UiT

THE ARCTIC
UNIVERSITY
OF NORWAY

Non-use Values in Natural Resource Management – A Bioeconomic Model of Fisheries and Habitat

Claire W. Armstrong*
Margrethe Aanesen*, Mikolaj Czakowski**,
Viktoria Kahui*** and Godwin Kofi Vondolia*

*Norwegian College of Fishery Science
University of Tromsø, Norway
**University of Warsaw, Poland
***University of Otago, New Zealand

NAAFE
Ketchican, Alaska 2015

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*)

Model of endogenous habitat change

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

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

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

a) Habitat is preferred

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

b) Habitat is essential

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

Nonrenewable habitat

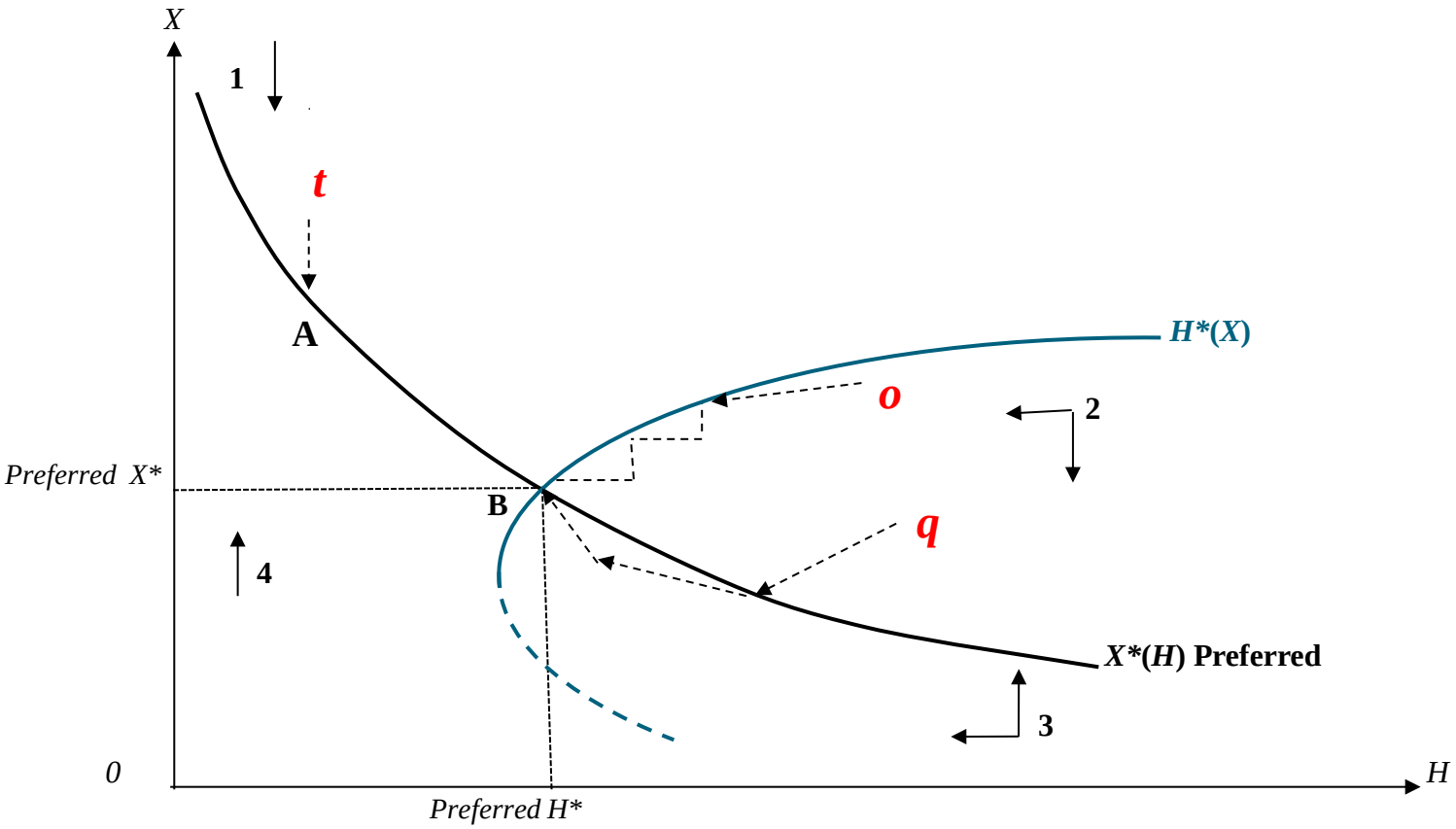
F(X,H) is the stock growth
X is the biomass of fish stock
H is the habitat
h_i is harvest (*i* harvesters; 1 and 2)
c_i is unit cost of harvest
p is unit price of harvest
α is the coefficient of habitat destruction perpetrated by harvest type 1
δ is the discount rate

Preferred habitat

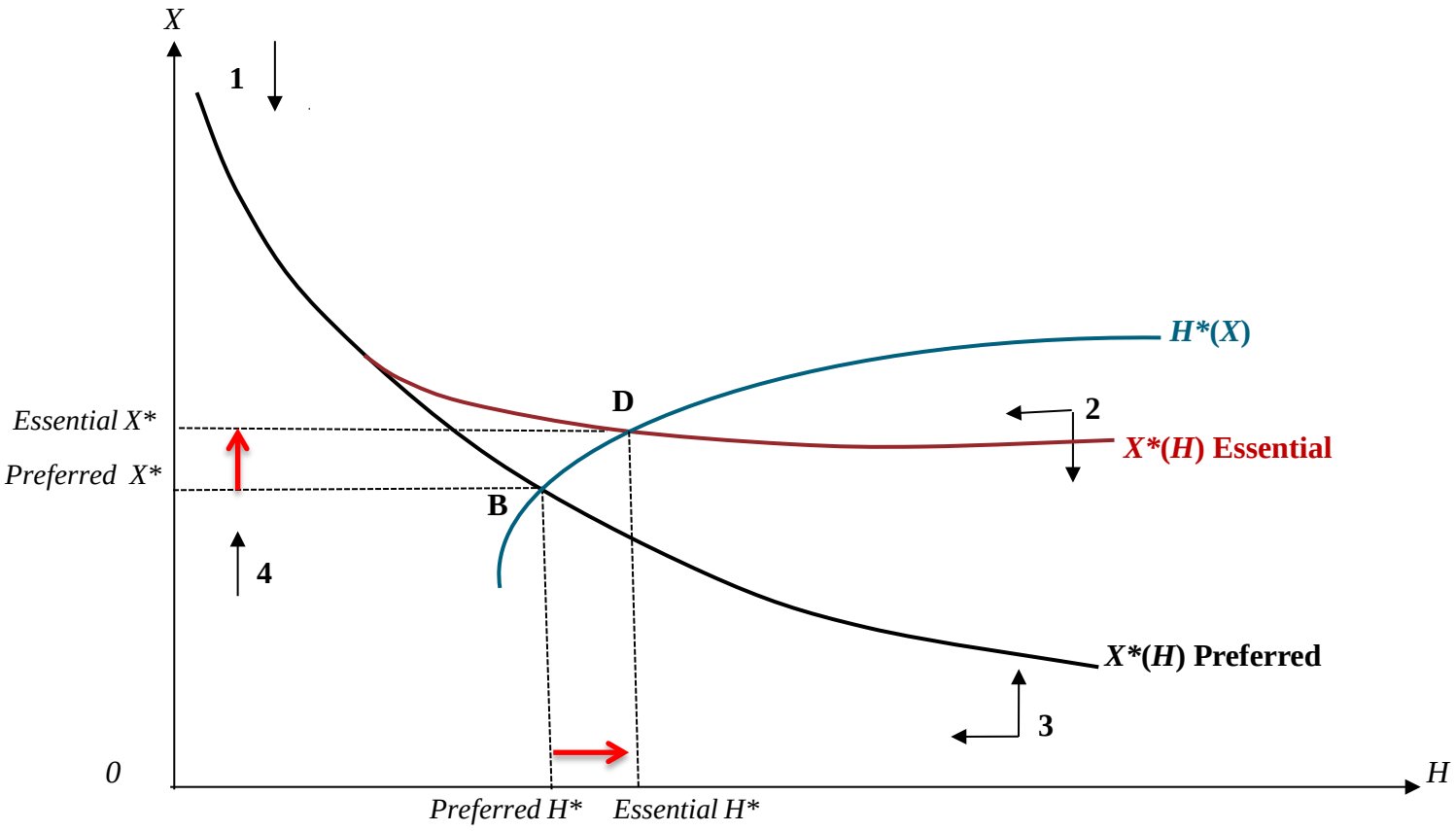
$$\delta = F_X(X^*) + \frac{-c_{2X}F(X^*) + (c_{2X} - c_{1X} + \alpha c_{2H})h_1}{(p - c_2(X^*, H))}$$

$$\delta = \frac{(c_{2X} - c_{1X})F(X) + (c_{1X} - c_{2X} - \alpha c_{2L})h}{(c_2(X, H^*) - c_1(X, H^*))} \qquad h = h_1 + h_2$$

Steady state analysis – preferred model



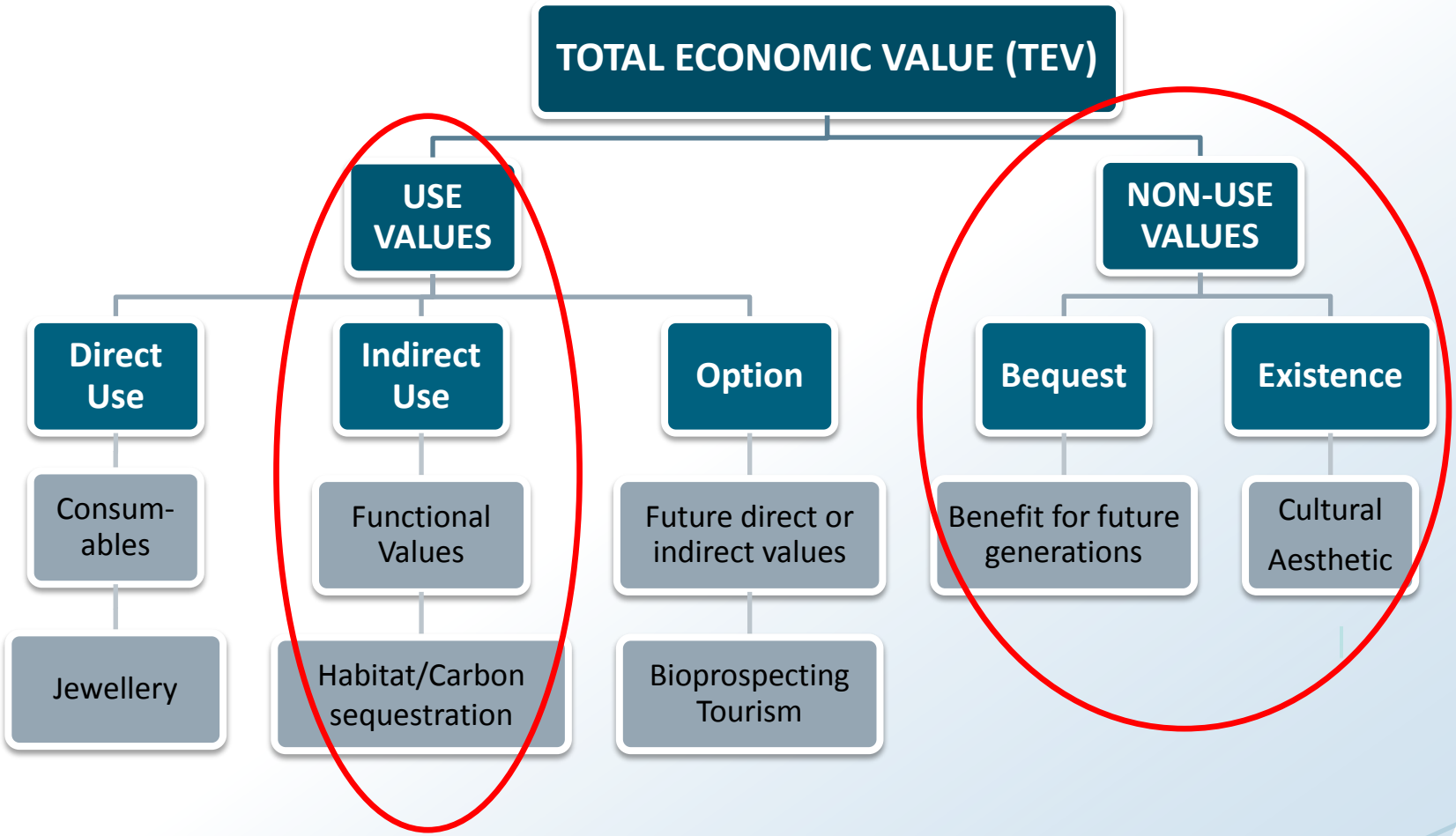
Steady state analysis – preferred and essential models



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*):

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

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

Habitat is preferred

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

Nonrenewable habitat

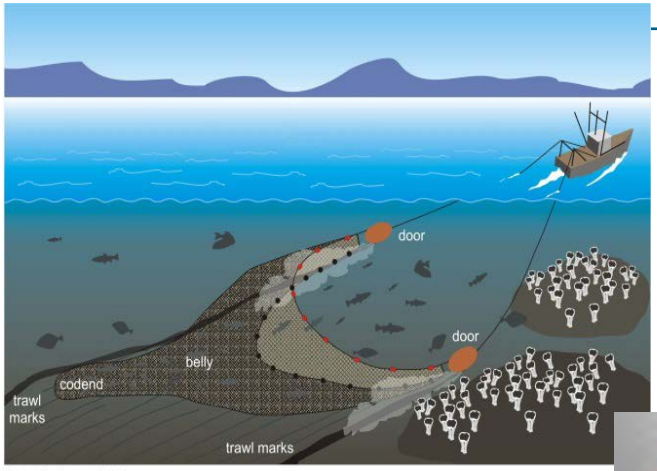
F(X,H) is the stock growth
X is the biomass of fish stock
H is the habitat
h_i is harvest (i harvesters; 1 and 2)
c_i is unit cost of harvest
p is unit price of harvest
α is the coefficient of habitat destruction perpetrated by harvest type 1
δ is the discount rate
V(*H*) is the non-use value function

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

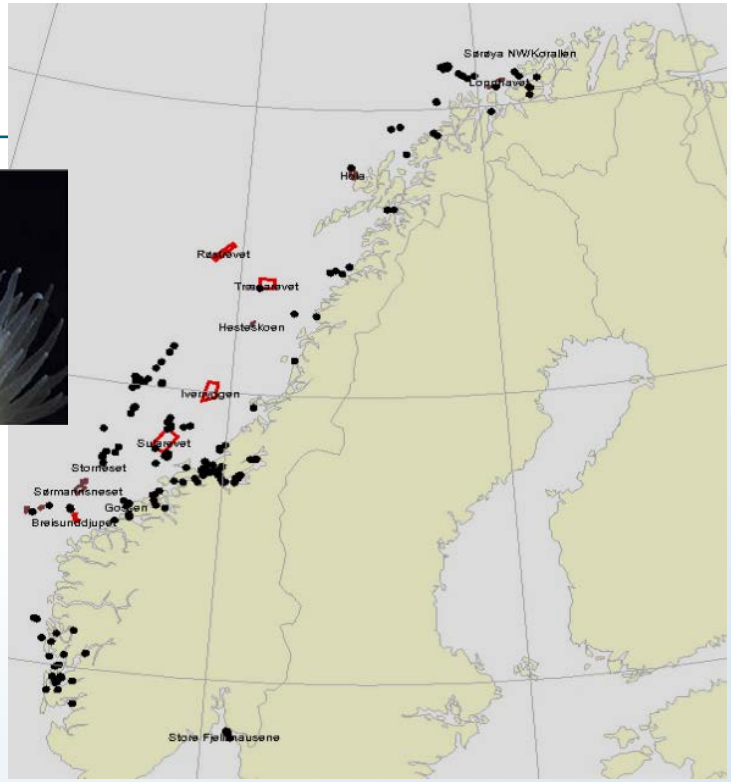
Attitudes and willingness to pay for protection

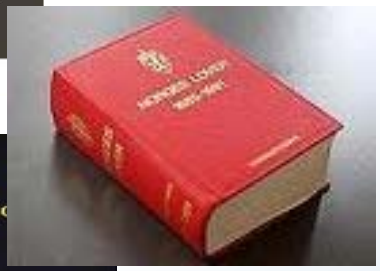
How do we capture this?

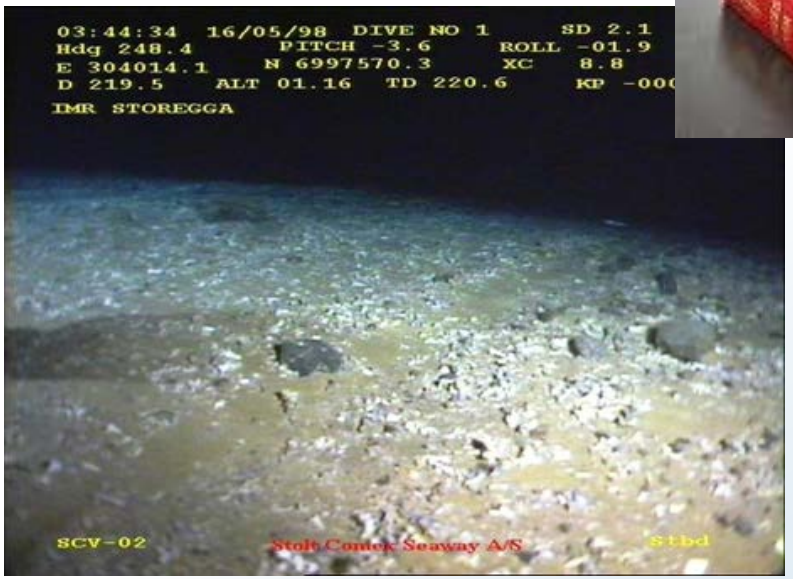
Bottom trawling may have damaged 30-50 % of CWC in Norway



(after Christen, 1999)

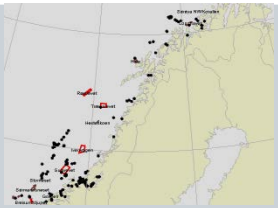
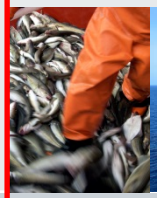






- Slow growing; 4-25mm/year
- 2445 km^2 protected
- Not allowed to damage on purpose

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

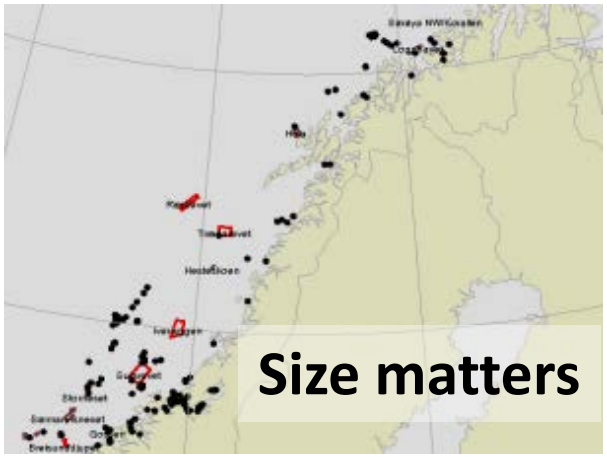
Estimated marginal WTP in Euros and standard errors, per household per year, using a generalized multinomial logit model in marginal utility space.

** and ** indicates significant estimates at 5% and 0.1% levels.*

Generalised mixed logit model		
	Means	
var.	coeff.	st.err.
SQ	0,7745**	0,2164
size	0,0392**	0,0136
petroleum	0,0551	0,0692
fisheries	0,2156*	0,0685
habitat	1,4523**	0,1294
cost	0,3488**	0,1001

Max logLikelihood = -3528, AIC/n =1,5124, logLikelihood ratio (pseudo R^2) = 0.3052.
n (observations) = 4683, k (parameters) = 13

People willing to pay, but…



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

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

a) Habitat is preferred

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

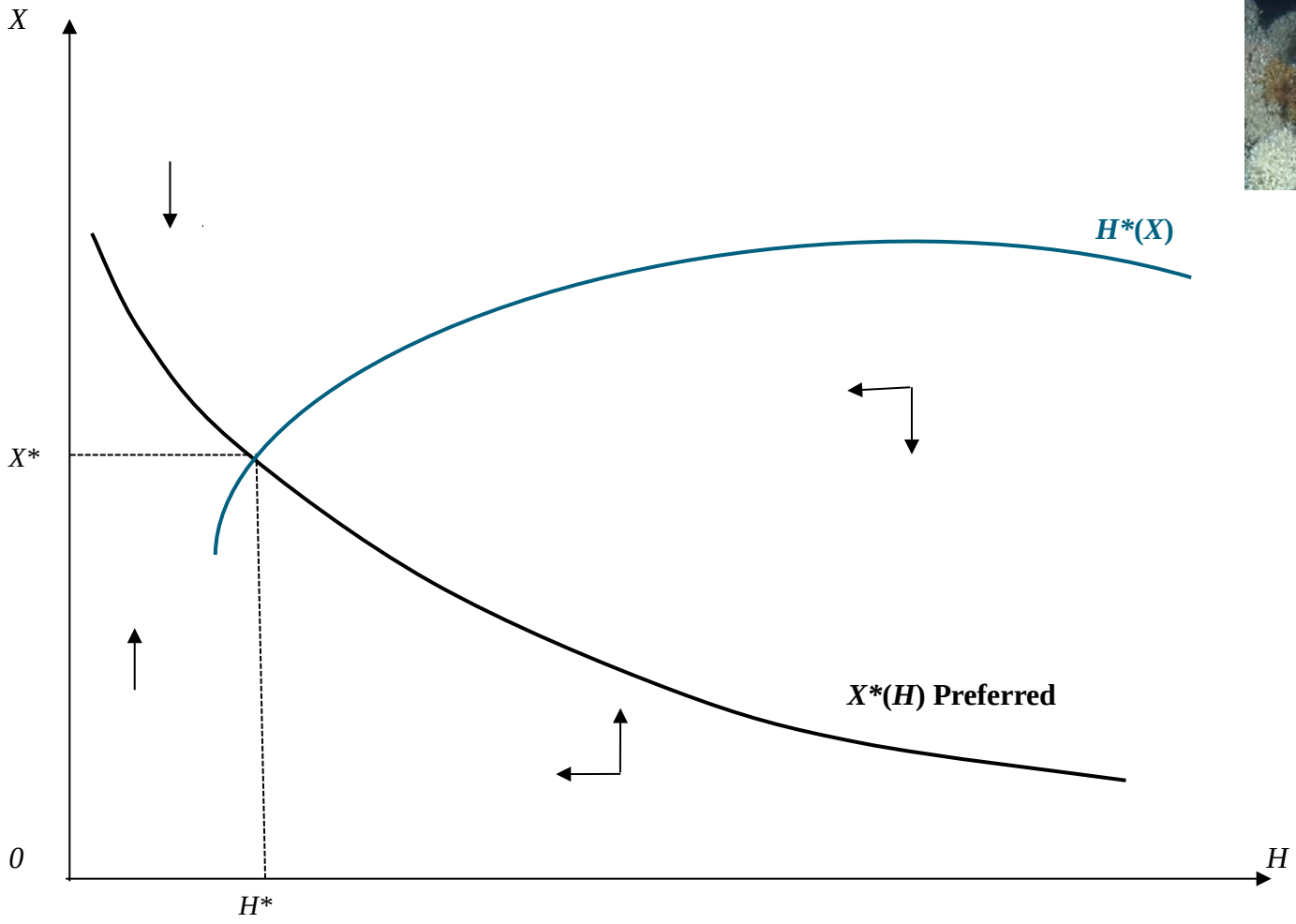
Nonrenewable habitat

$$V(H) = mH + n$$

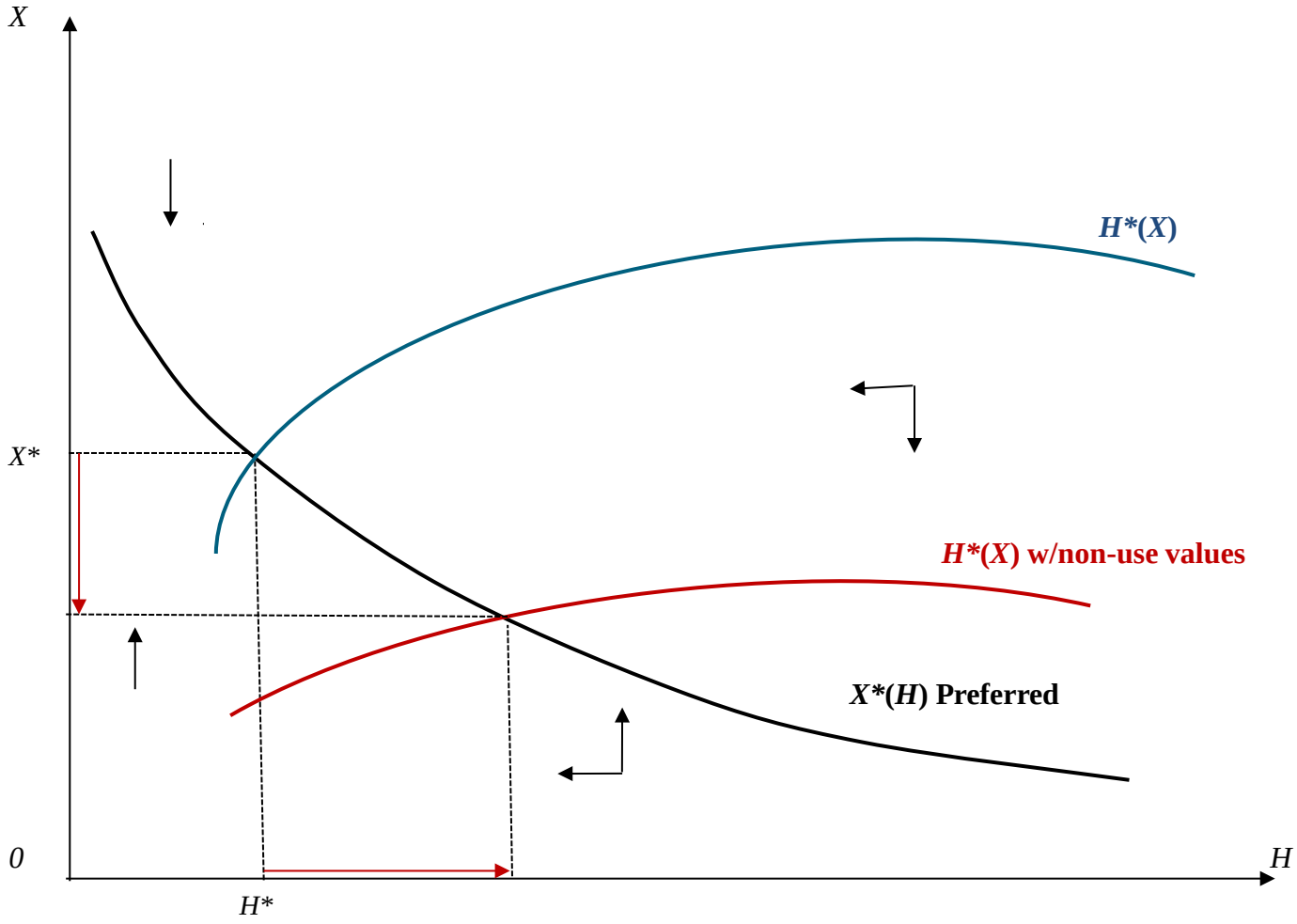
Non use value

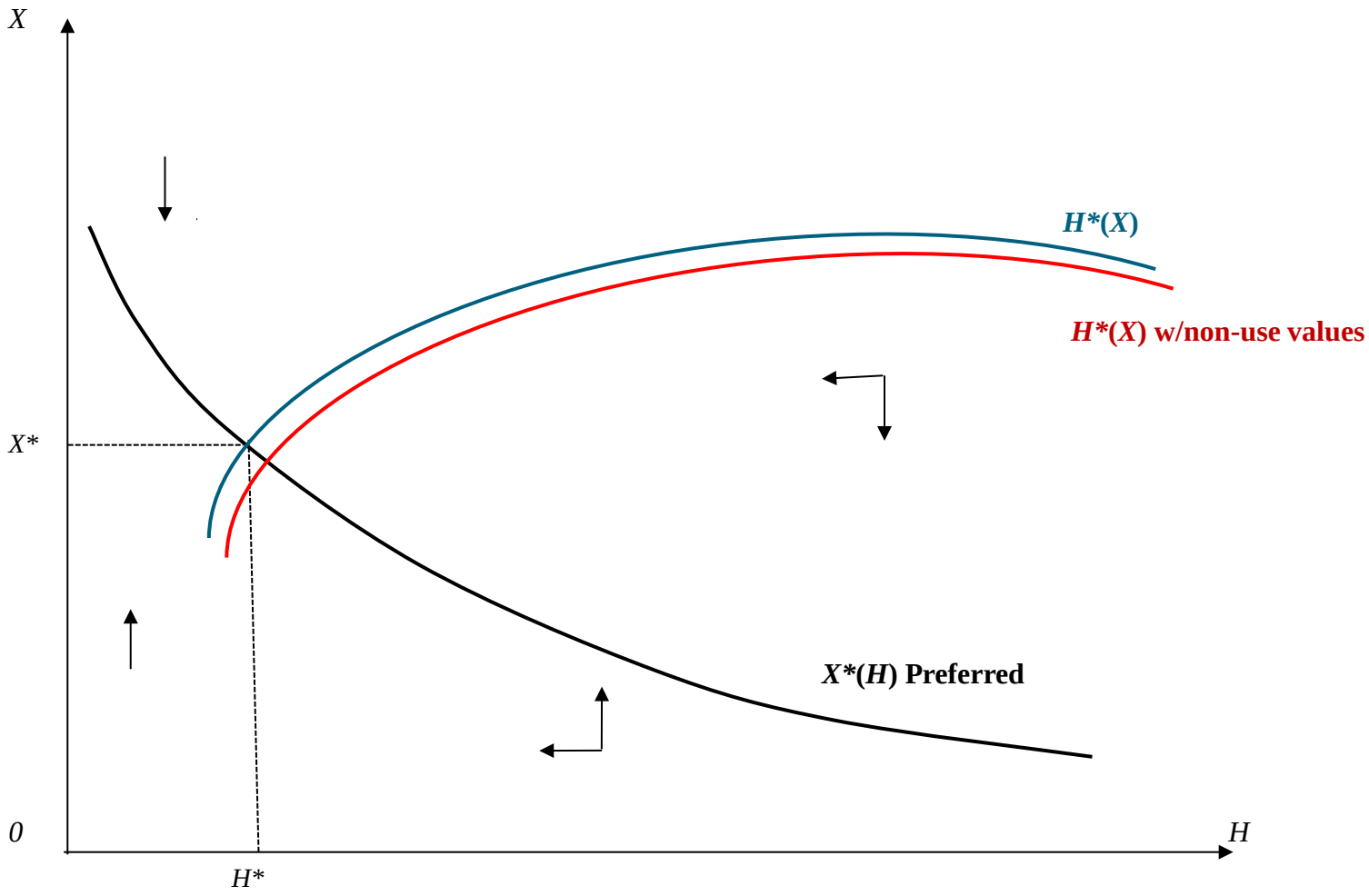
F(X,H) is the stock growth
X is the biomass of fish stock
H is the habitat
h_i is harvest (i harvesters; 1 and 2)
c_i is unit cost of harvest
p is unit price of harvest
α is the coefficient of habitat destruction perpetrated by harvest type 1
δ is the discount rate
V(*H*) is the non-use value function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

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*

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

But what about «the tragedy of common habitats”?

Thanks to:

- Pål Buhl Mortensen
- Jannike Falk-Petersen
- Naomi Foley
- Jan Helge Fosså
- Anthony Grehan
- Nick Hanley
- Ståle Navrud
- Erlend Dancke Sandorf

- The Research Council of Norway