded in Sepanggar Bay and it had not been accepting food and in poor condition succumbed to its injuries (Daily Express, 28th February 2013). A whale showed up at Kg Kapitangan in Pulau Banggi and came back to the shore and died shortly after the villagers guided it back to the sea. The carcass had been buried before the police reached the scene (Daily Express, 30th September 2014). Every stranded marine mammal can contribute to the cause and effect study if adequately handled by marine biologist with the aid of the Ministry and regulated by statutory guidelines by the Department of Environment. In most cases of whale stranding, incidents are not reported or records found. This lack of conservation acuteness by the agencies is a concern that need to be addressed.

Establishing a stranding network is important to ensure most of the strandings' are reported to the proper authority in a gazetted government environmental procedure. It also ensures that all strandings' are handle in best possible way for tissues samples collections for research purpose. This provides important and crucial information to monitor the impacts of seismic activities on cetaceans (Ponnampalam, 2010).

Institute of Malaysia (MIMA) concluded that if Malaysia is able to establish a fully functional marine mammal stranding response Maritime network with all relevant stakeholders cooperating with each other, then the country would be on par with countries that have established cetacean preservation programmes (Ponnampalam, 2010).

It is extremely crucial to mitigate impacts of the seismic activity, especially to endanger species of cetaceans that are discovered in Malaysia, like the fin whale and blue whale as documented in the IUCN Red List. This awareness was clearly not in the impact assessment prescribed activity to the stakeholders in DALAK Project in protecting and conserving these cetacean species from seismic survey activity.

7.10 Aerial visual survey conducted for Dugongs and Sea Turtles

There were two aerial surveys conducted on the 30 November 2012 and 8 December 2012 for the Dalak Project at the western coastline of Sabah in Brunei Bay. A total of 16 dugongs (Dugong, Family Dugongidae; 6 on first survey, 10 on second survey) and 13 turtles (all green turtles *Chelonia mydas*, Family Cheloniidae; 12 on first survey, 1 on second survey) were recorded during the aerial surveys. It was estimated that each survey transect covered a width of 370 m, and both first and second surveys covered 255.6 and 214.8 km, for effective ground coverage of 94.65 and 79.5 km2 respectively. The locations for each of these are provided in coordinates and raw data is presented in Table 18. Average densities calculated for each species were 0.0946 dugongs/km2 and 0.0697 turtles/km .This was the only two aerial survey

conducted for the two endangered species and there were no other survey concluded in the report for marine mammal sighting (EIA DALAK, 2012).

Date	Location	Altitude	Sighting
30/11/2012	N5 13.530 E115 25.134	210 m	Dugong
30/11/2012	N5 13.546 E115 25.141	210 m	Dugong
30/11/2012	N5 13.680 E115 25.201	204 m	Dugong
30/11/2012	N5 13.741 E115 25.229	204 m	Dugong
30/11/2012	N5 14.639 E115 26.322	214 m	Turtle
30/11/2012	N5 13.730 E115 28.032	208 m	Turtle
30/11/2012	N5 13.736 E115 28.052	202 m	Turtle
30/11/2012	N5 10.491 E115 30.202	258 m	Dugong
30/11/2012	N5 13.210 E115 23.182	225 m	Turtle
30/11/2012	N5 15.118 E115 22.511	197 m	Dugong
30/11/2012	N5 13.972 E115 22.134	212 m	Dugong
30/11/2012	N5 15.005 E115 21.445	217 m	Turtle
30/11/2012	N5 15.427 E115 21.659	214 m	Turtle

Date	Location	Altitude	Sighting
30/11/2012	N5 15.616 E115 19.715	223 m	Dugong
30/11/2012	N5 13.377 E115 19.415	245 m	Turtle
30/11/2012	N5 13.366 E115 17.734	220 m	Turtle
08/12/2012	N5 12.885 E115 26.543	223 m	Dugong (x5)
08/12/2012	N5 15.960 E115 22.819	225 m	Dugong
08/12/2012	N5 16.928 E115 20.463	236 m	Dugong
08/12/2012	N5 12.827 E115 19.040	230 m	Dugong
08/12/2012	N5 18.091 E115 18.542	212 m	Turtle
08/12/2012	N5 17.289 E115 17.929	227 m	Dugong

Table 18: Raw data for endangered wildlife sightings during Aerial Surveys for Dalak Project

7.11 Review of case study two

From a preliminary interview conducted with PETRONAS Carigali, it was understood that the seismic survey is contracted to a French seismic contractor, and they did not follow JNCC guidelines for mitigation on marine mammals' conservation. This was obvious as the protocol of JNCC calls for pre shooting search for marine mammals for at least 30 minutes and this was not executed. Furthermore, a third party QC was involved in overseeing the operation instead of a MMO, with no knowledge in seismic survey marine mammal mitigation. The practice of 'soft start' is never rehearsed prior to full power capacity even during line change, which is a crucial element in deterrent of marine mammals from survey sites. This highlights two issues, one, the lack of understanding in PETRONAS of such requirement and two, the importance in cetacean conservation internationally. This lack in awareness of a rich biodiversity of cetaceans in Malaysian waters, calls to reflect to a national agenda, in seeking to generate new scientific knowledge and strengthen the national research capacity and capability as a National objective (MOSTI, 2014)

It was made clear that objective of the DALAK EIA is to incorporate the fundamentals of sustainable development into country policies and agendas through implementation of sustainable development (PCSB, 2013). Achieving this purpose will strengthen the demand for the use of an amalgamated, inter-agency, well-rounded proposition in directing the innovation and execution of seismic mitigation guidelines. Such an approach in integrated assessment will focus on ensuring that sustainability aspects are incorporated into policy design and decision-making for the wellbeing of the cetaceans and overall Biodiversity management.

Overall, the DALAK EIA established a systematic integrated appraisal in the preparation and data collection and has the prospect to be a potent tool for growth of the project.

However the pragmatic utilization of integrated assessment in cetacean conservation may still be relatively uninformed. Although some international marine conservation organisation have moved directly from tried and tested methods such as JNCC mitigating guidelines for marine mammals, an investigation to empirical use of the guideline with sustainability mitigating plan are needed to enrich the EIA to attempt such integrated assessment like in the DALAK Project.

There are two principal reasons for widening the ambit of EIA. First, potentially affected marine ecosystem that is crucial and is vital for our National Physical Plan, NPP2 (EIA, 2010).

Secondly, some environmental impacts are caused by direct social and economic impacts of an action, and if they are not included in the EIA, then some potentially destructive environmental impacts may be excluded inadvertently from the detailed EIA. Thus, the EIA will progress in terms of measure of study and methods of analysis and evaluation, toward integration of a variety of issues relevant to decision-making. The extent of "integration" in EIA relies to some degree on the distinctness of the "environment" in national law-making and guidelines especially as stated for the ESA in NPP 2. In some international organizations this definition is broad, incorporating biophysical and socio-cultural dimensions (including health). In other jurisdictions the definition is more restricted with the emphasis on the biophysical aspects (World bank, 1991).

7.12 Chapter Summary

Of the 2 case studies observed, a systematic approach of how Stone, C J, mitigations had a complete marine mammal preservation methodology leading from a prescriptive base approach towards an industry performance based best practices. The five keys aspects and foundations in mitigation plan with UNCLOS requirement showed compliance and was measured in several ways.

1) A very detail level of appraisal and coverage of seismic surveys;

2) The usage of appropriate trained personnel as MMO

3) The maintenance of an adequate pre start watch for marine mammal before shooting commencing

4) The delay in commencing shooting if cetaceans were close by, and

5) The usage of a soft-start procedure.

The accuracy of the data report shows cetaceans were more probable to surface frequently throughout seismic shooting, while diving or surfacing infrequently was more prevalent when the airguns wasn't firing. The report also showed a much greater tendency of cetaceans to head off from the survey vessel during seismic shooting, although the tendency to head towards the ship was likewise slightly greater significantly at these times. To be more conclusive and efficient, this report should have shown species distribution instead of combination as a whole. By doing so, an analysis could be done as to which species are impacted by the frequency and studies into cetacean behaviour against range, intensity and genre can be plotted for further improvement in mitigation.

This chapter has clearly shown Stone, C. J. report had covered all bases of prescriptive and performance base procedure in seismic footprint management and documentation for cetacean behavioural and migratory patterns and for the adaptation of JNCC guidelines as an efficient mitigation tool in global conservation programme. The next chapter shall present the analysis and discussion of result of data obtained from this research in order to accomplish the objectives of this study.

CHAPTER EIGHT– ANALYSIS OF DATA AND DISCUSSION

8.1 Introduction

This research was carried out in a systematic literary review in several stages with the aim of understanding the project topic, how seismic survey is carried out by PETROMAS via seismic contractors, the effects of seismic survey on cetaceans, the judicial system associated with marine environmental law against marine pollution and endangered marine life conservation, the opinions of seismic contractors in mitigating seismic noise pollution via prescriptive-performance tools practiced. To accentuate the literature review, two comprehensive case studies was examined, compared and analysed to interpret the profoundness of the three core topics in managing marine seismic survey footprint. This composition together with the extensive comparative review of various international seismic guidelines is then employed to articulate questionnaires for interview sessions with stakeholders in the PETRONAS DALAK Project to investigate if there is a statutory seismic survey guidelines in the PTS, DOE and also in the Handbook of the Environmental Impact Assessment in Sabah for fulfilling the aims and objective of this research.

8.2 Interview Questionnaire

Each set of Questionnaire is establish after reviewing pertinent literature paper, JNCC guidelines, Malaysian EIA Oil and Gas ordinances, case studies, and international requirement in seismic pollution governance. Semi-structured interviews are used for data collection from the Environmental Government agencies, Non-Governmental Organizations (NGOs), PETRONAS, PETRONAS appointed Environment Consultants, PETRONAS appointed seismic contractors and other relevant stakeholders. There are different questionnaires for respondents from various subjects consisting of statutory, technical, environmental and general awareness. Several similar questionnaires are sent to different respondents in respective organization for comparing and analysing data.

After each face to face interview conducted, another set of survey questionnaire is provided to ascertain respondent awareness level of seismic survey guidelines, inquire commonly used seismic survey prescriptive/performance tools practised, investigate if there exist government environmental policies that seismic survey guidelines can be implemented and their personal sentiments on the matter.

8.3 Demographic structures and functionalities

There were difficulties in contacting some agencies, where phone calls were not answered and emails were not replied. However from the Table 19 below, there were some productive feedbacks. Citation below are transcripts taken in context to the interviews conducted. Interview transcripts are attached in Appendix.

Organization	Responsive	Unresponsive
Chairman of MareCet Research Organization	√	
Vice Chairman of MareCet	√	
Marine Park Department	√	
Non-profit research foundation, Sabah	√	
Director of Environment Consultant, Chemsain Konsultant Sdn Bhd, Subang Jaya	√	
Department of Environment (DOE), Sabah	√	
Department of Fisheries (DOF), Law Section	√	
PETRONAS	√	
Department of Environment (DOE), EIA Section		√
DOF, seismis survey section, EIA		√
Shell		√
Chemsain Konsultant Sdn Bhd, Sabah		√
Labuan Shipyard and Engineering		√
University Malaysia Terengganu (UMT)		√
Total	**8**	**6**

Table 19: Summary of respondents.

The analysis of results reveal that, percentage of respondents are 44% (20) from Engineering/Technical staff with seismic operators 12%(5) considered as contractors, whilst 55%(25) of them are fishermen. The majority of the respondent strength are of engineering and science disciplines which fully describes the nature and functions of seismic survey operations.

Pakdil et al, (2015) observe that "most government organisations are hierarchical, as there are few decisions that do not conform to a decision tree, giving little scope for acting outside of the rules". This was evident in in one of the respondents' reply when asked if their company would fund seismic research in collaboration with academia

> ***"……We are small scale company, will have limited fund to allocate to this type of research. But we believe we are able to support as co-sponsor. Overall, it will depends on the top management's decision whether to support this kind of research as one of the CSR."***

Positions, designations and responsibilities assigned to employees are critical to the operations of every organisation. Senior officers are equivalent to assistant managers and have 40% (8) and 35% (7) of respondents' represents seismic operators. Director and Deputy Directors also referred to as senior management shows 25 % (5) response.

Ranks, job positions and number of employees or organisation size are important elements or variables required for the design of organisational structure. A large organisation has tall vertical hierarchical structure in which authority; roles, responsibilities and reporting are executed from top to bottom. Supervisory channels and roles, for instance, to whom the staff members reports or who is being supervised are activities that are executed through the various ranks (junior, middle, senior, Management) with the people manning the job positions (i.e. Top Management, Senior Management, Middle Management, managers/Assistant managers and Frontline Officers) along the pyramid.

For reliability and validity mix samples are effectively the appropriate respondents for the study based on their demographic background, nature of their profession and position held in the organisation.

Leite et al, (2015) stressed that apart from the manufacturing sector, the service organisations strongly depend on people factors, which is responsible for the prospection, execution and delivery of service to the customer or end-users, who expects service with high quality. In this regard, employees' qualifications, field of studies, ranks, and positions are relevant people factors. Furthermore, people are in possession of skills, knowledge and experiences are of significant economic value to organisations whilst at the same time these skills, knowledge and experiences has corresponding effect on productivity, as they represent capital that is too valuable to be lost (King et al, 2008).

The respondents were asked on their level of understanding on seismic survey, awareness of existence of our own cetaceans and their views and knowledge on the current prescriptive practice before seismic survey.

The awareness on the existence of cetaceans in Malaysian maritime and the impacts of seismic blast are ranked as meagre from the majority of the respondent. This is probably due to fact that "Malaysian lifestyle is more beach dwelling, where recreational deep sea gratifying activities such as ocean fishing, surfing, sailing and diving are not as frequent as the communities in Australia, New Zealand, The UK and The US. Geographical location of these countries with cooler climate and the leisure time expended in the ocean, is a lifestyle and hobby as compared to Malaysia is also a contributing factor "said one respondent. Another researcher said awareness of cetaceans come from actually seeing it, since most of the stranding cases are found in Sabah and East Malaysia, the presence of marine mammal are more profound with community in East Malaysia and the ongoing research is much higher in these regions compared to Peninsular Malaysia.

As stated by Ponnampalam, (2012), there are three geographical regions in Malaysian waters designated as prime cetacean habitat. These are Peninsular Malaysia, Sarawak, and Sabah.

Within each region, two subcategories of 'live sighting' and 'stranding' were recorded, to determine the type of species occurring in each state.

27 cetacean species were documented in Malaysia so far, and encountered in continental shelf waters, intermediate depths and deep offshore waters. The Spinner dolphin was the most frequently encountered species, while the Pantropical spotted dolphins were the least frequently encountered species. 10 observations of marine mammals could not be distinguished to species level, including one unidentified whale that was sighted over the South China Sea (Ponnampalam, 2012).

According to the interview with a British Founder and Executive Director for a non-profit research and conservation organization based in Sabah, he suggested creating a dedicated stranding network with a dedicated hotline number to raise awareness at the National level of marine mammal existence in Malaysia. He is also a member for the International Union for Conservation of Nature (IUCN)).

In the interview conducted with a high profile PETRONAS Management, he was asked about the observation done for marine mammals before seismic survey. His response was, "In Malaysia we did not have issues of marine life. In Malaysia there is no species to watch during the survey. Our problem are the "bubu ikan" (fish trap in Malay Language) which could damage the seismic cable".

The Deputy Chairman of MareCet stated, "Malaysians need to first be made aware that marine mammals exist in Malaysian waters. This message has to be ongoing and information to be made available to the public for areas where research has revealed cetaceans inhabits. Having marine mammals broadly cited in various legislation, policies, guidelines and other documents would also fortify the message that marine mammals are present and are of conservation value. Specifically for the oil and gas industry, it would be expedient to introduce a marine mammal

awareness training for those involved in offshore operations, especially those pertained in activities that may be of substantial impacts to marine mammals (e.g. seismic survey, underwater piling, etc.)".

It is indispensable to educate PETRONAS on the existing marine mammals in Malaysia and propose a guideline that mitigates the preservation to the species by having an engaged assemblage to evoke knowingness of cetaceans in Malaysia.

From the interviews conducted, it was quite clear about the lack of awareness of cetaceans in Malaysia followed by lack of requisite knowledge that seismic survey causes detrimental effects on marine mammals.

The study reveals that majority of the respondents according to the demographics survey show significant number of degree holders operating seismic equipment and front-line staff performing the survey. Usually an organization that operates a traditional hierarchical organisational structure with bureaucratic culture of administration tends to be more mechanistic with authority and information disseminated to their subordinates. If PETRONAS lacks knowledge on marine mammal mitigation then this should be the same scenario with the seismic contractors. However in this research, this situation is found to be on the contrary.

The next section investigates the analysis conducted to ascertain whether seismic survey contractors use prescriptive and performance methods or otherwise in PETRONAS seismic surveys.

8.4 Analysis results (Mixed Analysis)

The mixed analysis is not only to complement the two broad extremes of quantitative and qualitative methods in both strengths and weaknesses, but also has a strong historical explanation of how in the later part of the 20th century, there was the development and growth

of interest in the use of mixed method analysis by researchers. This momentum was used to move past the 'either/or' methodological thinking of the paradigm war (Punch, 2014).

8.4.1 Quantitative Analysis

The survey questionnaires explores both closed and open-ended questions and were grouped into the 4 clusters:

a. Personal Biodata

b. The awareness of existing seismic survey concepts and implementation in PETRONAS.

C The use of prescriptive and performance methods for improvements in marine mammal mitigation in PETRONAS.

D Awareness of Government environmental policies where seismic survey mitigation policies can be implemented.

The interview on the other hand was conducted in order to validate the survey analysis results and to unravel the answers from the respondent's experiences to the research questions.

There are two categories of respondent group that the research streamlines. One the public that reside around the vicinity of the project (Group A), the other is the executive management (Group B) of various organisations.

8.4.1.1 Public (Group A)

There are two distinct issues with respect to cetaceans and seismic surveys:-

One is the potential for a seismic source to impact marine mammal physically, auditory, or behaviourally, which in turn could create a significant biodiversity impact. The other issue is commercial in nature, meaning the prospect for seismic surveys to impact the catch rate for fishermen.

Survey questionnaires were carried on at six seismic survey locations as per detailed in the Table 20. The mean number of years spent fishing was ±20 years, ranging from 3 to 37 years, suggesting a mix of experienced fishermen and newcomers to the industry.

Interestingly, 92% of responders pointed out their parents were fishermen, and 72% indicated their grandparents were fishermen. Over 83% of respondents indicated fishing was their main income-earning activity, of which 75% of respondents indicated that fishing was the only way they made a living, and that they fished every month of the year, for a minimum of 6 to 7 days a week.

Village	Latitude	Longitude	Numbers of Seismic Surveys conducted
Kg Weston Lubuk	**5.175819º**	**115.583013º**	**17**
Kg Patau Patau (Labuan)	**5.276817º**	**115.192119º**	**10**
Kg Rancha Rancha (Labuan)	**5.263335º**	**115.227725º**	**7**
Kg Sapok Palakat	**5.122367º**	**115.556223º**	**11**
Kg Weston Laut	**5.179796º**	**115.586799º**	**6**
Menumbuk	**5.304316º**	**115.372638º**	**2**

Table 20: Coordinates of seismic survey conducted at various village vicinity of the Dalak Pipeline Project.

Gill nets (19%) and traps (19%) were the most common fishing gears, with a large proportion of fishers also reporting the use of hook and line (20%), purse seines and trawls (Table 21). The mid-water longlines and bottom longlines were infrequently used.

Type of Fishing Gear	Proportion Use (%)	Use Frequency			Target			
		Only	Mostly	Sometimes	Fish	Crab	Shrimp	Mix
Longline	13%	0	25	75	56	0	0	44
Bottom Longline	11%	0	10	90	80	0	0	20
Hook and Line	20%	0	5	95	38	6	0	54
Purse Seine	10%	0	67	33	60	0	0	40
Trawl Nets	8%	0	50	50	20	0	0	80
Gill or Trammel	19%	0	61	39	36	0	14	50
Traps	19%	0	56	44	5	11	0	84
Total Catch					**42%**	**2%**	**2%**	**53%**

Table 21: Type of Fishing Gear Used By Fishermen

Catches were predominantly for fish (42%) or mixed catches of fish, crabs and shrimp (53%). This highlights the opportunistic nature of the fishery, where all catches are landed, irrespective of value or type. When catches from the larger trawls or purse seines were omitted, average daily catch values were reportedly approximately RM306 and it is ranging from RM 80 to 700 per day. However, the majority of daily earnings were valued from RM100 to RM200 per day.

The Beaufort and Kuala Penyu fish landings represent only ±1.7% of all Sabah fishery landings (extracted from Sabah Fishery Statistics 2002), reflecting the small-scale artisanal nature of the fishery in general. Some of the interviewed fishermen reported that larger catches were obtainable with greater travel times, which were uneconomical.

All of the fishermen indicated they sold all their catch and little or none of it is kept for consumption. 3% of the fishermen sold their catch directly to shops, while the balance 97% sold their catch via middlemen. Nearly all fishermen preserved their catch (88%) while the

balance indicated they fished for shorter periods and did not use any form of preservation. Ice was the usual form of preservation (87%) with the balance being preserved through drying.

All of the fishermen perceived there is a decline in both catch sizes and weights during and after seismic survey. This also confirms the hypotheses from the case study and literature review that marine mammals are effected from seismic blast. This is further validated by marine biologist Dr, Ponnampalam (Chairman of MareCet) in her interview:

> ***"……Reductions in marine mammal populations in some areas have resulted in ecosystem imbalance, which had environmental, social, and economic consequences."***

:

8.4.1.2 Executive management (Group B)

The lack of awareness of cetacean in Malaysia is further evaluated on various independent variables such as seismic contractors' knowledge and understanding of seismic survey guidelines, seismic survey equipment used, and value of service provided with respect to environment, customer/ client requested MMO and survey processes, as in figure below. The results the respondents presented are a contrary in view of awareness level of seismic survey guidelines as mentioned earlier in this chapter but believes that it is faced with such difficulties ranging from '*lack of awareness*' to '*amendment in government policies'*.

8.4.1.3 Inferential Results

The analysis showed all the variables at high levels of significance with one-sample test (t-test) at p value of < 0.05, including; seismic contractors knowledge, value of service provided with respect to environment, customer requested MMO, survey processes, were all significant to the status of seismic guideline awareness and implementation in the oil industry. The correlation of the contractor awareness level of seismic mitigation with management's knowledge revealed a significant difference at PV < 0.05. In particular, there were significant dependency with contractor using the right seismic equipment with customer/client request for MMO for value

added services with respect to marine mammal protection {PV = -0.028, 0.005, -0.063 and -0.027}

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations	PV	
	B	Std. Error	Beta			Zero-order	Partial	Part
(Constant)	2.011	0.487		4.127	0			
SEISMIC SURVEY EQUIP	-0.003	0.011	-0.026	-.307	0.759	0.026	-0.028	-0.024
VALUE OF ENVIRON SERVICE	0.001	0.013	0.004	0.052	0.958	0.054	0.005	0.004
CONTRAC KNOWLED	-0.051	0.074	-0.056	-.693	0.49	-0.118	-0.063	-0.054
MMO CSTM	-0.006	0.022	-0.023	-.294	0.769	0.024	-0.027	-0.023
STD SEISMIC PROCESS	-0.405	0.164	-0.194	2.471	0.015	0.214	-0.22	0.191
INT MMO REQUEST	0.018	0.015	0.097	1.199	0.233	0.109	0.109	0.093
MANAGE UNDERST ANDING	0.492	0.084	0.46	5.856	0	0.48	0.471	0.454

Correlation coefficient model of respondents' awareness level of seismic survey guidelines

However, standardize seismic processes, internal (PETRONAS) request for MMO and PETRONAS understanding of seismic survey mitigation were not significant {PV = -0.22,

0.109, and 0.471 respectively}. This development could be as a result of PETRONAS inadequate knowledge of the international requirements for seismic survey mitigation.

Furthermore, there is the general misconceptions that seismic survey mitigation is only a foreign practice and hence might not be applicable to Malaysian offshore geo-survey.

From table, the linear regression of seismic contractor awareness of seismic survey indicates a very high significance level of 0.000 at f = 6.66.

Model 1		Sum of Squares	df	Mean Square	F	Sig.
Dependent Variable: Awareness of seismic survey mitigation	Regression	36.057	7	5.151	6.66	.000b
	Residual	92.818	120	0.773		
	Total	128.875	127			

(Linear regression) of seismic contractor awareness level of seismic survey mitigation

Despite the fact that the seismic contractors do not officially implement seismic survey mitigation, more than a third of the respondents maintain that prescriptive and performance methods like soft start are practiced when client requested.

The seismic contractors (respondents) tend to have exhibited relative knowledge of the working mechanism in relation to seismic survey prescriptive and performance methods. This significant prescriptive and performance knowledge and awareness of seismic survey mitigation may provide a good ground for adoption in PETRONAS. This may therefore facilitate PETRONAS acceptance and increase their level of commitment in this regard

towards public awareness of Malaysian cetacean and towards the Nations biodiversity policies.

8.4.1.4 Hypothesis I

		Commonly used prescriptive /performance tools in PETRONAS	Internal regulations	International regulations	Seismic survey mitigating tools
Commonly used prescriptive /performance tools in PETRONAS	Pearson Correlation	1	0.091	.188*	.180*
PV	Sig. (2-tailed)		0.31	0.034	0.042
	Sum of Squares and Cross-products	9389.492	333.921	932.516	1094.695
	Covariance	73.933	2.65	7.343	8.62
	N	128	127	128	128

Use of prescriptive and performance tools for improvement and efficiency in PETRONAS

The correlation of commonly used practices by seismic contractors in prescriptive and performance methodology for improvement revealed a significant relationship at the PV<0.05. In particular, there were significant relationships with the international regulations used in marine mammal mitigation and seismic survey mitigating tools used by contractors for improvement {PV = 0.034 and 0.042 respectively}. PV= 0.31 (internal regulations) reveals an obvious situation where seismic survey mitigation methods in PETRONAS may not be in congruence with the commonly used prescriptive and performance methodology tools

deployed by the seismic contractors. This gap of noncompliance should be of concern since the practice is performed as and when requested without standardised seismic process guidelines in PETRONAS Technical Specification. The significant methodology used by seismic contractors and international regulations used in marine mammal mitigation improves effectiveness and efficiency in PETRONAS, thereby affirming hypothesis I, as thus:

H1: The adoption of seismic survey guidelines would improve the quality, effectiveness and efficiency of EIA in PETRONAS Technical Specification (PTS)

And the null hypothesis rejected

H0: The adoption of seismic survey guidelines would NOT improve the quality, effectiveness and efficiency of EIA in PETRONAS Technical Specification (PTS)

According to the environmental Consultant, EIA guidelines are formed under the requirement of Environmental Quality Act 1974 in complying with Malaysia's legislative requirement and adopting international established guidelines for best practice in Malaysia. EIA guidelines are also formed through consultative process led by DOE and typically through an appointed consultant. This is supported by the view of another respondent; he says, currently, there are no EIA guidelines that refer to seismic surveys specifically for the impacts on marine mammals and is not considered during the EIA. Due to the foreign company requirements and some conducted on voluntary basis, there are a few operators in Malaysia actually prepared EIA on seismic surveys where impacts on marine mammals are considered in keeping with existing guidelines from other countries i.e. JNCC, DOC, etc. but these EIAs are not submitted to DOE as it is not a prescribed activity under the Environmental Quality Act (Prescribed Activities) Order 1987 but is submitted to PETRONAS only for their reference.

The Consultant adds that each EIA is sent to its relevant departments in advance to review but there is a risk that the risks are not reviewed by experts. The quality of consultation is

determined by the consultant and the budget of the developer. DOE will review the terms of reference for the work proposed and if DOE approved the terms of reference, it is then up to the consultant to do the work. There is a risk where DOE might accept the terms and reference if the consultant proposes lower standards of work and these are not understood by DOE will results in lower standard in getting job done. For example, Consultant A proposes JNCC measures, but Consultant B does not, DOE officer might not pick up the discrepancy if the reviewing officer is unaware of the possible consequences. Therefore, the degree of importance given to environmental goals vary between operators, relying on the level of significance such issues are given attention to within the organization. Then, DOE will conduct a One Stop Agency meeting where representatives from all relevant departments are present. If the EIA report is categorized as a Detailed EIA by DOE, the report review will be assisted by a panel of expert reviewers from universities and NGOs.

The consultant goes on to add "Following the EIA approval by DOE, there is no third party overseeing action to assure that the mitigation plan actually takes place by the proponent for offshore-based projects as this mitigation plan is just a proposal and not a prescriptive requirement but the third party monitoring mechanism is implemented for onshore-based projects only."

The seismic contractor is asked if there would be constrains if all the survey company in Malaysia adopts the international rules and regulation as practice. She says, in every operation, there will be a client representative placed on-board to ensure the surveys are performed according to the scope of works survey specifications. If the regulation is enforced by law, the crew members will follow the procedure and will not be a problem, since the clients are responsible to engage a QC representative to be on-board the seismic vessel, who will ensure the procedures are adhered.

This goes on to validate the quantitative analysis, that commonly used prescriptive and performance methodology tools deployed by the seismic contractors are only practiced as and when requested without standardised seismic process guidelines in PTS. This noncompliance gap identified must be amended for marine mammal mitigation to improve effectiveness and efficiency in PETRONAS seismic geophysical exploration.

8.4.1.5 Hypothesis II

Correlation		Malaysian environmental policies	Government biodiversity programmes	NGO influence on marine mammal conservation effort	Government's efforts in protecting ESA
Malaysian environmental policies PV	Pearson Correlation	1	0.161	.212*	-.180*
	Sig. (2-tailed)		0.076	0.017	0.042
	Sum of Squares and Cross-products	6135.719	770.268	0.017	-82.328
	Covariance	48.313	6.314	0.939	-0.648
	N	128	123	128	128

Environmental policies that seismic survey guidelines can be implemented

The correlation of existing Malaysian environmental policies, with independent variables like Government biodiversity programmes, NGO influence on marine mammal conservation effort, Government's efforts in protecting ESA that influence performance show a significant relationship at the PV<0.05. In particular, there were significant relationship with NGO on marine mammal conservation, existing National Policy on Biodiversity 2016 that contribute to Government's efforts in protecting ESA {PV = 0.076, 0.017 and 0.042 respectively}. This

result of analysis reveals that NGO involvement on marine mammal conservation is in congruence with Government's efforts in protecting ESA that may contribute to an implementation of seismic survey guideline in PETRONAS (PTS) and shows a positive correlation to existing NPBD 2016, thereby consummating hypothesis II of the research as thus:

H1: There exist government environmental policies that seismic survey guidelines can be implemented.

And the null hypothesis rejected.

H0: There exist NO government environmental policies for seismic survey guidelines to be implemented.

This is also verified by the consultants, he says, "There is no environmental law to be proposed by the State Government on this matter. The immediate need is probably by amending the guidelines by the relevant departments/ministry."

The Director of a non-profit research foundation stated that in order to establish guidelines, the Government should not simply extrapolate other countries' guidelines as different depth and salinity may differ the transmission of seismic sound and hence has different effect on the marine mammals. "We need to understand that seismic survey activities do not have many research expertise in Malaysia. That is the reason why seismic survey companies will have to hire crews from all over the world, as they cannot get local crews with this in-depth knowledge".

He further states "The JNCC (UK) and some from other countries (US, NZ, Australia) have been in the industry for so long and they have become very dominant. Since they have played a big role in seismic survey market and the industry itself is not that huge, it is pointless for Malaysia to start from scratch and be a part of them".

Asked if what measures are required to get the mechanism in motion, he suggest through Policies, especially NPBD 2016, since nobody knows this criteria even existed and not much exposure dealt with seismic survey activities. The attitude to hire third parties to get the job done and lack of encouragement by the government and not good return of investment by oil companies are all contributing factors to this regulation being overlooked and ignored.

He iterated that in the UK, New Zealand and Australia, the government are really stern about this and with conservation efforts. Due to their geographical locations, they see more cetaceans and will start to ardour them. Hence, from close interaction and awareness, they will make rules to protect the mammals and create conservation guidelines. But, in Malaysia, the geographical location is the main factor why there is weak human-marine mammal interaction. "The less we see the species, the less we care about them. It's up to the seismic contractors to do whatever they want" (Interview, NGO, non-profit research).

A DOF officer says, in order to implement an Act it must be formed under Parliament while any subsidiary laws will be constituted under the Minister. In Malaysia policy making is set before making the law. The knowledge of seismic impacts towards cetaceans is almost zero in the DOF Law Department, resulting in sloppiness in perceiving regulations pertaining this issue. The Law Department will take action only when there are complaints about the matter and also they need concrete evidence to proof that seismic surveys can cause disturbance to marine mammals. It is critical for experts to motion the relevant Department and accentuate this issue. (DOF, Interview).

A Marine Park Department officer states "Voluntarily seismic guideline is not compulsory in Malaysia or even South East Asia region as far as I know. This could be due to our area is on the equator and not in the critical zone for marine mammal life such as dolphins and whales (just my opinion)". He claims, even without an MMO representative on-board, they still do

the regular soft start procedure however mainly as a requirement and not to ward off marine mammals.

In general, research on marine mammals in Malaysia has been fairly limited and has only started to gain traction in recent years, said Dr. Ponnampalam, Chairman of MareCet. As a consequence, research has mainly focused on collecting general information on these populations such as species diversity, population abundance, distribution, and threats identification. Research on the impact of seismic blast on cetaceans is never undertaken in Malaysia to date and any information is currently derived from research conducted in other nations (NGO, interview). MareCet Chairman emphasizes "In my opinion, research on underwater noise impacts to coastal cetaceans and dugongs should be prioritised in lieu of the high interaction between humans and cetaceans in the coastal areas".

A DOE high ranking official was asked, why these regulations are not looked into as it is part of NPBD 2016 Policy. He stated that this is probably due to the way in which biodiversity and oil and gas industry activities are managed in the country. Both sectors are being managed under different ministries with very minimal interaction between them. Furthermore, regulatory bodies in the country do not have adequate capability to manage marine biodiversity management and thus are unable to prepare and enforce any seismic survey regulation. In addition, there does not seem to be much interest from those regulating the oil and gas industry in the country to proactively manage biodiversity impacts arising from oil and gas activities.

Asked if Malaysia has not complied with International treaties, he states "There is no proof and data to support that Malaysia has offended UNCLOS". Due to inadequate research on the impacts of seismic blast in Malaysia, the government is not aware of this issue including the DOE officer, who might not be aware that these regulations even exist. Funding from government or PETRONAS is needed to research the effect of seismic survey on marine

mammal. He says “There must be regulations and modus operandi to be followed but I am not sure about this. But one thing is for sure, the seismic contractors must be registered with International Association of Geophysical Contractors (IAGC)” (DOE, Interview).

PETRONAS claims their survey standard is based on approved world standard since their contractors are from US or France based company. During survey they will hire 3rd party QC to the survey, to maintain the task to ensure the data taken is in good quality. “In Malaysian waters, we use seismic survey standards guidelines based on nearby international waters such as Australia and New Zealand (PETRONAS, interview).

A respondent claimed that technical expertise in seismic survey mitigation procedure is not practiced in Malaysia but goes on project requirement basis and rarely practiced because nobody has yet convinced the Government that this issue is important. He has brought forth however, concerns that the most crucial point to emphasize is that EIA is part of the evolution process for people to act on existing knowledge and not continually compromising the damage of the environment and wildlife.

“……We need to understand that seismic survey activities do not have too many expertise. That is the reason why seismic survey companies will have to hire crews from all over the world,…..”.

-……. Not enough exposure to the seismic survey activities. Nobody knows this job ever exist

- ……..The JNCC (UK) and some from other countries (US, NZ, Australia) have been in the industry for so long and they have become very dominant. Since they have played a big role in seismic survey market and the industry……”

This analysis reveals attributes with Government’s efforts in protecting ESA that may contribute to an implementation of seismic survey guideline in PTS and shows a positive correlation to existing National Polices on Biodiversity.

8.4.2 Qualitative analysis

PETRONAS must be the focal point to working closely with the NBC (National Biodiversity Council) providing resources to establish the NSC (National Steering Committee) with capabilities to review of current and projected gaps in the next MEXCOE (Meeting of Ministers of the Environment) to implement these proposal as stipulated in the NPBD, 2016 National action plan. Table 22 below tabulates the qualitative analysis from the interviews conducted.

Recommendation	Response Expected
PETRONAS must develop and demonstrate how seismic mitigation procedures will better manage risk to achieve safer outcomes for cetaceans.	PETRONAS to be a member of JIP for international benchmarking, however Country Specific Guidelines, operations and local biodiversity must influence regulatory requirements.
PETRONAS must adopt a culture of safety and move towards developing a notion of safety as a collective responsibility not only to human factor but ecology as well, with a focused commitment to continuous improvement and a zero failure rate. Oil industry should establish a "Safety Campaign" which would be an industry-sponsored entity aimed at developing, adopting and enforcing seismic standards of excellence to international benchmark.	Petronas has a strong safety culture, but safety programs differ between companies and broad systems (operational, technological, management and communications) may not always be aligned. In order for this steps to be taken, PETRONAS Safety Campaign, which will drive national seismic practices, must be warranted in every seismic geophysical exploration.
Existing conventional safety regulations in PETRONAS standards (PTS) should be expanded to address all features essential to seismic noise safety, and should be updated and enhanced to ensure safer exploration in all offshore seismic operations.	Seismic Safety Regulations in the PTS (PETRONAS Technical Specification) need to sustain a balance of prescriptive vs. performance-based requirements.
These new, updated PTS regulations should be supplemented by a "risk-based" regulatory approach that requires all offshore seismic contractors to demonstrate that they have thoroughly evaluated all of the risks associated with	Standards are typically developed by PETRONAS with the strong involvement of prescribed Environmental Impact Assessment with the cooperation of Department of Environment. EIA can cite

seismic survey and are prepared to address any and all risks pertaining to it.	industry standards by reference to PTS (PETRONAS Technical Specification) code.
PETRONAS should lead to develop global best practices for seismic survey that can be adopted and applied in the ASEAN region.	PETRONAS must increase staffing, training, and adequate predictable funding for regulatory oversight in seismic survey mitigation as a leader in ASEAN.
An independent seismic agency within the Department of Environment (DOE) should be created with appropriate expertise to oversee all aspects of offshore seismic survey mitigation.	The recent reorganization announced by the PM with the launching of NPBD 2016 appears to provide the proper oversight/ funding for experienced and knowledgeable staff.
Broader consultations involvement among federal agencies, especially Biodiversity Agencies is crucial prior to seismic exploration and will help identify and address risks better.	1MBEON (1Malaysia Biodiversity Enforcement Operation Network) should receive a more formal consultation role in NBC. A distinct environmental science office should be created within NBC with appropriate expertise and funding and tasks including seismic environmental mitigation training.
There should be a regulatory guidelines proposed to the Government of Malaysia for seismic survey mitigation based on international regulatory standards	Regulatory decisions must be based not only on sound science but also should be pointed out that substantial scientific studies have to be performed in comparative review of seismic guidelines worldwide. Baseline science studies should be developed with participation by industry and academia experts wherever possible.
Scientific and technical research in all areas related to offshore seismic geophysical exploration needs to be explored. Better scientific and technical information is essential to making risk decisions before seismic survey commences.	Caution must be used of prescriptive seismic tools, such as Minimising sound output, Safety zones, Soft-start, Visual observations, Passive acoustic monitoring (PAM), that need further development and review prior to widespread adaptation.
Greater attention should be given to new tools, like coastal and marine spatial planning and ocean observation systems, to improve environmental protection, management of ESA, MPA and ecosystem restoration efforts in marine environments.	There must be focused attention on integrated planning among agencies that share the stewardship of the nation's ocean environment's temporal and spatial restrictions.

Table 22 : Raw data qualitative analysis

In a marine seismic hydrocarbon exploration projects in Malaysia, there are 2 main parties involved; the client and the seismic contractor, says a seismic surveying company Manager.

> ***"……Depends on which 'COMPANY' you are talking about. In a marine seismic exploration project, the 2 main parties are:***
>
> ***- the client (Petronas, Shell, Murphy oil etc.)***
>
> ***- the seismic contractor (PGS, CGG Veritas, Polarcus etc)……."***

He states that these two parties in reality, do not bother much about the marine mammals, as their main concern is the discovery of oil in the ocean bed. However, when a third party gets involved (MMO, JNCC etc.), there is a lot of budget to be allocated for them. When seismic contractors has to stop an operation due to marine mammals in the area, the client loses thousands of dollars just to restart the streaming line once again. In other words, without the marine life conservation guidelines getting involved, the job for client and contractor would be much easier than investing on seismic survey mitigation, which is not favorable to them. The PAM equipment that are currently used are not as efficient and they are not willing to invest on it as well.

There is limited funding for biodiversity conservation and research. Public budget allocations are relatively low as compared to the significant values that biodiversity and ecosystem services generate for the Malaysian economy and population. Most biodiversity managers face critical financing constraints. The last decade has seen some diversification of conservation funding. Various trust funds (e.g., Marine Parks Trust Fund, Taman Negara Trust Fund) and recently, the NCTF for Natural Resources, have been arranged as long-term sustainable financing mechanisms. Private corporation, too, have become increasingly engaged in funding conservation. However the sum from these sources is insufficient compared to the total needs (NPBD, 2016)

Besides the government, few groups contribute directly to funding of conservation, and there is limited accumulation into the budgets of the other sectors. Aside from the Federal and State budgets, there is no consolidated long-term funding mechanism for biodiversity (17.1, NPBD, 2016). This stimulates investors, consumers and producers, to degrade or deplete biodiversity in the course of their commercial activities, because it makes more financial sense to exploit rather than to conserve and sustain it.

8.5 Discussion on prescriptive and performance methods applied in Malaysia

Qualified MMO is critical as they are the foundation for all mitigation procedures available to be efficient in Malaysia. Any seismic survey standard adopted by any given project within Malaysian maritime is currently done on a voluntary basis by the operator due to their own internal corporate policy. Many of the MMO employed are foreign-based agencies and they are not familiar with the local conditions and species that are likely to be present within Malaysian waters. Thus, there is a potential misidentification of species or species overlooked due to their cryptic behaviour resulting in inaccurate data collection. Besides, crew integration is more difficult due to the communication and cultural barrier while on board the vessel. Efficient rotation of duties for MMOs during all daylight hours is important to maintain the full coverage and also to ensure effective execution of the control system.

One respondent says “There is no Malaysian MMO, but we conduct seismic survey anyway, even though this is not part of the government regulation, we actually keep observing for mammal in the area. For example, in a seismic survey site, when we spot a mammal in the area, we report to the manager of the operation. So, even though it is not formal, it is done informally”.

Another respondent says, PAM technology is currently being used directly for marine mammal protection or conservation in their company. They use the equipment to study marine

mammal's activity during seismic survey in Malaysia. She says "Our technology that can potentially be useful to assist in their conservation is the passive monitoring equipment which can be deployed in areas of concern. Passive monitoring equipment can either be acoustic or visual and may be deployed either onshore or underwater".

She goes on to add "I can't speak for any of the operator or any other seismic contractor apart from our company. But for us, we definitely have it, because we have a global footprint. We tend to bring in the best practices from the other end of the world. So, even though it is not officially documented, it is something that we will keep an eye on because, for us, we have a commitment to health, safety and environment. When we are conducting the seismic operation, we always want to make sure it is done as safely as possible which includes those mammals coming close to the seismic vessels".

According to her, seismic signal itself will propagate very large distance and that is not something that can be controlled. The signal she claims, can be detected 10km away and are not harmful to marine mammal and don't cause structural damage.

"……Seismic survey and the effects on marine mammals is something that cannot be avoided and that is why it is called marine mammal observation and not marine mammal avoidance. All we can do is to conduct observation and will cease fire if a mammal enters certain radius".

In another interview with an international seismic survey Manager, he claims the MMO requirement and PAM utilization differs greatly with country and whichever guideline it uses. So, for example, if they do it at Gulf of Mexico, the requirement for the MMO have to be qualified to US standards and are normally offshore personnel but attend training as they require to distinguish the mammals. He adds "In our operations here, we do not have this type of PAM monitoring device or MMO on-board as it is not mandatory in Malaysia but my experience in Sakhalin Island Russia, the MMO is mandatory".

Asked if PAM monitoring is a cumbersome job, he relates that PAM cable are laid in the sea, using a small winch of about 0.3 m width x 0.3 m radius and the equipment itself is just about a size of a LaserJet printer. The cable length is just about 200m and sometimes the crew just pulled it by hand. The work desk for the PAM operator don't take too much space either.

He stated that some vessels are small, so that they will just make arrangements for 1 MMO representative instead of four. But, he claims the issue is usually from the availability of cabins for the crew who are working on 24 hour shift. If the space is limited, the MMO on-board, sometimes becomes the PAM operator.

One of the respondents (seismic operation Manager) was asked on her opinion as to who would be of best interest to be a Marine Mammal Observer. "Based on what I have seen and met some of them, they could be from a retired navy to a marine biologist. No matter from which background they are from, they must at least, understand the basic operation of marine seismic survey so that they know when not to cross the line. The real field training would be a good suggestion, one day should be enough. If MMO is made mandatory in Malaysia, the company will send personnel for training. Right now, this is not regulated. MMO would be good coming from Fishery Department/marine biologist who familiar with the marine life."

"….If MMO is mandatory, sure company will send personnel for this type of training. Right now this is not regulated. MMO would be good coming from Fishery Department/marine biologist who familiar with the marine life."

Another seismic operator claims, real field training should be included in work scope, but it will also depend on the vessel capacity. The duration seem appropriate should be around a minimum of one week or depending on the project schedule.

He also stated that a balanced action for the industry need should be adhered to if an optimized procedure is adopted for the compliance with MMO and PAM. This, he states, should be well

received by the all stakeholders for the interest of the country's marine environment. He welcomes this guidelines as an overall good perspective for the environment in the seismic operation industry. However he says there will be issues relating to cost since every prospect seismic line aborted due to MMOs order to stop the survey, it is an additional cost to client and considered as downtime as well.

The other issue will be on manpower. Recruitment to hire MMOs is an additional cost to the client. There other shortfalls are shortage of competent crew if the current seismic activities are on active. On a regular basis, the crew will have a 6 weeks on/off rotation on the vessel. But, due to shortage of competent crew, some of them will have to do double up 12 weeks rotation on-board, which make this an unfavourable situation.

He also has witnessed conflict in professional judgments in marine mammal observation. Conflicts and arguments between seismic contractor and MMO representative are common, and these issues are usually brought up to clients.

Soft start is a normal practice everywhere including Malaysia. There is a soft start log to be submitted to the client together with the seismic data at the end of the project and there is no evasion from this procedure. There is also a soft start log being QC audited by the client representative on-board at the end of the survey.

Soft start procedure is not only important to MMOs but to seismic operators and technicians as well to monitor their gun performance. In case if there is a gun failure or under performance, the crew will still have time to fix the problems or plan their maintenance schedule.

8.6 Summary of interview

Seismic airgun noise must be conceived a grievous marine environmental pollutant that can have detrimental impact on biodiversity. Overall, from the interviews, the awareness on impacts of seismic noise towards cetaceans is low within PETRONAS but is even lower in

some Government agencies. Public awareness is significant to ascertain that each stranding case is reported and documented by Government agencies where research can be carried on based on each stranding incidents.

Seismic survey should be included as part of the EIA prescribed activities under the EQA to enforce a standard requirement for petroleum companies. A third party supervision mechanism after an EIA is approved should be set as a requirement for offshore based project similarly to secure the mitigation plan conducted by PETRONAS.

This epistemological interview describes the mitigation methods for seismic blast to the EIA guidelines presently comprised, and describes the deficiencies in the Planning Guidelines for the Environmental Noise Limit and Control of the Department of Environment, Malaysia. The need to also further review international seismic survey policy with a recommendation that a National seismic survey mitigation guideline can be implemented. However, further detail technical analysis and prior comparative review must be examined benefiting both the PETRONAS and the marine mammal conservation without conciliatory factor.

The next chapter presents the conclusion of the study by summarising the research findings in affiliation to the research objectives and outlining the contributions of the research. It continues by looking at the limitations of the research and finally provides the directions for future research and recommendations in the study.

CHAPTER NINE– CONCLUSION

9.1 Summary of research findings

Malaysia has established a new NPBD 2016 that appears to be contributing for the target and objectives of this research study. The research question of this thesis to constitute a nation-wide code in the marine seismic survey seems possible with this Policy. This improved policy is mandate to accommodate with the nation's significant population increase and socio-economic changes and is a useful public awareness campaign to educate the public and industry alike on the impacts of seismic survey.

The Policy states in Section 3.1 that by 2018, a policy and/or regulatory framework for incorporating biodiversity conservation into national and state development and into sectoral policies and plans is in place. One of the actions in meeting the target is to strength the biodiversity component of the EIA process, including the post EIA enforcement. Under Section 9.2, it also states that by 2025, all endangered species and threatened species are protected by Federal and/or State legislation (NPBD, 2016). One of the actions is to formulate conservation action plans for threatened animals on the National Red list to ensure that all rare and threated species are protected by the Malaysia's legislation. There is a clearly an improved target set for the future and action to strengthen legislative framework to support seismic survey regulations. Discussion will relevant agencies and stakeholder in effectuation of this guidelines must take place now in order for Government planned targets and goals can be accomplished effectively.

Unlike many other countries, Malaysia has been involved in the development of biodiversity related policies, which provides the way forward for seismic survey mitigation guidelines in legislative frameworks and biodiversity related initiatives. Biodiversity conservation in Malaysia overall have met with many successes especially in the area of macro environmental policy development (NRE, 5th National Report, 2014). These issues are founded on legislative frameworks that regulate many aspects of biodiversity conservation apart from structuring the

delivery and satisfying of the nation's biodiversity agenda. That said, the areas highlighted in the previous section need improvements and potency in overall execution. If seismic survey mitigation is regarded to be a tool for preservation of threatened cetaceans, then these limitations as mentioned below need to be discussed at once.

9.2 Current state of environmental affairs and limitations

Like all countries, Malaysia has had to grapple with environmental degradation issues. Notably, as a consequence of the rapid urbanization and industrial growth during 80's Malaysia has seen an increment in air and water contamination just as the biodiversity in certain areas has declined due to neglect of the natural ecology (Malaysia– European, 2013)

Malaysia depends heavily on hydrocarbon for its energy supply and the supply of renewable energy in the gross distribution is very limited. As Malaysia moves inexorably towards developed nation status, energy requirements are certain to increase. Malaysia is anticipated to become a net oil importer around 2010 (gas and coal are already being imported) and will therefore require substantial financial resources to develop additional generation, transmission, and distribution capacity. Even if the growth of clean energy is given specific priority in the Malaysia's Energy plan (2001-10), the promotion and execution of clean energy is nevertheless a capital issue. Malaysia has proposed in the "Eight Malaysian Plan" the utilization of renewable energy in power generation with a target of 5% of total electricity generation by 2005 and 10% by 2010 (Malaysia– European, 2013).

Malaysia recognizes that environmental sustainability is a decisive factor to accomplish for economic development and social maturation by divesting from fossil fuel. Renewable energy alone will not be sustainable enough, but requires systematic effort to avoid undesirable ecological influences and enhance biodiversity conservation for all types of noise pollution. These principles of sustainable growth have progressively been integrated into national policy

making. These include sector-specific policies legislation, and approval to proceed on the basis of rigorous EIA for major projects. Malaysia's National Policy on the Environment which was formulated and approved in 2002, integrates three elements of sustainable development: economic, social and cultural development and environmental conservation. The policy focusses at prolonged economic, social and cultural advancement and improvement of the life of Malaysians through environmentally sound development (Malaysia– European, 2013).

The National policy on sustainable development is established on a unique equilibrated concept where the environment and development supplement each other. The rationales behind sustainable development were presented in the Third Malaysia Plan (1976–80) and have been reiterated in subsequent development plans. The Eighth Malaysia Plan (2001–5) states that "emphasis will be aimed on covering environmental and resource affairs in a unified and "holistic manner" (Malaysia– European, 2013). Hence, in a "holistic manner", national development should in principle safeguard the environment, establish schemes for sustainable growth and guide management policies towards biodiversity conservation.

The National environmental policy should in general terms perpetuate to contribute greater economic value to maintenance of an uncontaminated environment and minimizing impairment. This balancing the goals for bio-economic development must be attained by not compromising growth on marine biodiversity and ensure that the benefits of economic development is not at the expense of environmental decline. By placing of greater emphasis on prevention through conservation rather than on curative measures is preserving the country's biodiversity and into project planning and implementation. Hence by determining the implication of the proposed projects and the costs of the required environmental mitigation measures through EIA, this will promote greater cooperation and increased coordination between the relevant federal and State authorities as well as between the member governments of the Association of South East Asian Nations (ASEAN) in the future.

9.3 PETRONAS involvement

The New Zealand Guidelines has been founded for more than 10 years and it is remarkable to know that PEPANZ was instrumental in establishing this guidelines in concurrence with DOC (PEPANZ, 2016).

The EIA for seismic survey in NZ is a constituent of HSE Plan which are regularly enforced in the petroleum sector. HSE for oil and gas proponent PETRONAS in Malaysia, has safety regulations that are transcribed from DOE and guidelines are adopted from government regulatory legislations. PETRONAS is obligated to follow up with laws and statutory regulations but not much involved in policy making. In order to be an effective stakeholder and major contributor towards biodiversity conservation in seismic survey, PETRONAS needs to be instrumental in the policy making process with DOE similar to PEPANZ contribution to DOC.

In addition it is well encouraged for PETRONAS to be a member of the JIP to manage research programmes that educates on the impacts of seismic survey on cetaceans in Malaysia.

9.4 Loop holes and weakness in the system

Malaysian environmental legislative have embraced international regulations in some way and the time has come for policy making with local talents of researchers, scientist, legal advisor and conservationist. Fisheries Act 1999 was constituted to conserve the endangered marine life notwithstanding the need to update with Malaysian endangered marine mammals' list and include regulations for petroleum companies to abide by the guidelines during seismic surveys.

Besides amending the updated checklist, a combined legislation that governs Wildlife Conservation Act 2010 and Fisheries Act 1985 under a single administrative body, will be effective to manage seismic survey related activities to petroleum industry's onshore and offshore activities more efficiently. This would provide shared resources and mutual

environmental emergences in a collective Information Database for environment resource and management planning on the contrary to the current maritime biodiversity.

There is also poor synchronizing within Government agencies because there is no clear and effective integration policy and evident deficiency in sharing of information towards voluntary effort by NGOs' or research institutions. Lack of communication, lack of ecological & biological information, baseline data, lack of research funds to researchers in marine conservation, are major disadvantages to be improved by the Government. Malaysia has comparatively good research institutions, working on marine mammal research and conservation, namely Universiti Malaysia Sabah (UMS), University Malaysia Terengganu (UMT), Universiti Sains Malaysia (USM), Universiti Malaya (UM), and research foundations like MareCet and Marine Research Foundation (MRF), just to name a few. There are already pertinent number of researchers in Malaysia that can assist in the development of the Seismic Survey Guidelines with the Ministry to provide the research elements on sound engineering, policy review, sampling and taxonomy on marine mammals' mitigation.

Implementing the Policy will call for the best scientific expertise and knowledge. Malaysia has a large research community at our universities and research institutions and this community has an important function. Educators draw curiosity by raising the community's knowledge of biodiversity conservation by demonstrating pragmatic partnerships and experiential learning.

Therefore an imperative need for all sectors to conjoin to deal with impacts relating to seismic survey must be carried on. The Government contrives to launch partnerships programmes with institutions to create post-doctoral opportunities for qualified Malaysians to work on biodiversity conservation (16.1, NPBD, 2016). It is imperative now for PETRONAS to spearhead and elevate these concerns to the State Steering Committee (SSC). The SSC in return

will advise the National Biodiversity Council (NBC) on topics associated to seismic survey guidelines.

This will be the new start for Malaysia in conservation of biodiversity from anthropogenic marine noise, where other sources of noise pollution can also be policy managed and bio resource preserved. Proper understanding of noise impacts and measures to prevent it instead of rectifying the ramification, using regulation is the best practice to reduce complications.

9.5 Science independent of economic interest approach

In the NZ Government seismic legislation review, the conflict between fast tracking projects and establishing and implementing national standards, policies and regulations in order to mandate full oceans policy, requires a coherent approach to environmental management. Currently NZ uses international law and industry written guidelines for seismic policies. ECO urges the NZ Government to give a high legislative priority to introduce EPA seismic legislations for integrated human activity on the oceans since applying international codes alone is not sufficient but to be integrated in the legislation. These constrains and conflicts are areas that will hamper the seismic legislation if not addressed where technology and law making is urgently needed for an effective regulatory management in biodiversity protection.

For petroleum projects in Malaysia, project sites are usually selected for economic and technical feasibility and less towards marine habitat and ecological importance (Ramli, 1985). Accordingly, Malaysia has to nurture ‘science independent of the economic interests’ integrated approach to biodiversity management and render opportunities to the scientific community to participate in decision making to formulate legislations.

9.6 Challenges faced in implementing guidelines on seismic survey mitigation

At present, Malaysia is the world's second-largest exporter of liquefied natural gas and the second-largest oil and natural gas producer in Southeast Asia. By 2020, Malaysia aim to be one of Asia's top energy players by leveraging resources and geographic location (International energy data and analysis, 2014)

At the environmental level, Malaysia is devoted to sustain a pristine, secure and fertile environment for present and future generations, and support preservation of the nation's unparalleled biodiversity with successful engagement by the community.

The challenge of establishing a proper equilibrium amidst ecological concerns and economic interests is also evident in the petroleum industry.

The environment is increasingly becoming a policy issue in Malaysia. The major ecological concerns that the country faces are the imbalance amongst environmental deteriorations and economic interests and to demonstrate the long term positive economic impingement of environmental policies. In order to determine that national policies are implemented uniformly at all levels of government throughout the country, their effectiveness largely relies on the PETRONAS responsibility and accountability to raise public awareness of ecological issues especially on the known cetaceans' species in Malaysia.

To address this environmental concerns in an effective way, the objectives of this research must be prioritized and pursued by PETRONAS to enrich their competence in prescriptive/performance tools currently practiced by their seismic contractors and take an upper hand to effectively regulate seismic survey mitigation policies from the PTS.

9.7 Future Research

Seismic survey relies on frequencies that transmits and at a certain frequency. Further research to undertake a study on the impact of the frequency on marine mammals towards alternative frequency and develop co-management partnerships with civil society and the private sector to increase and diversify revenue is an optimistic consideration. This research has also the possibility for setting up a research program aimed at covering particular areas of scientific uncertainty in the frequency emission study against salinity in Malaysian maritime sector.

Much more autographic data of hearing measurements (sensitivity of individual species vs. frequency of sound) is needed for marine mammals in order to assess impacts. This can be achieved by measurements of behavioural reactions to various underwater seismic frequency to establish more robust cause-effect relationships for behavioural responses vs sound exposure.

It is also necessary to further investigate the physiological effects of underwater noise for effects of sound exposure on masking like PTS (Permanent Threshold Shift) and TTS (Temporary Threshold Shift) from species to species. This can be achieved by establishing a standardised protocol for testing the extent to which seismic sound radiates in the marine environment by collecting data in appropriate formats for future models in predicting ambient noise in the seas.

9.7.1 Frequency tolerance

Further research on Seismic Survey mitigation for Marine Mammal, may look at the theory of sound transmission calculation from the source of airgun to the marine mammal critical in Malaysian waters. This threshold distance may vary in species of marine mammals in tropical region. Utilising transmission loss equation and including variables of temperature, salinity and

pH value, the frequency tolerance of these mammals can be charted versus audio frequency of airguns. This can be an alternative solution to mitigate impacts on the cetaceans by excluding or including species spatial distribution from seismic airgun frequency.

9.7.2 Seismic waste sound

Another research, one compiled by Weilgart (2013), highlight the potential in new or improved technologies to reduce the environmental footprint of seismic imaging. The Weilgart (2013) report, which was based on a 2009 workshop of industry experts and biologists, concluded that airguns emit "effluent sound" that is not applied by the industry, yet has in all likelihood to impact marine life. This waste sound which is mostly high frequencies could be eradicated without relinquishing any data quality for the oil and gas industry by reducing peak sound levels even at the expense of requiring a slightly longer signal.

Weilgart report shows that less sound may be required to gather the same quality of data due to sensitive receivers available and does not present any anthropogenic noise pollution into the marine environment.

9.7.3 Non acoustic electromagnetic survey

Non-acoustic sources including electromagnetic surveys, which can image the subsurface by relying on differences in electrical resistance among different types of rocks, originally developed for land-based exploration, can assist to delineate and characterize hydrocarbons by measuring the earth's seismic wave field.

These technologies have different applications within the exploration and production cycle and different time horizons for commercial use. In general, the non-acoustic technologies, while promising, are less mature than the acoustic ones and are either emerging or in an early stage of development. Further research and investigation on non-acoustical survey is crucial for

reducing impact on environment. Incentives and more funding to formulate these applied science and technology will speed up their usability and widen their applications in Malaysia.

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Appendix

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APPOINTMENT LETTER FOR RESEARCH ASSISTANT

SUBJECT: ENVIRONMENTAL IMPACT ASSESSMENT STUDY ON DISTURBANCE TO MARINE MAMMALS DURING SEISMIC SURVEY OPERATIONS

Dear KS Nathan,

The faculty in the Department of Mechanical Engineering at the University of Nottingham are pleased to appoint you as a research assistant for Environmental Impact Studies conducted for subsea operations and for mitigating effects on acoustics disturbance in the ocean during seismic survey.

We feel with your extensive experience in the oil and gas design, construction and operational knowledge, you will be able to contribute to our University and nation-wide study in reviewing guidelines for minimising acoustic disturbance to marine mammals from seismic survey operations.

You are appointed to participate in this research study and the anticipated benefit of this study is a better understanding of the effect of acoustic disturbances on marine mammals and management mitigation plan in high-technology oil and gas corporations.

Research records will be kept as confidential as possible. No individual identities will be used in any reports or publications without prior consent and authorisation.

Any questions about the research, you may contact Dr. Lee Chan Wai at 03-8924 8608. If you have further questions about the study, you may contact University of Nottingham 03-8924 8000, which is concerned with confidentiality of individuals in this research project.

Yours Faithfully,

Lee Chan Wai
Assistant Professor
E: Chan-Wai.Lee@nottingham.edu.my
T: +6(03) 8924 8608

Ethics Approval

Ethnics Application

KONG ING

Wed 3/16/2016 5:26 PM

To: SKANDA NATHAN AL N KANDASAMY <kedx4snn@nottingham.edu.my>;

Dear Skanda Nathan

On behalf of the Science and Engineering Research Ethics Committee (SEREC), I can confirm that your research ethics application SKN130316 has been approved as a "minimal risk" project.

If there are any significant changes or developments in the methods, treatment of data or debriefing of participants, then you are obliged to seek further ethical approval for these changes.

We would remind all researchers of their ethical responsibilities to research participants as outlined in the University of Nottingham Code of Research Conduct and Research Ethics. Responsibility for compliance with the University Data Protection Policy and Guidance as well as all statutory requirements also lies with the project supervisor. SEREC approval does not alter, replace or remove those responsibilities, nor does it certify that they have been met.

We would remind all researchers of their responsibilities:

- to provide feedback to participants and participant organisations whenever appropriate, and
- to publish research for which ethical approval is given in appropriate academic and professional journals.

If you would like to discuss any issues relating to your project please make an appointment to see me.

On behalf of SEREC,

Dr Kong Ing
Associate Professor
Senior Admissions Tutor
Department of Mechanical, Materials and Manufacturing Engineering
The University of Nottingham Malaysia Campus
Jalan Broga
43500 Semenyih
Selangor, MALAYSIA
Tel: +60389248362

Consent to Participate in Research

Why it is Important to Implement Guidelines on Seismic Survey in Malaysia and Why Further Research is needed

Introduction and Purpose

My name is KS Nathan. I am a PhD student at the University of Nottingham Malaysia Campus in the Department of Mechanical, Materials and Manufacturing Engineering. I would like to invite you to take part in my research study, which concerns the effect of seismic survey to marine mammals.

Procedures

If you agree to participate in my research, I will conduct an interview with you via phone, email, Skype or physical according to your preference. With your permission, I will audiotape and take notes during the interview. The recording is to accurately record the information you provide, and will be used for transcription purposes only. If you choose not to be audiotaped, I will take notes instead. If you agree to being audiotaped but feel uncomfortable at any time during the interview, I can turn off the recorder at your request. Or if you don't wish to continue, you can stop the interview at any time.

I expect to conduct only one interview; however, follow-ups may be needed for added clarification. If so, I will contact you by mail/phone to request this.

Benefits

It is hoped that the research will help to propose a suitable local seismic mitigation guidelines which can minimize the harm of seismic operation to marine mammal.

Risks/Discomforts

As with all research, every effort will be made to ensure confidentiality is not compromised.

Confidentiality

Your study data will be handled as confidentially as possible. If results of this study are published or presented, individual names and other personally identifiable information will be quoted. However, if you do not wish to expose your identity, your identity is promised to not being revealed in the publication.

Rights

Participation in research is completely voluntary. You are free to decline to take part in the project. You can decline to answer any questions and are free to stop taking part in the project at any time. Whether or not you choose to participate in the research and whether or not you choose to answer a question or continue participating in the project, there will be no penalty to you or loss of benefits to which you are otherwise entitled.

Questions

If you have any questions about this research, please feel free to contact me. I can be reached at 0126695103 or kedx4snn@nottingham.edu.my

****

Independent social science researcher verify and validate questionnaire

Technical

1) Check-shot surveying is a form of seismic surveying used for correlation of well data with conventional surface seismic data. Comparing to this check-shot with the common vertical seismic profiling is better or moreover most used in the line of seismic surveying? Which form does Malaysia use? (http://www.ogp.org.uk/pubs/448.pdf)

2) As understood in the JNCC guidelines, in Malaysian waters, such as the ongoing Dalak Project in Labuan, what is the capacity being used or being referred to in comparison to a Level 1(> 427 in^3), Level 2 (151 in^3 to 426 in^3) , and Level 3(< 150 in^3) surveys?) (PCSB CHO/2013/DSL/0002, 2013, Petronas Carigali Sdn Bhd. Dalak Project) (Chemsain Konsultant Sdn.Bhd, 2013, CK/EV113-061(3)/12, :1-7)

Commented [SML1]: Ambiguous. A statement indicating the term ' understood'.

Preferably,

JNCC guidelines, as used in the Malaysian waters for example Dalak Project in Labuan uses... (state example from dalak project using JNCC)

What is the capacity being used as referred

3) Every survey has a line turn when an area of interest is covered; does it disturb the survey when every turn comes? Is the survey not always continuous throughout the operation? (http://www.ogp.org.uk/pubs/448.pdf)

Commented [SML2]: Interest it covered...(continue with) In your opinion, does this disturb the survey when every turn comes?

NB:

4) Based on the standard Vertical Survey Profiling (VSP), a similar Offset VSP is used with a stationary acoustic source positioned at a fixed distance from the borehole. What kind of conditions must be met when using the Offset VSP? Or is the standard VSP enough for a normal survey operation? (http://www.ogp.org.uk/pubs/448.pdf)

5) Operational capacity of every seismic operation is understood as the amount of weight with the space on the vessel (weight). As understood again, the vessel must have sufficient weight and buoyancy to load and carry the machinery used as well as the people on board. The bigger the space the better? Even with just a handful of people on board? Wider vessel equals to more arrays for a better data collection? (http://www.ogp.org.uk/pubs/448.pdf)

Commented [SML3]: Omit

Commented [SML4]: Leading questions, respondents are likely to say yes. Use more neutral tones. Such as " Are larger spaces necessary?

Survey Questionnaire

Item	Questionnaire	Yes or No	If yes, is it significant?	Closed ended (CE) Open ended (OE)
1.	There is an existing environmental regulatory framework used during seismic survey to protect marine mammals in offshore seismic operations by PETRONAS			(OE)
2.	There is government environmental policies that can be implemented for seismic survey guidelines in Malaysia			(OE)
3.	Can application of prescriptive and performance methods tools and techniques for seismic survey actually implemented in PETRONAS			(OE)
4.	Will the survey result in any toxic and hazardous ocean pollution			(OE)
5.	Will the survey result in excessive vibration. Proposed vibration 10mm/s			(CE)
6.	Will the survey result in excessive noise levels A) Industrial boundaries 65 dBA B) Residential boundaries 55 dBA C) Ocean Boundaries ??????			(CE)
7.	Will the survey result in discharge to reduce clarity in sea			(CE)
8.	Will the survey result in discharge of noise in ocean			(CE)
9.	Has a separate EIA been prepared for seismic survey mitigation			(CE)
10.	Did the survey document endemic rare and endangered species and loss of biodiversity prior to Commencement			(CE)
11.	Could the survey result in destruction of rare endangered species			(CE)
12.	Is there any evidence of endemic, rare and endangered species?			(CE)
13.	Is the survey likely or indirectly result in loss in any environmentally sensitive area?			(CE)
14.	Will the survey result in evacuation of migratory marine mammal species?			(CE)

Research Questionnaire

Preamble

There is an increasing level of interest in the effects of anthropogenic sound on the marine environment, particularly the potential effects of widespread marine geophysical exploration upon marine mammals on seismic exploration typically involves the use of airgun.

There is a growing body of evidence detailing a host of behavioural effects caused by a variety of underwater noise sources, as well as the potential for physical damage. Physical damage includes damage to body tissues resembling decompression sickness ('the bends') and auditory damage. Symptoms resembling decompression sickness may result from the initiation of bubble growth caused by sound.

Currently seven (UK, US, Canada, Australia, NZ, Russia, Brazil) nations where there are high levels of geophysical activity have recognised the potential for such impacts, and as seismic exploration increases; guidelines and regulations that aim to minimise disturbance and potential damage to marine mammals during seismic surveys have been formulated.

The UK's 'Guidelines for minimising acoustic disturbance to marine mammals from seismic surveys' produced by the joint nature conservation committee (JNCC) were the first such guidelines to come into effect. Introduced in 1995, developed from a draft produced by the sea mammal research unit (SMRU), these guidelines have been used as a model by other countries when producing their own mitigation guidelines.

Each set of guidelines is put in place in order to implement national and/or international environmental policies as defined in Article 1 (1) (4) of the United Nations Convention on the Law of the Sea (UNCLOS). Malaysia ratified UNCLOS on 14 October 1996 and UNCLOS came into force on Malaysia on 13 November 1996

The competence of a country to adopt measures to protect marine species from noise caused by such activities is circumscribed by international law (UNCLOS, Article 204-206). Even when an activity is not of an international nature or confined within its boundaries, noise emissions can have significant trans boundary impacts.

This interview examines the mitigation measures central to the guideline documents, in order to identify improvements within Malaysian Environmental Impact Assessment in the Oil & Gas sector. The fundamental basis of this interview is in ensuring to formularise and elaborate rules, standards, recommended practices and procedures for the prevention, reduction and control of seismic survey marine pollution by cooperating directly through a competent international organisation such as JNCC.

Our intention is in establishing a Malaysian guidelines, pioneering within the Asian region for best seismic survey practices worldwide. The interview will be conducted with consultation between Oil and Gas industry, government and the environmental authorities, with the intention to propose implementation to Malaysian codes in marine protection as well as work towards fulfilling aspects of international treaties such as the 3rd United Nations Convention on the Law of the Sea, internationally effective since 1994.

Questionnaire

Legislation/ Standards

1) How are Malaysian seismic survey guidelines incorporated? Are they being compiled from an international guidelines? Are they approved by an international organisation or just the DOE Director General?

2) As understood, the proponent will be responsible for planning out the operations, but are these proponents the head/owner of the project itself? Or are they another body/organisation/NGO/company that is hired to work on the planning?

3) MMO's and PAM operators are required to undergo training before undergoing any practical work on the vessel itself. What kind of training are they given? What certificates are needed to be approved as a full commitment MMO or PAM? Who authorises and certify this MMO/PAM?

4) In Malaysian waters, do we use seismic survey standards based on nearby international waters such as Australia and New Zealand?

Environment (including species involved)

5) As understood in Australian waters and New Zealand waters, cetaceans (whales and dolphins) are the animals of importance to watch out for during any operation involved. What kind of common species are encountered/sighted during any seismic survey activities in Malaysian waters?

6) What mitigation plan is being used to lessen the risk of harming the marine species?

7) How are these mitigation plans undertaken? Are some species overlooked during the operation?

8) What is an operator likely to do if an environmental issue arises in the area (e.g. an animal is accidentally struck by the vessel, animals appear to be in distress) while the seismic survey activity is ongoing?

9) What do you think the Malaysian O&G industry stands to gain or lose, should it be subject to mandatory MMO and PAM requirements, as per JNCC and other international guidelines?

General

10) What would you like to improve on the Malaysian DOE Codes for the implementation of guidelines and mitigation measures for EIA on marine mammals due to acoustics disturbances from seismic survey activities?

11) Please indicate the extent to which you agree or disagree to formularise a nationwide Code for adoption by stakeholders in the marine seismic survey sector which should be implemented and formally endorsed by the national oil and gas industry.

12) Also please elaborate what is in your opinion the willingness for the stakeholder/operator to comply with MMO and PAM, should it be introduced and implemented.

13) Please elaborate on what problems or issues that will arise if individuals and organisations agree to comply with the Code and treat its provisions as mandatory.

14) In your opinion does that underwater noise associated with seismic surveys cause considerable damage and disturbance to marine mammals? If so which species should be mitigated for?

15) What is your perception on seismic survey in terms of detrimental effects on marine mammals? Does it have a negative impact on cetaceans? Are there any possible differences in the levels of impact in deep water surveys vs shallow water seismic survey activity?

16) What greater collaboration with academic institutions, regulators and industry do you envisage in order to make more use of the data collected by MMOs (Marine Mammal Observer) and PAM (Passive Acoustic Monitoring) operators from around the world?

17) What type of analysis may help to delineate areas that may be suited to management as MPA (Marine Protected Area) in Malaysian waters?

18) Do you think soft-start procedures should not be initiated during times of poor visibility or darkness without the use of existing PAM technology to confirm that no cetaceans are present?

19) How well do you feel we are currently executing practical source safety zones with the need for further research into mitigation zones based on safe sound pressure levels?

20) How important do you think monitoring is required during all daylight hours, where two and preferably three MMOs should be present in order to allow efficient rotation of duties and maintain full coverage?

21) How important do you think it is to pay greater attention to training Malaysian MMO's in terms of identifying marine mammals, accurate range estimation, and the use of PAM technology and crew integration?

Technical

22) Check-shot surveying is a form of seismic surveying used for correlation of well data with conventional surface seismic data. Comparing to this check-shot with the common vertical seismic profiling is better or moreover most used in the line of seismic surveying? Which form does Malaysia use?

23) As understood in the JNCC guidelines, in Malaysian waters, such as the ongoing Dalak Project in Labuan, what is the capacity being used or being referred to in comparison to a Level 1(> 427 in^3), Level 2 (151 in^3 to 426 in^3) , and Level 3(< 150 in^3) surveys?

24) Every survey has a line turn when an area of interest is covered; does it disturb the survey when every turn comes? Is the survey not always continuous throughout the operation?

25) Based on the standard Vertical Survey Profiling (VSP), a similar Offset VSP is used with a stationary acoustic source positioned at a fixed distance from the borehole. What kind of conditions must be met when using the Offset VSP? Or is the standard VSP enough for a normal survey operation?

26) Operational capacity of every seismic operation is understood as the amount of weight with the space on the vessel (weight). As understood again, the vessel must have sufficient weight and buoyancy to load and carry the machinery used as well as the people on board. The bigger the space the better? Even with just a handful of people on board? Wider vessel equals to more arrays for a better data collection?

27) At the start of any seismic survey operations, a 'soft start' in relation to an acoustic source must be incorporated. A soft start is the gradual increase of the source's power to the operational power requirement over a period of at least 20 mins and not more than 40 mins, starting with the lowest capacity/power acoustic source. Is the soft start a compulsory procedure for every time when a seismic operation begins? What happens if the soft start is not obliged and a full capacity /power acoustic source is released in one go? If the soft start is compulsory, why not more than 40 mins? What happens to the vessel/machine/waters if the soft start were to go for longer than 40 mins?

28) JNCC Guidelines has stated to stop seismic air guns the moment cetaceans are sighted within 500m of source. Are there willingness of operator to voluntarily halt operations if cetaceans are sighted during a soft start or while the seismic survey is ongoing? In the absence of MMO and PAM requirements, will the crew be willing to collect cetacean sightings data and self-implement MMO and PAM requirements even when it is not a national requirement?

29) What suggestions do you propose for implementing seismic guidelines in Malaysia as a national requirement and utilising MMO/PAM to monitor compliance?

30) For the main machinery used during the operation, other than the Generator-Injector (GI) airgun used as stated in the 2013 Code of Conduct, Department of Conservation New Zealand, are there other types of airgun involved? Is the GI airgun the most efficient one in the market right now?

Interview with Petronas Carigali, National Oil Company

Legislation

Q How the seismic survey guidelines are incorporated in Petronas standards? Are they compiled by other international standards or guidelines? Or are they approved by another international body/organisation or just the General-Director?

A Petronas survey standard is based on approved world standard since our contractors are from US or France based company.

Q As understood, the proponent will be responsible for planning out the operations, but are these proponents the owner of the project itself? Or are they another body/organisation/company that is hired to work on the planning?

A During survey we will hire 3rd party QC to the survey, his main task to ensure the data taken is good quality if not has to re shoot the line again.

Q In Malaysian waters, do we use seismic survey standards based on nearby international waters such as Australia and New Zealand?

A Yes

Technical

Q Check-shot surveying is a form of seismic surveying used for correlation of well data with conventional surface seismic data. Comparing to this check-shot with the common vertical seismic profiling is better or moreover most used in the line of seismic surveying? Which does Malaysia use?

A Check shot is a cheaper survey than vertical seismic profiling (VSP), since the interval for VSP could be every 10 meters, whereas for check shot it depends on selective horizons. In Malaysia both survey are used depending on the requirement.

Q Every survey has a line turn when an area of interest is covered, does it interrupt the survey with every turn it takes? Is the survey always continuous throughout the operation?

A During line turn, there will be no recording, once the position is in the survey line the recording will begin i.e. start firing the airgun.

Q Based on the standard Vertical Survey Profiling (VSP), a similar Offset VSP is used with a stationary acoustic source positioned at a fixed distance from the borehole. What kind of conditions must be met when using the Offset VSP?

A If the well are within shallow gas area or near a fault zone, the offset survey will be conducted so that the signal could be compared when it pass the shallow gas and signal outside the shallow gas. If the well is close to fault zone, the VSP will determine accurately the fault location from the well.

Interview with Petronas Carigali, National Oil Company

Q Operational capacity of every seismic operation is understood as the amount of weight with the vessel. As understood, the vessel must have sufficient dead weight and buoyancy checked to load and carry the machinery used as well as the people on board. The bigger the volume space is better? Does wider vessel better to equip more arrays for a better data collection or otherwise?

A Bigger vessel could carry many streamer (seismic geophone cable) some vessel could deployed 12 cables as such could acquire 12 seismic lines per run. Therefore the time of survey will be shorten.

Q At the start of any seismic survey operations, a 'soft start' in relation to an acoustic source must be incorporated. A soft start is the gradual increase of the source's power to the operational power requirement over a period of at least 20 minutes, starting with the lowest acoustic power source. Is the soft start a compulsory procedure for every time when a seismic operation begins? What happens if the soft start is not complied and a full capacity is released from the beginning?

A I never heard about soft start. Normally there will be equipment test for airgun and seismic streamer on the way to survey area. Once the survey begin the airgun will be shot at full capacity as specification design by the geophysicist in charge.

Q For the main machinery used during the operation, other than the Generator-Injector (GI) airgun used as stated in the 2013 Code of Conduct, are there other types of airgun involved? Is this airgun the most efficient one in the market right now?

A Currently all seismic survey offshore is using airgun. The capacity power is based on how deep and length of seismic cable.

Marine mammal mitigation plan

Q As understood in Australian waters and New Zealand waters, cetaceans and dolphins are the animals of importance to watch out for during any operation involved. What kind of common species in Malaysia waters are sighted during any seismic survey activities?

A In Malaysia there is no species to watch during the survey

Q MMO stands for Marine Mammal Observers where these observers are to be on top of the vessel with clear line of sight and report for any sightings of marine species of importance. PAM stands for Passive Acoustic Monitoring. PAM operators use a software for marine mammal detection and report data collected throughout the whole operation while managing the equipment. How is it done with Petronas seismic survey?

A In Malaysia we did not have issue of marine life. Our problem are the fish trap or "bubu ikan" (in Malay Language) which could damage the seismic cable. As such I am not familiar with MMO and PMO.

Interview with Marecet Org, Marine mammal research scientific NGO

1. Q: In your opinion, why should we protect marine mammals? What benefits can their existence bring to us?

   A: Marine mammals are apex predators (i.e. sits at the top of the food chain) and thus are good indicators of ocean health. They consume similar seafood as humans and their presence indicate fish resource availability in a particular area. Additionally, as mammals their biology is relatively similar to humans and thus any abnormalities observed in their anatomy may be indicative of the state of the ocean which may then affect human communities. For example, high concentrations of contaminants in their tissues or blubber may indicate bioaccumulation of these contaminants as it moves up the food chain (i.e. from fish to fish) which will similarly affect humans that consume similar seafood diet. As predators, they provide balance to the marine ecosystem to keep prey populations in check, which in turn, play their role in maintaining lower-level organisms such as algae, jellyfish, sea urchins, etc. in check. Reductions in marine mammal populations in some areas have resulted in ecosystem imbalance, which had environmental, social, and economic consequences.

2. Q: What current technology are being used to protect marine mammals in Malaysia? In your opinion, what is the technology that should be introduced into Malaysia next?

   A: Technology is currently not being used directly for marine mammal protection or conservation in Malaysia. We use certain equipment to study marine mammals in Malaysia but not for their conservation. One technology that can potentially be useful to assist in their conservation would be passive monitoring equipment which can be deployed in areas of concern. Passive monitoring equipment can either be acoustic or visual and may be deployed either onshore or underwater.

3. Q: What are the researches/information regarding the effect of noise pollution to marine mammals being done in Malaysia to date? In your opinion, what is the research that should be funded and done next?

   A: In general, research on marine mammals in Malaysia has been fairly limited and has only started to gain traction in recent years. Therefore, research has mainly focused on collecting general information on these populations such as species diversity, population abundance, distribution, and threats identification. Research on the effects of noise pollution on marine mammals has not been undertaken specifically in Malaysia to date and any information is currently derived from research conducted in other countries. In my opinion, research on underwater noise impacts to coastal cetaceans and dugongs should be prioritised in lieu of the high interaction between humans and cetaceans in the coastal areas.

Interview with Marecet Org, Marine mammal research scientific NGO

4. Q: We have seismic surveys and marine mammals as foreign countries, eg. UK, Australia. In your opinion, why do you think Malaysia do not have seismic survey guidelines?

   A: This is probably due to the way in which biodiversity and industry activities is managed in the country. Both sectors are being managed under different ministries with very minimal interaction between them. Furthermore, regulatory bodies in the country do not have sufficient capacity to conduct marine biodiversity management and thus are unable to prepare and enforce any seismic survey regulation. In addition, there does not seem to be much interest from those regulating the oil and gas industry in the country to proactively manage biodiversity impacts arising from oil and gas activities.

5. Q: In your opinion, what can be done to increase the awareness of protecting marine mammals in Malaysia?

   A: Malaysians need to first be made aware that marine mammals exist in Malaysian waters. This message has to be ongoing and information to be made available to the public for areas where research has revealed populations exists. Having marine mammals specifically mentioned in various legislation, policies, guidelines and other such documents would also reinforce the message that marine mammals are present and are of conservation importance. Specifically for the oil and gas industry in Malaysia, it would be beneficial to introduce a marine mammal awareness training for those involved in offshore operations, especially those involved in activities that may be of significant impacts to marine mammals (e.g. seismic survey, underwater piling, etc.).

Interview with Seismic Contractors

Questionnaire

Q1. Is there any mitigation measures of minimizing the impact of seismic noises on marine animal being carried out during the operation? If there is, please briefly illustrate the method. Is there any obstacle to implement such seismic guideline? If there is, please briefly describe the obstacles.

Answer:

Rosla:

Yes. There is a standard procedure to fire the guns (seismic source), which are ranging typically between 2000 to 8000 cubic inch in total volume.

The normal procedures for firing the guns are as below:

1. 30 minutes before ***soft start,** ***Seismic Observer** will inform the MMO representative to start pre watch, looking for marine mammals within the area. This can be either by:

   - watching from the vessel deck by using binoculars (normally during daylight), OR

   - using the PAM equipment (normally during night time)

   In some cases, both are operating at the same time

2. After 30 minutes pre watch, Seismic Observer will check with MMO representative if the sea is clear from any mammals nearby and ask permission to start soft start

3. If the MMO confirms everything is clear, Seismic Observer will begin the soft start, starting firing from the lowest gun volume, to the highest (the lowest is 40 cu in and the highest is normally 250 cu in) until full volume is reached. The smallest gun volume (40 cu in) is good enough to keep the marine mammals away from the survey area before firing the bigger guns. Depending on the contract, the soft start will normally take about 30 minutes to complete

4. When the guns are firing, the MMO is responsible to watch or monitor via PAM signal until the survey line is complete

5. The MMO has the right to instruct Seismic Observer to stop firing the guns at any time if the marine mammals spotted within 500m radius

6. The time for every task performed must be recorded either by local time or UTC. In some contract, the position for every task performed also must be recorded. This will be the reference in case if there are arguments among the involved parties (client, contractor, MMO)

7. Firing the guns in marine park is strictly prohibited

***Soft Start**: The term used for firing the guns incrementing for the lowest to the highest volume

***Seismic Observer**: The operator for the guns and seismic recording system

No obstacle to implement the guidelines

Interview with Seismic Contractors

Mr Mo:

So far, during our operation, no mitigation measurement being done.

Mr Woo:

No, not in South East Asia.

Daisy:

There are 2 immediate environmental laws in Sabah. (i) Environment Protection Enactment 2002 – being enforced by our Sabah Environmental Protection Department. This is a state law. (2) Environmental Quality Act 1974 being enforced by Department of Environment, Sabah. This is a Federal law. There are other laws especially state laws that are governing the protection of natural resources and environment in Sabah.

As for marine seismic noise, I am not aware of any control being implemented in Sabah so far. Thus, I am not able to answer your question regarding the type of method and so forth.

However, you may want to enquire the Department of Environment, Putrajaya (DOE) and the Federal Department of Minerals and Geology, Putrajaya whether they have started marine seismic activity. To assist you further, you may also make enquire at the Ministry of Natural Resources and Environment, Putrajaya. DOE is under this Ministry.

Analysis: From the responses of interviewees, in Malaysia, there is no standard mitigation measure or regulation being carried out officially by government. However, depending on different companies and clients, they might have their own mitigation measures to be followed with referencing to other's country guideline.

Q2. According to New Zealand Code of Conduct for seismic survey 2013, the seismic air gun's capacity can be categorized into three ranges: Level 1 (>427 cubic inches), Level 2 (151-426 cubic inches), Level 3 (<150 cubic inches). Which air gun's capacity is generally being used in the industries?

Answer:

Rosla:

The seismic air gun capacity in this question is referred to as an individual gun. Depending on the project, the answer can be a single gun or multiple gun arrays. If it is just a site survey project, you may use only 150 or 160 cu in single gun at 2000 psi. But, if it is an oil exploration project, you may have 4-6 gun arrays where each array may have 7 gun clusters, a combination of small and big volume of guns (around 40+ units) and this would range from 3000 – 8000 cu in at 2000 psi normally.

Mr Mo:

In our operations, we normally use air gun with total volume up to 160 cubic inches (4 x 40 cubic inches) or total volume 80 cubic inches (4 x 20 cubic inches). Depends on the

requirement by the Client's specification. This type of volume is generally for high resolution seismic survey.

For Exploration like 2D and 3D survey, the total gun volume will be greater. But we are not doing this, this normally carried out by Company like PGS, CGG, Nordic, Geco.

Mr Woo:

Level 2

Q3. Exclusive zone is an area that the mitigation measures will be undertaken when marine mammal is observed within the area. Based on JNCC, exclusive zone is 500m radius from the centre of air gun array. However, some recent research found that 500m exclusive zone is not sufficient enough to prevent the auditory damage to the marine cetaceans. Instead of using arbitrary 500 m radius excusive zone, an isopleths of sound pressure in the unit of decibel should be used. The exclusive zones for different waters should be calculated differently by taking water depth, salinity, and water temperature into account. Will the company willing to fund the research on the calculation of exclusive zone?

Answer:

Rosla:

Depends on which 'COMPANY' you are talking about. In a marine seismic exploration project, the 2 main parties are:

- the client (Petronas, Shell, Murphy oil etc)

- the seismic contractor (PGS, CGG Veritas, Polarcus etc)

These two parties in reality, they don't bother much about the marine mammal activities, as their main concern is the oil trap in the sea. But, when the third party gets involved (MMO, JNCC etc.), a lot of budget has to be allocated for them. When seismic contractor has to stop operation due to marine mammals in the area, the client has lost thousands of dollars just to restart the line once again. In the simplest word, without the marine life organization gets involved, the job for client and contractor would be much easier and I would say there is a slim chance for them to invest on the research on the calculation of exclusive zone.

Even for the MMO organization, the PAM equipment that currently they are using is good enough. I am not very sure the range, but definitely more than 500m radiuses. I would say that they are not willing to invest as well.

Mr Mo:

We are small scale company, will have limited fund to allocate to this type of research. But we believe we are able to support as co-sponsor. Overall, it will depends on the top management's decision whether to support this kind of research as one of the CSR.

Mr Woo:

No

Interview with Seismic Contractors

Q4. Almost every international guideline introduces Marine Mammal Observer (MMO) and Passive Acoustic Monitoring (PAM) system. Do the vessels currently in used have enough space for implementing MMO and PAM system?

Answer:

Rosla:

Yes, more than enough. For the PAM cable to be laid in the sea, a small winch of about 0.3 m width x 0.3 m radius. The cable is just about 200m and sometimes the crew just pulled it by hand. The work desk for the PAM operator won't take too much space. The PAM equipment is just about a size of a LaserJet printer.

But, the issue will come from the available cabins for the crew. Some vessels are small that they do not have available cabins for additional crew. In this case, sometimes they will just make an arrangement for 1 MMO representative instead of 4 (working on 24 hour shift). Due to 1 MMO person onboard, sometimes, the PAM operation is not required.

Mr Mo:

In our operations (high resolution seismic survey), we do not have this type of monitoring device or MMO onboard as it is not mandatory in Malaysia. My experience, in Sakhalin Island Russia, the MMO is mandatory.

Mr Woo:

Yes

Q5. Is there any MMO or PAM systems being implemented in recent? Or there is any unit with similar function to detect the marine mammal?

Answer:

Rosla:

Only PAM and MMO are in used.

Mr Mo:

No

Mr Woo:

No

Q6. MMOs are required to undergo a training course to be qualified. Is there any suggestion to be included into the training course so that a trained MMO can be more professional and well prepared? Do you think the real field training should be included during training? If it is, how long should the real field training period be?

Answer:

Rosla:

As a Marine Seismic Observer, this question would be beyond my knowledge. But, based on what I have seen and met some of them; they could be from a retired navy to a marine biologist. No matter from which background they are from, they must at least, understand the basic operation of marine seismic survey so that they know when not to cross the line. The real field training would be a good suggestion. 1 day should be enough.

Mr Mo:

If MMO is mandatory, sure company will send personnel for this type of training. Right now this is not regulated. MMO would be good coming from Fishery Department/marine biologist who familiar with the marine life.

Yes, real field training should be included during training, but it will depend on the vessel capacity. The duration should be around minimum 1 week or per project basis.

Mr Woo:

Yes, six-month training at sea

Q7. Soft starts are generally used in other countries waters when the air gun operation commences. Soft start is the gradual increase of the air gun power from the lowest to the operating power over a period of 20min to 40 min. Should the soft start be implemented in Malaysia? If it is, how can the crew member being ensured to follow the procedure?

Answer:

Rosla:

Soft start is a normal practice everywhere including Malaysia. There is no way the crew member can escape the procedure as there is a soft start log to be submitted to client together with the seismic data at the end of the project. Also, the soft start log is being QC by client representative onboard.

Soft start is not only important to MMOs. Soft start is also important for Seismic Observers and mechanics to monitor their gun performance. In case if there is a gun underperformed or failure, the crew still have time to fix the problems or plan the maintenance schedule.

Mr Mo:

Yes, it should. In fact, all the survey company adopts the international rules and regulation / practice. So it will not be a problem, to ensure crew member to follow the procedure. In every operation, there will be a client representative placed onboard to ensure the surveys are performed according to the scope of works/ survey specifications.

Mr Woo:

Yes. Clients are responsible to engage a representative to be onboard the seismic vessel, who will ensure the procedures.

Interview with Seismic Contractors

Q8. What are the frequencies normally used when seismic survey are being conducted?

Answer:

Rosla:

Which frequency? Seismic streamer or guns?

Seismic streamer frequency range is approximately between 3hz – 300 hz. The deeper the cable, the lower the frequency.

Mr Mo:

In our survey operations, several type equipment being deployed.

1. Echo sounder – using 33 kHz & 200 kHz
2. Multibeam echo sounder – 240 kHz
3. Shallow seismic profiler – 1.0 kHz to 3.5kHz
4. Side scan sonar – 100 kHz & 410 kHz
5. High Resolution seismic – 8kHz – 410 kHz (useful)

Mr Woo:

10-400 Hz

Q9. Is there any voluntary seismic guideline implemented in current seismic industry in Malaysia? If there is, please briefly describe the mitigation measures being implemented. Which country's guideline is being referred? (Eg. JNCC, Australia, Brazil, etc)

Answer:

Rosla:

Voluntarily seismic guideline is not compulsory in Malaysia or even South East Asia region as far as I know (please re-confirm). This could be due to our area is on the equator and not in the critical zone for marine mammal life such as dolphins and whales (just my opinion). However, even without an MMO representative onboard, we still do the regular soft start without so many restrictions.

Mr Mo:

So far in Malaysia, we are not very sure if there is any voluntary guideline. But for our company, we normally follow the IMCA guideline.

Q10. Malaysia is subjected to complying UNCLOS as being a member of United Nations. However, having no protection on marine mammal from the seismic activities' negative

impact, Malaysia has offended the Article 192 under the UNCLOS. Why is there no rule and regulation being established by Malaysia government?

Answer:

Mr Albert:

There is no proof and data to support that Malaysia has offended UNCLOS. As there is no enough research on the effect of seismic activities in Malaysia, government does not aware of this issue. DOE officer might not aware this issue. Funding from government or seismic companies such as Petronas is needed to research the effect of seismic survey on marine mammal.

Q11. Which authority should be approached if a proponent intends to propose a seismic activity plan? Is there any rule to be followed in order to obtain the license?

Answer:

Rosla:

Not 100% sure. But based on my experience, it may vary depending on which countries/area you are working. For example:

- In red zone area, security level 2 and 3 (high piracy), the navy must be informed

- High fishing activities – Department of fisheries (to acknowledge fishermen to stay away from the survey area)

- Near Marine Park – state government, UNESCO etc.

- State government – for documentation matters

- Port authority (port of embarkment)

There must be rules and procedures to be followed but I am not sure about this. But one thing for sure, the contractors must be registered with International Association of Geophysical Contractors (IAGC)

Mr Mo:

For seismic activity related to oil and gas, it should approved by the Petronas. Yes, there will be rules to follow in order to obtain the license.

Q12. If the seismic guidelines are being regulated, what kind of difficulties should be expected which affect the seismic industry? (etc profit, human resource, technology)

Answer:

Rosla:

i. cost : Every prospect line aborted due to MMO order is an additional cost to client and considered as downtime as well

ii. more manpower needed: more manpower to hire MMOs is also an additional cost to client. But, on the MMO side, they might have an issue on shortage of competent crew if the current seismic activities are active. On a normal basis, the crew will have a 6 weeks on/off rotation on a vessel. But, due to shortage of crew, some of them will have to do 12 weeks onboard.

iii. technology : not quite affected

iv. human conflict: Conflict an arguments between seismic contractor and MMO representative are common. In some cases, the issues could be brought up to governing bodies

Mr Mo:

It will depends what kind of seismic guidelines and how stringent is the rules. Probably is the cost.

Mr Albert:

Cannot simply extrapolate others countries guidelines as different depth and salinity may differ the transmission of seismic sound and hence has different effect on the marine mammals.

Q13. If there is any environmental law to be proposed to the government, what are the procedures to go through from proposal to the implementation of the laws?

Answer:

Daisy:

There is no environmental law to be proposed by the State Government of Sabah. The immediate probably is the guideline that is being worked out by immediate relevant departments/ministry.

Q14. Why is Malaysia lacking in technical expertise in seismic survey mitigating procedure?

Answer:

Rosla:

We need to understand that even in the world, seismic survey activities do not have too many expertise. That is the reason why seismic survey companies will have to hire crews from all over the world, as they cannot get all crews from the same country at one time.

Back to the question, I would say:

- Not enough exposure to the seismic survey activities. Nobody knows this job ever exist

- The JNCC (UK) and some from other countries (US, NZ, Australia) have been in the industry for so long and they have become very dominant. Since they have played a big role in seismic survey market and the industry itself is not that huge, it is pointless for Malaysia to start from scratch and be a part of them

- Lack of encouragement by our government as it is not a good return of investment. Just hire third parties to get the job done

Q15. Why is there weak coordination among the relevant government agencies and seismic contractors?

Answer:

Rosla:

Depends on which countries. If you say UK, New Zealand and Australia, the government are really stern about this. But, if Malaysia, the answer is no. Due to their geographical locations, they might see more cetaceans than us. As they will start to learn to love them, from awareness, they will make rules to protect them and create guidelines.

Back to the question, I would say our geographical location is the main factor why there is weak coordination. The less we see the species, the less we care about them. Up to the seismic contractors to do whatever they want.

Q16. Why is there the lack of public awareness in cetacean stranding?

Answer:

Rosla:

I do not have an exact answer for this. But, it based a lot on the country geographical locations. Countries such as Australia/New Zealand are big islands, and cool climate. Most of the people recreational activities are at the coastlines (surfing, swimming, sailing, diving etc.). Due to the countries' cool climates and the people would spend a lot of time at the beach, they might fancy more whales, dolphins, etc. than people who are living in the equator like us. This could be where the awareness comes from. The more you see them, the more awareness comes from you.

Same goes to the UK, which is also a bunch of islands. That could explain why the MMOs mostly come from this region.

Q17: I am going to investigate the differences between the guidelines from different countries and suggest some suitable parts for the guideline that we planned to implement in Malaysia.

A: Since you plan to implement in Malaysia, have you been approached by government to set regulation?

Q18: Instead of being approached by government, we are going to propose a guideline to the government. The final objective is to propose a suitable guideline to Malaysia since there is no current mitigation measure in Malaysia to minimize the harm of seismic survey to marine mammal.

A: Ok, that is actually correct. There is no regulatory in place at relate to offshore for Malaysia. Regarding the impact on marine mammal, why do we implement the user guideline?

Q19: Because the seismic survey will affect the living style of the marine mammal as it may cause TTS, PTS etc which is some negative impact on marine mammal.

A: The reason that we actually employ this guideline, we call MMO for short, Marine Mammal Observation, we undergo a seismic survey where they have this regulation in place, what we are doing is actually scanning for any marine mammal such as whale and dolphin within the environment. The reason we do it, primarily is to prevent direct physical damage to the whale due to the fact that the seismic signal can affect their navigation. What we found out by experience is for some marine mammals, there is no definite established item on this. What we assume or presume is that when we are conducting the seismic survey, especially the whale, they tend to be curious, so they tend to go and investigate the source of the seismic signal. So, obviously, there is no good for neither seismic survey nor the mammal. So, for example, when we conduct a seismic survey from the bottom of the ship, the mammal coming close to one of the ships could be a potential for danger. So, it is a potential hazard and not a direct threat in that regard. So, you have to be clear on that for your investigation that it is not like some people think that we fire the seismic pulses may injure mammal. That is not the case. In fact, what we are trying to do is to keep the mammal out of the seismic survey and we don't want injury.

Q20: In this case, there is MMO in Malaysia?

A: There is no MMO, but what we do is when we conduct seismic survey anyway, even though there is not part of the government regulation, what we are doing is we are actually kept observing for mammal in the area. For example, in a seismic survey site, when they spot a mammal in the area, they need to report to the manager of the operation. So, even though it is not formal, it is an informally internal guideline.

Q21: According to JNCC, they have to delay the operation if a marine mammal enters within 500m.

A: Correct, yes. What we do is we stop firing the airgun because this is what attracts the marine mammal such as whale and dolphin. We stop the operation until they leave the area and we can't resume at the full level fire. We need to do the soft start, the gradual increase of power in shots from low level to high level until we reach the operational level.

Q22: So, soft start has been done in Malaysia?

A: Yes, I mean, I will presume it is. I can't speak for any of the operator as any other service provider apart from our company. But for us, we definitely have it, because we have a global footprint. We tend to bring in the best practices from the other end of the world. So, even though it is not officially documented, it is something that we will keep an eye on because, for us, we have a commitment to health, safety and environment. When we are conducting the seismic operation, we always want to make sure it is done as safely as possible which includes those mammals coming close to the seismic vessels.

Q23: So the voluntary guideline has been implemented in your company? Can I say that?

A: Yes, but you should not officially be quoting me on anything as this is an unofficial conversation. If you want any formal comment after we run through a formal appropriate procedures.

Q24: So, for the MMO, is there any qualification for them in your company?

A: We normally follow local regulation. I am going to send you the regulation that we employ offshore Australia. I will send you a couple of articles on that to help you establish the criteria.

Q25: Thank you very much. Beside the soft start and the delay, is there anymore that you will do to reduce the harm of the seismic survey to marine mammals?

A: You can't really avoid that. It is the nature of the seismic survey. Seismic signal itself will propagate very large distance and that is not something you can troubleshoot. I mean, seismic signal can be detected 10km away. They are not harmful to (marine mammal), they don't cause structural damage, but the propagation through water is very similar to the way whales communicate to each other which is in very low frequency pressure wave. So that is something you can't really avoid and that is why it is not called marine mammal avoidance, it is called marine mammal observation. All we can do is that we conduct observation and we cease fire if a mammal enters certain radius.

Q26: So, the marine mammal observation has been done by human or the system?

A: It is a human procedure. So, for example, if we do it officially at Gulf of Mexican, it requires MMO on the vessels to scan the horizon with the document for the whale and the dolphin. The requirement for MMO, they have to be Qualified. They are normally offshore personnel but need to attend training course and they need to learn to identify the mammal.

Q27: Other than MMO, is there any other system in use in Malaysia such as PAM?

A: That is not being used in Malaysia.

Q28: So what if the weather is not really good?

A: We have internal guideline for whether to do seismic operation in severe weather. But it is not really related to mammal, it is related to human safety.

Q29: So may I know which organization qualify the MMO of your company?

A: We do not qualify our MMO. MMO is set by governmental authority. I think the best thing to do is I will send you via email the example of Australia and articles of MMO to help you with your project. What you can do is to read them and digest them and we can talk later.

Q30: Thank you very much for approving this interview. If I need any further clarification, I will email you. Thank you very much again.

A: Yes please. If you are going to be publishing anything on this conversation, I will need to receive a copy of it to be approved by our legal team. Alright, thank you very much.