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Monitoring Guidance on Ecological Objective 02: Non Indigenous Species

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Monitoring Guidance on Ecological Objective 2: Non Indigenous Species

1. INTRODUCTION

1.1 Definition of key terms

Non-indigenous species (NIS; synonyms: alien, exotic, non-native, allochthonous) are species, subspecies or lower taxa introduced outside of their natural range (past or present) and outside of their natural dispersal potential. This includes any part, gamete or propagule of such species that might survive and subsequently reproduce. Their presence in the given region is due to intentional or unintentional introduction resulting from human activities. Natural shifts in distribution ranges (e.g. due to climate change or dispersal by ocean currents) do not qualify a species as a NIS. However, secondary introductions of NIS from the area(s) of their first arrival could occur without human involvement due to spread by natural means.

Invasive alien species (IAS) are a subset of established NIS which have spread, are spreading or have demonstrated their potential to spread elsewhere, and have an effect on biological diversity and ecosystem functioning (by competing with and on some occasions replacing native species), socio-economic values and/or human health in invaded regions. Species of unknown origin which cannot be ascribed as being native or alien are termed **cryptogenic species**. They also may demonstrate invasive characteristics and should be included in IAS assessments.

1.2 Invasive species in the Mediterranean

Marine invasive species are regarded as one of the main causes of biodiversity loss in the Mediterranean (Galil, 2007; Coll et al., 2010), potentially modifying all aspects of marine and other aquatic ecosystems. They represent a growing problem due to the unprecedented rate of their introduction (Zenetos et al., 2010) and the unexpected and harmful impacts that they have on the environment, economy and human health (Galil, 2008). This is a general phenomenon that extends to all regions of the Mediterranean (Galil, 2007, Galil et al., 2009; Zenetos et al., 2010). That is why invasive species are considered 'focal species' and should be monitored in all regions (Pomeroy et al., 2004).According to the latest regional reviews, more than 6% of the marine species in the Mediterranean are now considered non-native species, around 1000 alien marine species having been identified (Zenetos et al., 2012), while their number is increasing at a rate of one new record every 2 weeks (Zenetos et al., 2012). Of these species, 13.5% are classifieed as being invasive in nature, with macrophytes (macroalgae and seagrasses) the dominant group in the western Mediterranean and Adriatic Sea, and polychaetes, crustaceans, molluscs and fishes in the eastern and central Mediterranean (Galil, et al., 2009; Zenetos et al., 2010; Zenetos et al., 2012). The vast majority of alien species occur in the eastern Mediterranean; some are located exclusively in the south-eastern basin, others are restricted to the western basin, while others have colonized the entire Mediterranean.

Although invasive alien species may be responsible for strong ecological impact in particular for reducing the population of some native species, some NIS, particularly crustaceans and fish have become an important fishery resource. The migration of Lessepsian NIS appears to play an important role for fisheries, particularly in the Levantine basin.

1.2.1 Pathways of introduction of non-indigenous species in the Mediterranean Sea

According to the latest regional review (Zenetos et al., 2012) more than half (54%) of the marine NIS in the Mediterranean Sea were probably introduced by corridors (mainly the Suez Canal). Shipping is the second most common pathway of introduction, followed by aquaculture and aquarium trade.

The **Suez Canal**, as a pathway of NIS, is believed to be responsible for the introduction of 493 alien species into the Mediterranean, approximately 11% being invasive (55 species). However, only 270 of these species are definitely classified as Lessepsian immigrants. Of these 270 Lessepsian immigrants, 71 consist of casual records (based on one or two findings) while 175 are successfully established. 126 out of them (including 17 invasive ones) are limited to the Eastern Mediterranean sub-region, whereas the others are progressively spreading in the neighbouring Mediterranean sub-regions.

Shipping is blamed directly for the introduction of 12 species only, whereas it is assumed to be the only pathway of introduction (via ballast or fouling) of a further 300 species. For approximately 100 species shipping counts as a parallel possible pathway along with the Suez Canal or aquaculture.

About 20 NIS have been introduced with certainty via **aquaculture**, either as escapees of imported species, mostly mollusks, or associated as contaminants: parasites; epibionts; endobionts; or in the packing materials (sessile animals, macrophytes).

Aquarium trade, although currently limited to 2%, is gaining importance as a pathway of introduction. A total of 18 species are assumed to have been introduced by aquarium trade, the only certain case is that of *Caulerpa taxifolia*. With the exception of four species, for which aquarium trade is suspected to be a parallel mode of introduction, the remaining 13 species are all tropical fish species kept in marine aquaria. The most plausible explanation for their presence appears to be accidental release, though unaided introduction via the Suez Canal cannot be ruled out for those also occurring in the Red Sea.

The growth of **marinas** in many Mediterranean coastal areas in recent years could be providing a platform (hulls, chains, anchors, propellers, immersed sides of floating pontoon units, poles, immersed portions of floating structures supporting boardwalks) for the spread of NIS as these sites are closely associated with the movements of vessels (fishing or recreational boats) carrying alien species as hull fouling. Although antifouling paints help to control fouling, hulls are still an important means of transport for invasive species.

NIS introduced via corridors (essentially the Suez Canal) are the majority in the Eastern Mediterranean sub-region, and their proportion declines towards the western basin. The reverse pattern is evidenced for ship mediated species and for those introduced with aquaculture. Regarding those species linked to both the Suez Canal and to shipping some of these Indo-Pacific species might have actually been introduced by shipping and not by natural means via the Suez Canal but there is insufficient information. They constitute a considerable portion ranging from approximately 9% in the Eastern Mediterranean sub-region to approximately 6% in the Western Mediterranean sub-region.

1.2.2 Climate change effects on the spread of NIS in the Mediterranean

Climate change is likely to affect the structure of marine communities and provide further opportunities for alien species to spread and out-compete native species. In general, many native and alien species are shifting their areas of distribution towards higher latitudes (CIESM, 2008). As the majority of NIS in the Mediterranean are thermophilic that originated in tropical seas of the Indo-Pacific, warming sea temperatures favour the introduction of more Red Sea species into the south-eastern Mediterranean and their spread northwards and westwards. Similarly, it will also assist the spread of species of (sub) tropical Atlantic origin into the western basin, although by definition such introductions via the Strait of Gibraltar do not account as alien species invasions.

2. Monitoring Strategy

2.1. Selection of monitoring locations

The monitoring of IAS generally should start on alocalised scale, such as “hot-spots” and “stepping stone areas” for alien species introductions. Such areas include ports and their surrounding areas, docks, marinas, aquaculture installations, heated power plant effluents sites, offshore structures. Areas of special interest such as marine protected areas, lagoons etc. may be selected on a case by case basis, depending on the proximity to alien species introduction “hot spots”. The selection of the monitoring sites should therefore be based on a previous analysis of the most likely “entry” points of introductions and “hot spots” expected to contain elevated numbers of alien species. New sampling sites may need to be considered according to future human and resource user activities in the sea. Table 1 shows how data relating to different pathways could be used to quantify pathway intensity.

Monitoring at “hot-spots” and “stepping stone areas” for alien species introductions would typically involve more intense monitoring effort, sampling at least once a year at ports and their wider area (e.g. the wider Gulf area) and once every two years in smaller harbours, marinas, aquaculture sites. The number of monitoring stations will vary from i.e. typically 10 stations at large ports including their immediate surroundings, to 2-3 stations in smaller commercial bays and 1 station at aquaculture sites. Monitoring should preferably take place in the warmer months as most species are present then.

Regarding the spatial scope of monitoring, marine species, and especially invasive marine species, tend to have relatively large distributional ranges in comparison to terrestrial and fresh water species as there are less physical barriers in the marine environment that may limit their spread. Most species for example have a pelagic stage during which they can drift along with the sea currents over large distances. Monitoring the presence of marine non-indigenous species in for example a part of a sea port, will therefore provide a reasonably good indication of the species that are present in the whole port and adjacent waters. One can therefore obtain an overview of the non-indigenous species present at a large spatial scope, while only monitoring a relatively small number of locations.

Table 1. Estimating the relative pathway intensity into locations (OSPAR 2014).

Pathway	**Data used to determine intensity of the different pathways.**		**Pathway intensity score formula.**	**Scale.**
Commercial Shipping	The total number of unique connections into ports within a grid square.	The total number of voyages into ports within a grid square.	Number of unique connections multiplied by number of voyages. E.g. if grid receives traffic from 10 different ports and receives in total 300 voyages, the likelihood of introduction score for that grid = 3000.	0-100.
Recreational Boating	The total number of potential recreational cruising routes into each grid square (present information)	The estimated intensity with which the cruising routes are used (present information).	The sum of the number of recreational cruising routes multiplied by the Intensity (where heavy intensity =3, medium intensity =2, low intensity =1). E.g. if there is 1 heavy intensity route, 4 medium intensity routes, and 5 light intensity routes into a grid square, the likelihood of introduction score for that square = (3*1)+(2*4)+(1*5)=16).	0-100
Aquaculture	The number of live imports into that grid (present information). The number of individual animals imported is not incorporated into the score.		Total number of imports.	0-100
Natural dispersal – ocean current	For grid squares identified as being at increased risk of introduction of non-indigenous species by ocean current: proximity by sea from landmass where ocean current is flowing from.		Proximity to landmass *proximity to offshore platforms and buoy associated with oil and gas platforms * proximity to operating wind farms	0-100
Natural dispersal – offshore structures	Offshore structures (oil, gas and wind) in close proximity.		The total number of offshore structures in the coastal grid and the adjoining coastal grid	0 -100
Combined pathways	Scaled risk scores for each individual pathway		Mean of scores for each individual pathway.	0-100

2.2. Deciding what to monitor

2.2.1 Creation and regular updating of a national database of invasive species

Each Contracting Party, if not having already embarked on the endeavor, would need to conduct survey(s) in order to create an initial list of NIS and particularly of invasive species existing in their marine waters, while preferably also monitor all cryptogenic species known in an area. The area of origin and a pathway account should as far as possible also be linked to the species identified as a measure of anthropogenic pressure. Ongoing surveys should list newly arrived NIS, IAS and cryptogenic species, along with newly colonised localities.

An important tool for deciding what species to target for monitoring, are already existing national, regional and international information networks and databases, notably for the Mediterranean the Marine Mediterranean Invasive Alien Species (MAMIAS [1]) database developed for RAC/SPA with information up to 2012. The "Andromeda" invasive species database for the Mediterranean and Black Sea is currently being developed under the PERSEUS [2] Project, to be operational by end of 2014. The European Alien Species Information Network (EASIN[3]) developed by the Joint Research Centre of the European Commission facilitates the exploration of non-indigenous species information in Europe (and the entire Mediterranean), from distributed resources through a network of interoperable web services, following internationally recognized standards and protocols. Other essential websites and databases with valuable sources of information on the distribution and facts on alien species are listed in Annex I.

Risk assessing species to determine potential impact and risk of introduction is an important tool in developing policy and control programmes for invasive species. Within this mechanism risk assessments are conducted by independent experts and peer reviewed. From this process species can be assigned into one of four categories: high, moderate, low and unknown impact. It could be useful to prepare a risk matrix detailing the relative importance of invasive species traits for introduction mechanisms associated with key pathways.

2.2.2. Collection of socioeconomic information

Important complementary information to the monitoring of invasive species will be the collection of data on socioeconomic factors linked to the pathways of invasive species introduction such as shipping traffic at major ports, recreational craft traffic at marinas, aquaculture production, aquarium trade statistics, etc.

2.3 NIS, IAS data collection method

It is recommended to use standard monitoring methods traditionally being used for marine biological surveys, including, but not limited to plankton, benthic and fouling studies described in relevant guidelines and manuals. However, specific approaches may be required to ensure that alien species are likely to be found, e.g. rocky shores, port areas and marinas, offshore areas and aquaculture areas. Further, it is important to consider sampling of different depths for e.g. plankton and use of appropriate methods for the sampling and storage of delicate organisms, such as jellyfish.

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[1] http://www.mamias.org
[2] http://www.perseus-net.eu
[3] http://easin.jrc.ec.europa.eu/

To be most cost efficient, existing monitoring and surveying programmes should be adapted, as appropriate:

- Make researchers aware of the problems caused by alien species and that aliens should be documented in monitoring efforts no matter for what reasons those were undertaken (e.g. monitoring studies required prior and after off shore installations, such as for wind farms and larger bridge constructions and previously completed port sampling programmes (e.g. CIESM PORTAL[4]).

- Using different methodologies at high priority sampling sites (hot spots, stepping stones)

- Consider more frequent sampling events to catch all life stages of NIS which may only occur during certain seasons.

- Not all taxonomic groups are addressed in ongoing monitoring efforts. For example the bathing water quality monitoring is focused on certain human pathogens. Possibly, these studies can broaden their scope also including non-indigenous disease agents, bacteria and viruses.

- Monitoring of marine protected areas could be adapted for bio-invasion assessments. (Otero et al., 2013).

- Consider the monitoring efforts of all other Ecological Objectives as appropriate.

- Consider scientific publications

Future monitoring programmes should always provide for documentation (i.e. voucher specimens, including samples for molecular investigations) of NIS/IAS and a standardization of sampling strategies and frequencies.

It is recommended that Contracting Parties make an inventory of existing marine biological monitoring programs, surveys, and datasets which may be used (adapted) to report findings of IAS. Examples include:

- National and sub-regional databases, that should be eventually linked so that the spread of IAS can more easily be monitored;

- Fisheries data collection systems applicable in the region, in particular young fish and trawl survey data should be considered;

- Continuous Plankton Recorder surveys;

- Environmental Impact Assessment surveys (off shore oil terminals, ports, etc.);

- Areas of special interest, such as nature conservation sites e.g. MPAs monitoring;

- Consideration of dedicated working group reports, such as ICES and CIESM reports.

Points of importance when setting up a monitoring protocol focusing on finding non-indigenous species (as adapted from OSPAR, 2013):

[4]http://www.ciesm.org/marine/programs/portal.htm

- Involve taxonomists, typically working for or in close cooperation with natural history museums. These are scientists specialized in identifying and describing species. Identifying non-indigenous species can be very difficult as these species may originate from anywhere worldwide. The involvement of “true” taxonomists is therefore very important;

- The number of samples that has to be taken in an area should be estimated based on the homogeneity of the species communities in that area. This can for example be done by the obligation that one needs to take/search through new samples until at least 90% of the species in that area are found. To check this, various statistical analytic methods exist with which the total species diversity in an area can be estimated on the basis of the species found in past samples taken;

- An assessment should preferably be made of the micro-habitats based on variations in salinity, substrate, wave-action, etc. that are present at a location, and to ascertain that an assessment of non-indigenous species is carried out in each of these habitats with the best available monitoring method (from a cost-benefit perspective). Hereby one should focus on scoring species of various trophic groups and life strategies including endofauna and epifauna, but also the species with a mainly pelagic occurrence;

2.3.1 Rapid Assessment Surveys (RAS)

As a complimentary measure and in the absence of an overall IAS targeted monitoring programme, rapid assessment studies may be undertaken, usually but not exclusively at marinas, jetties, fish farms (e.g. Minchin, 2007, Pedersen, 2005, Ashton et al., 2006).
An RAS is conducted by a team of marine species experts to identify both native and introduced species found at selected sites. The goal of an RAS is to make a quick assessment of introduced species present and use this information to document their distribution and collect environmental data.

A team of scientists, each with a different specialty in marine taxonomy, spend approximately one hour at the survey site and identify species. A site master records the scientists, findings and abundance of species at each site. Samples of specimens are usually taken back to the lab, where scientists spend several more hours, to confirm species identities. Water quality data such as salinity, dissolved oxygen content, and water temperature is also taken at every site. For online mapping purposes the longitude and latitude of the location is also taken.

RAS provide a baseline of species in fouling communities and, for those monitored over time, show the changes in introduced and cryptogenic populations versus the native populations. This allows scientists to analyze the spread of the species and predict future changes in the marine population. Such surveys assist management in controlling alien species. It may be possible to eliminate them when found at an early stage, reduce their rate of spread or develop techniques to mitigate effects to commercial interests.

Port studies, such as those undertaken in Australia, (Hewitt et al., 1999, Hewitt and Martin, 2001) involve a wide range of sampling techniques, including diving, and these surveys provide extensive accounts of both native and alien biota. However there is considerable effort involved in such surveys. The relative ease that species can be collected make the RAS approach time efficient. Although many of the species collected in such surveys have little recognizable impact, some invasive forms are readily identifiable (Minchin, 2007).

Rapid assessment can be further refined through developing a supplementary target list of invasive species not present in the country, or (sub) region, that could be sought in future surveys based on four criteria that include known invasiveness elsewhere, their presence with known vectors and whether these vectors are active. In a desk assessment, these species can be arranged according to relative risk of invasion (Hayes et al, 2002).

2.3.2. Citizen Science support to monitoring NIS

Detection gap generates biases in the observed spatial and temporal distribution of alien species and contributes to underestimating the dimension of marine bio-invasions, with obvious consequences for management. Due to the large work force needed to monitor expansive areas, citizen science is a vital component for the success of properly monitoring the spread of invasive species. Indeed members of local communities, because of their broad geographic distribution and familiarity with their natural environment, can be of great help to track invasive species in both terrestrial and aquatic systems (Delaney et al., 2008). Moreover the increasing use of inexpensive photo and video equipment is giving citizens unprecedented chances to provide real data and verifiable observations about the natural world. Volunteers are increasingly involved in environmental research and their role in monitoring biological invasions is rapidly expanding in the internet era. The creation and proliferation of ‘‘bio-blitzes’’, with volunteers gathering samples to be identified by scientists may trigger important synergies, generating public awareness and enhancing the exchange of information within the broad public, something that is another primary goal, in the field of invasion biology (Delaney et al., 2008). The compilation of citizen scientist input, validated by taxonomic experts, demonstrated the geographic expansion of more than twenty invasive species in Greece, while it provided information on four previously considered “casual” species known only from single records (Zenetos at al., 2013).

3. Monitoring to address “Trends in abundance, temporal occurrence and spatial distribution of non- indigenous species, particularly invasive non indigenous species, notably in risk areas in relation to the main vectors and pathways of spreading of such species”

The February 2014 Integrated Correspondence Group on GES and Targets (Integrated CorGest) of the EcAp process of the Barcelona Convention selected the common indicator “Trends in the abundance, temporal occurrence and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas in relation to the main vectors and pathways of spreading of such species” from the integrated list of indicators adopted in the 18th Conference of the Parties (COP18), as a basis of a common monitoring programme for the Mediterranean in relation to non-indigenous species.

3.1 Status of development

The trend indicator for non-indigenous species is considered to become operational when at least two years of relevant data on the parameters are made available. In the absence of relevant data, it is advised to use two years data collected after the development of the indicator.

3.2. Selection of parameter/metric

3.2.1 Abundance of non-indigenous species

Abundance of non-indigenous species may be considered to play a limited role in the calculation of the trend indicator for non-indigenous species. Abundance monitoring is relatively expensive. Effort, also from a cost benefit perspective, may be focused more on recording all local non-indigenous species, as this may be more targeted to NIS-goals for the trend indicator:

- ideally no new non-indigenous species are introduced, and
- ideally the number and composition of non-indigenous species remains at a level where only non-indigenous species that have already settled at a location are present, i.e. a reference level indicating that the number of non-indigenous species has remained the same in the period of three successive years i.e. the non-indigenous encountered species in the system appear to have settled for the “long-term”.

3.2.2 Temporal occurrence and spatial distribution of non-indigenous species

The management measures for marine non-indigenous species should be focused on preventing new introductions through various ways. This approach is the most cost-efficient and in most cases it is the only way to manage non-indigenous species. To evaluate this management measure, one should monitor the trends in the temporal occurrence and spatial distribution of recently introduced species. To monitor the trend indicator of non-indigenous species two parameters [A] and [B] should be calculated on a yearly basis. Parameter [A] provides an indication of the introductions of “new” species (in comparison with the prior year), and parameter [B] gives an indication of the increase or decrease of the total number of non-indigenous species:

[A]: The number of non-indigenous species at T_n (for example T_{2013}) that was not present at T_{n-1} (for example $T_{2013-1=}T_{2012}$). To calculate this parameter the non-indigenous species lists of both years are compared to check which species were recorded in 2013, but were not recorded in 2012 regardless of whether or not this species was present in 2010 and earlier years. To calculate this parameter only the total number of non-indigenous species is used in the comparison (species names are not compared).

[B]: The number of non-indigenous species at T_n minus the number of non-indigenous species at T_{n-1}. Hereby T_n stands for the year of reporting.

Trends in both [A] and [B] should be monitored to develop the best management plan for non-indigenous species in an area. A positive or negative trend in [B] illustrates respectively an increase and a decrease in the total number of non-indigenous species in an area, which is a good trend indicator of non-indigenous species. One also needs to calculate [A] however as it is possible to have both a negative trend in [B], indicating a decrease in the total number of non-indigenous species, and a positive trend in [A] at the same time, indicating that management in the area is not sufficient yet. A positive trend in [A] ([A]>0) indicates that “new” species are introduced into the area and one should therefore investigate how and with which pathway they are introduced. If this concerns a pathway introduced by anthropogenic activities, one may focus management on that pathway. If the new non-indigenous species arrive by their natural distribution capacities, one may focus on back tracking the location of origin and focus management on that location.

These parameters should be calculated for at least 2 “hot spot” locations per “potential import pathway”, e.g. “commercial shipping”, “marinas”, and “aquaculture transport”. The criteria on the basis of which these locations are chosen can be the following:

- Past research has shown them to be hotspots for non-indigenous species that can be transported with the transport vector concerned;
- The species communities at the two locations do not directly influence each other;
- Vulnerable areas with prospects for invasion by new introductions.

The number of non-indigenous species at each of the selected locations has to be monitored following a specific protocol for that location, ensuring that the number of non-indigenous species within a location can be compared over the years to produce trends. The monitoring protocol developed for each location should aim at reflecting the occurrence of many non-indigenous species at that location. Monitoring protocols may be different between locations. The use of different monitoring protocols at different locations must not be a problem as long as all protocols aim at scoring non-indigenous species present in the location.

3.3. Baseline and Reference level

The reference level is set based on the above parameters [A], [B] and T_n. T_n stands for the year of reporting.

The reference value (at which impacts from anthropogenic pressures are absent or negligible) for metric [A] is [A] at T_n = [A] at T_{n-1} = [A] at T_{n-2} = 0, indicating that in the last three years no new non-indigenous species were introduced.

The reference value for [B] is [B] at T_n = [B] at T_{n-1} = [B] at T_{n-2}, indicating that the number of non-indigenous species has remained the same in three years’ time, i.e. the non-indigenous species present appear to have settled for the “long-term”.

In conclusion the impacts from anthropogenic pressures are assumed to be absent or negligible when [A] at T_n = [A] at T_{n-1} = [A] at T_{n-2} = 0 and [B] at T_n = [B] at T_{n-1} = [B] at T_{n-2}.

The baseline is set by considering the following statements:

- Ideally no new non-indigenous species are introduced; and,
- Ideally the number of non-indigenous species reduces to a level where only non-indigenous species that have already settled at a location are present, i.e. the number of non-indigenous species is decreased to a level where only settled non-indigenous species are present. It is hereby assumed that the eradication of settled non-indigenous species in the marine environment is virtually impossible.

3.4 Target setting

The target for the trend indicator for non-indigenous species is trend-based: An acceptable target situation for the indicator is a negative trend in the numbers of “new” species introductions, occurrences and spatial distribution.

Consequently, when [A] at T_n< [A] at T_{n-1} (indicating that the number of “new” species introduced to the area in the reporting year is lower than in the previous year, and [B] <0 (indicating that the number of non-indigenous species at a location has decreased), until the Reference level is reached. The reference level [A] at T_n = [A] at T_{n-1} = [A] at T_{n-2} = 0 and [B] at T_n = [B] at T_{n-1} = [B] at T_{n-2}, should indicate that no new non-indigenous species were introduced in the last three years, and that the number of non-indigenous species is decreased to a level where only settled (for at least three years) non-indigenous species are present. Of course, this target accounts for all locations that are monitored.

3.5. Concluding remarks

Contracting Parties should have at least three years of data per location in order to calculate the trend indicator and to define the reference level for the non-indigenous species. This is assumed to be so when no new non-indigenous species were introduced in the last three years, and the number of non-indigenous species is decreased to a level where only characteristic resident non-indigenous species (settled for at least three years) are present. For developing new monitoring protocols specifically aiming at finding non-indigenous species, one should at least plan two years during which each country monitors non-indigenous species according to the monitoring programme they have developed. During those two years, the results of the monitoring programmes can be compared in time (between the two years) and space between the various Contracting Parties. These results are compared with one question in mind: how can each of the monitoring programmes be improved (from a cost/benefit point of view) aiming at finding as many non-indigenous species as possible. After those two years an evaluation should take place during which what percentage is estimated of the non-indigenous species present at the various locations, which is indeed found in the monitoring protocol that was chosen. If less than ~90% of the non-indigenous species present in an area are scored, the monitoring protocol is probably not fit for producing the data necessary to calculate the non-indigenous species trend indicator. If the majority of the Contracting Parties are not able to develop and maintain a monitoring programme that is able to score at least ~90% of the non-indigenous species present in an area, the use of any “trend indicator for marine non-indigenous species” would not be feasible.

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Annex I

Essential websites and databases on facts and distribution of invasive species

Global Coverage

CABI Invasive Species Compendium (ISC)
http://www.cabi.org/isc/

Food and Agriculture Organization (FAO), database on Introductions of Aquatic Species (DIAS)
http://www.fao.org/figis/servlet/static?dom=collection&xml=dias.xml

FISHBASE
http://www.fishbase.org/

Global Invasive Species Programme (GISP)
http://www.gisp.org

Global Invasive Species Database (GISD)
http://www.invasivespecies.net/

Global Invasive Species Information Network (GISIN)
http://www.gisinetwork.org

GloBallast Partnerships: To implement sustainable, risk-based mechanisms for the management and control of ships' ballast water and sediments to minimize the adverse impacts of aquatic invasive species transferred by ships.
http://globallast.imo.org/

The IUCN Invasive Species Specialist Group and IUCN Global Invasive Species Database (GISD),
http://www.issg.org/#ISSG
http://www.issg.org/database/welcome/

The Nature Conservancy (TNC)
http://www.nature.org/invasivespecies
http://tncinvasives.ucdavis.edu/

European Coverage

European Alien Species Information Network (EASIN)
http://easin.jrc.ec.europa.eu/

European Information System for Alien Species (COST TD1209)
http://www.cost.eu/domains_actions/fa/Actions/TD1209

North European and Baltic Network on Invasive Alien Species European (NOBANIS) Database
http://www.nobanis.org/

European Environment Agency 'Signals':

http://www.eea.europa.eu/pressroom/newsreleases/killer-slugs-and-otheraliens

Delivering Alien Invasive Species Inventories for Europe
(DAISIE)
http://www.europe-aliens.org/

Information system on aquatic non-indigenous and cryptogenic species (AquaNIS)
http://www.corpi.ku.lt/databases/index.php/aquanis
Mediterranean records are based on DAISIE. Will be updated.

Mediterranean Coverage

CIESM Atlas of Exotic Species in the Mediterranean Sea is linked to NISbase, a distributed database managed by the Smithsonian Institute, aiming at a census of all non-indigenous aquatic species introduced around the world.
http://www.nisbase.org/nisbase/index.jsp

MAMIAS Database from Regional Activity Centre For Specially Protected Areas (RAC/SPA) of the Barcelona Convention
http://www.rac-spa.org/
http://www.mamias.org

ESENIAS East and South European Network for Invasive Alien Species. Regional data portal on invasive alien species (IAS) in East and South Europe (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Kosovo under UNSC Resolution 1244/99, FYR Macedonia, Montenegro, Serbia, Romania (invited country) and Turkey.
http://www.esenias.org/

National Coverage

InvasiBer, Especies ExσticasInvasoras de la PenvnsulaIbırica (Spain)
http://invasiber.org/

Ellenic Network on Aquatic Invasive Species (ELNAIS) - Greece
https://services.ath.hcmr.gr/

SIDIMAR, Italy
http://www.sidimar.tutelamare.it/distribuzione_alieni.jsp

National Biodiversity Information Facilities - BIFs;
http://www.gbif.org/participation/participant-nodes/bif/

Other Relevant Documents

Assessing Large Scale Environmental Risks for Biodiversity with Tested Methods (ALARM)
http://www.alarmproject.net

EU website:
http://ec.europa.eu/environment/nature/invasivealien/index_en.htm

Scope for EU action:
http://ec.europa.eu/environment/nature/invasivealien/docs/2006_06_ias_scope_options.pdf

Annex II
Indicators Monitoring Fact Sheets on Ecological Objective 2: Non-indigenous species

ECOLOGICAL OBJECTIVE 02: Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem

Indicator Name	Indicator No	Operational Objective	State, pressure or impact	DESCRIPTION Parameters and/or Elements, matrix	Assessment Method	Guidelines	Reference Methods for sampling and analysis	QA/QC	Recommendations /Additional Data needed
Trends in the abundance, temporal occurrence and spatial distribution of non-indigenous species, particularly invasive non indigenous species, notably in risk areas in relation to the main vectors and pathways of spreading of such species”	2.1.1. (2.1.2 combined)	2.1. Invasive non-indigenous species introductions are minimized	Pressure	Presence/absence of NIS focusing especially on IAS Focusing on high risk locations monitored at least annually with lower risk sites less frequently i.e. every two years	Temporal trends between years will be assessed	For Rapid Assessment Surveys (RAS): Aston et al., 2006; Minchin, 2007; Pedersen et al., 2003 For Mediterranean marine protected areas: Otero et al., 2013.	Considering the broad range of taxonomic groups that will need to be covered sampling protocols will be very varied. Which sampling protocol should be employed and where should in part be driven by risk analysis. Hewitt, C.L., Martin, R.B., 2001. Revised protocols for baseline port surveys for introduced marine species (Hewitt and Martin, 2001) and HELCOM/OSPAR guidelines developed for the assessment of exemptions under the BWC could provide a useful source of sampling protocols for some taxa.	Requires development	Traditional taxonomic techniques may fail to identify key species (e.g. if present in low numbers, juveniles life stages, or damaged). The development of molecular techniques could greatly increase the ability of samples to be accurately and quickly assessed.