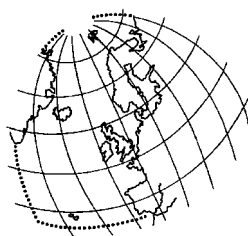


**Convention-wide
Practices and Procedures
in relation to marine dumped chemical
weapons and munitions
(2004 Update)**



**OSPAR Commission
2004**

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention") was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l'Espagne.

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1. INTRODUCTION

As part of a broader overview of the issue of dumped conventional and chemical munitions in the OSPAR area, in response to a request by OSPAR (OSPAR 00/20/1, §10.15), Ireland has prepared the following assessment of the practices and procedures of Contracting Parties in relation to marine dumped chemical weapons and munitions. In order to collate the relevant information to complete this task, a questionnaire (attached as Appendix I) was circulated to Contracting Parties to gather information on the following three key topics:

- a. Reporting, Recording and Assessment of Encounters with Marine Dumped Conventional and Chemical Munitions;
- b. Guidelines for Fishermen and Other Users of the Sea and its Coastline; and
- c. Surveillance and Management Practices.

Observers and NGOs were also circulated with the questionnaire and invited to comment.

Of the 12 coastal states bordering the Convention area, replies were received from 11 (Table 1). The following assessment is laid out in accordance with the three topics outlined above.

Reporting, Recording and Assessment of Encounters with Marine Dumped Conventional and Chemical Munitions (Table 1).

All of the 11 Contracting Parties that responded to the questionnaire have formal systems in place for the reporting of encounters with marine dumped conventional and chemical munitions (Table 1). The authorities to which such incidents are reported range from the police to the coast guard and Navy, and in some cases directly to dedicated munitions recovery services. Fishermen and other users of the sea are informed of the reporting procedures by a number of means, e.g. marine notices, brochures, newsletters etc.

Many of the Contracting parties indicated that there were formal procedures for recording and assessment of encounters – generally information is recorded on the location, date, time, description of the object etc. – and for follow-up procedures. However, only Sweden provided information on the steps taken in the event of an encounter with chemical weapons (Appendix II).

Only two Contracting Parties indicated that there have been reported encounters with munitions (chemical or conventional) in the OSPAR Convention area in the last 10 years. In the period 1995-2000 a total of 11.3 tonnes of conventional munitions have been encountered by fishermen and reported to the authorities in the German state of Lower Saxony. An average of 10 conventional explosives have been located annually by Dutch fishermen over the last decade, and destroyed. Swedish and Danish fishermen have recovered quantities of chemical munitions from the Baltic over the past several decades.

The remaining seven Contracting Parties (Ireland, Belgium, France, UK, Portugal, Spain and Norway) indicated that there was ‘no information’ available on reported incidents (i.e. date, location, details etc.). It is unclear whether this reflects the fact that there have been no incidents reported in these countries or if such information is either unavailable or unrecorded. Thus, whilst there are formal procedures in place for reporting encounters, these procedures do not go as far as maintaining easily accessible central records of historic incidents.

2. GUIDELINES FOR FISHERMEN AND OTHER USERS OF THE SEA AND ITS COASTLINE (TABLE 2)

Four of the 11 Contracting Parties (Portugal, Spain, Norway and Belgium) that responded to the questionnaire have no specific guidelines available for fishermen on how to deal with conventional and chemical munitions caught at sea. Of the remaining countries, the information available in guidelines varies considerably (Table 2).

The French (Service Hydrographique et Oceanographique de la Marine, 2000), Dutch (Interdepartementale Coördinatiecommissie voor Noordzee-aangelegenheden, 1991) and Irish (Department of the Marine and Natural Resources, 2001) guidelines make no specific reference to chemical weapons and the associated risks. The UK (UKHO, 2001) and Swedish (Kustbevakningen – Naturvårdsverket, 1994) guidelines focus on the risks associated with a specific chemical agent, i.e. respectively, phosphorus devices and mustard gas. No other chemical agents are considered. Both the German (Seeberufsgenossenschaft, 1992, 1994) and Danish¹ guidelines deal with a range of chemical agents.

The Danish, Dutch and Swedish guidelines give information regarding the location of possible dumpsites and/or high risk/prohibited areas where chemical weapons and munitions may be encountered. The majority of the remaining guidelines refer the users to nautical charts and sailing directions for the co-ordinates of high risk/prohibited areas.

Physical descriptions of various types of ordnance (Germany, Sweden, Netherlands and Denmark), information on the various chemical agents (Denmark, Germany and Sweden), and first aid procedures in the event of contact with such agents (Denmark, Germany and Sweden) are only provided in some countries.

Contracting parties indicated that there are no specific guidelines available to users of the coastline (e.g. recreational) in the event of encounters with beached munitions. Those available for fishermen are also applicable to such incidents.

3. SURVEILLANCE AND MANAGEMENT PRACTICES (TABLE 3)

There is only limited ongoing monitoring and/or once-off assessments of dumpsites containing conventional and chemical munitions in the OSPAR Convention area. Only a handful of the recorded dumpsites (DUMP 00/6/1) have been subject to assessments. In at least some of the situations where assessments have been carried out, the need for further monitoring has been identified.

Only two Contracting Parties (Netherlands and Belgium) currently have ongoing monitoring/surveillance programmes in place at munitions dumpsites (See Table 3). The Dutch authorities survey two conventional dumpsites annually and remove/destroy ammunition found outside the safety zone. Sediment samples from the Belgian Paardenmarkt site are analysed at three-year intervals. A third country, Spain, conducts occasional surveys at dumpsites.

Assessment of conditions at chartered dumpsites has been undertaken in the past by a number of Contracting Parties in the OSPAR Convention area. The most recent of these were a comprehensive site evaluation at the Paardenmarkt site off the Belgian coast (OSTC, 2002) and an investigation of scuttled ships loaded with chemical ammunition in the Skagerrak (Tørnes *et al.*, 2002). An outline of all recent site investigations in the OSPAR area is attached as Appendix III.

In response to a query in relation to mechanisms within Contracting Parties to assess the risks associated with seabed activities in the vicinity of dumped conventional and chemical munitions (other than fishing), some respondents indicated that it is unlikely that activities would be permitted in the vicinity of such areas. Others indicated that intensive surveillance work (including sonar surveys) must be carried out to allow assessment of the risks and to minimise or eliminate the risk of disturbing munitions. There are no specific protocols available to assess the risks associated with activities in the vicinity of dumpsites.

Little consideration has been given by Contracting Parties to methods to recover and/or make safe dumped chemical weapons and munitions. The consensus of scientific opinion is that

¹ The Danish guidelines were used as a model for the template provided by the HELCOM CHEMU working group (HELCOM, 1995) to Contracting Parties for elaboration of national guidelines for fishermen on how to deal with caught chemical weapons.

munitions on the seabed present no risk to human health or the marine environment if they are left undisturbed. Recovery of dumped munitions is a costly and highly risky operation that could result in the release of large amounts of toxic compounds into the environment – and may even result in the loss of life.

A notable exception is the recently published evaluation of the Paardenmarkt site off the Belgian coast (OSTC, 2002). The study of the site examined the options for making safe (sand suppletion and construction of an island over and around the dumpsite) and recovering the munitions. It concluded, however that the best option was to leave the dumpsite untouched and to carry out regular monitoring.

4. CONCLUSIONS

Although there are systems in place in most countries to record encounters with dumped chemical weapons and munitions, such records are not centrally maintained and/or easily accessible. A framework for regular reporting of encounters with marine dumped conventional and chemical munitions (OSPAR, 2003) has been adopted by OSPAR (OSPAR 03/17/1, §4.32).

The information contained in guidelines produced by Contracting Parties for fishermen and other users of the sea varies considerably between countries. In order to ensure that sufficient information is available to fishermen who may encounter dumped chemical weapons and munitions a set of draft OSPAR guidelines is currently being considered (EIHA 03/2/5).

Given the number of dumpsites recorded in the OSPAR overview of dumped weapons (EIHA 03/2/7) there has been relatively little monitoring to date. Where monitoring has taken place the need for further monitoring has been identified. The requirement for further site assessments and ongoing monitoring may need to be considered by Contracting Parties.

Table 1. Reporting, recording and assessment of encounters with marine dumped chemical weapons and munitions in the OSPAR Convention area. (The numbers refer to the questions in the attached questionnaire – Appendix I).

Contracting Party	Reporting System (1.1)	Reporting System Communicated (1.2)	Procedure for Recording & Assessment (1.3)	Follow-up procedures (1.4)	Encounters recorded in last 10 years (1.5)	References
Belgium	Yes	Yes	No	No info	No info	
Denmark	Yes	Yes	Yes	No info	None	
France	Yes	Yes	Yes	Yes	None known	1, 2
Germany	Yes	Yes	Yes	Yes	11.3 tonnes (1995-2000)	3
Ireland	Yes	Yes	Yes	Yes	Not co-ordinated	4
Netherlands	Yes	Yes	Yes	Yes	10 conventional per annum	5
Norway	Yes	No	No	No info	No info	
Portugal	Yes	Yes	No	No	None	
Spain	Yes	Yes	Yes	Yes	Not co-ordinated	
Sweden	Yes	Yes	Yes	Yes	None	6
United Kingdom	Yes	Yes	Yes	Yes	No info	7, 8

No response to the questionnaire was received from Iceland.

References:

1. Service Hydrographique et Océanographique de la Marine, 2000
2. Préfecture Maritime de la Méditerranée, 2000
3. Information by Niedersächsisches Umweltministerium.
4. Department of the Marine and Natural Resources, 2001
5. Interdepartementale Coördinatiecommissie voor Noordzee-aangelegenheden, 1991
6. Kustbevakningen – Naturvårdsverket, 1994
7. UKHO, 2001
8. Maritime & Coastguard Agency, 1999

Table 2. Information contained in national guidelines for fishermen on how to deal with chemical weapons and munitions caught at sea.

Contracting Party	Guidelines Available	Refer Chemical Weapons to	Locations	Physical Description	Description of Chemical Agents	First Aid	Notes	References
Belgium	No	-	-	-	-	-		-
Denmark	Yes	Yes	Yes	Yes	Yes	Yes	i	
France	Yes	No	No	No	No	No		1, 2
Germany	Yes	Yes	No	Yes	Yes	Yes		3, 4
Ireland	Yes	No	No	No	No	No		5
Netherlands	Yes	Yes	Yes	Yes	No	No	ii	6
Norway	No	-	-	-	-	-		
Portugal	No	-	-	-	-	-		
Spain	No	-	-	-	-	-		
Sweden	Yes	Yes	Yes	Yes	Yes	Yes	iii	7
United Kingdom	Yes	Yes	No	No	No	No	iv	8, 9

Notes:

- i. The Danish guidelines were used as a template for the development of guidelines by HELCOM member states – through the CHEMU working group (HELCOM, 1995).
- ii. The Dutch guidelines contain descriptions of the various devices but do not differentiate devices that may contain chemical agents.
- iii. The Swedish guidelines focus specifically on Mustard gas bombs and provide descriptions of specific bomb types.
- iv. The guidelines available for UK fishermen mention only phosphorus devices. The guidelines do not provide descriptions of the various types of munitions but refer to a chart where such information is displayed.

References:

1. Service Hydrographique et Océanographique de la Marine, 2000
2. Préfecture Maritime de la Méditerranée, 2000
3. Seeberufsgenossenschaft, 1992
4. Seeberufsgenossenschaft, 1994
5. Department of the Marine and Natural Resources, 2001
6. Interdepartementale Coördinatiecommissie voor Noordzee-aangelegenheden, 1991
7. Kustbevakningen – Naturvårdsverket, 1994
8. UKHO, 2001
9. Maritime & Coastguard Agency, 1999

Table 3. Surveillance and Management Practices in Relation to Dumped Chemical Weapons and Munitions in OSPAR member states. (The numbers refer to the questions in the attached questionnaire – Appendix I).

Contracting Party	Surveillance/Monitoring Programme (3.1)	Past Monitoring (3.2)	Consideration of Methods to Make Safe/Recover (3.4)	Notes	References
Belgium	Yes	Yes	Yes	i	1
Denmark	No	No	Yes		
France	No	No	No		
Germany	No	Yes	Yes		2, 3
Ireland	No	No	No		
Netherlands	Yes	Yes	Yes	ii	
Norway	No	Yes	No		4
Portugal	No	No	No		
Spain	Occasional	Yes	No		
Sweden	No	Yes	No		
United Kingdom	No	Yes	Yes		5

Notes:

- i. The Paardenmarkt site is monitored approximately every three years (heavy metals, yperite, TDG, Clark and TOC in sediments; toxicology).
- ii. Two known conventional weapons dumpsites off the Dutch coast are surveyed yearly in order to remove/destroy ammunition found outside the safety zone of these sites.

References:

1. OSTC, 2002
2. Information by Niedersächsisches Umweltministerium.
3. Rapsch and Fischer, 2000
4. Tørnes et al., 2002
5. SOAEFD, 1996

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- Department of the Marine and Natural Resources, 2001. Marine Notice No. 16 of 2001. (i. Explosives picked up at sea in trawls or sighted; and ii. The removal of explosive items from wrecks). DoMNR, Dublin.
- HELCOM, 1995. Final Report of the ad hoc Working Group on Dumped Chemical Munitions. Attachment III - HELCOM Guidelines to be used by the Contracting Parties when elaborating National Guidelines for fishermen on how to deal with caught chemical weapons – Fisheries and Warfare Agents, Preventive Measures and First Aid. (HELCOM CHEMU) HELCOM 16/10/1.
- Interdepartementale Coördinatiecommissie voor Noordzee-aangelegenheden, 1991. Bijstands - En Bijdrageregling Opgeviste Explosieven.
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- OSPAR, 2003. OSPAR Framework for Reporting Encounters with Marine Dumped Chemical Weapons and Munitions. Biodiversity and Dumped Material Series. Publication No. 186.
- OSTC, 2002. Scientific Support Plan for a Sustainable Development Policy – Paardenmarkt Site Evaluation. OSTC Project Nr. MN/02/88. Federal Office for Scientific, Technical and Cultural Affairs (OSTC).
- Prefecture Maritime de la Mediterranee, 2000. Arrete Prefectoral No. 69/2000. Precisant la conduite a tenir en cas de decouverte ou de reperege de mines ou d'engins dangereux.
- Seeberufsgenossenschaft – Ship Safety Division, Hamburg, 1992. "Merkblatt über Munitionsfunde auf See" (Instructions Concerning Munitions Finds at Sea) of 26 June 1992.
- Seeberufsgenossenschaft – Ship Safety Division, Hamburg, 1994. "Merkblatt über das Verhalten bei Kampfstoffvergiftungen auf Fischereifahrzeugen" (Instructions Concerning Actions to be Taken in Case of Poisoning with Warfare Agents on Fishing Vessels) of 30 September 1994.
- Service Hydrographique et Oceanographique de la Marine, 2000. Guide du Navigateur, Vol 3. Reglementation Nautique.
- Tørnes J.A., Voie Øyvind A, Ljønes, M., Opstad A.M, Bjerkeseth, L.H. and Hussain, F., 2002. Investigation and risk assessment of ships loaded with chemical ammunition scuttled in Skagerrak. Forsvarets forskningsinstitut.
- UKHO, 2001. Annual Notice to Mariners Number 6 – Former mine danger areas: Swept routes and instructions regarding explosives picked up at sea. UK Hydrographic Office.

APPENDIX 1: CHEMICAL WEAPONS QUESTIONNAIRE

1) Reporting, Recording and Assessment of Encounters with Marine Dumped Chemical Weapons and Munitions.

1.1

a) Is there currently a system in place whereby fishermen and other users of the sea and its coastline can report encounters with chemical weapons and munitions?

Yes _____ No _____

b) To what national authority are such encounters reported?

1.2

Through what means is the reporting procedure communicated to fishermen and other members of the public (e.g. fishermen's organisations, trade papers)?

1.3

a) Once an encounter has been reported is there a formal procedure for recording, and assessment of, such incidences?

Yes _____ No _____

b) What national authority is responsible for recording, and assessment of, encounters with marine dumped chemical weapons and munitions?

c) Outline the reporting and assessment procedure/system. For example, what information is recorded (location, description of item etc.)? If possible please provide an example of a logged incident.

1.4

Please provide information on the follow-up procedures for such incidences. For example, site visit if the incident relates to a beached object.

1.5

Please provide a summary, if available, of all incidents recorded over the last 10 years – include number, type and location information.

2) Guidelines for Fishermen and Other Users.

2.1

a) Is there currently a set of national guidelines available for fishermen on how to deal with chemical weapons and munitions caught at sea – other than simply reporting such finds to the relevant authority.

Yes _____ No _____

b) If yes, please provide a copy of the guidelines.

c) If a copy of the guidelines is not available please provide a summary of the topics covered (e.g. description of agents, First Aid procedures).

d) Do the guidelines include co-ordinates for areas that are considered to be of high risk or prohibited to fishing activity?

Yes _____ No _____

If yes, please provide these co-ordinates.

e) What national authority is responsible for producing/updating and distributing these guidelines?

f) How are these guidelines distributed to fishermen (e.g. through fishermen's organisations)?

2.2

a) Is there currently a set of national guidelines available for users of the sea and its coastline, other than fishermen?

Yes _____ No _____

b) If yes, please provide a copy of the guidelines.

c) If a copy of the guidelines is not available please provide a summary of the topics covered (e.g. description of agents, First Aid procedures).

d) What national authority is responsible for producing/updating and distributing these guidelines?

e) How are the guidelines disseminated to the members of the public?

3) Surveillance and Management Practices

3.1

a) Is there currently a monitoring/surveillance programme in place for dumpsites containing chemical weapons and munitions?

Yes _____ No _____

b) If yes, please name the authority responsible for the programme.

c) Outline the details of the monitoring/surveillance programme, e.g. frequency of monitoring, parameters examined, etc.

3.2

a) Has any monitoring taken place at the dumpsites in the past.

Yes _____ No _____

b) If yes, please provide the details and, if available, the outcome of the monitoring.

3.3

a) What mechanisms, if any, exist to assess the risks associated with seabed activities, other than fishing, in the vicinity of dumped chemical weapons and munitions?

3.4

a) Has there been any consideration/investigation of methods to recover and/or make safe marine dumped chemical weapons and munitions?

Yes _____ No _____

b) If yes, please outline what methods/technologies have been evaluated. If possible please provide literature relating to these methods/technologies.

APPENDIX II: SWEDISH PREPAREDNESS FOR ACTIONS AGAINST FINDS OF CHEMICAL WARFARE AGENTS

Swedish preparedness for actions against finds of chemical warfare agents

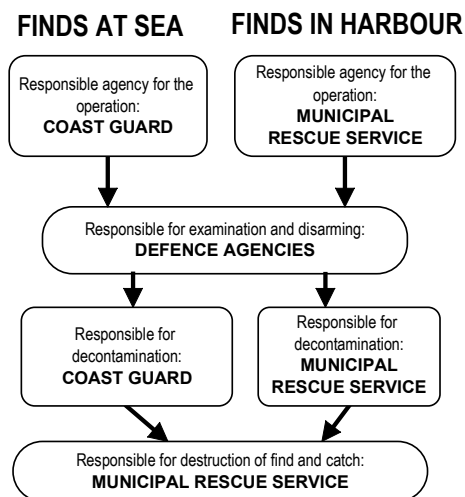
Responsibility

Actions against finds **at sea** of chemical warfare agents are classified as emergency response (“rescue service”). The **Coast Guard** is responsible for such operations and the subsequent decontamination activities. The responsible organisations **in harbours** for such operations are the **municipal authorities** (fire brigades).

Examination of finds in order to ascertain if they are warfare items is performed by **defence agencies**. The **National Environmental Protection Agency** has the overall responsibility, as the supervisory authority, for destruction of finds and contaminated catch. The municipalities have the operational responsibility for these actions. Actions concerning safety of life at sea shall be given priority. Such actions are conducted by the **National Maritime Administration** via the Maritime Coordination Centres.

Steps of an operation

1. Cooperative bodies are alerted according to routines outlined in the Coast Guard's Emergency Response Manual. Cooperation is always established with Defence Agencies. If the find is suspected to contain explosives it must not be moved until it has been examined by defence personnel.
2. A Coast Guard vessel is commissioned for a first action involving transport of personnel, warning of seafarers and necessary assistance to fishing vessels.
3. If the affected fishing vessel can run by its own engines it is primarily directed to a suitable decontamination anchorage
4. Coast Guard environmental protection vessels are utilised for decontamination activities in these locations. Vessels are commanded for transport of disarming personnel and safety equipment. The vessels carry safety equipment for own personnel.
5. The Coast Guard has the overall responsibility for the decontamination regardless of whether performed by defence or own personnel. A found bomb is brought to land by the defence personnel.
6. Decontamination waste, discarded catch etc. is brought to land and taken care of according to Swedish legislation on environmentally dangerous waste and be transferred to the responsible municipality.
7. A report on the operation is elaborated by the Coast Guard District. Cooperative agencies should give necessary contributing information to the report.
8. Emergency instrumental monitoring and sampling of chemical warfare agents are performed by the Defence.



APPENDIX III: OVERVIEW OF RECENT DUMPSITE ASSESSMENTS

A number of OSPAR Contracting Parties have carried out recent site assessments of chemical and conventional weapons dumpsites in the OSPAR Convention area. The following is a brief synopsis of these.

Belgium

The Paardenmarkt dumpsite, 1-2km off the coast of Belgium, extends over 3 km². After the First World War approximately 35,000 tonnes of munitions (one third of which consists of chemical weapons) was dumped in very shallow water (1.5-5.5m). In 2001, a two-year evaluation of the Paardenmarkt site combining geophysical, geochemical, sediment-dynamics, biological, engineering and ecological expertise, was concluded. The objectives of this study included:

- *'Detailed analysis and scientific evaluation of all available data related to the area, in order to make a correct evaluation of the actual dimension of the encountered problems';*
- *'Analysis of possible strategies of scientific research with respect to the dumped munitions and natural setting, and the possible perspectives for continuous monitoring of the area';*
- *'Re-evaluation of the present-day 'status quo' policy and the evaluation of different options for possible engineering solutions, including a nature conservation area'; and*
- *'Evaluation of possible strategies related to communication and information transfer in order to meet public concern, and further expansion of the international dimension'.*

The final report of the study (OSTC, 2002) included a series of conclusions and recommendations for future policy and research.

- The munition is not yet too heavily corroded. The oxygen-poor conditions related to the presence of biogenic gas are expected to slow down the corrosion process. It could take hundreds of years, possibly 1000 years, before all of the munition has corroded completely.
- Many factors remain unknown in relation to the dumpsite. In order to allow a correct evaluation of the dumpsite, *in-situ* measurements and monitoring are indispensable.
- In order to evaluate the actual condition of the munitions and their state of corrosion, it is necessary to recover a (representative) number of shells. The recovered munitions can be used to model the degradation process.
- A regular monitoring programme should be set up as soon as possible. Geochemical sampling should be started with high priority. The analysis of water and soil samples can give information on the actual state of potential leakage and detoxification processes. Additional biological assays should be carried out in order to verify the degree of ecological damage.
- Seabed monitoring is crucial to map the erosion/accumulation processes and detect possible objects on the sea floor.
- Although it is unlikely that munitions shells may be easily displaced, the possibility of Yperite lumps reaching the shore cannot be ruled out entirely. Therefore, it may be useful to keep a chemical watch (e.g. chemical sensors) between the dumpsite and the beach as a basic safety measure.
- Together with the *in-situ* data and monitoring, further research is needed. Important knowledge gaps include the behaviour of toxic agents; their long-term environmental effects (also on seafloor-related organisms); and risk assessment modelling.
- If monitoring indicates potential surfacing of the munitions (due to erosion of the sediment cover) the construction of an artificial island should be seriously considered.

- Recovery of the dumped munitions would be a costly and highly risky operation, and may cause the release of unverifiable amounts of toxic compounds into the environment. Unless there is acute danger involved recovery is therefore not considered to be the best solution. The best option, therefore, seems to be to leave the dumpsite untouched and to carry out regular monitoring.

Germany

A survey of seven dumpsites in the North Sea, off the coast of the Federal German state of Lower Saxony, was carried out in 1990-92 (Rapsch and Fischer, 2000). Most of the munitions were covered with sediment, therefore, in addition to side scan sonar and sediment echography, a seafloor sled with inductive coils was used to locate munitions. Sediment and water samples from the dumpsites were analysed and an ecotoxicological assessment was carried out.

The total amount of dumped munitions within the dumpsites was estimated to be 10,000 tonnes of heavily corroded conventional munitions. No evidence of chemical weapons was found and the results of the ecotoxicological assessment of the dumpsites concluded that the munitions did not constitute a threat to the marine environment.

The study concluded that the dumped munitions did not represent a risk to shipping. However, due to the frequency at which fishermen were catching munitions, a pilot project was established to provide financial compensation to fishermen catching and handing over such munitions. So far a total of about 1.2 tonnes of munitions have been recovered by fishermen, thus breaking the cycle of catching and dumping.

Norway

The main dumpsite for munitions from World War II in Norwegian waters is in the Skagerrak, in an area of 14 km x 14 km, 25 nautical miles south-east of the city of Arendal. Thirty-six ships containing conventional and chemical weapons were scuttled in 6-700m of water. A site evaluation was carried out in 1989 by the Norwegian Defence Research Establishment (Forsvarets forskningsinstitutt). Fifteen shipwrecks were located using sidescan sonar. Five wrecks were investigated in greater detail. The corrosion status of the surface and cargo of these ships were examined using a remote-operated vehicle (ROV) with a television camera. Most of the shipwrecks and their cargo (bombs) were intact, but showed minor signs of corrosion. However, a small number of ships were seen to have broken into several parts and were spread out. Mustard gas, tabun and thiodiglycol were not detected in water samples collected close to where metal corrosion of bombs or the ships occurred.

A further investigation and risk assessment of the Norwegian Skagerrak site (described above) was carried out by the Norwegian Defence Research Establishment in 2002 (Tørnes *et al.*, 2002). The assessment involved inspection of the condition of four wrecks and their cargo; analysis of sediment and water samples for chemical warfare agents, degradation products and elemental arsenic; and a risk assessment of the situation and theoretical a chemical release scenario.

Visual examination of the site (by ROV) showed the following:

- One of the four wrecks was in several parts, the others were intact;
- Munitions were observed outside the damaged wreck;
- Munitions were observed in the holds and on the decks of the intact wrecks;
- Some ammunition was corroded and the content lost;
- The wrecks had caught fishing nets; and
- There was abundant sea-life in the vicinity of the wrecks.

Chemical analysis revealed:

- No chemical warfare agents or related compounds were identified in water samples;
- Sulphur mustard and degradation products were identified in a number of sediment samples;
- Arsenic containing compounds were found in many sediment samples; and
- The nerve agent Tabun was not found in sediment samples.

The recommendations arising out of the assessment were as follows:

- The remaining wrecks (possibly 21) should be located;
- The ban on trawling in the area should remain in place;
- The ammunition should not be brought to the surface;
- Further studies should be carried out on the effects of arsenic and other chemical warfare degradation products on marine organisms; and
- Further wreck inspections should be conducted within 10 years.

Sweden

In 1992 the Swedish Coast Guard participated in a sampling operation with the National Maritime Administration and the Geological Survey of Sweden at an area off the West Coast of Sweden. The target area contains a number of wrecks with various types of munitions (including chemical). A group of five wrecks, probably tied together, were examined). Sediment samples taken in the area 20-30m from nearest wrecks were found to contain 'very low' concentrations of mustard gas. The following conclusion was made: "*The number of samples taken was not large enough and the geographical positions of the sampling sites not wide enough to be statistically relevant for any general conclusions*".

United Kingdom

One of the most heavily used areas for dumping of conventional and chemical warfare munitions is the Beaufort's Dyke, a 200 to 300 meters deep trench located between Scotland and Northern Ireland. It has been estimated that over 1 million tons of conventional and chemical munitions have been dumped in the Beaufort's Dyke since the early 1920s (Hart, 2000).

A detailed survey of the Beaufort's Dyke disposal site was undertaken by the Marine Laboratory, Aberdeen (SOAEFD, 1996). Side-scan sonar, magnetometer underwater video and pulse induction surveys were undertaken, to confirm the distribution and densities of dumped munitions in the survey area.

The results of this study showed that munitions dumping operations in the Beaufort's Dyke have not resulted in chemical contamination of the surface sediments or the edible flesh of commercially exploited fish or shellfish. It also clearly showed munitions and munitions-related materials at high densities outside the charted dumpsite. The condition of the dumped munitions was not assessed.

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