

## **Risk Assessment Toolkit and DSS. The online Risk Assessment Toolkit and Decision Support System for introductions of invasive alien species for the Black Sea catchment**

<b>Title</b>	Risk Assessment Toolkit and DSS. The online Risk Assessment Toolkit and Decision Support System for introductions of invasive alien species for the Black Sea catchment
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## **Executive Summary**

The Decision Support System (DSS) for management of introductions of invasive alien species (IAS) for the Black Sea basin (The Black Sea basin IAS management DSS) has been developed during 2009-2012 within the framework of the European Commission FP7 *enviroGRIDS* project (Building Capacity for a Black Sea Catchment Observation and Assessment System supporting Sustainable Development, Grant Agreement No. 26740). The online Black Sea basin IAS management DSS represents a part of the Regional Euro-Asian Biological Invasions Centre (REABIC) information system and consists of four main information management tools: risk assessment protocols, searchable species directory with species profiles, GIS application for mapping species records, and searchable experts database. It also includes additional supportive tools such as the international open access journals *Aquatic Invasions* and *BioInvasions Records*, and links to other relevant online tools and resources needed for IAS management. The incorporation of open access journals into the REABIC information system represents an innovative approach to IAS-related information management and ensures sustainability of REABIC-based information management tools. In addition, the developing Black Sea basin IAS management DSS will include an early warning component, and currently we are working on mechanisms for the more effective transfer of scientific information from publications in the open access journals upwards to the level of decision-making, by focusing on the Black Sea basin area as a model region.

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## **1 Introduction**

### **1.1 Purpose and scope**

The development of open databases and information systems on invasive alien species (IAS) is essential for effective international cooperation in data and expertise sharing, and provides support for management and control efforts. The international legal regime requires governments and other relevant organizations to support the creation and maintenance of such information resources (CBD 2002). These resources may provide comprehensive information for the management of invasive alien species, as well as for scientific and educational purposes.

There is an urgent need for open information on aquatic alien species in the Ponto-Caspian area (Panov 2004). This region is particularly heavily affected by species invasions: the list of alien species includes more than 200 names only for the Black Sea itself (Alexandrov et al. 2007; TDA 2007). The Black Sea region is serving both as recipient of a number of non-native species, and as an important donor area for invasive species introductions worldwide. In Europe, the Black Sea basin represents a southern part of the European invasion network – the network of river and sea basins, interconnected via inland water and coastal invasion corridors (Figure 2). The current invasion corridors and the projected future developments of the European network of inland waterways may highly facilitate the transfer of alien species across European inland waters and coastal ecosystems. Appropriate risk assessment-based management options are required to address risks posed by human-mediated introductions of these species (Panov et al. 2009).

However, open information resources in the region are restricted to three web sites with limiting value for risk assessment and decision-making (see in Chapter 2).

Essential scientific information on IAS and relevant expertise are available in the region, but this information remains generally unpublished (or published with serious delays) and international networking in information management in the region is generally lacking. This is one of reasons for the absence of effective management of invasive species in the region. The purpose of this document is to introduce innovative information management tools for IAS-related information, developed by members of the *enviroGRIDS* consortium and associate project partners in 2009-2012.

This document is intended for public release as an introduction to the developing regional information and Decision Support System for management of introductions of invasive alien species (IAS) for the Black Sea basin.

### **1.2 Document structure**

The document is divided into six chapters. Chapter 2 briefly introduces the current cooperation on both regional and EU levels regarding the issue of IAS-related information management. Chapter 3 describes online tools for risk assessment and other information management instruments of the regional DSS developed in the *enviroGRIDS* project. Conclusions and recommendations are given in Chapter 4. A list of key references is provided in Chapter 5, and a list of presentations at relevant international meeting, in Chapter 6. Definitions and abbreviations of key terms for risk assessment of non-native species are provided in Appendix 1.

## **2 European and regional cooperation on IAS information management and REABIC information system**

### **2.1. European cooperation on IAS information management**

In this section, we give a brief overview of current European cooperation on IAS information management issues, relevant to our activities in the *enviroGRIDS* project.

On the EU level, increasing awareness on IAS issues during the last decade has resulted in the funding of several research projects, aimed at the development of relevant risk assessment and information management tools, including the European Commission FP6 projects ALARM (2004-2009, Assessing Large-scale environmental Risks with tested Methods, <http://www.alarmproject.net>) and DAISIE (2005-2008, Delivering Alien Invasive

Species Inventories for Europe, <http://www.europe-aliens.org>). Both projects significantly contributed to international networking in information management. Specifically, the ALARM project supported the development of the Regional Euro-Asian Biological Invasions Centre (REABIC) information system (<http://www.reabic.net>) and provided start-up funding for the REABIC-based international open access journal *Aquatic Invasions* as an early warning tool, providing protection of authors rights on aquatic IAS primary information (Panov et al. 2011). Although the DAISIE project resulted in the creation of a large centralized Pan-European information system on alien species (<http://www.europe-aliens.org>), nevertheless its functionality currently is seriously limited and its database is missing geo-referenced species records information (Vandekerkhove and Cardoso 2011). The second largest European informational resource on IAS, NOBANIS (European Network on Invasive Alien Species, <http://www.nobanis.org>), also lacks geo-referenced species records information, considered essential for early warning and management purposes.

Meanwhile, the 'European Council conclusions on a mid-term assessment of implementing the EU Biodiversity Action Plan and Towards an EU Strategy on Invasive Alien Species' adopted at the 2953rd Environment Council meeting, Luxembourg, 25 June 2009, underlines that the cooperation of all Member States and the Commission in addressing IAS issues such as early warning is a necessary condition for successful management of IAS. It also underlines the urgent need for the Commission and the Member States to develop together an appropriate information system for early warning and rapid response, including mechanisms on developing and updating specific lists of IAS, linking European lists to international lists, cooperating on biosecurity and control measures within the EU, with neighbouring countries and with international organisations.

DAISIE and NOBANIS databases, along with other regional and national online informational resources on non-native species, have been recently reviewed in a comprehensive report to the European Commission "Online information systems with alien species occurrence records in Europe" by Vandekerkhove and Cardoso (2011). According this report, "the distributed and largely independent nature of existing alien species information systems has multiple consequences: (i) In the absence of an overarching data exploration system, it complicates the retrieval of information, and the identification of knowledge gaps; (ii) It allows systems to diverge and as such become less compatible; (iii) It potentially makes inefficient use of existing financial and intellectual resources". As it was found by the authors of this study, alien species databases currently report occurrences primarily at country level, with limited value for scientists and managers. A shift towards georeferenced occurrences could be achieved in a cost-effective way by linking to biodiversity databases and digitized archives of relevant journals (Vandekerkhove and Cardoso 2011). As it was also noted in this report, a "sustainable and yet cost-effective mechanism to support expert contributions is to attach author rights to them. This approach is successfully adopted by the journal *Aquatic Invasions*, which has already encouraged many experts to share their knowledge of alien species introductions. Access to published records is facilitated by the development of an online, GIS-based search and mapping tool".

A study by Vandekerkhove and Cardoso (2011) also shows that the online DAISIE database is still the most comprehensive in Europe in terms of national level alien species occurrences, despite the termination of the project more than three years ago. On the other hand, there are strong indications that despite occasional updates DAISIE is at present no longer a sufficient source of information. Furthermore, the absence of georeferenced records, together with the doubtful nature of at least some of the DAISIE records force authors of this report to reconsider the data centralisation approach. An alternative approach to increase the accessibility of information is to create a network of online interoperable web services through which information in distributed resources can be accessed. This concept was first realized in Europe in the early 2000s, with the establishment of the virtual Regional Biological Invasions Centre (RBIC). RBIC served as a thematic regional hub, linking all European online information resources on aquatic invasive species. During 2001-2006, RBIC web site also hosted the first European on-line GIS-based information platform with geo-referenced record data on aquatic invasive species. The platform linked to species fact sheets (*AquaInvader* information system) and to the first Alien Species Expert Registry (European Research Network on Aquatic Invasive Species; ERNAIS). With the support of FP6 (ALARM) and FP7 (*enviroGRIDS*) projects, this information platform has been developed further into the Regional Euro-Asian Biological Invasions Centre information system (<http://www.reabic.net>).

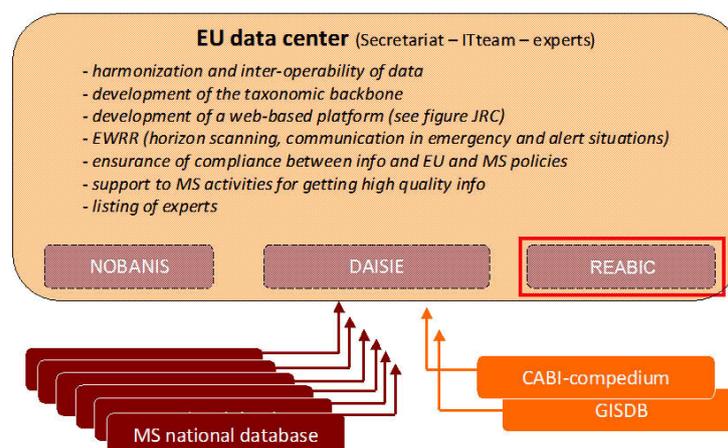
Vandekerkhove and Cardoso (2011) further suggest that a similar approach to the one developed by REABIC could be adopted at the European scale, encompassing all environment types. The successful implementation of such an ambitious concept relies on (1) continued engagement at national and regional scale to collect and provide data; (2) the willingness of database managers to harmonize their information (3) the development of a set of interoperable web services through which the information can be explored; and (4) appropriate and sustainable funding to allow for (1) to (3). In the longer term, this approach would increase the availability and accessibility of information on alien species, and ultimately support a cost-efficient invasive alien species policy.

In 2010 European Commission initiated expert consultations in support of developing a EU legal instrument on IAS. Specifically, the EC Working Group on Invasive Alien Species was established and during a series of experts meetings on the EU level, this working group prepared a report with recommendations on establishment of an EU information system on alien and invasive alien species (ECWGIAS 2011), including the following recommendations:

1. A current and comprehensive information system is required to underpin EU policy on IAS and to enhance understanding through scientific research;
2. The information network should combine basic information for a large number of species with more detailed information on a defined sub-group of species (such as black list and alert list species or watch list (IAS of EU concern));
3. The information should be open and easily accessible;
4. The information network should ensure (1) the coordination of the harmonization of existing resources (global databases (such as GISD and CABI ISC), European databases (such as DAISIE), regional databases (such as Mediterranean Database, NOBANIS, REABIC), national databases (such as GBNNSIP - GB, National Invasive Species Database – Ireland, Harmonia – Belgium and Hellenic Network for Aquatic Alien Species – Greece), taxonomic and systems (marine, terrestrial and freshwater) based databases –examples in appendices), (2) the development of a web-based platform that facilitates access to distributed information, and (3) to ensure that the information is compliant with and informs European and National policy instruments;
5. The information network would need to support and sustain activities in the member states and updates to existing resources to ensure continued availability of high quality information for the web-based platform and ensure regional and national relevance;
6. The information network should encourage the gathering and rapid sharing of high resolution occurrence data at a national level through monitoring and surveillance with effective flow of data through the network to end users. To support interoperability, the information network would issue guidelines and standards for data collation and exchange;
7. The information network should comprise a list of experts, decision makers or national contact points, which is maintained through regular updates by contributors. Additionally other people directly and indirectly participating in the evaluation process of IAS should be listed as appropriate. This component of the database could be maintained using readily available social networking mechanisms (such as ResearchGate or LinkedIn).

These recommendations were carefully considered during our work within *enviroGRIDS* on the development of REABIC-based information management tools for the Black Sea basin IAS management DSS.

A simplified schema of data flow into the developing EU Data Centre on invasive alien species (see European Alien Species Information Network portal at the EC Joint Research Centre website at <http://easin.jrc.ec.europa.eu/>) and role of REABIC in this process is shown in Figure 1.



**Figure 1.** Simplified schema of data flow into the developing EU Data Centre on invasive alien species and role of REABIC (modified from ECWGIAS (2011)).

## 2.2. Open information resources on IAS in the Black Sea region and REABIC information system

The open information resources on IAS in the Black Sea basin countries are limited to the regional *Mnemiopsis leidyi* database (Vladymyrov et al. 2011), the database of aquatic invaders of Belarus (Mastitsky et al. 2010) and the Ukrainian node of the GloBallast programme (GloBallastUkraine 2011). Development of the Black Sea *Mnemiopsis leidyi* database is supported by the regional Black Sea Commission, but mechanisms of regular updates of this database with new information are lacking and only 5-years old species record data are available in open access.

With the support of the *enviroGRIDS* project, currently we are focusing on development of the regional risk assessment-based Decision Support and Early Warning System on IAS for the Black Sea basin, which will be based on online information management tools available at the REABIC information system.

The Regional Euro-Asian Biological Invasions Centre (REABIC, <http://www.reabic.net/>) is an independent regional data centre for invasive alien species (IAS) serving as an international repository of geo-referenced record data on IAS, and currently focusing on elaboration of effective mechanisms of online open access to the datasets of geo-referenced IAS monitoring data. Specifically, REABIC provides services for data holders in the protection of their author rights on IAS related information via timely publication of their papers in the international open access thematic journals *Aquatic Invasions* and *BioInvasions Records*, established by REABIC (<http://www.reabic.net/journals/>). These thematic journals include a peer-reviewing system as the mechanism of quality control of IAS data, available after their publication in the online information system of REABIC. These scientific journals, as part of the information system of REABIC, serve to provide a unique opportunity to develop early warning systems, based on the most recent geo-referenced records of IAS (Panov et al. 2011; Lucy and Panov 2012). In combination with other REABIC-based online services, including the European Research and Management Network on Aquatic Invasive Species (ERNAIS) experts database (<http://www.reabic.net/ZnExp.aspx>), REABIC also provides a virtual platform for linking the international research community and general public, managers and decision-makers (see also in previous sub-chapter). REABIC is registered as GEOSS component, and will serve as data provider for developing EU Data Centre on invasive alien species (see EASIN portal at <http://easin.jrc.ec.europa.eu/>).

## 3 Regional online Decision Support System on IAS

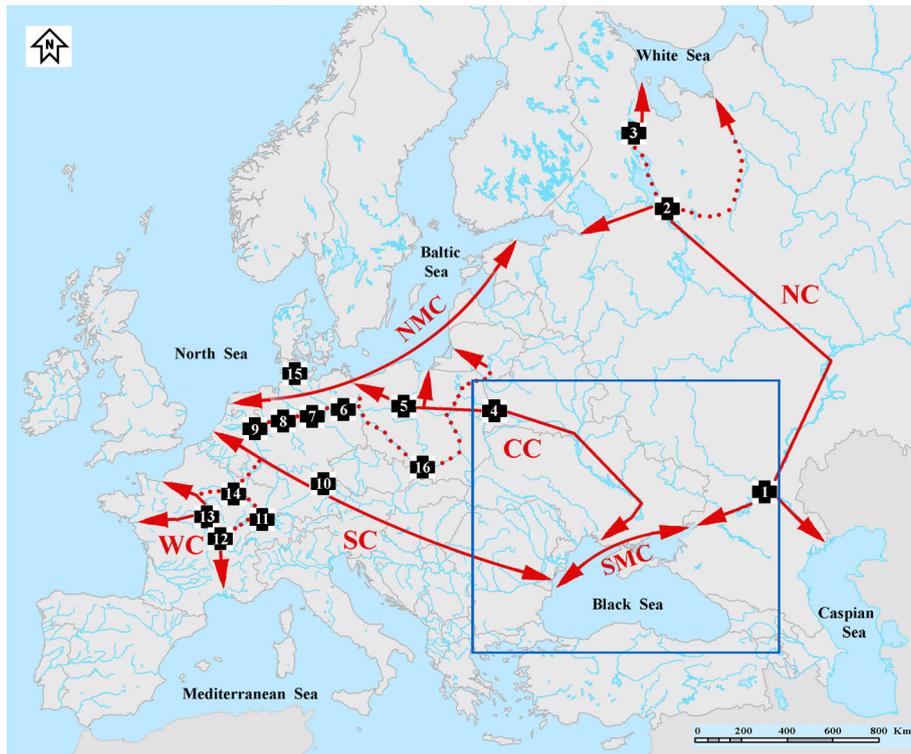
### 3.1 Outline of the regional DSS

Our goal was to develop relevant risk assessment protocols and water quality indicators on IAS for possible consideration in river basin management on the national and regional levels, and to develop relevant online information management tools and user-friendly web interfaces both for experts and managers.

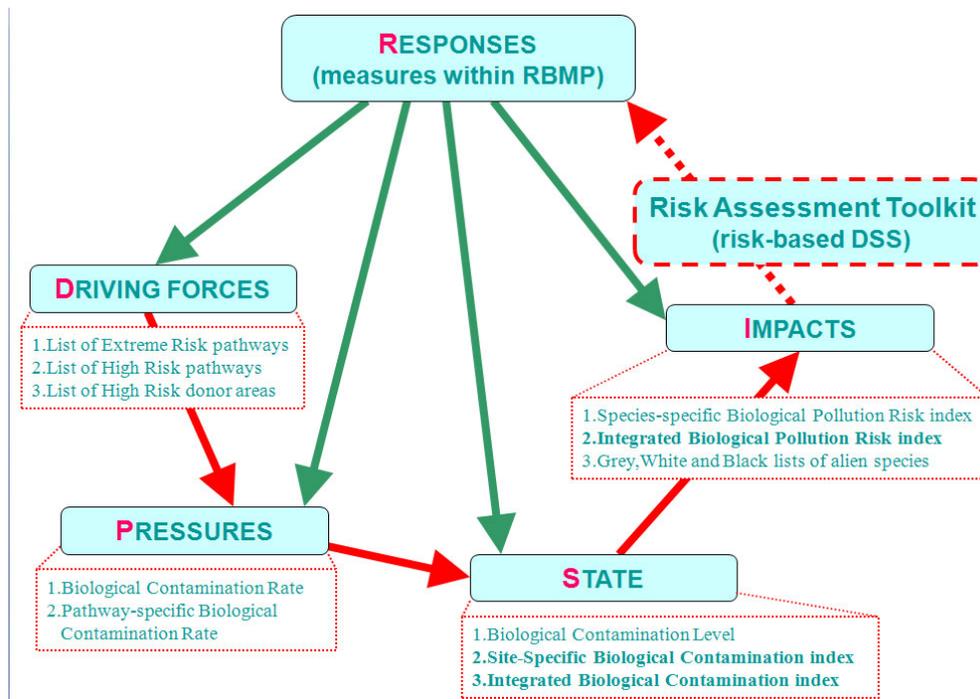
The European Environmental Agency (EEA) ‘Typology of indicators’ and the Driving forces–Pressures–State–Impact–Response (DPSIR) framework was used to structure developed environmental indicators in the socio-economic context (Figure 3).

We decided to use a qualitative model of risk assessment of IAS, initially suggested for risk assessment of IAS introductions via navigable European waterways (Panov et al. 2009, 2010), which includes six main components (see also Figure 3):

1. Identification of the main invasion gateways, routes and corridors in Europe, and selection of ecosystems as assessment and management units (AUs) within invasions corridors/invasion network
2. Identification and analysis of pathways of IAS introductions within the ecosystem – ‘**Driving forces**’ according to the DPSIR framework
3. Assessment of inoculation rates (propagule pressure) within the ecosystem– DPSIR ‘**Pressures**’;
4. Assessment of biological contamination level of the ecosystem - DPSIR ‘**State**’
5. Assessment of invasiveness of alien species, established in the ecosystem (potential biopollution risk) - DPSIR ‘**Impacts**’
6. Development of an online risk-based regional Decision Support System with early warning service for reporting of environmental indicators and recommendations for risk management to stakeholders – DPSIR ‘**Responses**’



**Figure 2.** Main invasion corridors in Europe, related to the Black Sea basin (schematically indicated by blue square): NC – Northern invasion corridor, CC – Central invasion corridor, SC – Southern invasion corridor, SMC – Southern meridian invasion corridor (after Panov et al. 2009, modified).



**Figure 3.** Environmental indicators on IAS structured in DPSIR framework (after Panov et al. 2009).

Within the Black Sea basin, we selected 19 Assessment Units for collection of datasets needed for assessment of IAS-related environmental indicators:

1. 6 assessment units in the Danube River basin – Danube Delta, lower part of River Danube, middle part of River Danube, River Sava, River Tisa, upper part of River Danube
2. 6 assessment units in the Dniepr River basin - Dnieper-Bug Liman, Dnieper Delta and Kahovka Reservoir, Zaporozhye, Dneprodzierzhinsk and Kremenchug reservoirs, Kanev and Kiev reservoirs, upper Dnieper River, River Pripyat
3. 4 assessment units in the Don River basin – Lower Don, Manych River basin, Middle Don basin, Seversky Donec River basin
4. Inland waters of Crimean Peninsula
5. Black Sea
6. Azov Sea

These datasets are currently in the process of incorporation in REABIC databases and their publication in open access journals *Aquatic Invasions* and *BioInvasions Records*, and will be available via web interface of the Black Sea basin IAS management DSS (Figure 4). The interface include user-friendly services to access risk assessment tools, AU-specific species lists and species profiles, geo-referenced species occurrence data,

These services are briefly discussed in specific sub-chapters below.



**Figure 4.** Decision Support System for Management of Invasive Alien Species in the Black Sea Basin main web page ([http://reabic.net/DSS\\_BlackSeaBasin/](http://reabic.net/DSS_BlackSeaBasin/))

### 3.2 Risk Assessment Tools

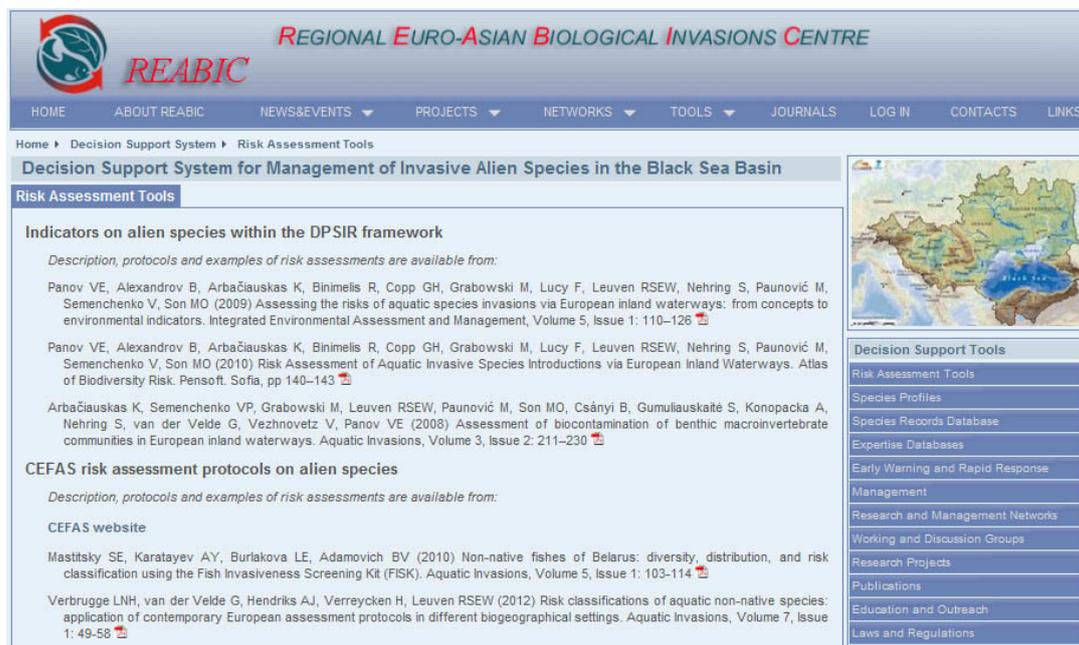
The developed DPSIR environmental indicators for alien species (“Drivers” - List of Extreme Risk pathways for AUs, List of High Risk pathways for AUs, List of High Risk Donor Areas for AUs; “Pressures”- Biological Contamination Rate (BCR), Pathway-specific Biological Contamination Rate (PBCR); “State” - Biological Contamination Level (BCL), Site-specific Biological Contamination (SBC) index, Integrated Biological Contamination (IBC) index; “Impacts” - Species-specific Biopollution Risk (SBPR) index, Grey, White and Black lists of alien species and Integrated Biopollution Risk (IBPR) index, Figure 2) can be useful for risk management at local, river basin, national and regional levels.

Management measures for the DPSIR “Driving forces” and “Pressures” may include preventive actions toward management of Extreme Risk and High Risk pathways. Biological Contamination Rate (BCR) and

Pathway-specific Biological Contamination Rate (PBCR) can be used as indicators of the effectiveness of preventive management. In contrast, the management actions for “State” and “Impacts” may involve the control and eradication of established species from Black List (according to CBD provisions), and Site-specific and Integrated Biological Contamination indices. Along with the Integrated Biopollution Risk index, these can be used as comparatively simple indicators of the effectiveness of these measures.

Three environmental indicators from this list can be recommended as cost-effective ‘Quality Elements’ (QEs) according to the Common Implementation Strategy of the Water Framework Directive for assessment of ecological status of aquatic ecosystems: Site-specific Biological Contamination (SBC) index, Integrated Biological Contamination (IBC) index and, specifically, based on precautionary approach, the Integrated Biopollution Risk (IBPR) index.

Details on risk assessment protocols and description of these environmental indicators on IAS are provided in standard Excel files and relevant research articles (Arbačiauskas et al. 2008; Panov et al. 2009, 2010) available at the Risk Assessment Tools (RAT) page of DSS (Figure 5).



**Figure 5.** Risk Assessment Tools web page of the Black Sea IAS management DSS ([http://www.reabic.net/DSS\\_BlackSeaBasin/RiskAssessmentTools.aspx](http://www.reabic.net/DSS_BlackSeaBasin/RiskAssessmentTools.aspx))

Online protocols supporting risk assessment include:

1. Protocols for estimation of indicators for Driving forces and Pressures, based on annotated checklists of non-native species in assessment units (Excel file);
2. Protocols for estimation of indicators for State: biocontamination indices (Excel file);
3. Protocols for estimation of indicators for Impacts (risk assessment of certain species and attribution of invasive species to Black list) (Excel file)

The RAT page also provides links to alternative risk assessment instruments, including: CEFAS risk assessment protocols on alien species; risk assessment protocols for use of alien species in aquaculture and stock enhancement; risk assessment scheme for non-native species in Great Britain; the German-Austrian black list information system (GABLIS); and ballast water risk assessment tools.

### 3.3 Species profiles and searchable species database

The Species Profiles page of DSS includes list of all non-native species, recorded in assessments units of the Black Sea basin, by main taxonomic groups, with links to species online profiles. Specifically, for aquatic species these groups include: aquatic plants, aquatic invertebrate species, fish species, other aquatic vertebrate species and semi-aquatic mammal species (Figure 6).

Online species profiles include information on taxonomic position, distribution in native and introduced ranges, abundance in different assessment units, life cycles and reproduction, feeding habits, salinity tolerance, temperature range, habitat preference, ecological and socio-economic impacts, position in listing systems, management options and main publications (Figure 7). In addition, species profiles include links to species profiles in other online databases, if available.

Regular updates of essential information for species profiles will be conducted by key international experts, interested in regular publication of updated information and risk assessments of certain species in the REABIC journals *Aquatic Invasions* and *BioInvasions Records*.



Figure 6. Species Profiles web page ([http://www.reabic.net/DSS\\_BlackSeaBasin/SpeciesProfiles.aspx](http://www.reabic.net/DSS_BlackSeaBasin/SpeciesProfiles.aspx)).

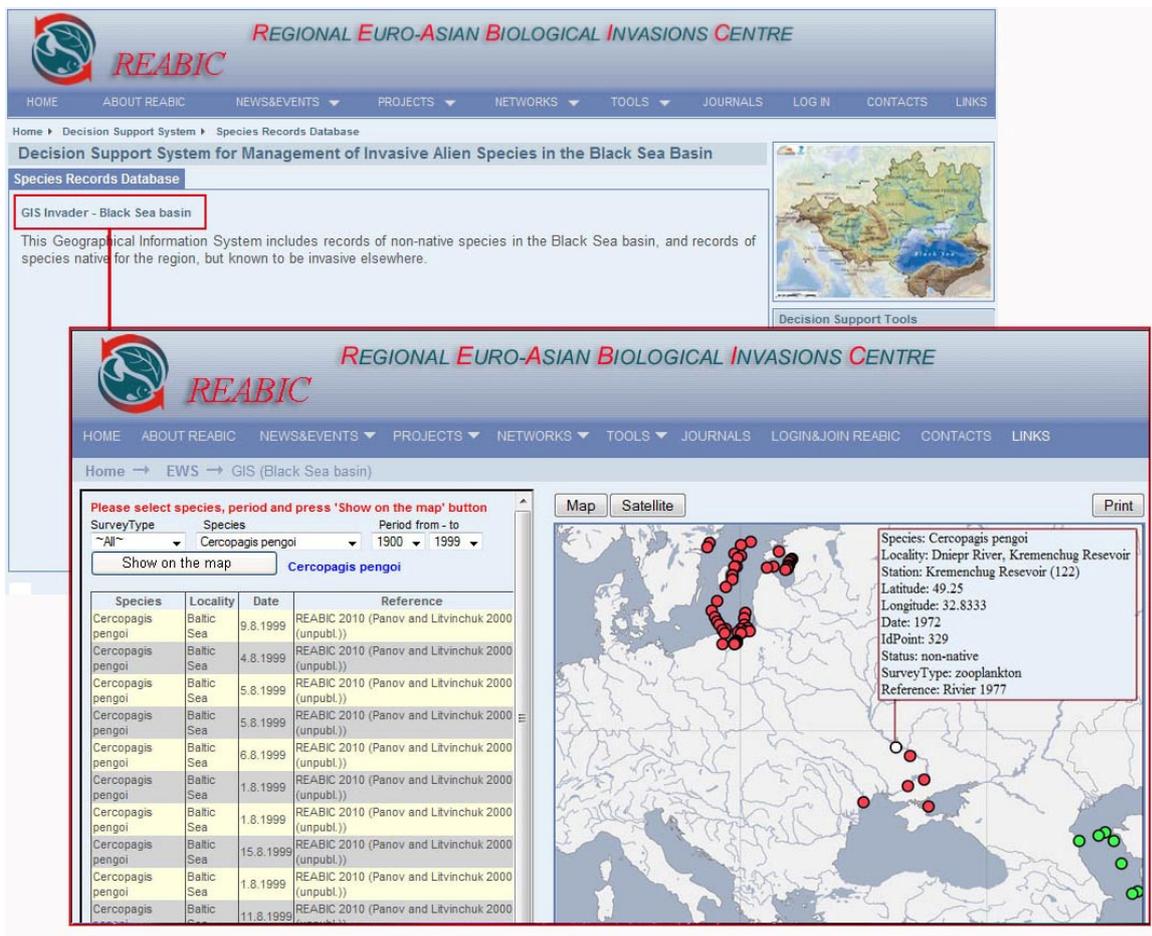


Figure 7. Example of species profile (<http://www.reabic.net/SpDetails.aspx?sp=Pontogammarus%20robustoides#RiskAssess>).

In addition, currently we are working on an additional online service for management of information from aquatic species profiles. The searchable AquaInvader Database will allow sorting of species profiles by geographical area (specific sea, river basin or assessment unit), taxonomic groups, pathways of introduction and will allow interested users to download checklists of the most invasive species (Black list species) for specific geographical areas or countries (a prototype of AquaInvader Database interface is available at <http://www.reabic.net/Aquainv.aspx>)

### 3.4 Species records database

The REABIC species records database includes an online GIS application, which allows geo-referenced species records data management and simple mapping service for generation of species distribution maps. An example of such a mapping service for the Black Sea area is provided in Figure 8. GIS application provides an opportunity to download primary species record information available in the REABIC database, including species name, location name, name of sampling station, geographic coordinates, species status in studied area (native or non-native), and a reference to the data provider (Figure 8).



The screenshot shows the REABIC website interface. The top navigation bar includes: HOME, ABOUT REABIC, NEWS&EVENTS, PROJECTS, NETWORKS, TOOLS, JOURNALS, LOG IN, CONTACTS, LINKS. The main content area is titled "Decision Support System for Management of Invasive Alien Species in the Black Sea Basin" and "Species Records Database". A link for "GIS Invader - Black Sea basin" is highlighted. Below this, a description states: "This Geographical Information System includes records of non-native species in the Black Sea basin, and records of species native for the region, but known to be invasive elsewhere." A map of the Black Sea basin is shown to the right.

The GIS application interface is shown below, with the following details:

- Navigation: HOME → EWS → GIS (Black Sea basin)
- Search filters: SurveyType: ~All, Species: Cercopagis pengoi, Period from: 1900, to: 1999
- Buttons: "Show on the map" and "Cercopagis pengoi"
- Map: Shows the Black Sea basin with red markers indicating species locations. A "Print" button is visible.
- Data Table:

Species	Locality	Date	Reference
Cercopagis pengoi	Baltic Sea	9.8.1999	REABIC 2010 (Panov and Litvinchuk 2000 (unpubl.))
Cercopagis pengoi	Baltic Sea	4.8.1999	REABIC 2010 (Panov and Litvinchuk 2000 (unpubl.))
Cercopagis pengoi	Baltic Sea	5.8.1999	REABIC 2010 (Panov and Litvinchuk 2000 (unpubl.))
Cercopagis pengoi	Baltic Sea	5.8.1999	REABIC 2010 (Panov and Litvinchuk 2000 (unpubl.))
Cercopagis pengoi	Baltic Sea	6.8.1999	REABIC 2010 (Panov and Litvinchuk 2000 (unpubl.))
Cercopagis pengoi	Baltic Sea	1.8.1999	REABIC 2010 (Panov and Litvinchuk 2000 (unpubl.))
Cercopagis pengoi	Baltic Sea	1.8.1999	REABIC 2010 (Panov and Litvinchuk 2000 (unpubl.))
Cercopagis pengoi	Baltic Sea	15.8.1999	REABIC 2010 (Panov and Litvinchuk 2000 (unpubl.))
Cercopagis pengoi	Baltic Sea	1.8.1999	REABIC 2010 (Panov and Litvinchuk 2000 (unpubl.))
Cercopagis pengoi	Baltic Sea	11.8.1999	REABIC 2010 (Panov and Litvinchuk 2000 (unpubl.))

Map information box:

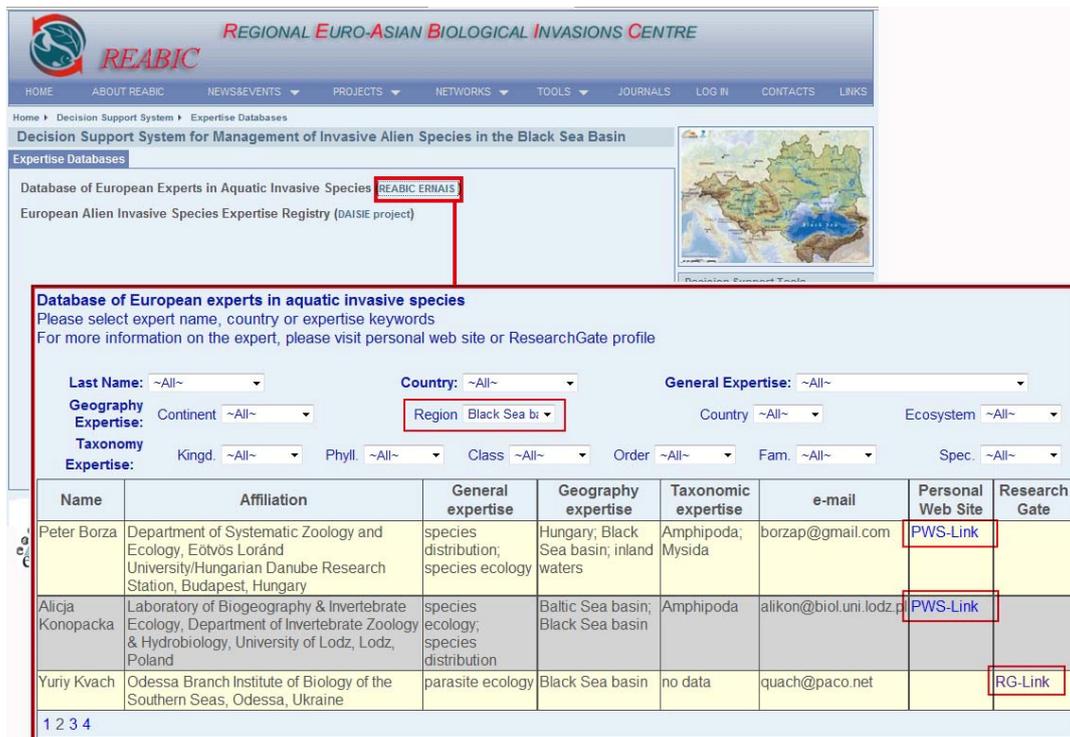
- Species: Cercopagis pengoi
- Locality: Dniepr River, Kremenchug Reservoir
- Station: Kremenchug Reservoir (122)
- Latitude: 49.25
- Longitude: 32.8333
- Date: 1972
- IdPoint: 329
- Status: non-native
- SurveyType: zooplankton
- Reference: Rivier 1977

**Figure 8.** Species Records Database page of DSS ([http://www.reabic.net/DSS\\_BlackSeaBasin/SpeciesDB.aspx](http://www.reabic.net/DSS_BlackSeaBasin/SpeciesDB.aspx)) and GIS Invader - Black Sea basin ([http://www.reabic.net/GIS\\_black.html](http://www.reabic.net/GIS_black.html))

### 3.5 Searchable expertise database

Currently the REABIC expertise database includes contact information for 60 experts on bioinvasions, working in the Black Sea region or with expertise on Ponto-Caspian invasive species. Interface of the searchable expert database is shown in Figure 9.

The database includes links to expert profiles, available on their personal web pages or personal profiles in specialized virtual networks of scientists – ResearchGate and LinkedIn.



**Database of European experts in aquatic invasive species**  
Please select expert name, country or expertise keywords  
For more information on the expert, please visit personal web site or ResearchGate profile

Last Name: ~All~ Country: ~All~ General Expertise: ~All~  
Geography Expertise: Continent ~All~ Region: Black Sea basin Country ~All~ Ecosystem ~All~  
Taxonomy Expertise: Kingd. ~All~ Phyll. ~All~ Class ~All~ Order ~All~ Fam. ~All~ Spec. ~All~

Name	Affiliation	General expertise	Geography expertise	Taxonomic expertise	e-mail	Personal Web Site	Research Gate
Peter Borza	Department of Systematic Zoology and Ecology, Eötvös Loránd University/Hungarian Danube Research Station, Budapest, Hungary	species distribution; species ecology	Hungary; Black Sea basin; inland waters	Amphipoda; Mysida	borzap@gmail.com	PWS-Link	
Alicja Konopacka	Laboratory of Biogeography & Invertebrate Ecology, Department of Invertebrate Zoology & Hydrobiology, University of Lodz, Lodz, Poland	species ecology; species distribution	Baltic Sea basin; Black Sea basin	Amphipoda	alikon@biol.uni.lodz.pl	PWS-Link	
Yuriy Kvach	Odessa Branch Institute of Biology of the Southern Seas, Odessa, Ukraine	parasite ecology	Black Sea basin	no data	quach@paco.net		RG-Link

1 2 3 4

Figure 9. Experts Databases page of the Black Sea IAS management DSS and interface of the searchable European experts database (<http://www.reabic.net/ZnExp.aspx>).

### 3.6 Early warning module

The early warning module of the Black Sea basin IAS management DSS is under intense development and, according to the *enviroGRIDS* description of work, the DEMO version of the regional early warning system on invasive species should be ready by the end of the project (Deliverable D5.10 - mo 48). Currently the Early Warning and Rapid Response web page includes description of our general approach to early warning and links to relevant international documents, including the European Environment Agency technical report “Towards an early warning and information system for invasive alien species (IAS) threatening biodiversity in Europe” (EEA 2010) and recent recommendations of the European Commission Working Group on Early Warning and Rapid Response (Figure 10).

Also, the early warning module of the Black Sea basin IAS management DSS includes a map of the Black Sea basin with first records of aquatic IAS in the Black Sea Basin published in the REABIC open access journal *Aquatic Invasions* in 2009-2011.

During rest of the project we will focus on rapid publication of case studies on new records of invasive species in the new REABIC open access journal *BioInvasions Records* and timely transfer of this information to the level of decision-makers (Lucy and Panov 2012), and, specifically, will work on issues of interoperability with developing *enviroGRIDS* portal and with EU Data Centre on Invasive Alien Species (the European Alien Species Information Network portal at <http://easin.jrc.ec.europa.eu/>). This work will be described in our next report (forthcoming Deliverable D5.10 - Illustrated pilot case studies for the Black Sea catchment Disaster Early Warning System).

REGIONAL EURO-ASIAN BIOLOGICAL INVASIONS CENTRE

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**Decision Support System for Management of Invasive Species in the Black Sea Basin**

**Early Warning and Rapid Response**

The need to develop a Europe-wide early warning and information system to report new and emerging alien species and crucial role of information management for future pan-European early warning and rapid response system to tackle biological invasions has been recently recognized.

EEA Technical report Towards an early warning and information system for invasive alien species (IAS) threatening biodiversity in Europe

Recommendations of the European Commission Working Group on Early Warning and Rapid Response (EU CIRCA website)

A complete and effective early warning system (EWS) comprises four inter-related elements: risk knowledge, monitoring and warning service, dissemination and communication and response capability (UN Global Survey of Early Warning Systems report [1](#)). The Regional Euro-Asian Biological Invasions Centre (REABIC) is currently developing several information tools in order to contribute to most of these key elements of regional and national EWSs, including: international open-access journals *Aquatic Invasions* and *BioInvasions Records* as instruments of rapid IAS information dissemination and communication platform of experts.

Panov VE, Gollasch S, Lucy F (2011) Open-access journal *Aquatic Invasions*: An important part of the developing European information and early warning system on invasive alien species. *Aquatic Invasions*, Volume 6, Issue 1: 1-5 [2](#)

First Records of Invasive Alien Species in the Black Sea Basin (published in *Aquatic Invasions* in 2009-2011)





**Decision Support Tools**

- Risk Assessment Tools
- Species Profiles
- Species Records Database
- Expertise Databases
- Early Warning and Rapid Response Management
- Research and Management Networks
- Working and Discussion Groups
- Research Projects
- Publications
- Education and Outreach
- Laws and Regulations

**Figure 10.** Early Warning Module of the Black Sea IAS management DSS, including map with first records of Invasive Alien Species in the Black Sea Basin published in *Aquatic Invasions* in 2009-2011. Numbers indicate: 1 – First record of predatory isopod *Saduria entomon* in coastal waters of the Black Sea (Kvach 2009) , 2 – First record of parasitic worm *Aspidogaster conchicola* in the Black Sea basin (Yurshynets and Krasutska 2009) , 3 – First record of Asian prawn *Palaemon macrodactylus* in coastal waters of the Black Sea (Micu and Niță 2009); 4 – First record of Asian prawn *Palaemon macrodactylus* in Bulgaria (Raykov et al. 2010), 5 – First record of Japanese shore crab *Hemigrapsus sanguineus* in coastal waters of the Black Sea (Micu et al. 2010), 6 – First record of subtropical ctenophore *Bolinopsis vitrea* in coastal waters of the Black Sea (Öztürk et al. 2011), 7 – First record of Asian clam *Corbicula fluminea* in Moldova (Munjiu and Shubernetski 2010), 8 – First record of the Ponto-Caspian amphipod *Echinogammarus trichiatus* for the Middle-Danube (Borza 2009), 9 – First record of Chinese pond mussel *Sinanodonta woodiana* in Croatia (Lajtner and Crnčan 2011), 10 – First record of round goby *Neogobius melanostomus* in Croatia (Piria et al. 2011), 11 – Ponto-Caspian polychaete *Hypania invalida* in inland waters of Serbia (Zoric et al. 2011). Source: [http://www.reabic.net/DSS\\_BlackSeaBasin/EarlyWarning.aspx](http://www.reabic.net/DSS_BlackSeaBasin/EarlyWarning.aspx)

### 3.7 Other online tools

The Black Sea basin IAS management DSS includes also several additional tools, providing links to other important online information resources, available at the REABIC information system and external web sites. These additional tools include: links to information on management of invasive species (GloBallast Programme, GloBallast in Ukraine and others), links to web sites of international research and information management networks (such as REABIC based ERNAIS - European Research and Management Network on Aquatic Invasive Species, EASIN - European Alien Species Information Network, NOBANIS - European Network on Invasive Alien Species, GIN - Global Invasions Research Coordination Network, GISIN - Global Invasive Species Information Network and others), links to web sites of international working and discussion Groups (such as REABIC based Ponto-Caspian Invasive Species Experts Group and SIL Working Group on Invasive Aquatic Species, IUCN/SSC Invasive Species Specialist Group, European Commission Working Groups on Invasive Alien Species), links to web sites of relevant European Commission projects, links to web sites of relevant international laws and regulations (such global conventions as Convention on Biological Diversity and Ballast Water Management Convention, regional conventions and relevant web sites of European Commission). The Publications web page of the Black Sea basin IAS management DSS includes a list of key scientific publications and technical reports with links to pdf files of these resources of important information on IAS.

The international open access REABIC journals *Aquatic Invasions* and *BioInvasions Records* represent additional online tools, important for support of main databases of the Black Sea basin IAS management DSS. During 2009-2011 *Aquatic Invasions* was a main platform for publication of research articles by experts from the Black Sea basin countries, including papers on new records of aquatic IAS in the Black Sea coastal waters and basins of the Danube and Dnieper rivers (Figure 10). With start-up support by *enviroGRIDS*, in late 2011 we established a new international open access journal *BioInvasions Records*, which will serve as a new platform for publication of research articles and technical reports by regional experts both in aquatic and terrestrial bioinvasions (Lucy and Panov 2012).



Figure 11. Main web page of new international open access journal *BioInvasions Records* (<http://www.reabic.net/journals/bir/>)

New species records, published in *BioInvasions Records*, will support early warning component of the Black Sea basin IAS management DSS (see in previous subchapter). *BioInvasions Records* will also support online invasive species profiles and their regular updates via publication of papers on invasion biology of selected invasive species. In addition, both *Aquatic Invasions* and *BioInvasions Records* will publish review papers with

checklists of non-native species, also supporting regular updates of information in the REABIC information system and in the Black Sea basin IAS management DSS, respectively. In late 2012, we plan to release a special issue of *Aquatic Invasions*, with review papers by key regional experts focusing on analysis of patterns of biological invasions in the main river basins and the Black Sea itself, and these papers will include verified checklists of non-native species highly relevant for update of REABIC databases.

## 4 Conclusions and recommendations

The REABIC-based Black Sea basin IAS management DSS includes user-friendly services for data users, specifically for decision-makers involved in the river basin management both on the national and regional levels. The regional information system also provides an important services for primary data owners, as repository of their data on invasion biology and geo-referenced records of IAS, with their authors rights on this information, are protected by scientific publications in two REABIC international open access journals – *Aquatic Invasions* and *BioInvasions Records*. These innovative capacity-building tools ensure a regular update of the information system with new information verified via peer reviewing process by key international experts.

In order to achieve sustainability of the developed information tools, more close cooperation with regional bodies such as the Black Sea Commission and the International Commission for the Protection of the Danube River (ICPDR) is needed. Also, development of additional online services for data owners (local experts), for instance, species distribution mapping services coupled with rapid publication of new records in REABIC open access journals, could greatly facilitate data flow from data owners to the level of decision-making. In this regard we plan during rest of the project to resolve issues of interoperability with developing *enviroGRIDS* portal and European Alien Species Information Network portal (<http://easin.jrc.ec.europa.eu/>).

Finally, more close collaboration with other relevant European Commission projects could contribute to further development of the Black Sea basin IAS management DSS and sustainability of developed information management tools. Specifically, cooperation with EC FP7 project ‘Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors’ (VECTORS, <http://www.marine-vectors.eu>) currently includes publication of this project results in REABIC journals (Deidun et al. 2011, Galil et al. 2011, Gasith et al. 2011, Goren et al. 2011, Pasternak et al. 2011, De Grave et al. 2012), and further cooperation with VECTORS in information management and development of new DSS tools is foreseen.

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## 6 List of presentations

- Two *enviroGRIDS* technical workshops on risk assessment and early warning: 13-14 September 2010, Odessa, Ukraine, and 4 November 2011, Odessa, Ukraine (last report and presentation are available at the project page at EMDESK)
- Technical meeting on Early Warning and Rapid Response, 2-3 March 2011, EC Joint Research Centre, Ispra, Italy. Invited presentation by Panov V: "Regional Euro-Asian Biological Invasions Centre information system" (presentation is available at the project page at EMDESK)
- Expert Meeting on Improving SEBI Indicators on IAS, 26-27 September 2011, European Environment Agency, Copenhagen, Denmark. Invited presentation by Panov V: "DPSIR framework based approach for developing indicators on aquatic invasive species" (presentation is available at the project page at EMDESK)
- 7th Int. Conference on Marine Bioinvasions, 23-25 August 2011, Barcelona, Spain. Oral presentation by Panov V, Shestakov V, Son M, Lucy F. "Towards a Decision Support System for Management of Invasive Aquatic Species in the Black Sea Basin" (presentation is available at the project page at EMDESK)
- 3rd Bi-annual Black Sea Scientific Conference, 1-3 November 2011, Odessa, Ukraine. Oral presentation by Panov VE, Alexandrov BG, Son MO, Semenchenko VP, and Shestakov V "Decision Support System for Management of Invasive Aquatic Species in the Black Sea Basin" (presentation is available at the project page at EMDESK)

**Appendix 1.** Definitions and abbreviations of key terms for risk assessment of non-native species (after Panov et al. 2009)

**Alien species** - refers to a species, subspecies or lower taxon, introduced outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce

**Non-native species** - synonym for “Alien species”

**Invasive species** - means indigenous or nonindigenous species, that spreads, with or without the aid of humans, in natural or semi-natural habitats, producing a significant change in composition, structure, or ecosystem processes, or causes severe economic losses to human activities

**Introduction** - refers to the movement by human agency, indirect or direct, of an alien species outside of its natural range (past or present). This movement can be either within a country or between countries or areas beyond national jurisdiction

**Establishment** - refers to the process of an alien species in a new habitat successfully producing viable offspring with the likelihood of continued survival

**Risk analysis** - refers to: (1) the identification of risks and their assessment with regard (in non-native species terms) to the likelihood and consequences of the introduction, establishment, spread and impact of an alien species using science-based information (i.e. risk assessment), and (2) to the identification of measures that can be implemented to reduce or manage these risks (i.e., risk management), taking into account socio-economic and cultural considerations

**Assessment Unit** - part of ecosystem, serving as assessment and management unit

**Biological contamination (biocontamination)** - the introduction of alien species which may or may not result in noticeable or measurable effects

**Biological Contamination Rate (BCR)** - a number of recorded alien species in an Assessment Unit per reporting period

**Pathway-specific Biological Contamination Rate (PBCR)** - a number of recorded alien species in an Assessment Unit by specific pathway during reporting period

**Biological Contamination Level (BCL)** - a number of established alien species in an Assessment Unit since 1900

**Site-specific Biological Contamination (SBC)** - index for estimation of biological contamination of the specific location (sampling site) within an Assessment Unit and ecological status of the specific location within the water body

**Integrated Biological Contamination (IBC)** - index for estimation of biological contamination of an Assessment Unit and ecological status of the water body

**Biological pollution (biopollution)** - the introduction of alien species with noticeable effects on individuals, populations and communities of native species, and/or resulting in adverse socio-economic consequences

**Biological Pollution Level (BPL)** - index for estimation of actual impacts of alien species in Assessment Units

**Species-specific Biological Pollution Risk (SBPR)** - index for estimation of potential invasiveness of the species

**Integrated Biological Pollution Risk (IBPR)** - index for estimation of potential impacts of alien species in an Assessment Unit and ecological status of the water body

**Invasibility** - a probability of establishment of alien species as a complex function of abiotic and biotic resistance by the ecosystem to introductions under specific level of propagule pressure

**Invasiveness** - degree to which an organism is able to spread from site of primary introduction, to establish a viable population in the ecosystem, to negatively affect biodiversity on the individual, community or ecosystem level, and cause adverse socio-economic consequences

**Pathways** - principal human activities involved in the spread of alien species

**Low Risk pathway** - a pathway with low certainty of the existence of a specific pathway for a specific Assessment Unit

**High Risk pathway** - a pathway with a high level of certainty of its existence in an

Assessment Unit (operating pathway), but with no evidence existing of the introduction of alien species into the Assessment Unit by this pathway during the observation/reporting period

**Extreme Risk pathway** - an operating pathway responsible for an introduction of specific alien species into an Assessment Unit during an observation/reporting period

**Invasion route** - the route between the source region of alien species and its location of introduction

**Invasion gateway** - refers to a transitional type of ecosystem (brackish-to-freshwater estuary, coastal lagoon or lake), that due to its salinity regime and high level of human activity (ship transportation) may serve as an “acclimatization chamber” for potentially euryhaline species enabling them further to colonise inland waters

**Vector** - specific human transport or natural carrier that transmits alien species to the recipient ecosystem

## **Abbreviations and Acronyms**

BS	Black Sea
CABI ISC	CABI Invasive Species Compendium
CBD	Convention on Biological Diversity
DSS	Decision Support System
EASIN	European Alien Species Information Network
EEA	European Environment Agency
ERNAIS	European Research Network on Aquatic Invasive Species
EWS	Early Warning System
GBNNSIP	Great Britain's Non Native Species Information Portal
GEOSS	Global Earth Observation System of Systems
GIS	Geographic Information System
GISD	Global Invasive Species Database
IAS	Invasive Alien Species
RAT	Risk Assessment Tools
REABIC	Regional Euro-Asian Biological Invasions Centre