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Valuation of an unfamiliar environmental good
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cold-water coral off the Norwegian coast

Analysis

Willingness to pay for unfamiliar public goods: Preserving cold-water coral in Norway

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A R T I C L E   I N F O

A B S T R A C T

The world's largest concentration of cold-water coral (CWC) is found off the Norwegian coast. Most CWC discoveries are recent, posing new challenges for Norwegian coastal and fishery authorities regarding the management of deep-sea resources. Scientific knowledge of CWC is limited, and many citizens have not even heard about them. This creates problems for the application of the stated preference methods to capture their economic value, and very few such studies have been conducted. To fill this gap, we designed a discrete choice experiment, which was implemented in a valuation workshop setting in order to derive estimates of participants' willingness to pay (WTP) for increasing the protection of CWC. Despite the fact that marine industries such as oil/gas and fisheries could be adversely affected by CWC protection, this did not reduce the respondents' willingness to pay for further protection. The possibility that CWCs play an important role as habitat for fish was the single most important variable to explain respondents' WTP for CWC protection. The survey revealed a high degree of preference heterogeneity, while we found an average WTP for CWC protection in the range of EUR 274–287.
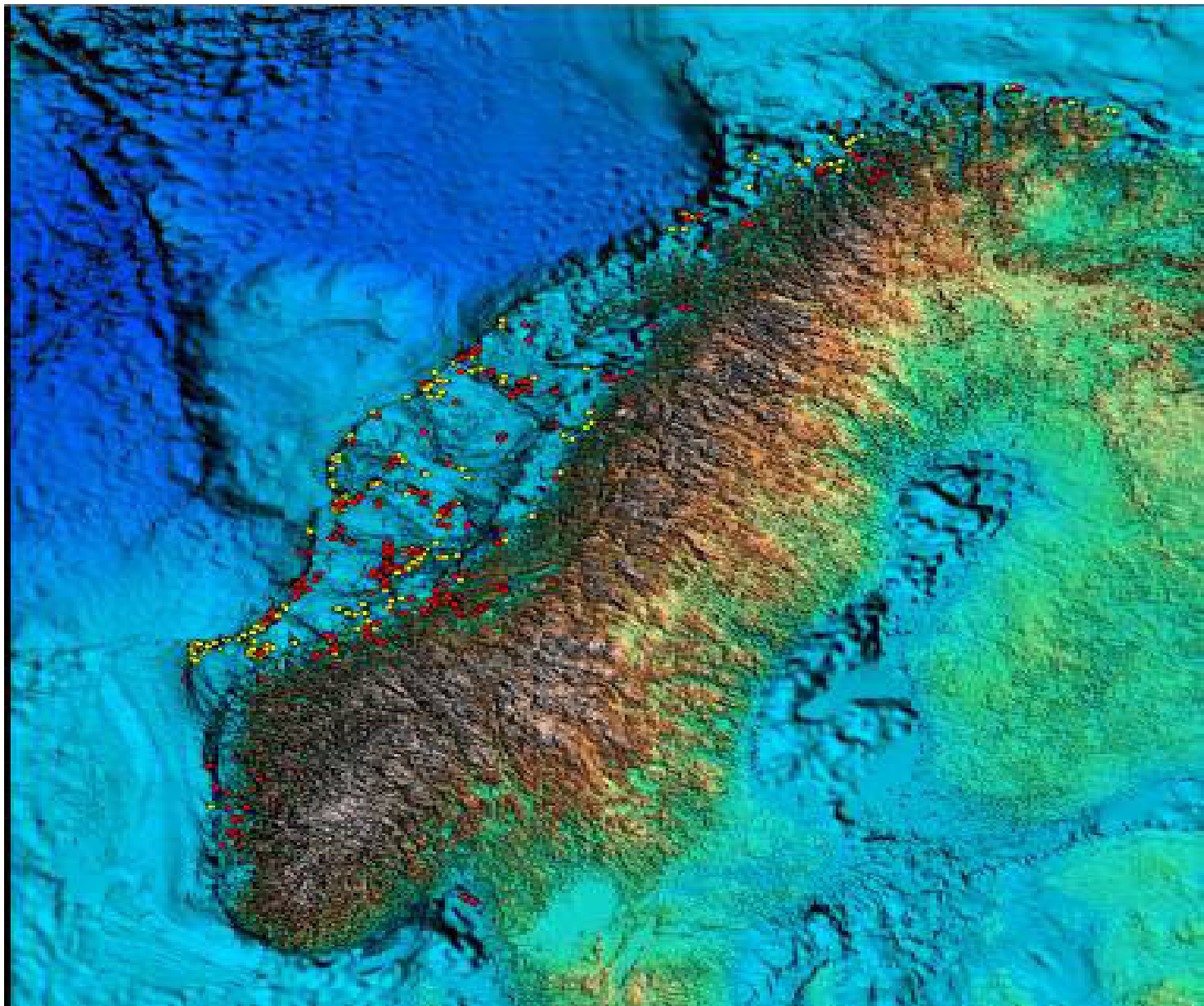
Yellow dots are reported CWC reefs by fishers and others, red dots are scientifically verfied occurences of CWC off the Norwegian coast per 2004 (IMR, Ministry of Environmental protection web site)

MAPPING

Multistråle-ekkolodd
Ngu.no

Ngu.no

- **New technology has enabled better mapping of CWC occurrences and reefs**
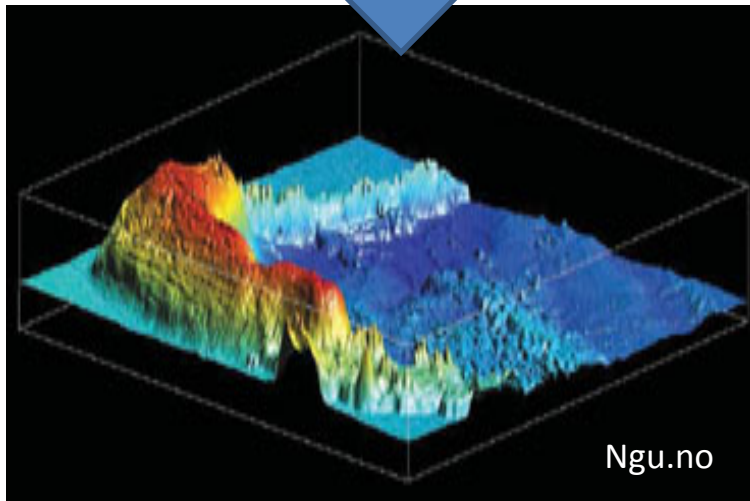
Argus remote systems

What do we know about CWC off the Norwegian coast?

- The stonecoral *Lophelia pertusa* is the most common one to form reefs

- 1100 CWC verified occurrences

- The Røst reef is the largest CWC-reef in the world; 35 km long and 3 km broad

- The oldest reef is about 9000 år old

COLD-WATER CORAL

- **Live at depths between 100-3000 meter**

- **Live in cold water (4-13°C)**

- **Grow slowly, between 4-25 mm per year**

- **We know relatively little about their ecological role**

Many unknowns ...

- Scientists have observed that there often is fish staying at CWC reefs

- The scientists have not yet, however, been able to verify that CWC is a (important) habitat for fish

- The ecological role of the CWC is to date still relatively unknown

- Most people have never heard about cold-water coral, not to say know that it is abundant off the Norwegian coast

Classification of Environmental Valuation Techniques (based on individual preferences)

	Indirect	**Direct**
Revealed preference (RP)	Travel Cost method Hedonic Price analysis Averting Behaviour	Production Function (Market prices) Replacement Costs Mitigation Costs
Stated Preferences (SP)	Discrete Choice Experiments (DCE)	Contingent Valuation (CV)

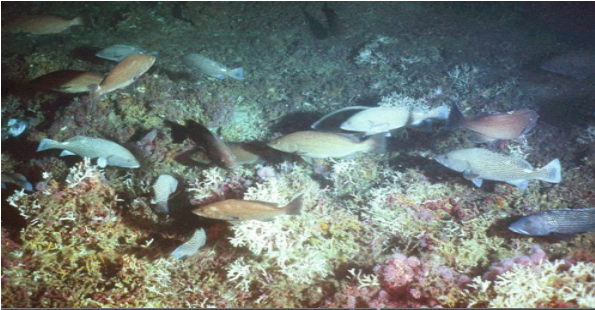# Valuation workshops

Data collection – valuation workshops

- **5 focus groups**
- **3 pilots**
- **21 workshops**
- **402 participants**
- **397 filled in questionnaire**
- **4683 choices**
- **14242 observations**
- **Costs around 800k NOK**

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Types of value

Ecosystem services provided by CWC (Foley et al., 2010)

Use values

- Direct use values
  - Jewelry

- Indirect use values
  - Habitat for non-commercial marine organisms
  - Deep sea regulation services

- Option values
  - Medicinal components (input to biotechnology industry)
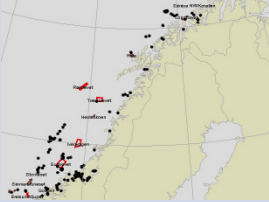
Non-use values

- Existence value

- Bequest value

Questionnaire

- Opinion on the Norwegian management of the coastal zone, fjords, and open sea
- Concern for environmental issues relative to other issues, as health and education
- Choice cards
- Attention to attributes
- Opinions on CWC protection in general
- Payment vehicle
- Personal characteristics

DISCRETE CHOICE EXPERIMENT

		Alternative 1	Alternative 2	Alternative 3 (no change)
Size of protected areas		5.000 km²	10.000 km²	2.445 km²
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				

RESULTS

Do people have preferences for further protection?

	% of choices
SQ	0.26
More protection	0.74

Results

Table 2 *The estimation results of the MNL and MXL models in WTP-space (in EUR). ***,*
** and * indicate estimates significant at 1%, 5% and 10% level, respectively.

	MXL model		MNL model
	Coefficient	Std.dev.	Coefficient
	(s.e.)	(s.e.)	(s.e.)
Small-size	-11.12	28.34***	194.96***
	(8.9988)	(9.2600)	(13.1564)
Large-size	17.19**	37.96***	255.94***
	(8.5533)	(10.6825)	(15.2381)
Oil/gas	10.04	3.23	85.34***
	(5.6239)	(5.4317)	(4.9380)
Fish	24.06***	27.50**	83.21***
	(6.0647)	(5.8470)	(5.4337)
Habitat	146.35***	136.12***	139.49***
	(12.6406)	(8.5869)	(7.6377)
Price	64.65***	54.09***	63.69***
(in preference space)	(5.5016)	(6.0676)	(7.0554)
N	4683		4683

MXL: LogLikelihood = -3480.38, AIC/n = 1.4980, pseudo-R^2 = 0.3146.

MNL: LogLikelihood = -4759.73, AIC/n = 2.0353, pseudo-R^2 = 0.0626.

People willing to pay, but...

Size matters

Don't care

Don't care
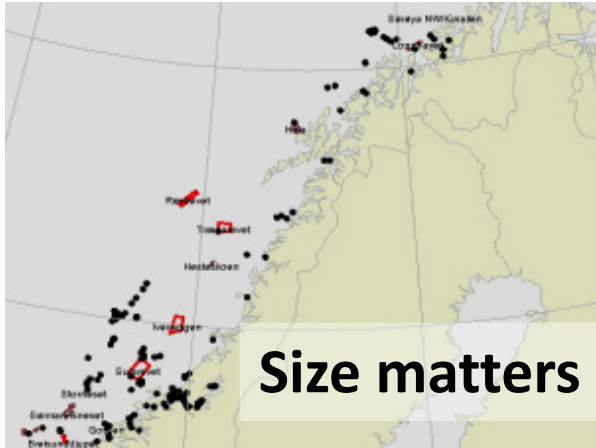
Prefer to pay less for more

Really care

Results

Table 3   WTP per household per year in EUR for small and large protection scenario

	MNL model		MXL model	
	WTP (s.e.)	95% c.i.	Mean WTP (s.e.)	95% c.i.
Small protection scenario	169.33*** (12.7856)	144.28 – 194.39	195.39*** (11.5216)	172.32 – 217.42
Large protection scenario	197.63*** (14.1822)	169.83 – 225.44	204.94*** (13.0509)	178.99 – 230.68

Message to Norwegian authorities responsible for the management of marine resources

- Protect more CWC than the case is today

  - People value CWC first and foremost due to its function as habitat for fish

  - People also value CWC due to its pure existence

Message to Norwegian authorities:
be aware of the NEMO effect

- Combining the results of our survey yields the following message:

- People do not only want to protect CWC because it in turn provides more fish for them to eat

- People also value CWC because it makes the deep sea a nice place for fish, NEMO, to live

Methodological issues

The interviewer effect:
middle aged women vs young male

Valuation workshops

Table 4   *Relative frequency of the alternatives*

Alternative	Survey 1	Survey 2	Survey 3	Survey 4
SQ	0.256	0.197	0.37	0.411
Alternative 1	0.366	0.386	0.293	0.297
Alternative 2	0.378	0.417	0.337	0.293

Table 2   *CLM results for 4 DCE surveys on CWC protection, mean parameter estimates, std.error in parenthesis, *, ** and *** indicating significance level at 5%, 1% and 0.1% respectively, ● indicate 10% significance level*

Attribute	Survey 1	Survey 2	Survey 3	Survey 4
Small size	0.038 (0.05)	0.1 (0.11)	-0.36 *** (0.043)	-0.44 *** (0.1)
Large size	0.22 *** (0.05)	0.48 *** (0.107)	-0.16 *** (0.04)	-0.47 *** (0.86)
Oil	0.03 ● (0.018)	0.01 (0.04)	-0.017 (0.017)	-0.085 * (0.04)
Fish	0.078 *** (0.019)	0.007 (0.047)	0.033 ● (0.018)	0.05 (0.04)
Habitat	0.95 *** (0.042)	1.25 *** (0.08)	0.74 *** (0.038)	1.17 *** (0.084)
Cost	-0.65 *** (0.055)	-0.76 *** (0.116)	-0.76 *** (0.054)	-0.018 *** (0.002)
Max LL	-4760	- 1165	-6217	-1643

Conclusions

- The elicitation method does matter

- Personal characteristics of the interviewer matter

- Is Web-surveys the solution (gave the most conservative estimates)?

- But; we could not have implemented a good web-survey without the experiences from the valuation workshops

Norwegian Research Council

508 anonymous Norwegian survey participants

Institute of Marine Research:
- Jan Helge Fosså
- Pål Buehl-Mortensen

Collegues at Norwegian College
Of Fisheries Sciences:
- Claire Armstrong
- Jannike Falk-Petersen
- Erlend D Sandorf

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- Ståle Navrud

Table 1   Surveys on CWC protection

Time of survey	Type of survey	Elicitation method	Nationality	Number of responses
Survey 1 – spring 2013	Valuation workshop, female moderator	Oral PP-presentation and paper questionnaire	Norwegian	397
Survey 2 – spring 2014	Valuation workshop, male moderator	Oral PP-presentation and paper questionnaire	Norwegian	106
Survey 3 – august 2014	Web-survey	Video and e-questionnaire	Norwegian	500
Survey 4 – October 2014	Valuation workshop – male moderator	Oral PP-presentation and paper questionnaire	Irish	139

Table 3   *Marginal WTP, NOK/Euro*

Attribute	Survey 1 (NOK)	Survey 2 (NOK)	Survey 3 (NOK)	Survey 4 (Euro)
Small size	59	128	-475	-24 (-192 NOK)
Large size	342	634	-205	-26 (-208 NOK)
Oil	50	14	-22	-5 (-40 NOK)
Fish	120	9	43	3 (24 NOK)
Habitat	1463	1634	970	64.5 (516 NOK)
Small protection scenario	1583	1634	495	284 (NOK)
Large protection scenario	1925	2268	765	268 (NOK)

Results

- Individul characteristics

a1: gender – women pay more*

a2: age – the younger pay more

a3: personal income – poorer pay more*

a4: education – the more educated pay more

a5: household size – smaller households pay more

a6: occupation – the persons occupied in marine industries pay more*

a7: residence 1 - people living in urban areas pay more

a8: residence 2 – people living on the coast pay more*

* Not significant

Classification of ecosystem services

Millennium Ecosystem Assessment

BENEFITS TO PEOPLE

Provisioning

Regulating

Cultural

INDIRECT

Supporting

Necessary for production of all other ecosystem services