Moving from Fisheries Economics to Ocean Economics
Expanding bioeconomic fisheries models

Claire W. Armstrong, et al.

Contributed presentation at the 60th AARES Annual Conference,
Canberra, ACT, 2-5 February 2016

UiT

THE ARCTIC UNIVERSITY OF NORWAY

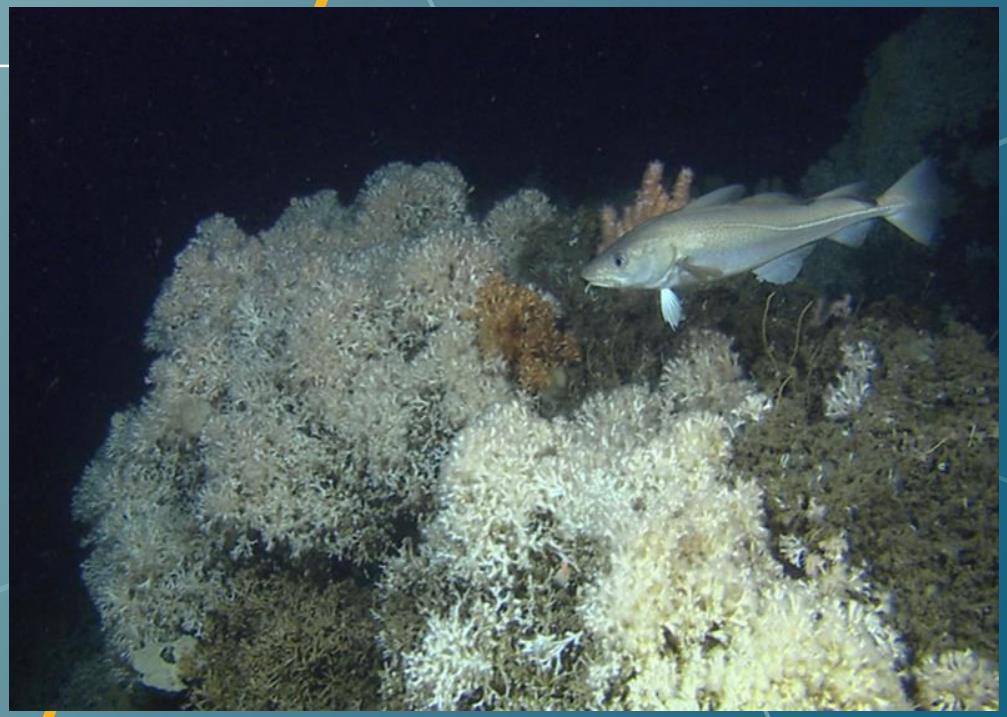
Moving from Fisheries Economics to Ocean Economics

Expanding bioeconomic fisheries models

Claire W. Armstrong and MANY more!

Norwegian College of Fishery Science,
The Arctic University of Norway

AARES, Canberra, 2016




Source: Institute of Marine Research, Bergen

Video picture from Sørmannsneset, Norway, 220 m depth (16. mai 1998), showing the crushed remains of Lophelia cold water coral spread over the area, due to trawling.

30-50% of CWC habitats in Norwegian waters have been destroyed or impacted av (Fosså et al 2002, *Hydrobiologia*)

Aims

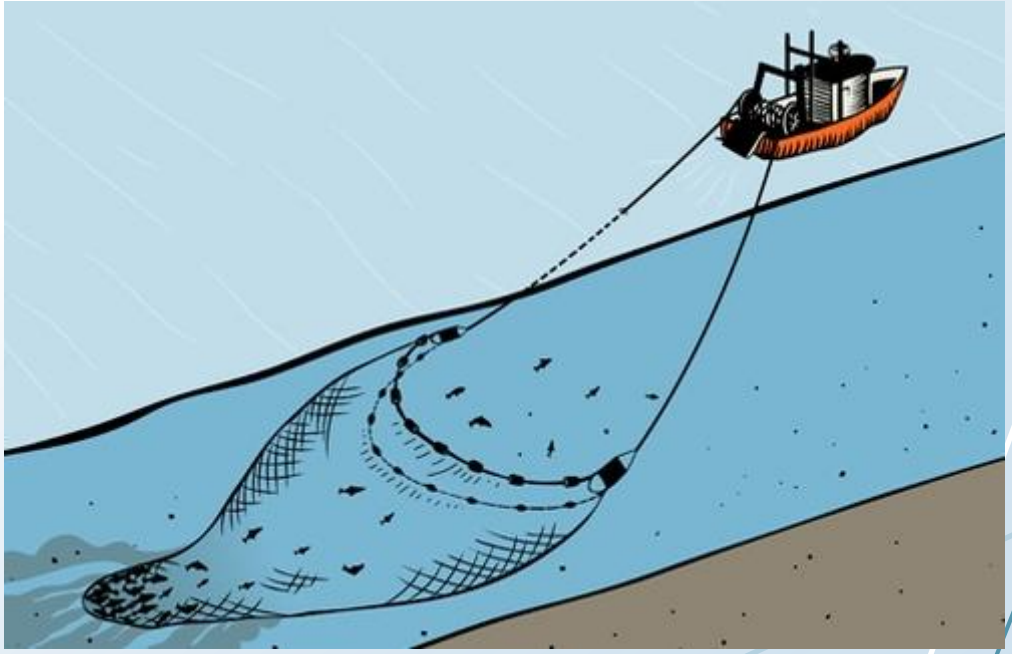
- Broader bioeconomic model than purely fisheries
- Ecosystem based – include habitat
- Ecosystem services – include non-use values of habitat

=> Combine valuation and bioeconomic modelling for more holistic model of marine ecosystem service

Millennium Ecosystem Assessment (2005)

Model of endogenous habitat change

- Fishery-habitat interaction; growth and cost
- Two gear types – habitat destructive and non-destructive
- Non-renewable habitat



$$\Pi = \int_0^\infty e^{-\delta t}\left[\overbrace{\left(p - c_1(X,H)\right)h_1}^{\text{Trawling}} + \overbrace{\left(p - c_2(X,H)\right)h_2}^{\text{Gill netting}}\right]dt$$

$$\frac{dX}{dt} = F(X) - h_1 - h_2$$

a) Habitat is preferred

$$\frac{dX}{dt} = F(X,\underline{H}) - h_1 - h_2$$

b) Habitat is essential

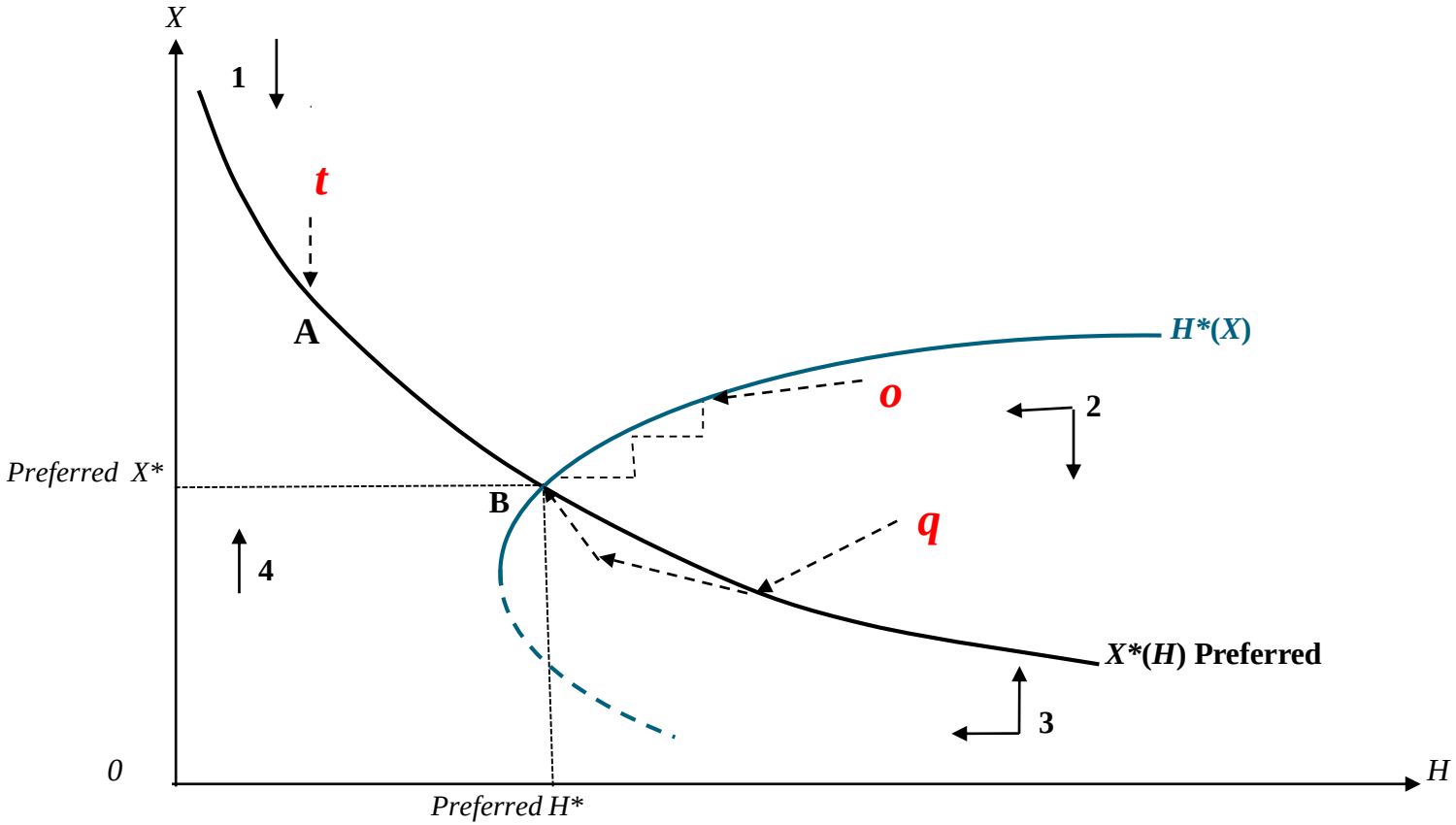
$$\frac{dH}{dt} = -\alpha h_1$$

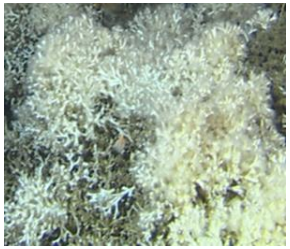
Nonrenewable habitat

X is the biomass of fish stock
H is the habitat
F is the stock growth
h_i is harvest (i harvesters; 1 and 2)
c_i is unit cost of harvest
p is unit price of harvest
α is the coefficient of habitat destruction perpetrated by harvest type 1
δ is the discount rate

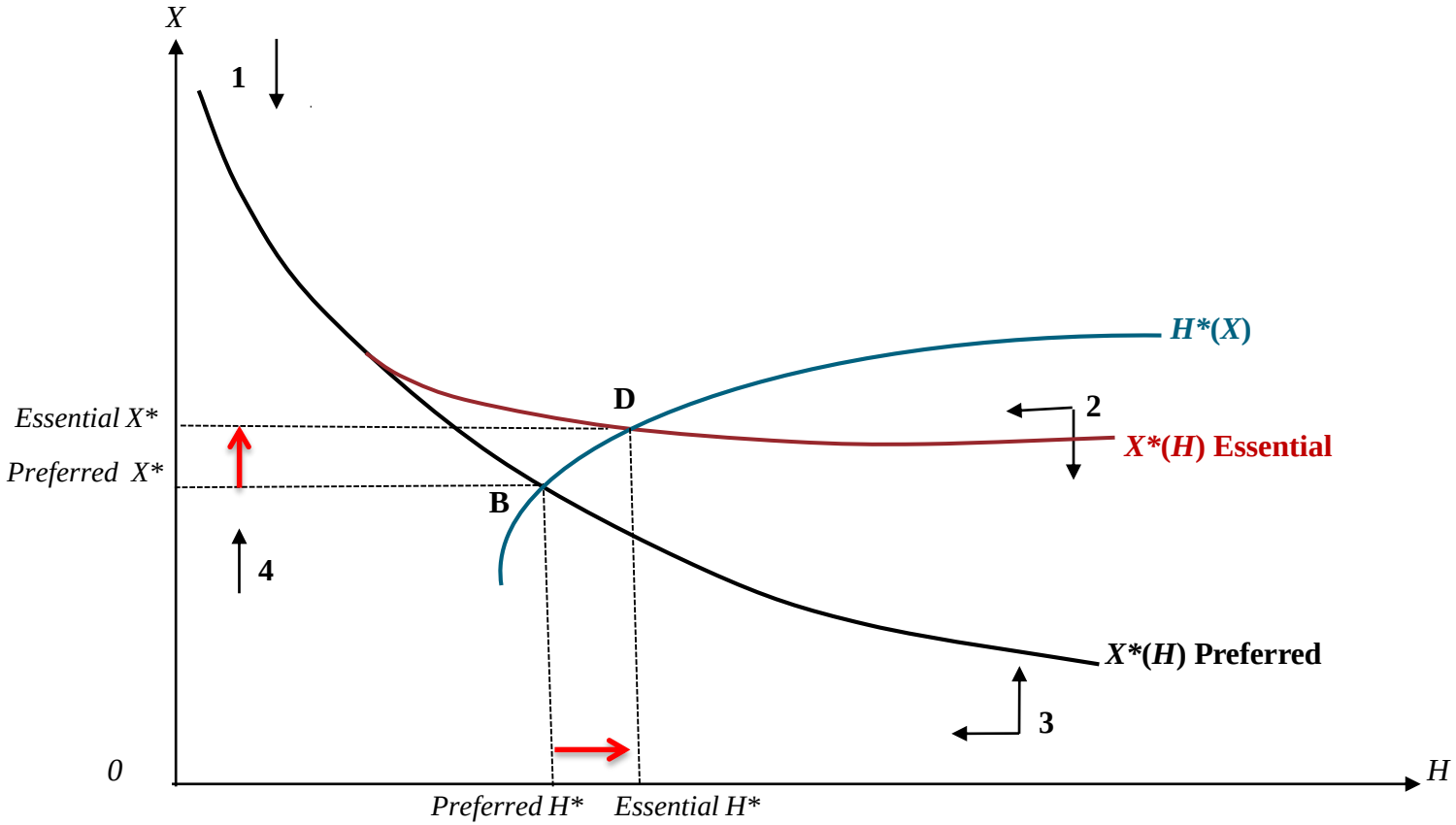
Kahui et al (forthcoming Land Economics), based on Swallow in JEEM (1990)

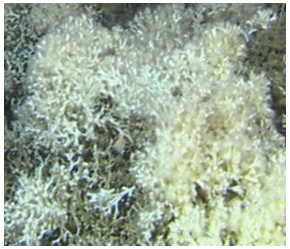
Steady state analysis – preferred model





Steady state analysis – preferred and essential models

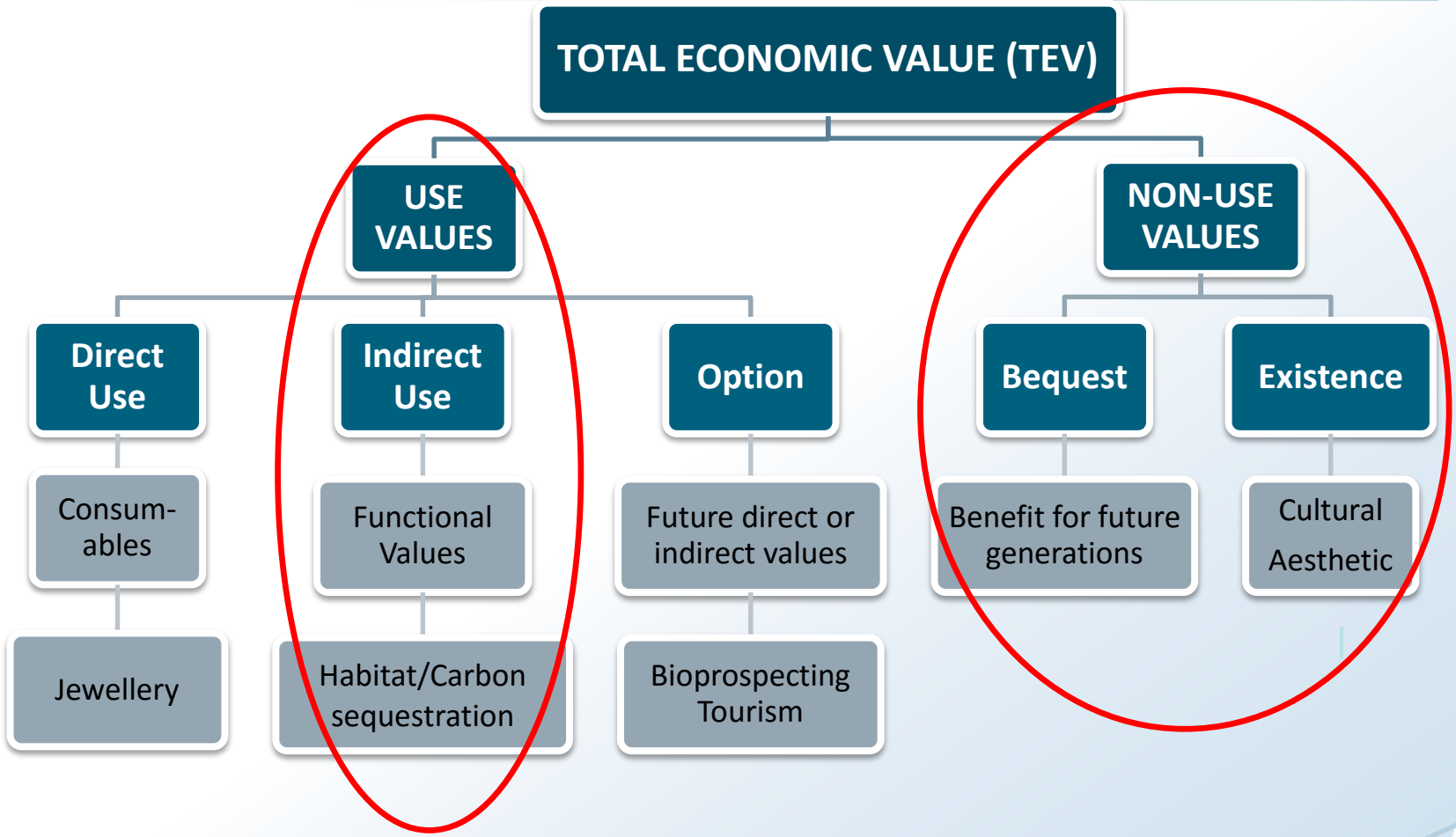




So far CWC as habitat provider….

But what other services might cold water corals supply?

Components of TEV associated with CWC



Existence values

Existence values

How manage fisheries when taking into account these values?

Adding non-fishery values $V(H)$:

$$\Pi = \int_0^\infty e^{-\delta t}\left[\left(p - c_1(X,H)\right)h_1 + \left(p - c_2(X,H)\right)h_2 + V(H)\right]dt$$

$$\frac{dX}{dt} = F(X) - h_1 - h_2$$

Habitat is preferred

$$\frac{dH}{dt} = -\alpha h_1$$

Nonrenewable habitat

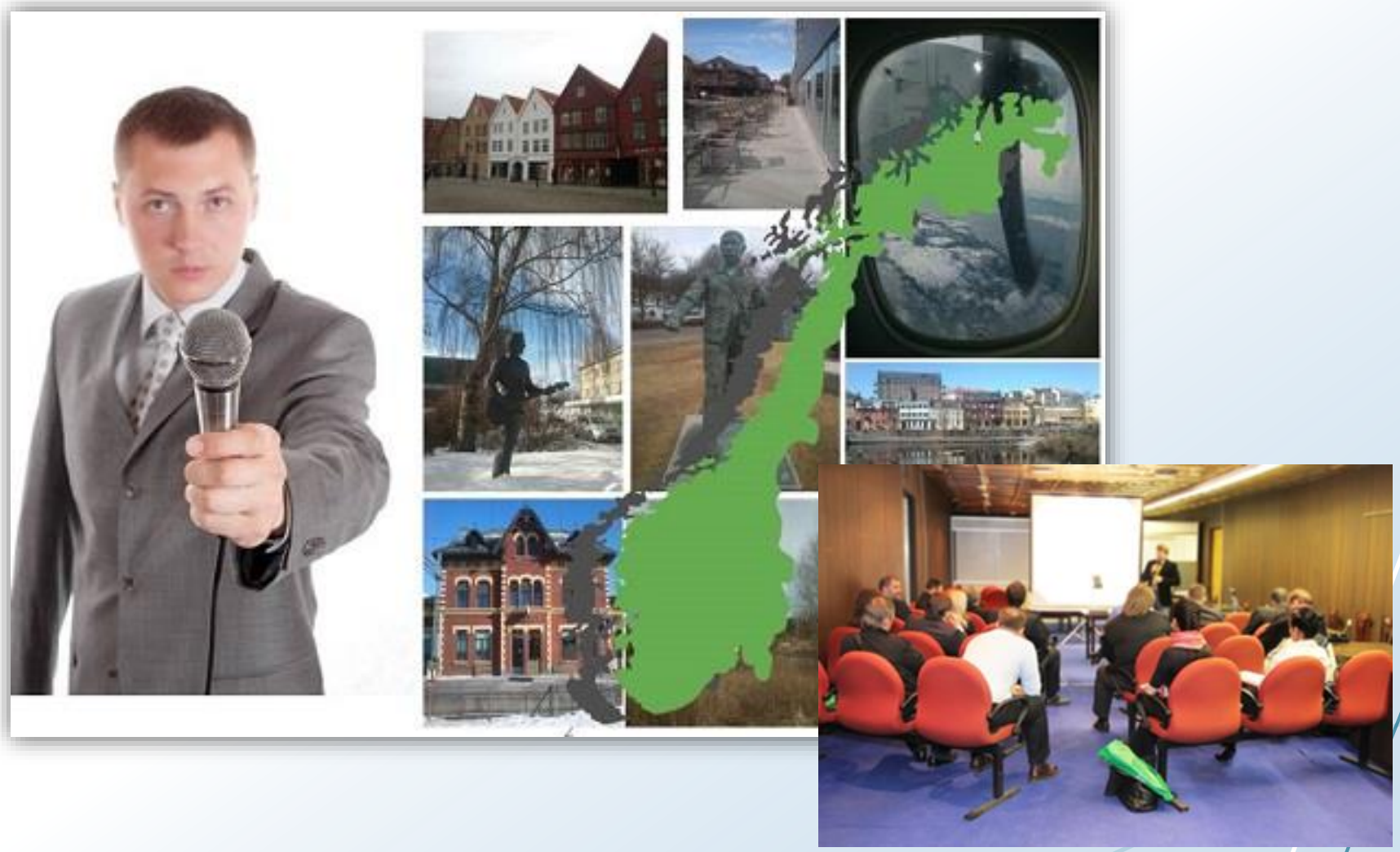
F(X,H) is the stock growth
X is the biomass of fish stock
H is the habitat
h_i is harvest (i harvesters; 1 and 2)
c_i is unit cost of harvest
p is unit price of harvest
α is the coefficient of habitat destruction perpetrated by harvest type 1
δ is the discount rate
V(*H*) is the non-use value function

But what functional form does *V*(*H*) have, if it exists?

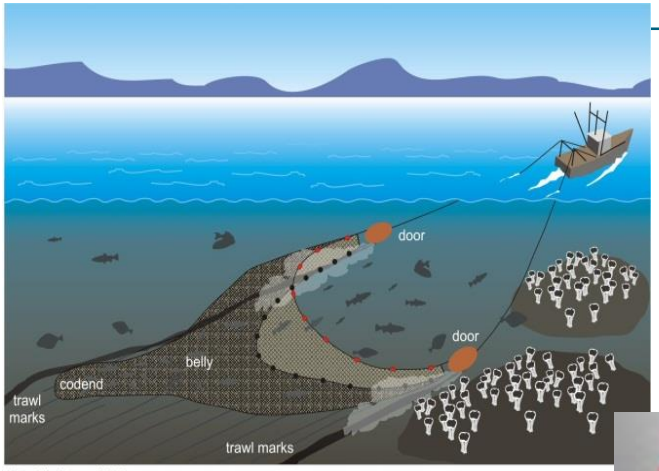
"I don't know why I don't care about the bottom of the ocean, but I don't."

New Yorker

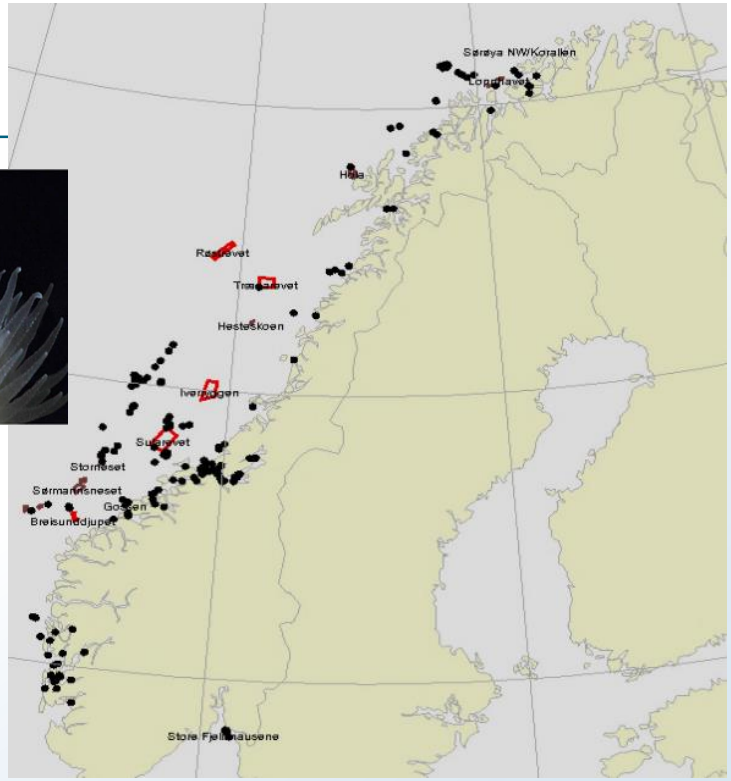
Discrete Choice Experiment - workshops

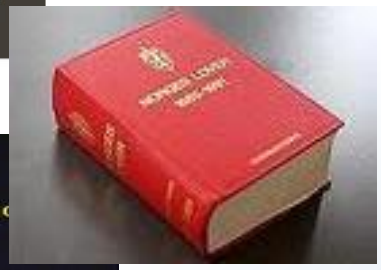


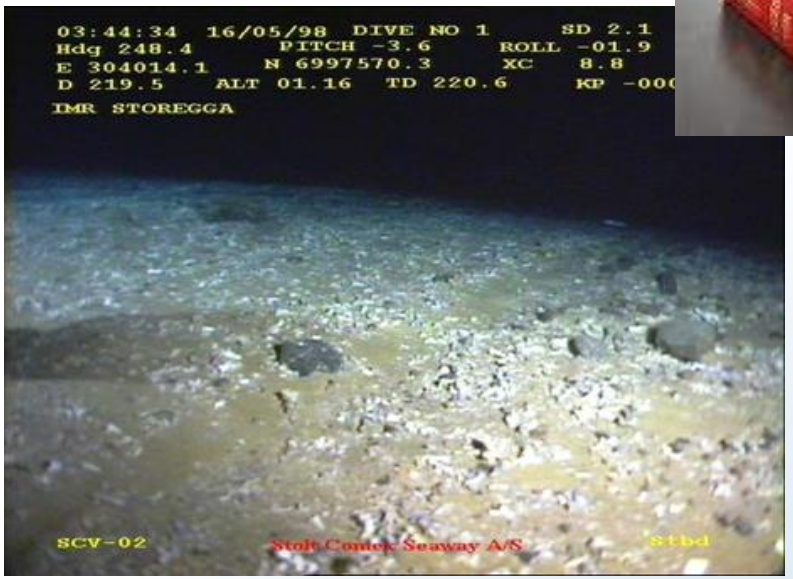
Bottom trawling may have damaged 30-50 % of CWC in Norway



(after Christen, 1999)

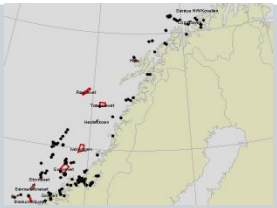






- Slow growing; 4-25mm/year
- 2445 km^2 protected
- Not allowed to damage on purpose

DISCRETE CHOICE EXPERIMENT

		Alternative 1	Alternative 2	Alternative 3 (no change)
Size of protected areas		5.000 km^2	10.000 km^2	2.445 km^2
Attractive for industry	 	Attractive for oil/gas	Attractive for fisheries	To some degree for both
Importance as habitat for fish		Not important	Important	To some degree
Cost per household per year to protect more cold water coral areas		100 kr/year	1000 kr/year	0
I prefer				

22 municipalities * 20 participants * 12 choice cards = 4800 choices

- average willingness to pay to protect more cold water coral
- preferences for what factors should be emphasised

Marginal willingness to pay (WTP) in EUR per household using the Mixed logit model.

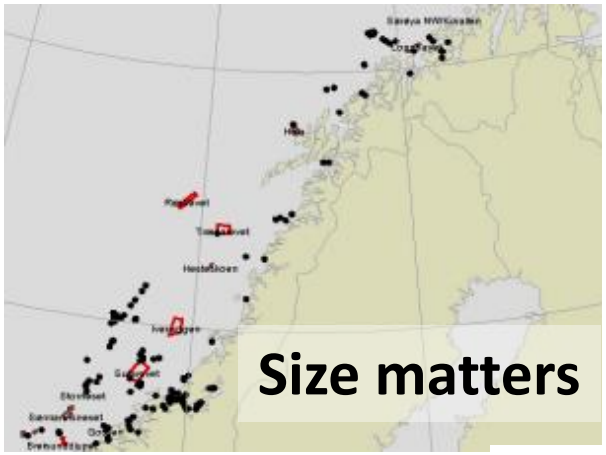
***, ** and * indicate estimates significant at 1%, 5% and 10% levels, respectively.

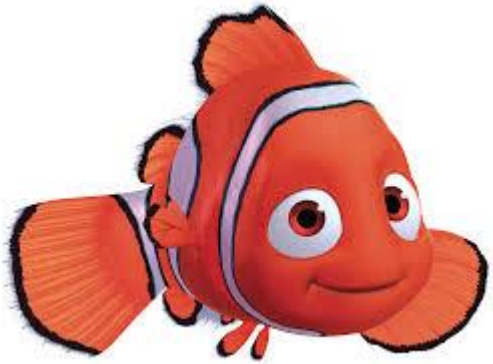
	Marginal WTP (EUR)	s.e.
Size small (5000 km^2)	35.0046***	8.7921
Size large (10 000 km^2)	51.5938***	9.6956
Oil/gas	10.6724	6.2237
Fishing	19.4476*	7.2791
Habitat	163.5352***	10.3174

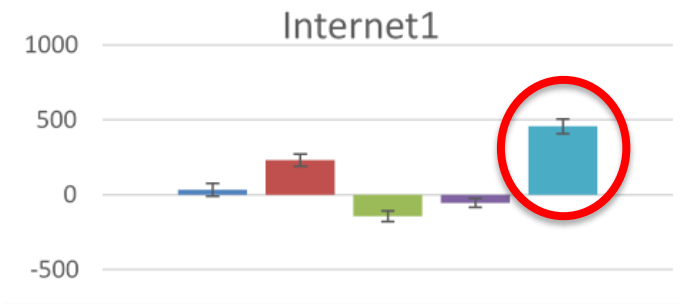
Max logLikelihood = -3424, AIC/n =1.4961, pseudo R^2 = 0.3255, n (observations) = 4683

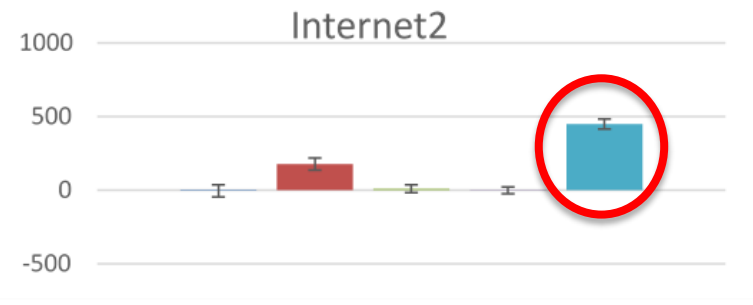
Aanesen et al Ecol Econ (2014)

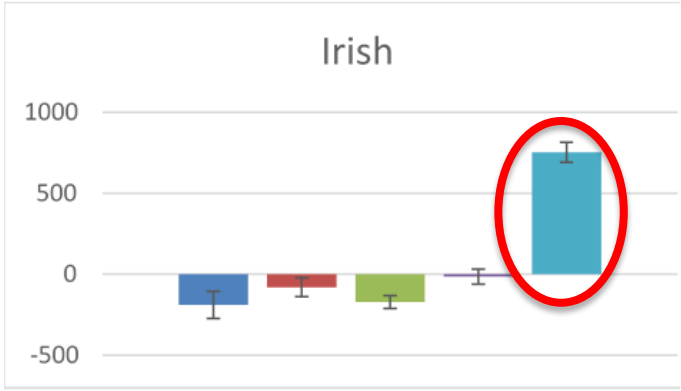
People willing to pay, but…











Size-small
Size Large
Oil/gas
Fisheries
Habitat

$$PVNB = \int_0^{\infty} e^{-\delta t}\left[\left(p - c_1(X,H)\right)h_1 + \left(p - c_2(X,H)\right)h_2 + V(H)\right]dt$$

$$\frac{dX}{dt} = F(X) - h_1 - h_2$$

a) Habitat is preferred

$$\frac{dH}{dt} = -\alpha h_1$$

Nonrenewable habitat

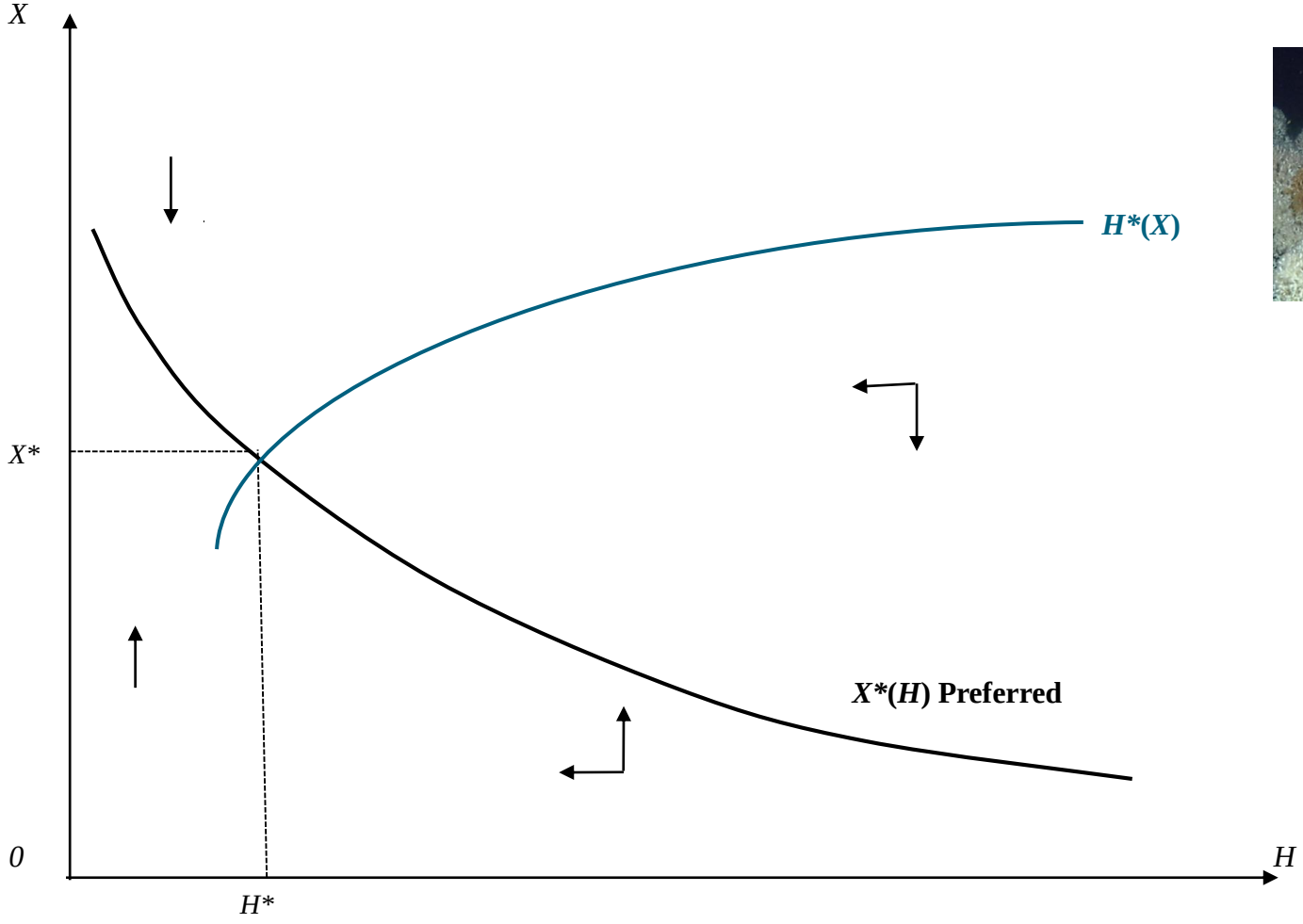
F(X,H) is the stock growth
X is the biomass of fish stock
H is the habitat
h_i is harvest (i harvesters; 1 and 2)
c_i is unit cost of harvest
p is unit price of harvest
α is the coefficient of habitat destruction perpetrated by harvest type 1
δ is the discount rate
V(*H*) is the non-use value function
b and γ are constants

$$V(H) = b\log H + \gamma$$

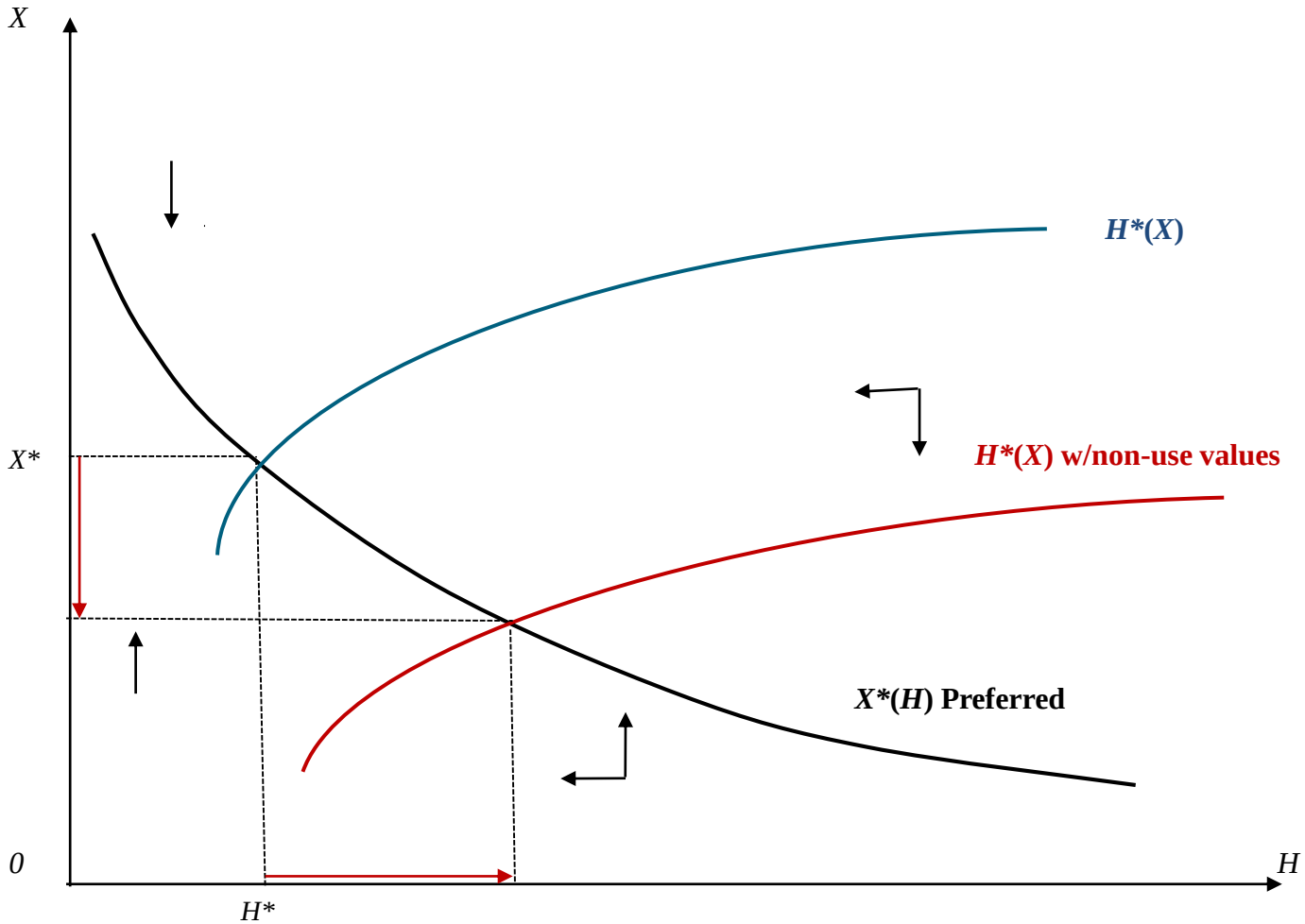
Non use value

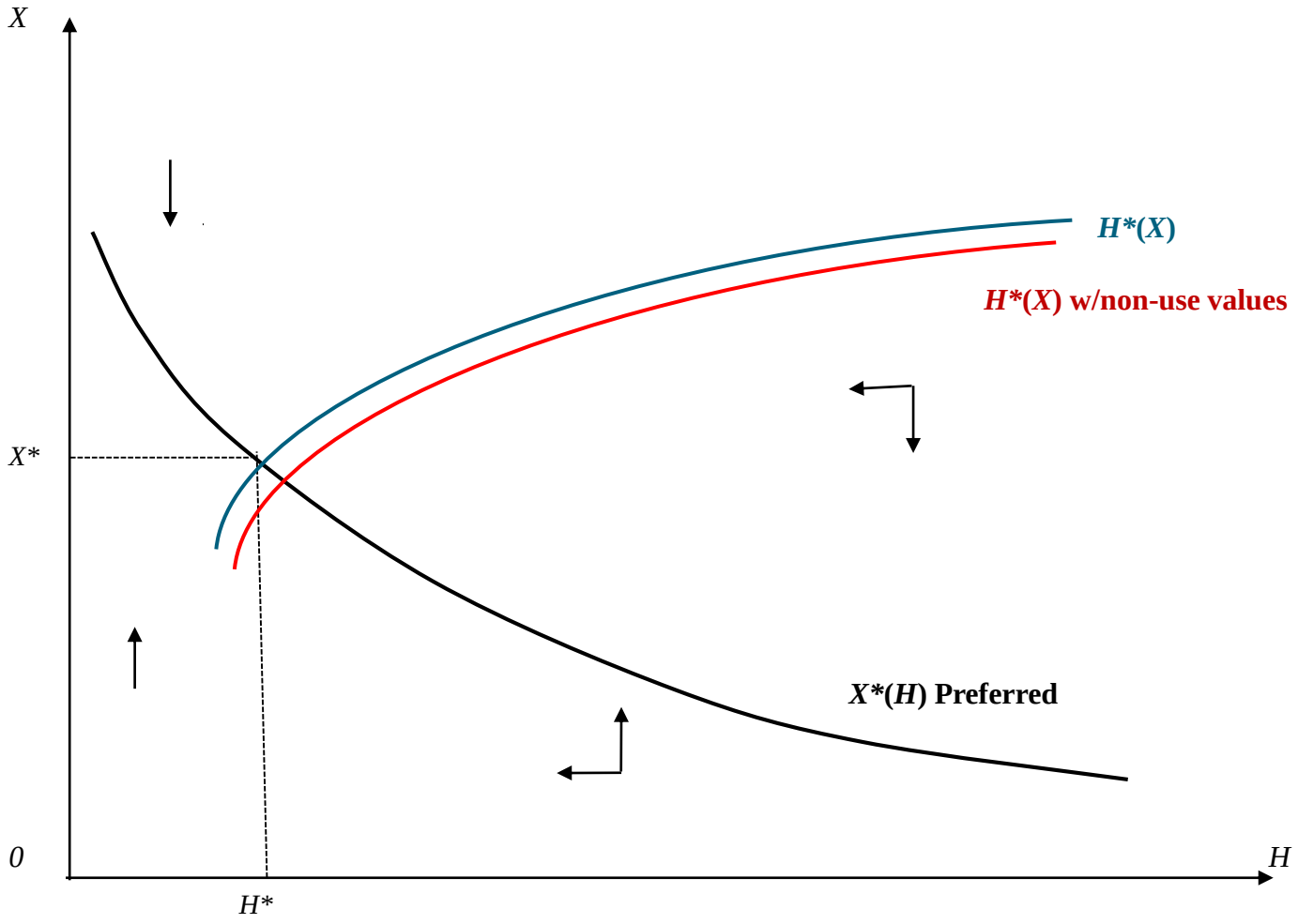
Hammond and Brown (1974) and Rondeau in JEEM (2001)

Steady state analysis – Preferred model for CWC and North East Arctic cod fishery data

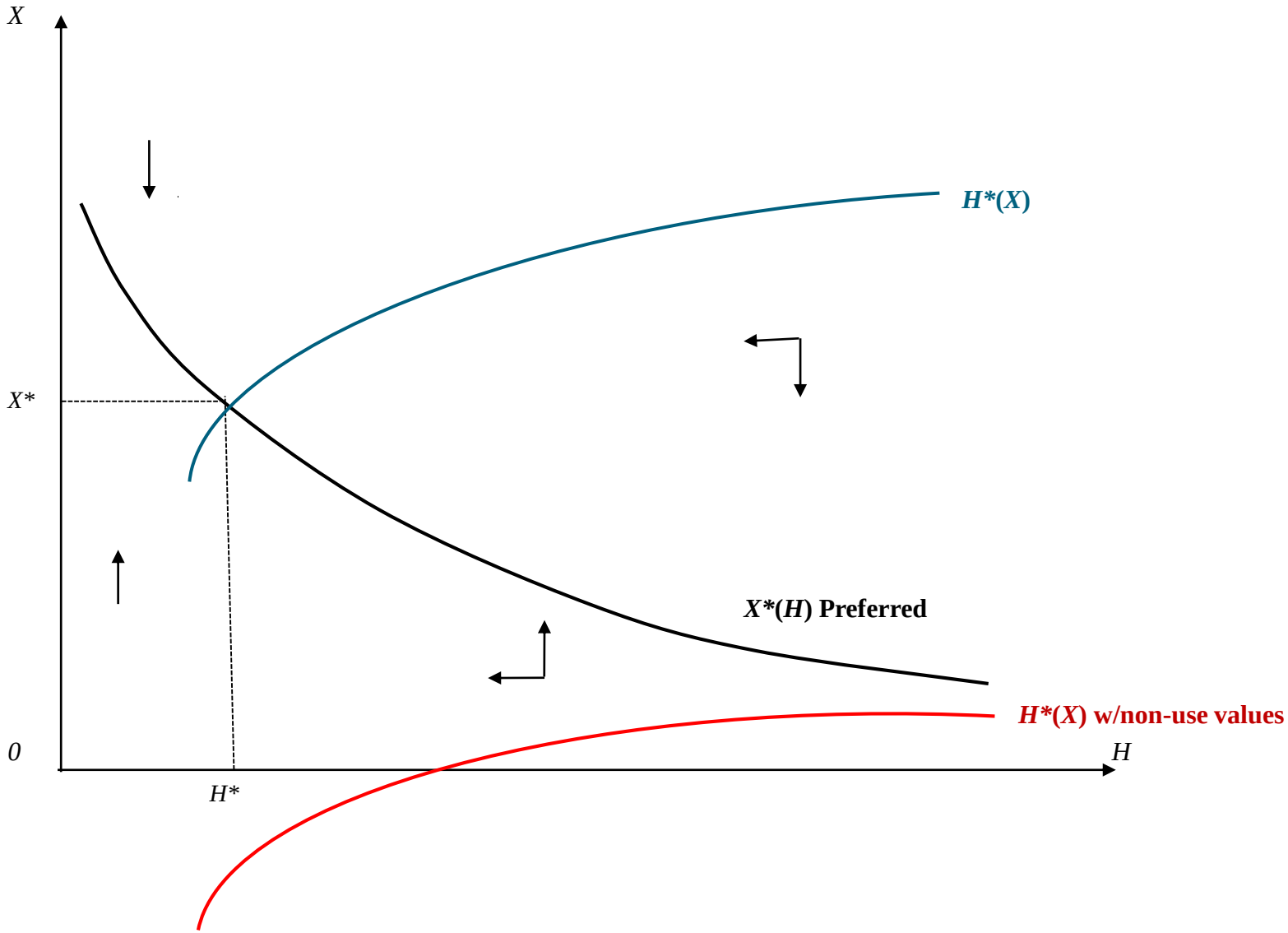


Steady state analysis – Preferred model for CWC and North East Arctic cod fishery data and non-use values




X
H*(X)
H*(X) w/non-use values
X*
X*(H) Preferred
0
H
H*

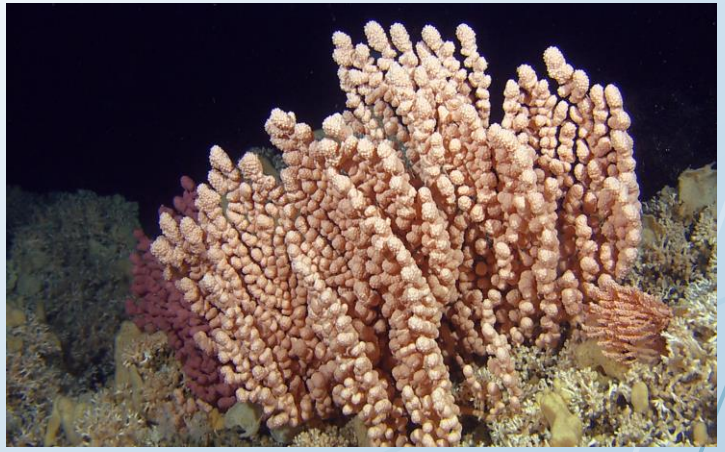
Including 1.3% of the EU population



This raises some issues:

We have to a large degree solved (or at least understand) «the tragedy of the commons» in fisheries.

1. But what about «the tragedy of common habitats»?
2. How are we incorporating the broader ecosystem services in our fisheries management?
3. Are we including the broader public values or just stakeholder values?
4. Do we have governance systems that enable a more holistic management?



Thanks to:

- Margrethe Aanesen
- Viktoria Kahui
- Kofi Vondolia
- Mikolaj Czajkowski
- Pål Buhl Mortensen
- Jannike Falk-Petersen
- Naomi Foley
- Jan Helge Fosså
- Anthony Grehan
- Nick Hanley
- Ståle Navrud
- Tom van Rensurg
- Erlend Dancke Sandorf

- The Research Council of Norway

Join us at the 18th conference of the

INTERNATIONAL INSTITUTE OF FISHERIES ECONOMICS AND TRADE

in Aberdeen, Scotland
11th - 15th July 2016