# Some Environmental Aspects of Naval Applications

Detailed information and a fundamental understanding of the marine environment will make the difference in operating effective and responsible for-naval purposes.

Over the last decade, international developments (such as the end of the Cold War, peace keeping, terrorist threats) have driven the focus of naval operations towards (very) shallow water. Such an environment is too complicated for most sensors to function well. Detailed knowledge and understanding of key environmental parameters can make the difference in any action at or from sea: there are many recent examples where knowâ€“ledge of the environment is being used for optimising sonar processing (environmentally adaptive sonar).

Making best use of the marine environment is one thing. Doing no damage is another; and this is the aim of most modern navies. Careful monitoring of marine mammals during sonar operations is an example of this.

### (M)REA and BP

A joint requirement for all navies is to have available the Recognized Envirâ€“onmental Picture (REP). However, this can be done in many ways. In collecting all relevant information and translating this to the key parameters needed, tools for (Maritime) Rapid Environmental Assessment (MREA or REA) are being developed. To get this to a more operational level, we refer to Battlespace Preparation (BP). There are many elements that can be part of the REA. Some examples are a standard meteorological forecast, detailed wave and surf modelling, inversion techniques to estimate propagation parameters for sonar performance prediction and ensemble modelling and forecast of ocean currents. All examples come along with remote sensing and in situ data collection (by ship, buoys, AUVs, etc.) for ground truth or for assimilation.

REA exercises are held periodically; for example, this spring in the Mediterranean Sea. The exercise is co-ordinated by the NATO Undersea Research Centre, together with the Netherlands Defence Academy, TNO and many others. New techniques tested during this exercise will be reported later.

### Marine Mammal Risk Mitigation

Operation of active sonar can disturb marine mammals. There are a limited number of well-documented cases where the stranding of whales (mostly beaked whales) can probably be related to sonar exercises. Many modern navies have initiated research to collect information necessary to prevent any future incidents. Understanding of the mechanisms involved is increasing quickly. The most important information on marine mammals required for giving good advice to sonar users are the distribution, behaviour and hearing sensitivity of the mammals. To improve this knowledge, NL/TNO focuses on the following four items to contribute to safe sonar operations.

### Acoustic Monitoring

A dedicated towed array (the Delphinus) for acoustic detection of marine mammal sounds has been developed. The array, which consists of 18 hydrophones, has been tested and improved during three trials at sea in 2004 (Biscay), 2005 (Mediterranean) and 2006 (Vestfjorden). The related signal-processing chain provides a real-time display of marine mammal sounds that are detected. These sounds can be played back for classification purposes. Fully automated classification is currently a promising research topic. This array can be used to collect acoustic information on marine mammals 24 hours a day.

### Visual Monitoring, Identification and Registration

In support of visual as well as acoustic observations, software is being developed for Identification and Registration of Marine Animals (IRMA). Naval observers can use this software to collect visual observations and store them in a local version of the software (laptop or PDA) that will later be fed into a central database in order to get an overview of the distribution of marine mammals in the ocean.

### Sonar Support

The software package SAKAMATA is being developed to support any active sonar operation. SAKAMATA (the Japanese name for a killer whale) can be used at sea or in the planning stage of a sonar exercise. Its function comprises 4 steps:

1.place a platform and sonar at any particular position at sea at any given date; information from a worldwide database can be

used, as can actual measurements
2.use a database to identify which marine mammals are expected in this area; these mammals are grouped together according to their hearing sensitivity (using all currently available knowledge)
3.assess the received sound level for all mammals with a dedicated sound-propagation model
4.advise mitigating measures, such as estimated stand-off ranges, and a ramp-up scheme for gradually increasing the sound level of the sonar system and taking into account the hearing sensitivity and swimming speed of all mammals, thus preventing any unwanted sound level at the position of the mammal.

### Controlled Exposure Experiments

Currently available knowledge is one of the limitations of any risk management tool. There is still much uncertainty about marine mammal response to actual sonar sounds. In this respect, there is an international need for studying the behaviour of animals that are carefully exposed to a low-to-moderate amount of sonar sounds. Some animals can be studied in captivity, but it is also important to study wild animals. Therefore, in a combined international effort, FFI (NO), SMRU (UK), TNO (NL) and WHOI (USA) are investigating the behaviour of tagged killer whales carefully exposed to sound.

### Geospatial (GIS/AML) Aspects

Both elements â€“ as discussed above, REA (Figure 1) and mammal risk mitigation (Figures 2â€“4) â€“ provide clear examples for data to be presented in a geographical context. It appears that there is a trend for REA to incorporate dynamic data (4D fields); for example, in forecasted fields for water currents or sound propagation. For military use, the extracted key parameters are envisaged for presentation in a so-called additional military layer (AML).

### Concluding Remarks

Understanding the marine environment makes all the difference in operating effectively and responsibly. International collaboration is a key issue, both in research progress and in useful and constructive regulation of sound production worldwide.

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