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Guidelines for Controlling the Vectors of Introduction into the Mediterranean of Non-Indigenous Species and Invasive Marine Species

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Draft Guidelines for controlling the vectors of introduction into the Mediterranean of non-indigenous species and invasive marine species

INTRODUCTION

The Mediterranean is susceptible to biological invasions because of its emplacement between the Atlantic, Pontic and Erythrean regions, busy maritime traffic, and lagoons and bays that are crowded with fish and shell-fish farms. However, the greatest influx of invaders resulted from the opening of the Suez Canal in 1869 that allowed entry of Indo-Pacific and Erythrean biota. Alien macrophytes, invertebrates and fish are found in many coastal habitats in the Mediterranean. Some invaders have outcompeted or replaced native species locally, some are considered pests or cause nuisance, whereas other invaders are of commercial value. The rate of marine biotic invasions has increased in recent decades; collectively they have significant ecological and economic impacts in the Mediterranean.

The Mediterranean has fewer species than the subtropical eastern Atlantic. This faunal impoverishment has been attributed to the sea's comparatively recent recolonisation after the Messinian crisis, to pleistocenic climatic fluctuations and to its comparative oligotrophy. It has been suggested that the high temperature and salinity prevailing in the southeastern Mediterranean made it unsuitable for many Atlantic-Mediterranean species. The present-day Mediterranean fauna is not truly representative of the water temperature, since the tropical Atlantic species are mostly barred and their niche is only partially occupied, with many of the taxa present presumably at the limit of their ecological tolerance, leaving parts of the Mediterranean vulnerable to invasion. Consequently, when thermophilic species arrived, there were few ecological obstacles to prevent their successful implantation. An increase of the seawater temperature would allow tropical invasive species to gain a distinct advantage over the native fauna.

Shipping is considered the largest single vector for the movement of alien marine species across the globe and has been implicated in the dispersal of numerous neritic organisms, from protists and macrophytes to fish. Though in the Mediterranean, vessel-transported aliens lag behind the Erythrean invasion in the number of species introduced, it is of great significance. Following the opening of the Suez Canal in 1869, the Mediterranean regained its prominence as a hub of commercial shipping, and ever more so since the development of the Middle Eastern oil fields, and the ascendance of the southeast Asian economies. It is estimated that about 220,000 vessels of more than 100 tons cross the Mediterranean annually, carrying 30% of the international sea borne trade volume, and 20% of the petroleum. With some 2000 merchant ships plying the Mediterranean at all times, transfer of biota stemming from the regular operation of ships, is significant.

It is seldom possible to ascertain the precise means of transmission, as some organisms may be conceivably transported by several vectors, yet it is assumed that port and port-proximate aliens are primarily dispersed by shipping. The transport on the hulls of ships of boring, fouling, crevicolous or adherent species is certainly the most ancient vector of aquatic species introduction. Fouling generally concerns small-sized sedentary, burrow-dwelling or clinging species, though large species whose life history includes an appropriate life stage may be disseminated as well. Ballast (formerly solid, but for the past 130 years aqueous) is usually taken into dedicated ballast tanks or into empty cargo holds when offloading cargo, and discharged when loading cargo or bunkering (fuelling). Ballast water therefore consists mostly of port or near port waters. Water and sediment carried in ballast tanks, even after

voyages of several weeks' duration, have been found to contain many viable organisms. Since the volume of ballast water may be as much as a third of the vessel's deadweight tonnage, it engenders considerable anxiety as a vector of introduction.

The Mediterranean Sea, a hub of commercial shipping lines and encircled by major ports, is susceptible to ship-borne aliens, whether they occur in fouling communities or in ballast. The global maritime trade connections of Mediterranean ports sustain a large-scale dispersal process of both inbound and outbound biota. Shipping is also an important vector for secondary introduction - the dispersal of an alien beyond its primary location of introduction. The widely invasive algae *Sargassum muticum, Caulerpa taxifolia* and *Caulerpa cylindracea* spread across the Mediterranean by ships, fishing boats and recreational craft. Trade patterns ensure that the Mediterranean exports biota as well as imports: The Indo-West Pacific portunid crab *Charybdis hellerii*, an alien present in the eastern Mediterranean since the 1920s, was collected in 1987 in Cuba, and in rapid succession in Venezuela, Colombia, Florida, and Brazil. Transport in ballast tanks is the most probable mode of dispersal since the crab's arrival corresponds with increased coal shipping from Port Drummond, Colombia, to Israel. The presence of two Erythrean aliens, *Alepes djedaba* and *Stephanolepis diaspros*, identified along with four other fish species in a survey of biota in floodable cargo holds and dedicated ballast tanks arriving in Baltimore, U.S.A., from Israel, attest that this is a major pathway for transoceanic dispersal. The movement of ballast water also provides opportunities for the transfer of microorganisms, including pathogens, which exceed concentrations of other taxonomic groups by several orders of magnitudes. Of special concern are possible human pathogens such as the bacteria *Vibrio cholerae* 01 and 0139, agents of human cholera. *Vibrio cholerae* is endemic in the Mediterranean and indeed, a survey of plankton arriving in ballast water in Chesapeake Bay, USA, from the Mediterranean revealed viable *Vibrio* bacteria. The risk of invasion of a new strain is of grave concern given the proximity of some ports to aquaculture facilities and to bathing shores. The increase in shipping-related invasions was noted in a recent series of Atlases that summarized the extant knowledge on 'Exotic species in the Mediterranean' (www.ciesm.org/atlas/). The increase may be attributed to the increase in shipping volume throughout the region, changing trade patterns that result in new shipping routes, improved water quality in port environments, augmented opportunities for overlap with other introduction vectors, and rising awareness and research effort.

Since ballast-mediated bioinvasions into freshwater, estuarine and marine habitats have caused significant economic losses in the past two decades, the International Maritime Organization (IMO) and the shipping industry have concentrated their attention on ways to address that issue. In February 2004 the new International Convention on the Control and Management of Ship's Ballast Water and Sediments was adopted by a Diplomatic Conference. This Convention, a significant environmental achievement, provides a uniform international instrument to regulate ballast water management, though to be effective, the parties to the Convention have to implement it through appropriate national legislation and enforcement. Like an earlier IMO resolution (A.868(20), November 1997) it relies on Ballast Water Exchange (BWE, the replacement of coastal water with open ocean water) to reduce the risk of inoculation. Hull fouling, an important vector in the Mediterranean for the dispersal of both macrophytes and invertebrates, was held in check since the 1970s by the widespread use of biocidal antifouling paints. However, the adoption of an IMO Convention prohibiting the application of TBT-based antifouling paints as of January 2003, may lead to an increase in fouled hulls, and consequently, hull-transferred biota. On the other hand, the abolition of these TBT-based antifouling is necessary, regarding the resulting environment pollution problems.

The Barcelona Convention (1976) and its relevant protocols, initially aimed at reducing pollution, has been updated with the adoption of new protocols. The Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD), that had been adopted in 1995 and came into force in 1999, invites the Contracting Parties to "*take all appropriate measures to regulate the intentional or accidental introduction of non-indigenous species*" (Article 13). In 2003 the United Nations Environment Programme Mediterranean Action Plan (UNEP/MAP) adopted an "Action Plan concerning species introductions and invasive species in the Mediterranean Sea". Action plan paragraph 7 recognizes that shipping is a major vector of introduction into the Mediterranean Sea. Paragraph 23 of the Action Plan strongly recommended that "*Given the importance of shipping-mediated introductions of non-indigenous species in to the Mediterranean, … a regional project be developed to overcome gaps for the Mediterranean countries, and strengthen the capacities of the countries to reduce the transfer of aquatic organisms via ships' ballast water and sediments and hull fouling*".

Market-driven demands for alien fish and shellfish are on the rise with the increasing affluence of Mediterranean countries. This, coupled with the crisis in wild fisheries, has created a surge in development of marine aquaculture (mariculture) farming along the shores of the Mediterranean in the last twenty years. Production of shellfish has increased from 461,000 T in 1992 to 626,080 T in 2001, and two commercially-important shellfish, alien to the Mediterranean, *Crassostrea gigas* and *Ruditapes philippinarum*, were intentionally introduced to the Mediterranean in the 1960s and 1970s, respectively. Though most of the species used in cage farming in the Mediterranean are native to the sea (seabream, seabass, mullets), aquaculture operations are susceptible to stock loss and concern over possible deleterious genetic impact of escaped or released cultured stock. This impact on wild populations has been growing in recent years.

Transport and transplantation of commercially important alien oysters has resulted in numerous unintentional introductions of pathogens, parasites and pest species. Oyster farms have served as gateways into Mediterranean coastal waters for these alien camp-followers. A plethora of algae were introduced with oyster stock from East Asia: *Laminaria japonica, Sargassum muticum, Undaria pinnatifida* have thus been imported into the Mediterranean through negligence. The slipper limpet, *Crepidula fornicata*, an invasive mollusc on the European Atlantic coast and the North Sea is also assumed to have been introduced with oyster farming. Two oyster-parasites, *Mytilicola orientalis* and *Myicola ostreae*, arrived with their host, but are able to settle on other host species in the Mediterranean.

The past decade saw the introduction of European Union and national regulations aiming to control the deliberate importation of aliens and to limit their dispersal. However, mariculture policies, administration and legislation are very diverse with a lack of specific aquaculture policy in most areas, a lack of a centralized administrative framework, and overlapping between authorities. Legislation on introduction and transfers of alien species exists in some countries. In practice the administrative measures to control alien species introductions are still rudimentary and an effective policy of prevention is hardly enforced. Key industry groups, governmental bodies, and even local environmental groups have a poor appreciation of the magnitude of the problem. As a consequence, too often, responses are insufficient, late and ineffective.

Preventing alien species introductions is a task which needs scientific, administrative and political coordination at the regional level. It is in this context that **RAC/SPA** has identified the problem of alien species as one of its major initiatives at the **regional level**. The proposed guidelines draw on and incorporate relevant parts of the most advanced guidelines and codes of practice for the prevention of biodiversity loss caused by alien invasive species.

The proposed guidelines address four substantive concerns of the alien species issues: enhancing knowledge and research efforts; improving understanding and awareness; strengthening the management response; providing appropriate legal and institutional mechanisms. The **goal** of these guidelines is to **prevent further loss of biological diversity due to the deleterious effects of the intentional and unintentional introductions of alien invasive species, while encouraging environmentally-sound and responsible use of the Mediterranean marine environment**. The intention is to assist the Contracting Parties to the Barcelona Convention in implementing the SPA/BD Protocol (Barcelona, 1995) that calls on them to take "*… all appropriate measures to regulate the intentional or non-intentional introduction of non-indigenous or genetically modified species into the wild and prohibit those that may have harmful impacts on the ecosystems, habitats or species*" (Article 13).

I. BALLAST WATERS

1. INTERNATIONAL CONVENTION FOR THE CONTROL AND MANAGEMENT OF SHIPS' BALLAST WATER AND SEDIMENTS, 2004

It is estimated that about 220,000 vessels of more than 100 GRT (Gross Register Tonnage) cross the Mediterranean annually, carrying 30% of the international sea borne trade volume, and 20% of the petroleum (Galil, 2006). With some 2000 merchant ships plying the Mediterranean at all times, the risk of ballast-transported alien species is significant.

In February 2004 the International Maritime Organization (IMO) adopted the International Convention for the control and management of ships' ballast water and sediments. The Convention will enter into force one year after its ratification by at least 30 Parties to IMO controlling at least 35% of the world fleet by tonnage. So far the only Mediterranean countries that ratified it were Spain and Syria.

Once the Convention is ratified, ships will have to meet ballast water management standards that include ballast water exchange standards and performance standards, as specified in the Convention, to prevent, minimize and ultimately eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ballast water and sediments. The performance standards will come into force (subject to ratification) between 2009 and 2016, depending on the size (i.e. ballast water capacity) and construction of the ship. Until those standards come into force the Convention recommends that regional management strategies based on oceanic Ballast Water Exchange (BWE) are developed.

The main objective of the Action Plan concerning species introductions and invasive species in the Mediterranean Sea is "*to promote the development of coordinated measures and efforts throughout the Mediterranean region in order to prevent, control and monitor the effects of species introduction*". It was determined that among the actions required to attain the objectives of the Action Plan at the regional level "*A workshop made up of experienced Mediterranean scientists should convene … that examines the different vectors of non-indigenous species introduction and propose possible control measures for their prevention.*" (Paragraph 21). One of the aims of this workshop is to advise RAC/SPA concerning regional control measurements including "*Guidelines for controlling the vectors of introduction into the Mediterranean of non-indigenous species and invasive marine species*".

It is thus incumbent on us to review the existing scientific research with respect to ballast-transported alien organisms in the Mediterranean, and provide RAC/SPA with recommendations on the following relevant priority issues for the Mediterranean region:

2. BALLAST WATER EXCHANGE IN THE MEDITERRANEAN REGION

Open ocean exchange of ballast water is at present the single widely-practiced procedure relied upon by management to reduce the risk of ballast-mediated bioinvasions. Indeed, it is widely recognized that the BWE standard is appropriate in the **interim** as a management measure. The premise for advocating BWE is that it replaces the entrained coastal species with oceanic plankton species that are ill adapted for survival in near-shore environments. Moreover, where harbours are riverine or estuarine, the osmotic stress of salinity change following BWE is perceived to act as a biocide.

The International Convention decrees (Regulation D-1) that "*ships performing Ballast Water Exchange in accordance with this regulation shall do so with an efficiency of at least 95*

percent volumetric exchange of Ballast Water." "*For ships exchanging Ballast Water by the pumping-through method, pumping through three times the volume of each Ballast Water tank shall be considered to meet the standard described in paragraph 1. Pumping through less than three times the volume may be accepted provided the ship can demonstrate that at least 95 percent volumetric exchange is met*".

It is stated (Regulation B-4) that "A *ship conducting Ballast Water exchange ... shall: whenever possible, conduct such Ballast Water exchange at least 200 nautical miles from the nearest land and in water at least 200 meters in depth*". In cases where the ship is unable to do so, exchange shall be conducted "*as far from the nearest land as possible, and in all cases at least 50 nautical miles from the nearest land and in water at least 200 metres in depth*".

In areas where the distance from the nearest land or the depth does not meet the parameters, "*the port state may designate areas, in consultation with adjacent or other States, as appropriate, where a ship may conduct Ballast Water exchange*" (Reg. B-4.2). The designation of BWE Areas represents an issue underlining the need for regional cooperation and must take into account the guidelines on designation of areas for ballast water exchange (G14).

Nearly the entire Mediterranean lies within 200 nm distance to the nearest shore and much of the internal traffic and most shipping lanes pass within the 50 nm limit.

PROBLEM: Finding areas within the Mediterranean where a ship may conduct BWE given the time and route constraints, yet ensure sufficient dilution while avoiding secondary introduction risk.

RESPONSE: Risk assessment studies – and data on shipping and ballasting patterns, biological surveys and monitoring.

3. INTRA-MEDITERRANEAN VOYAGES

Regulation A-4 concerning Exemptions from the Regulations states: "*A Party or Parties, in water under their jurisdiction, may grant exemptions to any requirements….* ", but an exemption will be granted only if based on "*Guidelines on risk assessment*", and only if it does ".. *not impair or damage the environment, human health, property or resources of adjacent or other states*". IMO currently works towards completion of the risk assessment guideline (G7).

PROBLEM: Are intra-Mediterranean voyages inherently "harmless" (because alien species once settled in one part of the sea, are able to spread through natural means, as well as through other anthropogenic vectors) and therefore should be exempt?

RESPONSE: Risk assessment studies – and data on shipping and ballasting patterns, biological surveys and monitoring.

4. REGIONAL EARLY WARNING SYSTEMS

Regulation C-2 that deals with "*Warnings Concerning Ballast Water Uptake in Certain Areas and related Flag State Measures*" encourages Port States to warn mariners of areas where ships should not uptake ballast water due to outbreaks of harmful aquatic organisms and pathogens. This assumes regional monitoring and communication.

PROBLEM: No regional early warning system exists.

RESPONSE: Port and port-proximate biological surveys and monitoring, combined with a common information system.

5. RECOMMENDATIONS

Taking into account the regional geography, biodiversity, shipping patterns within the Mediterranean and those entering and exiting the sea, it is a given that cooperation within the Mediterranean Sea region is crucial for minimizing the risk of ballast-transported introductions of alien species. Therefore, it is recommended that the RAC-SPA Action Plan encourage the Contracting Parties to sign and ratify the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004, to ensure rapid and harmonized implementation of the Convention and of guidelines developed thereto, and, insofar as it means permit, assist the Contracting Parties in implementing the actions required at the national level, in cooperation with REMPEC and IMO.

Priority at the regional level should be given to establishing the research capacity and financial resources needed for:

- collecting reliable data concerning maritime traffic and ballast water uptake and discharge.
- carrying out biotic baseline surveys for alien species and harmful aquatic organisms and pathogens in major ports using harmonized methodologies.
- gathering information for the identification of potential BWE areas, monitoring and reviewing of designated BWE areas, taking note of the relevant IMO guideline.

- carrying out harmonized risk assessment studies for major ports using appropriate methodologies, taking note of the relevant IMO guideline.
- assessing risk caused by vessel movement within the Mediterranean and from without the Sea.
- Conducting vector-based risk assessment, species-based risk assessment in combination with a pathway-based risk assessment.
- establishing a common regional information 'clearing house' linking data obtained from the traffic and ballast water studies, from the ports' risk assessment studies and the biotic surveys, and forming an early warning system flagging outbreaks of harmful aquatic organisms and pathogens.

II. HULL FOULING

1. BACKGROUND

As with ballast water, species transports with hull fouling is an important vector for species invasions – regionally possibly the dominating introduction vector. When addressing hull fouling, it should be noted that this vector does not refer to sessile organisms only, but also that many mobile species have been transported on ship hulls. Further, fouling organisms are also transported on surfaces inside vessels, e.g. in-tank fouling and fouling in the ships cooling circuit.

Vessels unprotected by anti-fouling paints may gather up to 150 kg of fouling per square metre in less than six months while being at sea. On a very large oil carrier with 40,000 square metres underwater surface, this may total to 6,000 tonnes of fouling. A small amount of fouling may already increase of fuel consumption of up to 40% or more due to the increased resistance to movement. A clean ship can sail faster and with less energy and effective antifouling systems also increase the interdocking time period of the vessel thereby reducing the operational costs. Consequently, the shipping industry developed antifouling systems driven by financial interest.

Compared to the attempts to manage other species introduction vectors, such as ballast water and species imports for aquaculture purposes, little has been done in Europe to manage hull fouling. It is in this context that RAC/SPA has identified the problem of alien species as one of its major initiatives. In the Mediterranean Sea, hull fouling is the prime species introduction vector in shipping which needs to be addressed – at best on a regional approach.

Several initiatives to address hull fouling and biological invasions are currently developing – many of those, focus on unwanted impacts caused by the biocide component of the antifouling paint – rather than aim to reduce the introduction of non-indigenous species, which certainly is a much appreciated "side-effect" when applying antifouling systems. Concern was also expressed that non-organotin vessel paints may not be as effective in preventing organism fouling and may therefore increase the number of species being moved unintentionally with ships. As a result the species invasion rate may increase. It should be noted that newly designed antifouling systems are believed to be as effective as organotin-based paints. Long-term application tests are currently underway. Biocide-free paints, such as silicone-based paints, have also been tested.

The International Maritime Organization (IMO), the United Nations body which deals with shipping, adopted a Convention on Anti fouling Systems (see below). This Convention was prompted by the unwanted impact of harmful organotins, e.g. Tri-butyl-tin (TBT), previously in use as toxic component of antifouling paints. These compounds slowly "leach" into the sea water, killing barnacles and other marine life that have attached to the ship. But studies have shown that these compounds persist in the water, harming the environment and possibly entering the food chain. One of the most effective anti-fouling paints, developed in the 1960s, contains the organotin TBT, which has been proven to cause deformations in oysters and sex changes (imposex) in whelks – thereby threatening marine biodiversity, as reported e.g. from certain European coastal waters.

The harmful environmental effects of organotin compounds were recognized by IMO in 1989. In 1990 IMO’s Marine Environment Protection Committee (MEPC) adopted a resolution which recommended that Governments adopt measures to eliminate the use of anti-fouling

paints containing TBT on non-aluminium hulled vessels of less than 25 metres in length and to eliminate the use of anti-fouling paints with a leaching rate of more than 4 µg of TBT per day. The 1990 IMO Resolution is now completed with a mandatory instrument. In November 1999, IMO adopted an Assembly resolution that called on the MEPC to develop an instrument, legally binding throughout the world, to address the harmful effects of anti-fouling systems used on ships.

1.1 The IMO Convention on the Control of Harmful Antifouling Systems on Ships

The international Convention on the Control of Harmful Antifouling Systems on Ships (AFS Convention) was adopted on 2001. The convention will enter into force 12 months after 25 States representing 25% of the world's merchant shipping tonnage have ratified it[1]. However, the Convention did not enter into force yet.

By 2008, ships either:
(a) shall not bear such compounds on their hulls or external parts or surfaces; or
(b) shall bear a coating that forms a barrier to such compounds leaching from the underlying non-compliant anti-fouling systems.

This Convention applies to ships of all types and sizes (including fixed and floating platforms, floating storage units (FSUs), and Floating Production Storage and Offtake units (FPSOs).

1.2 European Commission

As an interim measure before the IMO Convention on antifouling systems enters into force, an EC regulation (782/2003) on the prohibition of organotin compounds on ships was introduced in 2003. There were concerns with the dates prescribed in the IMO Convention and the Commission has issued an interpretation of the regulation.

The regulation:

- bans the application of TBT antifouling paints on all ships flying flags of EU states from 1/1/2003
- bans the presence of TBT antifouling paints on all ships in EU ports by 1/1/2008 (sealer coats accepted)
- requires surveys and certification for EU flagged vessels coated after 1/1/2003 and for foreign flag vessels when the AFS Convention enters into force

When the IMO AFS Convention comes into force, member states may take action against foreign flag vessels in their ports to which TBT antifouling paints were applied after 1/1/2003, if allowed under their National laws.

1.3 National regulations

Various countries, including some European countries, have issued national regulations on antifouling systems. Most of these refer to the registration of antifouling paints which contain biocides.

USA
Since 2001 a comprehensive Ballast Water and Hull Fouling Management Program for the State of Hawaii is under development. Management options/requirements considered to prevent new organisms from being introduced include periodic cleaning of the underwater

[1] As per March 31, 2007 23 IMO member states with a gross tonnage of 17.06% of the world's fleet ratified the Convention.

surfaces, and effective and environmentally friendly coatings. There are three main components to allow for a useful hull fouling management programme (Scott Godwin, pers. comm.):

- Pro-active measures, i.e. monitoring programmes, risk assessment, awareness raising, education
- Re-active measures, i.e. rapid response programme
- Post-event measures, i.e. management plan

AUSTRALIA
Another comprehensive instrument entitled "National Protocol to Regulate Hull Fouling Organisms" is currently under development in Australia with the aim to reduce the introduction of non-indigenous species via hull fouling. Australia believes that the IMO Convention addresses larger vessels in a sufficient manner. This Australian initiative focuses on smaller ships, i.e. for internationally plying vessels less than 25 meters and apprehended vessels.

2. GOALS AND OBJECTIVES

The goal of this document is to avoid a further change in Mediterranean biological diversity caused by biological invasions. The guideline also intents to assist the Contracting Parties to the Barcelona Convention in implementing the SPA/BD Protocol (Barcelona, 1995) that calls on them to take “all appropriate measures to regulate the intentional or non-intentional introduction of non-indigenous or genetically modified species into the wild and prohibit those that may have harmful impacts on the ecosystems, habitats or species” (Article 13).

The guideline have a general objective to minimise the number of unintentional species introductions associated with hull fouling, to achieve this, seven (see below) specific objectives are targeted.

1. To encourage necessary research and the development and sharing of an adequate knowledge base to address the problems of hull fouling mediated introductions of alien species in the Mediterranean.

2. To increase awareness of hull fouling as a major introduction vector.

3. To technically assist and advise the Mediterranean coastal States, if requested, to ratify the IMO AFS Convention.

4. To encourage the development and implementation of control efforts, such as hull cleaning measures.

5. To encourage the development of a framework for national legislation and regional cooperation to regulate the introduction of hull fouling mediated species introductions, their eradication and control.

6. To design a lead agency, which would have a central responsibility within the government for coordinating the national response to the above issues.

7. To form a national taskforce to develop and implement the proposed guidelines. This national taskforce may be cross-sectoral and multidisciplinary.

This guideline addresses three substantive concerns of the alien species problem:

- enhancing knowledge and research efforts;
- improving understanding and awareness; and
- providing appropriate prevention measures.

Each of the following sections include possible actions for consideration of RAC/SPA and others. It should be noted that these actions may be combined with recommendations resulting from other management approaches aiming to reduce alien species introductions, such as ballast water mediated species introductions and/or species imports for mariculture purposes.

3. KNOWLEDGE AND RESEARCH

An essential element in the campaigns against alien invasive species is the effective and timely collection of information and sharing of data. Sometimes information which may alert management agencies to the potential dangers of new introductions is unknown. Frequently, however, useful information is not widely shared or available in an appropriate format for many countries to take prompt action, assuming they have the resources, necessary infrastructure, commitment and trained staff to do so.

Recommended Actions

1. Develop an adequate knowledge base (including, but not limited to the dimension of the hull fouling situation, evaluation of potential control options) as a primary requirement to address the problems of hull fouling mediated introductions, and to make this easily available through an Internet-based database.

2. Develop, review and update a list of known alien invasive species which are likely to become dispersed in the hull fouling of ships and whose introduction into the Mediterranean Sea should be avoided.

3. Encourage research initiatives on prevention measures, such as biocide-free antifouling paints or hull cleaning measures.

4. AWARENESS

Improved public awareness based on scientific information is fundamental to prevent or reduce the risk of species introductions with hull fouling, this is also importance in smaller vessels such as motor yachts and sailing boats. However, an education programme alone is unlikely to achieve the desired objective of minimising the risks posed by hull fouling.

It should also be addressed in the awareness programme that fouling organisms are transported on surfaces inside vessels (e.g. in-tank fouling and fouling in the ships cooling circuit).

Recommended Actions

1. Identify the specific interests and roles of relevant stakeholders, sectors and communities with respect to hull fouling mediated species invasions. The general public, especially (recreational) boat owners, are an important target group.

2. Port and marina operators are key target groups for information/education efforts leading to an increased awareness and understanding of the issues, their role in prevention and possible solutions.

3. Dockyard and ship scrapyard operators also belong to the key target group. Organisms removed form ship hulls while in dock should not be dumped in the sea, but should be discharged on land.

4. Include communication strategies in the planning phase of all prevention and control programmes. By ensuring that effective consultation takes place with all affected stakeholders, many issues may be resolved or accommodated in advance.

5. PREVENTION AND CONTROL

Preventing the introduction of alien species is the cheapest, most effective option, i.e. prevention is better than cure. Since the impacts of alien species are unpredictable, the precautionary principle should apply. Further, once introduced and established eradication efforts to eliminate a species from the marine environment are very costly and for many species this may prove impossible.

Recommended Actions

1. Encourage industry and stakeholders to develop guidelines and codes of conduct to reduce hull fouling of vessels and so to minimise species invasions.

2. Develop dissemination programmes for such guidelines to all stakeholders.

3. Evaluate the applicability of existing international hull cleaning and management measures (monitoring and control).

6. ROLE FOR RAC/SPA

Effective response measurements depend on national and regional legislation which provide for preventive as well as remedial action, establishing clear accountabilities and operational mandates.

Cooperation between countries is essential to prevent or minimize risks from introductions of potential or proven alien invasive species. Such cooperation is to be based on the responsibility that countries have to ensure that activities within their jurisdiction or control do not damage the marine environment of other countries or the Mediterranean Sea.

It may further be considered to follow the currently emerging hull fouling guidelines (e.g. in Australia, U.S.A.) and, once completed, to evaluate these guidelines for application in the Mediterranean Sea.

6.1 Regional level

1. Evaluate the need for bilateral or multilateral approaches including the consideration to adapt existing multi-country efforts, with respect to the prevention or control of hull fouling mediated alien species introductions.

2. Recommend cooperative action to prevent potential alien invasive species from spreading across borders; recommend coordination with REMPEC when relevant.

3. Provide assistance and technology transfer as well as capacity building related to hull fouling and its management techniques and control options.

4. Exchange findings with neighbouring and other countries and bodies as appropriate.

6.2 National level

1. Recommend the ratification of the IMO AFS Convention.

2. Encourage the development of national strategies and plans for responding to actual or potential threats from alien invasive species introduced in the hull fouling of vessels, within the context of national strategies and plans for the conservation of biodiversity and the sustainable use of its components. These strategies may include

- Routine vessel monitoring to document the risk of species invasions in hull fouling.
- Identification of vessels which likely carry high risk species in their hull fouling (risk assessment).
- Identify ports which receive a large number of "critical" vessels.
- Evaluate hull treatment methods for "critical" vessels.
- Make all dockyards and scrapyards operators aware that organisms removed from ship hulls should be collected and discharged safely on land.
- Strongly encourage marina operators to apply the proposed guidelines

3. Ensure that appropriate national legislation is in place, and provides for the necessary control, as well as the necessary administrative powers to respond rapidly to emergency situations.

4. Encourage the development of adequate National knowledge base (including, but not limited to the dimension of the hull fouling situation, evaluation of potential control options).

5. Encourage the exchange of findings with neighbouring and other countries and bodies as appropriate.

III. AQUACULTURE[2]

1. BACKGROUND

Market-driven demands for exotic fish and shellfish are on the rise with the increasing affluence of Mediterranean countries. This, coupled with the crisis in wild fisheries, has created a surge in development of marine aquaculture (mariculture) farming along the shores of the Mediterranean in the last twenty years. Production of shellfish has increased from 461,000 T in 1992 to 626,080 T in 2001 (Basurco & Lovatelli, 2004), and two commercially-important shellfish, alien to the Mediterranean, *Crassostrea gigas* and *Ruditapes philippinarum*, were intentionally introduced to the Mediterranean in the 1960s and 1970s, respectively. Though most of the species used in cage farming in the Mediterranean are native to the sea (seabream, seabass, mullets), aquaculture operations are susceptible to stock loss and concern over possible deleterious genetic impact of escaped or released cultured stock. This impact on wild populations has been growing in recent years (UNEP/MAP/MED POL, 2004).

The impacts of invasive marine alien species are immense, insidious, and usually irreversible. The impacts may stem from cultured alien species that become established in the wild, from mixing of cultured and wild population of a Mediterranean native species, and from the unintentional introduction of organisms associated with the intentional cultured species. Quarantine practices, developed to guard against diseases and pests, are often inadequate and insufficient safeguards against species that threaten Mediterranean biodiversity. Factors like urbanization, environmental pollution, eutrophication and habitat degradation commonly associated with intensive fish and shellfish farming can provide conditions that favour alien species. Many alien species are opportunistic species, which benefit from the reduced competition that follows habitat degradation. Climate change is also a significant factor assisting the spread and establishment of alien species.

The past decade saw the introduction of European Union and national regulations aiming to control the deliberate importation of aliens and to limit their dispersal. However, mariculture policies, administration and legislation are very diverse with a lack of specific aquaculture policy in most areas, a lack of a centralized administrative framework, and overlapping between authorities (e.g. involvement of 11 ministries in some countries). Legislation on introduction and transfers of alien species exists in some countries. In practice the administrative measures to control alien species introductions are still rudimentary and an effective policy of prevention is hardly enforced.

Mediterranean countries have not developed comprehensive legal and institutional systems that are capable of responding effectively to the introduction of alien species for use in mariculture. Key industry groups, governmental bodies, and even local environmental groups have a poor appreciation of the magnitude of the problem. As a consequence, too often, responses are insufficient, late and ineffective. Preventing alien species introductions is a task, which needs scientific, administrative and political coordination at the regional level. It is in this context that RAC/SPA has identified the problem of alien species as one of its major initiatives at the regional level.

The proposed guidelines draw on and incorporate relevant parts of the IUCN Guidelines for the prevention of biodiversity loss caused by alien invasive species, the ICES Code of Practice on Introduction and Transfer of Marine Organisms 2004, the U.S.A. National

[2] **Cultured marine organisms for human consumption and ornamental purposes.**

Aquatic Invasive Species Act of 2005, the Canadian National Code on Introductions and Transfers of Aquatic Organisms, 2003, and follow the FAO Code of Conduct on Responsible Fisheries (CCRF, Art. 9.1.1, 1995) – "*States should promote responsible development and management of aquaculture, including an advance evaluation of the effects of aquaculture development on the* ***genetic diversity*** *and* ***ecosystem integrity****, based on the best scientific knowledge*".

2. GOALS AND OBJECTIVES

Growth of mariculture in the Mediterranean is compatible with sustainable management of the marine ecosystem – but only if public policy and technology encourage sound practices. The goal of these guidelines is to prevent further loss of biological diversity due to the deleterious effects of the intentional and unintentional introductions of alien invasive species, while encouraging environmentally sound and responsible use of the Mediterranean marine environment for mariculture. The intention is to assist the Contracting Parties to the Barcelona Convention in implementing the SPA/BD Protocol (Barcelona, 1995) that calls on them to take "… all appropriate measures to regulate the intentional or non-intentional introduction of non-indigenous or genetically modified species into the wild and prohibit those that may have harmful impacts on the ecosystems, habitats or species" (Article 13).

The proposed guidelines are concerned with preventing further change of biological diversity caused by cultured marine alien species intentionally introduced into the Mediterranean, or moved between different areas in the Mediterranean, as well as the loss of genetic diversity through interaction with conspecific cultured stocks. They do not address the issue of genetically modified organisms (GMOs), although many of the issues and principles stated here could apply.

The proposed guidelines address four substantive concerns of the alien species issues: enhancing knowledge and research efforts; improving understanding and awareness; strengthening the management response; providing appropriate legal and institutional mechanisms.

The objectives of these guidelines are:

1. To encourage the necessary research and development and sharing of an adequate knowledge to address the issues of mariculture of alien species introduced or translocated (open sea and land base, containment), and the genetic and other risks from escaped or released cultured stock conspecific with native populations in the Mediterranean.

2. To increase among all stakeholders public awareness of mariculture-introduced or translocated alien species as a major issue affecting native biodiversity in the Mediterranean.

3. To minimize unauthorised introductions of alien species.

4. To minimise unintentional introductions (non target species, including but not limited to disease agents and parasites).

5. To reduce loss of genetic diversity due to interactions with escaped or released cultured conspecifics (i.e. *Sparus aurata*).

6. To ensure that intentional introductions are properly evaluated in advance (i.e. risk assessment), with full regard to potential impacts on biodiversity, and that unauthorized importation and introduction of alien species are fully prohibited.

7. To encourage the development and implementation of eradication and control programmes for alien invasive species and for accidentally-released cultured stock, in case earlier measures fail.

8. To encourage the development of a framework for national legislation and regional cooperation to regulate the introduction of mariculture-introduced alien species and cultured conspecifics, the eradication and control of mariculture-introduced invasive species, and accidentally-released cultured stocks.

9. To designate a lead agency which would have a central responsibility within the government for coordinating the national response to the above issues.

10. To form a national taskforce to develop and implement the proposed guidelines. This national taskforce may be cross-sectoral and multidisciplinary.

3. KNOWLEDGE AND RESEARCH

An essential element in the campaign against alien invasive species is the effective and timely collection of information and information-sharing. Sometimes information that could alert management agencies to the potential dangers of new introductions is lacking. Frequently, however, useful information is not widely shared or available in an appropriate format for many countries to take prompt action, assuming they have the resources, necessary infrastructure, commitment and trained staff.

Recommended Actions

1. Develop an adequate knowledge base, balancing scientific rigor with practicability, timeliness, and breadth of sampling activities, as a primary requirement to address the problems of mariculture-introduced alien species, and make it easily accessible through a global database (or linked databases). Identify existing databases that may meet these criteria. In addition, establish a database of species on trial for commercial use and those used for experimental/scientific purposes

2. Develop a reviewed and regularly updated "Black List" of introduced or translocated cultured alien invasive species, that is easily accessible to all interested parties.

3. Develop a database of genetic profiles of hatchery broodstock of species currently cultured in the Mediterranean, in order to enable tracking of hatchery-bred stock in the wild (released or escaped).

4. Encourage research initiatives on the ecology of the invasion process; impacts of global climate change on alien invasive species; ecological and economic losses and costs associated with mariculture introductions; natural population structure of species at risk from genetic and other interactions with cultured stock, as well as procedures and methods for eradication and control.

4. AWARENESS

Strengthen public awareness based on scientific information is fundamental to prevent and/or reduce the risk of unintentional or unauthorised introductions, and to establish evaluation and authorisation procedures for proposed intentional introductions.

Recommended Actions

1. Identify the specific interests and roles of relevant stakeholders and communities with respect to mariculture-introduced alien species and conspecific stock issues, and target them with easily accessible and accurate information and recommended actions.

2. Make use of existing instruments and, if necessary, foster new ones.

3. Mariculture operators are key target groups for information/education efforts leading to better awareness and understanding of the issues, concerning their role in prevention, monitoring and addressing possible solutions.

4. Build communication strategies into the planning phases of all prevention, eradication and control programmes. By ensuring that effective, transparent consultation takes place with all relevant stakeholders, most issues may be resolved or accommodated in advance.

5. PREVENTION

Preventing the unintentional introduction of alien species, or the release of cultured conspecific stock, is the cheapest and most effective measure to control them. Since the impacts of alien species are unpredictable, any planned intentional introductions and efforts to identify and prevent unintentional introductions should be based on the precautionary principle. Intentional introductions should be prevented if experience elsewhere indicates that the probable result will adversely impact biodiversity.

Intentional introductions of alien species or cultured stock should only take place with authorisation from the relevant authority. Authorisation should require comprehensive evaluations (ecosystem, species, genome) and consultation with neighbouring states as marine biological introductions create transboundary issues.

5.1 Intentional Introductions - Recommended Actions

1. Encourage the establishment of appropriate institutional mechanisms as part of national legislative reforms on introduction of cultured alien species.

2. Establish guidelines for Minimum Information Requirements (MIR) for the screening process which includes risk assessment. The MIR should include the purpose and objectives of the introduction, the stage(s) in the life cycle proposed for introduction, the native range, the donor location, and the target area(s) of release. The MIR should also include a review of the biology and ecology of the species (physical, chemical, and biological requirements for reproduction and growth, and natural and non-natural and human-mediated dispersal mechanisms) and information on the receiving environment. The MIR should include a thorough review of the ecological, genetic, and disease impacts and relationships of the proposed introduction in its natural range and donor location; the expected ecological, genetic, and disease impacts in the proposed release area, as well as vectors for further spread (see for example the ICES Code of Practice on Introduction and Transfer of Marine Organisms 2004, www.ices.dk).

3. Carry out a screening process before coming to a decision on introducing an alien species, requiring the intending importer to provide the burden of proof that a proposed introduction will not adversely affect biodiversity within the country of introduction, or another country to which the species may be spread by human-mediated or natural means. Where relevant, require that specific experimental trials be conducted in donor and recipient countries as part of the assessment process. Ensure that the evaluation process allows for

the likely environmental impacts, risks, standardized costs and benefits analyses (direct and indirect, monetary and non-monetary), and alternatives, to have been identified and assessed. These will apply, when appropriate, also to subsequent importation of alien species that may occur after completion of the initial introduction process.

4. The organisms of each authorized introduction should be used to establish a broodstock in quarantined facilities (i.e. containment). Only progeny of the authorized quarantined broodstock may be transferred into the natural environment, after an environmental impact assessment, and/or risk assessment indicates minimal or no impact.

5. Impose appropriate monitoring conditions on the introduction of alien species, or species conspecific with Mediterranean wild populations.

6. Endeavour to ensure the ability to take rapid and effective action to eradicate or control, in the event that an unauthorised or accidental introduction occurs, or that an authorised introduction unexpectedly or accidentally results in a potential threat of bioinvasion.

7. Include consultation with neighbouring and other countries potentially affected in the evaluation process.

8. Subject mariculture operations utilizing alien species or cultured species conspecific with Mediterranean, wild populations to appropriate levels of monitoring, control and reporting with an explicit agreement as to the roles and responsibilities (including financial) in the event of an introduction.

5.2 Unintentional Introductions - Recommended Actions

1. Develop guidelines and codes of conduct to minimise or eliminate unintentional introductions of species occurring in association with the target species, including pathogens, disease agents, parasites, and other organisms. Periodically review guidelines to ensure up-to-date information is available.

2. As for intentional introduction, subject mariculture operations utilizing alien species or cultured species conspecific with Mediterranean wild populations to appropriate levels of monitoring, control and reporting with an explicit agreement as to the roles and responsibilities (including financial) in the event of an introduction.

6. ERADICATION AND CONTROL

When prevention fails, steps to mitigate adverse impacts of an alien invasive species include eradication, containment and control. *Eradication* aims to completely remove the alien invasive species. *Control* aims for the long term reduction in abundance or density of the alien invasive species, either with the view to ultimate eradication or reducing the impact to an acceptable level. Controlling an established population of a marine alien species in the wild is difficult. A special case of control is *containment*, where the aim is to limit the spread of the alien invasive species and to contain its presence within defined geographical boundaries.

Early detection of potential or known alien invasive species, together with the capacity to take rapid action, is the key to successful and cost-effective eradications. Appropriate measures against intentionally or unintentionally introduced alien invasive species should be provided for in any legislation. Reporting of new incursions to relevant authorities should be mandatory. Give priority to eradication at sites where a new alien invasion has occurred and

is not yet well established, provided risk analysis determined the species poses a risk and is easily eradicable.

6.1 Eradication - Recommended Actions

1. Ensure eradication methods utilized have no long-term effects on non-target and/or native species. Some incidental loss to non-target species may be an inevitable cost of the eradication measure and should be balanced against the long-term benefits to native species.

2. Develop a rapid response toolkit for the Mediterranean that includes an emergency response flow chart of required steps to be taken when an unauthorized introduction is detected.

6.2 Control - Recommended Actions

1. Increase the exchange of information between scientists, managers and policy makers concerning alien invasive species and control methods. As techniques are continuously changing and improving it is important to disseminate information.

2. Construct a standardized control strategy for the Mediterranean that includes identifying and agreeing to the prime target species, areas for control, methodology and timing. The strategy may apply to parts of, or to a whole country, or a region. Such strategies should be publicly available, be open for public input, and be regularly reviewed and updated.

3. Consider containment as an appropriate strategy when eradication is not feasible, but only where the range of the alien invasive is limited and containment within defined boundaries is possible. Regular monitoring outside the containment boundaries is essential, with quick action to eradicate any new outbreaks.

7. ROLE FOR RAC/SPA

To be effective, the prevention, early detection, control, and rapid response to mariculture introduced invasive species should be coordinated regionally.

Effective response measures depend on national and regional legislation that provides for preventive as well as remedial action, establishing clear accountabilities and operational mandates.
Cooperation between countries is essential to prevent or minimize risks from introductions of potential or proven alien invasive species utilized or translocated for mariculture. Such cooperation is to be based on the responsibility that countries have to ensure that activities within their jurisdiction or control do not damage the marine environment of other countries of the Mediterranean Sea.

7.1 Regional level

1. Consider the desirability, or as the case may be, necessity, of developing agreements, on a bilateral or multilateral basis, or adapting existing ones, with respect to the prevention or control of introductions of alien species introduced or translocated by mariculture.

2. Consider the desirability of cooperative action to prevent potential alien invasive species from spreading across borders, including agreements to share information, through, for example, information alerts, as well as to consult and develop rapid responses in the event of transboundary issues.

3. Develop an adequate regional knowledge base concerning mariculture-introduced alien species (released into the wild), and make it easily accessible through a global database (or linked databases).

4. Develop the regional knowledge base (including, but not limited to distribution, biology, invasive characteristics, impacts and control options) of cultured marine alien species currently in containment in the Mediterranean.

5. Provide assistance and enhance technology transfer, as well as capacity building, related to risk assessment and invasive species management techniques.

7.2 National level

1. Encourage the development of national strategies and plans for responding to actual or potential threats from alien invasive species introduced or translocated by mariculture, within the context of national strategies and plans for the conservation of biodiversity and the sustainable use of its components.

2. Ensure that appropriate national legislation is in place, and provides for the necessary controls of intentional and prevention of unintentional introductions of alien species or of those translocated by mariculture. The necessary administrative powers to respond rapidly to emergency situations should be provided as well.

3. Endeavour to ensure that funding exists to develop an adequate knowledge base (including, but not limited to distribution, biology, invasive characteristics, impacts and control options). Ensure that this knowledge base is readily available to scientists, managers and mariculture facility operators.

4. Encourage the development of national databases of mariculture-introduced alien species.

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