



The GloBallast BW Risk Assessment Method

Based on Rob Hilliard's Presentation

Types of BW Risk Assessment

- **Qualitative Risk Identification ('low', 'medium', 'high').** Based on subjective parameters drawn from previous experience, scientific opinion, 'expert' inputs, etc.
- **Semi-Quantitative Ranking of Risk (to minimise subjectivity wherever possible; such as including a multivariate Environmental Similarity Analysis).**
- **Quantitative Risk Assessment (QRA).** For BWRA this requires emerging procedures requiring 'Target' species, large amounts of data collation, and evaluation and input of all uncertainties.

Four Objectives of the GloBallast 'First Pass' Risk Assessment

- 1) Identify the trading routes and vessel types that represent the Highest Risk of Introducing a Pest;
- 2) Training and familiarisation In Risk Assessment terminology, approach and methods;
- 3) Providing a 'Demonstration Tool' that allows each Pilot Country to undertake further risk assessments in future, including for other ports in their country and region;

and

4) Providing information allowing the Pilot Country to decide on the need and value of adopting either:

- a 'blanket' approach to BW management;**
- or**
- a selective approach.**

Three Components Required for the GloBallast Risk Assessment

1) Determine the 'Innoculation' Potentials;

- Source, frequency and quantities of BW discharges;
- Conditions affecting survival of organisms
 - voyage time,
 - tank size,
 - BW exchange
 - etc

- 2) Determine the presence of High Risk species at the source ports (or in their region if there is inadequate information).
- 3) Determine the Environmental Similarity of the receiving and donor ports (by multivariate analysis).

Use the above information to identify the relative risks for each port (with respect to each of its main BW donor and destination ports)

Six Main Activities for achieving a 'First Pass' Risk Assessment:

1) Establish GIS and map the port's facilities, local marine habitats and resources, and show the port's deballasting/ballasting patterns.

[use ESRI Arcview 3.2] = Tasks 1,2

2) Establish a computer database that contains the port's shipping and BW data (IMO BWRF), and identify the port's main BW source and destination ports.

[use MS Access] = Tasks 2,3,4,5

3) Collate the environmental data (10-15 parameters) for the port and each of its main source and destination ports, and input to the database;

= Task 6

4) Undertake the Environmental Similarity Analysis (by multivariate technique); then:

[use Primer v.5]

= Task 7

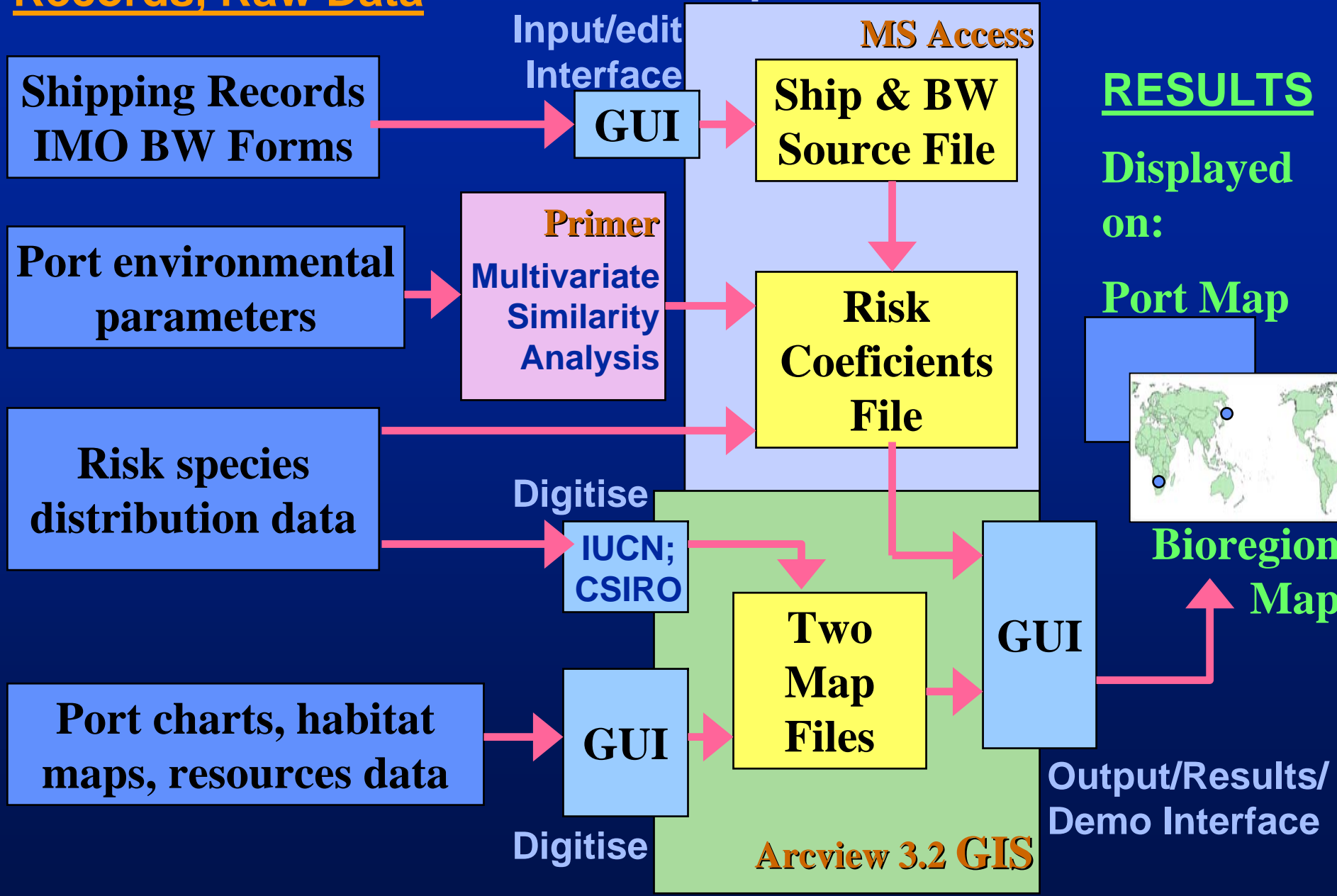
**5) Collate risk species distribution data and add to a world IUCN bioregion map on the GIS
[with CSIRO input] = Task 8**

then:

**6) Use the GIS to undertake and display the Risk Assessment, using the results from Activities 1-5.
= Task 9**

Records, Raw Data

Computer Database



Components used to calculate the relative risk:

Frequency of ships discharging BW from each Source Port

Percentage of all BW tank discharges (C1)

Amount discharged from each Source Port

Percentage of total BW vol. discharged (C2)
+ a risk reduction factor for small tanks (R1)

Similarity between the receiving port & each Source Port

Environmental matching coefficient (C3)
(measure of relative similarity vs other source ports)

Percentage of all 'available' risk species in each Source Port

Coefficient of risk species threat (C4)

BW storage times (voyage duration, etc)

Risk reduction factor for long storage times (R2)

Was BW Exchanged?
If true, how effective?

This potential risk reduction factor was ignored (varies with location, vol. flushed, sediment, etc)

C1: BW discharge frequency (% of total)

C2: BW discharge volume (% of total)

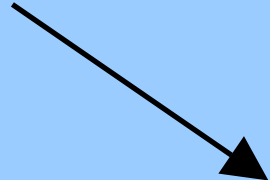
**C3: Environmental matching (0.05 - 1)
(port-to-port similarity analysis)**

C4: Risk species threat (0 – 1)

Example of C1 (% frequency of BW discharges)

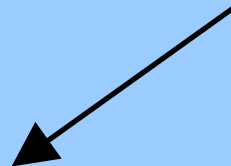
500 BW tank fills per year
C1 = 0.5 (50% of total)

Port X



100 BW tank fills per year
C1 = 0.1 (10% of total)

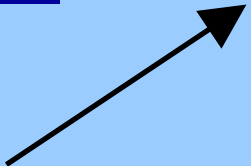
Port Y



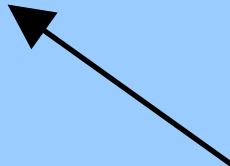
Receiving Port

RECEIVES: A total of 1000 tank discharges/year

Port W



Port Z



150 BW tank fills per year
C1 = 0.15 (15% of total)

250 BW tank fills per year
C1 = 0.25 (25% of total)

Example of C2 (% volume of discharged BW)

200,000 tonnes per year
C2 = 0.2 (20% of total)

Port X

500,000 tonnes per year
C2 = 0.5 (50% of total)

Port Y

Receiving Port

RECEIVES: 1,000,000 tonnes per year (total)

Port W

250,000 tonnes per year
C2 = 0.25 (25% of total)

Port Z

50,000 tonnes per year
C2 = 0.05 (5% of total)

Example of C3 (environmental matching)

Up-River port;
 $C3 = 0.15$ (15% similar)

Jetty terminal in tropics
 $C3 = 0.25$ (25% similar)

Port X

Port Y

Bay port in a temperate area
Receiving Port

Port W

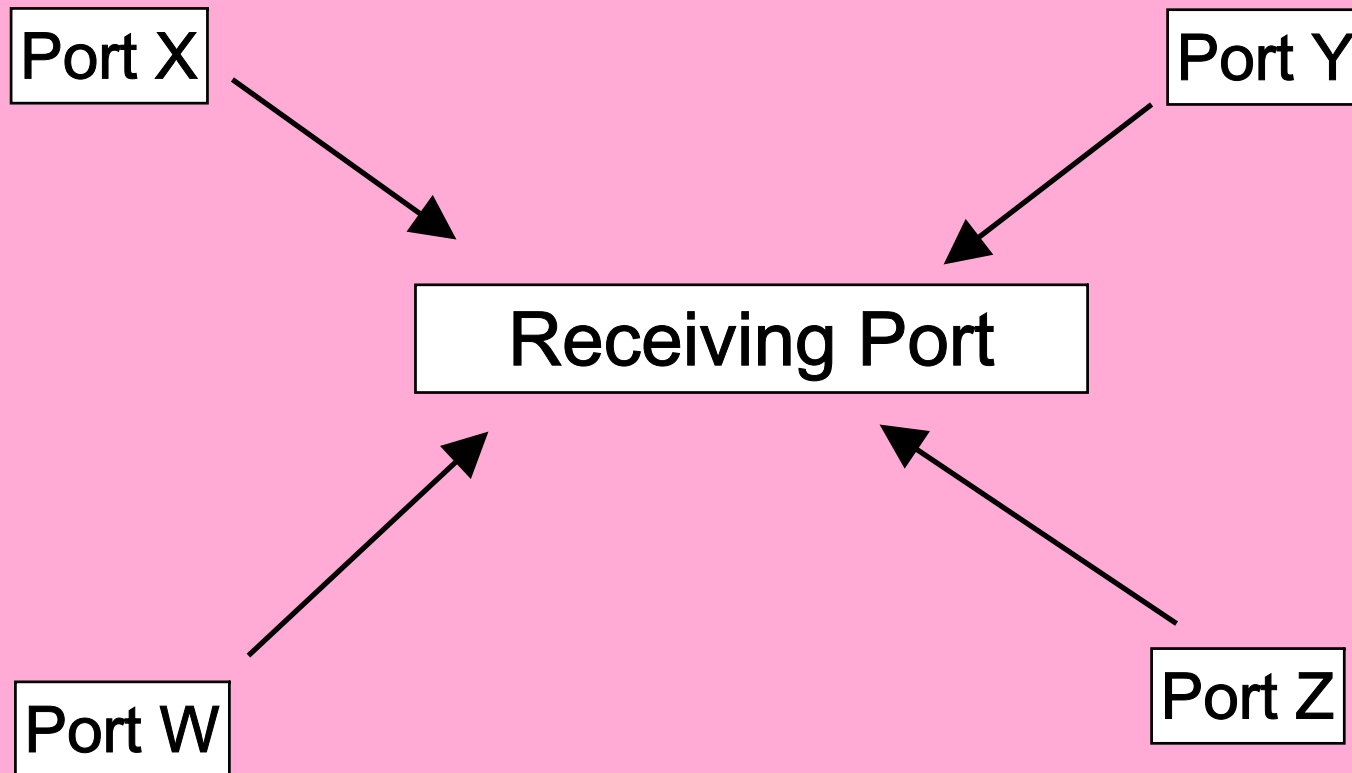
Port Z

Bay port in a cold area;
 $C3 = 0.55$ (60% similar)

Estuary port in a temperate area
 $C3 = 0.70$ (70% similar)

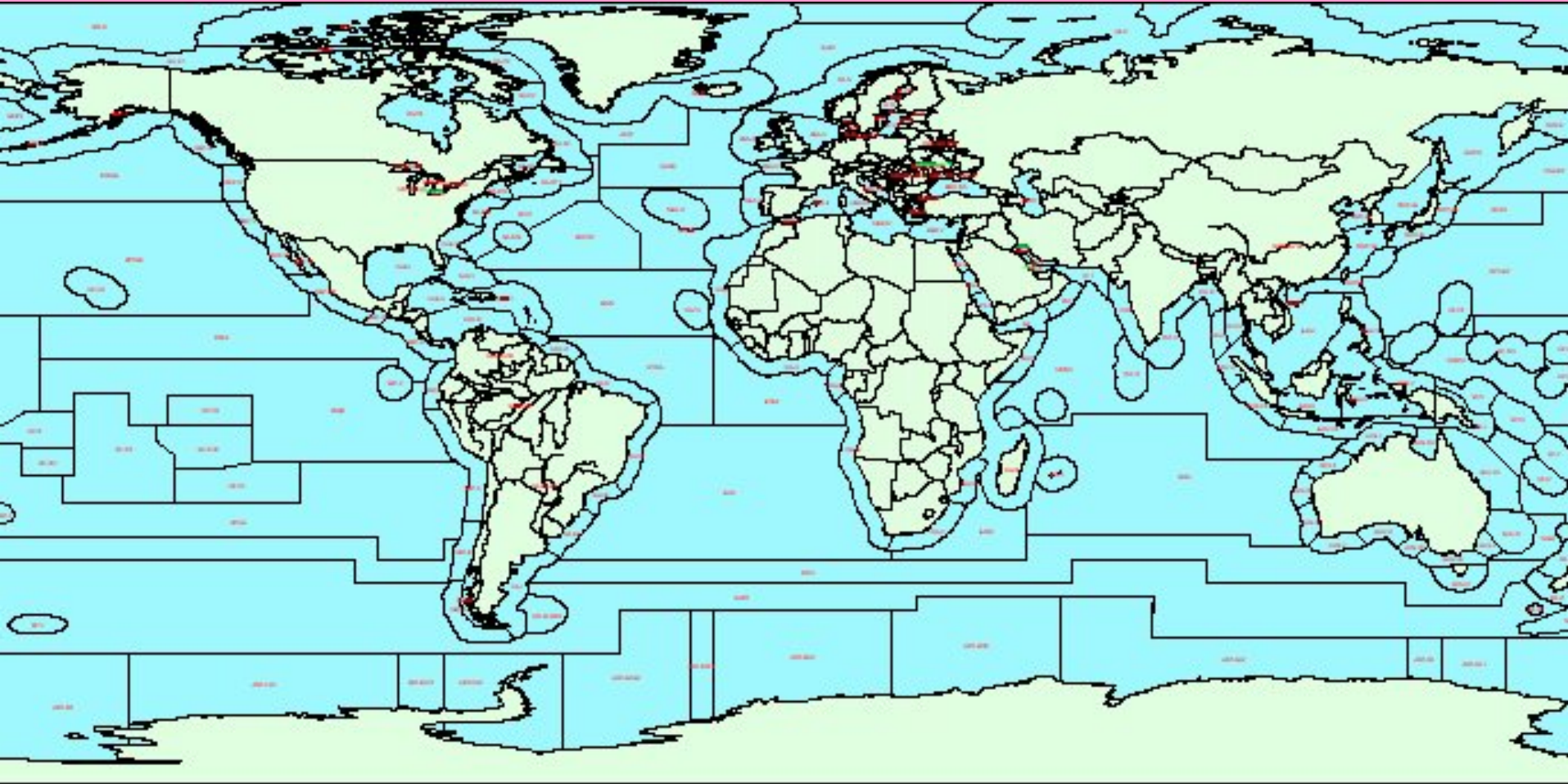
Example of C4: (the risk species threat)

Where and what are the risk species?



Example of C4: (risk species threat)

What and where are the risk species?



Example of C4: (risk species threat)

Bioregion of Port X contains:

- 23 Introduced Species (I; no reported harm)
- 4 Suspected harmful (S; including natives)
- 1 Known harmful (K; including natives)

Port X

$$[23 + (4 \times w1) + (1 \times w2)]$$

C4= *Total value for all species in all source port bioregions** x w3

- Project default value for w1 = 3
- Project default value for w2 = 10
- Project default value for w3 = 1

* = value representing all 'available' risk species (no double counts)

- 45 Introduced Species (I)
- 6 Suspected Pests (S)
- 3 Known Pests (K)

Bioregion of Port Y contains:

- 8 Introduced Species (I)
- 2 Suspected Pests (S)
- 0 Known Pests (K)

Port Y

Port Z

- 14 Introduced Species (I)
- 2 Suspected Pests (S)
- 0 Known Pests (K)

Sources of the data

From Database's own calculations (visit & tank tables)

(C1) Proportion of all BW tank discharges
(C2) Proportion of total disch'd BW (tonnes)
(R1) max. BW tank volume (tonnes)
(R2) min. BW tank storage time (days)

Port environmental data
XLS

thru PRIMER

(C3) Environmental Matching Coefficient
(a measure of the relative similarity to each source port)

From Database's risk species calculations (for each bioregion)

(C4) Risk Species Coefficient $\times w3$
 $[I + (S \times w1) + K \times w2)] / \text{Total}$

Add/change in the Database's BWRA calculation
Formula Bar...

(w1) weight applied to Suspected pests (default = 3)
(w2) weight applied to Known pests (default = 10)
(w3) weight applied to C4 risk spp. coeff. (default = 1)
(w4) risk reduction factor for max. BW tank volume.
(w5) risk reduction factor for BW tank storage time

Database allows the user to modify the calculations and weightings....

Factor Description	Factor Formula
Risk Reduction Factor for Max B/W Discharge Volume (R1)	<code>IIF([Max B/W Volume Discharge Per Tank]<100,0.4,IIF([Max B/W Volume Discharge Per Tank]<500,0.6,IIF([Max B/W Volume Discharge Per Tank]<1000,0.8,1)))</code>
Risk Reduction Factor for Min B/W Storage (R2)	<code>IIF([Min B/W Storage (Days)]>50,0.2,IIF([Min B/W Storage (Days)]>=20,0.4,IIF([Min B/W Storage (Days)]>=10,0.6,IIF([Min B/W Storage (Days)]>=5,0.8,1)))</code>
Weight for Suspected Pests	3
Weight for Known Pests	10
Weight for the Risk Species Value	1
Relative Overall Risk Coefficient	<code>[(Percentage of Tank Discharges] + [(Percentage of B/W Volume Discharges] * [Tank Vol Size Risk Reduction]) + [(Relative Risk Species Weighting Value] * [Storage Risk Reduction]) + [Env Matching Coefficient)]/4</code>
Risk Category Assessment	<code>IIF([Relative Risk Ratio]<0.2,"5 - Lowest",IIF([Relative Risk Ratio]<0.4,"4 - Low",IIF([Relative Risk Ratio]<0.6,"3 - Medium",IIF([Relative Risk Ratio]<0.8,"2 - High","1 - Highest")))</code>

To restore the default formula for the SELECTED Factor, click this button. Restore Default Formula

The BWRA 'Project Standard' calculation of the Relative Overall Risk (ROR):

$$\text{ROR} = [C1 + (C2 \times w4) + C3 + (C4 \times w5)] / 4$$

(the default $w3$ value (1) leaves $C4$ with the same weight as $C1-C3$ and the ROR values lie between 0 – 1)

Risk reduction factors:

Maximum volume discharged (all source port BW tank records):

When R1	<100	100-500	500-1000	>1000 tonnes
then $w4$ =	0.4	0.6	0.8	1

Minimum storage time (all source port BW tank records):

When R2	<5	5-10	10-20	20-50	>50 days
then $w5$ =	1	0.8	0.6	0.4	0.2

Records, Raw Data

Computer Database

Shipping Records
IMO BWR Forms

Input/edit
Interface

GUI

MS Access

Ships, ports,
visits & tank
disch. tables

RESULTS

Displayed on:

Port environmental
parameters

Primer
Multivariate
Similarity
Analysis

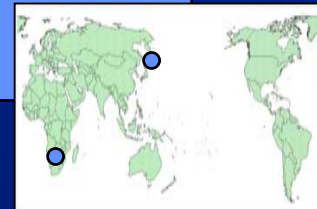
Spp
table

Relative risk
coefficients
table

Port Map

Risk species
distribution data

IUCN/CSIRO
world
bioregion
map



Bioregion
Map

Port charts, habitat
maps, resources data

GUI

Digitise

Two
map
files

GUI

Output/Results/
Demo Interface

Arcview 3.2 GIS

The BWRA 'Engine'...



Displaying the BWRA Results

Results can be ranked and displayed in a large table (= the basic output from Access for printing or export to spreadsheets, etc)...

Port Code	Source Port	Country	C1 BW Freq	C2 BW Vol	Max. Tank Disch (MT)	R1	Min. Tank Stor. (d)	R2	C3 Env. Match.	<i>Estimated</i>	C4 Risk Spp.	Relative Overall Risk (ROR)	% of Total Risk	Cumulative Percentage	Risk Category	Standardised ROR
BRSSZ	Santos	Brazil	0.0440	0.0716	65,688	1.0	2	1.0	0.776		0.2698	0.2904	1.32	1.32	Highest	1.00
BRRIO	Rio de Janeiro	Brazil	0.0075	0.0028	22,837	1.0	0	1.0	0.861		0.2698	0.2853	1.30	2.62	Highest	0.99
BRRIG	Rio Grande	Brazil	0.0009	0.0027	28,877	1.0	2	1.0	0.700	Y	0.2897	0.2483	1.26	3.88	Highest	0.96
BRPOA	Porto Alegre	Brazil	0.0009	0.0000	504	0.8	3	1.0	0.700	Y	0.2897	0.2477	1.26	5.14	Highest	0.95
BRPNG	Paranagua	Brazil	0.0028	0.0004	1,816	1.0	1	1.0	0.717		0.2698	0.2476	1.21	6.36	Highest	0.92
BRSFS	Sao Francisco do Sul	Brazil	0.0019	0.0076	53,430	1.0	1	1.0	0.700	Y	0.2698	0.2448	1.21	7.57	Highest	0.91
BRTRM	Tramandai	Brazil	0.0009	0.0026	27,904	1.0	2	1.0	0.700	Y	0.2698	0.2433	1.20	8.77	Highest	0.91
BRSSO	São Sebastiao	Brazil	0.0009	0.0023	24,999	1.0	0	1.0	0.700	Y	0.2698	0.2433	1.20	9.98	Highest	0.91
BRIBB	Imbituba	Brazil	0.0009	0.0001	1,480	1.0	2	1.0	0.700	Y	0.2698	0.2427	1.20	11.18	Highest	0.91
UYMVD	Montevideo	Uruguay	0.0019	0.0050	29,353	1.0	3	1.0	0.512		0.2897	0.2021	1.15	12.33	Highest	0.86
ESCRS	Carboneras	Spain	0.0037	0.0099	54,403	1.0	7	0.8	0.538	Y	0.3036	0.1986	1.04	13.37	Highest	0.76
NLRM	Rotterdam	Netherlands	0.0899	0.1336	107,600	1.0	6	0.8	0.351		0.2897	0.2017	1.02	14.39	Highest	0.75
NLJM	IJmuiden	Netherlands	0.0421	0.0404	52,848	1.0	8	0.8	0.447		0.2897	0.1904	0.99	15.38	Highest	0.73
ITTA	Taranto	Italy	0.0122	0.0086	12,358	1.0	17	0.6	0.603		0.3036	0.2015	0.90	16.28	Highest	0.65
ITSVN	Savona	Italy	0.0047	0.0017	5,866	1.0	18	0.6	0.600	Y	0.3036	0.1971	0.89	17.17	Highest	0.64
LYMRA	Misurata	Lyoran Arab Tanzania	0.0009	0.0025	27,197	1.0	16	0.6	0.600	Y	0.3036	0.1964	0.89	18.06	Highest	0.64
BRNAT	Natal	Brazil	0.0037	0.0124	47,889	1.0	4	1.0	0.700	Y	0.1587	0.2187	0.89	18.94	Highest	0.64
ESTAR	Tarragona	Spain	0.0028	0.0017	8,706	1.0	15	0.6	0.567		0.3036	0.1884	0.87	19.81	Highest	0.62
FRFOS	Fos sur Mer	France	0.0215	0.0281	47,380	1.0	15	0.6	0.516		0.3036	0.1869	0.87	20.68	High	0.62
ESGJ	Gijon	Spain	0.0253	0.0227	27,964	1.0	10	0.6	0.552		0.2917	0.1936	0.87	21.55	High	0.62
SIKOP	Koper	Slovenia	0.0056	0.0042	10,980	1.0	18	0.6	0.619		0.2817	0.1995	0.87	22.41	High	0.62
ITTRS	Trieste	Italy	0.0009	0.0001	584	0.8	18	0.6	0.622		0.2817	0.1980	0.86	23.27	High	0.62
GRKLX	Kalamata	Greece	0.0009	0.0015	16,708	1.0	17	0.6	0.550	Y	0.3036	0.1837	0.86	24.13	High	0.61
BRPRM	Praia Mole	Brazil	0.0412	0.0361	55,175	1.0	1	1.0	0.799		0.1171	0.2483	0.86	24.99	High	0.61
GIGIB	Gibraltar	Gibraltar	0.0197	0.0245	56,619	1.0	13	0.6	0.561		0.2817	0.1935	0.85	25.84	High	0.61
ITRAN	Ravenna	Italy	0.0009	0.0029	31,335	1.0	18	0.6	0.596		0.2817	0.1922	0.85	26.69	High	0.61
ESBIO	Bilbao	Spain	0.0019	0.0002	1,374	1.0	15	0.6	0.562		0.2917	0.1848	0.84	27.53	High	0.60
FRMRS	Caronte (Marseilles)	France	0.0009	0.0001	1,483	1.0	15	0.6	0.527		0.3036	0.1775	0.84	28.38	High	0.60
ESCAD	Cadiz	Spain	0.0056	0.0021	8,609	1.0	10	0.6	0.550	Y	0.2917	0.1832	0.84	29.22	High	0.60
ESSCI	San Ciprian	Spain	0.0037	0.0018	11,335	1.0	14	0.6	0.550	Y	0.2917	0.1826	0.84	30.06	High	0.60
PTSIE	Sines	Portugal	0.0178	0.0158	19,426	1.0	10	0.6	0.521		0.2917	0.1825	0.84	30.90	High	0.60
PTSET	Setubal	Portugal	0.0019	0.0029	18,321	1.0	13	0.6	0.550	Y	0.2917	0.1824	0.84	31.74	High	0.60
ITGOA	Genoa	Italy	0.0094	0.0029	25,052	1.0	16	0.6	0.501		0.3036	0.1738	0.84	32.57	High	0.59
GRMIL	Milaki	Greece	0.0131	0.0080	11,229	1.0	18	0.6	0.554	Y	0.2817	0.1861	0.83	33.41	High	0.59
GREEU	Eleusis	Greece	0.0009	0.0000	130	0.6	17	0.6	0.570		0.2817	0.1850	0.83	34.24	High	0.59
ITPVE	Porto Vesme (Portoscuso)	Italy	0.0028	0.0002	1,022	1.0	15	0.6	0.500	Y	0.3036	0.1713	0.83	35.07	High	0.59
ITNAP	Napoli	Italy	0.0009	0.0001	932	0.8	18	0.6	0.500	Y	0.3016	0.1705	0.83	35.89	High	0.59

Displaying the BWRA Results

Not easy to see patterns in large tables, so results are exported to ArcView for graphically displaying:

- the C1-C4 coefficients and RORs on the World Map
- Summary table for each berthing area plotted on the Port Map.

The ROR values are displayed in one of five categories of

relative risk:

0.8 - 1 = Highest

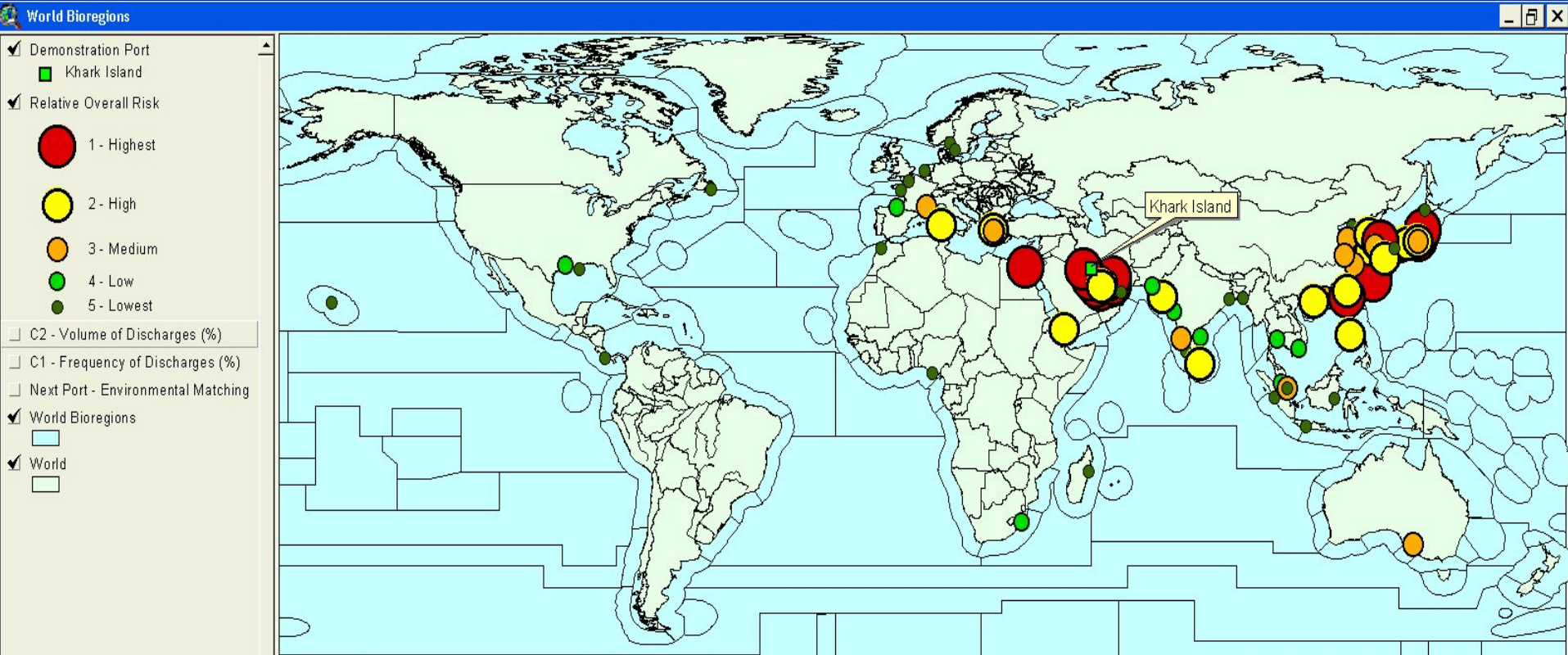
0.6 - 0.8 = High

0.4 - 0.6 = Moderate

0.2 - 0.4 = Low

0 - 0.2 = Lowest

To a picture showing the relative risk of BW sources



Outcomes & Benefits

- Huge data set on shipping, environmental & risk species data for more than 350 ports world-wide

Outcomes & Benefits

Each Pilot Country now has:

- Fully operational database for management and analysis of IMO BW reporting forms
- GIS for the port
- Comprehensive understanding of the nature of the problem at their site

Outcomes & Benefits

Each Pilot Country now has:

- Indication of relative risks posed by each port the demo site trades with
- Fully operational risk assessment system
- Trained risk assessment team for replication / ongoing activities

GloBallast RA Reports

- Please Visit www.globallast.imo.org to download all RA reports
- Please send email to jmatheic@imo.org for obtaining the USER Guide for GloBallast RA Method