



**MINISTERIO  
DE MEDIO AMBIENTE**

DIRECCIÓN GENERAL DEL AGUA

SUBDIRECCIÓN GENERAL DE GESTION  
INTEGRADA DEL DOMINIO PUBLICO  
HIDRAULICO

# Design of inland water monitoring networks in Spain

WORKSHOP ON SURFACE WATERS MONITORING NETWORKS



**Javier Ruza**

# River Basin Districts



# River Basin Districts Competences State vs Regions



# Surface Water Bodies

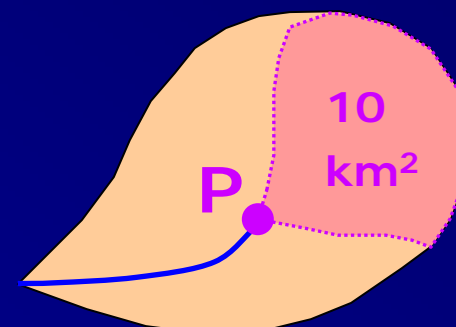
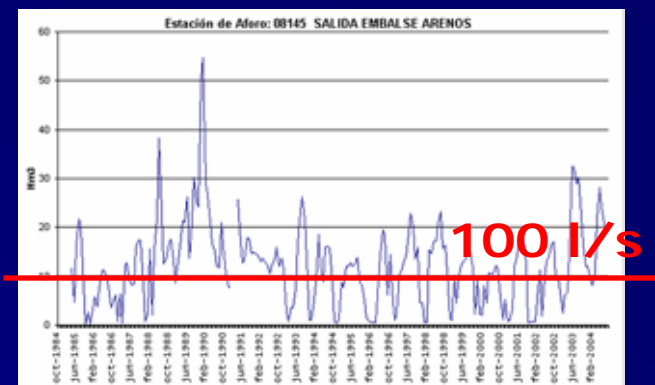


RIVER BASIN DISTRICT	RIVERS	LAKES	HMWB	ARTIFICIAL
NORTE	478	20	64	5
GALICIA COSTA	436		30	0
CUENCAS INTERNAS PAIS VASCO	34		14	0
DUERO	297	6	50	6
TAJO	183	1	85	49
GUADIANA	137	32	79	13
GUADALQUIVIR	273	4	52	0
CUENCA MEDITERRANEA ANDALUZA	82	3	37	3
CUENCA ATLÁNTICA ANDALUZA	88	4	15	10
SEGURA	64	1	23	4
JUCAR	227	10	78	1
EBRO	592	59	138	5
CUENCAS INTERNAS DE CATALUÑA	225	54	35	0
BALEARES		3	0	2
<b>TOTAL</b>	<b>3.116</b>	<b>197</b>	<b>700</b>	<b>98</b>



# Water bodies identification criteria - Rivers

- **Hydrological criteria:**  
(average flow > 100 l/s)
- **Geographical criteria:**  
(catchment area > 10 Km<sup>2</sup>)
- **Hydrological criteria:**  
(>75% months with flow ≠ 0)



3.116 WB	
Average size	21 Km
Median size	13 Km



# Water bodies identification criteria – Lakes



- **Initial criteria:** size > 50 ha

But some high ecological quality ecosystems were excluded so...

**Additional criteria:** size > 8 ha and depth > 3 m

New water bodies considered: i.e. La Caldera

- Other water bodies with special interest included



197 WB	
Average size	0,95 Km <sup>2</sup>
Median size	0,21 Km <sup>2</sup>

# Water Body Types – Rivers



TYPE CODE	RIVERS: TYPE NAME	N OF WB
1	Ríos de llanuras silíceas del Tajo y Guadiana	90
2	Ríos de la Depresión del Guadalquivir	44
3	Ríos de las penillanuras silíceas de la Meseta Norte	40
4	Ríos mineralizados de la Meseta Norte	77
5	Ríos manchegos	26
6	Ríos silíceos del piedemonte de Sierra Morena	72
7	Ríos mineralizados mediterráneos de baja altitud	45
8	Ríos de la baja montaña mediterránea silícea	153
9	Ríos mineralizados de baja montaña mediterránea	384
10	Ríos mediterráneos con influencia cársica	19
11	Ríos de montaña mediterránea silícea	118
12	Ríos de montaña mediterránea calcárea	419
13	Ríos mediterráneos muy mineralizados	26
14	Ejes mediterráneos de baja altitud	18
15	Ejes mediterráneo-continentales poco mineralizados	77
16	Ejes mediterráneo-continentales mineralizados	47
17	Grandes ejes en ambiente mediterráneo	40
18	Ríos costeros mediterráneos	92

TYPE CODE	RIVERS: TYPE NAME	N OF WB
19	Ríos Tinto y Odiel	2
20	Ríos de Serranías Béticas húmedas	19
21	Ríos cantabro-atlánticos silíceos	354
22	Ríos cantabro-atlánticos calcáreos	56
23	Ríos vasco-pirenaicos	30
24	Gargantas de Gredos-Béjar	17
25	Ríos de montaña húmeda silícea	103
26	Ríos de montaña húmeda calcárea	186
27	Ríos de alta montaña	138
28	Ejes fluviales principales cantabro-atlánticos silíceos	22
29	Ejes fluviales principales cantabro-atlánticos calcáreos	8
30	Ríos costeros cantabro-atlánticos	256
31	Pequeños ejes cantabro-atlánticos silíceos	96
32	Pequeños ejes cantabro-atlánticos calcáreos	27
33	Ríos de mineralización alta de llanuras sedimentarias de la submeseta sur	3
	Pendientes de clasificación	10
TOTAL		3.114

ARTIFICIAL	35
HMWB	632

# Water Body Types - Lakes



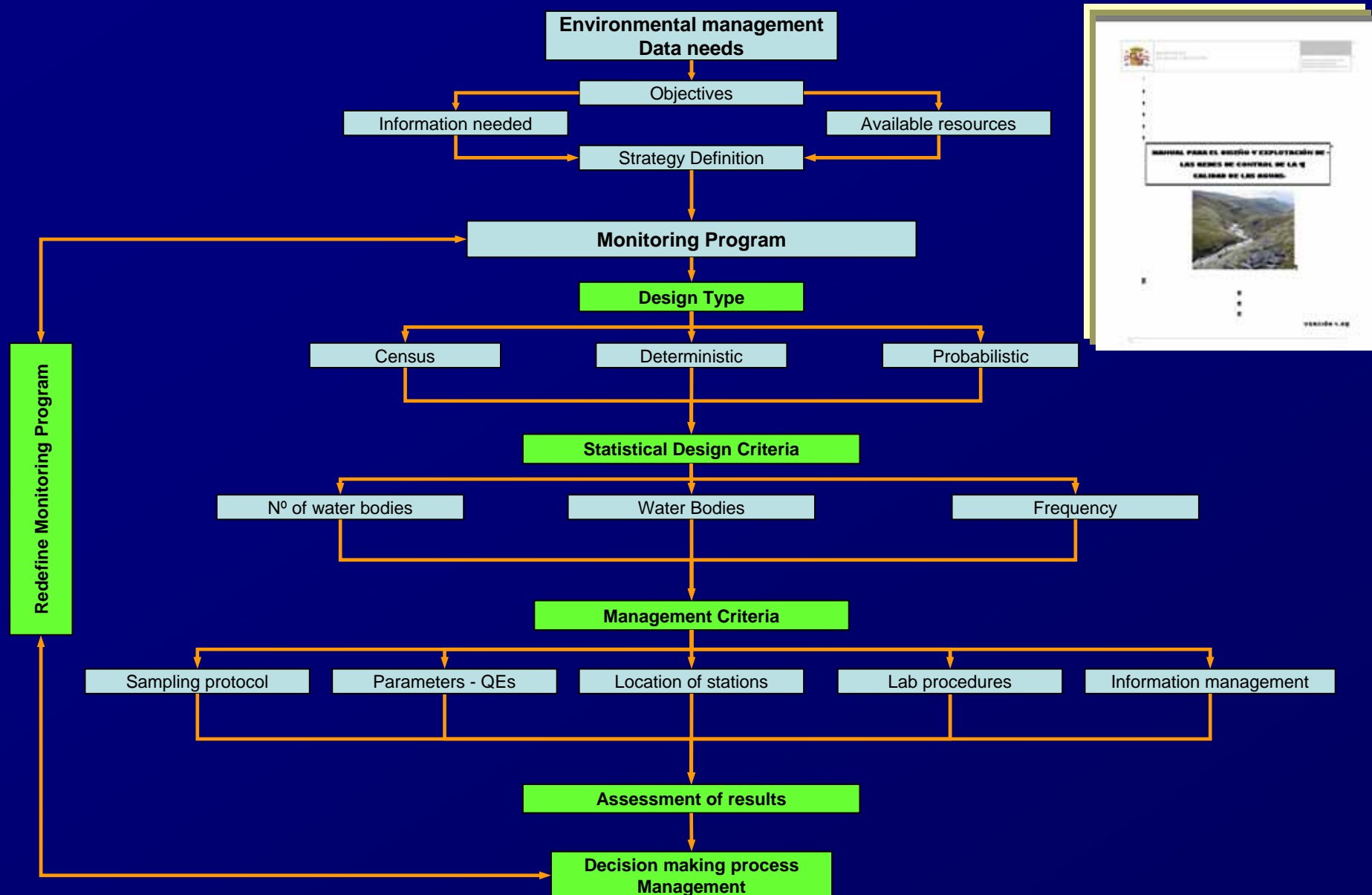
TYPE CODE	LAKES: TYPE NAME	N OF WB
1	Alta montaña septentrional, dimíctico, aguas ácidas	37
2	Alta montaña septentrional. Dimíctico, aguas alcalinas	1
3	Alta montaña septentrional, monomíctico frío, aguas ácidas	3
4	Media montaña septentrional, monomíctico, cálido, aguas ácidas	1
5	Media montaña septentrional, monomíctico cálido, aguas alcalinas	1
6	Media montaña septentrional, monomíctico frío, aguas alcalinas	1
7	Alta montaña meridional, monomíctico, frío, aguas ácidas	3
8	Interior en cuenca de sedimentación, cárstico, hiogénico, grande	1
9	Interior en cuenca de sedimentación, cárstico, hiogénico, pequeño	6
10	Interior en cuenca de sedimentación, cárstico, hipogénico, pequeño tipo torca	4

TYPE CODE	LAKES: TYPE NAME	N OF WB
11	Interior en cuenca de sedimentación, cárstico aportación mixta	32
12	Interior en cuenca de sedimentación, no cárstico, permanente, profundo, salino	0
13	Interior en cuenca de sedimentación, no cárstico, permanente, profundo, no salino	2
14	Interior en cuenca de sedimentación, no cárstico, permanente, somero, salino	7
15	Interior en cuenca de sedimentación no cárstico, permanente, somero, no salino	17
16	Interior en cuenca de sedimentación, no cárstico, temporal, salino	5
17	Interior en cuenca de sedimentación, no cárstico, temporal, no salino, aguas ácidas	13
18	Interior en cuenca de sedimentación, no cárstico, temporal, no salino, aguas alcalinas	4
19	Litoral en complejos dunares	4
	Pendiente de clasificación	53
<b>TOTAL</b>		<b>195</b>

ARTIFICIAL	54
HMWB	68



# Design of monitoring networks





## *Art.8*

2. These programmes shall be operational at the latest six years after the date of entry into force of this Directive unless otherwise specified in the legislation concerned. Such monitoring shall be in accordance with the requirements of Annex V.

- WFD is not a completely coherent text, written by a unique person, and it doesn't reflect a clear strategy of action
- WFD as all legislative text has been agreed by consensus, so it admits different interpretations
- In many cases the different points of view are reflected explicitly in different articles creating clear contradictions between them
- Guidance documents can help to understand what the key questions are, but they don't give an answer to them
- The only way to implement correctly the directive is to adopt in each RBD or MS a global strategy so all incongruences in the directive are understood in the same way along the whole text

# WFD Monitoring networks design



## *Guidance Document for the design of Monitoring networks in compliance with the WFD*






# Surveillance monitoring - Subprograms

## Type of design, target population and WB to monitor



Subprograms	Type of statistical design	Target Population	N of WB to control
Assessment of the overall surface water status and Assessment of trends due to human activity	Probabilistic	All WB in the RBD	Different approach for overall status and for trend assessment 
Estimation of tranboundary pollutant loads and emissions to the sea	Deterministic	Main transboundary rivers and main river mouths	Selection criteria depends on RBD: <ul style="list-style-type: none"> <li>• Catchment size (ie. &gt; 1000 km<sup>2</sup>)</li> <li>• Flow (ie. &gt; 10 m<sup>3</sup>/s)</li> <li>• Major load bearing rivers (ie. control 90% of loads: Ospar Criterium)</li> </ul>
Assessment of trends in natural conditions	Probabilistic or Census (?)	All reference sites	Now all reference sites. In a near future only a probabilistic selection Reference network in both cases
Information exchange Decision	Deterministic (census)	15 stations designated under 77/795/CEE Decision	15 stations designated

*Only Surveillance monitoring generates monitoring networks stable with time*

*Operational monitoring and Investigative monitoring are monitoring efforts of a limited duration*

# Surveillance monitoring – Overall assessment

## Number of WB to monitor



- **Probabilistic design of sampling** i.e. Simple random sampling
- To estimate a parameter

$$n = \left( \frac{u_{\alpha/2} \cdot \sigma}{d} \right)^2$$

n	Number of stations (WB) needed
$u_{\alpha/2}$	Level of significance for a given level of confidence (i.e., u equal to 1,65 for a level of confidence of 90%) (Statistical tables for a normal distribution normal)
$\sigma$	Standard deviation
d	Desired precision
$(1-\alpha)$	Level of significance

- To estimate trends

$$n = 2 \cdot \left( \frac{(u_1 + u_2) \cdot \sigma}{\Delta} \right)^2$$

n	Number of stations (WB) needed
$u_1$	1,96 (normal standard value for a level of significance $\alpha = 0,05$ )
$u_2$	(normal standard value for a power of $1 - \beta = 0,20$ )
$\sigma$	Standard deviation
$\Delta$	Minimum difference that we want to detect

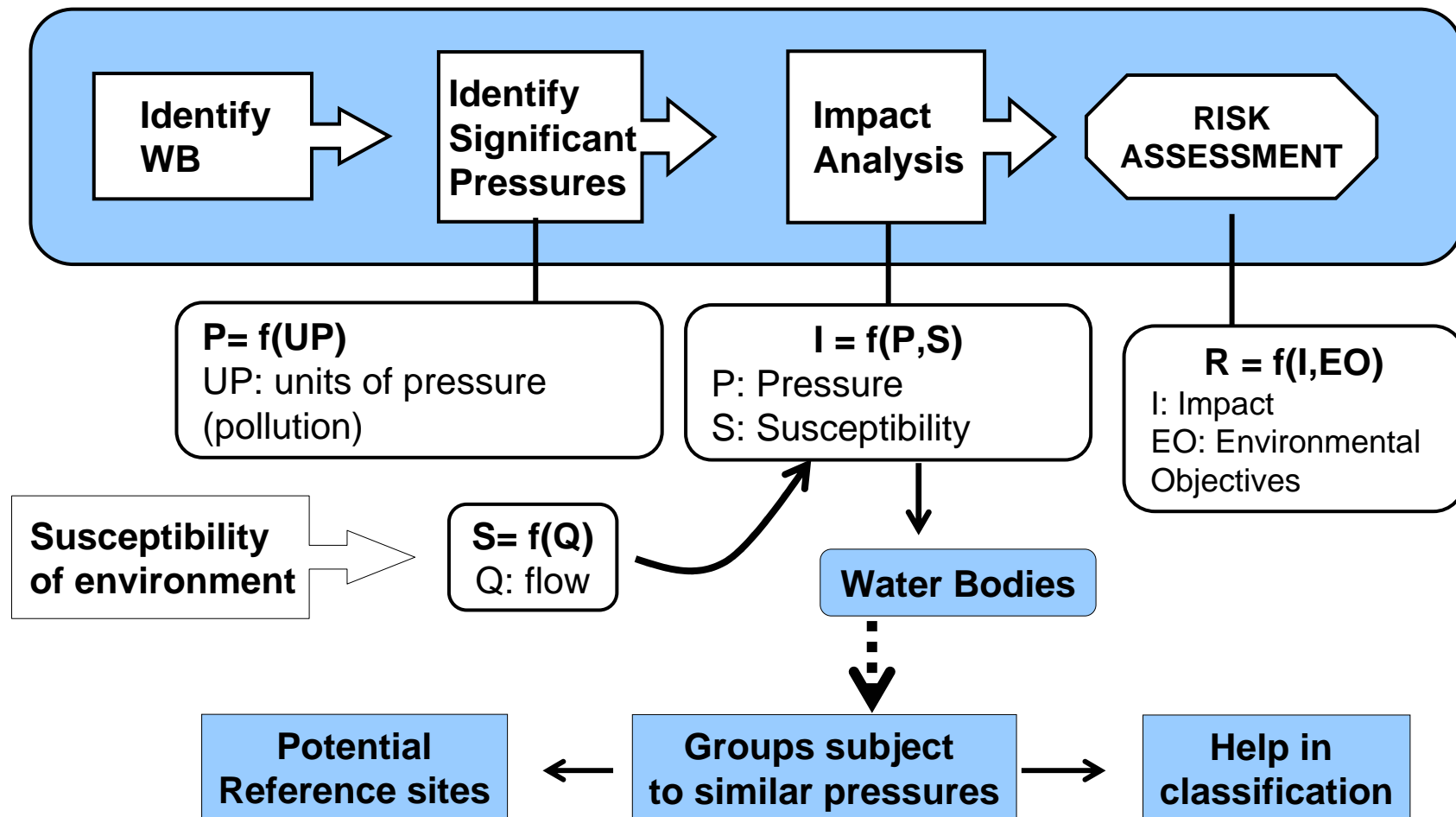
# Surveillance monitoring pilot study. Duero RBD



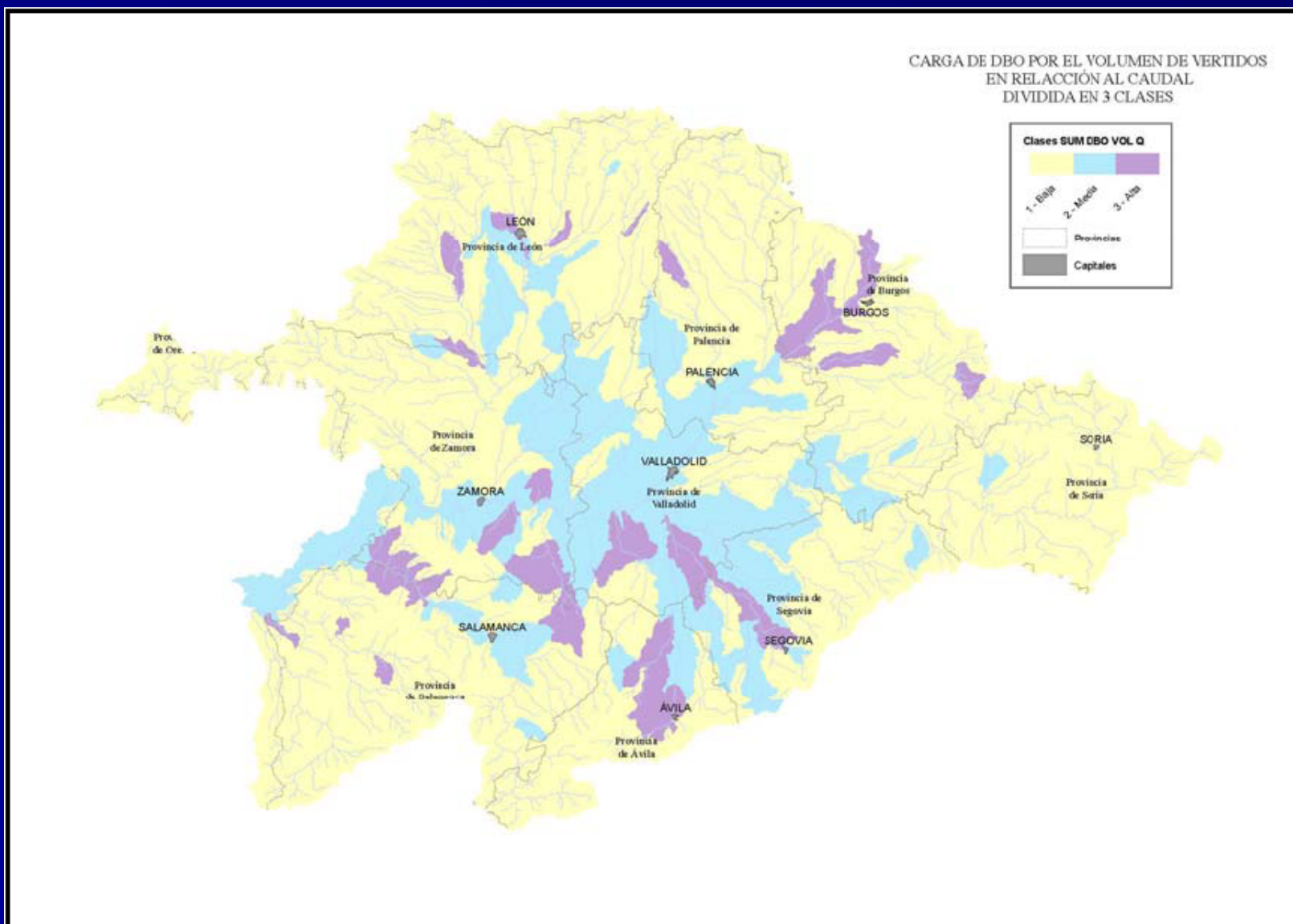
- Probabilistic sampling design: **stratified random sampling** according to
  - typology (recommended by monitoring guidance)
  - pressures
- First attempt using typology gives bad results
  - no correlation between typology and status (only in natural conditions)
- Target population: **690 WB**



# Quantitative IMPRESS

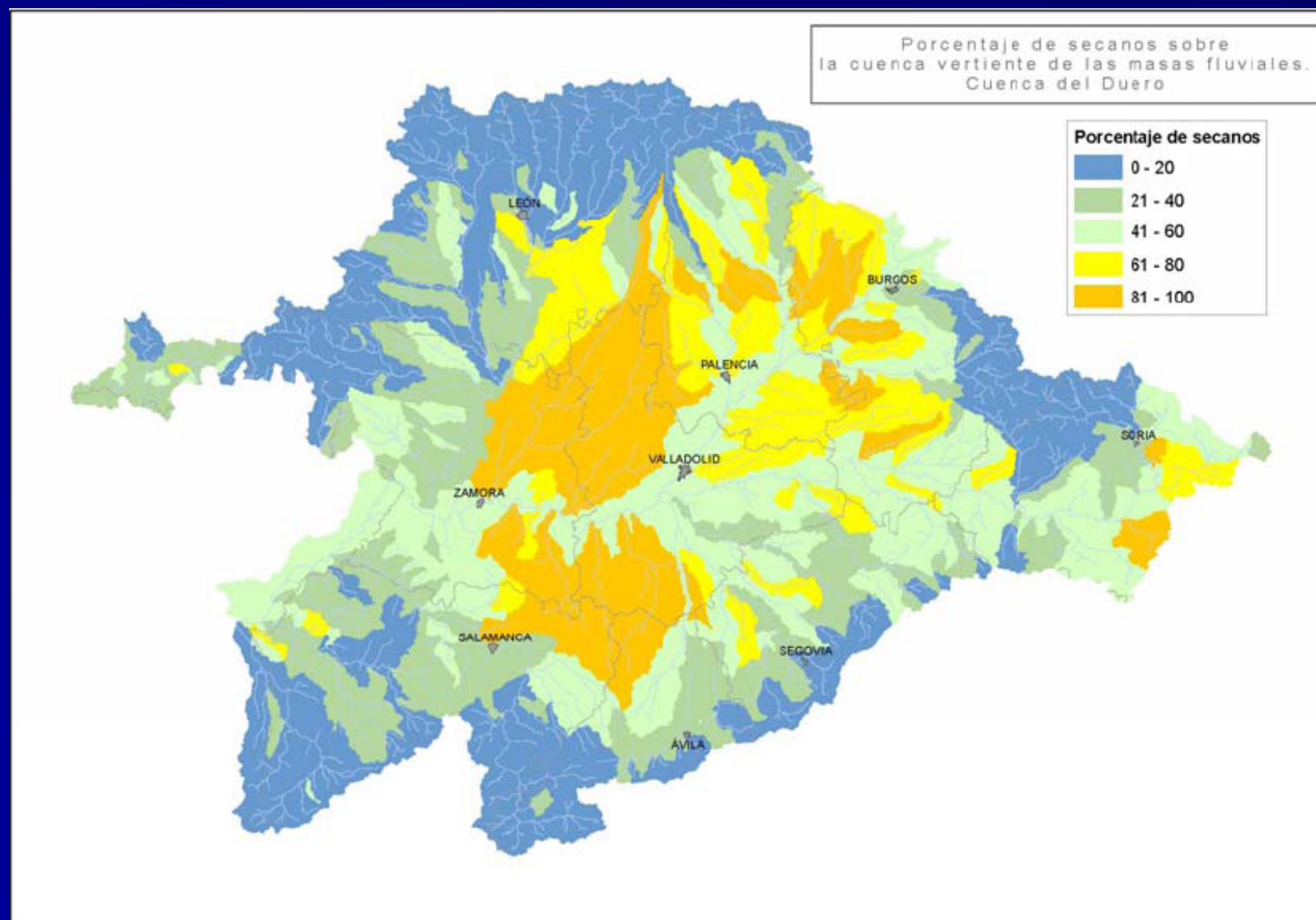


# Pressure strata: Point source pressures model



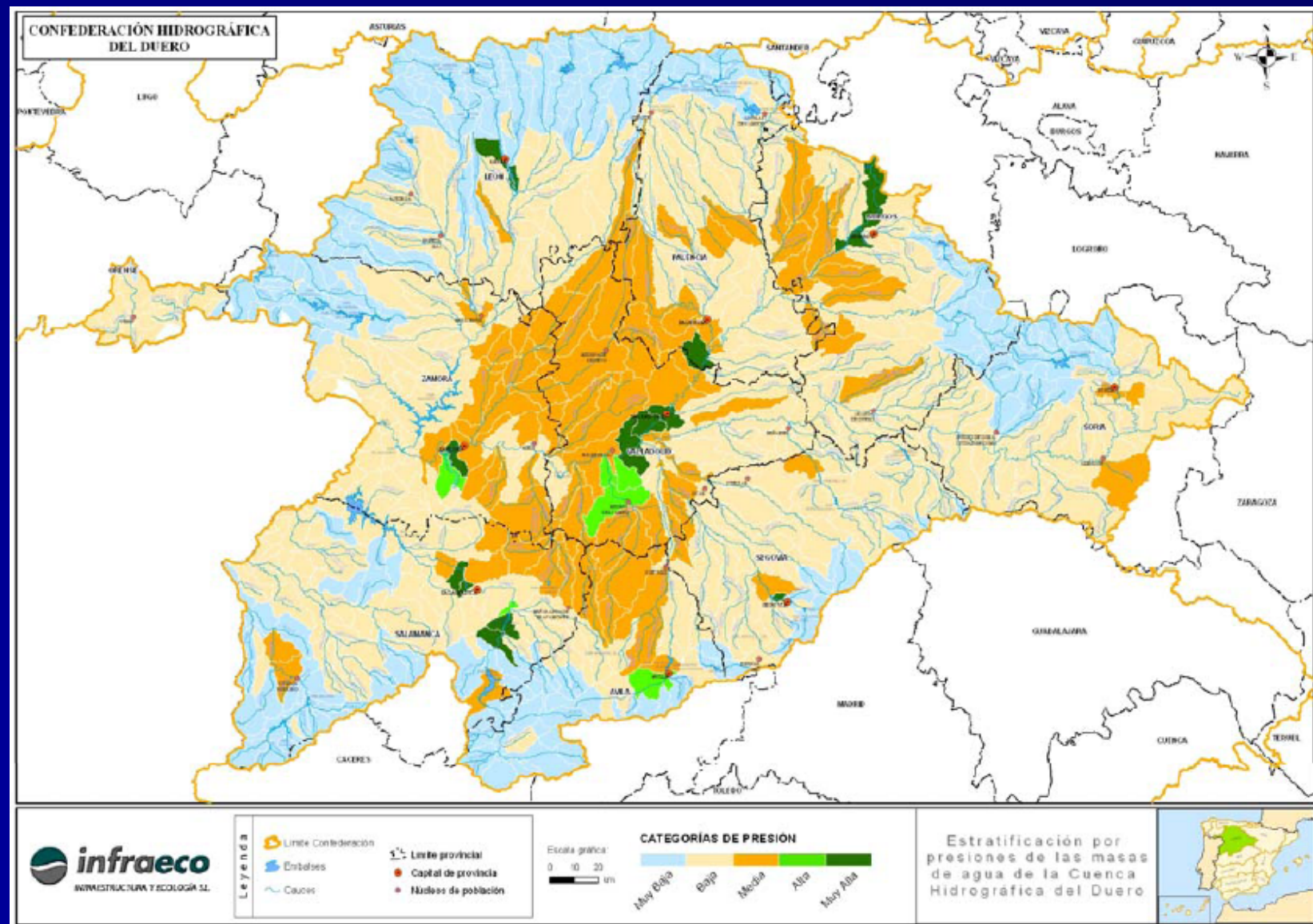
Calibrated with data of: P, NO<sub>2</sub>, NO<sub>3</sub>, IBD, PO<sub>4</sub>, DBO, NH<sub>4</sub>

# Pressure strata: Diffuse source pressures model



Calibrated with data of: P, NO<sub>2</sub>, NO<sub>3</sub>, IBD, PO<sub>4</sub>, DBO, NH<sub>4</sub>

## Pressure strata: All sources





# Estimation of the number of stations needed



- 91 existing stations (what does sufficient precision mean in WFD?)
  - Eionet-water criteria (1station/1000 km<sup>2</sup>) → 78 stations
  - Common specifications for biological networks in Spain → 90 stations
  - Budget constraints
- Neyman assignment, taking into account:
  - Size of each stratum (n WB)
  - Internal variability within each stratum

$$n_h = n \left( \frac{W_h \sigma_h}{\sum_{h=1}^L W_h \sigma_h} \right)$$

Apply to the modeled data for NO<sub>3</sub> and IBD: get the average

Estrato de Presión	Nº Estaciones
Muy Baja	15
Baja	51
Media	15
Alta	2
Muy Alta	8

## PRECISION AND CONFIDENCE

$$SE = (1 / N) * \sqrt{\sum [ N_h^2 * (1 - n_h/N_h) * s_h^2 / n_h ]}$$

Statistics	NO <sub>3</sub>	IBD
Average value	5,43 mg/l	13,63
Standard error	0,51 mg/l	0,4
Relative standard error	9,42 %	2.93 %
Confidence	95%	95%

# Operational Monitoring

## Nº of Water bodies at risk - RIVERS



**Operational Monitoring** All water bodies which on the basis of either the impact assessment or surveillance monitoring are identified at risk

RIVER BASIN DISTRICT	RISK CLASSIFICATION					
	SURE		UNDER STUDY		NULL	
	% WB	nº WB	% WB	nº WB	% WB	nº WB
Norte	1,1%	6	74,4%	402	24,4%	132
Duero	3,5%	12	83,6%	286	12,9%	44
Tajo	3,5%	10	94,7%	270	1,8%	5
Guadiana	17,0%	39	74,2%	170	8,7%	20
Guadalquivir	12,6%	41	62,5%	203	24,9%	81
Segura	11,6%	8	87,0%	60	1,4%	1
Júcar	36,5%	108	63,2%	187	0,3%	1
Ebro	5,3%	37	52,6%	368	42,1%	294
País Vasco	64,6%	31	0,0%	0	35,4%	17
Galicia Costa	4,7%	22	74,5%	347	20,8%	97
Cuenca atlántica andaluza	13,3%	15	77,0%	87	9,7%	11
Cuenca mediterránea andaluza	44,2%	53	50,8%	61	5,0%	6
Cuencas internas de Cataluña	43,5%	113	0,0%	0	56,5%	147
Islas Baleares	0,0%	0	0,0%	0	0,0%	0
Canarias	0,0%	0	0,0%	0	0,0%	0
<b>TOTAL</b>	<b>13,1%</b>	<b>495</b>	<b>64,4%</b>	<b>2441</b>	<b>22,6%</b>	<b>856</b>



# Operational Monitoring

## Nº of Water bodies at risk - LAKES



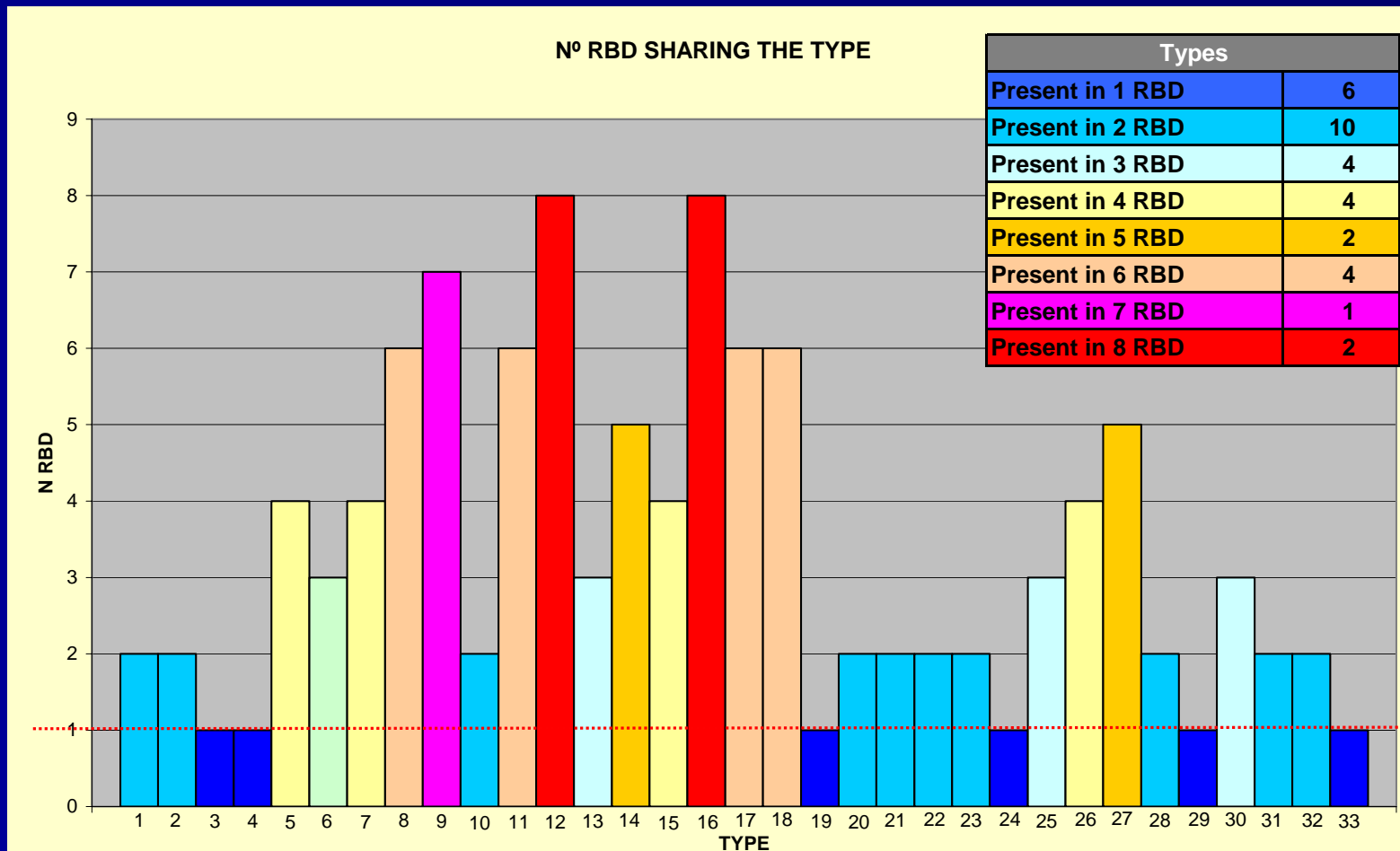
**Operational Monitoring** All water bodies which on the basis of either the impact assessment or surveillance monitoring are identified at risk

RIVER BASIN DISTRICT	RISK CLASSIFICATION					
	SURE		UNDER STUDY		NULL	
	% WB	nº WB	% WB	nº WB	% WB	nº WB
Norte	0,0%	0	92,6%	25	7,4%	2
Duero	0,0%	0	94,1%	16	5,9%	1
Tajo	0,0%	0	100,0%	33	0,0%	0
Guadiana	0,0%	0	100,0%	32	0,0%	0
Guadalquivir	0,0%	0	100,0%	4	0,0%	0
Segura	4,3%	1	95,7%	22	0,0%	0
Júcar	0,0%	0	100,0%	20	0,0%	0
Ebro	0,0%	0	100,0%	95	0,0%	0
País Vasco	0,0%	0	0,0%	0	0,0%	0
Galicia Costa	0,0%	0	0,0%	0	0,0%	0
Cuenca atlántica andaluza	0,0%	0	50,0%	2	50,0%	2
Cuenca mediterránea andaluza	0,0%	0	80,0%	4	20,0%	1
Cuencas internas de Cataluña	9,3%	5	63,0%	34	27,8%	15
Islas Baleares	0,0%	0	100,0%	5	0,0%	0
Canarias	0,0%	0	0,0%	0	0,0%	0
<b>TOTAL</b>	<b>1,9%</b>	<b>6</b>	<b>91,5%</b>	<b>292</b>	<b>6,6%</b>	<b>21</b>

# Reference conditions. RBD sharing types of WB



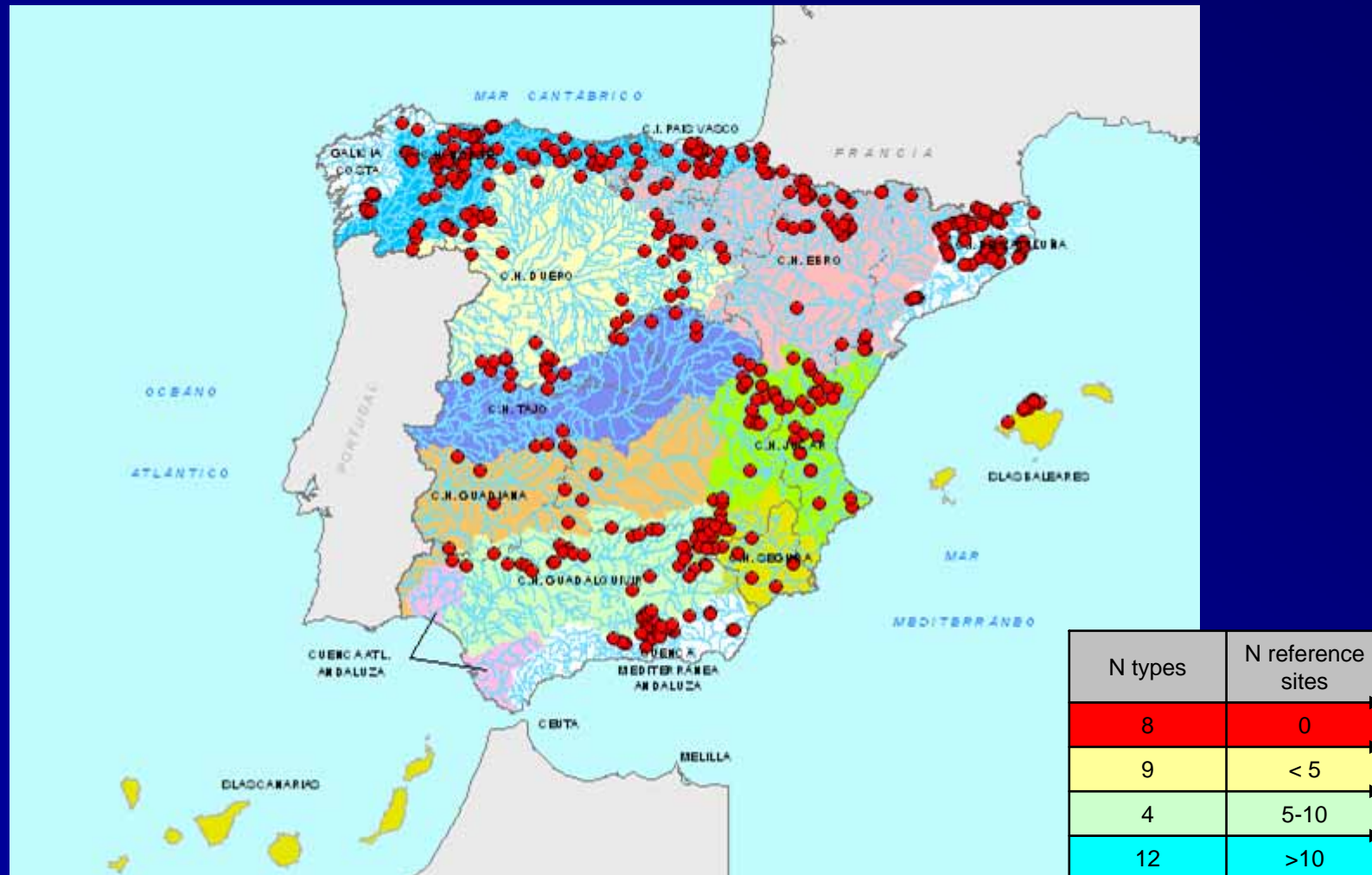
- Reference conditions have been established at RBD level
- Only 6 types are not shared between RBDs
- Need for coordination: national intercalibration but using results of European intercalibration



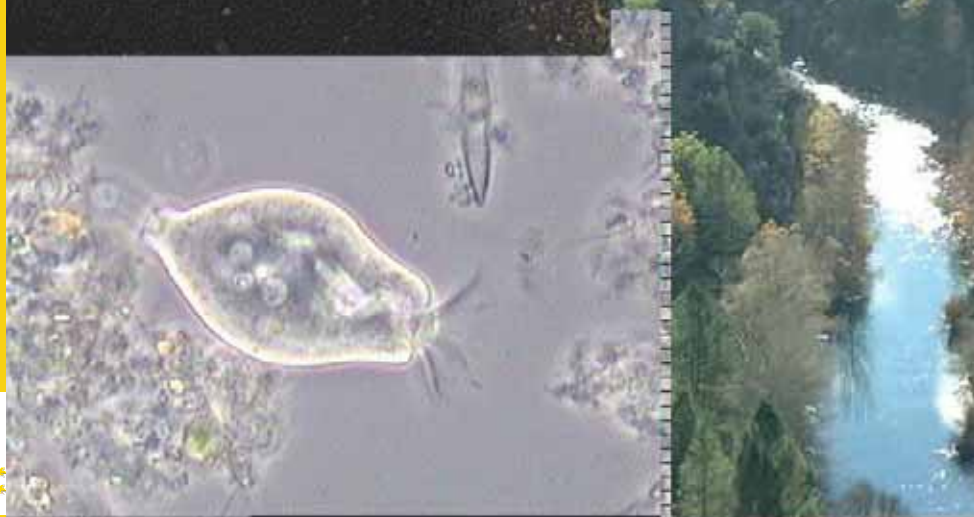
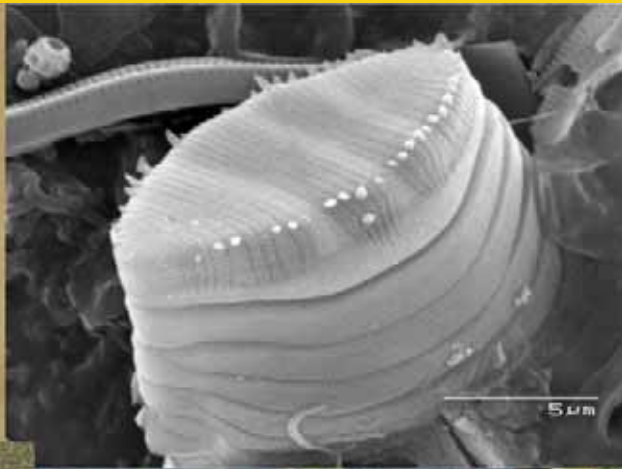
## Reference network - Rivers



- 441 reference sites identified
- 25 types of 33 existing have reference sites
  - 16 types have sufficient number of reference sites



# Biological monitoring methods - RIVERS





# Number of monitoring stations



BIOLOGICAL MONITORING NETWORKS					
RBD	DATE BEGINING	Nº OF MONITORING STATIONS			
		Invertebrates	Diatoms	Fish	Macrophytes
PAÍS VASCO	1993	107	71	107	97
GALICIA	2006	103			
NORTE	2003	436			
DUERO	2003	90			
TAJO	2006	90			
GUADIANA	2001	220			
GUADALQUIVIR	2006	90			
SEGURA	2006	90			
JÚCAR	1999	272	90	90	60
EBRO	1993	500	200	200	300
CATALUÑA	1993-1997	118	39	39	130



Higher frequency than required by WFD has been defined for the first River Basin District Management Plan in order to satisfy information needs – every year for surveillance monitoring

- Biological Quality Elements
  - Phytoplankton - 2 / year
  - Macrophytes - 2 / year
  - Benthic Invertebrates – 2 / year
  - Phytobenthos - 2 / year
  - Fish - 2 / year
- Physicochemical: monthly (ICA)
- Hydromorfological: continuous and 2 / year (QBR and IHF)



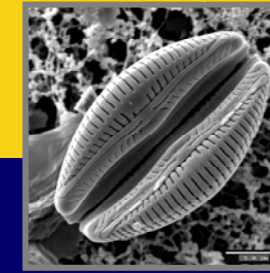
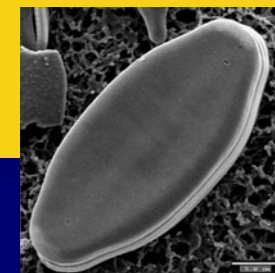
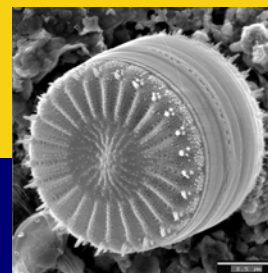
# RIVERS - Biological monitoring Macroinvertebrates



Method	PV	NO	GC	DU	TA	GN	AA	GV	MA	SE	JU	EB	CAT	BA	CAN
Quantitative Sampling Protocol ( <b>20 kicks</b> ) US EPA (Barbour et al)		X	X											X	--
Quantitative Sampling Protocol ( <b>5 kicks</b> ) based on US EPA procedure from Barbour et al.	X														--
Quantitative Sampling Protocol ( <b>3 minutes</b> ) based on Furse, M.T., Wright, J.F., Armitage, P.D. & Moss, D. 1981.											X				--
<b>Semi-quantitative</b> approach based on IBMWP/GUADALMED Protocol Agència Catalana de l'Aigua (2006) BIORI													X		
Qualitative approach developed in order to determine <b>IBMWP</b> . Alba-Tercedor, J y A.Sánchez-Ortega, 1988					X	X				X		X			--
<b>GUADALMED (PRECE) Protocol. Protocol I</b> "Non reference stations" and "Reference stations"								X			X	X			--
<b>Modification of IBMWP</b> Protocol with sampling based on multimetric assessment. <b>Ebro</b> River Basin District Protocols <b>Handbook</b>				X											--
Type specific <b>Multimetric</b> approach by Pardo, I. et al. 2005		X	X											X	--
<b>Multimetric (MBI)</b> approach developed by G. de Bikuña et al.	X							X							--
<b>IBMWP</b> (Iberian Biological Monitoring Working Party) Alba-Tercedor, J y A.Sánchez-Ortega, 1988					X	X		X		X	X	X	X		--
<b>Multimetric</b> approach developed by the Spanish group (GIG-MED) in the Intercalibration exercise that combines EPT, nº taxa, IASPT and %Sel EPTCD indexes					X			X		X			X		--
Richness (Number of taxons - mainly families and for some groups, upper levels)													X		--
Application of this two indexes separately: Shannon-Weaver diversity Index, Margalef diversity Index, IASPT, Nº de taxa, EPT				X											--

# RIVERS - Biological monitoring

## Phytobenthos



Method	PV	NO	GC	DU	TA	GN	AA	GV	MA	SE	JU	EB	CAT	BA	CAN
<b>CEN EN 13946:2003 Water Quality.</b> Guidance standard for routine sampling and pre-treatment of benthic diatoms from rivers.	X	X	X	X	X	X				X	X	X		X	--
Sampling, identification and sorting: Ebro River Basin District Protocols Handbook		X		X	X			X		X		X			--
IPS (CEMAGREF, 1986)	X			X		X		X		X	X	X	X		--
IBD (Prygiel y Coste, 1998)	X			X	X	X		X		X	X	X			--
CEE (Lange-Bertalot, 1979)				X		X		X			X	X			--
<b>Multimetric</b> approach IDAP, IDG, SHE, TDI and IPS		X	X					X						X	--

# RIVERS - Biological monitoring

## Macrophytes



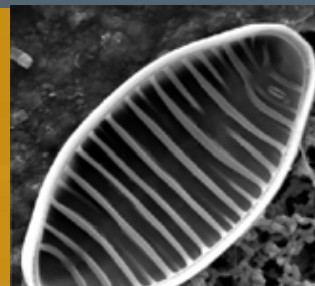
Method	PV	NO	GC	DU	TA	GN	AA	GV	MA	SE	JU	EB	CAT	BA	CAN
<b>CEN EN 14184:2003 Water Quality</b> - Guidance Standard for the surveying of aquatic Macrophytes in running waters	X	X			X					X	X			X	--
<b>Ebro River Basin District Protocols Handbook</b>				X	X	X		X		X		X			--
<b>IM Macrophyte Index.</b> M.L. Suarez et. al. 2005				X	X			X		X	X				--
<b>SLA</b> (Sládecek & Sladeckova, 1996) y <b>SAP</b> (Wegl, 1983)								X							--
<b>ECV index.</b> Índice ECV. Moso, M., Fraile, H. & G. de Bikuña, B. 2002.	X							X							--
<b>Multimetric</b> index to be defined with IBMR, MTR, GIS		X													--
<b>IVAM:</b> Generic aquatic vegetation Index. Índice Genérico de Vegetación Acuática. Moreno, J.L. et. al. (2005)					X							X			--
Assessment by <b>expert judgment</b>						X									--

# RIVERS Biological monitoring Fish



Method	PV	NO	GC	DU	TA	GN	AA	GV	MA	SE	JU	EB	CAT	BA	CAN
Ebro River Basin District Protocols Handbook					X			X		X		X		Not applicable. There are no fish	--
CEN EN 14011:2003 Water Quality. Sampling of fish with electricity	X	X		X	X	X				X	X	X			--
Adaptation of CEN standard to Mediterranean rivers. <b>BIORI</b> : Agència Catalana de l'Aigua (2006).													X		--
Species composition		X				X		X		X	X				--
CPUE (abundance)		X			X	X		X		X	X				--
Nº of introduced species		X			X	X		X		X	X				--
<b>IBICAT</b> . Sostoa, A de Caiola, N y F.Casals (2004) A new IBI (IBICAT) for the application of the E.U Water Framework Directive								X				X	X		--
<b>IBICAT v2.0</b> adjustment of IBICAT to the results of intercalibration. To be developed during 2007.													X		--
<b>ECP</b> : multimetric approach developed to estimate the state of the fish population for river streams. Aguirre,A et. al. 2006.	X							X							--
<b>European Fish Index - EFI</b> (first approach). Multimetric index to be developed during 2007 (metrics density, biomass, population structure of sentinel specie)		X		X											--
<b>IBI</b> adapted to Southern river basins (Prenda) to be developed during 2007						X					X				--

# Biological monitoring methods - LAKES



# LAKES Biological monitoring Macroinvertebrates



Method	PV	NO	GC	DU	TA	GN	AA	GV	MA	SE	JU	EB	CAT	BA	CAN
Qualitative - semiquantitative sampling protocol for the littoral zone. Sampling with salabre "dipping" - Ebro River Basin District - Sampling Protocols Handbook		X (L)		X (L)	X	X		X		X	X	X		--	--
Qualitative - semiquantitative sampling protocol for the littoral zone. Sampling with salabre "dipping"- Agència Catalana de l'Aigua. 2006. ECOZO: zones humides.													X (L)	--	
Sampling protocol for epiphytic invertebrates (Kornijow y Kairesalo, 1994) - Ebro River Basin District - Sampling Protocols Handbook					X	X		X		X		X		--	--
Sampling protocol for the littoral zone (País Vasco)	X													--	--
Qualitative sampling protocol for the littoral zone. Handnet sampling - en Agència Catalana de l'Aigua. 2006. ECOES: estanys.													X (L)	--	
Artificial substrates					X					X				--	--
Taxonomic richness and aloctonous species	X	X (L)		X (L)	X			X		X		X		--	--
Diversity of taxa: Shannon index		X (L)		X (L)	X			X		X		X		--	--
Macroinvertebrates index: InMacro.		X (L)		X (L)				X					X	--	--
QAELS Index (Institut d'Ecologia Aquàtica, Universidad de Girona)						X		X			X		X	--	--



# LAKES Biological monitoring

## Phytoplankton (chlorophyll a)



Method	PV	NO	GC	DU	TA	GN	AA	GV	MA	SE	JU	EB	CAT	BA	CAN
Integrated sampling form photic layer: Method used by the L-M GIG for reservoirs for Intercalibration exercise			X		X	X				X	X			--	--
Simple sample form photic layer (mixing season) and epilimnion (stratification season).	X				X			X		X		X		--	--
Two samples (from surface and 2,5 m. x prof. SD)				X										--	--
2 - 5 samples at diferent depths. The result is taken from the sample with highest concentration values (chlorophyll a). Agència Catalana de l'Aigua. 2006. ECOES: estansys.													X (L)	--	
Integrated sample from photic layer or first 7 m													X (R)	--	
Direct measurement of chlorophyll by fluorimetric sensor in the water column													X (R)	--	
Two samples (one form surface and the other from the peak of chlorophyll or in the absence of this to 2,5m x SD depth)		X												--	--
Fluorimetric sensor to determine sampling depth												X		--	--
Concentration of chlorophyll a: APHA, AWWA, WPCF. "Standard Methods for the Examination of Water and Wastewater". Ed Leonore s. et a.l	X	X	X	X	X	X		X		X	X	X	X (L)	--	--
Chlorophyll index InCio: Agència Catalana de l'Aigua. 2006. ECOES: estansys													X (L)	--	
Concentration of Chlorophyll from cianophytes													X (R)	--	
Chl a and Geen-Blue algae profile (vertical section) by fluorimetry											X R			--	--

# LAKES Biological monitoring

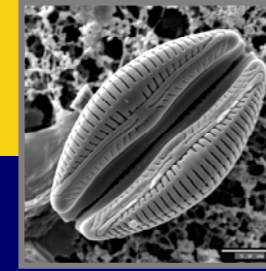
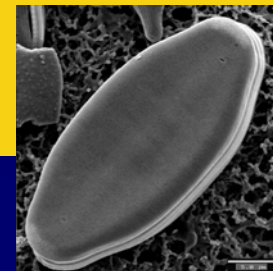
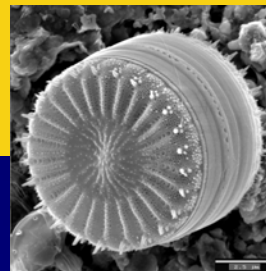
## Phytoplankton (composition and abundance)



Method	PV	NO	GC	DU	TA	GN	AA	GV	MA	SE	JU	EB	CAT	BA	CAN
Integrated sample form photic layer (L-M GIG)			X		X					X	X			--	--
Simple sample form photic layer (mixing season) and epilimnion (stratification season).	X				X	X		X		X		X		--	--
CEN TC 230/WG 2/TG 3/N83. (Working draft stage) Water quality-Guidance standard for the routine analysis of phytoplankton abundance and composition using inverted microscopy (Utermöhl technique).		X		X	X					X				--	--
Two samples (surface and 2,5 mx SD depth)				X										--	--
Two samples (one form surface and the other from the peak of chlorophyll or in the absence of this to 2,5m x SD depth)		X												--	--
Integrated sample or composite sample from 2 - 5 subsamples from different depths, summer time: Agència Catalana de l'Aigua. 2006. ECOES: Protocol d'avaluació de l'estat ecològic dels estanyes.													X (L)	--	--
Analysis of Biomass and Composition: using sedimentation techniques (Lund et al., 1958; Utermöhl, 1958; Hasle, 1978; Rott, 1981) and Inverted Microscope	X													--	--
Fluorimetric sensor to determine sampling depth												X		--	--
Total Biovolume		X		X	X			X		X	X	X		--	--
% of bloom by Cyanobacteria	X	X		X	X			X		X		X		--	--
Algae group index: InGa.		X		X		X		X				X	X (L)	--	--
Planktonic trophic index (PTI) (Barbe et al., 1990)	X	X		X	X			X		X				--	--

# LAKES Biological monitoring

## Phytobenthos



Method	PV	NO	GC	DU	TA	GN	AA	GV	MA	SE	JU	EB	CAT	BA	CAN
Ebro River Basin District - Sampling Protocols Handbook		X (L)		X (L)	X	X		X		X		X		--	--
<b>Integrated sample from surface sediment Muestra integrada de sedimento superficial</b> (3 mm). En: Agència Catalana de l'Aigua. 2006. ECOES: Protocol d'avaluació de l'estat ecològic dels estanys													X (L)	--	--
<b>Diatom index InDia:</b> Agència Catalana de l'Aigua. 2006. ECOES: Protocol d'avaluació de l'estat ecològic dels estanys.													X (L)	--	--
Expert judgement						X								--	--

# LAKES Biological monitoring Macrophytes



Method	PV	NO	GC	DU	TA	GN	AA	GV	MA	SE	JU	EB	CAT	BA	CAN
Ebro River Basin District - Sampling Protocols Handbook for wadeable and non wadeable lakes		X (L)		X (L)	X	X		X		X				--	--
<b>Perpendicular transects to littoral:</b> <i>Agència Catalana de l'Aigua. 2006. ECOES: Protocol d'avaluació de l'estat ecològic dels estanys.</i>													X (L)	--	
Index for the evaluation of wetlands (Cirujano et al., 1992)						X		X						--	--
Analysis of vegetation cover of representative communities (carophytes, helophytes...); and presence of alloctonous species.	X													--	--
<b>% of littoral with helophytic vegetation ringa:</b> <i>Agència Catalana de l'Aigua. 2006. ECOES: Protocol d'avaluació de l'estat ecològic dels estanys.</i>													X (L)	--	
Macrophytes index: InMac. Agencia Catalana del Agua								X					X (L)	--	--

# LAKES Biological monitoring Fish



Method	PV	NO	GC	DU	TA	GN	AA	GV	MA	SE	JU	EB	CAT	BA	CAN
Ebro River Basin District - Sampling Protocols Handbook - Net sampling for lakes and deep rivers		X		X	X	X		X		X	X			--	--
Proposal for the intercalibration of quantitative methods based on combination of hydroacoustic techniques with scientific sampling nets (CEN 14757).		X												--	--
Quantitative analysis by hydroacoustic techniques				X										--	--
Different net types for deep zone: <i>Agència Catalana de l'Aigua. 2006. ECOEM: embassaments.</i>													X (R)	--	--
Electric fishing from boat for littoral areas: <i>Agència Catalana de l'Aigua. 2006. ECOEM: embassaments.</i>													X (R)	--	--
Nordic nets and Phoxinus phoxinus tramps: <i>Agència Catalana de l'Aigua. 2006. ECOES: estanys.</i>													X (L)	--	--
Under study the possibility of using fish census by hydroacoustic techniques												X		--	--
Native species versus introduced species	X	X		X	X	X		X			X			--	--
% of fish with anomalies		X		X	X	X		X		X	X		X (R)	--	--
CPEU littoral carp						X		X			X		X (R)	--	--
CPUE limnethic carp						X		X			X		X (R)	--	--
% littoral carp						X		X			X		X (R)	--	--
% limnethic carp						X		X			X		X (R)	--	--
Introduced species													X (L)	--	--
Size / age structure	X	X		X	X	X		X		X	X			--	--
Under development a new multimetric index including density, biomass and size structure for different habitats		X												--	--



# Location of sampling points inside the water body



Depending on the monitoring objectives different criteria should be considered for the location of sampling points inside the water body:

## **General assessment (surveillance):**

Average value of a given parameter inside the water body

## **Pressures assessment (operational):**

Worst situation inside the water body affected by a given pressure

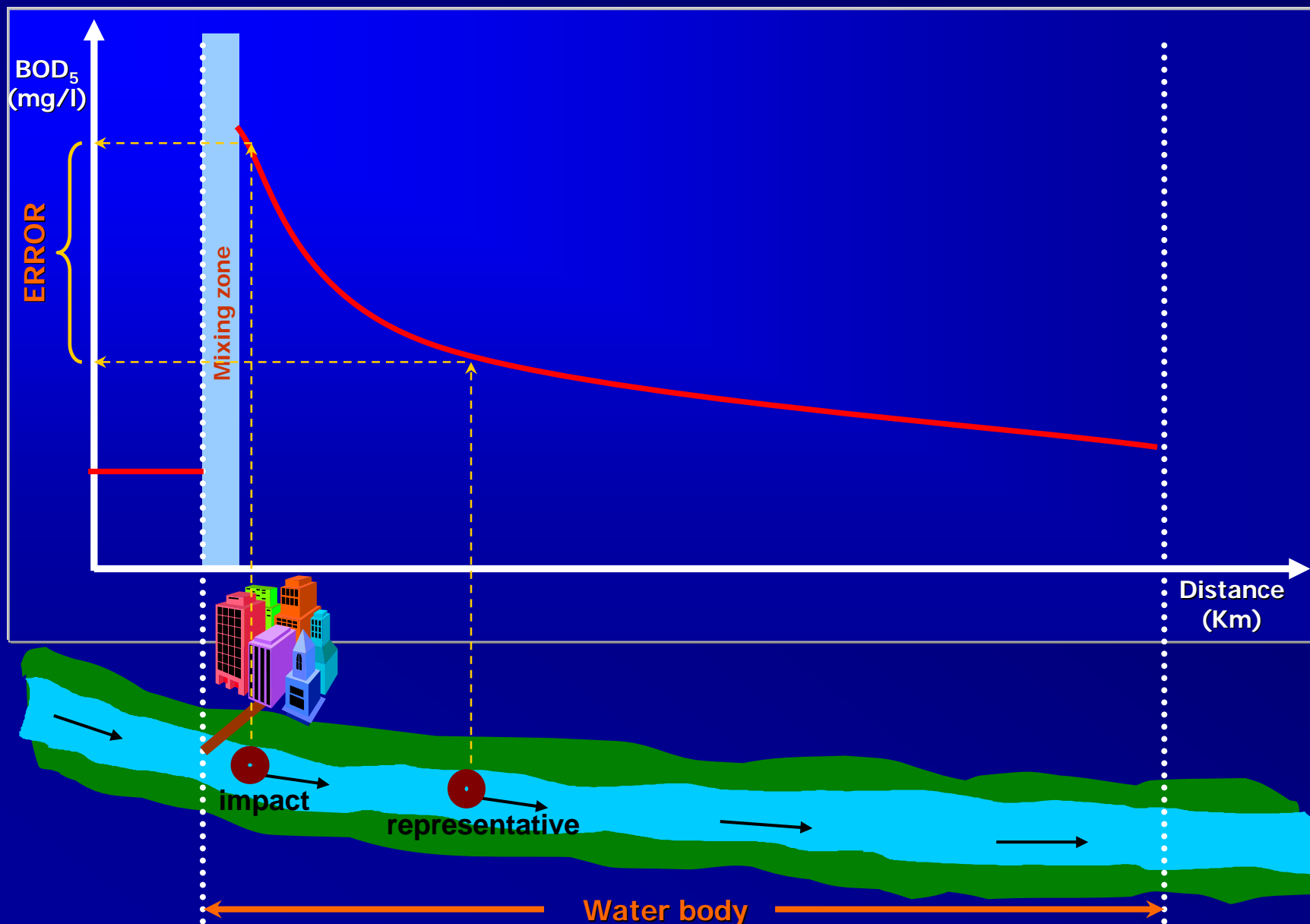
**Particular circumstances related with the different QEs and types of water bodies should also be considered** (i.e. phytobenthos sampling points must have an adequate substrate)

## **Accessibility to the sampling point**

# Location of sampling points inside the water body

## Representative stations vs. impact stations

(Surveillance vs. operational)



# Protocols: sampling, analysis and assessment Ebro RBD



## Guidance on biological sampling and analysis protocols in accordance with WFD

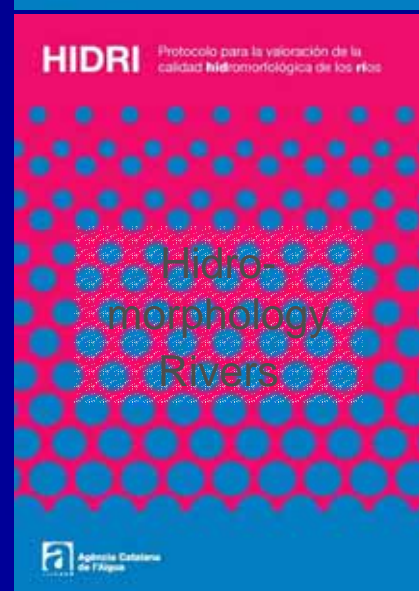
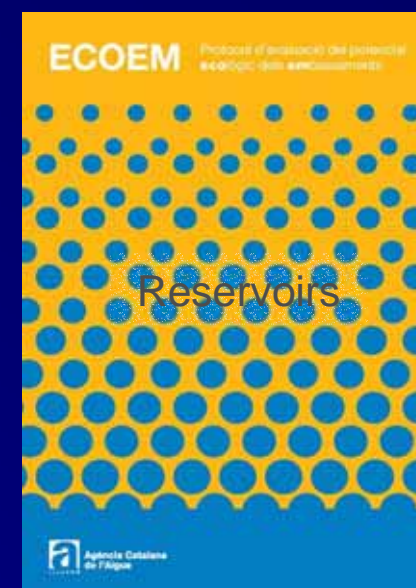
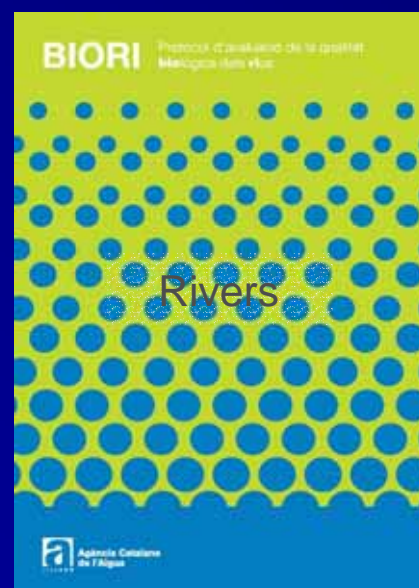
Specific expert workshops for each  
biological QE

### Guidance including:

- sampling procedures
- handling and preparing the physical sample
- analytical method to obtain a result
- metrics

<http://oph.chebro.es/DOCUMENTACION/Calidad/dma/manuales/>

# Protocols: sampling, analysis and assessment Cataluña RBD



**Guidance on biological sampling and analysis  
protocols in accordance with WFD**

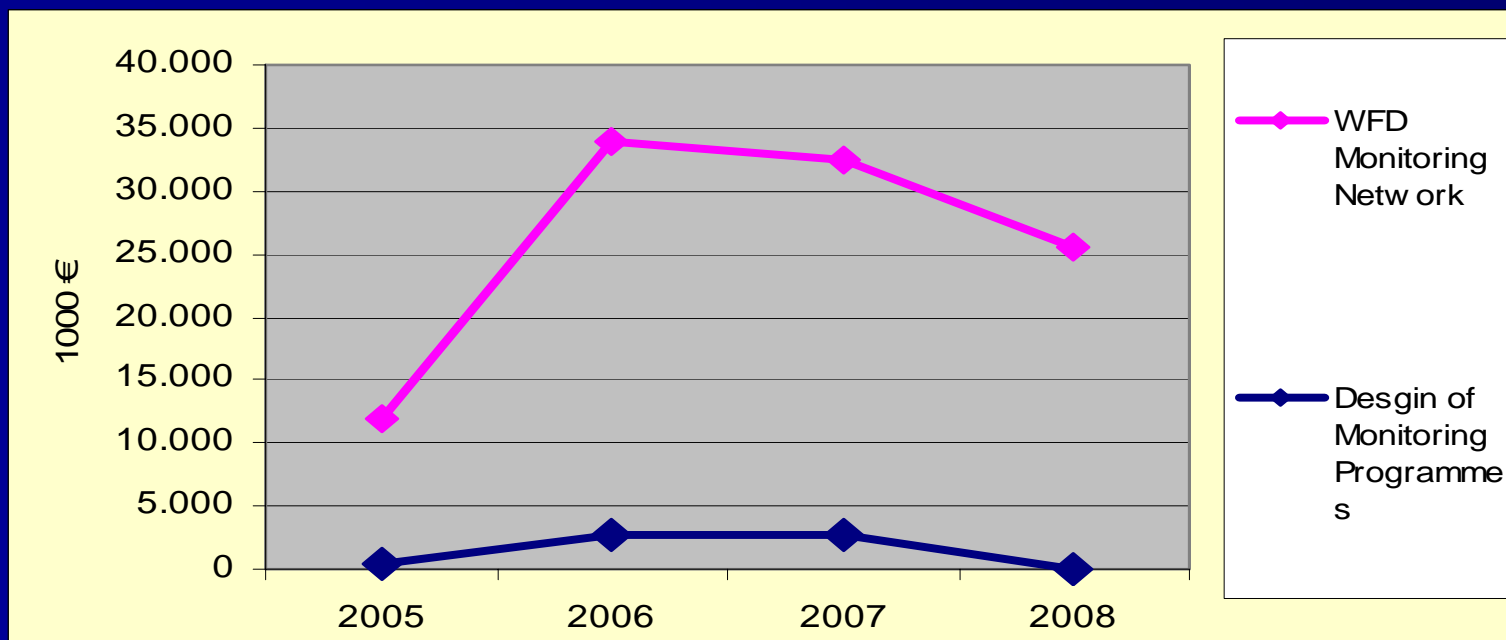
Specific expert working groups for each water category

<http://mediambient.gencat.net/aca/es//planificacio/directiva/protocols.jsp>

# Costs estimation of the WFD monitoring networks (1.000 €)



	2005	2006	2007	2008
Design of Monitoring Programs	500	2.750	2.750	0
WFD Monitoring Network	11.335	31.100	29.672	25.507
<b>TOTAL</b>	<b>11.835</b>	<b>33.850</b>	<b>32.422</b>	<b>25.507</b>







**Thank you**