

# Alien species and the Water Framework Directive

## Questionnaire results

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## SUMMARY

Alien species constitute a major pressure in aquatic environments, both ecologically and economically. This recognition has initiated a debate on the role of alien species in ecological status classifications. We distributed a questionnaire to review how EU Member States (MSs) deal with alien species in their national status assessments under the Water Framework Directive (WFD). The questionnaire was filled and returned by 23 EU MSs and Norway.

Analysis of the questionnaire returns and referred methods revealed the existence of a wide range of approaches:

- (1) The majority of MSs do not take alien species explicitly into account for classification under the WFD. This implies that the biological methods that were developed for assessing anthropogenic pressures are assumed to be able to pick up pressures by alien species, but this remains to be verified. Some of these MSs do acknowledge the need for a more direct or supplementary account of alien species, but fail to do so because of the lack of information on the impact and distribution of alien species within their territory.
- (2) Few MSs assess ecological status using the pressure-based tools, and subsequently downgraded the status in case of presence of predefined high-impact alien species. The main critiques to this approach are that it puts too much weight on alien species, compared to other pressures, and that it may result in downgrading of many water bodies, even in the absence of any perspectives for remediation of the problem.
- (3) Others account for alien species by attributing aliens a different score than native species in a metric, or by including alien species in comparisons with alien-free reference communities. Such approaches may blur the impact assessment of other pressures, and may obscure the magnitude of the alien species problem.
- (4) Almost all MSs support the idea of a supplementary biopollution index. Such an index would uncouple alien species and anthropogenic pressure assessments, and allow for a correct appraisal of the problem without affecting the WFD classification. A pan-European index may not be feasible because of different trade-offs between practicability and accuracy across MSs.

A better harmonization of the views on alien species and water body classification within Europe is desirable, but a challenging task. It requires an agreed interpretation and usage of alien species related terms, and an increased compatibility and completeness of national and regional alien species lists. These topics have been added for discussion to the 2010-2012 mandate of the WFD Working Group on Ecological Status.

# 1. Introduction

## 1.1. Context

The Water Framework Directive (WFD) is the main policy document for the management of inland, transitional and coastal waters in the EU. For the prioritisation of management measures under this Directive water bodies are being classified according to their chemical and ecological status. Ecological status assessment are designed to detect responses to anthropogenic pressures such as eutrophication, acidification, hydromorphological modification and dangerous substances. Also alien species may constitute an important pressure at the level of the communities, habitats and ecosystems. Because they are not explicitly recognized as such by the text of the Directive, a debate has arisen on their role in classification under the WFD.

The issue of alien species and WFD classification was formally discussed during a workshop that was held in April 2008 in Bordeaux. A paper built on the discussions of this meeting and set out some important issues that need to be resolved. This paper was discussed at the WFD Ecological Status Working Group (ECOSTAT<sup>1</sup>) meeting in Brussels on 1 October 2008.

Three topics were covered in the paper: (i) the need to agree definitions of terms used with respect to the distribution, introduction and establishment of alien species that are meaningful in the context of the WFD; (ii) the need for consistent criteria in assembling lists of alien species for individual countries or regions, and in assigning levels of potential impact; (iii) how to apply data on alien species to water body classification.

Following the resolutions made at the ECOSTAT meeting, a further paper, written by Professor Phil Boon (SNH, UK) and Dr Ana Cristina Cardoso (JRC, Italy), was submitted to DG Environment proposing the next steps for the work on alien species. The approach suggested was to complete the information on the three topics listed above by means of a questionnaire, and in particular to gather evidence on sensitivity of national assessment and classification systems to impact from alien species.

This report presents the results of this questionnaire.

## 1.2. Returns and analysis

The questionnaire was issued on 30 January through ECOSTAT to national experts addressing the problems of alien species under the WFD. In case multiple experts filled the questionnaire, the ECOSTAT contact was asked to integrate the different replies into a single reply per Member State (MS). In some cases it proved difficult to merge views from different sources within a country and two or more questionnaires were returned by a single MS (see Table 1). Deadline for replies was 27 March 2009.

Thirty questionnaires were returned, covering 24 countries including the non-EU country Norway. Four EU MSs (Bulgaria, Malta, Portugal and Slovakia) did not reply, and four other countries (Belgium, Germany, Norway and Spain) provided two or more replies. Belgium and Germany sent a separate reply per WFD water body type (rivers, lakes and coastal/transitional waters), for Norway

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<sup>1</sup> ECOSTAT: working group set out in 2002 to provide guidance to the Member States on the implementation of the WFD recommendations regarding the assessment of ecological status in surface water bodies

both a governmental agency and a research institute replied and Spain provided an integrated response and a reply for Catalonia.

A key objective of the questionnaire was to document the divergence in views among MSs. For several questions it was not possible to present ‘the’ answer of a given MS, as this answer sometimes varied according to the type of water body, region or organism group considered. The graphs presented in this report also account for this source of variation: views that are not concordant within a MS or even questionnaire return were treated as separate returns. These returns were subsequently weighted within a MS, taking care that the total weight of each MS was identical. If for example a respondent replied to question X that answer A is valid for lakes, and answer B is valid for rivers and coastal/transitional waters, then we added 0.33 returns to answer A and 0.66 returns to answer B for that question. As such, the sum of replies equals for all questions the number of countries that replied (n=24).

*Table 1: Number of questionnaire replies per country.*

<i>Member State</i>	<i>Number of returns</i>
Austria	1
Belgium	3 (coastal/transitional waters, Flanders and Wallonia)
Bulgaria	0
Cyprus	1
Czech Republic	1
Denmark	1
Estonia	1
Germany	3 (coastal/transitional waters, lakes and rivers)
Greece	1
Finland	1
France	1
Hungary	1
Italy	1
Latvia	1
Lithuania	1
Luxembourg	1
Malta	0
Norway	2 (Directorate for Nature Management; Institute of Marine Research)
Poland	1
Portugal	0
Republic of Ireland	1
Romania	1
Slovakia	0
Slovenia	1
Spain	2 (integrated and Catalonia separately)
Sweden	1
The Netherlands	1
United Kingdom	1
<b>TOTAL</b>	<b>30 replies / 24 countries / 23 EU MSs</b>

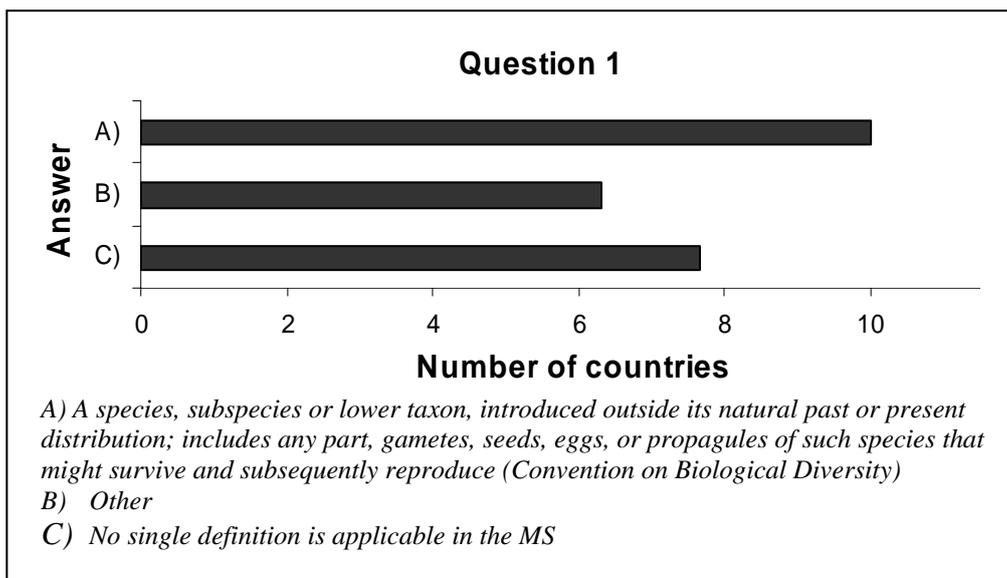
## 2. Results

The questionnaire was arranged in three main sections, with a fourth available for general comments. The first section (A) sought information on how alien species are defined in each MS. Because the focus of the exercise was the WFD, MSs were asked to concentrate their attention on aquatic species, but others (e.g. riparian species, birds) that may have an impact on WFD water bodies should also have been considered where relevant. The second section (B) explored the way that MSs construct lists of alien species for use under the WFD and how levels of impact are assessed. The third section asked MSs to explain how information on alien species is being used in the classification of ecological status.

### A. Member States' definition of alien species under the WFD

#### Q1. How are alien species defined by the MS?

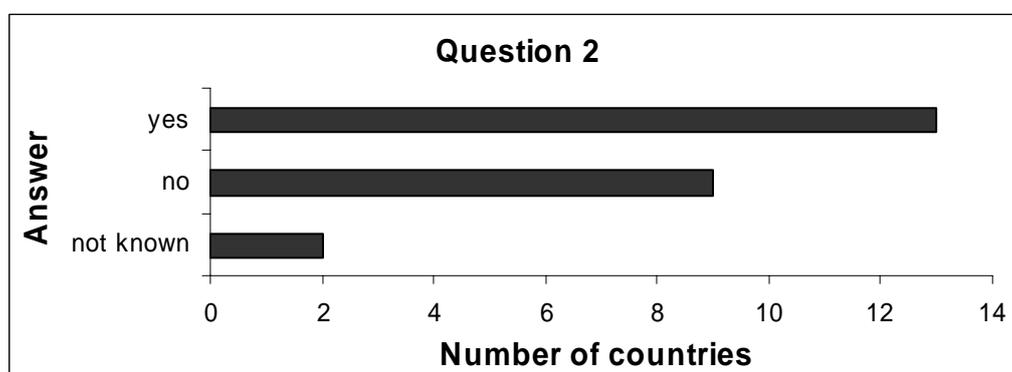
The definition for alien species adopted by the Convention on Biological Diversity (CBD; Annex VI/23) is the most commonly applied definition by EU MSs for use under the WFD.



Still, the majority of MSs have modified the CBD definition for this purpose, or interpret the term differently according to the situation. A large number of MSs consider the CBD definition inappropriate for use under the WFD, as it is not limited to invasive and/or established species, and it does not specify that the introduction should be human mediated.

## Q2. Are *translocated native species*<sup>2</sup> considered as alien species?

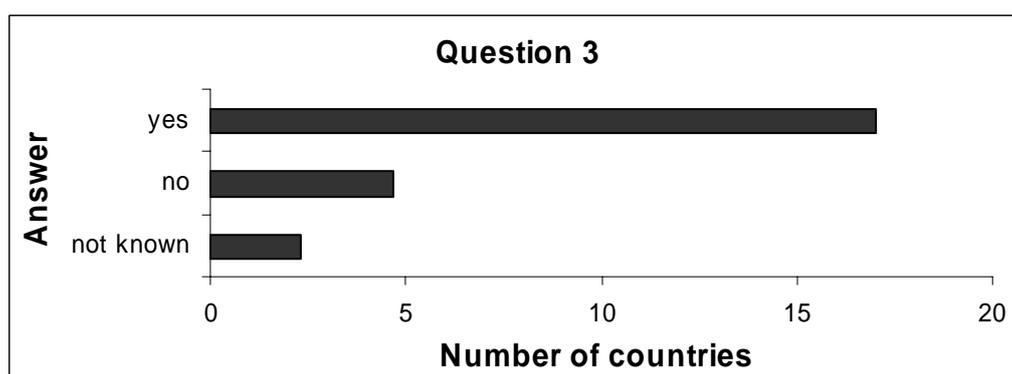
Most of the MSs consider in principle translocated native species as alien species.



Only for ten countries examples of translocated native aquatic species are reported through the questionnaire (Austria, Czech Republic, Greece, Spain, Republic of Ireland, Norway, Poland, Romania, Sweden and United Kingdom). Of the sixteen Translocated native aquatic species by country reports, the majority are freshwater fish (75%). Other examples include the freshwater shrimps *Gammarus roeselii* and *Mysis relicta*, respectively in the Czech part of the Labe river basin and in parts of Norway; and a riparian tree (*Ulmus laevis*) and a duck (*Anas platyrhynchos*) in parts of Sweden. Two countries (Hungary and Denmark) noted that their territory is too small for consideration of translocated species, and this is likely to be true also for some countries that answered yes (in principle) or no to question 2. Three other MSs disagreed with the use of the term, and stressed that translocated native species either should be considered as native species, or as alien only if they reached the status of invasive.

## Q3. Are casual alien species<sup>3</sup> considered as alien species?

The majority of the MSs does consider casual alien species.



Examples were provided by twelve MSs. These include mainly fish species used in aquaculture or released for angling purposes, like different species of carp and trout. In Cyprus, continuous human-mediated introductions since the late sixties resulted in the eradication of the native freshwater fish

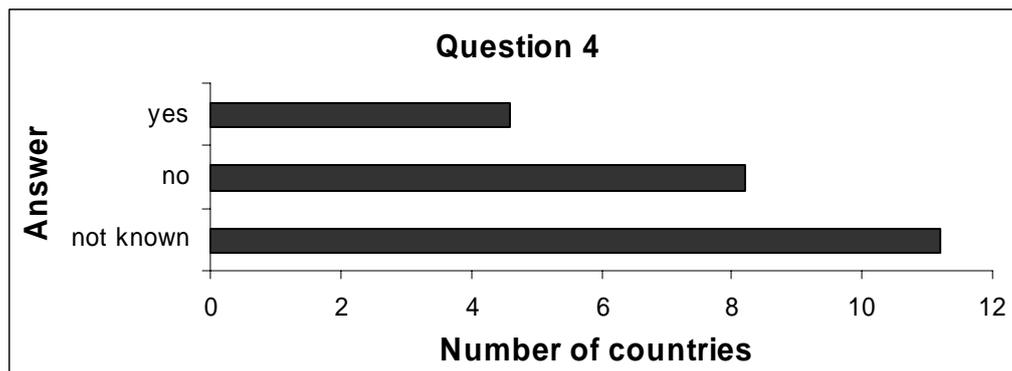
<sup>2</sup> Translocated native species: A native species that displays the characteristics of an alien species when deliberately moved to a different region, catchment or sub-catchment of the same country.

<sup>3</sup> Casual alien species: Alien species that may flourish and even reproduce occasionally in an area, but which do not form self-replacing populations and which rely on repeated introductions for their persistence.

fauna. Apart from fish, also aquarium plants (e.g. *Elodea* spp., *Azolla* spp. and *Eichhornia* spp.) and marine crustaceans (e.g. *Leucosia signata*, *Eriocheir sinensis* and *Homarus americanus*) are locally introduced. Several MSs stressed that casual alien species are only dealt with if they have a (negative) impact, which relates to the frequency and magnitude of the introductions.

#### Q4. Are species that are present as a result of climate change considered as alien species?

Only five countries (partially) agreed that alien species that are present as a result of climate change should be considered under the WFD.



Examples are restricted to Southern and Central Europe. Both marine and freshwater systems are at risk, mainly by exotic macrophytes (e.g. *Lemna turionifera* in Czech lakes and ponds; *Caulerpa racemosa* in Greek coastal waters) and phytoplankton species (e.g. *Diadlesmis confervacea* in Hungarian rivers). Greek and Spanish seas have also been colonised by exotic species, respectively *Lagocephalus sceleratus* and *Xyrichthys novacula*.

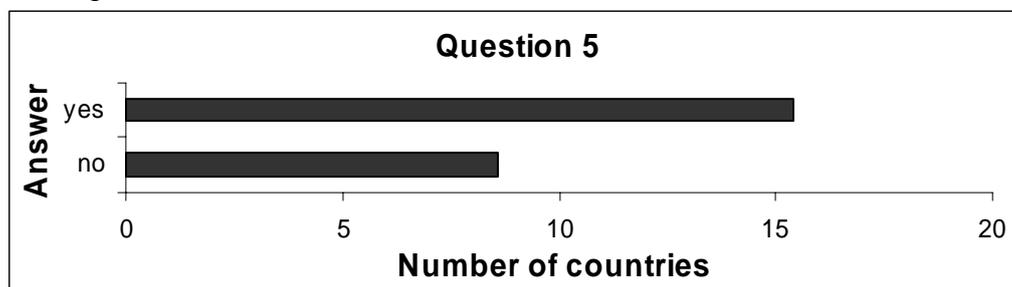
Despite the prevalence of documented examples, the majority of MSs found it difficult to answer the question. This was partially because it was not specified if it only covered 'natural' range expansions, or also human mediated introductions.

Several MSs consider species that have expanded their range 'naturally' not as alien species. Alien species are here per definition species that have been introduced by humans, albeit intentionally or unintentionally. This implicitly ignores an association between climate change and human activity. Given this restriction, it remains in some cases a complex task to assess the status of a species.

In general, species expansions are considered natural and mediated by climate change if they are gradual and northwards. However, for many species the historical record is poor, and/or the pathway of introduction is enigmatic. Also man-made hydromorphological alterations may facilitate range expansions, and render it difficult to assess the role of climate change. For example in The Netherlands, a number of species entered the Rhine basin after the creation of a connection with the Danube basin. The establishment of several of these species might have been mediated by climate change, but it is unclear if this was a necessity for their arrival. Some MSs also stress that climate change is not a recent phenomenon, and that certain species that arrived decades ago are already naturalized and now considered native.

### Q5. Are all introduced species considered to be alien species, regardless of the date of introduction?

Currently, only nine countries have defined a date to distinguish between naturalized introduced species and alien species.



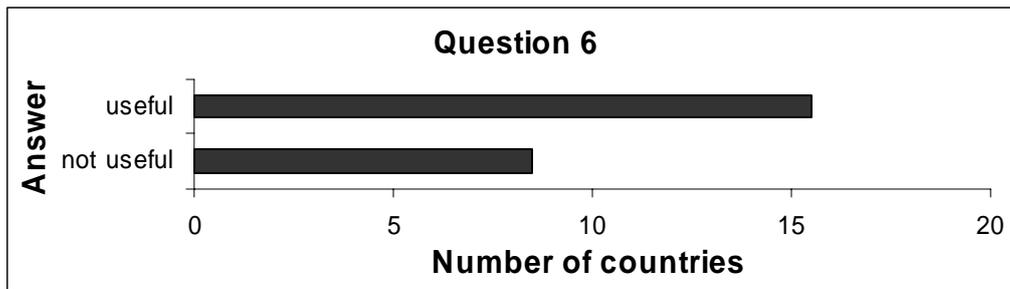
These dates cover a vast period, starting at ‘historical times’ (Norway) and continuing until 1943 (Belgium: Flanders). Most of these countries selected an ecologically meaningful date: the discovery of America in 1492 (Austria, Belgium for marine waters, Germany for lakes and rivers, Ireland (post Middle Ages), Italy (1500; except for Atlantic immigrants) and Luxembourg) or the opening of the Suez Channel in 1869 (Greece). Others selected an arbitrary date, like Belgium for Flanders. A resolution of the Flemish Executive defines ‘non-indigenous’ animal species as species ‘not present in Belgium 50 years before the date of commencement of this resolution’, thus 1943.

It is noteworthy that dates may vary within MSs across organism groups (e.g. Estonia: 1750 for plants and 1900 for animals), across water body types (e.g. Germany: 1492 for lakes and rivers, no date for marine systems), and across regions (e.g. 1910 for Wallonia and 1943 for Flanders (except plants)).

The most cited example of a naturalized species is the common carp (*Cyprinus carpio*). This fish introduction in Europe probably dates back to Roman times. The date of arrival of certain species is debatable, and therefore also their conservational status. This is the case for the white-clawed crayfish (*Austropotamobius pallipes*) in Ireland. This species is currently protected by national and European legislations under the assumption that it is native to Ireland. However, some argue that this species was introduced by man from British stocks in the sixteenth century, and consequently plead for eradication. Another presumably naturalized species is the Roman snail in the United Kingdom. This snail was supposedly introduced a millennium ago but is a benign addition to the native fauna and is now protected under national legislation because of its scarcity.

### Q6. Is it useful to apply a historical date as one of the criteria to determine non-nativeness of a species?

Most MSs agree that a cut-off date is useful to determine whether a species should be considered alien or native, but fail to establish one for different reasons.



MSs argue that cut-off dates should vary among organism groups (as a function of their generation time) and water body types. The latter is linked to the diversity in pathways: the steep increase in the number of alien species at the end of the 19<sup>th</sup> century in the Eastern Mediterranean basin is clearly linked to the opening of the Suez channel in 1869, but this event is not relevant to rivers and lakes. For inland water bodies, the discovery of America in 1492 is most often suggested as a reference.

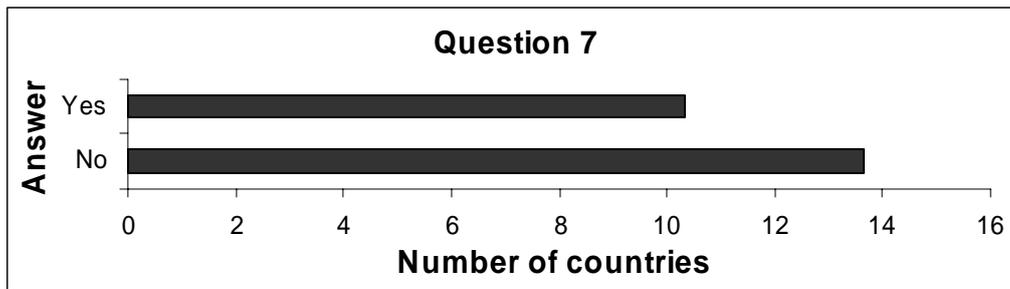
The applicability of historical dates is further limited by the scarcity of historical records. The availability of reference data might differ within MSs among organism groups and types of water bodies. For example, in Spain, the longest record of a marine species is 80 years, whereas some fish species in rivers have been recorded centuries ago.

Furthermore, there is controversy about the spatial scale for standardisation of the cut-off dates. Most proponents of a historical date plead for standardisation on a national scale. Suggestions for cut-off dates include 1800 for fish in Austria (date of establishment of systematics and availability of scientific literature and reference specimens), 1200 for Belgian marine waters (in order to include also *Mya arenaria* and *Balanus improvisus* in alien species lists), 1869 (Cyprus and Greece: opening of the Suez channel), and 1492 (Germany: discovery of America). Borders are usually of no ecological relevance, especially for marine environments, but do often separate areas with different reference data sets. Others argue for a region-specific reference date or even an EU standard (e.g. 1492: proposal by Austria). Given the scarcity of reference data for certain regions by organism groups, a large-scale harmonisation of cut-off dates is only possible if a relatively recent date is selected. One argument to focus on recently introduced species is that these are (often) the only species that still can be eradicated or at least controlled. If not the date itself should be standardized across Europe, then one MS argues that at least the date-setting criteria should be better harmonized.

## ***B. Alien species lists and their maintenance***

**Q7. Are there monitoring programmes running in the MS that are specifically designed for the detection of predefined alien species or the expansion of their ranges?**

Less than half of the EU MSs has monitoring programmes that are specifically designed to detect or monitor the spread of alien species.



The number of alien species that are targeted by these (combinations of) programmes varies from one (e.g. American lobster *Homarus americanus* in Norway; Carolina fanwort *Cabomba caroliniana* in Hungary) to 17 (Ireland). Most monitored species are macrophytes, but also fish and macroinvertebrates are looked after. Other species that are subject to monitoring are typically of economic concern (e.g. parasitic Salmon fluke *Gyrodactylus salaris* in Norway), and less frequently of environmental concern (e.g. the seaweed of the *Caulerpa* genus in Mediterranean coastal waters). The nature of the monitoring programmes was not always detailed in the questionnaire. For those where additional information was provided, it often concerned regional scale surveys, project-based sampling campaigns or assessments made by volunteer organisations. As a result, species level data are often decentralized, discontinuous and difficult to compare (variation in sampling stations, abundance estimations, etc.). Standardized long term national level data are scarce, even for key aliens like the zebra mussel (*Dreissena polymorpha*). Although it was not explicitly asked for, it is remarkable that only one of the respondents referred to a European monitoring programme (FP6 concerted action IMPASSE on the “Environmental impacts of invasive alien species in aquaculture”; concluded in 2008).

**Q8. Would the routine monitoring programmes running in the MS detect the following alien species?**

In nearly all MSs there are routine monitoring programmes that are able to detect one or more of the alien species that are listed in Table 2.

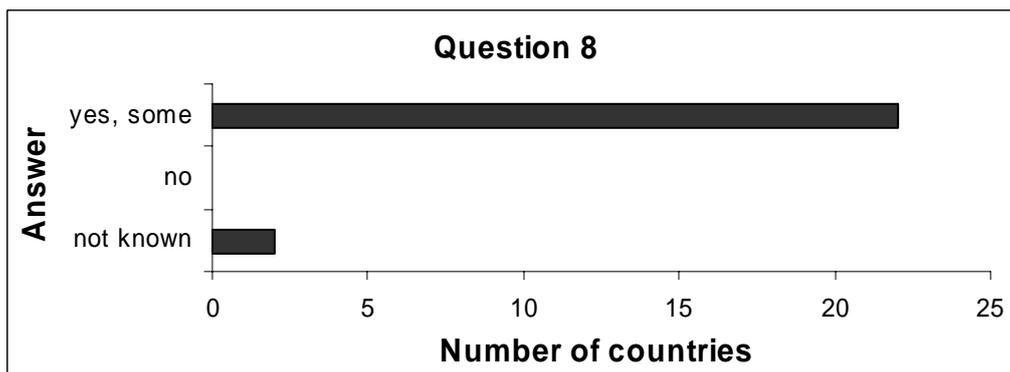


Table 2 shows that within water body types, the probability of detection is comparable for the main WFD biological quality elements (BQEs). For other organism groups there are large differences: only four countries would detect the American bullfrog through routine monitoring, whereas the comb jelly is detectable by nine countries. Basically, the organism groups that are captured with the traditional biological monitoring methods (mostly fishing nets, zoobenthos grabs and plant collectors) have a high chance of being detected. Parasites and riparian species require special capturing devices and are often missed. Also across water body types there is a clear difference in the detection probability: WFD

monitoring programmes for lakes are in general better suited for the detection of alien species than those designed for rivers, and the detection of aliens is least likely in coastal/transitional waters.

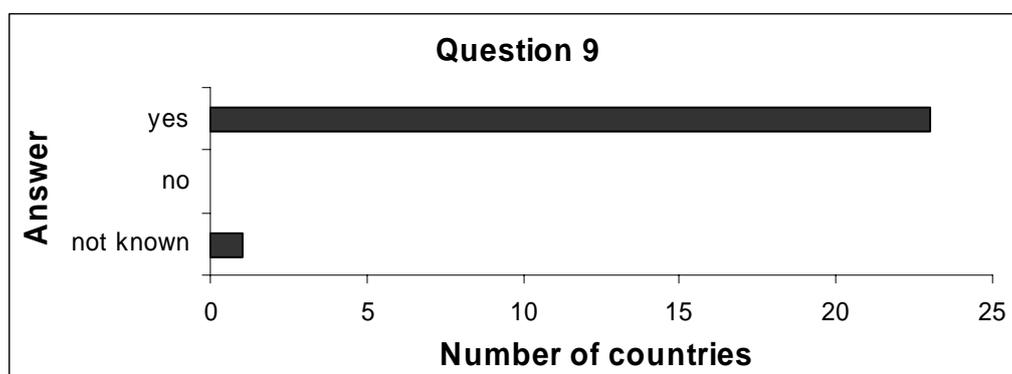
Obviously these values may vary according to the organism considered: e.g. planktonic aliens may be more easily detectable than sessile organisms. As for every other question, also here the data provided by the questionnaire respondents may not be complete and potentially biased according to scientific background and expertise of the respondents. However, this is unlikely to be a sufficient explanation given the large number of questionnaire returns (30 returns, most of which were compiled by more than person and/or institute; see Annex 1 and Acknowledgements).

Table 2: Percentage of countries that would detect the listed alien species in at least part of their surface water bodies. Numbers between brackets give the number of countries that would detect the species relative to the number of countries that responded and have water bodies of that category.

	<b>Macrophytes</b>	<b>Invertebrates</b>	<b>Fish</b>	<b>other</b>	<b>Average</b>
<b>Lakes</b>	<b>78% (18/23)</b> <i>Elodea canadensis</i> (Canadian pondweed)	<b>65% (15/23)</b> <i>Pacifastacus leniusculus</i> (Signal crayfish)	<b>65% (15/23)</b> <i>Pseudorasbora parva</i> (Topmouth gudgeon)	<b>17% (4/23)</b> <i>Lithobates catesbeianus</i> (American bullfrog)	<b>56%</b>
<b>Rivers</b>	<b>42% (10/24)</b> <i>Crassula helmsii</i> (New Zealand pigmyweed)	<b>33% (8/24)</b> <i>Dikerogammarus villosus</i> (Killer shrimp)	<b>63% (15/24)</b> <i>Salvelinus fontinalis</i> (Brook trout)	<b>21% (5/24)</b> <i>Gyrodactylus salaris</i> (Salmon fluke)	<b>40%</b>
<b>Coastal/ transitional waters</b>	<b>35% (7/20)</b> <i>Spartina anglica</i> (Common cord grass)	<b>40% (8/20)</b> <i>Balanus improvisus</i> (Bay barnacle)	<b>25% (5/20)</b> <i>Saurida undosquamis</i> (Brushtooth lizardfish)	<b>45% (9/20)</b> <i>Mnemiopsis leidyi</i> (Comb jelly)	<b>36%</b>
<b>Average</b>	<b>52%</b>	<b>46%</b>	<b>51%</b>	<b>28%</b>	<b>44%</b>

### Q9. Are lists of alien species available in the MS?

All but one of the MSs that returned the questionnaire made reference to one or more (sub)national lists of alien species.



Only the respondent from Slovenia had no knowledge of an alien species list for that country. Denmark, Latvia, Norway and Sweden referred to the North European and Baltic Network on Invasive Alien Species (NOBANIS : [www.nobanis.org](http://www.nobanis.org)). This network provides an online portal that makes alien species list for 17 European countries available. With over 14.000 species by country entries it is the largest alien species database in Europe, at least in terms of species number. A pan-European

database covering over 11.000 species was created within the framework of the FP6 project DAISIE (“Delivering Alien Invasive Species Inventories for Europe”; [www.europe-aliens.org](http://www.europe-aliens.org)). Since the ending of this project it is unclear how this valuable resource will be maintained and updated. For Mediterranean countries the Mediterranean Science Commission ([www.ciesm.org/about/index.htm](http://www.ciesm.org/about/index.htm)) published detailed and encompassing alien species atlases. These atlases collate data from 23 countries, but are limited to the marine environment and cover only four organism groups (fishes, crustacean decapods and stomatopods, molluscs and macrophytes).

Table 3: Links to online (sub)national alien species lists.

Country	Organism groups	Link
Austria	various	<a href="http://www.umweltbundesamt.at/fileadmin/site/publikationen/DP089.pdf">www.umweltbundesamt.at/fileadmin/site/publikationen/DP089.pdf</a>
Belgium	various	<a href="http://www.vliz.be/EN/Figures_Policy/nietinheemsLIJST">www.vliz.be/EN/Figures_Policy/nietinheemsLIJST</a>
Belgium	various	<a href="http://ias.biodiversity.be/ias/species/all">ias.biodiversity.be/ias/species/all</a>
Estonia	various	<a href="http://eelis.ic.envir.ee/voorliigid/eng">eelis.ic.envir.ee/voorliigid/eng</a>
Greece	various	<a href="http://services.ath.hcmr.gr">services.ath.hcmr.gr</a>
Spain	various	<a href="http://www.ingurumena.ejgv.euskadi.net/r49-3074/es/contenidos/informacion/especies_invasoras/es_bio/indic_e.html">www.ingurumena.ejgv.euskadi.net/r49-3074/es/contenidos/informacion/especies_invasoras/es_bio/indic_e.html</a>
Ireland	various	<a href="http://www.invasivespeciesireland.com">www.invasivespeciesireland.com</a>
Ireland	various	<a href="http://www.nbdc.ie">www.nbdc.ie</a>
Lithuania	various	<a href="http://www.corpi.ku.lt/nemo">www.corpi.ku.lt/nemo</a>
Lithuania	various	<a href="http://www.ku.lt/lisd/species.html">www.ku.lt/lisd/species.html</a>
Luxembourg	various	<a href="http://www.environnement.public.lu/conserv_nature/dossiers/PNPN/PNPNvfinale200407-2.pdf">www.environnement.public.lu/conserv_nature/dossiers/PNPN/PNPNvfinale200407-2.pdf</a>
Norway	various	<a href="http://www.biodiversity.no/Article.aspx?m=173&amp;amid=2578">www.biodiversity.no/Article.aspx?m=173&amp;amid=2578</a>
Norway	various	<a href="http://www.artsdatabanken.no/frontpage.aspx?m=2">www.artsdatabanken.no/frontpage.aspx?m=2</a>
Poland	various	<a href="http://www.iop.krakow.pl/ias/Baza.aspx">http://www.iop.krakow.pl/ias/Baza.aspx</a>
United Kingdom	various	<a href="http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5332/alien_tag_table">www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5332/alien_tag_table</a>
Austria	invertebrates	<a href="http://www.boku.ac.at/hfa/">www.boku.ac.at/hfa/</a>
Austria	fish	<a href="http://www.umweltbundesamt.at/fileadmin/site/D">www.umweltbundesamt.at/fileadmin/site/D</a>
Belgium	fish	<a href="http://www.inbo.be/content/page.asp?pid=EN_FAU_FIS_EXOTICS">www.inbo.be/content/page.asp?pid=EN_FAU_FIS_EXOTICS</a>
Czech Republic	macrophytes	<a href="http://www.ibot.cas.cz/invasions">www.ibot.cas.cz/invasions</a>
Finland	birds	<a href="http://www.birdlife.fi/english/index.shtml">www.birdlife.fi/english/index.shtml</a>
Luxembourg	macrophytes	<a href="http://mnhnl.lu/cgi-bin/baseportal.pl?htx=/projects/neophytes/neophytes">mnhnl.lu/cgi-bin/baseportal.pl?htx=/projects/neophytes/neophytes</a>
Luxembourg	mammals	<a href="http://webplaza.pt.lu/lshchley/images/stage.pdf">webplaza.pt.lu/lshchley/images/stage.pdf</a>
United Kingdom	fish	<a href="http://www.defra.gov.uk/marine/pdf/freshwater/species.pdf">www.defra.gov.uk/marine/pdf/freshwater/species.pdf</a>

Nineteen countries have multigroup alien species lists that are operational, while Spain, Finland and The Netherlands are in the process of constructing such lists. The majority of alien species lists are made accessible on the internet (see Table 3). Others published lists in the form of a book or paper (e.g. Czech Republic: Mlikovsky & Styblo 2006, Hungarian macrophytes: Balogh et al. 2004; Irish macrophytes: Reynolds 2002, Italian aquatic animals: Gherardi et al. 2008). Only in the UK there are alien species lists that are specifically designed for use under the WFD. For other countries a query function sometimes allows to retrieve the information for specific organism groups or water body types.

The compatibility of existing lists was assessed by comparing information on the coverage of the existing alien species lists, in terms of number of species, organism groups, habitat types and

ecological information (level of impact and establishment). The overall variability across countries is well illustrated by the high variation among countries in the number of species listed (see Fig. 1). Figure 1 only includes data for (combinations of) lists that cover both aquatic and terrestrial environments. Part of the observed variation can be explained by the absence of (lists for) marine environments in some countries. Some countries list not only established, but also potential invaders, while others have lists that are restricted to high impact or invasive alien species. A straightforward comparison of national data is further hampered by differences in the structure and categorisation. Some lists are structured according to environment categories (most often marine vs. inland), while others make distinction between taxonomic groups (usually plants versus animals). The impact level can be detailed in a very minimalistic way (with vs. without impact), in 3-4 categories (e.g. no, low, high, unknown or potential impact) or in a prosaic text. The assessment of the level of establishment is also variable, and if done it is mostly through categorisation or distribution maps (either grids or point localities). It would be a huge challenge to merge the available data sets without excessive loss of information.

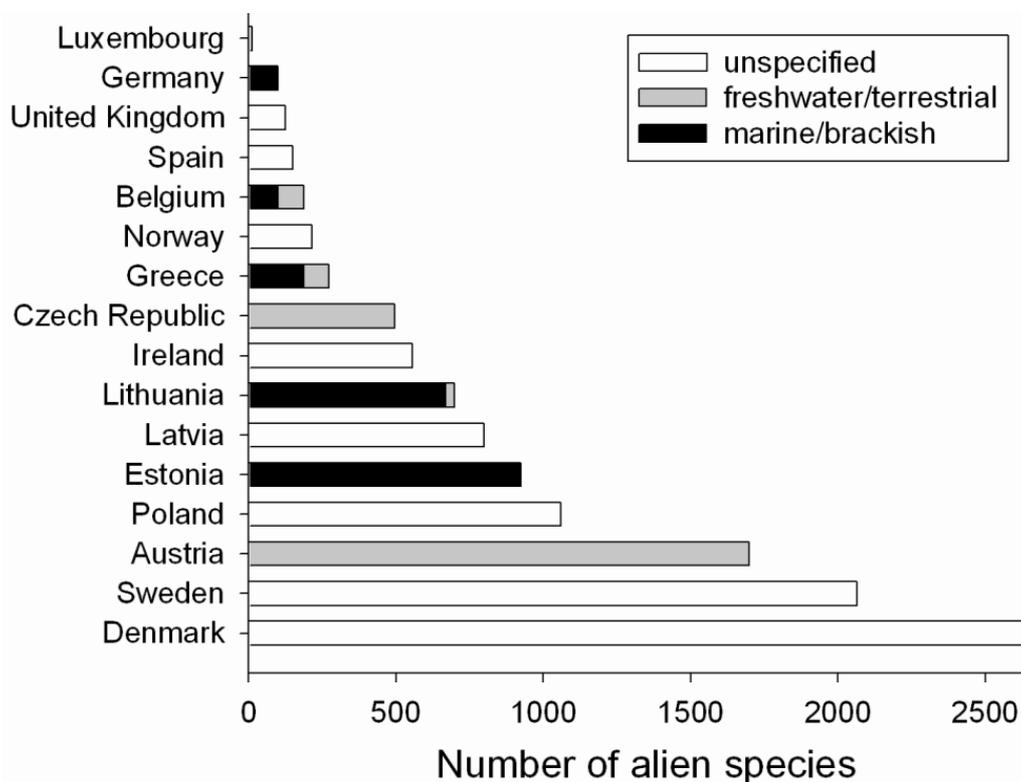


Figure 1: Histogram showing the variation across countries in the number of listed alien species. Only species lists that cover both plant and animal taxa are included. Most lists cover both terrestrial and aquatic environments and several include also potential invaders and low/no impact aliens.

A preliminary examination of the lists to which the questionnaire respondents referred allowed us to identify the main gaps within Europe in the coverage of the different aquatic water body types and species groups (Table 4). Based on the questionnaire results, more than half of the EU27-countries have lists ready that include marine (if not landlocked) and freshwater animals and plants (15 countries). For nine countries alien species list are either absent or under construction, and three other countries have lists with one or more major gaps. Also, within the (combinations of) lists that contain examples of plants and animals from freshwater and marine environments, there may be substantial variation in taxonomical or habitat coverage. A comprehensive comparison of the lists would require all lists to be accessible.

Table 4: Overview of the coverage by the different EU MSs and Norway of alien plant and animal species lists in the main aquatic environments (“-”: no data provided; “na”: not applicable).

country	number of species	accessible	freshwater		marine	
			plants	animals	plants	animals
Austria	1700+	yes	yes	yes	na	na
Belgium	189	yes	yes	yes	yes	yes
Bulgaria	-	-	-	-	-	-
Cyprus	?	no	-	-	yes	yes
Czech Republic	ca. 1800	yes <sup>1</sup>	yes	yes	na	na
Denmark	2656	yes	yes	yes	yes	yes
Estonia	924	yes	yes	yes	yes	yes
Germany	ca. 100	no	-	-	yes	yes
Greece	268	no	yes	yes	yes	yes
Finland	241	yes	yes	yes	yes	yes
France	?	no	under construction			
Hungary	?	no	under construction (plants finished)			
Italy	310	yes <sup>2</sup>	-	yes	yes	yes
Latvia	807	yes	yes	yes	yes	yes
Lithuania	721 <sup>3</sup>	yes	yes <sup>3</sup>	yes <sup>3</sup>	yes	yes
Luxembourg	11	yes	yes	yes	na	na
Malta	-	-	-	-	-	-
Norway	215	yes	yes	yes	yes	yes
Poland	1060	yes	yes	yes	yes	yes
Portugal	-	-	-	-	-	-
Rep. of Ireland	557	yes	yes	yes	yes	yes
Romania	?	no	yes	yes	yes	yes
Slovakia	-	-	-	-	na	na
Slovenia	-	-	-	-	-	-
Spain	?	no	under construction (plants finished)			
Sweden	2065	yes	yes	yes	yes	yes
The Netherlands	?	no	under construction			
United Kingdom	125	yes	yes	yes	yes	yes

<sup>1</sup> 496 species are listed in a book written in Czech, and 1378 alien plants are listed in a paper in English.

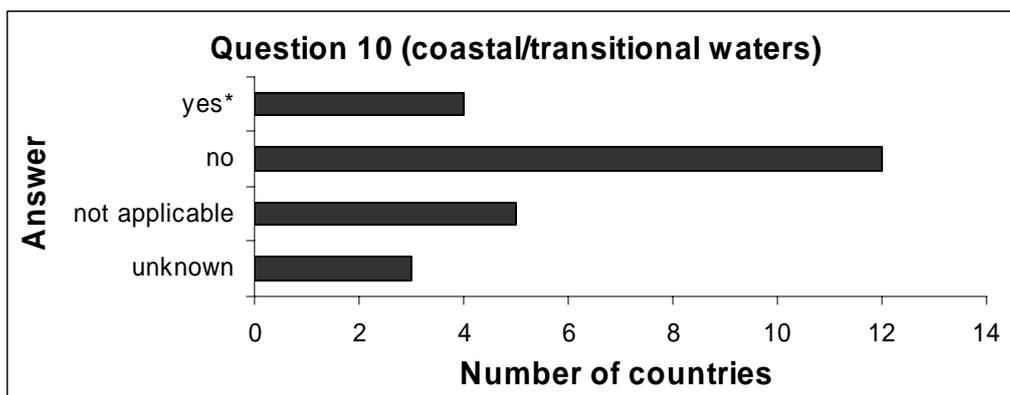
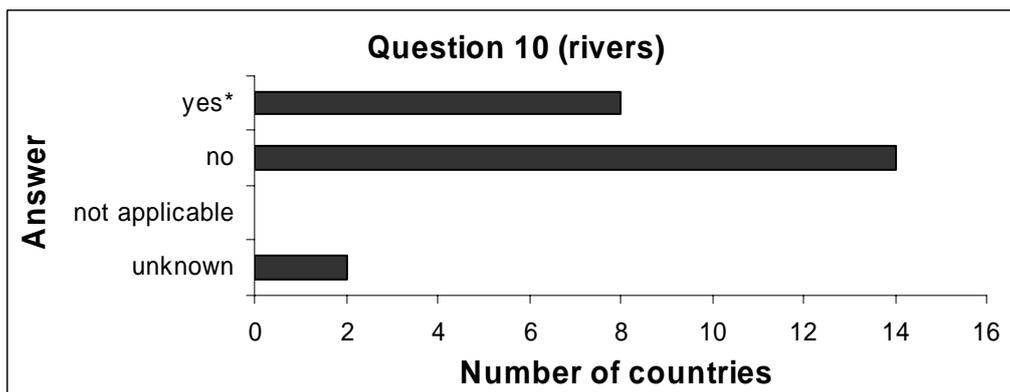
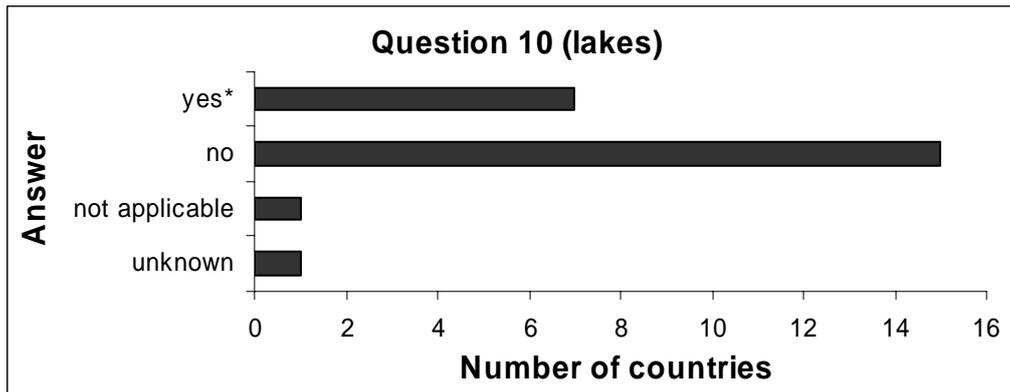
<sup>2</sup> A paper in English lists 112 aquatic animals and a list of marine macrophytes, invertebrates and fish can be obtained through a contact person (resp. 83, 88 and 27 species)

<sup>3</sup> Of the 721 aliens listed, 96% are marine species.

### C. Alien species in ecological status assessment and classification under the WFD

#### Q10. Are alien species explicitly taken into account by the MS in ecological status assessment and classification under the WFD?

Only about one third of the interrogated MSs takes alien species explicitly into account when assessing the ecological status of a surface water body under the WFD. This figure is comparable for the different water body types.



\* A country was considered to take explicit account of alien species also if this is true only for part of its territory or water bodies, or for a subset of the WFD BQEs (see text for details). Hungary stated to account directly for alien species, but no information was provided to verify this.

Although it was not explicitly asked for in the questionnaire, a number of MSs also supported their choice with arguments. Among the countries that do not include directly alien species in their assessment method, we identified three groups, each with a different argumentation. A first group argued that any major pressure by alien species would already be detected by the other pressure-based assessment tools, and that there is no need for an additional assessment nor for refinement of the existing tools. A second group fails to account directly for aliens because of practical reasons, most often the scarcity of data (species distributions and impacts) and the budgetary limitations for sampling. One MS states that alien species were not included because they do not constitute a significant pressure in their territory.

A review of the different assessment methods revealed that there are several approaches in use to account for alien species:

1) The most direct and presumably also most dramatic way to account for alien species in classification is through a post-hoc adjustment of status as assessed using the traditional pressure-based tools. This approach is adopted to assess ecological status of all water body types in the United Kingdom and in the Republic of Ireland. These countries created lists of species, categorized according to their (potential) impact, and downgrade water bodies from high or good to good or moderate status according to presence of blacklisted species. Downscaling in the UK is based on two principles: (1) A water body classified as being at high status (i.e. in reference condition) should contain no established alien species known to cause serious impacts to water bodies, and (2) a water body that demonstrates more than a slight adverse impact from one or more established alien species on the high-impact list is considered to be failing to achieve good status. To apply these principles a list of alien species has been created, and is regularly updated. Currently the UK WFD list covers 34 high impact aquatic and riparian alien species. The blacklist includes mostly macrophytes (15 species) and invertebrates (16 species), and only few vertebrates (3 fish: Topmouth gudgeon, Common carp and Goldfish). The UK acknowledges that the ability to apply their principles is severely limited by a lack of data on the distribution of invasive non-native species. In the Republic of Ireland only few aliens are considered for status adjustments. Water bodies containing Zebra mussel cannot be in high status, and also some alien fish species (like roach, pike, perch and rudd) that were locally introduced post 1980 allow downscaling of the water body, but only if these exhibit at least a moderate negative impact on the existing native populations. A similar approach is used to assess the status of high mountain lakes in Catalonia, Spain. These lakes were originally void of fish, but in recent years and decades many have been stocked for angling purposes. The presence of fish therefore justifies a downgrading of lakes from high to good ecological status. Also in the Ebro river basin efforts are ongoing to assess the impact of alien species within the WFD. In the expectation of more elaborate lists of alien species for the region, only two aliens are currently being considered: Zebra mussel and Wels catfish (*Silurus glanis*).

2) Several MSs assess the dissimilarity between the composition of the actual community and that of a hypothetical or historical reference community as part of the ecological status assessment. The reference communities most often lack alien species. If then alien species are collected and included in this assessment, they directly affect the status value estimate. This approach is being used by Belgium and the Netherlands in coastal and transitional waters (BEQI index), by Austria in rivers (FIA fish index; only alien salmonids are considered) and is under consideration by Norway (metric under development). In some cases observed and reference communities are compared, but without including records of alien species (e.g. for lakes in Austria).

3) A third way to account for alien species in a direct way is by making them an integral part of a multimetric index. For example Germany has developed the PTI index for large rivers. For this index, about 300 species were scored (A-C) according to their linkage with a predefined reference status through expert judgement, in a way that aliens score lower than most native species. This results in a

demonstrable association between the status class and the abundance of alien species. Also the classification of most Belgian inland waters is based on metrics that account for alien species. Fish metrics evaluate the total weight percentage of alien species present (the less, the better the metric) for lakes and for the bream and barbel zone of rivers but not for upstream zones of rivers. For macrophytes, black-listed aliens are in all cases listed as “not type-specific” which implies that they negatively affect the relevant metric of the macrophyte assessment method for rivers and lakes. In Spanish estuaries, an index has been developed that includes, as one of the nine metrics, the presence of alien species. This method is currently being applied in the Basque country region.

**Q11. In which water bodies are alien species ABSENT when applying the MS’s protocol for ecological status? Note that.**

- No answer
- Alien species presence is not linked with ecological status
- Alien species are absent in waters of high ecological status\*
- Alien species are absent in waters of good ecological status\*
- Alien species with impact are absent in waters of high ecological status\*
- Alien species with impact are absent in waters of good ecological status\*
- Established alien species are absent in waters of high ecological status\*
- Established alien species are absent in waters of good ecological status\*
- Other direct link with ecological status

*\* These answers are not mutually exclusive.*

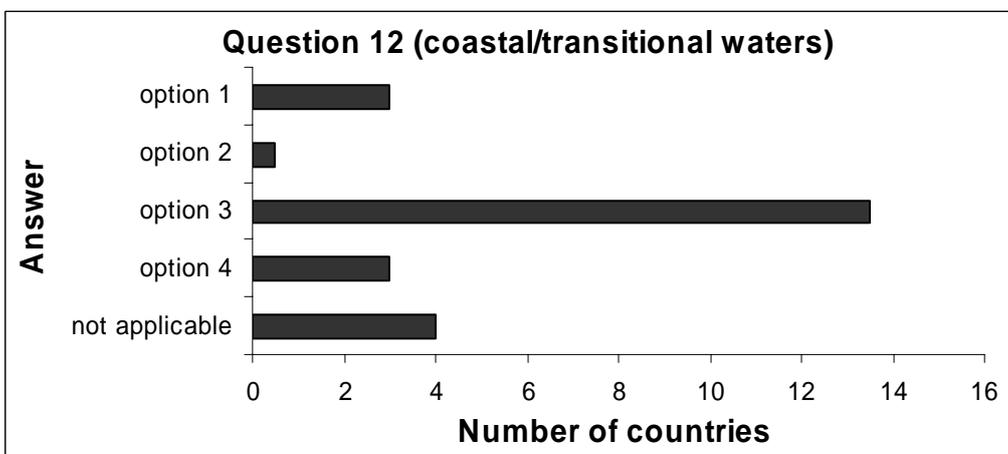
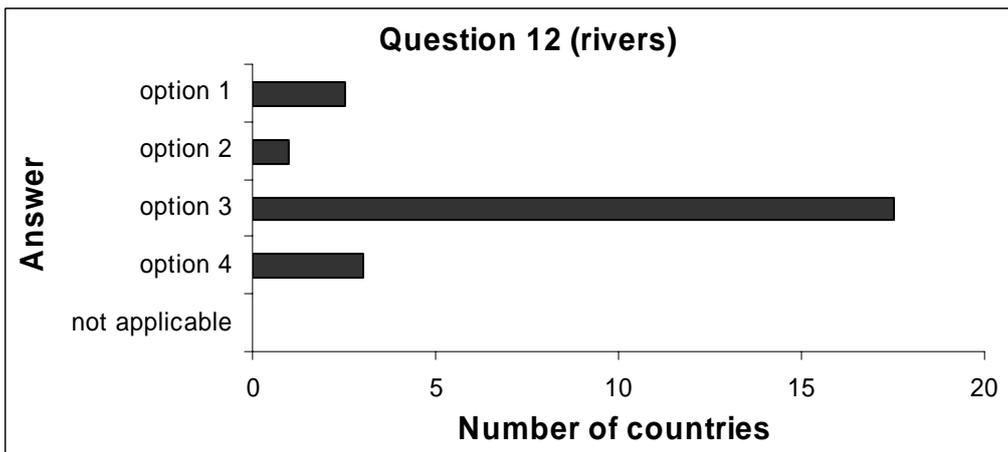
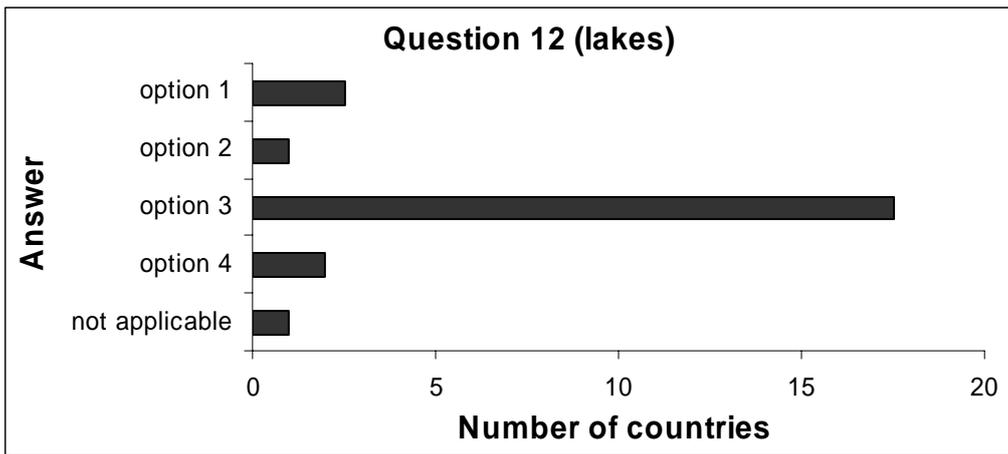
This question was included under the assumption that most MSs would account for alien species by downgrading the status as assessed by the biological assessment methods. However, only three countries used this approach (see question 12). Most of the approaches do not result in a direct link of alien species presence/impact/establishment with ecological status class. As a result, most MSs left this question unanswered or suggested there was a link which was questionable given the method description provided under Question 10. Therefore we opted not to present the results to this question.

**Q12. Under which option<sup>4</sup> does the current MS’s WFD ecological status assessment fall?**

The vast majority of MSs currently applies classification option 3: assessments are done without explicitly accounting for alien species, but their pressures and impacts are assumed to do be picked up by the biological assessment methods.

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<sup>4</sup> The four options and their advantages and disadvantages are listed in Annex 2.



The replies to question 10 indicate that only few MSs directly account for alien species when assessing the ecological status of a water body. This does not necessarily imply that pressures by alien species remain undetected. In fact, several MSs state that their current assessment tools are sensitive enough to detect these pressures, even though they were originally designed for other purposes. This partly explains why so many MSs currently apply option 3 (‘No additional assessment of alien species is taken, as the pressure-based classification tools are assumed to already detect any impacts caused by alien species’). Others opted for Option 3 because it is the most practicable or because they assume that alien species pressures are insignificant.

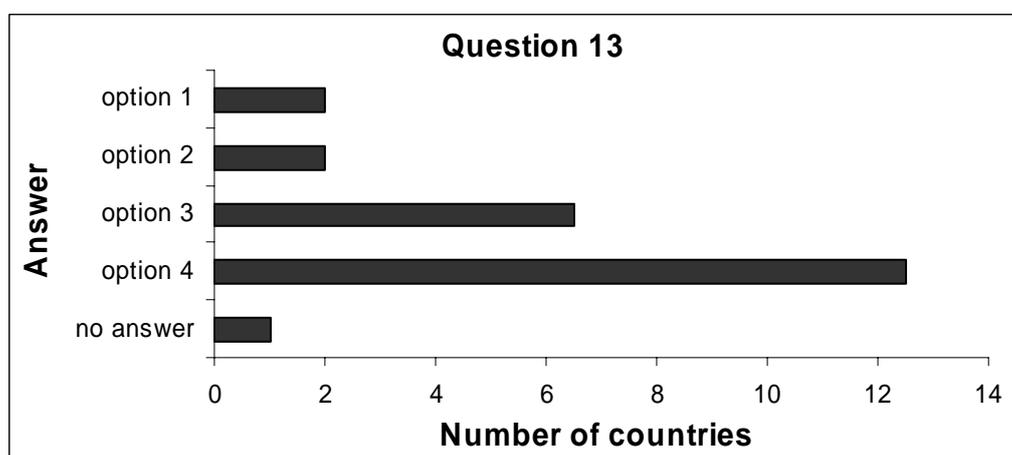
Option 1 (‘Classify water bodies using pressure-based classification tools, and then modify the classification based on presence/absence of alien species (and their ecological impact)’) is only being implemented by the United Kingdom, the Republic of Ireland, and for certain habitat types in particular regions of Spain (see question 10).

Hungary responded that they use of a quantitative variant of option 1 (i.e. option 2: ‘As for option 1, but use quantitative assessments linking the abundance or percentage cover of alien species to the five WFD quality classes’), but details of the approach were not communicated.

Cyprus, Greece, Luxembourg and Norway (coastal waters only) are planning to supplement the WFD classifications with separate risk assessment by applying one or more biopollution indices that measure the risk and/or impact of alien species. These would then be published alongside the WFD water body classification (i.e. option 4).

**Q13. Which option (see question 12) WOULD BE the most appropriate considering both feasibility and usefulness in ecological status assessment and classification under the WFD?**

Although most MSs currently do not take explicit account of alien species (option 3; see questions 10 and 12), most would prefer to include aliens in a more explicit way (options 1, 2 and 4: ca. 70%), even when considering the feasibility of such an approach.



In particular the calculation of a supplementary biopollution index is supported by a large number of countries. This approach would allow separating most easily the pressure by alien species from those by nutrients, hydromorphological alterations and inorganic pollutants. Only if the stress by alien species is identified independently from other stressors, targeted management is possible. Another argument to separate alien species risk and impact assessments from other pressure assessments is the particular nature of species introductions. In contrast to other sources of pollution, alien species have the capacity to reproduce and exponentially increase their impact over time.

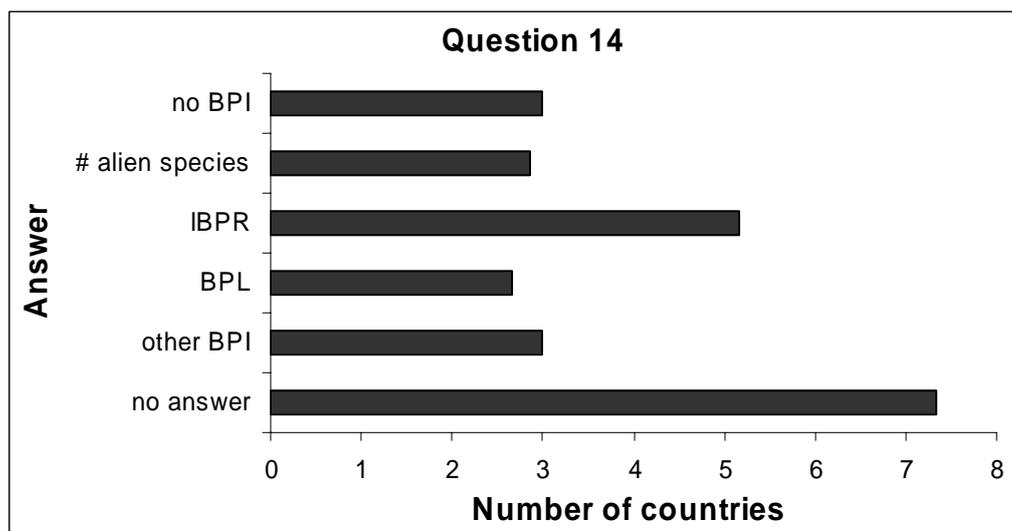
It may also be possible to derive the pressure by aliens through a post hoc analysis of integrative classification methods. This is for example the case when indices are used that are composed of metric that differ in their sensitivity to the different pressures. However, it remains largely unexplored how the existing classification tools respond to alien species impacts.

Options 1 and 2, which directly downscale pressure-based assessments based on alien species presence or abundance, are generally considered to be too stringent, and may attribute a higher weight to aliens than to other pressures. Some MSs make here the distinction between alien species that can be managed and others for which no effective control measures are at hand. MSs are worried that under options 2 and 3 the presence of uncontrollable aliens, like many macroinvertebrate species, would

permanently downgrade the majority of their water bodies. Therefore, consideration of these options urges for an evaluation of the risk of not achieving the good ecological status due to alien species.

**Q14. Which biopollution index (BPI, see option 4 in previous question) is the most appropriate considering both feasibility and usefulness? All suggested BPIs are scaled in five categories in accordance with WFD bad-high ecological status categorization.**

MSs agree that the pressure-based assessment tools that are not sensitive to alien species impacts should be complemented with a biopollution index (see question 13).



In recent years, several of these indices have been developed, and MSs were asked to choose amongst these taking into account their feasibility and usefulness.

The simplest approach is to use the number of alien species present in a water body as a proxy for alien species pressure. The usefulness of this approach is limited because it fails to account for differences among species, and most countries argue that this cannot be ignored. Within the FP6 project ALARM ('Assessing Large scale environmental Risks for biodiversity with tested Methods') an index was developed that takes into account not only the number of aliens, relative to the number of native species, but also the potential impact and spread of each alien species (Panov et al. 2009). For this so-called 'Integrated Biological Pollution Risk' (IBPR) index the available ecological information is used to allocate species to black, grey or white lists. The relative number of species in the different lists then determines the biopollution level. For the calculation of the IBPR index, presence-absence species data are sufficient. This explains why it was considered to be the most adequate index for use under the WFD by five MSs.

The Biopollution Level (BPL) index (Olenin et al. 2007) is more elaborate, as it requires semi-quantitative data on the abundance and distribution range of the alien species, and on their impacts on community, habitat and ecosystem level. Many questionnaire respondents supported in principle this holistic approach, but casted doubt on its applicability on a large scale. Others noted that the different impact levels of the BPL index can also be integrated in a multimetric index originally designed for use under the WFD. For example the BEQI method, a tool that is currently being used in coastal waters in Belgium and the Netherlands, is suitable for detecting and uncoupling effects of alien species on community, habitat and ecosystem level. One respondent suggested to modify the BPL index in a way that it takes better account of the local abundance and distribution of the alien species (e.g. by

making qualitative assessments of absolute and relative biomass and species number), and by slightly changing the impact categorisation (using indicator species for ecosystem processes).

Others refused to select an index because all were considered limited for use under the WFD, or they were unable to judge on any of the proposed indices in the absence of comparative data.

### 3. Conclusions

The high number of questionnaire returns (n=30) indicates a high interest of EU MSs in the issue of alien species, in particular in relation to the classification of water bodies under the WFD. This is further illustrated by the fact that 64% of the respondents expressed their willingness to participate in a workshop on this topic. The need for discussion not only arises from an increased awareness of the impacts of aquatic alien species, but also from the controversy within the European community regarding the role of alien species in ecological status assessments.

This controversy is in part related to the lack of a universally accepted terminology. While some MSs have adopted the definition of the Convention on Biological Diversity for use under the WFD, others find this too inclusive and prefer to limit the discussion to human-introduced species that have a demonstrable impact. For a correct appraisal of the role of climate change the available data are in many cases insufficient. The scarcity of historical data also precludes for some organism groups and environments the setting of ecologically relevant dates to separate between naturalized aliens and newly introduced species. Despite these practical constraints, MSs acknowledge the need for a more consistent use of alien species related terms and conditions within Europe.

Alien species lists are a prerequisite to implement a classification that accounts directly for their pressures. Such lists are available in most MSs, and they cover in most cases the main taxonomical groups and habitat types. However, there exist important gaps, and there is a large potential for harmonisation of the different lists. For the moment, there is no pan-European structure or network that is taking care of these tasks.

The WFD does not explicitly require MSs to take account of alien species for the assessment of ecological status of their surface water bodies. As a result, most MSs developed ecological status assessment tools that do not directly account for the effects of alien species. However, the WFD does stipulate that the assessments should reflect the distraction from naturalness. This inspired four to eight countries to account for alien species explicitly, depending on the habitat type considered. In most cases, this is done by attributing aliens a different score than native species in a metric, or by including alien species in comparisons with alien-free reference communities. Others classify their water bodies using the pressure-based tools, and subsequently downgrade the high (and good) ecological status water bodies to lower classes based on the presence of predefined high-impact species. A third and significant group of MSs argues that their pressure-based assessment tools are adequate to pick up also the impacts of alien species, even though these species are not necessarily treated differently than native species during the process of assessment. This urges for an objective and comprehensive investigation of the sensitivity of existing assessment methods to the presence and impact of alien species.

Ecological status assessments that are designed to detect anthropogenic pressures may in some cases reflect the pressure by alien species, but remain inadequate to disentangle the magnitudes of the individual pressures. Because of this, many MSs supported the implementation of a supplementary biopollution index. An index that measures the pressure by alien species and that is an acceptable trade-off between practicability and accuracy could then be published alongside the values for the other pressure-based assessment methods. This approach would unambiguously demonstrate the

magnitude of the issue of alien species in European water bodies, and ultimately result in an adequate management of the problem.

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## **Annex 2: List of options that are under consideration to account for alien species under the WFD.**

### **Option 1: Classify water bodies using pressure-based classification tools, and then modify the classification based on presence/absence of alien species (and their ecological impact).**

- + Ensures that the impacts of alien species, undetected by other classification tools, are taken account of in status classification
- + Simplicity of approach with no attempt made to apply alien species data to all five status classes
- + Does not require detailed quantitative information
- + Sends out a clear message with respect to environmental and economic damage caused by alien species
- + Provides an incentive for action where alien species are the cause of a water body failing to meet its environmental objectives
- Requires a broad, non-specific assessment of adverse impact
- Will result in downgrading of water bodies otherwise at high or good status for which there may be no feasible measures available for tackling problems of alien species

### **Option 2: As for Option 1, but use quantitative assessments linking the abundance or percentage cover of alien species to the five WFD quality classes.**

- + Ensures that the impacts of alien species, undetected by other classification tools, are taken account of in status classification
- + Attempts to match different degrees of potential impact with the five levels of ecological status
- + Sends out a clear message with respect to environmental and economic damage caused by alien species
- + Provides an incentive for action where alien species are the cause of a water body failing to meet its environmental objectives
- Requires detailed quantitative information on percentage cover or population size of individual alien species
- Assumes a simple relationship between degree of infestation and impact on habitats and native species
- Will result in downgrading of water bodies otherwise at high or good status for which there may be no feasible measures available for tackling problems of alien species

### **Option 3: No additional assessment of alien species is taken, as the pressure-based classification tools are assumed to already detect any impacts caused by alien species.**

- + No additional work required on alien species to reach final water body classification
- The impacts of some alien species will not be picked up by other tools used for water body classification
- Will not take account of impacts from alien species that have recently arrived or are present at low levels

### **Option 4: Classify water bodies without taking account explicitly of alien species (as for option 3), but carry out a separate risk assessment by applying various 'biopollution' indices (BPI, see next question) for risk and impact of alien species and publish this alongside the WFD water body classification.**

- + Removes alien species from water body classification, preventing downgrading from high or good status solely on the basis of alien species
- + Highlights the risk of impact from alien species already present, as well as those at risk of invading a water body
- + Does not require proof of impact to trigger concern
- + Sends a clear message about alien species by separating it from other procedures for water body classification
- Does not fully meet the requirements of the WFD
- No statutory imperative to apply programmes of measures to reduce problems from alien species
- If a water body is at high or good status there is a risk that no action will be taken, even if the 'biopollution index' indicates there is a serious problem from alien species

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**Abstract**

Alien species constitute a major pressure in aquatic environments, both ecologically and economically. This recognition has initiated a debate on the role of alien species in ecological status classifications. We distributed a questionnaire to review how EU Member States (MSs) deal with alien species in their national status assessments under the Water Framework Directive (WFD). The questionnaire was filled and returned by 23 EU MSs and Norway. Analysis of the questionnaire returns and referred methods revealed the existence of a wide range of approaches: (1) The majority of MSs do not take alien species explicitly into account for classification under the WFD. This implies that the biological methods that were developed for assessing anthropogenic pressures are assumed to be able to pick up pressures by alien species, but this remains to be verified. Some of these MSs do acknowledge the need for a more direct or supplementary account of alien species, but fail to do so because of the lack of information on the impact and distribution of alien species within their territory. (2) Few MSs assess ecological status using the pressure-based tools, and subsequently downgraded the status in case of presence of predefined high-impact alien species. The main critiques to this approach are that it puts too much weight on alien species, compared to other pressures, and that it may result in downgrading of many water bodies, even in the absence of any perspectives for remediation of the problem. (3) Others account for alien species by attributing aliens a different score than native species in a metric, or by including alien species in comparisons with alien-free reference communities. Such approaches may blur the impact assessment of other pressures, and may obscure the magnitude of the alien species problem. (4) Almost all MSs support the idea of a supplementary biopollution index. Such an index would uncouple alien species and anthropogenic pressure assessments, and allow for a correct appraisal of the problem without affecting the WFD classification. A pan-European index may not be feasible because of different trade-offs between practicability and accuracy across MSs. A better harmonization of the views on alien species and water body classification within Europe is desirable, but a challenging task. It requires an agreed interpretation and usage of alien species related terms, and an increased compatibility and completeness of national and regional alien species lists. These topics have been added for discussion to the 2010-2012 mandate of the WFD Working Group on Ecological Status.

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