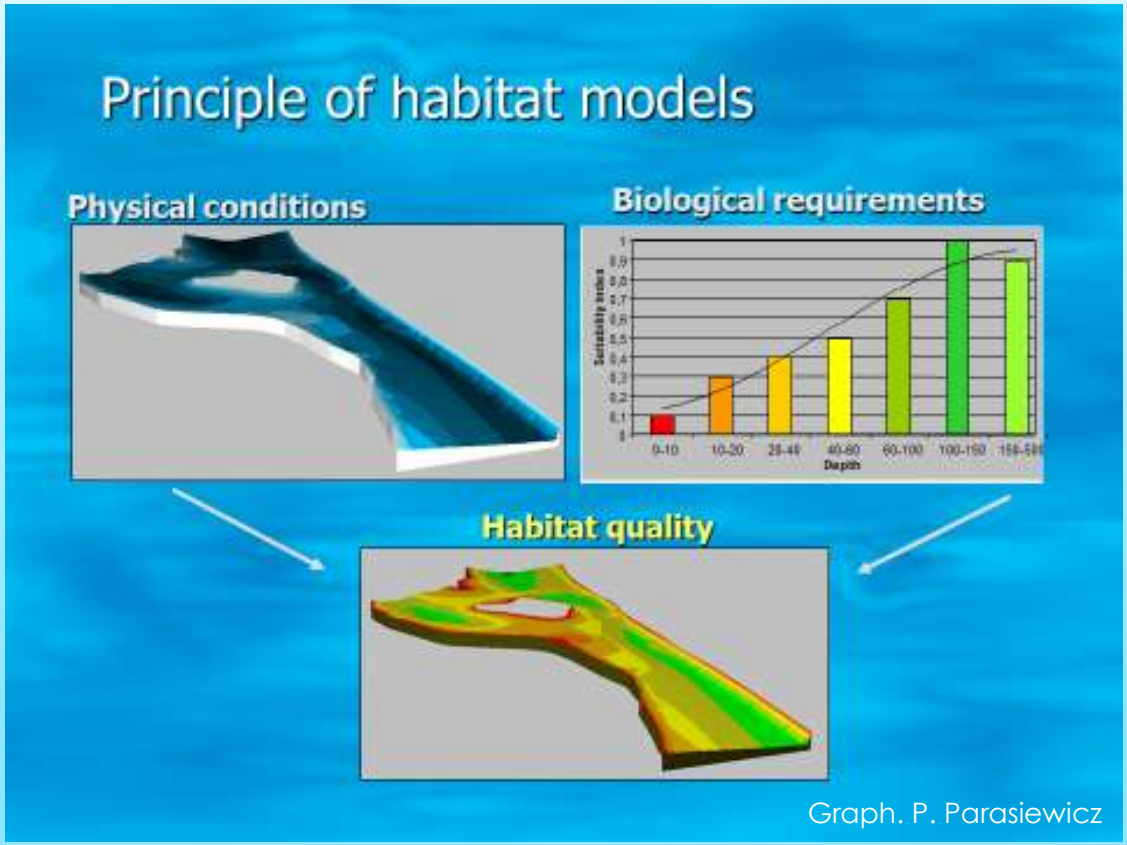
E-flow determination with habitat simulation models



Piotr Parasiewicz

S. Sakowicz inland Fisheries Institute in Poland

Critical Comparison of Instream Flow Methods

	1) Quality of assessment of influence of flows on aquatic an semi aquatic fauna				2) Applicability at the watershed scale			3) Applicability in administrative process			
Method	a. Choice of ecological targets and indicator organisms	b. Integration of hydrologic and biological data	c. Assessment of impact on communities and/or indicator organisms	d. Approach for establishing a common denominator	a. Aggregation of instream and riparian habitats	b. b. Method of selection of representative water bodies and sites	c. Method of extrapolation and simulation of hydrologic data on other points in the watershed	a. Development of water use criteria for watershed	b. Applicability in environmental impact assessment and permitting	c. Ability of derogation from watershed scale criteria	Sum of scores
Look-up methods											
Constant flows	1	1	1	1	1	1	1	3	3	2	15
Seasonally varying flows	1	2	2	1	1	1	1	3	3	2	17
Desktop methods											
IHA	1	2	2	2	1	1	1	2	2	2	16
HEFR	1	2	3	3	2	3	3	4	3	3	27
Global metod of Smakhtin	1	1	1	1	1	1	1	1	1	1	10
WPM	1	2	1	1	1	1	1	2	2	2	14
R-2 cross	1	2	1	1	1	2	3	2	2	2	17
LIFE	3	3	1	1	1	2	2	1	1	1	16
SWMI	3	3	1	2	1	2	5	4	3	3	27
HFSR - simplified version	2	2	2	2	2	3	4	2	2	2	23
Holistic methods											
ELOHA	5	3	3	4	3	3	1	4	3	1	30
Building Block Methodology	5	3	3	4	3	3	1	4	3	1	30
Benchmarking Methodology	5	3	3	4	3	4	3	4	3	2	34
Habitat simulation methods											
MesoHABSIM	4	5	5	5	5	5	4	5	4	5	47
CASIMIR	1	4	3	3	3	3	3	2	5	5	32
River Signature	1	4	3	3	3	3	3	3	5	5	33
MEM	1	4	3	3	4	3	3	3	5	5	34
PHABSIM	1	3	3	3	3	3	3	2	5	5	31
Norwegian Habitat Model	1	4	3	3	4	3	3	3	5	5	34
RHYHABSIM	1	3	3	3	3	3	3	2	5	5	31
ESTIMHAB	1	3	4	3	3	3	3	5	5	5	35

Pros and Cons of habitat models

Cons

Effort intensive

Many different methods

Limited range of flows (no so good for high flows)

Depend on suitability criteria

Site specific

May be manipulated

Used for instream flow only

Pros

Biologcally sound

Precise quantitative data

50 years of worldwide experience

Can be used for different animals, species, guilds and communities

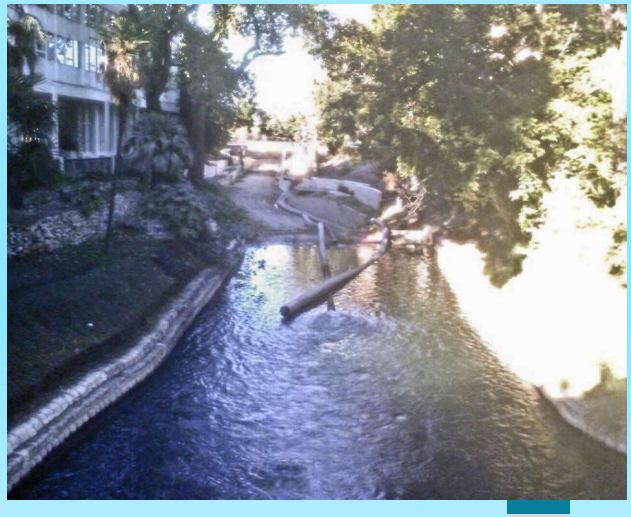
Simulation of flow and riverbed structure alteration

Temporal variation

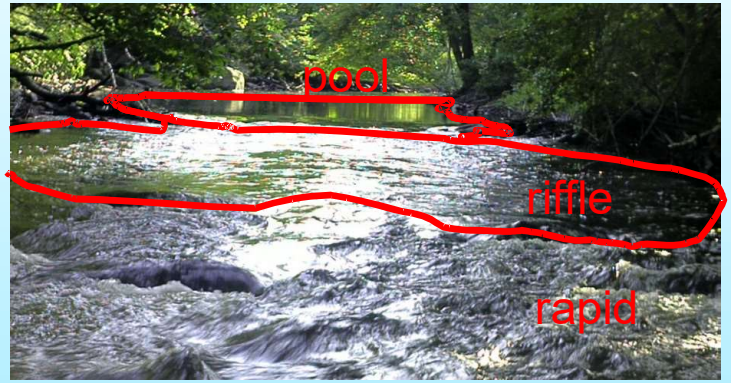
Good for monitoring

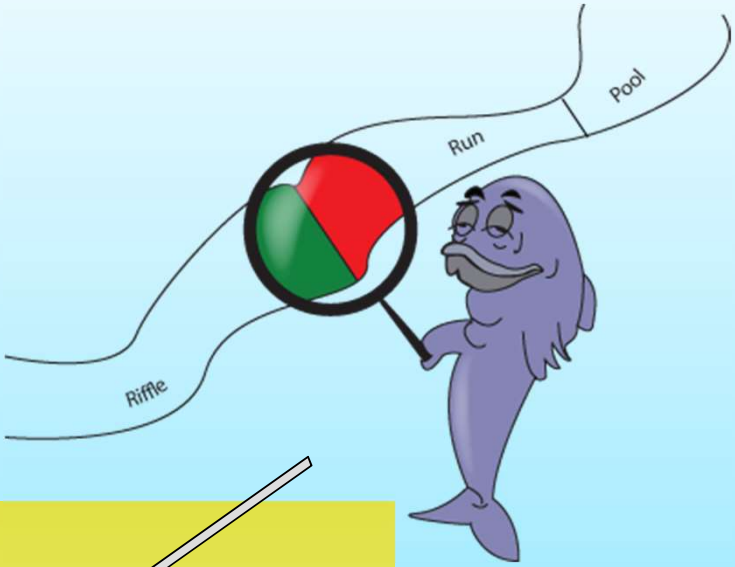
Can be easy verified

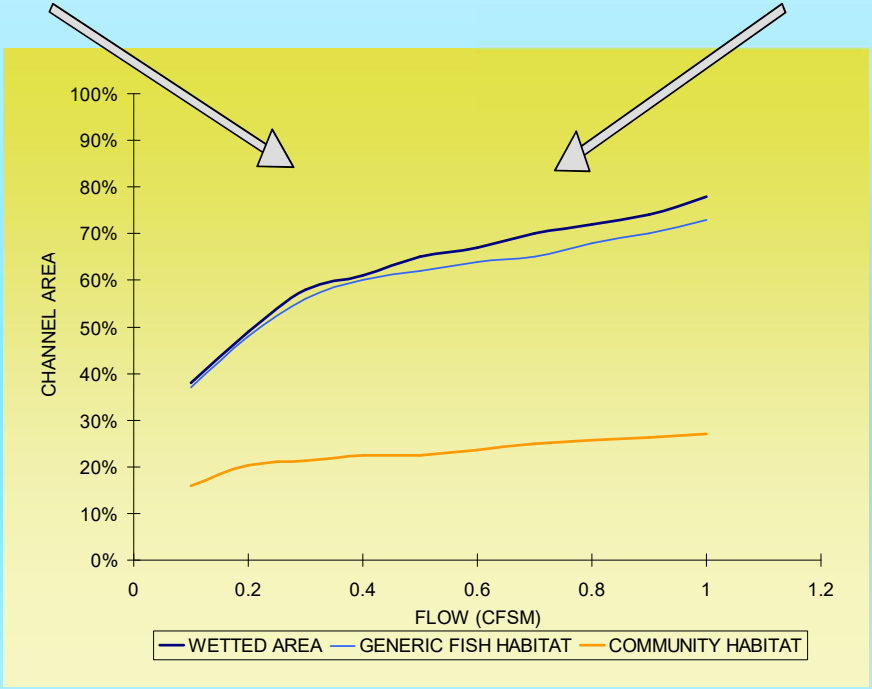
Can be monetized



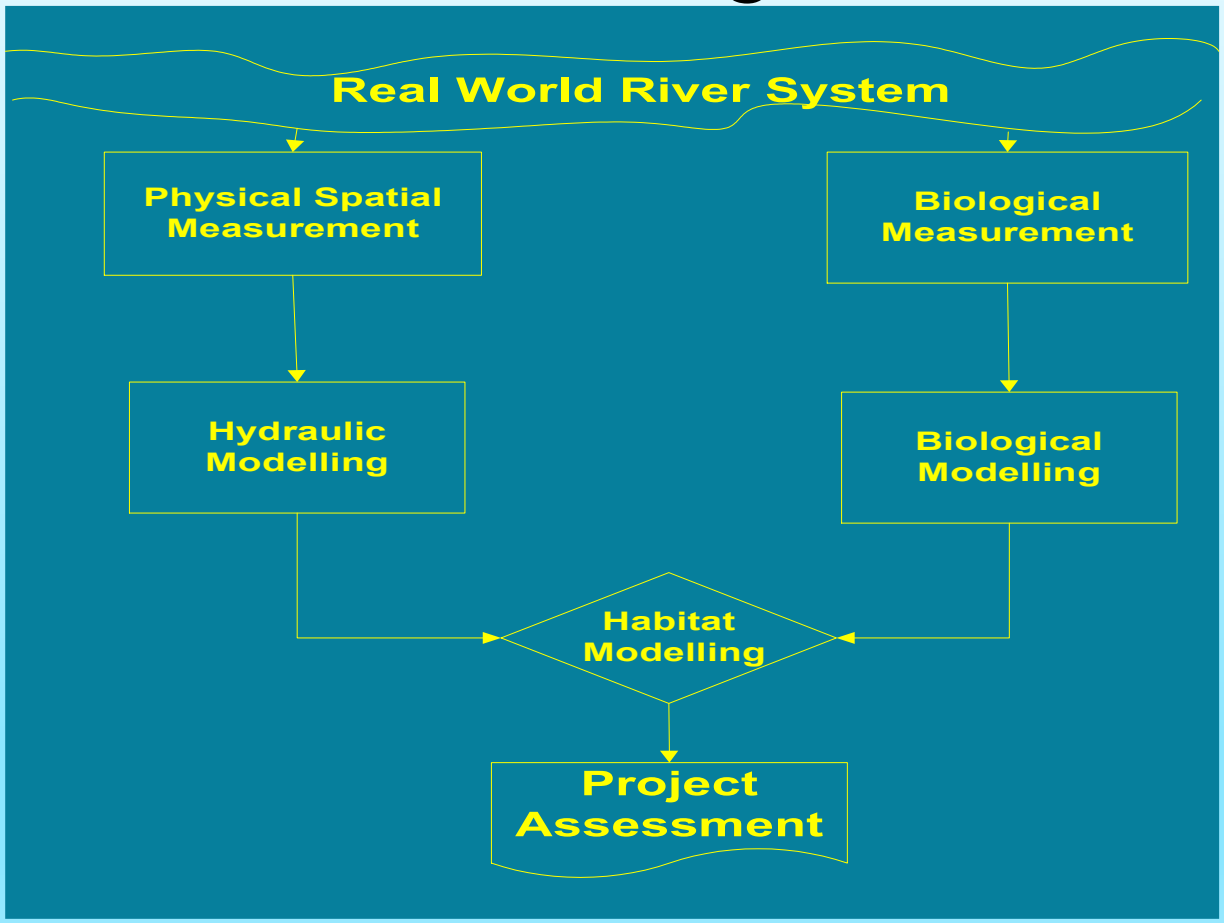
MesoHABSIM


pool
riffle
rapid


Pool
Run
Riffle

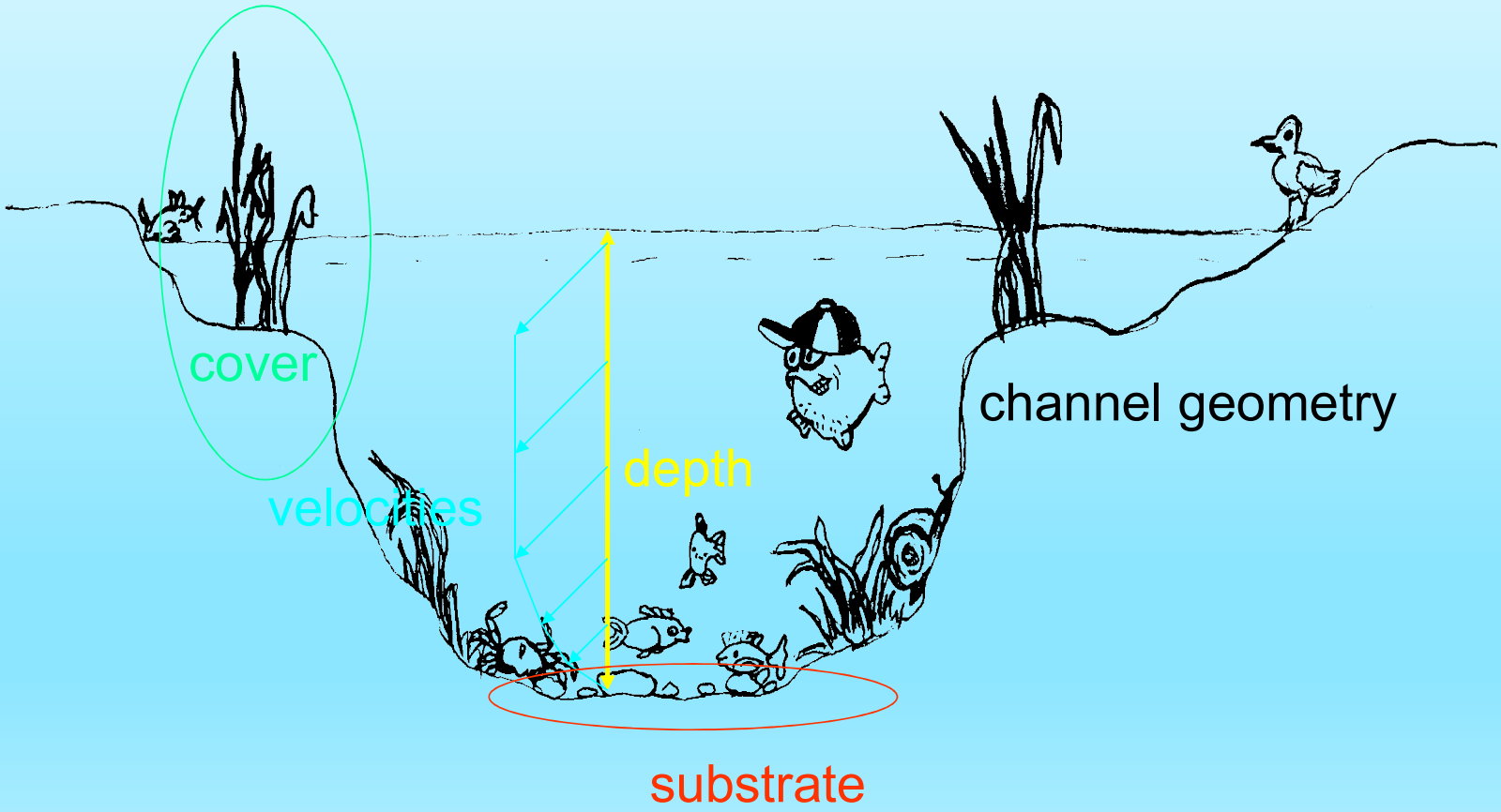

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CHANNEL AREA
0
0.2
0.4
0.6
0.8
1
1.2
FLOW (CFSM)
WETTED AREA
GENERIC FISH HABITAT
COMMUNITY HABITAT

Habitat modelling framework

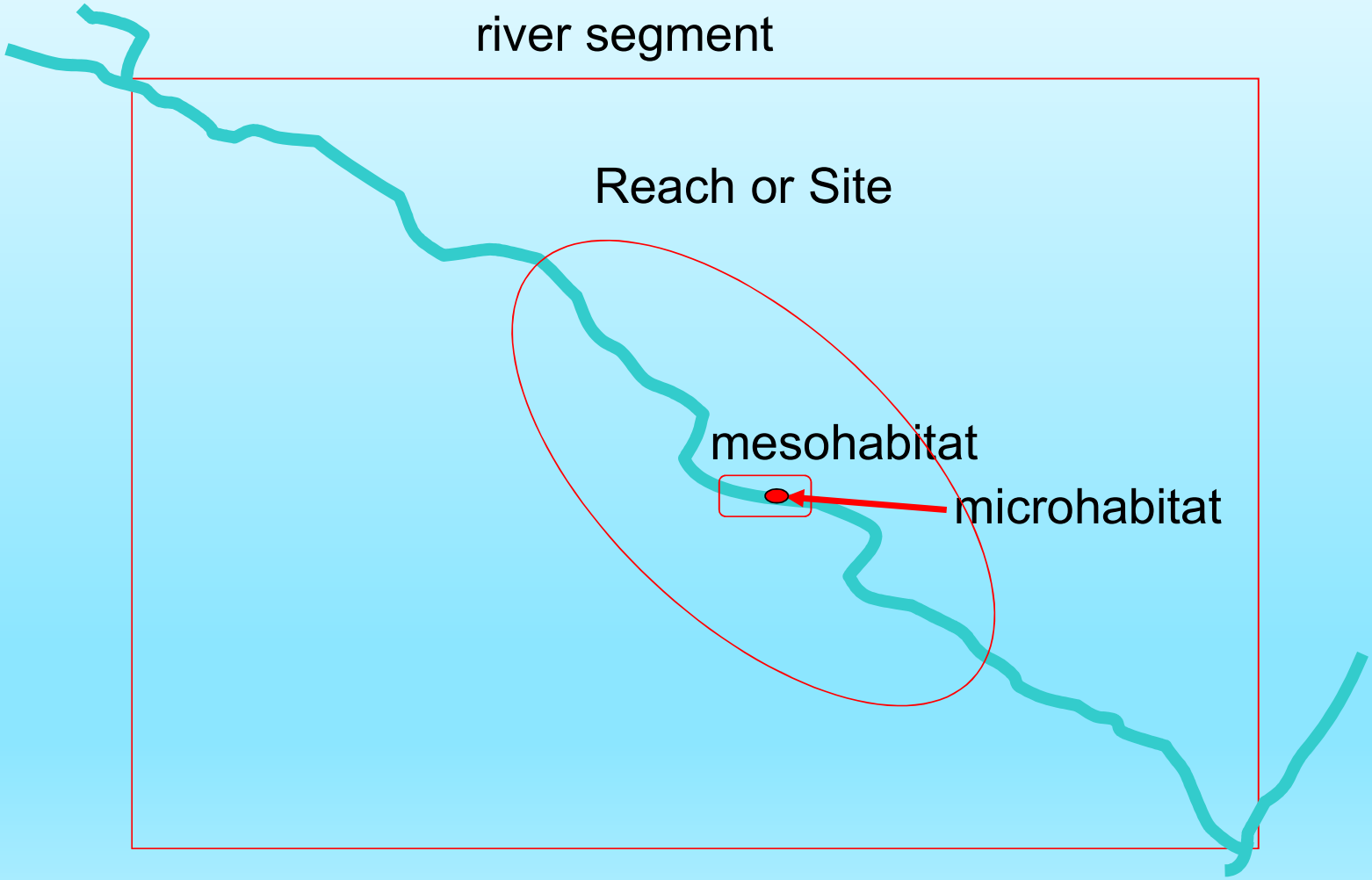


(Modified from Hardy 1994)

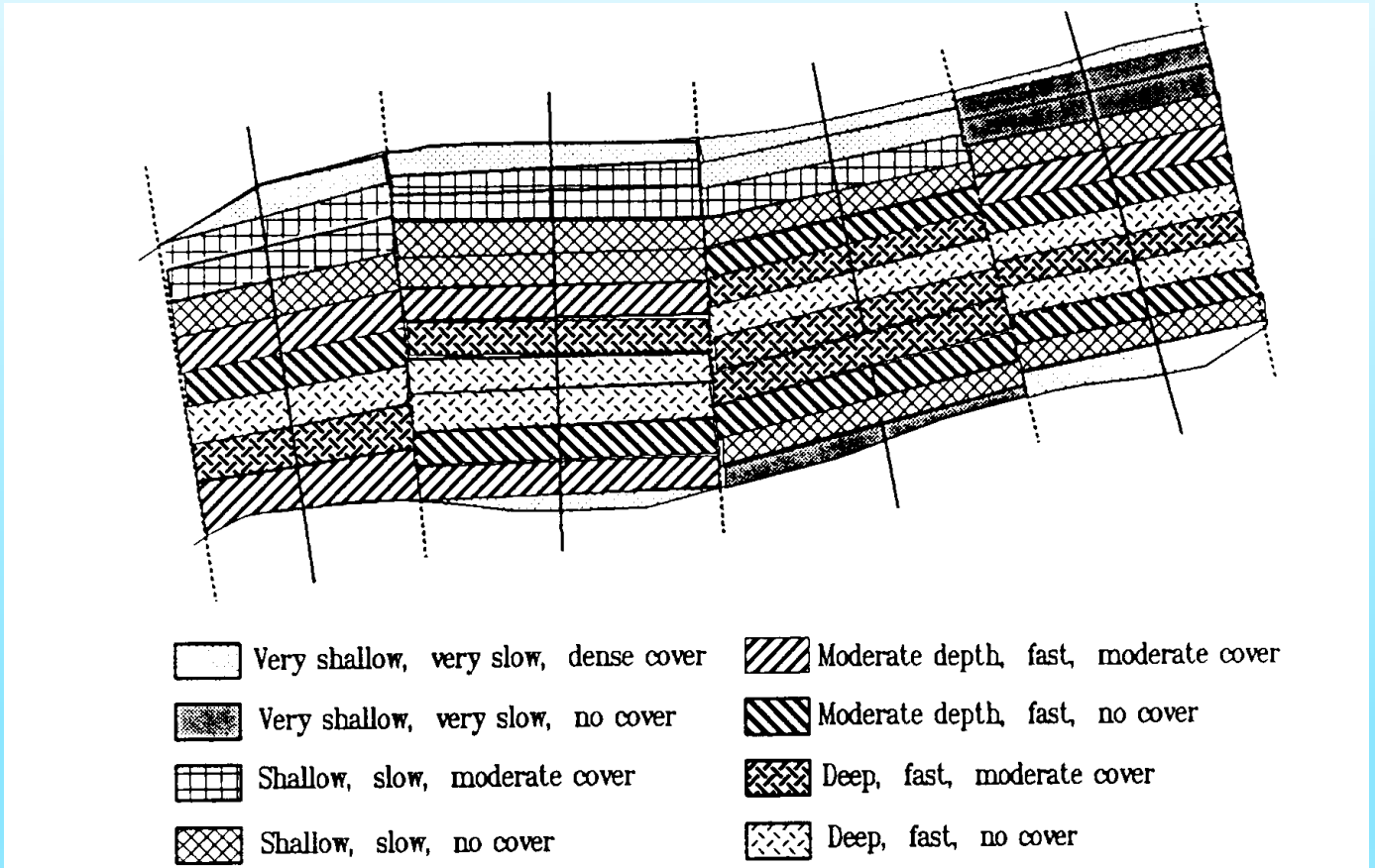
Habitat survey



Study area

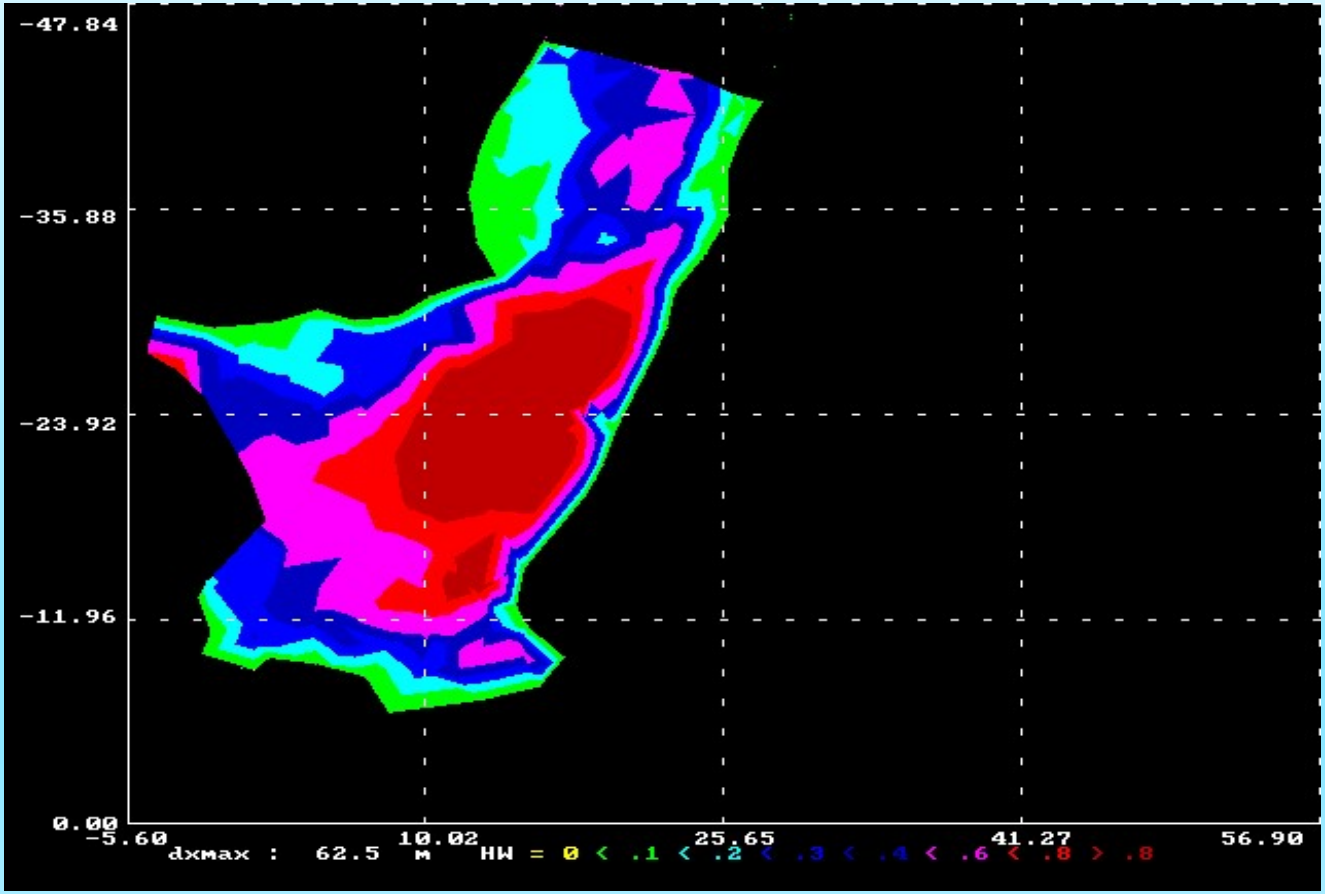


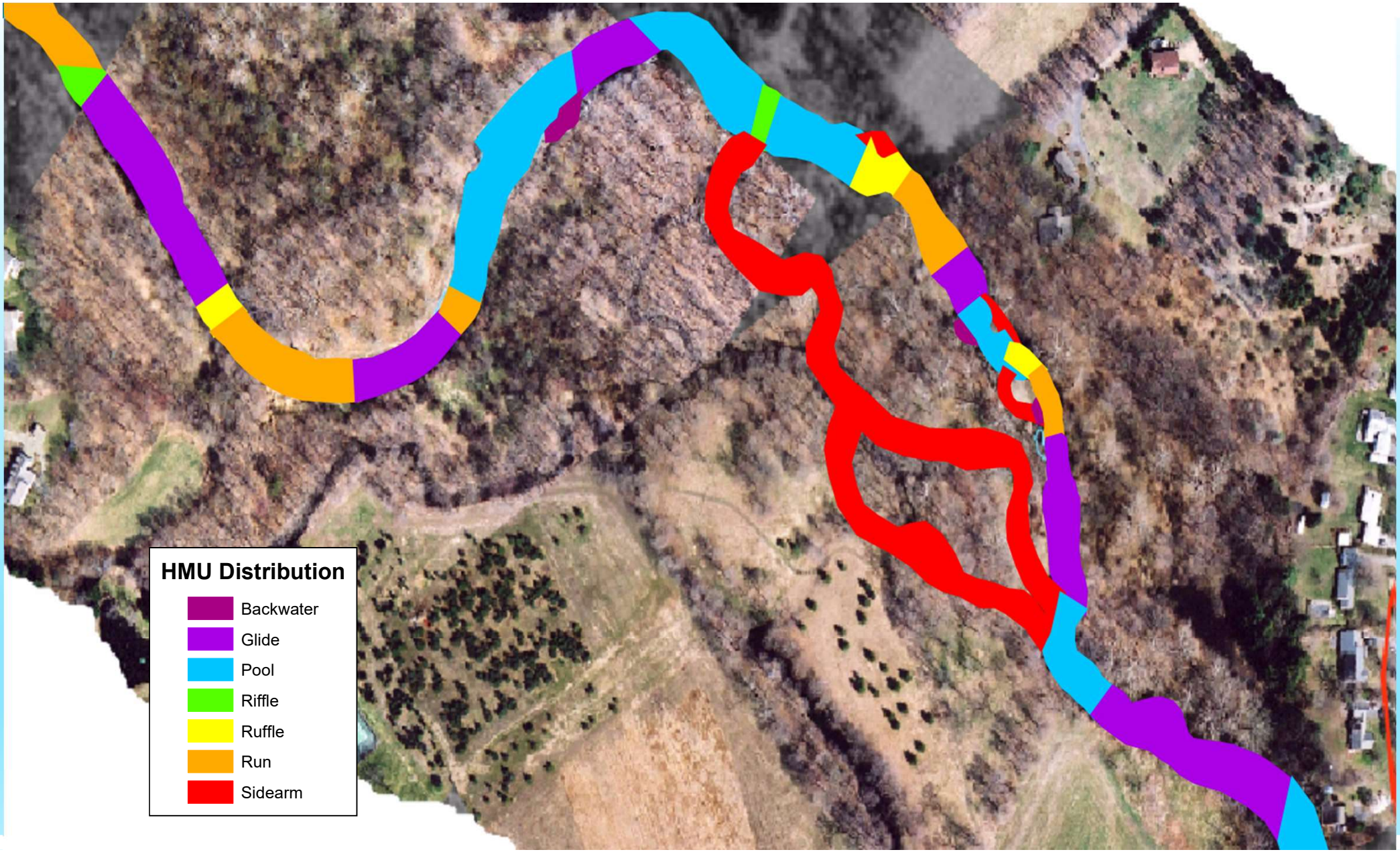
Discrete representation



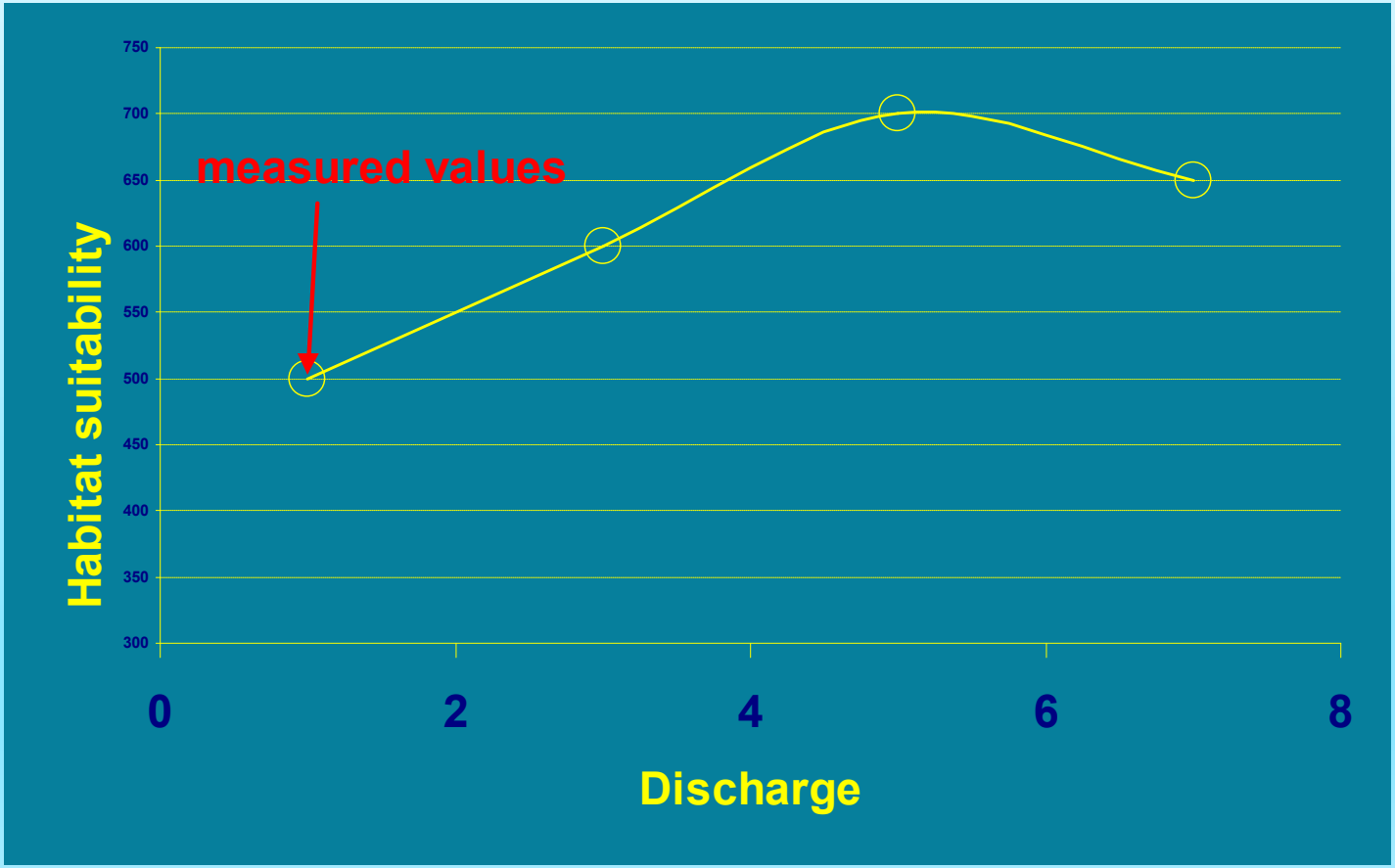
(Bovee 1994)

GBIS + curvilinear interpolation



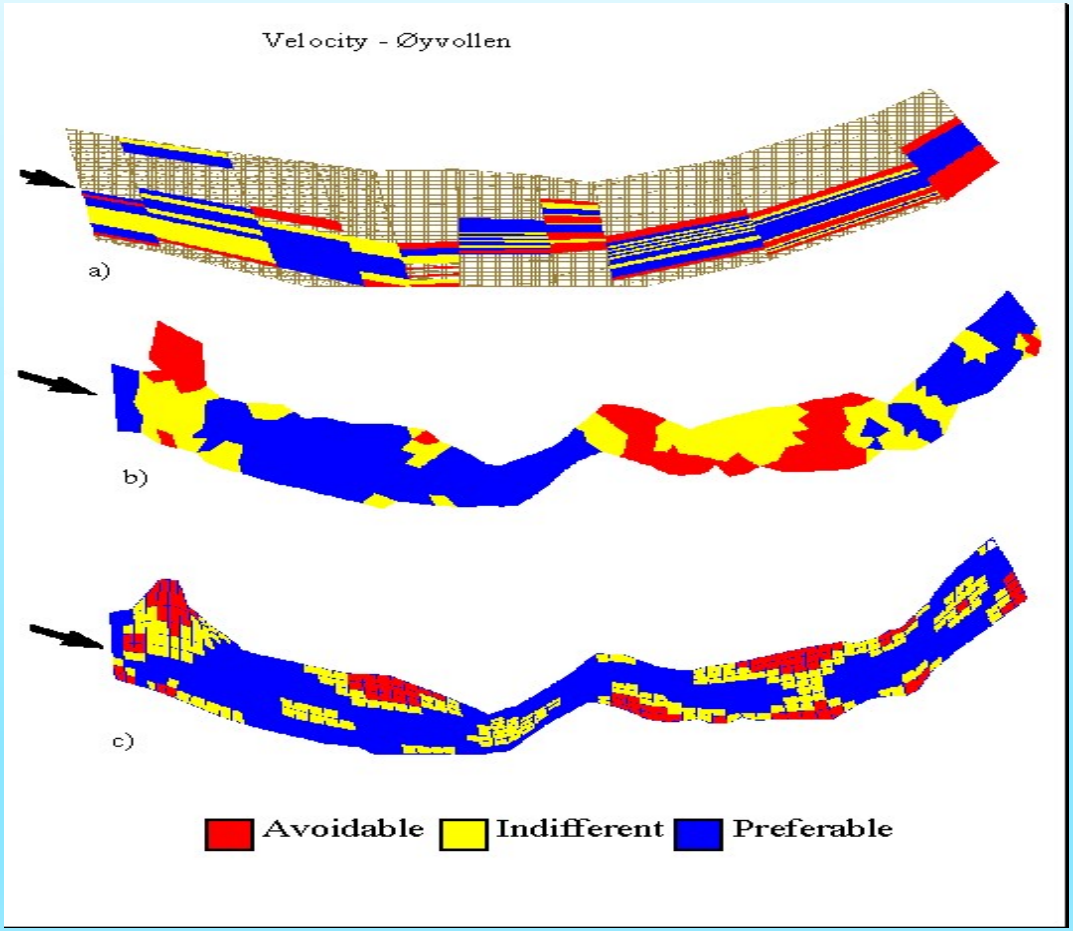

HMU Distribution
Backwater
Glide
Pool
Riffle
Ruffle
Run
Sidearm

Interpolation Hydraulic Models



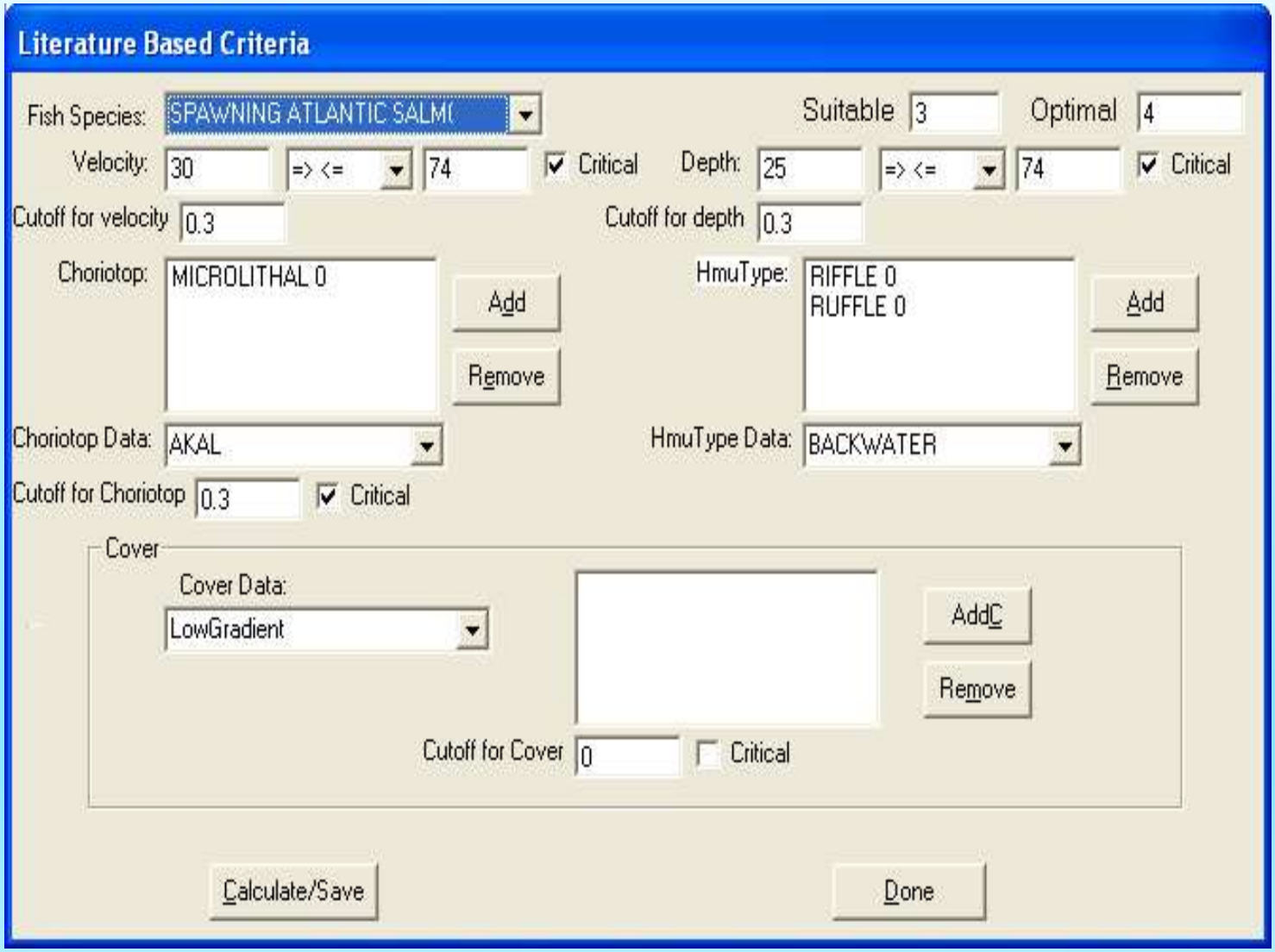
Mechanistic Hydraulic Models

- 1D (Hec-2)
- 2D (AquaDyn)
- 3D (SSIIM)



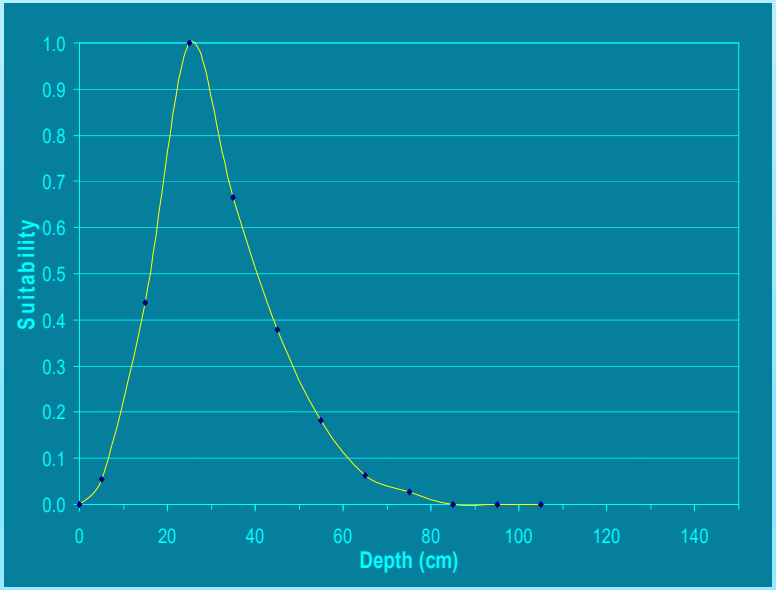
(Alfredsen et al. 1997)

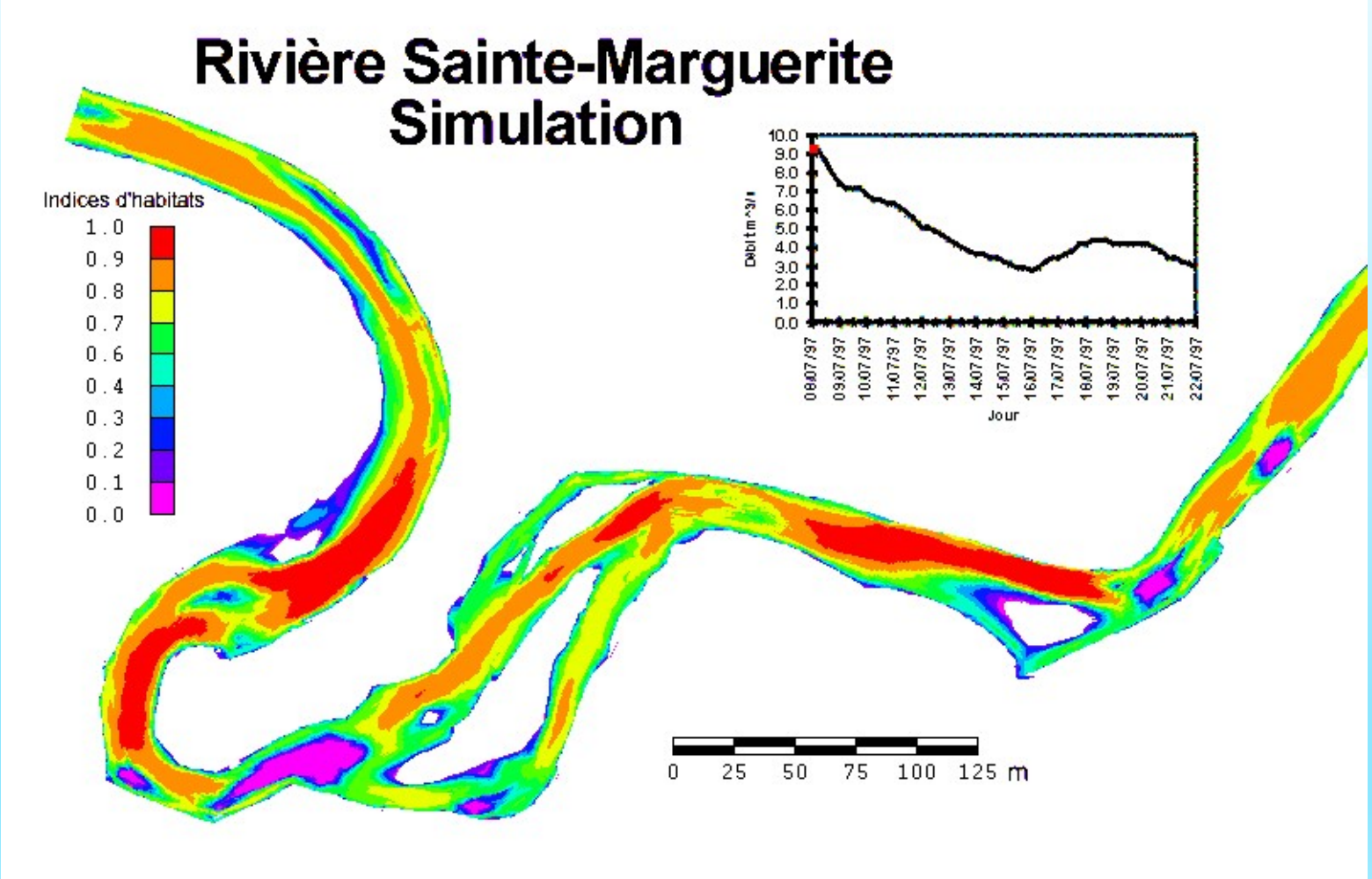
Conceptual biological models



Empirical Biological models

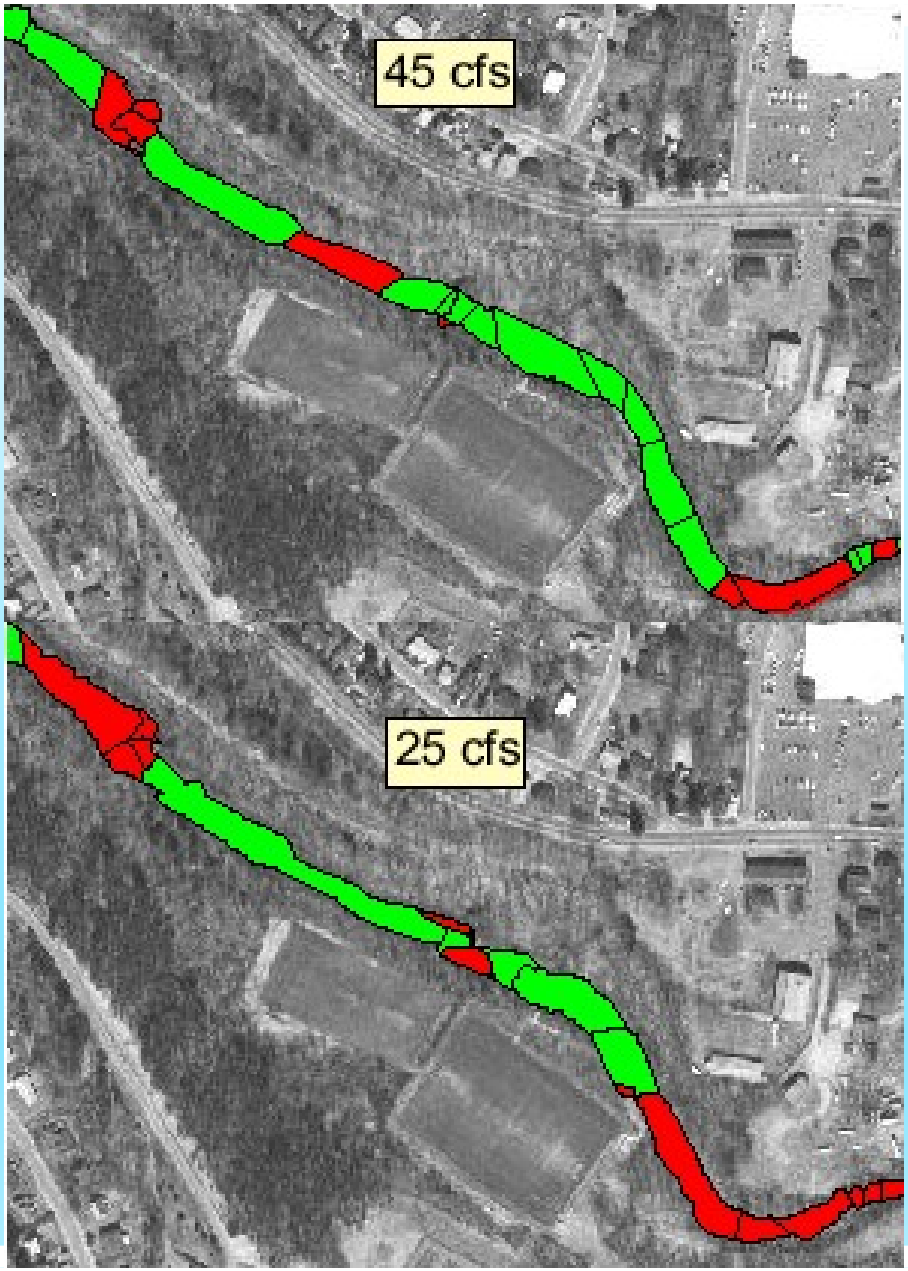
- Category 1
  - professional judgement
- Category 2
  - utilisation curves
- Category 3
  - preference curves
- Category 4
  - Multivariate models

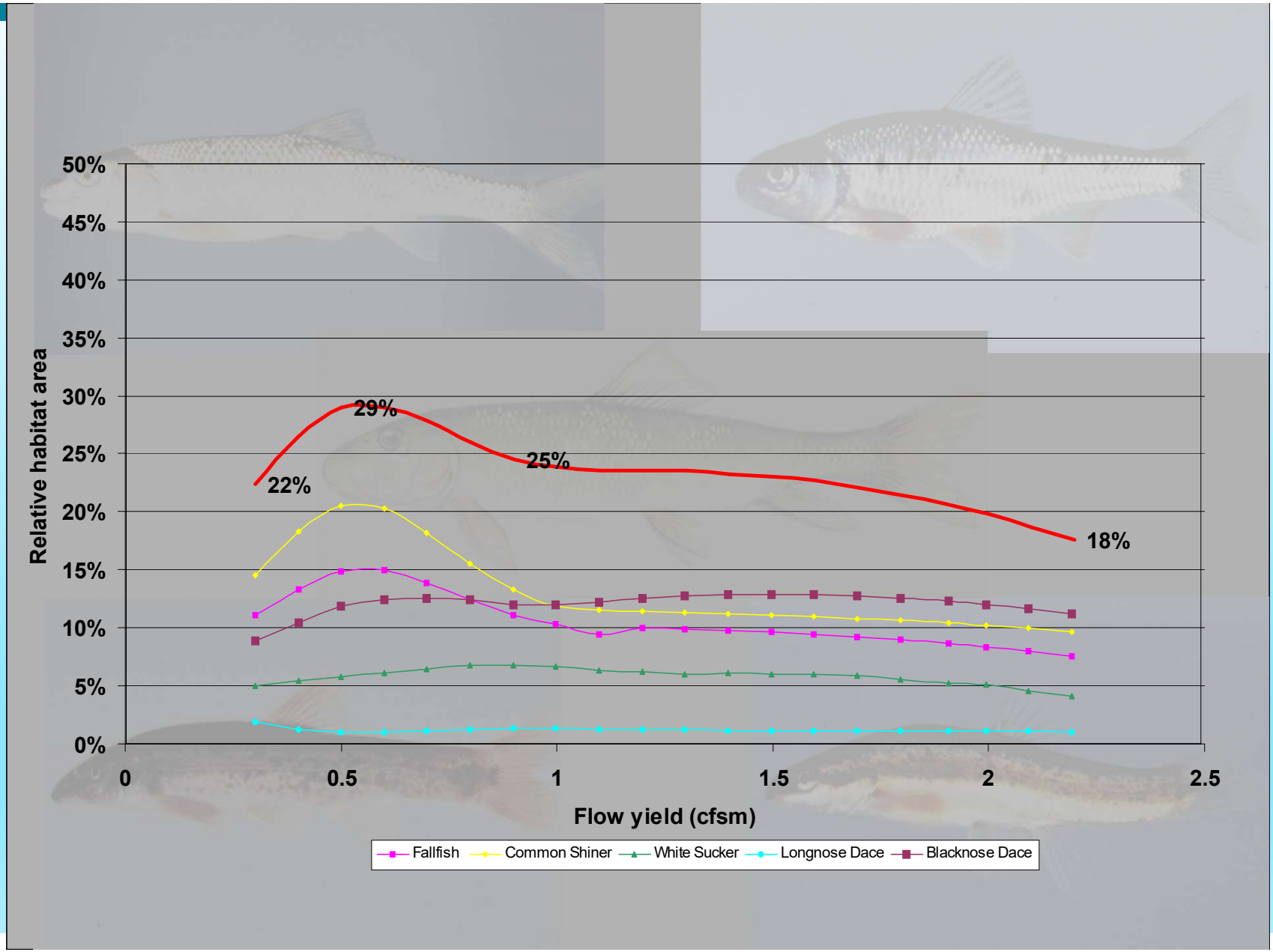




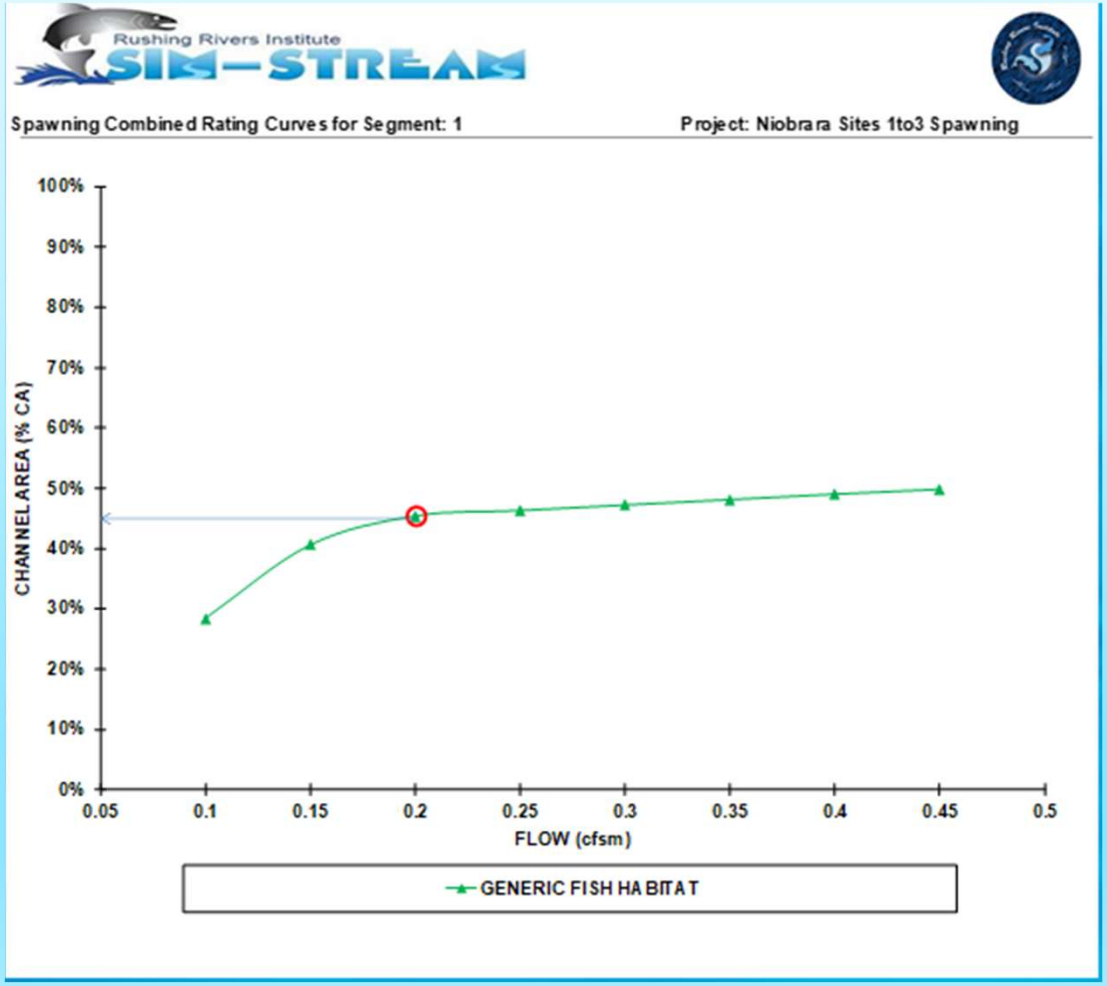
Yves Secretain: INRS-EAU Quebec

Suitability models

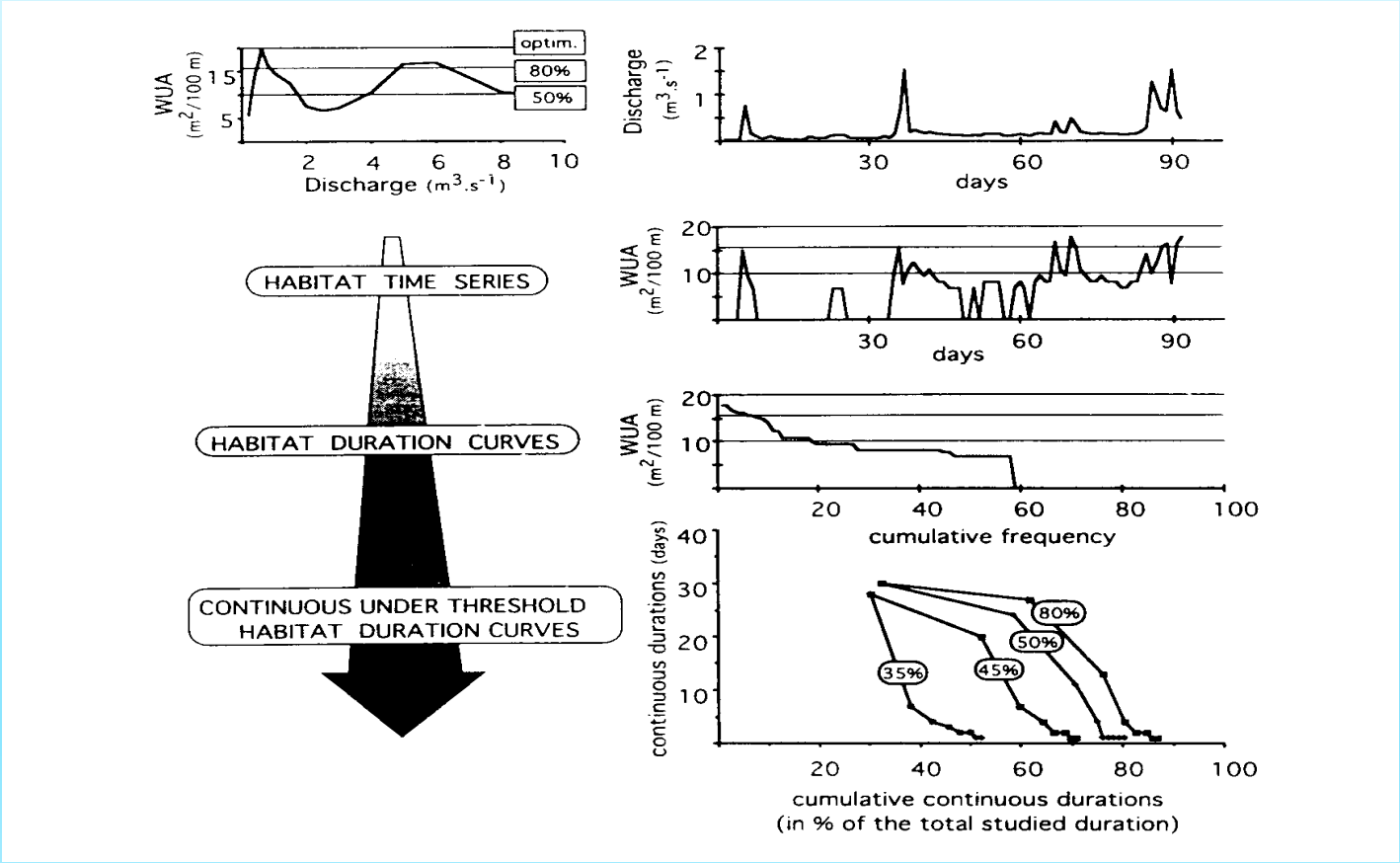



50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Relative habitat area
29%
25%
22%
18%
0
0.5
1
1.5
2
2.5
Flow yield (cfsm)
Fallfish
Common Shiner
White Sucker
Longnose Dace
Blacknose Dace

E-flow determination from rating curve



Time Series Analysis

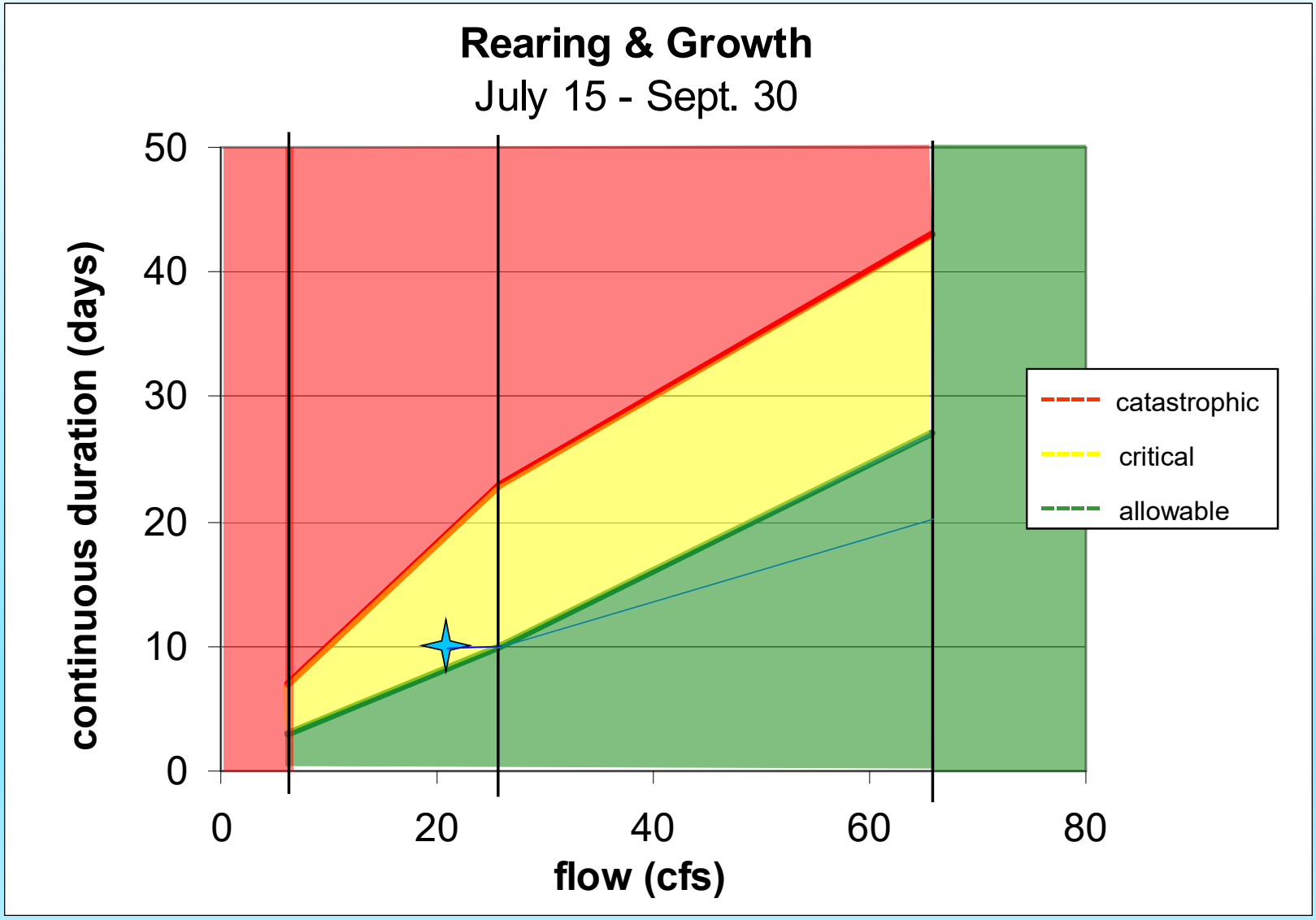


(Capra et al. 1995)

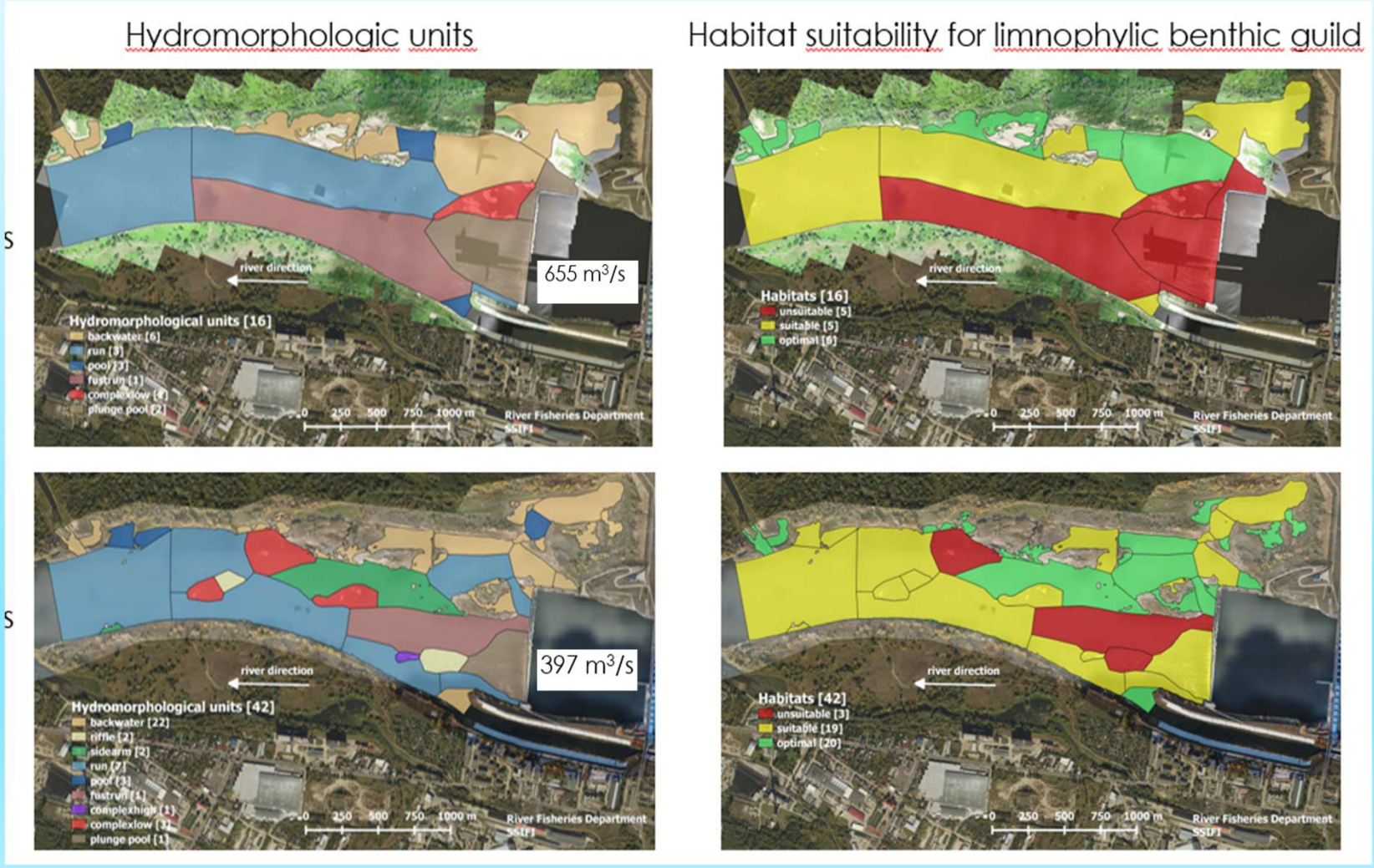
Intra-annual criteria for magnitude and duration

Bioperiod Approximate dates	**Rearing & Growth** July - Sept.	**Fall Spawning** Oct. - Nov.	**Overwintering** Dec. - Feb.
Base flow reference (cfsm)	**0.36**	**0.36**	**1.9**
Allowable duration under (days)	**22**	**13**	**20**
Catastrophic duration (days)	**86**	**56**	**47**
Subsistence flow reference (cfsm)	**0.05**	**0.05**	**0.4**
Allowable duration under (days)	**10**	**8**	**18**
Catastrophic duration (days)	**48**	**26**	**33**
Absolute minimum flow (cfsm)	0.002	0.005	0.047
Bioperiod Approximate dates	**Spring Flood** March - April	**Spring Spawning** May - June	
Base flow reference (cfsm)	**1.90**	**1.00**	
Allowable duration under (days)	**19**	**14**	
Catastrophic duration (days)	**35**	**42**	
Subsistence flow reference (cfsm)	**1.00**	**0.36**	
Allowable duration under (days)	**10**	**10**	
Catastrophic duration (days)	**15**	**20**	
Absolute minimum flow (cfsm)	0.185	0.046	

ACTogram

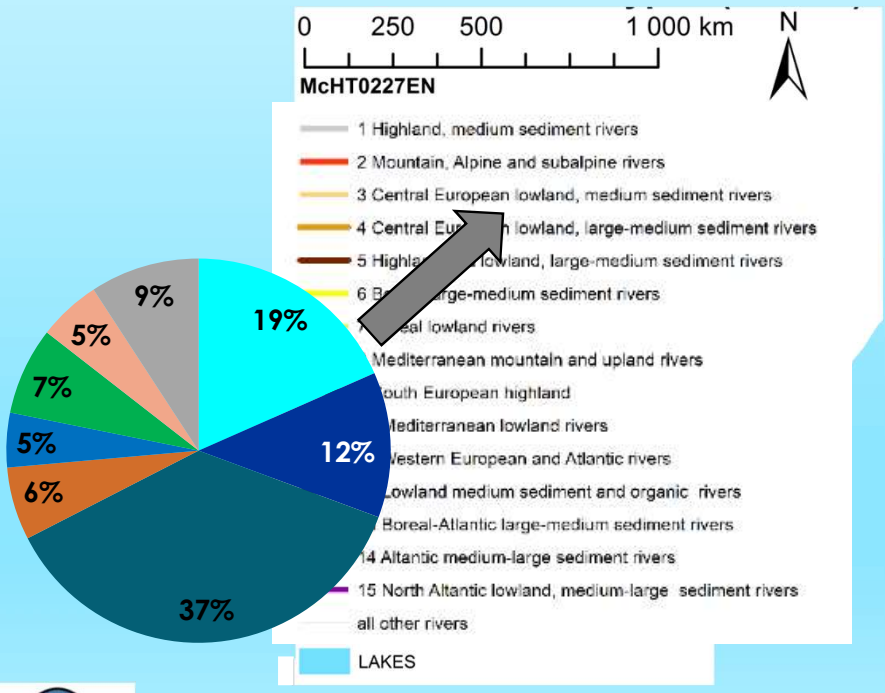

Rearing & Growth
July 15 - Sept. 30
continuous duration (days)
50
40
30
20
10
0
0
20
40
60
80
flow (cfs)
catastrophic
critical
allowable

Large River Mapping



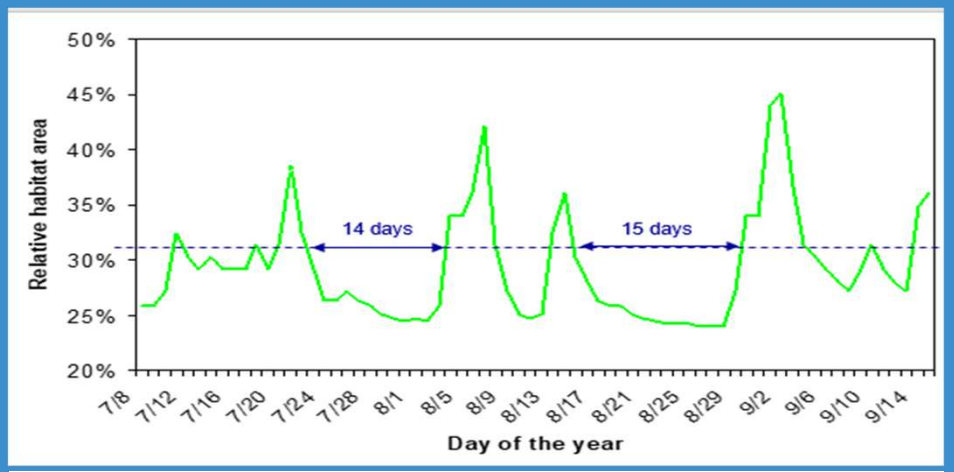
European rivers classified into Fish Community Macrohabitat types (FCMacHT)

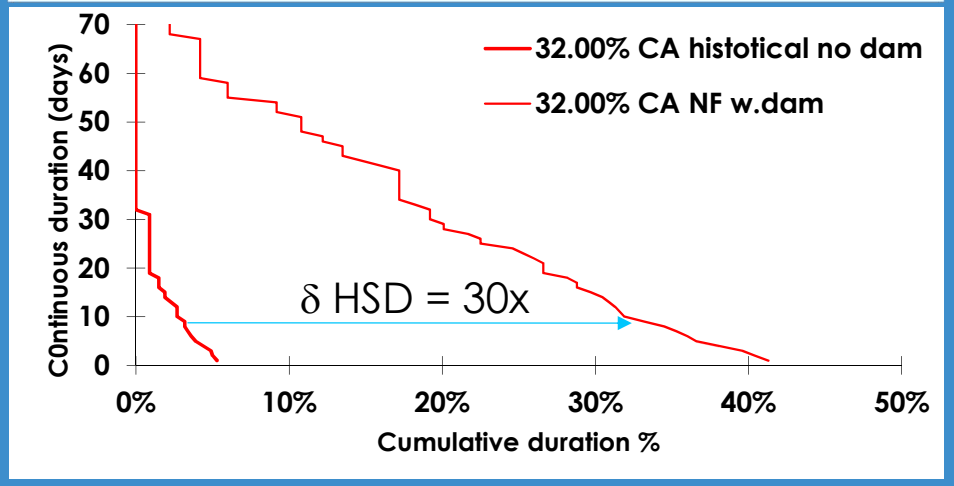
$$Q_e = p \cdot q \cdot A$$

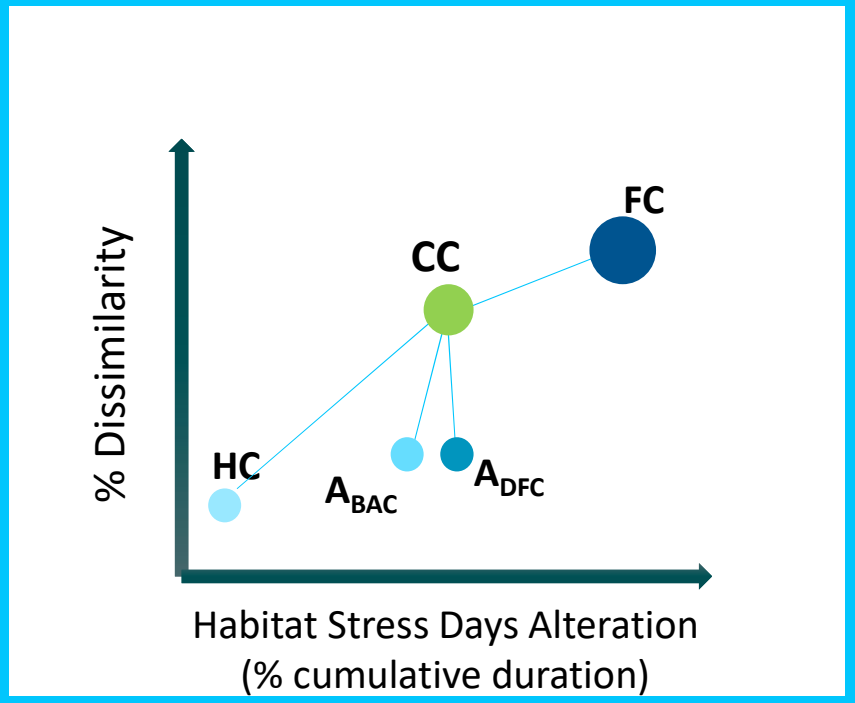


(AMBER D2.2, VERSION 3.0).

Modelling magnitude, duration and frequency

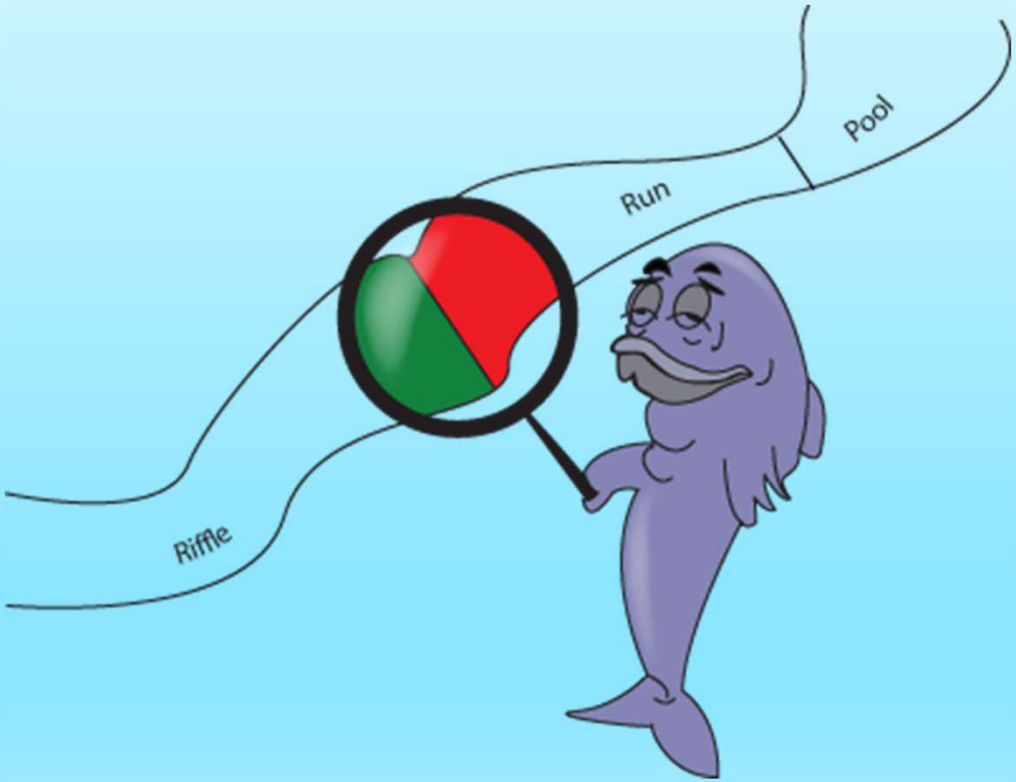






HC - historical conditions
CC - current conditions
FC - future conditions
A_{DFC} - **Desired Future Conditions** alternative
A_{BAC} - **Best Available Conditions** alternative

धन्यवाद्



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