COMPARATIVE REVIEW OF MARINE MAMMAL GUIDANCE IMPLEMENTED DURING NAVAL EXERCISES

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1. INTRODUCTION

Naval exercises occur on maritime ranges that can encompass many thousands of sq km². Exercises can be national or multi-national, of varying size in terms of numbers of combatant units and may include a variety of activities designed to simulate air, sea, surface and subsurface battle conditions. These activities generate varying intensities of sound, from ship mechanical and propeller sound, to low flying aircraft, missile launches and gun discharges, use of active sonar and explosives detonations. These activities are not always restricted to defined exercise ranges, although high end training generally is, to ensure safety of the public and participants (S. Cole, pers. comm.). Sources are generally mobile, such as high power modern mid frequency active sonar systems - that have been in operation since the 1960s - and low-frequency active sonar systems, introduced in the 1980s. Active sonars use a range of source levels and operating ranges (Table 1). Although not indicated here, mid and low frequency ranges have an overlap – the UK navy's Sonar 2087 is in the range of mid frequency active sonar according to the US definition of 1 kHz – 10 k Hz for mid frequency active sonar systems (DoD, 2007). There are estimated to be over 80 active sonar systems in use or development in NATO member countries (Jasny, 2005). Both mid and low frequency systems emit high-intensity sound into the ocean and listen for echoes that provide a 'sonic picture' of the environment. Such echoes include both natural marine features as well as returning signals from anthropogenic sources, including some 380 stealthy submarine targets operated by around 45 countries (Tomaszeski, 2004). In addition, point sources, such as active sonobuoys and explosives, are also routinely used during exercises and, rarely, sea shock trials, which are undertaken to determine a ship's ability to withstand damage caused by nearby explosions.

	SQS-53C	SQS-56	SURTASS LFA	Ship shock trial (10,000 lb TNT)
Source level, dB re 1µPa	235+	223	235	299
Ping duration, S	5	5	6-100	0.1
Ping energy	233	221	243	302
Duty cycle, %	4 to 8	6.2	10	Intermittent
Frequency, kHz	2.6, 3.3	6.8, 7.5, 8.2	0.1 - 0.5	low / broad
Bandwidth	narrowband	narrowband	30 Hz	broadband
Directionality	120x40	360x30	Horizontal	omni-directional
Reference	Møhl, 2004	Møhl, 2004	Hildebrand, 2005	Hildebrand, 2005

Table 1. Some naval sound sources

Marine mammals rely on sound for all of the fundamental biological and ecological aspects of their lives including navigation, prey location and capture, predator avoidance and communication (including during migration and reproduction). A detailed review of mass

1 The views expressed here are those of the authors and not necessarily WDCS

strandings and non-strandings (where corpses are recovered at sea) of beaked whales and other cetacean species associated with mid frequency active sonar is provided by Parsons et al. (in press) and Weilgart (2007). The causal mechanism for mortality of individuals from naval sonar remains unknown, as does the extent of its impact upon populations. Although most incidents examined to date have involved beach strandings linked to offshore naval activities, it is clear that mortality may also occur at sea (Jepson et al., 2005; Espinosa et al., 2005; IWC, 2006). In addition to non-auditory physiological impacts (such as damage to body tissue, gas and fat embolism), documented impacts include masking of marine mammal acoustic signals (potentially resulting in loss of opportunities for foraging or reproduction, anxiety or stress, and non-detection of predators) and altered behaviour such as changes in vocalisation rate/amplitude and spatial avoidance of the region of naval trials (Miller et al., 2000; Rendell and Gordon, 1999; Tyack and Clark, 1998). In addition, blast injury has been documented in humpback whales *Megaptera novaeangliae* during construction operations (including explosions and drilling) (Todd et al., 1996). Whilst observations of death, injury and behavioural changes have been documented for odontocetes and mysticetes, cumulative impacts are more difficult to study. The long term consequences and the biological significance of intense sound pollution, particularly in areas of repeated use, remain largely unknown.

To date, most attention has focussed on the operation of active sonar, and particularly mid frequency active sonar, due to a link with cetacean mortality worldwide (Brownell et al., 2004; Espinosa et al., 2005; Fernández et al., 2004; 2005a; 2005b; Fernández, 2006; Freitas, 2004; Martin et al., 2004; Taylor et al., 2004). Strandings and mortality at sea resulting from active naval sonar have been associated particularly with beaked whales and other primarily (although not exclusively) deep-diving species (see Parsons et al. in press for a review). As a result, marine mammal mitigation guidance is often directed at active sonar and this will form the focus of this review, except where otherwise stated.

This article summarises the mitigation guidance used to protect marine life during naval exercises (Table 2). It is based on the information available to the authors at the time of writing. Access to guidelines can be challenging. Guidance undoubtedly exists that is not publicly available or that may have since been updated to differ from that presented here.

2. EXISTING MITIGATION MEASURES

Guidance is developed individually by a country for use by their own Navy. On the whole, navies self-regulate and set their own mitigation strategies (Glassborow, 2006). The Royal Australian Navy (RAN) has produced extensive guidance under its Maritime Activities Environmental Management Plan (MAEMP). This is an overarching framework under which environmental management strategies, including Planning Handbooks, Planning Guides and Procedure Cards have been developed. Marine Mammal Impact Mitigation Plans are available for Canadian Navy sea trials in 2002 and 2003. Guidance on the French Navy (Marine Nationale) activities was based on a brief developed for the scientific and technical committee pertaining to the PELAGOS agreement (referring to the Ligurian Sea Cetacean Sanctuary) in 2006. Information on Italian Navy guidance in the northern Tyrrhenian Sea is available (Cerutti, 2005). The UK Royal Navy (RN) guidance pertains to CINCFLEET interim command guidance for users of in-service active sonars to mitigate against marine mammal disturbance. Some further guidance is available for Sonar 2087 sea trials that took place between 2002 and 2006. No detailed guidance could be found for the Royal Netherlands Navy or the Royal Navy of Norway, although the authors are aware of limited mitigation efforts. Despite freedom of information requests, ddocumentation about mitigation measures during active sonar use was not obtainable from the German Navy. Navy guidance in the US is not straight forward. In June 2006, the US Deputy Secretary of Defence provided a six month National Defence Exemption (NDE) from requirements of the Marine Mammal Protection Act (MMPA) for certain Department of Defence (DoD) mid frequency active sonar activities to the Secretary of the Navy (DoD, 2006a). During this period, specific guidance was set out on the use of mid frequency active sonar during major exercises, within established ranges and operating areas (DoD, 2006b). At the end of this NDE, in January 2007, a further Memorandum was provided to the Secretary of the Navy (DoD, 2007). This memorandum included Improved Extended Echo Range (IEER) Sonobuoys (a new sensor system nearing

deployment) as well as mid frequency active sonar, for a further period of two years (DoD, 2007), and retracted some of the measures required by the first exemption, such as a 12 nm coastal exclusion and special conditions for sonar use in low-visibility and significant surface-ducting conditions. Two important court cases concluded in 2008. Details of the history surrounding the cases, as well as mitigation measures imposed on the US Navy (USN) can be found in the Court of Appeals ruling from February 2008 affirming the district court's January 2008 preliminary injunction order[2], allowing completion of exercises in southern Californian waters on the condition that certain mitigation measures are employed. At the same time, an injunction was imposed in the District of Hawaii in relation to USWEX (undersea warfare exercises) around the Hawaiian Islands until January 2009[3].

The guidance of one country may be adopted by another during a joint exercise. In some circumstances, regional measures exist. The North Atlantic Treaty Organisation (NATO) has developed guidance for environmental protection during NATO led activities that identify sound as a potential impact upon wildlife (Fortescue et al., 2005). The NATO Underwater Research Centre (NURC) developed Human Diver and Marine Mammal Risk Mitigation Rules (NATO, 2006), following a mass stranding of Cuvier's beaked whales *Ziphius cavirostris* in Greece during 1998 (Frantzis, 1998). These Rules have been periodically updated, and whilst only applying to NURC activities, have formed the basis of guidance for other nations (Fortescue et al., 2005). In addition, the Scientific Committee of the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS) has generated mitigation guidelines for sonar, use of explosives and other active sound source activities (Pavan, 2007) that are not considered further here.

As with seismic survey marine mammal mitigation measures (see Weir and Dolman, 2007), the mitigation guidance used during naval exercises often incorporates three main components: (1) time/area planning (of exercises/active sonar use) to avoid marine mammals; (2) implementation of operational procedures (e.g. 'soft start'—where sound levels are gradually increased over time); and (3) detection of animals close to sound source and implementation of real-time mitigation measures (e.g. shut-down). The mitigation measures known to be operated during naval exercises are summarised (Table 2).

3. GUIDANCE TOWARDS A WORLDWIDE NAVY STANDARD

The marine mammal mitigation guidance in use during naval exercises and operations worldwide shows variation in most parameters between regions (Table 2). This lack of consistency needs to be addressed so that a minimum 'best practice' with a scientific basis offering adequate protection to all marine mammal species is adopted worldwide. Guidance is also needed for the management of naval exercises in waters where no guidance currently exists, perhaps starting with those countries that are members of NATO. A series of recommendations came out of a paper presented to the NATO Military Oceanography Group (Fortescue et al., 2005), one of which was that 'NURC should be requested to act on behalf of MILOC as the NATO focal point to support marine mammal risk mitigation by promoting coordinated data standards, collection/data exchange/databasing, modelling, legal considerations, etc. and to maintain a composite database for NATO nations'.

In the absence of standard international guidelines, naval activities in some areas, and on the high seas, presently appear to be carried out: a) without any mitigation measures in place, or b) using guidelines that vary in their parameters. Development of a realistic mitigation protocol must incorporate measures to: 1) ensure explicit protection of marine mammal species, particularly endangered species and feeding/breeding/migrating concentrations; 2) reduce associated mortalities of beaked whales; and 3) protect all marine life (including turtles and fish) more generally. The most significant environmental gains are achieved at the planning stage (MoD Sustainable Development and Environment Manual, 2005). It is currently unclear how the recent US court decisions from California and Hawaii are likely to change the future of guidance in the USN, and no doubt in other navies. Naval activities to ensure protection of

2 NRDC vs. Winter, 527 F.Supp.2d 1216 (C.D. Cal. 2008), aff'd 518 F.3d 658 (9th Cir. 2008)

3 OMI vs. Gates, F.Supp.2d, 2008 WL 564664 (D. Hawaii 2008)

marine wildlife should remain inside regulatory frameworks. The following points, some of which are already undertaken by some navies, are recommended for inclusion as a minimal 'best practice' mitigation procedure.

AVOIDING DENSITIES OF ANIMALS

• Designation of closed areas (seasonal and/or year round as appropriate) where scientific data support the occurrence of vulnerable species and/or key marine mammal breeding/feeding/migratory habitat;
• Avoidance of established marine protected areas;
• Implementation of buffer zones around closed and marine protected areas, where active sonar is prohibited during particular seasons or on a year-round basis so that damaging or disturbing sound levels are not created (Agardy et al., 2007);
• Clear definition of closed areas and buffer zones in naval guidance, so that all operators are equally subject to and aware of restrictions;
• Limitations of sonar use during months with historical significant surface ducting conditions, and use of power-downs during significant surface ducting conditions at other times, to minimise disturbance;
• Avoidance of fronts and other major oceanographic features, which have the potential to attract concentrations of animals;
• Planning of naval exercises to avoid impacting entire habitats or migration paths, to reduce stranding potential and to provide escape routes for marine mammals;
• Concentration of exercises in surveyed offshore habitat identified as being of low use by marine mammals;
• Undertaking of predictive habitat modeling to determine key habitat that should be avoided;
• Ground-truthing of model results by funding dedicated field surveys in high use exercise areas;
• Prioritising research in areas where naval exercises regularly take place and where the distribution, density and seasonality of cetaceans in an area are poorly known;
• Development of passive acoustic monitoring (PAM) techniques, including long term static monitoring, and use of these in preparation of major exercises should be a requirement in order to detect beaked whale hot spots;
• Avoidance of fish spawning grounds and of important habitat for fish species potentially vulnerable to significant behavioral change, such as wide-scale displacement within the water column or changes in breeding behavior; and,
• Avoidance of key sea turtle foraging habitat, and seasonal restrictions to coastal naval activity during turtle nesting seasons.

COMPLETION OF EIA'S

• Full and transparent EIAs should be developed for offshore exercise areas, to include long term and cumulative impacts of large scale and multi-national activities;
• Navies should employ rigorous standards of environmental review, including objective analyses of the sound levels emitted by the source at varying ranges, a comprehensive analysis of all reasonable alternatives and a thorough delineation of measures to mitigate impacts;
• Development of Strategic Environmental Assessments or National Environmental Management Plans (such as that produced by the RAN), to include information on the overall use of the sound sources (including outside of offshore exercise areas) is also required; and,
• There should be transparency and public input in the planning and drafting process.

3.3 SOURCE MODIFICATION AND ALTERNATIVE DESIGN TECHNOLOGIES

• Use of sonar and other active acoustic systems at the lowest practicable source level;
• Use of modelling to reduce or eliminate chokepoint exercises in near-coastal environments, particularly within canyons and channels, and use of other important habitat;
• Limitations to the use of active sonar in training through effective planning;
• Ongoing development of point sensors such as active sonobuoys as an alternative to hull generated active sonars; and,

• Development of improved range/bearing data using PAM technology, and development of PAM guidelines for implementing mitigation measures based on acoustic detection and PAM training, particularly since mitigation measures may be based on the PAM operators' judgment.

3.4 ONBOARD MITIGATION PROCEDURES

• Mitigation measures should apply to all marine mammal species;
• The use of the lowest practicable volume should be defined and enforced;
• Sound transmission properties in surface ducting conditions should be accounted for, particularly in the waters near the shelf break to aid in choosing areas to limit the impacts of sonar;
• Development of a series of standardised worldwide exclusion zones (EZ) based on a conservative and scientific basis rather than on arbitrary designation. EZ values should be calculated by the operator prior to the application process, using site-specific transmission loss modelling based on source parameters and the bathymetry, water properties and sound velocity profiles of the water column within the prospect area. The EZ value should be verified in the field at the start of the survey. During long duration surveys, the EZ should be regularly recalculated. The criteria used to calculate EZs should regularly be reviewed;
• Development of defined and well-implemented shut-down and delay measures when animals are detected in the area of naval activities, including where high densities or vulnerable species (to be regionally defined) are encountered unexpectedly within the EZ;
• Suspension or relocation of exercises when beaked whales or high densities (to be regionally defined) of other species are detected until the animals have cleared the area;
• Suspension or postponement of chokepoint exercises during surface ducting conditions and scheduling of such exercises during daylight hours;
• At least one dedicated third-party observer should be on watch 24 hr (max 4 hr shift), requiring at least two (and preferably three) dedicated and qualified MMOs on every vessel during large scale exercises. Equipment including high quality infra-red and night-vision binoculars should be provided to the MMO for night time observations;
• Ideally, sonar use should be prohibited at night since current mitigation techniques are inadequate to detect marine mammals;
• Because of the impact of adverse weather conditions on the visual detection of marine mammals, active sonar use during unfavourable conditions (at least Beaufort sea state ≥ 4, swell ≥ 2 m, visibility ≤ 1 km) should be prohibited (both night and day). This measure is particularly important at night when visual observations are already hindered;
• Every vessel (irrelevant of geographical area and local conditions) should implement a soft start procedure for every use of the active sonar (where possible);
• There should be a dedicated pre-shoot watch of at least 30 min. In areas where water depths exceed 200 m, the watch should be at least 60 min to help increase the probability that deep-diving species are detected;
• There should be a delay to commencement of soft start for all marine mammal species observed within the EZ. Soft start may not begin until 30 min after the animals depart the EZ or 30 min after they are last seen;
• There should be a shut-down of the active sonar source whenever a marine mammal is seen to enter the EZ. Following a shut-down, a full soft start is mandatory. Soft start should not begin until 30 min after the animals depart the EZ or 30 min after they are last seen;
• Use of dedicated passive acoustic monitoring to detect vocalising species;
• Modification of sonobuoys for passive acoustic detection of vocalising species;
• Use of aerial surveys and ship-based surveys before, during, and after major exercises;
• There should be improved and ongoing biological monitoring before, during and after naval exercises, to provide information on species occurrence, seasonal/temporal distribution, and reaction to active sonar sound;
• Disturbance from other vessels associated with the naval exercise (e.g. carrier ships, submarines etc) should be minimised. Those vessels free to manoeuvre should aim to provide at least 300 m clearance around cetaceans, in consistency with standard recommendations elsewhere;
• Where joint exercises are taking place, all nations should comply with the most stringent mitigation measures, even if these are not those of the Host Nation; and,
• Standardised, timely and public-access reporting should be a requirement.

4. CONCLUSIONS

The guidance currently in use by navies to mitigate potential impacts from sonar on marine mammals throughout the world varies in parameters such as the EZ radius, the marine mammal species included in mitigation, and delay/shut-down procedures. Relatively few aspects of current mitigation have a firm scientific basis and proven efficacy in the field, and there remains a total lack of effective mitigation during night and adverse weather. Recent US court cases have been successful in highlighting a number of these inadequacies. This review highlights a number of shortcomings in the existing mitigation guidance and makes recommendations towards improved standards of protection. Marine mammal mitigation measures should be utilised during all naval exercises by all nations. Where a number of nations are exercising together, the highest level of protection should be maintained. Area closures and avoidance of key marine mammal habitat remain the most effective and precautionary measure for active sonar and other intense naval sound sources. Areas of importance for marine mammals should be explicitly identified and such measures implemented. Given the particular sensitivity of beaked whales to mid-frequency active sonar, all navies have a responsibility to conduct their activities in a way that limits potential impacts on those species.

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MITIGATION	Australia	Canada	France	Italy	NURC	Canary Islands	UK	Hawaii	SoCAL	RIMPAC 2006	NDE I, 2006	NDE II, 2007
Selection of area	Y	N	Y	Y	Y	N	Y	N	N	N	N	Y
Buffer zone	Y	N	N	Y	N	N	N	N	N	N	N	N
Coastal exclusion	Y	N	N	N	N	Y	N	Y	Y	Y	Y	N
Det sys/database	Y	Y	N	Y	Y	N	Y	N	N	N	N	N
Pre/post ded. survey	Y	N	Y	Y	Y	N/R	Y	Y	Y	Y	Y	Y
Increased lookout	Y	Y	Y	Y	Y	N/R	Y	Y	Y	Y	Y	Y
Trained observers	N	N	N	N	N	N/R	Y	Y	Y	Y	Y	Y
Weather/sightability	Y	Y	N	N	Y	N/R	Y	Y	N	Y	Y	Y
PAM	Y	Y	Y	Y	Y	N/R	Y	Y	Y	N	Y	Y
Other monitoring	Y	N	N	N	Y	N/R	N	Y	Y	Y	Y	Y
Min source required	N	Y	N	N	Y	N/R	N	N	N	Y	Y	Y
Prop. conditions	N	Y	N	N	Y	N/R	N	Y	Y	Y	Y	Y
Soft start/ramp up	N	Y	Y	Y	Y	N/R	N	Y	N	N	N	N
Delay if cet obs'd	N	N	N	N	Y	N/R	N	N	N	N	N	N
Repeat rampup	N	N	N	Y	Y	N/R	N	N	N	N	N	N
Pwr dn if cet det	N	N	Y	N	Y	N/R	Y	Y	Y	Y	Y	Y
Sonar off if cet det	Y	Y	Y	N	Y	N/R	Y	Y	Y	Y	Y	Y
Exclusion zone	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
All marine mammals	N	Y	Y	Y	N	N/R	Y	Y	Y	Y	Y	Y
Cow/calf pairs	Y	N	N	N	N	N/R	N	Y	Y	N	N	N
Other species	Y	N	N	N	N	N/R	Y	N	N	N	Y	N
Stranding response	N	Y	N	N	Y	N/R	N	Y	N	Y	Y	Y
Reporting	Y	Y	N	N	Y	N/R	Y	Y	Y	Y	Y	Y
EIA	Y	N	N	N	Y	N/R	Y	Y	Y	Y	N	N
Excl. of spec. area	Y	N	N	Y	N	Y	Y	Y	N	Y	Y	Y
Research	N	N	N	N	N	N	N	Y	N	N	N	N

Table 2. Some marine mammal guidance implemented during naval exercises. Y=yes; N=no; N/R=not required. NDE=US National Defence Exemption