Expert system for biopollution

BINPAS
Bioinvasion impact (biopollution) assessment system

Sergej Olenin, Aleksas Narščius, Anastasija Zaiko

sergej@corpi.ku.lt

June 12-14, Istanbul, Turkey
Online Bioinvasion impact (biopollution) assessment system

- Based on the BPL method (Biopollution Level index)

Aims:
1. provide a user friendly system to calculate BPL;
2. accumulate and store information on abundance and distribution range of various NIS in different geographical domains as well as their impacts on communities, habitats and ecosystem functioning;
3. enable comparisons between different species, ecosystems and time periods.
BPL method and BINPAS development timeline

- **Elaboration of the theoretical background**
  - 2003-2008

- **Data gathering, testing of the method**
  - 2004-2008

- **Development of the online application BINPAS**
  - 2008-2012

- **Merging BINPAS with NIS databases into the European Information system on marine NIS AQUANIS**
  - 2011-2014
The BPL method is based on a classification of the abundance and distribution range of alien species and numerically expresses the magnitude of their impacts on communities, habitats and ecosystem functioning aggregated in a BPL index.
How BINPAS works?

- Data entering - according to BPL methodology:
  1. Define assessment unit (AU)
  2. Define assessment period (AP)
  3. Define ADR for the 1st NIS
  4. Define impacts (C,H,E) for the 1st NIS
  5. Repeat procedure…for n NIS in the AU
Data storage

PUBLICATION:

BINPAS DATA:

<table>
<thead>
<tr>
<th>Account for Species</th>
<th>Acartia tonsa</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADR</td>
<td>C</td>
</tr>
<tr>
<td>ADR confidence level</td>
<td>Medium</td>
</tr>
<tr>
<td>ADR comments</td>
<td>Co-dominates the Pomeranian Bay coastal planktonic community along with the native A. bifilosa. In the northern Baltic Proper, A. tonsa was abundant in the water column in autumn.</td>
</tr>
<tr>
<td>Impact on communities</td>
<td>C2</td>
</tr>
<tr>
<td>Impact on com. confidence level</td>
<td>Medium</td>
</tr>
<tr>
<td>Impact on com. references</td>
<td></td>
</tr>
<tr>
<td>Impact on habitats</td>
<td>HN</td>
</tr>
<tr>
<td>Impact on hab. confidence level</td>
<td>Medium</td>
</tr>
<tr>
<td>Impact on ecosystems</td>
<td>C2</td>
</tr>
<tr>
<td>Impact on eco. confidence level</td>
<td>Medium</td>
</tr>
<tr>
<td>Contributor</td>
<td>Anastasija Zaiko</td>
</tr>
</tbody>
</table>
Search function
Available assessment scenarios

1. One NIS in one \( AU \) for one \( AP \),
2. One NIS in one \( AU \) for several \( AP \),
3. One NIS in several \( AU \) for one \( AP \),
4. One NIS in several \( AU \) for several \( AP \),
5. Several NIS in one \( AU \) for one \( AP \),
6. Several NIS in one \( AU \) for several \( AP \),
7. Several NIS in several \( AU \) for one \( AP \),
8. Several NIS in several \( AU \) for several \( AP \).

(Narščius et al., 2012)
Assessment scenario #4: One NIS in several AU for several AP

- 11 sub-regions;
- 6 five years periods;
- Routine HELCOM phytoplankton monitoring data (1980–2008)
  - Problems: temporal variability, short term intervals of measurable impacts, quantification of impacts on habitats and ecosystem functioning

Assessing impacts of invasive phytoplankton: The Baltic Sea case

Dynamics of the bioinvasion impacts caused by the dinoflagellate *Prorocentrum minimum* in Baltic sub-regions during the 5 years assessment periods (Olenina et al. 2010)

Identification of the impact threshold
Assessment scenario #7: Several NIS in several AU for one AP

Biopollution caused by 43 IAS assessed in 9 Baltic sub-regions

Based on BPL values, species were classified into ‘alien’, ‘impacting’ and ‘invasive’ ones

A ‘group portrait’ of the most impacting invaders

Requires substantial scientific effort:
> 200 peer-reviewed papers and scientific reports examined. Only those accounts that had reliable (medium to high levels of confidence for data) were used

Zaiko et al. 2011
Assessment scenario #2: One NIS in one AU for several AP

- **ADR = A** (low numbers in one locality)
- **C0** - No impact (no displacement of native species)
- **H?** - Unknown (probably H0 - no habitat alteration)
- **E?** - Unknown (probably = E0)
- **BPL = 0** (No biopollution)

based on: Vinogradov et al., 1989; Shiganova 1998; Volovik, 2000; Ivanov et al., 2000; Shiganova et al, 2001; Kideys 2002; Kideys et al., 2005
Assessment scenario #2: One NIS in one AU for several AP

Max. Biomass: 4.6 kg WW m$^2$ (184 g m$^3$)
Max. Abundance: 7,600 ind. m$^2$ (304 ind. m$^3$)

ADR = E (high numbers in all localities)

C3 = Strong impact
(type specific zooplankton community is changed, reduced settlement of pelagic larvae of benthic organisms)

H4 = Loss of characteristic pelagic habitat

E4 = Extreme ecosystem-wide shift in the food web

BPL = 4 (Massive Biopollution)

based on: Vinogradov et al., 1989; Shiganova 1998; Volovik, 2000; Ivanov et al., 2000; Shiganova et al 2001; Kideys 2002; Kideys et al., 2005
Assessment scenario #2: One NIS in one AU for several AP

Date: Mon, 11 Jun 2012 21:41:30 -0700 (PDT)
From: rahimeh rahmati <rahimehrahmati@yahoo.com>
Reply-To: rahimeh rahmati <rahimehrahmati@yahoo.com>
To: sergej@corpi.ku.lt <sergej@corpi.ku.lt>

Dear Prof Olenin

We would like to interest to know more details regarding Bio-pollution of invasion species. As you knew the Caspian Sea was deal with invasion of Mnemiopsis leidyi. Our team try to do project related to biopollution. Please guide us about how we can classify our data including Phyto & zooplankton, Mnemiopsis leidyi and Physico-chemical factors (as a habitat factor) during 10 years to determine assessment unit, assessment period and ADR level of invasive species in each case study in southern area of Caspian Sea.

Thanks in advance for your kind cooperation and assistance.

Yours sincerely

Hassan Nasrollahzadeh Saravi (PhD)
Assistant Professor in Environmental Biology
Caspian Sea Ecology Research Center (CSERC), Farahabad, P.O. Box. 961, Sari, Mazandaran, Iran
H/P: 00989111519588
O/P: 00981513462497-98 and 00981513462512
Fax: 00981513462495
E-mail: hnsaravi@yahoo.com
Use of BINPAS
Is BINPAS practical for management?
BINPAS policy relevance: the basis for a HELCOM Indicator Fact Sheet

Biopollution level index

Version information: 25.5.2012

Cover note for HELCOM MONAS 17/2012

The biopollution level index was included on the list at an early stage of the HELCOM CORESET as it directs the EC in the EC Decision 477/2010/EU and because a version is available.

The non-indigenous species (NIS) are however a diverse group of assessments as almost no management measures are available to mitigate their impacts. Consequently, it is very challenging to determine their environmental status (GES).

Policy relevance

Since the early 1990s when the Marine Protection Committee (MEPC) of the International Maritime Organisation (IMO) put the issue of non-indigenous species (NIS) on the agenda, the problem has become more and more important for marine environmental protection. In 2004 the Ballast water Convention was adopted by the IMO. The convention requires ballast water management procedures to minimise the proliferation of non-indigenous species via ballast water and sediment. Once entered into force every ship has to treat its ballast waters unless exemption is given based on risk analysis.

In order to minimize adverse effects of introductions and transfers of marine organisms for aquaculture ICES drafted the ICES Code of Practice on the Introductions and Transfers of marine organisms for aquaculture purposes. On the other hand, the EU Council Directive 2007 concerning the use of non-indigenous species is based on the ICES Code of Practice for the prevention of the introduction of alien species into new areas.

MSFD
Good Environmental Status
Descriptor 2
“Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems”

- NIS (alien, non-native, exotic, introduced)
  - Introduced outside of natural range and dispersal potential
    - By human activities
  - Natural shifts … do not qualify as a NIS

Invasive alien species -
  - a subset of established NIS
  - which have spread, are spreading or have demonstrated their potential to spread elsewhere,
  - have an adverse effect on biological diversity, ecosystem functioning, socio-economic values and/or human health in invaded regions.
2.1. **Abundance and state characterisation of non-indigenous species**, in particular invasive species
   — **Trends** in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species, particularly invasive non-indigenous species, notably in risk areas, in relation to the main vectors and pathways of spreading of such species (2.1.1)

2.2. **Environmental impact of invasive non-indigenous species**
   — **Ratio** between invasive non-indigenous species and native species in some well studied taxonomic groups (e.g. fish, macroalgae, molluscs) that may provide a measure of change in species composition (e.g. further to the displacement of native species) (2.2.1)
   — **Impacts** of non-indigenous invasive species at the level of species, habitats and ecosystem, where feasible (2.2.2).
## Indicators (assessment tools)

<table>
<thead>
<tr>
<th>Indicator</th>
<th>What it shows</th>
<th>Assessment method / data availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Number of NIS recorded in an area</td>
<td>Areas with elevated numbers of NIS are at greater risk of exposure to human mediated vectors of introductions and hence to future invasions.</td>
<td>Online information systems</td>
</tr>
<tr>
<td>2. Ratio between NIS and native species (NS)</td>
<td>The greater the ratio NIS/NS, the greater the departure from naturalness.</td>
<td>National biodiversity datasets</td>
</tr>
<tr>
<td>3. Abundance and distribution range</td>
<td>An indication of the invasion stage of a NIS (arrival, establishment, expansion, etc.). A prerequisite for assessment of the impacts.</td>
<td>Biopollution index (BINPAS)</td>
</tr>
<tr>
<td>4. Impacts on communities</td>
<td>Changes in native community structure</td>
<td></td>
</tr>
<tr>
<td>5. Impacts on habitats</td>
<td>Measure of alteration, fragmentation and/or loss of native habitats</td>
<td></td>
</tr>
<tr>
<td>6. Impacts on ecosystem functioning</td>
<td>Measure of shifts in food webs, alteration of energy flow and organic material cycling</td>
<td></td>
</tr>
</tbody>
</table>

(Based on: TG2 report, 2010)
Biopollution index: setting the target

GES: the absence or minimal level of biological pollution

The adverse bioinvasion impact has been reduced/limited since the initial assessment (DEFRA 2010)

(Breen et al. 2012. Marine policy, 36: 1033-1043)

(Borja et al. 2012. Ecological indicators, 12: 1-7)
BINPAS is a “retrospective” tool.

How to make it “prospective”?
Further development

BINPAS

AQUANIS
Information on aquatic biological invasions

Existing NIS databases (DAISIE, etc)
Who is the next to come?

- **Suggestion and hypothesis:** NIS which are present in a warmer European Atlantic LMEs (or countries within LMEs) for more than 10 years and did not move northwards are temperature limited.
- If temperature will increase enough these species will move northwards (or will increase in numbers/distribution range and start causing problems, i.e. their BPL will increase)
- **Question:** How many NIS which are present in LME 25 for more than 10 years and are not yet in Norway (LME 22, 21)
- **Answer:** 173 NIS
- How many of them are impacting (BPL>1)? What are their biological traits? Where they came from? …

In AQUANIS geographical data is organised in the hierarchical way:
Oceans>Ocean regions>LME>LME sub-regions>countries
KUCORPI publications within MEECE

• “BINPAS” papers

KUCORPI publications within MEECE

Other papers (MEECE acknowledged)

Thank you for your attention!
Biopollution index: setting the target

GES: the absence or minimal level of biological pollution

The adverse bioinvasion impact has been reduced/limited since the initial assessment (DEFRA 2010)