An Attempt to Assess the Environmental Change in Downstream River of Dams by Benthic Macroinvertebrate Community

T2-370

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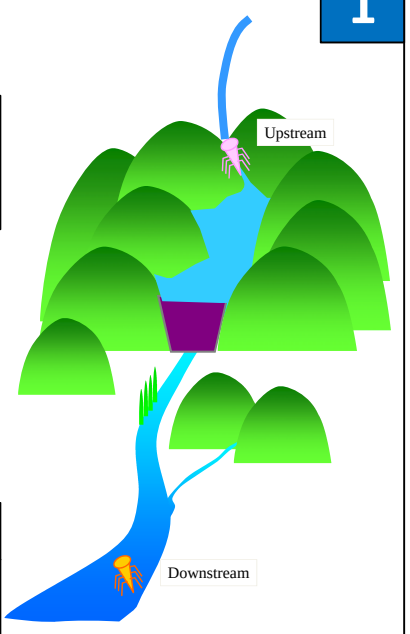
1 Background

Upstream → River Flow, Sediment, Water Quality → Community of Aquatic Organisms

Dam → Fragmentation of Streams, Flow Regime Shift, Water Quality Change, Sediment Transport Change

Downstream → Change of River Flow, Sediment, Water Quality → Change of Community of Aquatic Organisms



2 Survey Data

The data of the National Survey for River and Riparian Ecosystems which were obtained from 1996 to 2002.

Macroinvertebrate data which were collected simultaneously at upstream and downstream of a dam in winter.

→ **Total number of chosen dataset pairs is 56 out of 42 dams.**

Data Analysis

TWINSPAN is employed to classify data samples and macroinvertebrate taxa.

Number of samples at the first division by TWINSPAN

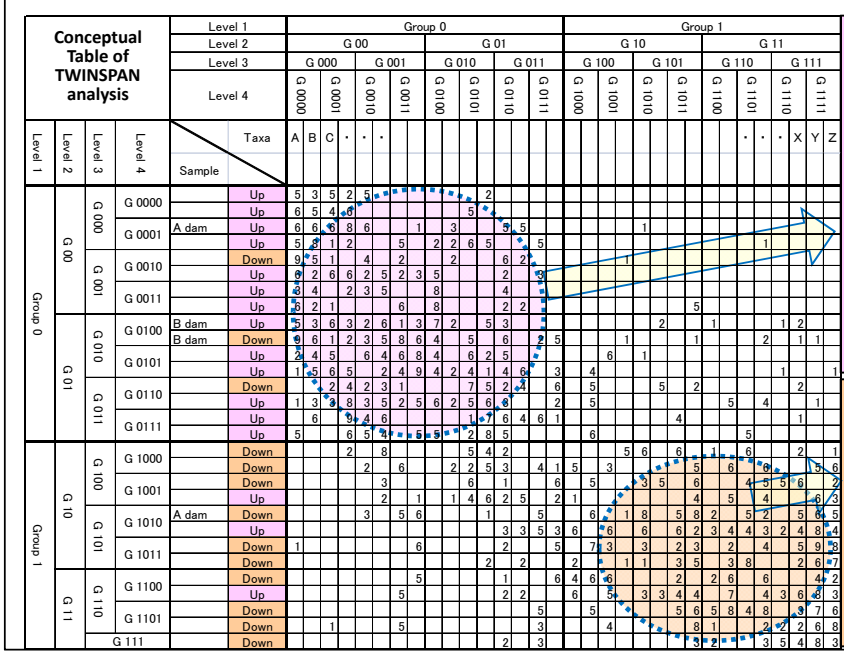
	Upstream	Downstream	Total
Group 0	47	22	69
Group 1	9	34	43
Total	56	56	112

Image of TWINSPAN Analysis

		Taxa A	Taxa B	Taxa C	Taxa D
Dam A	Upstream	5			4
Dam A	Downstream	1	4	5	1
Dam B	Upstream	4	1		3
Dam B	Downstream		5	6	1

			Group 0		Group 1	
			Taxa A	Taxa D	Taxa B	Taxa C
Group 0	Dam A	Upstream	5	4		
	Dam B	Upstream	4	3	1	
Group 1	Dam A	Downstream	1	1	4	5
	Dam B	Downstream		1	5	6

3 Difference of Benthic Macroinvertebrate Community in up-and-down stream of Dams



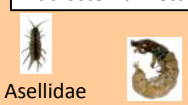
Taxon which often appeared in Group 0 (many upstream samples are included)

Capniidae
Chloroperlidae
Drunella
Epeorus
Glossosoma etc.

Epeorus Glossosoma

Taxon which often appeared in Group 1 (many downstream samples are included)

Asellidae
Macrostemum etc.



Asellidae Macrostemum

4 An Example of the Check of Bias in the Emergence of Index Taxa of Macroinvertebrate for a dam

Taxon		Epeorus	Rhithrogena	Capniidae	Chloroperlidae	Caroperla	Hydroptila	Cinygmula	Cinctocostella	Perlodidae	Goera	Simuliidae	Apsilochorema	Lepidostoma	Paraleptophlebia	Amphinemura	Glossosoma	Chironomidae	Tipulidae	Cheumatopsyche	Hydropsyche	Rhyacophila	Stenopsyche	Corydalidae	Gibosia	Corbicopsonidae	Atherlcidae	Uracanthella	Diptera	Crambidae	Kamimuri	Lymnaeidae	Pleuroceridae	Asellidae	Ephacerella	Ephemera	Baetiella	Paraphlebiidae	Lumbriculidae	Macrostemum	Turbellaria	Sphaeriidae
Rank of number	Upstream	7	5	5	5	5	5	5	5	3	3	3	2	1	1	1	1	7	8	9	8	4	2	5	7	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Downstream	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7	8	8	4	2	6	9	7	4	6	1	1	2	3	3	3	3	4	5	5	6	7	8	8
	Total	7	5	5	5	5	5	5	5	3	3	3	2	1	1	1	1	11	15	17	16	8	4	11	16	12	5	7	1	1	2	3	3	3	3	4	5	5	6	7	8	8
Ratio of upstream in total rank (%)		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	64	53	53	50	50	50	45	44	42	20	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Upstream biased ← → No biase ← → Downstream biased

- Taxon representing very slow flow
- Net spinning caddisfly to represent stable river bed
- Taxon represening the existence of sand

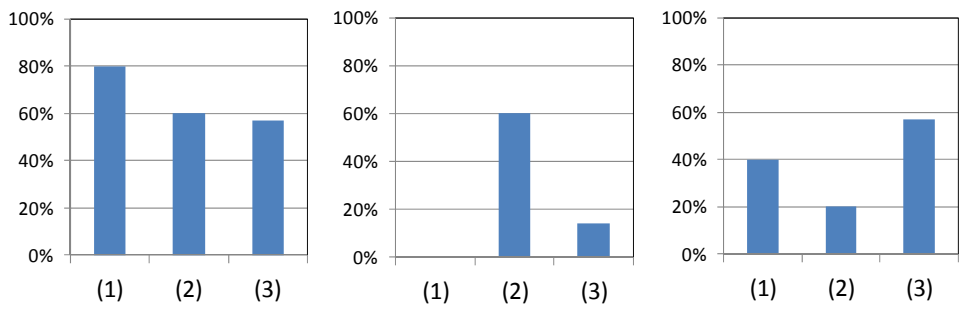
Upstream biased	The ratio of the rank at upstream to the total rank is more than 60%
No biase	The ratio of the rank at upstream to the total rank is between 40% to 60%
Downstream biased	The ratio of the rank at upstream to the total rank is less than 40%

The logarithm of the number of individuals per 1square meter is ranked by following threshold.

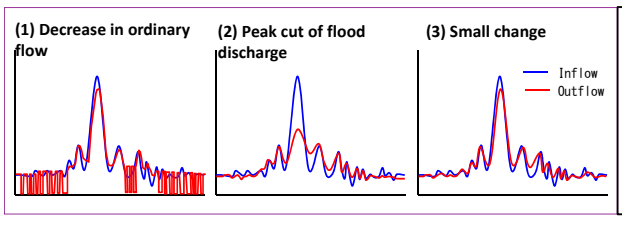
0 : =	0	5 : >	54.60
1 : >	0	6 : >	148.41
2 : >	2.72	7 : >	403.43
3 : >	7.39	8 : >	1,096.63
4 : >	20.09	9 : >	2,980.96

Group of Taxa	Number of Taxa: Upstream biased (a)	No bias (b)	Downstream biased (c)	Evaluation of bias (d)	Evaluation Equation	Criterion for Judgment
Taxon representing very slow flow	0	0	5	∞	d=c/(a+b)	Slow flow at downstream if d>2
Net spinning caddisfly to represent stable river bed	0	3	1	0.33	d=c/(a+b)	Stable bed at downstream if d>2
Taxon represening the existence of sand	4	0	1	4.00	d=a/(b+c)	Less sand at downstream if d>2

5 Correspondence to Implied Environmental Change by Index Taxa among dams with different flow regime change pattern



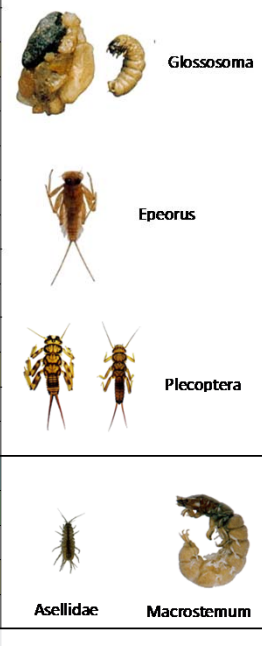
Left: Percentage of datasets which are implied to have slow flow at downstream,
Middle: Percentage of datasets which are implied to have stable riverbed at downstream,
Right: Percentage of datasets which are implied shortage of sand at downstream.



(1) Decrease of ordinary flow,
(2) Significant decrease of the peak of flood discharge,
(3) Small change.

6 Indictor Taxa Emerging Biased at Upstream or Downstream

Group	Taxon	IndVal value	Upstream A	Upstream B	Downstream A	Downstream B	significance (p≦0.01)
Typical at upstream	Drunella	91.64	1,330	16	36	1	**
	Cincticostell	84.50	3,947	17	724	8	**
	Glossosoma	78.38	1,026	14	52	4	**
	Epeorus	77.17	5,346	16	1,174	7	**
	Chloroperlidae	76.47	463	13	0	0	**
	Rhithrogena	64.64	1,905	11	2	1	**
	Perlodidae	61.56	1,228	12	180	4	**
	Capniidae	58.67	1,534	10	4	2	*
	Taeniopterygidae	58.13	1,857	10	22	2	*
	Paraleptophlebia	49.26	1,178	9	88	3	*
	Blephariceridae	40.56	265	7	4	2	*
	Lepidostoma	39.77	282	7	10	1	*
	Cinygmula	35.29	1,924	6	0	0	*
	Perlodidae	29.41	78	5	0	0	*
Typical at downstream	Asellidae	64.71	0	0	498	11	**
	Macrostemum	58.45	50	1	7,828	10	**
	Lumbriculidae	35.29	0	0	324	6	*
	Ceraclea	23.53	0	0	26	4	*
	Ameletus	5.79	84	6	5,310	1	*



- Taxon representing very slow flow
- Net spinning caddisfly to represent stable river bed
- Taxon represening the existence of sand

A: Toal number of individuals
B: Total of points of emergence (max. 17)

IndVal value = (A up or down / ΣA) * (B up or down / 17) * 100

Significance **: Significant for both A and B