Vannføring eller vannkvalitet: hva påvirker bunndyr og begroing?

- en studie fra regulerte og uregulerte elver -

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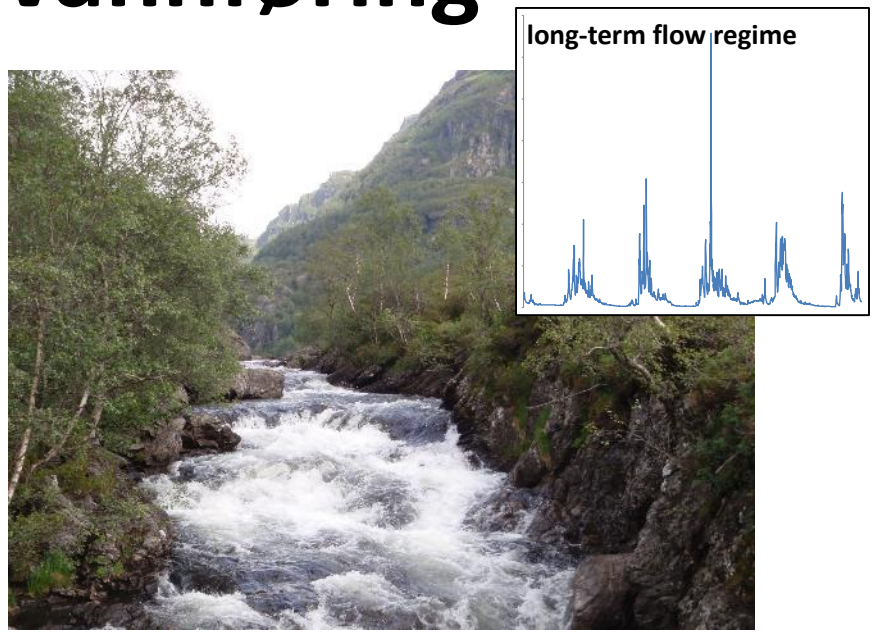
vannføring

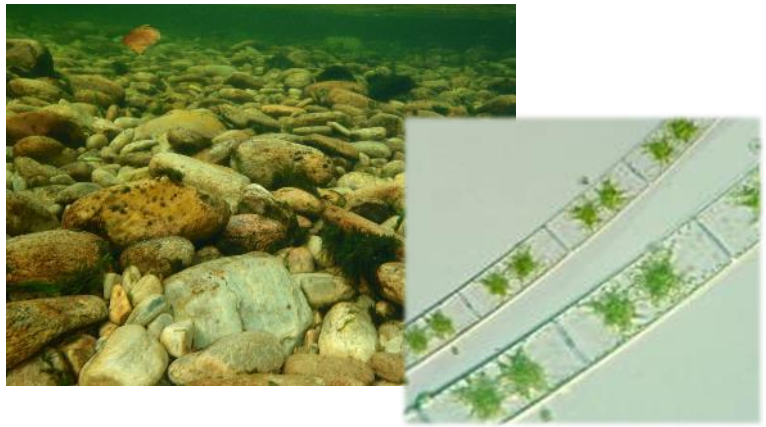


påvirker

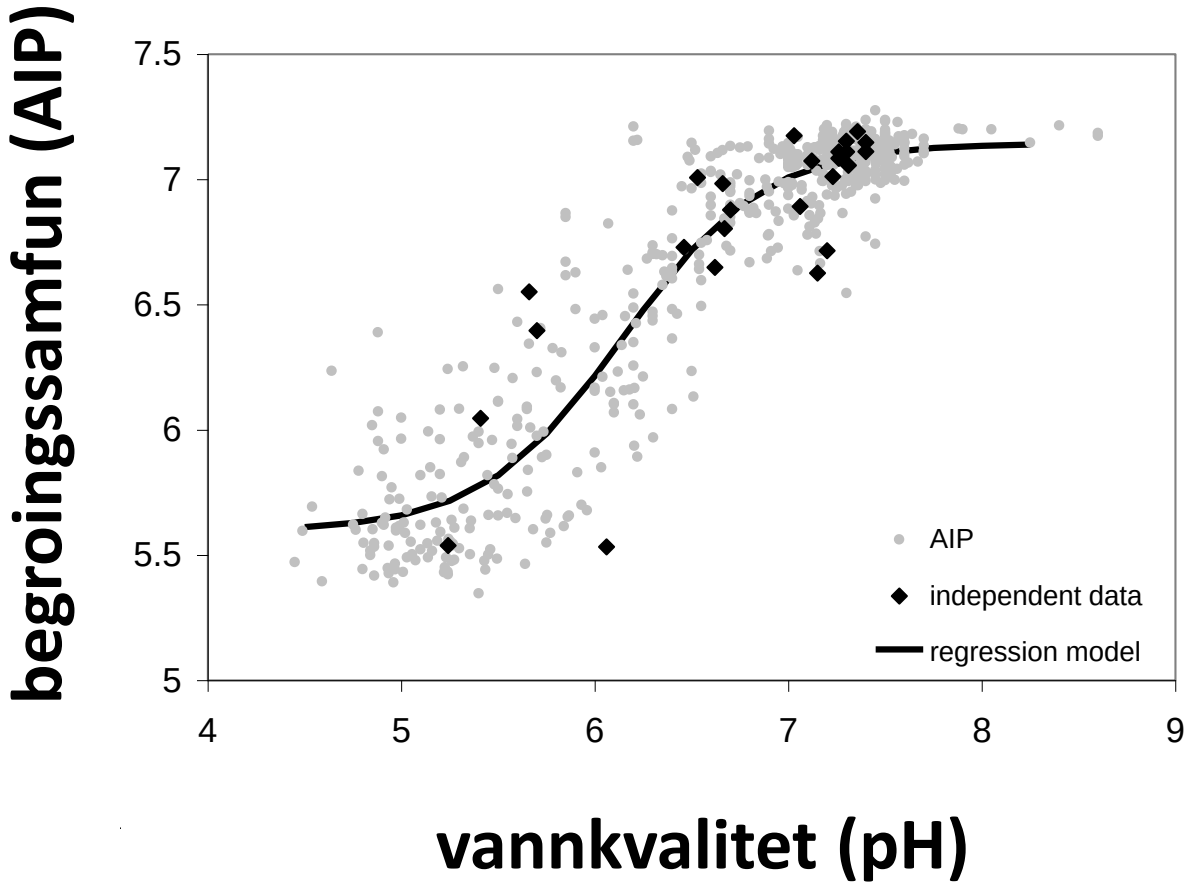
bunndyr

påvirker

begroingsalger

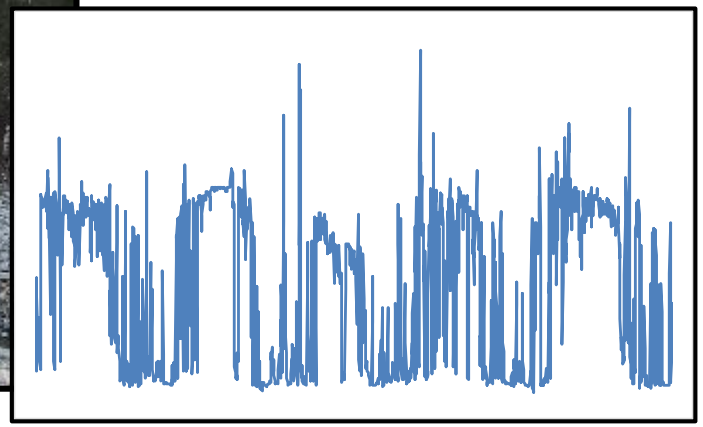


Dette vet vi!!! Hvorfor undersøke??

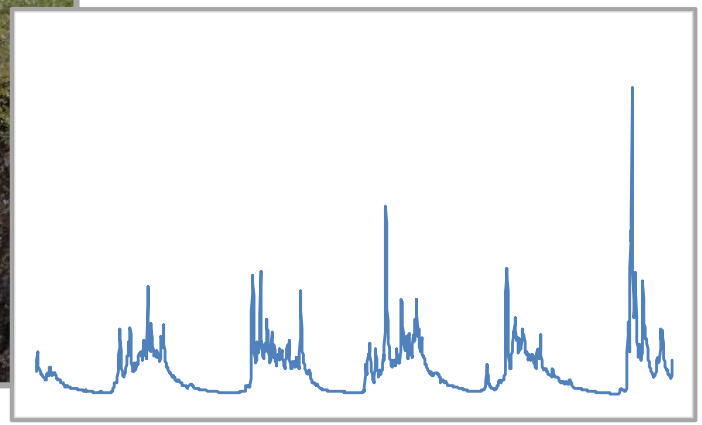


Det vet vi også!!! Hvorfor undersøke??

regulert



uregulert



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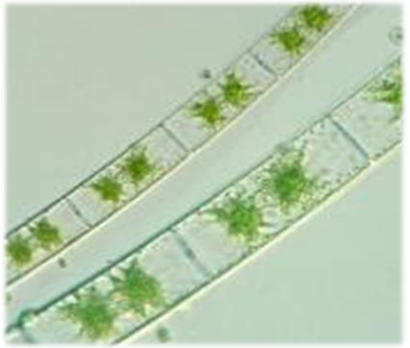
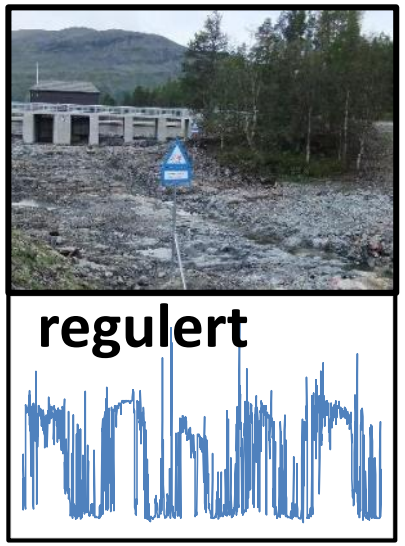
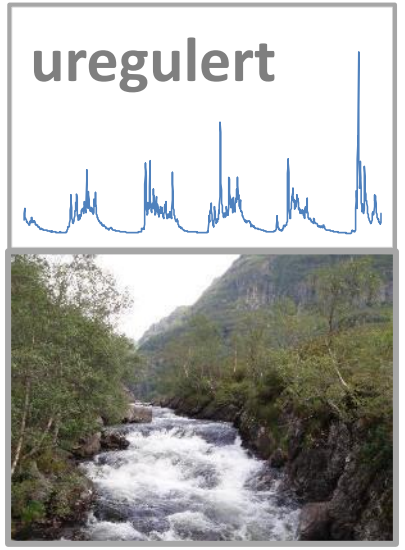
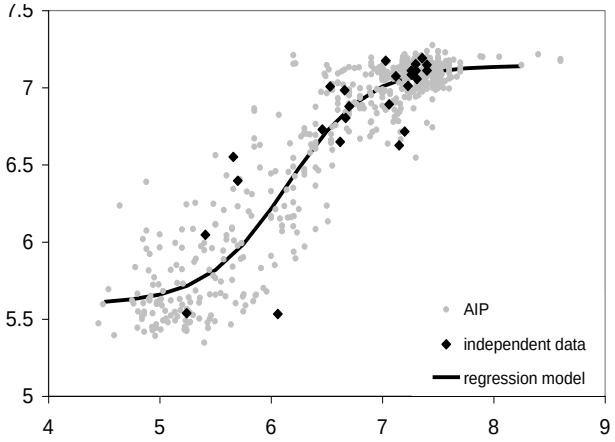




vannføring



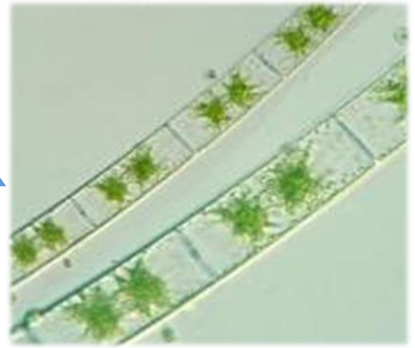


vannkvalitet

(pH, phosphor, nitrogen, …)

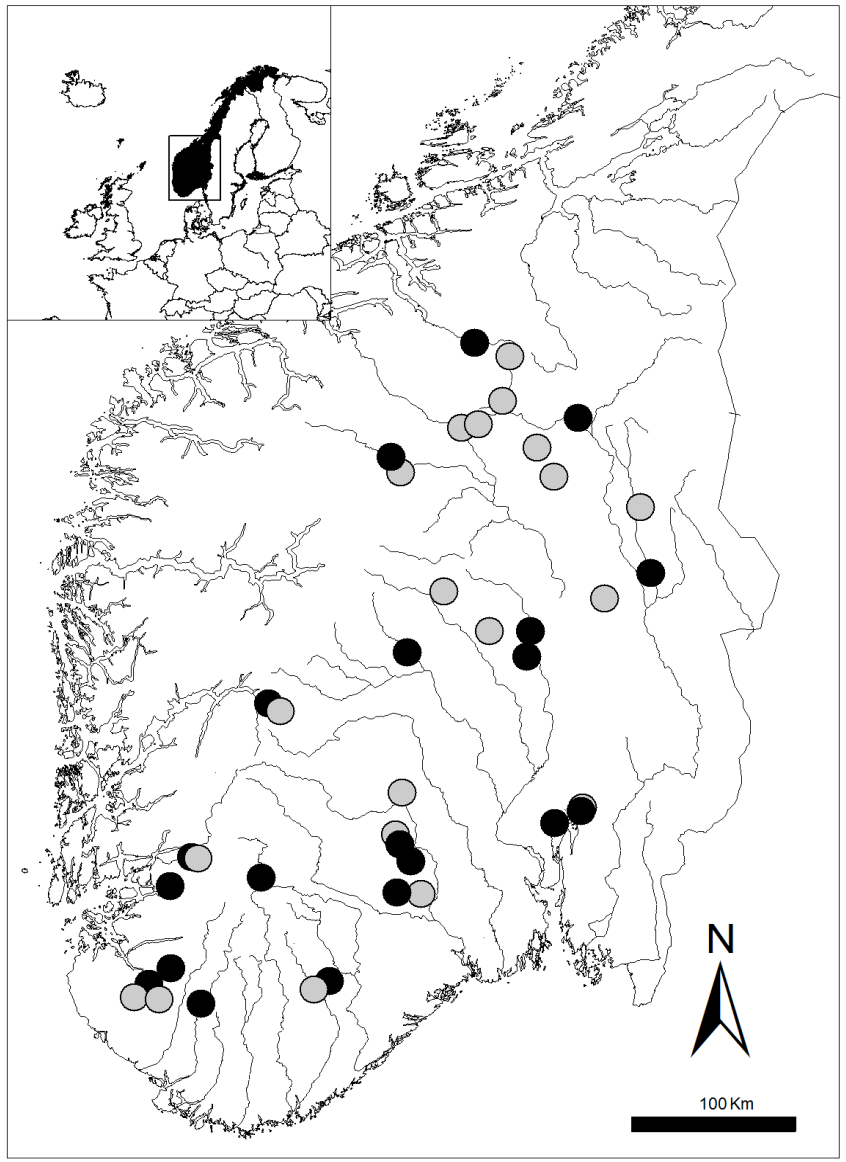
???

???



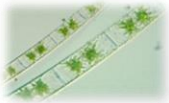
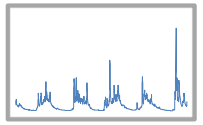
Det meste vi vet om effekter av vannføring på biologi stammer fra renne-eksperimenter

- men en renne er ikke en ekte elv!
- og forsøkene varer som regel bare noen få uker
- hva med rekolonisering?
- finnes det **langsiktige** effekter av et forandret vannførings-regime?
  => det kan vi ikke teste med renne-eksperimenter

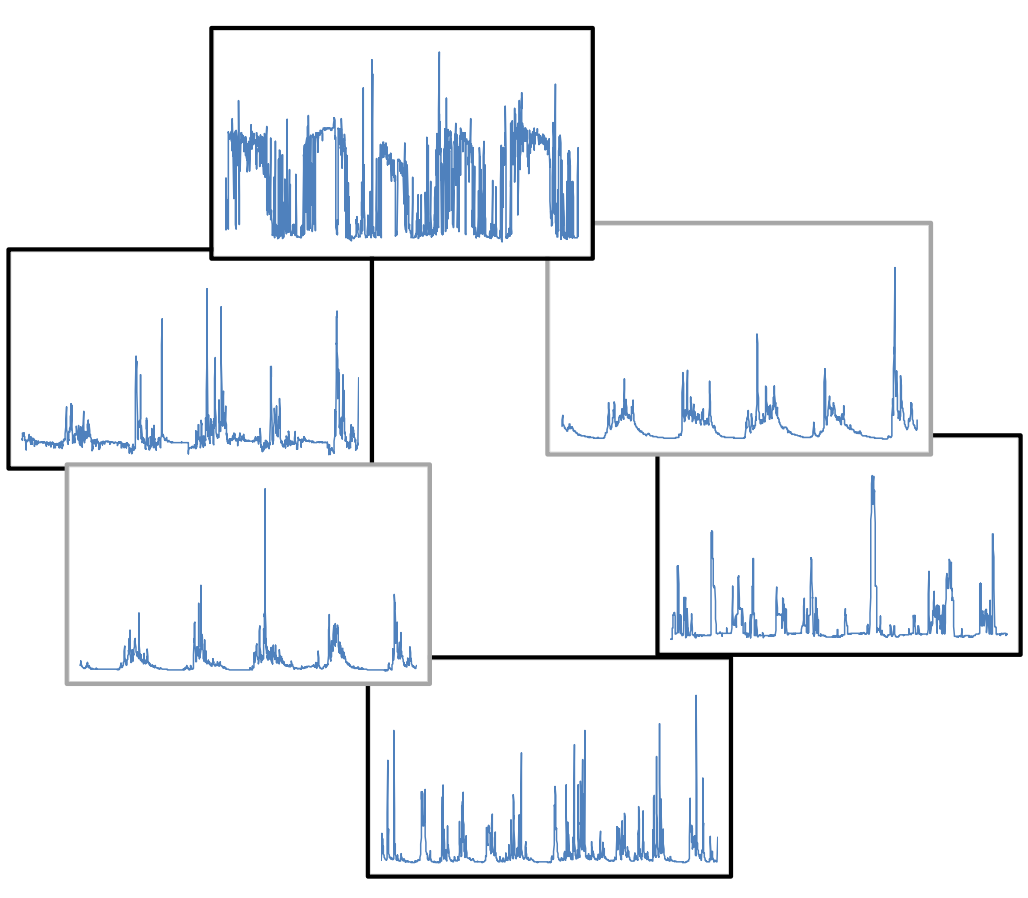


40 stasjoner i elver

● = regulert
○ = uregulert

- bunndyr (1x) 
- begroingsalger (1x) 
- vannkjemi (1x) 
- bunnsubstrat, latitude, longitude, høyde over havet, etc. (1x) 
- vannføring (døgnverdier for 5 år før prøvetaking) 

Hvordan påvirker vannføring bunndyr og begroing?



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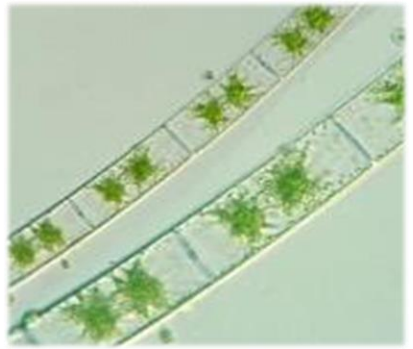
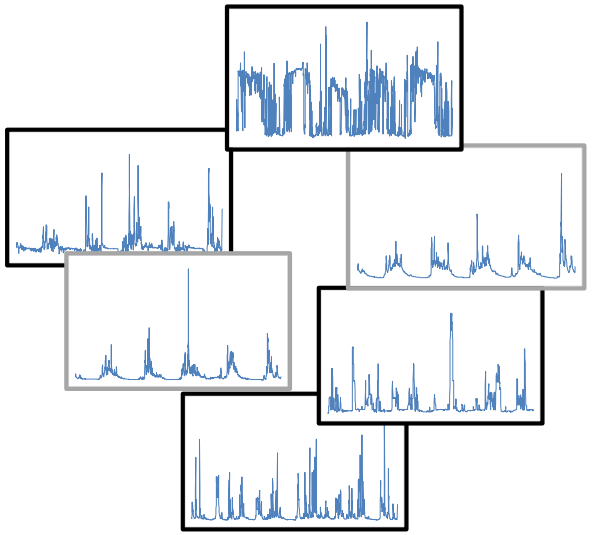


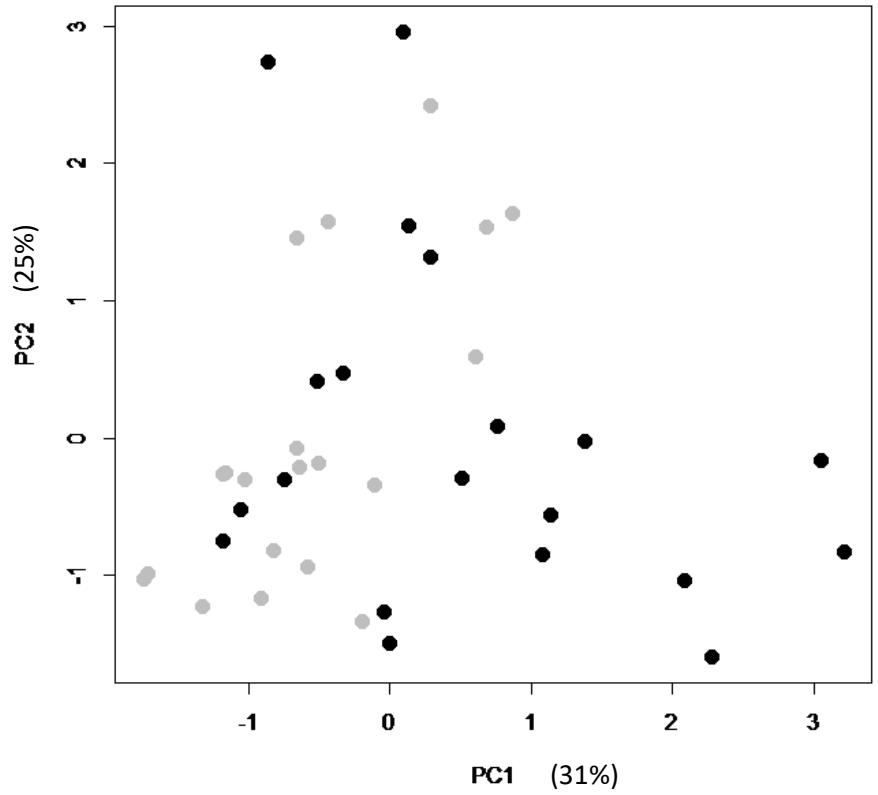


- gjennomsnittlig vannføring
- ekstremverdier
- timing av ekstremverdier
- hvor ofte finnes lav/høy vannføring, og hvor lenge varer det?
- hvor raskt er forandringene?
- base flow index

77 hydrologiske variabler

PCA

flushy rivers
(raske forandringer)



● = regulert
○ = uregulert

stabil vannføring
(små forskjeller mellom ekstremene)

	PC1	PC2
response variables		
species assemblages		
NMDS1 algae	-0.35	-0.41
NMDS2 algae	0.26	0.15
number of taxa algae	0.23	0.10
NMDS1 MI	**0.57**	**0.47**
NMDS2 MI	0.32	**0.46**
number of taxa MI	0.33	-0.12
abundance/biomass		
Chl a µg/cm²	**0.56**	0.37
% cover algae	**0.56**	**0.46**
density MI [ind/m²]	-0.05	**-0.49**
ecosystem functions		
% cyanobacteria with heterocsts	**0.60**	**0.62**
number of grazers / m2	-0.21	**-0.54**
number of shredders / m2	0.29	0.00
number of filter feeders / m2	0.18	-0.21
number of gatherers/collectors / m2	**-0.46**	**-0.74**
ecosystem assessment		
AIP	**-0.60**	**-0.64**
Raddum 2	**-0.53**	**-0.60**
PIT	-0.34	**-0.52**
ASPT	-0.14	**-0.46**
LIFE	**-0.62**	**-0.68**

Massevis av signifikante korrelasjoner mellom vannføring (PCA) og bunndyr/begroing!!

Inkludert indekser som brukes for å indikere vannkvalitet!!

⇨ vannføring påvirker bunndyr og begroing!!

Eller hva … ????

	PC1	PC2
response variables		
species assemblages		
NMDS1 algae	-0.35	-0.41
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	PC1	PC2
explanatory variables other than flow regime		
longitude (east; UTM 32)	-0.21	**-0.52**
latitude (north; UTM 32)	**-0.66**	**-0.88**
dist. to lake/reservoir upstream	**-0.50**	**-0.51**
catchment size	**-0.50**	**-0.51**
altitude (m asl)	-0.41	**-0.64**
Shading (%)	0.30	**0.50**
Tot-P/L [µg P/l]	**-0.48**	-0.26
Tot-N/L [µg N/l]	**0.66**	**0.79**
TOC [mg C/l]	**0.48**	**0.56**
Ca [mg/l]	-0.42	-0.36
conductivity (µs/cm)	-0.15	-0.04
temperature (degree C)	**0.53**	**0.63**
pH	**-0.61**	**-0.57**
% turbulent flow	-0.15	-0.29
average depth (m)	-0.11	-0.08
width (m)	-0.19	-0.22
sediment PC1	0.04	0.14
sediment PC2	-0.33	-0.38

⇨ er det vannføring, eller noen av co-variablene (deriblant vannkvalitet) som påvirker bunndyr og begroing??

Et lurt triks: skille mellom regulerte og uregulerte elver

	unregulated	
	PC1	**PC2**
response variables		
species assemblages		
NMDS1 algae	-0.35	-0.41
NMDS2 algae	0.26	0.15
number of taxa algae	0.23	0.10
NMDS1 MI	**0.57**	**0.47**
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number of taxa MI	0.33	-0.12
abundance/biomass		
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Shading (%)	0.30	**0.50**
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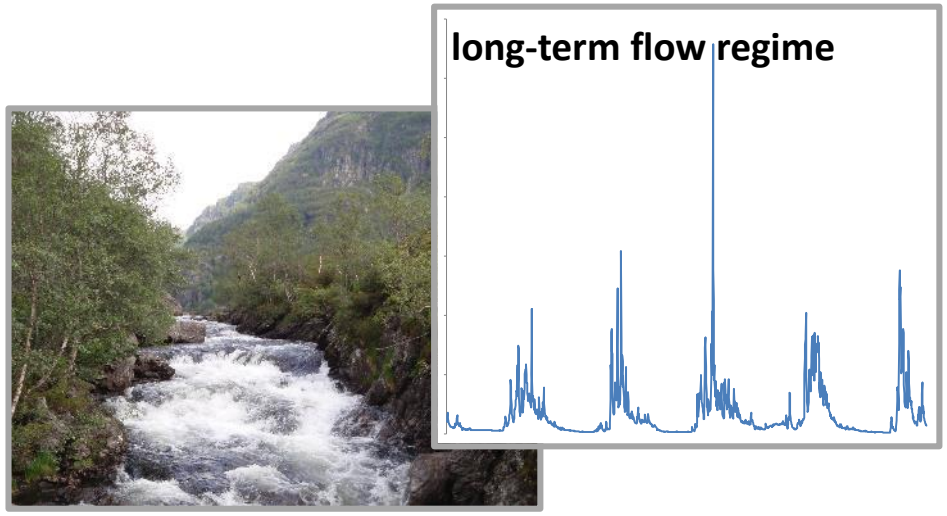
sediment PC1	0.04	0.14
sediment PC2	-0.33	-0.38

⇨ artssammensetning av bunndyr, og LIFE indeksen er påvirket av PC1, latitude, eller temperatur

formula	**Adjusted R2**		**F-statistic**	**p**
NMDS1.MI = -1.06 + 0.09*temperature + 0.12*PC1	0.5545		25.28 on 2 and 37 DF	1.20E-07
Analysis of Variance	**sum of squares**	**mean squares**	**F value**	**P**
temperature	3.9305	3.93	43.9016	8.98E-08
PC1	0.5953	0.60	6.6496	0.01403
Residuals	3.3126	0.09		

formula	**Adjusted R2**		**F-statistic**	**p**
LIFE = -8.05 + 2.360e-06*latitude - 0.146*PC1	0.6151		32.17 on 2 and 37 DF	8.05E-09
Analysis of Variance	**sum of squares**	**mean squares**	**F value**	**P**
latitude	7.1541	7.15	57.7778	4.55E-09
PC1	0.8114	0.81	6.5529	0.01469
Residuals	4.5814	0.12		

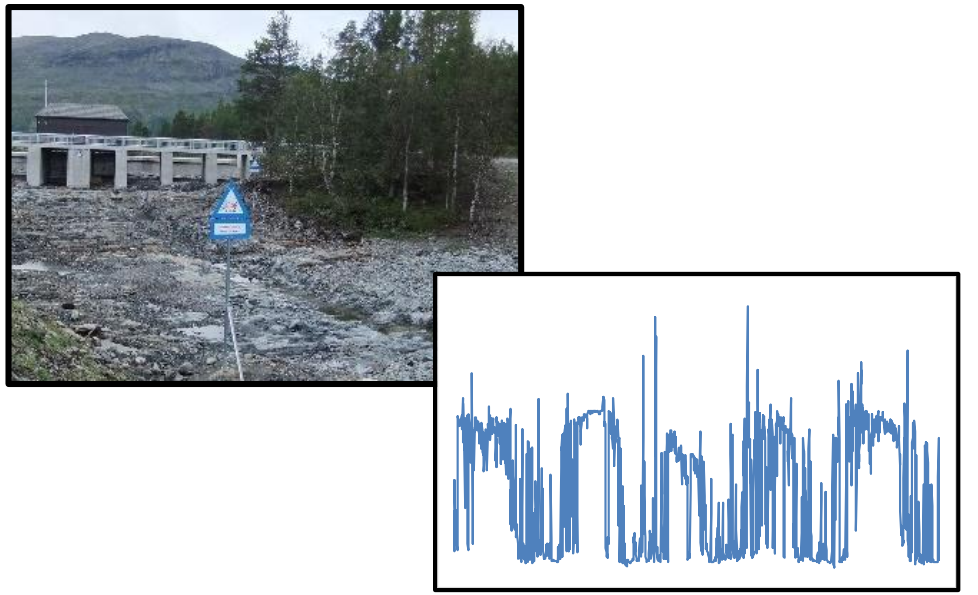
⇨ **PC1** påvirker **artssammensetning av bunndyr** og **LIFE indeksen**, men **ingen av de andre respons-variablene var relatert til vannførings-regime**



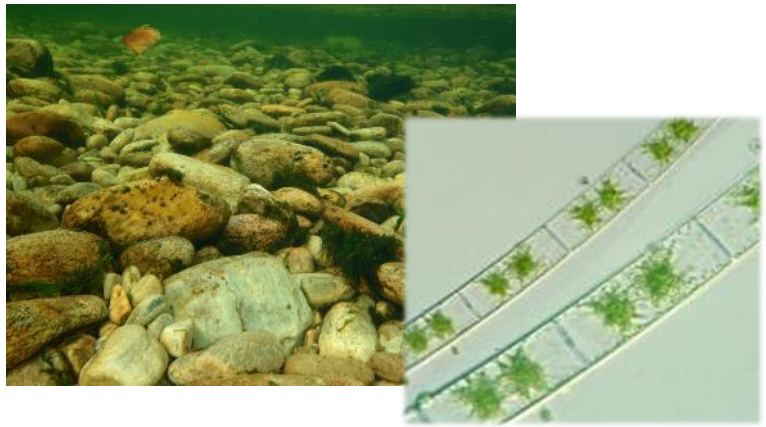
påvirker

bunndyr

konkret:
artssammensetning
og LIFE indeksen



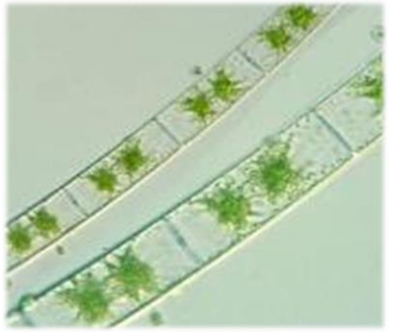
begroingsalger



Da stiller det seg to spørsmål:

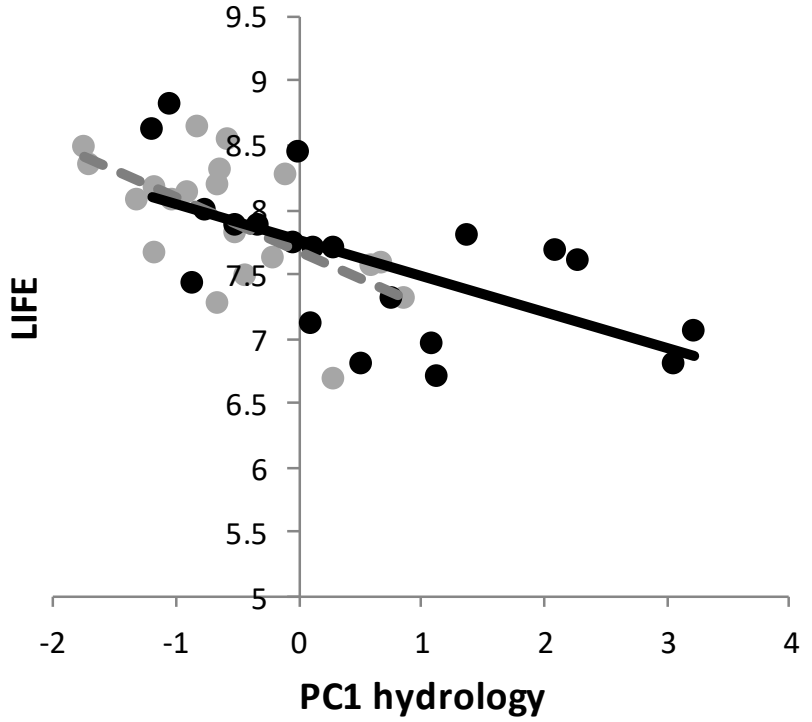
1) Hva i all verden er LIFE indeksen?

2) Hva er alle de andre respons-variablene påvirket av?
   (begroing, andre bunndyr-parametere?)

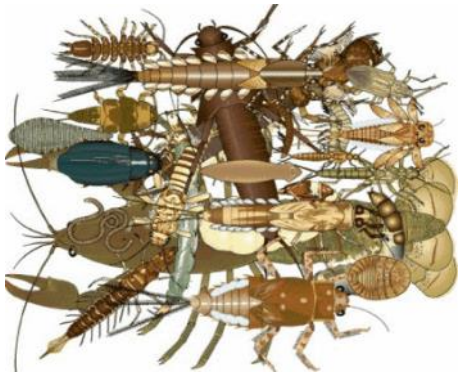


- LIFE = Lotic-invertebrate Index for Flow Evaluation (Extence et al., 1999)
- basert på bunndyr arter som foretrekker ulike vannhastigheter (fra «svært raskt» via «langsomt» til «stillestående»)
- designed to assess changes in prevailing flow regimes
- bunndyrne bryr seg ikke om vannføringen er man-made eller naturlig

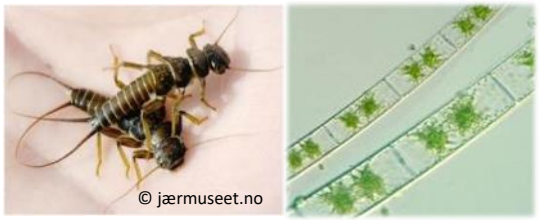
● = regulert
○ = uregulert



artssammensetning av begroingsalger => **kalsium, konduktivitet**



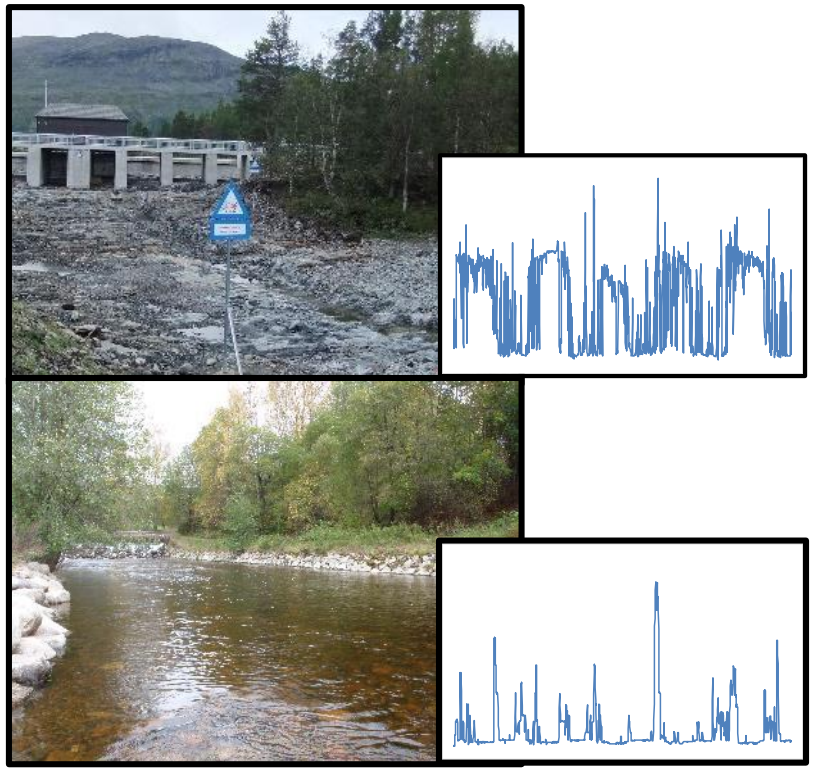
artssammensetning av bunndyr => **temperatur, TOC** (i tillegg til vannføring)

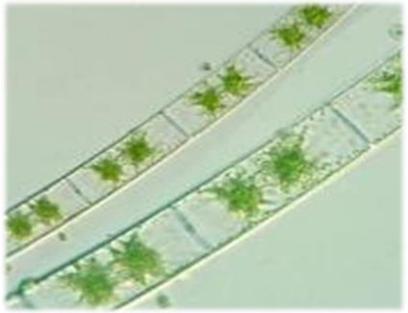


forsuringsindekser Raddum 2 og AIP => **pH**

⇨ **vannkvalitet!**

Bunndyr og begroingsindekser som brukes for tilstandklassifisering i norske elver kan også brukes i regulerte elver.

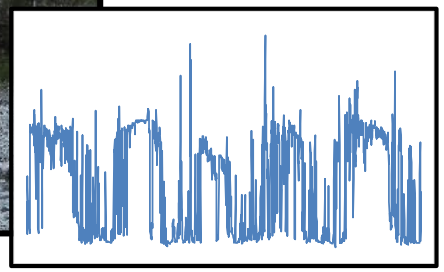




Eutrofiering: PIT
Forsuring: AIP

Organisk belastning: ASPT
Forsuring: Raddum 2

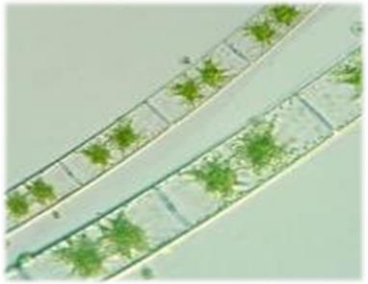
langsiktig vannførings-regime

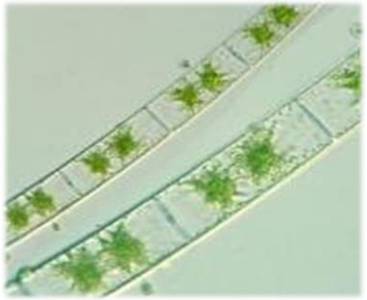


påvirker

og kan overvåkes med LIFE indeksen

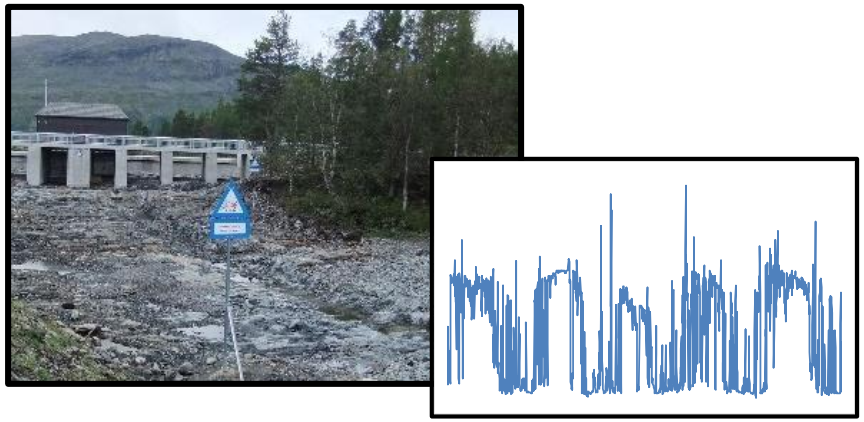
ingen langsiktige effekter





vanlige indekser (som **ASPT**, **PIT**)

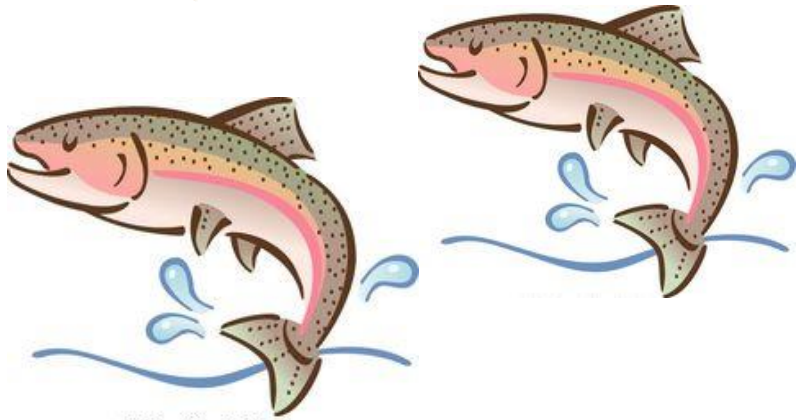
kan brukes

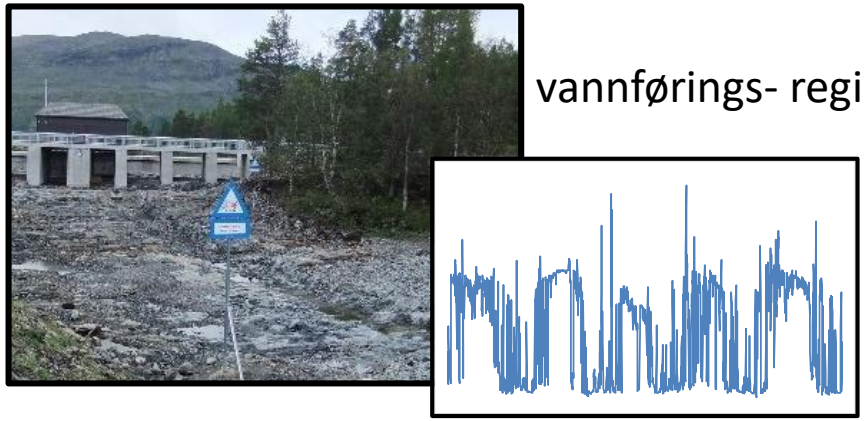


stor elv

liten bekk

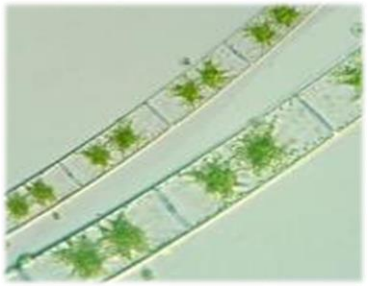
bunndyr og begroingsprøver ble tatt per m^2





vannførings- regime

ingen langsiktige effekter

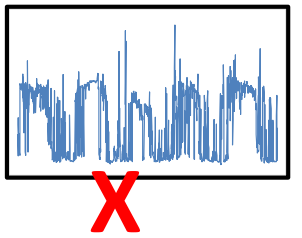


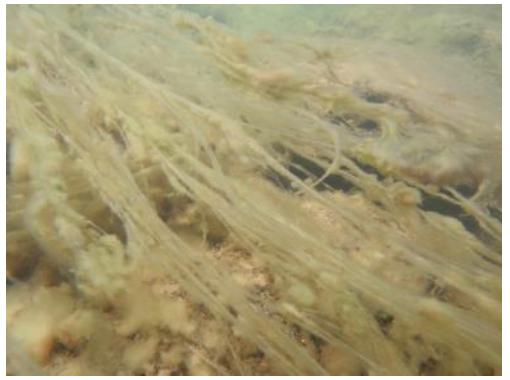
- ⇨ Begroingsalgene (og mange bunndyr respons-variabler) i en «minstevanns-strekning» oppfører seg på samme måte som i en vanlig «liten bekk».
- ⇨ Men det er et faktum at det er en liten bekk og ikke en stor elv lenger

Jeg sa: **vannføringsregime** har ingen langsiktige effekter på begroingsalger

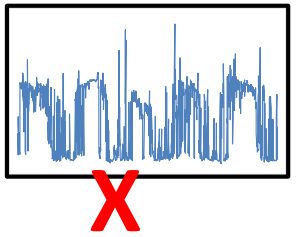
Jeg sa **IKKE: regulering** har ingen langsiktige effekter på begroingsalger

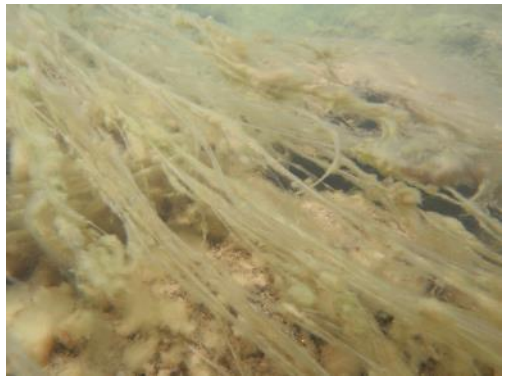
Regulering påvirker ikke bare **vannføring**, men også **vannkvalitet**!





⇨ «utfordringer» nedstrøms utløpet av kraftstasjoner er mest sannsynlig relatert til **vannkvalitet**, ikke til vannføring






Tusen takk!