Crayfish management in the Ljungan river

Managing with shocks

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Ljungan river

Important fishery for noble crayfish in Sweden

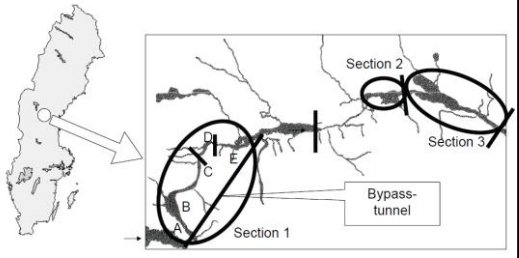
Affected by massive hydropower development in 1976, which had been discussed for years

Huge data collection effort, 1960 – 1990; detailed catch and effort data (however, no data on prices… yet)

After hydro development, catches dropped sharply in affected area

In 1999, disease killed population; reestablishment going on now

Ljungan river



Nice twist

Localised populations but similar biology

Fishing technology largely unchanged 1960 – 1990

Different management regimes along the river

We can see how much the difference in management mattered during the period studied…

…and compare to effects of hydropower shock

Keeping it simple…

We know a fair amount about the biology *now*, but a lot of this was not known to the fishermen at the time

Fishermen used CPUE as main indicator

Assume a simple, Schaefer biological management model

$$N_{t+1} - N_t = rN_t\left(1-\frac{N_t}{K}\right) - C_t = rN_t\left(1-\frac{N_t}{K}\right) - qE_tN_t$$

We know that intrinsic growth >> real interest rate; assume that this *was* known to fishermen, and set discount rate ≈ 0

Assumptions

Assume that Region 2 had sole ownership management

Assume that Region 1 and 3 were somewhere between open access and sole ownership management in fishing effort, $E_i = a_iE_{OA} + (1 - a_i)E_{SO} \quad i = 1,3$

Assume that the "distance" a_i between the two stayed the same throughout the studied period, for both regions

Assume that relative price between fishing effort and price of crayfish $c_{effort} / p_{crayfish}$ stayed the same throughout period

Model

Open access would give $CPUE = c_{effort} / p_{crayfish}$

Sole ownership would give $CPUE = 0.5\ c_{effort} / p_{crayfish} + 0.5\ qK_i$
(where q = catchability coefficient and K_i = carrying capacity in region i)

$K_1 = K_2 = K_3 = K$ before development

K_1 dropped after hydro development; K_2 and K_3 assumed to be unchanged

Model

For Region 2, we get the sole ownership CPUE:

$$CPUE_2 = \frac{qK}{2} + \frac{c}{2p}$$

For Regions 1 and 3, we get

$$CPUE_i = qK\frac{1-a_i}{2} + \frac{1+a_i}{2}\frac{c}{p} = a_i CPUE_{OA} + (1-a_i)CPUE_{SO}$$

For Region 1, after hydro development we get a new, lower K_1

Playing around with the numbers

Using sophisticated, state-of-the-art econometrics (OLS), we estimate

$$CPUE = \alpha_0 + \alpha_1 D_{Region\,1} + \alpha_2 D_{Region\,1\ after\ hydro\ dev} + \alpha_3 D_{Region\,3}$$

$$\frac{qK}{2} + \frac{c}{2p} \quad \frac{a_1}{2}\frac{c}{p} - \frac{a_1 qK}{2} \quad \frac{1-a_1}{2}q(K_{1new} - K) \quad \frac{a_3}{2}\frac{c}{p} - \frac{a_3 qK}{2}$$

OLS results

	Coefficient	SE
$\frac{qK}{2} + \frac{c}{2p}$	20.5975***	0.9047
$\frac{a_1}{2}\frac{c}{p} - \frac{a_1 qK}{2}$	- 6.88197***	1.5670
$\frac{1-a_1}{2}q(K_{1new} - K)$	- 5.25971**	1.7481
$\frac{a_3}{2}\frac{c}{p} - \frac{a_3 qK}{2}$	- 12.0453***	1.3535

Shuffling the numbers about a bit

Loss caused by hydro development – loss caused by poor mgmt

$$< \frac{1}{2}q(K - K_{1new}) - \frac{1}{2}a_1\left(qK_{1new} - \frac{c}{p}\right) = \text{(rearranging terms)}$$

$$= \frac{1}{2}(1-a_1)q(K - K_{1new}) - \frac{1}{2}a_1\left(qK - \frac{c}{p}\right) = 5.25971 - 6.88197$$

$$< 0$$

Conclusions

More research is needed: prices needed for a more serious analysis.

However, even the simple results so far suggest that…
…losses caused by hydropower matter a lot, but…
…losses caused by poor management may matter just as much

Hydropower has a value. Poor management, probably less so

Makes more sense to sort out problems related to management?