Milestone 5

Generic and sea-specific pressure-impact link matrices

Dissemination level

Public

LEAD CONTRACTOR

Marine Hydrophysical Institute (MHI)

AUTHORS

Olga Kryvenko (MHI), Vyacheslav Suslin (MHI), Tanya Churilova (MHI), KrysiaMazik (UHULL), Sally Little (UHULL), Steve Barnard (UHULL), Mike Elliot (UHULL)

SUBMISSION DATE

31 | December | 2014

DEVOTES is co-funded by the European Commission within the 7th Framework Programme 2007 -2013

www.devotes-project.eu
Contract number 308392

Contents

1. Introduction

Milestone 5 is the Generic and sea-specific pressure-impact link matrices produced under DEVOTES Task 1.1.2 and Deliverable D1.2, in relation to the Specific Objective 1.3 (Characterization of the impacts of present and future pressures, according to their potential effects on the structure and functioning of the ecosystem). It also feeds into Specific Objective 2.2 of WP2 (Identification and assessment of the socio-economic consequences of management practices aimed at achieving GES) and T3.1.2 of WP3 (Quantify the ability of indicators to identify threats and impacts on biodiversity in the regional seas). Task 1.1.2 aimed to create generic and regional sea-specific matrices of pressure-impact links and variations in biodiversity and to assess the mechanisms of those against shifting baselines due to climatic change. Furthermore, this task aimed to create and test with stakeholders generic and sea-specific matrices for use across European seas.

The framework of marine management promoted by DEVOTES has recently been modified to account for the separation between activities and pressures within a risk assessment and risk management framework (Elliott 2014). The latter paper suggests that the DPSIR (Drivers-Pressures-State change-Impacts-Responses) framework is modified to DAPSI(W)R in which the overarching Drivers result in Activities which then lead to Pressures, as mechanisms of change. These in turn lead to State Changes on the natural system which, if unchecked, leads to Impacts on societal Welfare. These then need societal responses to prevent the Drivers, Activities and Pressures causing State Changes and Impacts on Welfare.

The Generic Matrix (GM) developed here enables the assessment of the relative importance of a specific impact chain and its contribution to the overall impact that may result in a change in the state of Biodiversity Components (BC) state and thus the failure to achieve the policy objectives.

The GM includes links between sectors/activities and pressures and biodiversity components relevant to the habitats. The GM is universal and can be applied to any World Ocean area. With this aim, the GM includes ranking of pressure characteristics (i.e. spatial extent, temporal frequency and potential for impact). And characteristics could differ between regions because of regional specificities.

The GM application allows users to identify sector/pressure combinations, which currently pose the greatest threat to marine habitats and define the BC, which are most vulnerable. The GM enables users to assess both threats to BC (or key species for this BC) and threats from human activities to BC for particular habitats.

To change the scale from the GM to regional sea-specific (case study) matrices the list of BC should be more specific representing key/indicator BC relevant to the specified case study (CS) regional sea/area. The key sector/pressure and corresponding threatened BC chains should be defined for each regional sea/area which allows the creation of a more specific matrix.

2. Matrix components

The GM includes four main components: BC, Habitats, Sector/Activities and Pressures.

2.1. Biodiversity Components

Table 1. List of Biodiversity Components

#	Biodiversity Components
1	Phytoplankton
2	Zooplankton
3	Macroalgae/Angiosperms
4	Benthic invertebrates (sessile)
5	Benthic invertebrates (motile)
6	Fish (pelagic)
7	Fish (demersal)
8	Cephalopods
9	Marine mammals
10	Reptiles
11	Birds

2.2. Habitats

Table 2. List of Habitats

#	Habitats
1	Littoral rock and biogenic reef
2	Littoral sediments
3	Shallow sublittoral rock and biogenic reef
4	Shallow sublittoral coarse sediment
5	Shallow sublittoral sand
6	Shallow sublittoral mud
7	Shallow sublittoral mixed sediment
8	Shelf sublittoral rock and biogenic reef
9	Shelf sublittoral coarse sediment
10	Shelf sublittoral sand
11	Shelf sublittoral mud
12	Shelf sublittoral mixed sediment

13	Upper bathyal rock and biogenic reef
14	Upper bathyal sediment
15	Lower bathyal rock and biogenic reef
16	Lower bathyal sediment
17	Abyssal rock and biogenic reef
18	Reduced salinity water
19	Variable salinity (estuarine) water
20	Marine water: coastal
21	Marine water: shelf
22	Marine water: oceanic
23	Coast

2.3. Sector - Activities

Within the GM, sectors are disaggregated into relevant activities because not all activities exert the same pressures on BCs. This enables users to identify management options specific to particular activities rather than whole sectors. Some activities and some parts of activities may not be applicable for particular regions (CSs), in which case only the relevant parts should be considered.

Table 3. List of Sector-Activities

N	Sector	N	Activity
1	Aquaculture (including marine biotechnology which is based on aquaculture)	1	Fin-fish - set-up
		2	Fin-fish - operational
		3	Macro-algae - set-up
		4	Macro-algae - operational
		5	Shellfish - setup
		6	Shellfish - operational
2	Fishing	1	Benthic trawls and dredges - operations
		2	Benthic trawls and dredges - mooring/anchoring
		3	Benthic trawls and dredges - general
		4	Nets (fixed/set/gillnets/other nets/lines) - set up/recovery
		5	Nets (fixed/set/gillnets/other nets/lines) - operational
		6	Nets (fixed/set/gillnets/other nets/lines) - general
		7	Pelagic trawls - operations
		8	Pelagic trawls - mooring/anchoring

		9	Pelagic trawls - general
		10	Potting/creeling - set up/recovery
		11	Potting/creeling - operational
		12	Potting/creeling - general
		13	Suction/hydraulic dredges - operations
		14	Suction/hydraulic dredges - mooring/anchoring
		15	Suction/hydraulic dredges - general
3	Shipping	1	Mooring/anchoring/beaching/launching
		2	General
4	Renewable Energy	1	Wind farms – construction - installation/deinstallation of turbines on seafloor
		2	Wind farms - operational (active cables laying on seafloor, moving turbines)
		3	Wave energy – construction, cable laying/removing
		4	Wave energy - operational
		5	Tidal sluices - construction
		6	Tidal sluices - operational
		7	Tidal barrages - construction
		8	Tidal barrages - operational
5	Non-renewable Energy (oil, gas and hydro)	1	Oil and Gas -exploration/construction/deinstallation
		2	Oil and Gas - operational
		3	Hydro - operational
		4	Power stations (land-based on coast) - construction
		5	Power stations (land-based) - operational
6	Non-renewable Energy (Nuclear)	1	Power stations (land-based on coast) - construction
		2	Power stations (land-based) - operational
7	Telecommunications	1	Communication cables - laying cables
		2	Communication cables - active operational
8	Aggregates	1	Maerl - extraction of substrate
		2	Maerl - spoil/waste disposal
		3	Rock/Minerals - coastal quarrying - extraction of substrate
		4	Rock/Minerals - coastal quarrying - spoil/waste disposal
		5	Sand/gravel aggregates - extraction of substrate
		6	Sand/gravel aggregates - spoil/waste disposal
9	Navigational Dredging	1	Capital dredging - extraction of substrate
		2	Capital dredging - spoil/waste disposal
		3	Maintenance dredging - extraction of substrate

		4	Maintenance dredging - spoil/waste disposal
10	Coastal Infrastructure	1	Artificial reefs - construction
		2	Artificial reefs - operational
		3	Beach replenishment - operational
		4	Culverting lagoons - construction
		5	Culverting lagoons - operational
		6	Marinas and dock/port facilities - construction
		7	Marinas and dock/port facilities - operational
		8	Land claim - construction
		9	Land claim - operational
		10	Coastal defence - Sea walls/breakwaters/groynes - construction
		11	Coastal defence - Sea walls/breakwaters/groynes - operational
11	Land-based Industry	1	Industry with discharges into rivers and coastal waters - operational
12	Agriculture	1	Deforestation
		2	General
13	Tourism/Recreation	1	Angling
		2	Boating/Yachting/Diving/Water sports - mooring/anchoring/beaching/launching
		3	Boating/Yachting/Diving/Water sports - general
		4	Public beach - general
		5	Tourist Resort - construction
		6	Tourist Resort - operational
14	Military	1	Operations (specific to activity but can include: seismic activities, sonar)
		2	Mooring/anchoring/beaching/launching
		3	General
15	Research	1	Operations)
		2	Mooring/anchoring/beaching/launching
		3	General
16	Desalination	1	Operational
17	Waste Water Treatment	1	Operational
18	Harvesting/Collecting	1	Bait digging -
		2	Seaweed and saltmarsh vegetation harvesting
		3	Bird eggs
		4	Shellfish hand collecting
		5	Peels (boulder turning)
		6	Curios

2.4. Pressures

According to Stelzenmüller et al. (2010), a method of translating human activities into ecosystem specific pressures, together with a measure of ecosystem sensitivity to those pressures, is required to determine human impacts on ecosystem components. In order to achieve this, clear definition and consistent use of the term pressure is required. Martins et al. (2012) state that pressures are human actions that can induce environmental change and are usually associated with actions with the potential to cause damage or degradation.

The World Resources Institute (2009) database of ecosystem services defines pressure as: *biophysical influences that act directly on ecosystems and the biodiversity they harbour*. Pressures are differentiated from direct drivers in that they are the biophysical representation of human actions that directly impact ecosystems for example, emission or waste discharge. This definition is broadly consistent with that of Pirrone et al (2005) and Robinson et al (2008) who define pressure as: *the mechanism through which an activity has an effect on any part of an ecosystem*. Impacts are the consequences of pressures where a change occurs that is different to that expected under natural conditions. These definitions state that pressures can be physical, chemical or biological with the same pressure being caused by a number of activities and different pressures potentially resulting in the same impact.

However, despite the similarity of these definitions, many of the pressures identified (by The World Resources Institute, 2009) as being relevant to the marine environment are representative of activities according to the approach adopted by Robinson et al. (2008) and OSPAR. Examples include marine mineral mining, marine dumping and water abstraction. Essentially, Robinson et al. (2008) make clear the distinction between activities, pressures and impacts where these three terms have previously been used interchangeably.

For the purpose of DEVOTES, the definition of pressure used in Robinson et al. (2008) has been adopted.

'the mechanism through which an activity has an effect on any part of an ecosystem'

Following the general approach of OSPAR, Eastwood et al. (2005) and Robinson et al. (2008), the EC (2008) provides a list of pressures, for the purpose of MSFD. This approach identifies 8 pressure themes with 18 individual pressures or mechanisms. Robinson et al. (2008) listed further pressures, later updated by Koss et al. (2011). With the exception of pressures falling under the general theme of climate change, these pressures predominantly relate to anthropogenic activity and, according to Atkins et al. (2011) would be referred to as endogenic (within the system), managed pressures. These need to be managed in the context of unmanageable, exogenous (outside the system) pressures which may include those falling under the theme of climate change, isostatic/eustatic change, volcanic or seismic

activity. Furthermore, unmanageable pressures acting at a large scale require a different response to localised, manageable pressures and they require separate consideration. Pressures identified in previous work have been collated and updated, resulting in a list consistent with that being used in the ODEMM project (Koss et al., 2011), with separation of manageable and unmanageable pressures (Table 4,5).

Table 4. List of manageable pressures

##	Pressure	Description	Listed in MSFD
1	Smothering	By man-made structures/ disposal at sea	✓
2	Sealing/substratum loss	Sealing by permanent construction (coastal defences/wind turbines), change in substratum due to loss of key physical/biological features, replacement of natural substratum by another type (e.g. sand/gravel to mud)	✓
3	Changes in siltation	Change in concentration of suspended solids in the water column (dredging/run-off)	✓
4	Abrasion	Physical interaction of human activities with the seafloor/seabed flora and fauna causing physical damage (e.g. trawling)	✓
5	Selective extraction of non-living resources	Aggregate extraction/removal of surface substrata	✓
6	Underwater noise	Shipping/acoustic surveys	✓
7	Marine Litter	Litter	✓
8	Thermal regime changes	Temperature change (average, range, variability) due to thermal discharge (local)	✓
9	Salinity regime changes	Salinity change (average, range, variability) due to thermal constructions affecting water flow (at local scale)	✓
10	Introduction of Synthetic compounds	Pesticides, anti-foulings, pharmaceuticals	✓
11	Introduction of non-synthetic compounds	Heavy metals, hydrocarbons	✓
12	Introduction of Radionuclides	Radionuclides	✓
13	Nitrogen and Phosphorus enrichment	Input of nitrogen and phosphorus (e.g. fertiliser, sewage)	✓
14	Input of organic matter	Input of organic matter (industrial/sewage effluent, agricultural run-off, aquaculture, discards, etc.)	✓
15	Introduction of microbial pathogens	Introduction of microbial pathogens	✓

16	Introduction of non-indigenous spp. and translocations	Through fishing activity/netting/aquaculture/shipping	✓
17	Selective extraction of species	Removal and mortality of target (e.g. fishing) and non-target (e.g. by catch, cooling water intake) species	✓
18	Death or injury by collision	Caused by impact with moving parts of a human activity (ships, propellers, wind turbines)	x
19	Barrier to species movement	Obstructions preventing natural movement of mobile species. Barrages, causeways, wind turbines etc. along migration routes.	x
20	pH changes	Change in pH (mean, variation, range) due to run-off/change in freshwater flow etc. (local)	x
21	Change in wave exposure	Change in size, number, distribution and/or periodicity of waves along a coast due to man-made structures (local) or climate change (large scale)	x
22	Water flow rate changes	Change in currents (speed, direction, variability) due to man-made structures (local)	x

Table 5. List of unmanageable pressures.

##	Pressure	Description	Listed in MSFD
1	Thermal regime change	Temperature change (average, range, variability) due to climate change (large scale)	x
2	Salinity regime change	Temperature change (average, range, variability) due to climate change (large scale)	x
3	Emergence regime change	Change in natural sea level (mean, variation, range) due to climate change (large scale) and isostatic rebound	x
4	Water flow rate changes	Change in currents (speed, direction, variability) due to climate change (large scale)	x
5	pH changes	Change in pH (mean, variation, range) due to climate change (large scale), volcanic activity (local)	x
6	Change in wave exposure	Change in size, number, distribution and/or periodicity of waves along a coast due to climate change (large scale).	x

3. Matrices Linkage Tables and weighting of interaction – Pressure Assessment approach

Each Sector-Activity could produce a number of pressures. These linkages were developed in ODEMM (Koss et al., 2011a) and subsequently modified in DEVOTES. Each pressure could affect a number of BC and Habitats. All interactions are one-way (sector/activities could cause a particular pressure, which could affect BC).

The combinations shown in the linkage tables (Annex 1) describe only the potential pressure–BC pathways. In order to assess the actual relative threat caused by a particular activity-pressure on BC, a weighting of the interaction Sector-Activity – Pressure – Habitat/BC is required.

The ODEMM Pressure Assessment (PA) tool (Robinson, Knights, 2011) has been modified for evaluating threats from human activities to BC relevant to particular habitats.

At the first stage of the GM, the top 10 of the most dangerous Sector-Activity combinations in a particular sea area (Case study) are determined based on an Integrated Pressure Coefficient (IPC). The assessment of IPC takes into account three main aspects of pressure (i.e. spatial extent, temporal frequency of Sector-Activity, potential for impact of particular pressure), which allows the user to define the sectors/activity combinations which could affect biodiversity components with highest potential for impact.

At the next stage, the potential impact of the top 10 Sector-Activity on habitats existing in the area and associated biological groups is evaluated. The IPC is calculated again taking into account the spatial overlap between Sector-Activity and a particular habitat.

At the final stage evaluation of pressure impact on particular BC and their resilience is taken into account. Integrated potential impact of Pressure on Habitat is assessed as sum of this Pressure impact on all BCs sensitive to this Pressure and relevant to the Habitat.

BOX Pressure Assessment Approach

Following the Pressure Assessment approach, for each sub-region (CSs area) expert judgment was used to weigh these interactions in terms of:
(i) - the generic sensitivity of a biodiversity component/habitat to any sector/pressure combination (in terms of likely degree of impact and resilience);
(ii)- the actual footprint of the sector/activity or relevant pressure in the sea area being assessed where it overlaps with the habitat (spatial overlap and frequency of pressure occurrence)
Five criteria for weighting of the interaction:
(i) The **spatial overlap pressure** from sector/activity where there is overlap with habitat/biodiversity component (AHSO coefficient);
(ii) The **frequency of activity causing the pressure** where there is overlap with habitat/biodiversity component in an average year (AF coefficient);
(iii) Relative **Potential for Impact** of particular pressure from particular Sector/Activity;
(iv) The generic **degree of impact** of pressure from sector on biodiversity component (DoI coefficient);
(v) The generic **resilience** of biodiversity component within the region being assessed based on its current status.
Reference:
Robinson, L.A., Knights, A.M. 2011. ODEMM Pressure Assessment User guide. ODEMM Guidance Document Series No.2. EC FP7 project (244273) 'Options for Delivering Ecosystem-based Marine Management'. University of Liverpool. ISBN: 978-0-906370-62-9, 12 pp

The Generic Matrix includes 5 tables.

3.1. Table 1 "T1-AASO- AF-PI coefficients"

Table 1 assesses (by users) the activity/area spatial overlap coefficient (AASO) (column F), activity frequency coefficient (AF) (column G) and Potential for Impact (PI) coefficient for particular pressure caused by particular activity. The table links Sector-Activity-Pressure. The Table includes 19 sectors and ~ 88 activities (tables 1, 2, 3). Coefficient of AASO characterizes area covered by activity in the studied area. AASO is assessed as percentage of the CS area based on 5 levels of ranking. In case of activity located on the coast (for instance – coastal infrastructure, sewage, etc.), AASO is assessed as part of the coastline (in %) covered by the activity;

1. < 5%
2. 5-25 %
3. 26 -50 %
4. 51 – 75 %
5. > 75 %

The AF coefficient is assessed using 4 levels:

- 1 - R(rare) <3 months per year
- 2 - O (occasional) - 3-5 months per year
- 3 - C (common) - 6-8 months per year

- 4 - P - (persistent) 9-12 months per year

The PI coefficient for a particular pressure caused by a particular activity may be different depending on the type of activity. Four levels of ranking of PI between activities from min (1) to max (4) have been proposed (sheet "Pressure-Rank"). The ranking of the PI coefficient has been undertaken based on DEVOTES partners expert judgment.

3.2. Table 2 "T2-PEC-Coef"

Table 1 assesses (by users) the pressure extent coefficient - PEC (columns H –AC), which reflects the extension of Pressure relative to Sector/Activity localization. The AASO corrected by EC allows to assess spatial overlapping particular pressure with area investigated (CS area);

PEC coefficients could be equal to AASO ("1") or bigger ("2"). Users fill in "1" or "2" in this table (T2) to indicate this difference

3.3. Table 3 "T3-Top10-habit-overlap"

Table 3 identifies the top 10 Sector/Activities, which are most dangerous for the sub-region and defined based on the values of the IPC calculated by an algorithm (special program written by Dr. Vyacheslav Suslin) using information from the preceding user inputted matrix tables (T1+T2),.

In the table T3 user assesses coefficient AHSO (Activity/Habitat Spatial Overlap) that reflects spatial overlapping between the top most dangerous Sector-Activities and Habitats relevant to the investigated area. The AHSO coefficients reflect spatial overlapping of particular sector/activity with particular habitat (in % of Habitat area). Five levels of ranking have been proposed (see description in p. 3.1).

3.4. Table 4 "T4- P-BC (DoI)"

Table 4 assesses (by user) the severity of impact of a particular pressure on BC; that is, the degree of impact (DoI).

The DoI of a pressure (Robinson et al., 2011) on BC describes the generic severity of the interaction in terms of its effects on the BC. Thus to score degree of impact user score the type of response of the BC to the pressure type as either:

• Severe - Acute (A);

• Severe - Chronic (C); or

• Low severity (L).

A Severe - Acute (A) interaction is described as a severe impact over a short duration e.g. for species, a high proportion of individuals are killed by the interaction of the pressure and the characteristic. In the case of habitats, such interactions cause an immediate change in habitat type (i.e. change or loss of characteristic features and/or species). Thus a Severe – Acute (A) interaction can occur after just one event (Robinson et al., 2011).

A Severe – Chronic (C) interaction is described as an impact that will eventually have severe consequences if it occurs often enough and/or at high enough levels (e.g. where disease levels might

build up over time leading to levels eventually where high mortality in a population would be recorded). No inference is made as to when the pressure impact becomes severe; simply that at some frequency and intensity, a pressure can lead to severe impacts on that ecological characteristic (Robinson et al., 2011).

A Low severity (L) interaction is an interaction that, irrespective of the frequency and magnitude of the event(s), never causes high levels of mortality within a given population, or results in loss of habitat or change in its typical species or functioning i.e. proximate ecological responses (*sensu* Harley et al. 2006).

It was assumed that the severity of Pressure Impact on BC were the same for different Sector-Activities that caused this pressure with an exception being the selective extraction of species. For the selective extraction of species special columns are added in the T1.

3.5. Table 5 "T5-Resilience-Hab-BC"

The Resilience (coefficient –R) is assessed as recovery time. Recovery times for BC are assessed based on their turnover times (e.g. generation times) based on its current status in the analysed area (the sub-region/Case Study) using 4 levels of Resilience ranking categorized based on recovery times (Robinson et al., 2011):

1. None (no recovery or >100yr) (N);

2. Low (10 to <100 yr) (L);

3. Medium (2 to <10 yr) (M); or

4. High (0 to <2 yr) (H).

The ability of BC for recovery (Resilience, R) is assessed for a particular habitat.

Because R is assessed based on BC turnover times, R is unlikely to vary between sector/pressures which cause the Pressure. But BC resilience might be different due to Habitats conditions. Resilience can vary between BC due to inherent differences in recovery potential due to their characteristic features and species (e.g. deep sea habitats take longer to recover than intertidal sediment habitats) or BC resilience might be different between regions (there are regional differences in the current status of the same BC such that the inherent resilience is affected).

In algorithm program different values of coefficients used in the tables (T1-T5) for assessment impact degree are normalized by the way to get final score always be a proportion of 1 and therefore be readily interpretable.

4. Main steps in Matrix algorithm

The Matrix algorithm includes 12 steps. The general structure of the Matrix is presented in Figure 1.

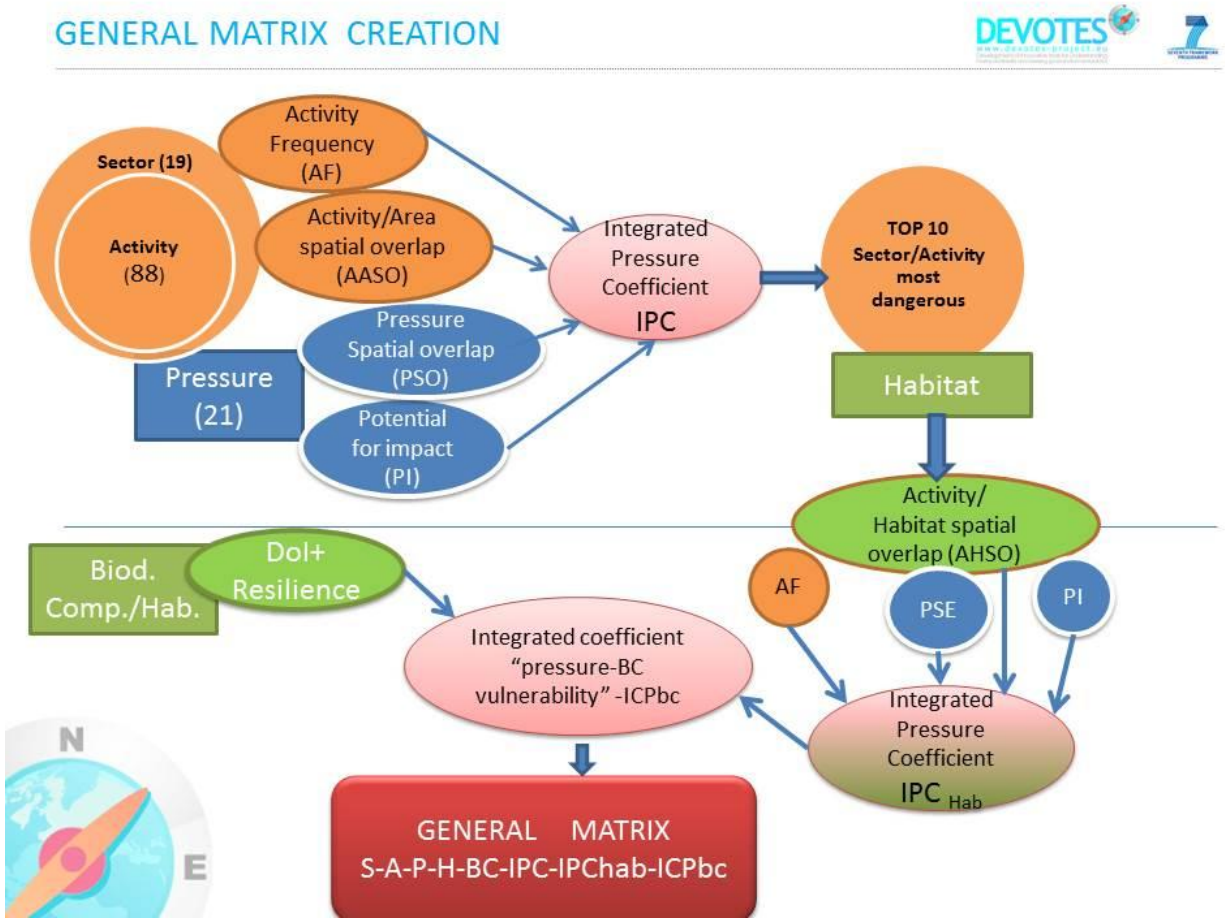

Figure 1. Scheme of General Matrix

Step -1. Assessment of activity/area spatial overlap (AASO) coefficients (5 levels of ranking in % of the CS area);

Step -2. Assessment of frequency (temporal characteristic) of sector/activity (AF) (4 levels of ranking);

Step -3. Assessment of coefficient reflecting 'Potential for impact' (IP) of particular pressure/activity (based on the table 6);

Step -4. Assessment of pressure extent relative to activity location (PEC coefficient);

Step -5. Integrated Pressure Coefficient – IPC is calculated (by algorithm/special program written by Dr. Vyacheslav Suslin) as

$$IPC = ((AASO \times PEC) \times AF \times IP \quad (1)$$

Where:
AASO –Activity/Area Spatial Overlap coefficient;
PEC – Pressure Extent Coefficient;
AF – frequency of sector/activity coefficient;
IP – Potential for impact coefficient;

Step -6. Identification of the top 10 Sector/Activities, which are the most dangerous for the sub-region (based on IPC values already calculated).

Step -7. Assessment of the spatial overlap of a particular activity with a particular habitat (in % of H area) – AHSO coefficient. AHSO coefficient is assessed only for the TOP (~10) Sector/Activities) using 5 levels of overlapping ranking (see p. 3.1)

Step 8. Integrated Pressure Coefficient for particular habitat (IPC_{Hab}) is calculated (by algorithm):

$$\mathbf{IPC_{HAB} = (AHSO \times PEC) \times AF \times IP}, \quad (2)$$

Where:

AHSO – Spatial overlap of particular activity with particular habitat (in % of H area) – AHSO coefficient
PEC – Pressure Extent Coefficient;
AF – frequency of sector/activity coefficient;
IP – Potential for impact coefficient

Step 9. Assessment of the severity of impact of particular pressure on Biodiversity Components –BC **(d**egree of impact - DoI) .

Step 10. Assessment of Resilience (recovery time) – (coefficient –R)
Step 11. The final Coefficient (IPC_{BC})calculated by algorithm, which reflects weighting/ranking of "S-A-P-BC/Hab links" . This coefficient allows to identify potential Risk of BC state change caused by particular P for particular habitats.

$$\mathbf{IPC_{BC} = IPC_{HAB} \times F(DoI, RES)} \quad (3)$$

IPC_{Hab}- result of equation (2)
F(DoI, R) – function of Degree of Impact (DoI) and Resilience (R) for the pressures caused by the top 10 most dangerous sectors/activities. F(DoI, R) values are evaluated according to the next matrix.

F(DoI,R)	H	M	L	N
A	3	4	4	4
C	2	3	3	3
L	1	1	1	2
N	0	0	0	0

Step 12 Output of the algorithm. As an output of the calculation **Specific Matrix** is obtained (T6_Specific matrix_Ukraine as example).

The Specific matrix includes columns Sectors, Activity, Pressure, Habitat, Biodiversity Component and IPC_{BC} coefficient. The coefficient is the output of the algorithm. The value of IPC_{BC} reflects relative weighting/ranking of "S-A-P-BC_{Hab} links" which allow to identify potential Risk of BC state change caused by particular Pressure in the particular Habitat.

5. Guidance for creation of Specific Matrix from Generic Matrix

Once the CS area has been selected, tables 1-5 used at the GM should be completed with information from the specific CS area.

Table 1"T1-AASO- AF-PI coefficients"

In the column "Presence" the user should indicate by "1" what Sector/Activity-Pressure links are present in the CS area. ("0" – should be used if S/A-P links is absent in this area).

In column AASO – activity/area spatial overlap coefficient the user should assess the area covered by particular activity in % of the investigated area/cost line (CS area) using 5 levels of ranking:

1. < 5%
2. 6-25 %
3. 26 -50 %
4. 51 – 75 %
5. >75 %

In column AF – Activity Frequency. The user should identify the number of months within a year when this activity takes place. The 4 levels of AF ranking are used :

1 - R(rare) <3 months per an averaged year
2 - O (occasional) - 3-5 months per an averaged year
3 - C (common) - 6-8 months per an averaged year
4 - P - (persistent) 9-12 months per an averaged year

Table "T3_Top10_habit_overlap"

The user should choose the TOP 10 Sector/Activities, which are the most dangerous for the sub-region/CS. This should be undertaken based on calculated IPC values.
In column G – there is AASO coefficient (taken from T2).
In columns H-AD (for the TOP (10) Sector/Activities), the user should assess the Spatial Overlap of particular activity with particular habitat area (in % of H area) and fill in using 5 levels of overlapping ranking (following the description in chapter 3.1):

1. < 5%
2. 6-25 %
3. 26 -50 %
4. 51 – 75 %
5. >75 %

Table "T4_P-BC(DoI)"

User should check whether severity of effect of particular Pressure on BC (DoI) is relevant particular region (CS area).
The DoI of a pressure on a BC:

- Severe - Acute (A);
- Severe - Chronic (C); or
- Low severity (L).

Table "T5_Resilience_Hab-BC "

The user should identify the BC which belong to particular Habitat and fill in the Resilience (recovery time – coefficient –R). The table includes all Habitats (DEVOTES catalogue) and BC (DEVOTES catalogue); however, the user should assess the R coefficient for BC, relevant for particular habitat. If BC is not represented in the particular H the user should leave cell empty.

Recovery time for BC is assessed based on their turnover time (e.g. generation time) based on its current status in the analysed area (the sub-region/Case Study) using 4 levels of Resilience ranking categorized based on recovery times:

1. None (no recovery or >100yr) (N);
2. Low (10 to <100 yr) (L);
3. Medium (2 to <10 yr) (M); or
4. High (0 to <2 yr) (H).

TABLE "T6_SPECIFIC_MATRIX_",
Table T6 is the output of the algorithm calculation. The Specific matrix is a pivot table including Sectors, Activity, Pressure, Habitat, Biodiversity Component and IPCbc coefficient (see Fig 1). This coefficient is the output of the algorithm. The value of the IPCBC reflects the relative weighting/ranking of "S-A-P-BCHab links" which enables the identification of the potential Risk of BC state change caused by particular Pressure in the particular Habitat.

6. References

Atkins, J.P., Burdon, D., Elliottt, M. & Gregory A.J. 2011. Management of the marine environment: Integrating ecosystem services and societal benefits with the DPSIR framework in a systems approach. Marine Pollution Bulletin 62: 215-226

Eastwood, P.D., Mills, C.M., Aldridge, J.N., Houghton, C.A. & Rogers, S.I. 2007. Human activities in UK offshore waters: as assessment of direct, physical pressure on the seabed. ICES Journal of Marine Science. 64: 453-463.

Elliott M. 2014. Integrated marine science and management: Wading through the morass. Marine Pollution Bulletin. 86: 1-4.

European Commission, 2008. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). Official Journal of the European Union, L164, pp. 19-40.

Harley, C. D. G., A. R. Hughes, K. M. Hultgren, B. G. Miner, C. J. B. Sorte, C. S. Thornber, L. F. Rodriguez, L. Tomanek, and S. L. Williams. 2006. The impacts of climate change in coastal marines systems. Ecology Letters 9:228-241.

Koss, R.S., Knights, A.M., Eriksson, A. and L.A. Robinson. 2011. ODEMM Linkage Framework User guide. ODEMM Guidance Document Series No.1. EC FP7 project (244273) 'Options for Delivering Ecosystem-based Marine Management'. University of Liverpool, ISBN: 978-0-906370-66-7.

Koss, R.S., Knights, A.M., Eriksson, A. and Robinson L.A. 2011a. ODEMM Linkage Tables (Version 1). EC FP7 project (244273) 'Options for Delivering Ecosystem-based Marine Management'. University of Liverpool

Martins, J.H., Camanho, A.S. & Gaspar, M.B. 2012.A review of the application of driving forces – Pressure – State – Impact – Response framework to fisheries management. Ocean & Coastal Management. 69: 273-281

Pirrone, N., Trombino, G., Cinnirella, S., Algieri, A., Bendoricchio, G. &Palmeri, L. 2005. The Driver-Pressure-State-Impact-Response (DPSIR) approach for integrated catchment-coastal zone management: preliminary application to the Po catchment-Adriatic Sea coastal zone system. Regional Environmental Change. 5: 111-137.

Robinson, L.A., Rogers, S. &Frid, C.L.J. 2008.A marine assessment and monitoring framework for application by UKMMAS and OSPAR – Assessment of Pressures and Impacts. Phase II: Application for regional assessments. Joint Nature Conservation Committee contract No. C-08-0007-0027.

Robinson, L.A., Knights, A.M. 2011. ODEMM Pressure Assessment User guide. ODEMM Guidance Document Series No.2. EC FP7 project (244273) 'Options for Delivering Ecosystem-based Marine Management'. University of Liverpool. ISBN: 978-0-906370-62-9, 12 pp.

Stelzenmüller, V., South, J.L.A. & Rogers, S.I. 2010. Quantifying cumulative impacts of human pressures on the marine environment? A geospatial modelling framework. Marine Ecology Progress Series. 398:19-32

World Resources Institute. 2009. Ecosystem service indicators database (http://www.esindicators.org/indicators_overview). Accessed on 30th January, 2013.

7. List of annexes

Annex 1 –M5.Annex1_DEVOTES-GeneralMatrix_blank (.xls)

Annex 2 – M5.Annex2_DEVOTES-SpecificMatrix_SNS (.xls)