Ecosystem-based management: preference heterogeneity and optimal regulations

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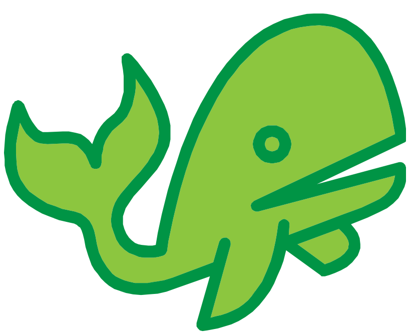


Two issues - one model

- **Preferences**

The need to regulate e.g. industrial acctivities emerges from the fact that the regulator and the regulated have different preferences. With coinciding preferences there is no need to regulate. Hence, a change in preferences for the regulator will change the optimal regulation.

- **Optimal regulation**

Walsh (1995) shows that the optimal regulation of a central banker is linear in the target variable (inflation).

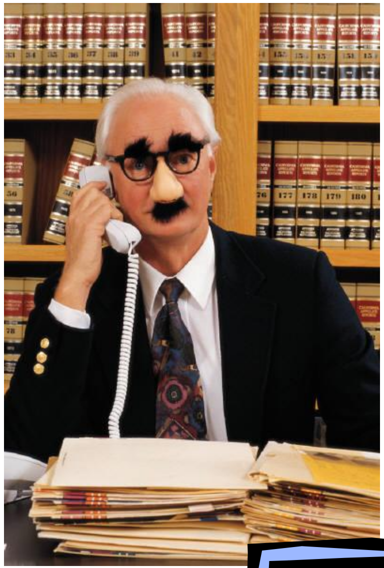
A formal regulator has the right to regulate away all rent

The Walsh contract:

$$W = w_0 + w_1 E$$

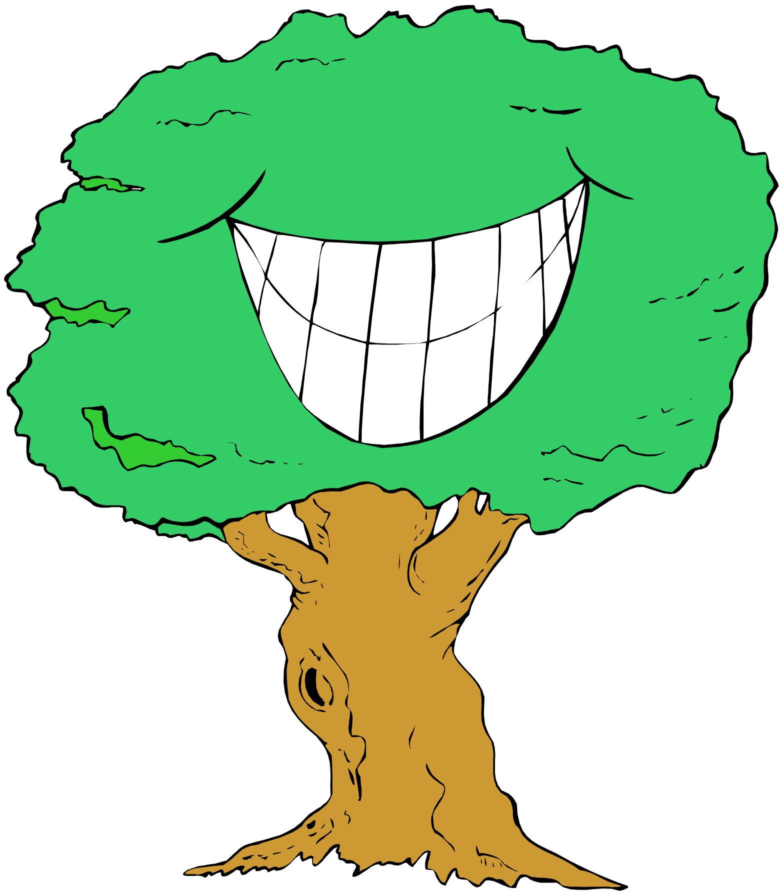
Traditional fisheries management models

- Traditional objective function: economic profit of fisheries activities
- $U = ph(E,X) - C(E)$
- s.t. dX/dt = F(X)-h ≡ 0
- With only economic preferences the long run equilibirum is the MEY harvesting level



New stakeholders with an interest in fisheries management

- ENGOs



- Community organisations

New stakeholders with an interest in fisheries management

- The fishing industry

- Tourist anglers

Recent statements about the Common Fisheries Policy (CFP)

- At a meeting of Agriculture and Fisheries Committees of National Parliaments from EU Member States held in Dublin, Mrs.Maria Damanaki, European Commissioner for Maritime Affairs and Fisheries outlined the current situation with the reform of the Common Fisheries Policy. The EU's Council of Ministers has now agreed a general Approach that includes sustainable fishing by respecting the MSY principle, cessation of discarding and strengthening powers of Regional Advisory Councils to take fisheries management decisions. The European Parliament has endorsed these reforms by a significant majority, and has also endorsed proposals for new external policy and market and labelling policy. The final stages of reform are still to be completed which are to complete the detailed legal measures to implement the political agreements made.

New preferences

ENVIRONMENTAL

- The long run harvest function
- $U = h(E,X) = qEK\left(1 - \left(\frac{qE}{r}\right)\right)$
- With equilibirum harvesting this means the MSY is the optimal long run harvest level

SOCIAL

- The use of effort translated into employment/man-months
- $U = S(E) \equiv sE$
- With only this preference and equilibrium harvesting we end up in the open access equilibrium; max E given the stock growth restriction

Multiple preferences

$$U = h(E, X) + \left(ph(E, X) - C(E)\right) + S(E)$$

Weighting the preferences

$$U = \lambda_1 h(E, X) + \lambda_2\left(ph(E, X) - C(E)\right) + \lambda_3 S(E)$$

Ecosystem-based fisheries management

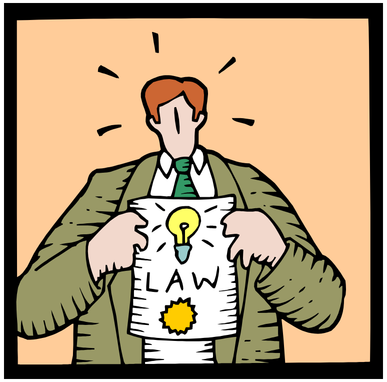
- Giving new stakeholders a say in the fisheries management
- Examples: bird watchers, community organisations, tourist anglers, ENGOs
- The point is that they represent new/other preferences than the authorities, and thus the optimal regulation will change

How may the new stakeholders affect fisheries management?

REGULATION

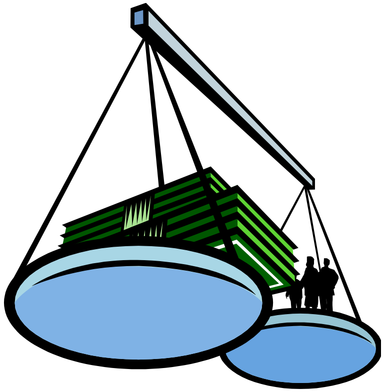
Walsh contract

$$W = w_0 + w_1 E$$



DIRECT INVOLVEMENT

- v, an addition to the harvest costs, (a+v)E



3 examples of multi-preferences fisheries management

- 1: common agency: two symmetric stakeholders regulating fisheries activities under symmetric and asymmetric information. Environmental and economic preferences (JITE 2013)
- 2: the political game of EU-fisheries management: national and EU authorities both trying to manage EU-fisheries (under submission to JPE)
- 3: rampant environmentalists: ENGO interfering (more or less legally) into fisheries activities and management (under revision for Land Economics)

Extended Utility function

$$ENV\text{: } h(E,X) = qKE\left(1 - \frac{qE}{r}\right)$$

$$ECN\text{: } \Pi(E,X) = pqKE\left(1 - \frac{qE}{r}\right) - aE$$

$$SOC\text{: } f(E) = SE$$

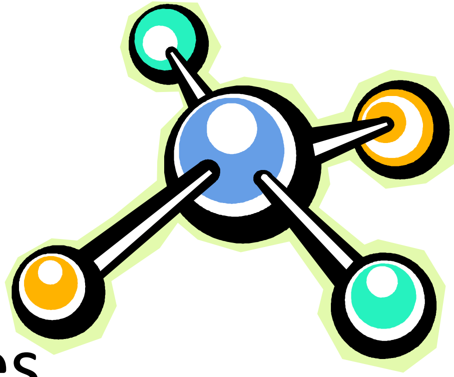
$$U^k = \lambda_1^k PqKE\left(1 - \frac{qE}{r}\right) + \lambda_2^k\left(pqKE\left(1 - \frac{qE}{r}\right) - aE\right) + \lambda_3^k SE$$

Extended objective functions with regulation

$U^k = \lambda_1^k PqKE\left(1 - \frac{qE}{r}\right) + \lambda_2^k\left(pqKE\left(1 - \frac{qE}{r}\right) - (a+v)E\right) + \lambda_3^k SE + \mu({w^k}_0 + {w^k}_1 E)$, k=A,N

$$U^F = \lambda_1^F PqKE\left(1 - \frac{qE}{r}\right) + \lambda_2^F\left(pqKE\left(1 - \frac{qE}{r}\right) - (a+v)E\right) + \lambda_3^F SE - ({w^A}_0 + {w^A}_1 E) - (wN0 + wN1E)$$

The model



- Each regulator with a say in the fisheries management acts as follows: Max $U^k, k = A, N, s.t. U^F \geq 0$, and is allowed to put a regulation upon the fishers
- Formal regulators use a Walsh contract
- Informal regulators, e.g. ENGOs, use direct involvement
- The fishers act as follows: max U^F given the regulations
- The model is solved by the use of the Lagrange method for conditioned maximisation

The preferences

	Ecology	Economy	Society
Industry	0.36	0.36	0.28
National authorities	0.5	0.28	0.22
EU authorities	0.48	0.29	0.23
NGO	0.44	0.3	0.26
Scientists	0.42	0.28	0.29

Source: Aanesen, Armstrong, Bloomfield and Rockmann (under revision for Society and Ecology

Model 1: Environmental and social preferences

- $U^F = (pg(E,X) - aE^2)$ -$(t_0 + t_1 E)$
- $U^k = \lambda_1^k Ph(E,X) + \lambda_2^k (pg(E,X) - aE^2) + \mu(t^k{}_0 + t^k{}_1 E)$, k=A,N

- Giving a new stakeholder with higher environmental and weaker social preferences a say in the management increases the regulation pressure and the equilibrium stock

Model 1:
Environmental and social preferences

$$w_1^* = \frac{-\lambda_1^{MS} h'_E + \gamma g'_E N}{\mu + \lambda_2^{MS}}$$

$$t_1^R = -\frac{\lambda_2^{MS}}{\mu + \lambda_2^{MS}} \tau_1 + \frac{-\lambda_1^{MS} h'_E + \gamma g'_E N}{\mu + \lambda_2^{MS}}$$

$$\tau_1^R = -\frac{\lambda_2^{NGO}}{\eta + \lambda_2^{NGO}} t_1 + \frac{-\lambda_1^{NGO} h'_E + \varphi g'_E N}{\eta + \lambda_2^{NGO}}$$

$$t_1^* + \tau_1^* = \frac{-(\mu\lambda_1^{NGO} + \eta\lambda_1^{MS}) h'_E + (\eta\gamma + \mu\varphi) g'_E N}{\eta\lambda_2^{MS} + \mu\lambda_2^{NGO} + \eta\mu}$$

Optimal regulation under asymemtric information

One regulator

$$r_{1L}{}^{*} = \frac{-\lambda_1{}^{MS} h'_{EL} + g'_{EL}\ \gamma N}{\lambda_2{}^{MS} + \mu}$$

$$r_{1H}{}^{*} = \frac{-\lambda_1{}^{MS} h'_{EH} + g'_{EH}\left(p\mu Q + \gamma N\right)}{\lambda_2{}^{MS} + \mu(Q+1)}$$

Two regulators

$$v_{1L}{}^{R} = -\frac{\lambda_2{}^{MS}}{\mu + \lambda_2{}^{MS}}\upsilon_{1L} + \frac{-\lambda_1{}^{MS} h'_{EL} + g'_{EL}\ \gamma N}{\mu + \lambda_2{}^{MS}}$$

$$\upsilon_{1L}{}^{R} = -\frac{\lambda_2{}^{NGO}}{\eta + \lambda_2{}^{NGO}} v_{1L} + \frac{-\lambda_1{}^{NGO} h'_{EL} + g'_{EL}\ \varphi N}{\eta + \lambda_2{}^{NGO}}$$

$$v_{1H}{}^{R} = -\frac{\lambda_2{}^{MS} + \mu Q}{\lambda_2{}^{MS} + \mu(Q+1)}\upsilon_{1H} + \frac{-\lambda_1{}^{MS} h'_{EH} + g'_{EH}\left(p\mu Q + \gamma N\right)}{\lambda_2{}^{MS} + \mu(Q+1)}$$

$$\upsilon_{1H}{}^{R} = -\frac{\lambda_2{}^{NGO} + \eta Q}{\lambda_2{}^{NGO} + \eta(Q+1)} v_{1H} + \frac{-\lambda_1{}^{NGO} h'_{EH} + g'_{EH}\left(p\eta Q + \varphi N\right)}{\lambda_2{}^{NGO} + \eta(Q+1)}$$

Model 1: Asymmetric information

- PROPOSITION 4 The inclusion of a new stakeholder may contribute to information revelation not being an optimal strategy even if this was the case with one regulator.
- PROPOSITION 5 Under asymmetric information and given that information revelation is an optimal strategy, the type-dependent regulations become more equal when a new stakeholder with stronger environmental interests and weaker economic interests is given a say in the fisheries regulation.

Model 2:
The political game of EU fisheries management

- $U^k =$
$\lambda_1^k PqKE\left(1-\frac{qE}{r}\right)+\lambda_2^k\left(pqKE\left(1-\frac{qE}{r}\right)-aE\right)+\lambda_3^k\, SE+\mu(w^k{}_0+w^k{}_1E)$
  k=A,N

- $U^F=\lambda_1^F PqKE\left(1-\frac{qE}{r}\right)+\lambda_2^F\left(pqKE\left(1-\frac{qE}{r}\right)-aE\right)+\lambda_3^F SE$
$-(w^A{}_0+w^A{}_1E)$-($w^N{}_0$ +$w^N{}_1$E)

- Both regulators apply the Walsh contract

Model 2: The political game of EU fisheries management

- $t_1^R = -\frac{\Gamma^A - \mu\Gamma^F}{\Gamma^A} v_1 + \frac{Q^A\Gamma^F - Q^F\Gamma^A}{\Gamma^A}$

- $v_1^R = -\frac{\Gamma^N - \eta\Gamma^F}{\Gamma^N} t_1 + \frac{Q^N\Gamma^F - Q^F\Gamma^N}{\Gamma^A}$

$$v_1^* + t_1^* = \frac{\mu(Q^N\Gamma^F - Q^F\Gamma^N) + \eta(Q^N\Gamma^F - Q^F\Gamma^N)}{(\mu\Gamma^N + \eta\Gamma^A - \eta\mu\Theta^F)}$$

Model 2:
The political game of EU fisheries management

	One regulator	Two regulators
Unit regulation authorities	-44	-40
Unit regulation EU	-	-40
Aggregate unit regulation	-44	-80
Effort level	29 535	29 950

Model 2: The political game of EU fisheries management

	One regulator	Two regulators
Unit regulation authorities	1023	690
Unit regulation EU	-	700
Aggregate unit regulation	1023	1390
Effort level	31 700	27 400

Industry has lower economic and higher social preferences than given in the survey

Model 3: Rampant Environmentalists

- $U^k = \lambda_1^k PqKE\left(1 - \frac{qE}{r}\right) + \lambda_2^k\left(pqKE\left(1 - \frac{qE}{r}\right) - (a+v)E\right)$
$+\lambda_3^k SE + \mu(w_0 + w_1 E)$, k=A

- $U^k = \lambda_1^k PqKE\left(1 - \frac{qE}{r}\right)$, k=ENGO

- $U^k = \lambda_1^k PqKE\left(1 - \frac{qE}{r}\right) + \lambda_2^k\left(pqKE\left(1 - \frac{qE}{r}\right) - (a+v)E\right)$
$+\lambda_3^k SE + (w_0 + w_1 E)$, k=F

Model 3: Rampant Environmentalists

$$w^R = \frac{\lambda_2^A \Gamma^F - \lambda_2^F \Gamma^A}{\Gamma^A + \mu \Gamma^F} v + \frac{Q^A \Gamma^F - Q^F \Gamma^A}{\Gamma^A + \mu \Gamma^F}$$

$$v^R = -\frac{1}{\lambda_2^F} w - \frac{Q^F}{\lambda_2^F}$$

$$w^{**} + v^{**} = \frac{Q^A(\lambda_2^F - 1) - Q^F(\lambda_2^A + \mu)}{\lambda_2^A + \mu \lambda_2^F}$$

Model 3: Empirical results

	One regulator	Environmentalist interference
Unit regulation authorities	-23	-2
Unit regulation ENGO	-	-390
Aggregate unit regulation	-23	-392
Optimal effort level	29 550	29 950

Model 3: Empirical results

	One regulator	Environmentalist interference
Unit regulation authorities	670	840
Unit regulation ENGO	-	2600
Aggregate unit regulation	670	3440
Optimal effort level	31 700	29 950

Industry has lower economic and higher social preferences than in the survey

Summarising

- Extending the number of stakeholders with a say in the management of a natural resource will change the optimal regulation if the new stakeholder(s) hold other preferences than that of the incumbent regulator
- Including stakeholders who are concerned about ecological aspects other than those of the incumbent regulator may be a way towards ecosystembased (fisheries) management

Harvest function

- Short term harvest function: $h(E,X)=qEX$
  - $X=h/(qE)$
- Logistic growth function: $F(X)=rX(1-(X/K))$
  - Insert for $X=h/(qE)$
- Long run harvest function: $h(E) = qEK(1-(qE/r))$
- Equilibrium stock: $X=K(1-(qe/r))$

Equlibrium harvesting and stock and logistic stock growth

$$\dot{X} = F(X) - h(X, E) \equiv 0$$

$$X = K\left(1 - \frac{qE}{r}\right)$$

$$F(X) = rX(1 - \frac{X}{K})$$

$$h(E, X) = qKE\left(1 - \frac{qE}{r}\right)$$