PUKFI Northern Scallops

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ECODREDGE; European project 1999-2003

Evaluation and improvement of shellfish dredge design and fishing effort in relation to technical conservation measures and environmental impact:

- 9 partners, 5 nations
- Scallop and clam dredging

Ecodredge project
Objectives

- Develop novel techniques to measure physical parameters at the dredge-seabed interface. Utilise under a range of conditions

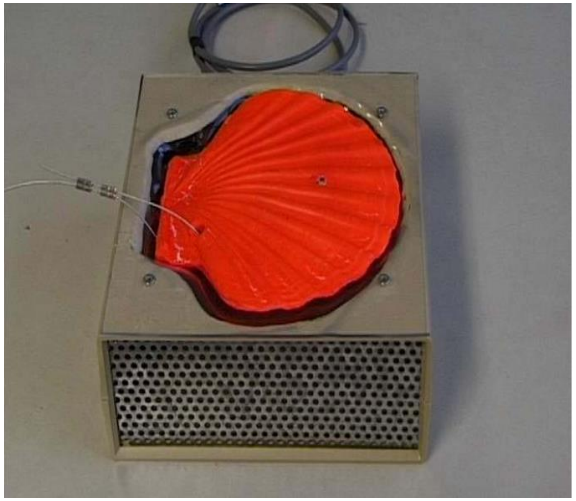
- Develop the means to assess physiological stress in the target organism and determine how this affects survival

- Assess the ecological effects of experimental dredging on benthic communities

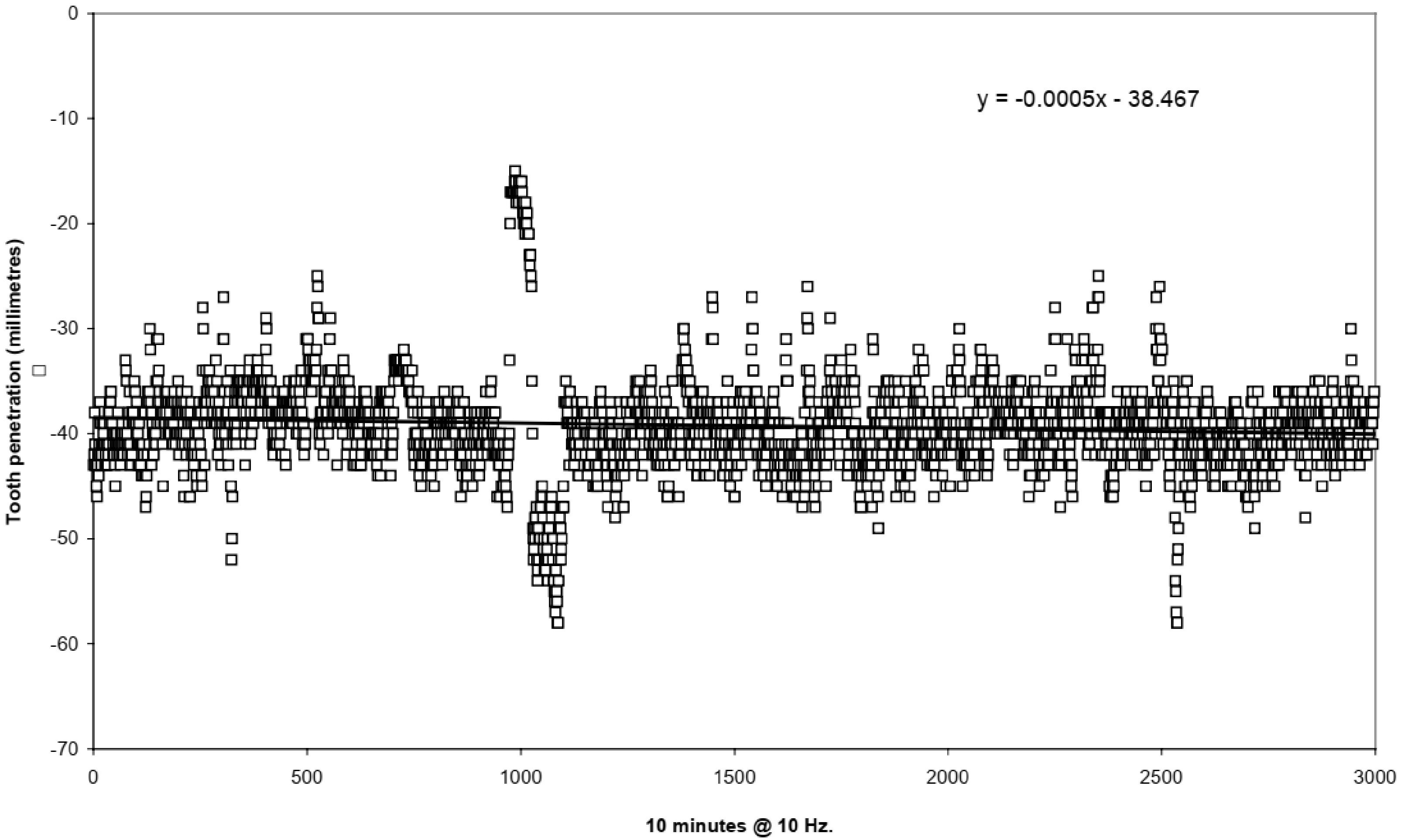
- Quantify the role of dredge components in the size and species selectivity of dredges.

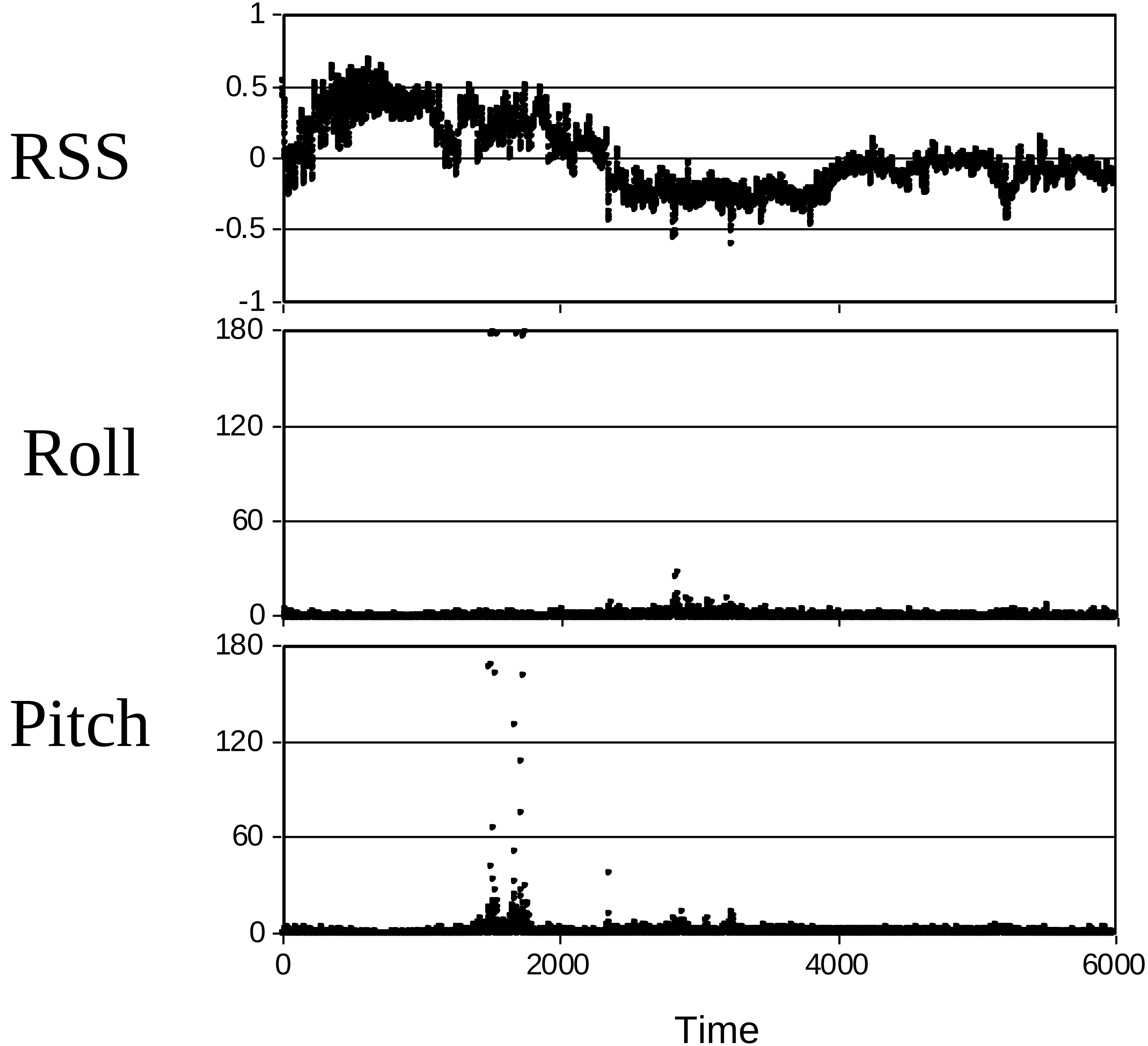
- Test innovations in dredge design

Physical effects



Tooth penetration with time

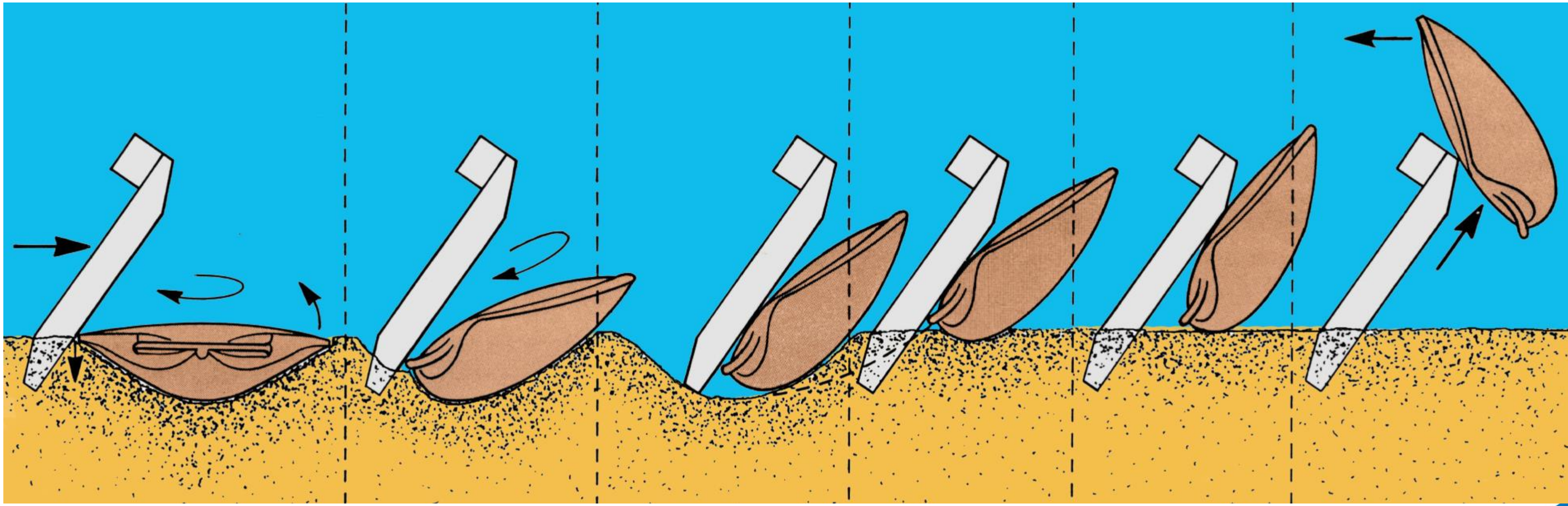




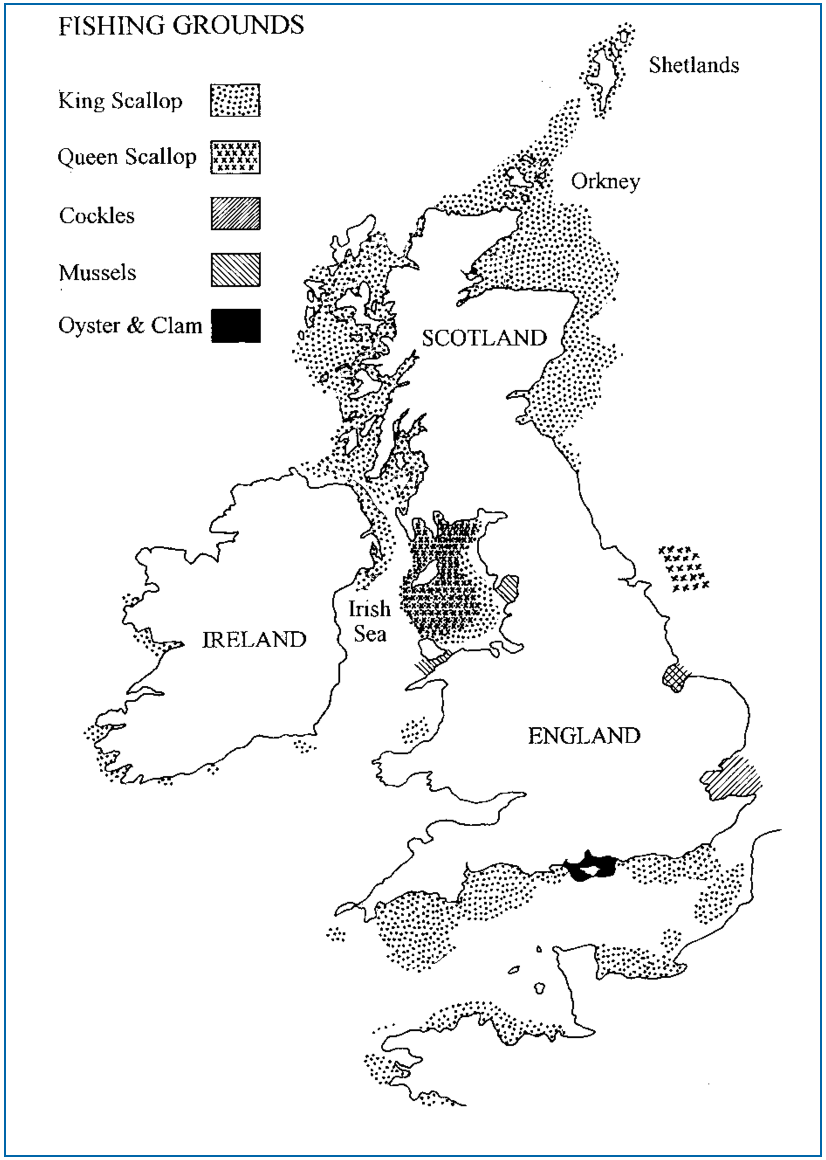
RSS
Roll
Pitch
1
0.5
0
-0.5
-1
180
120
60
0
180
120
60
0
0
2000
4000
6000
Time

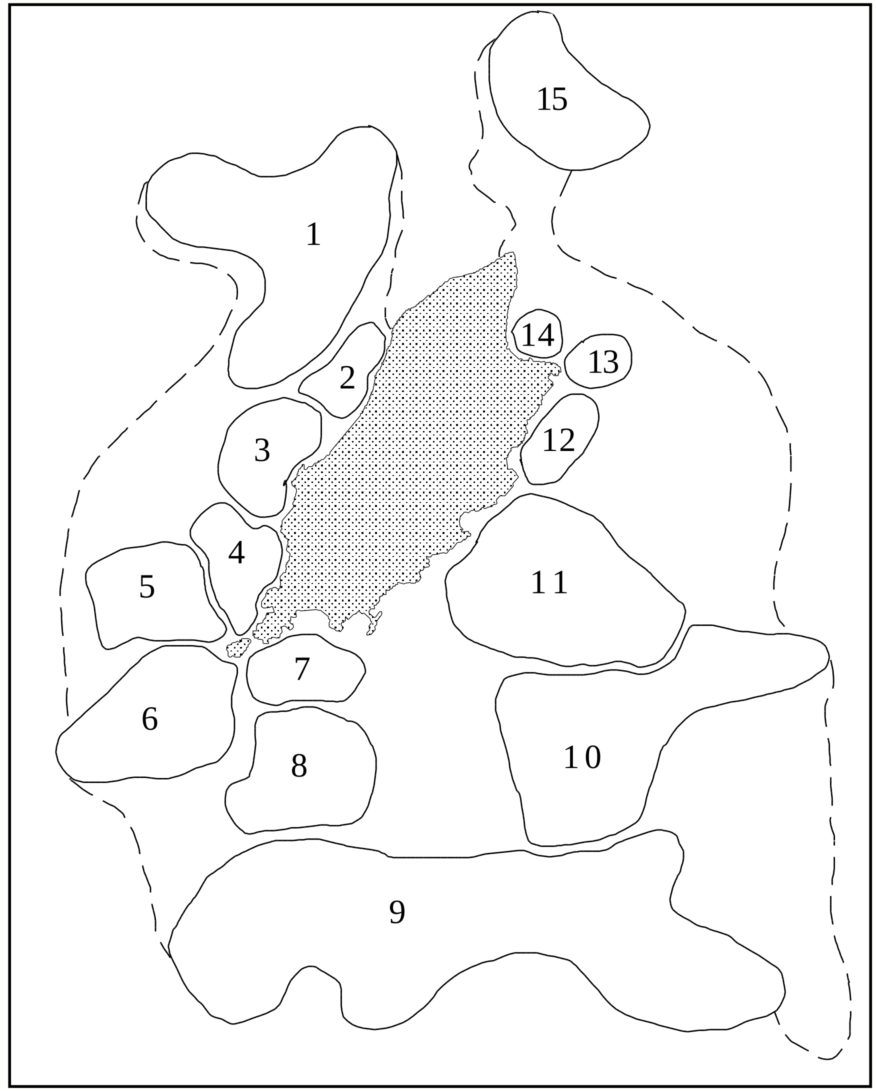
Capture mechanism for king scallops; spring toothed dredge

From video observations;



Scallop discard survival


FISHING GROUNDS
King Scallop
Queen Scallop
Cockles
Mussels
Oyster & Clam
Shetlands
Orkney
SCOTLAND
IRELAND
Irish
Sea
ENGLAND

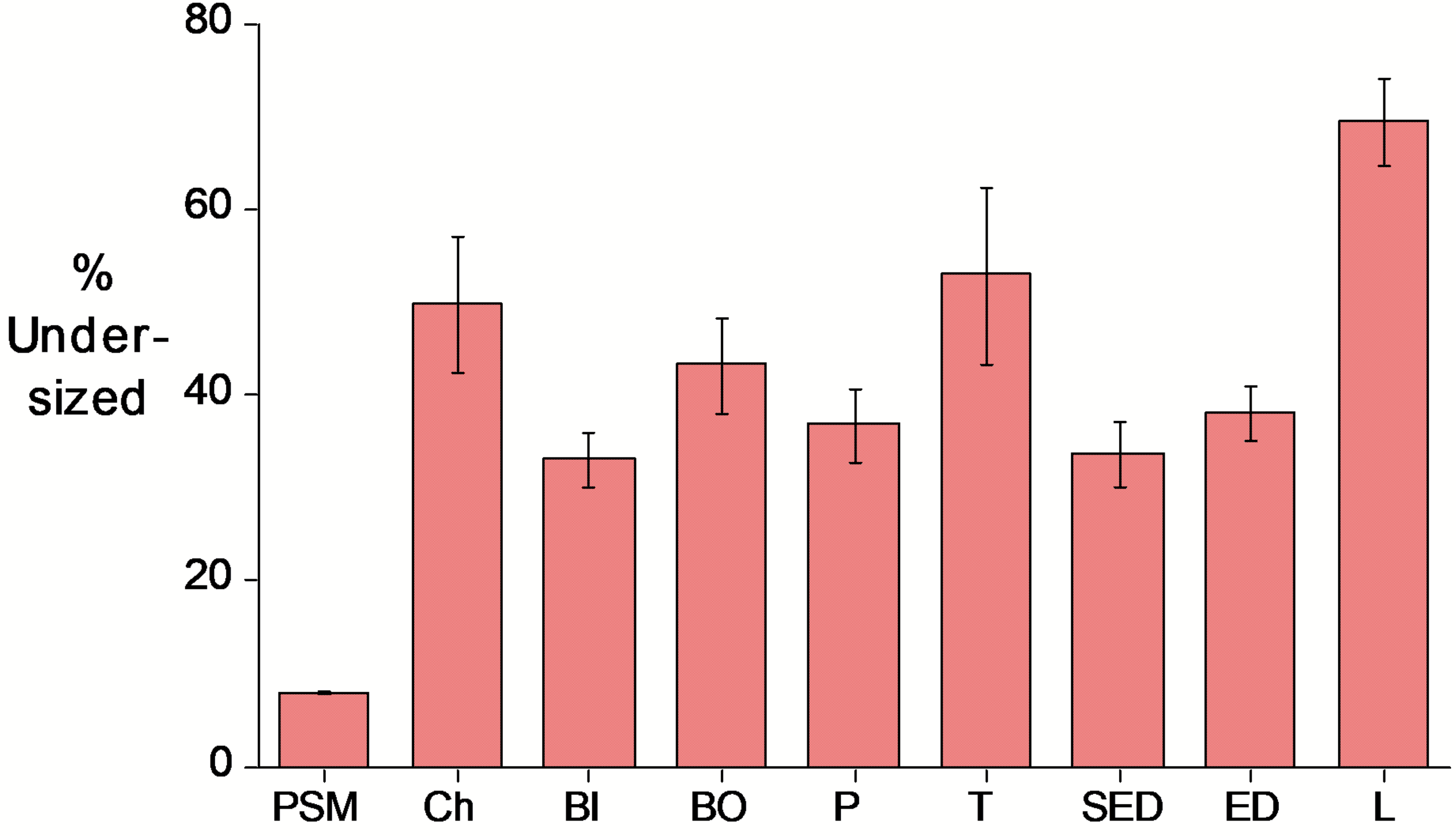

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

Discards in the scallop fishery

Minimum Legal Landing Size (MLLS):

- Irish Sea, Eastern English Channel = 110mm shell length
- Western English Channel, Scotland = 100mm shell length

What proportion of the catch is under the Minimum Legal Landing Size (MLLS)?



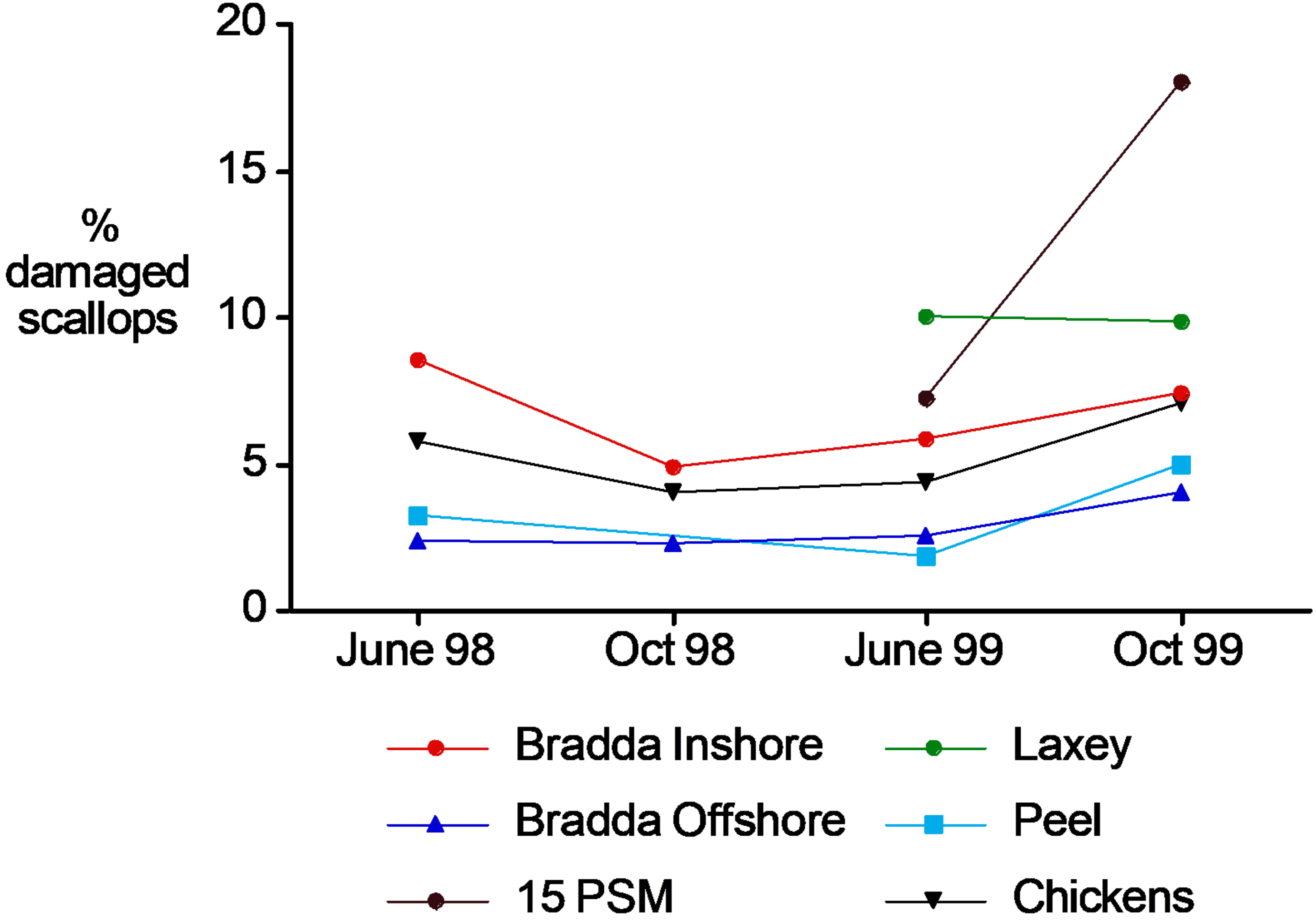
Damage of scallops; Manx fishery

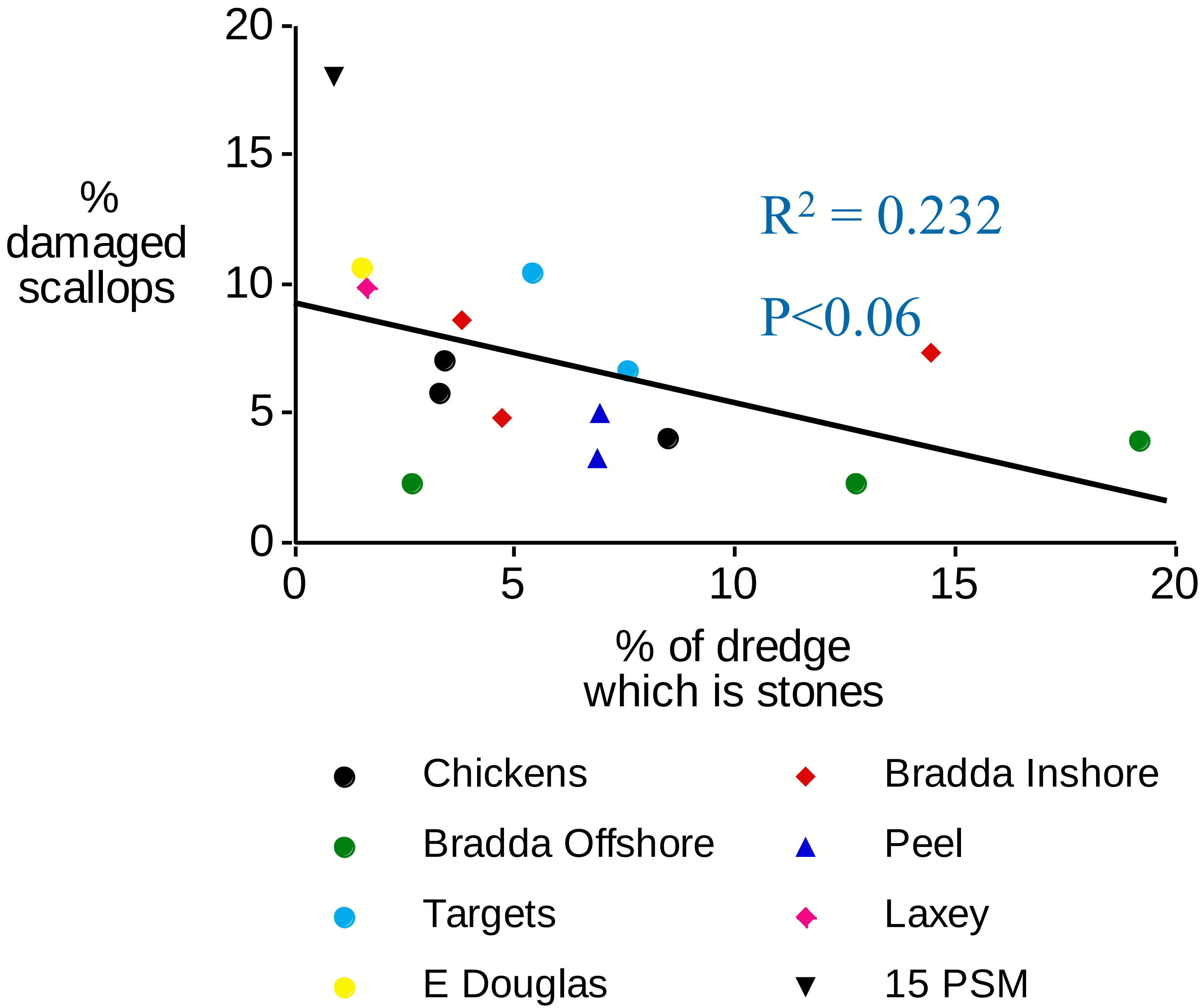
- **Damage** to catch and bycatch was assessed on 8 fishing grounds over 3 years

- Potential **explanatory variables** were recorded, including rock volume, dredge fullness, three way acceleration.

- Finally the shell **strength and structure** of scallops from different grounds was measured

Damage of scallops related to ground; annual survey observations





20
15
10
5
0
% damaged scallops
R² = 0.232
P<0.06
0
5
10
15
20
% of dredge which is stones
Chickens
Bradda Inshore
Bradda Offshore
Peel
Targets
Laxey
E Douglas
15 PSM

Results

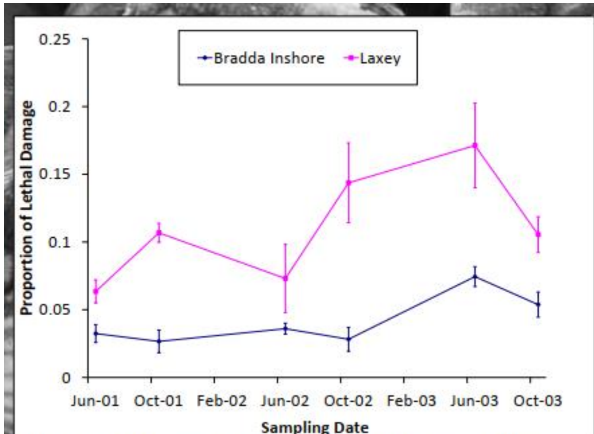
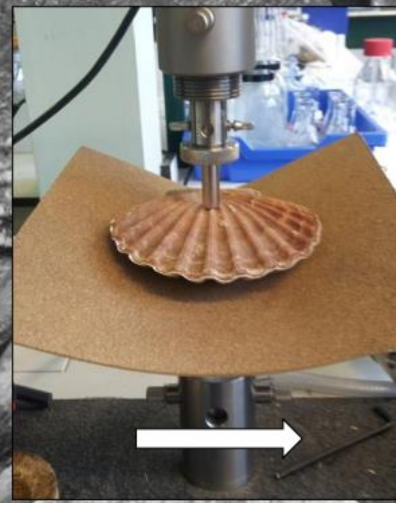


Figure 2. Spatial variation in the proportion of lethal damage to *Pecten maximus* captured in scallop dredges (mean ± SE) on two fishing grounds around the Isle of Man



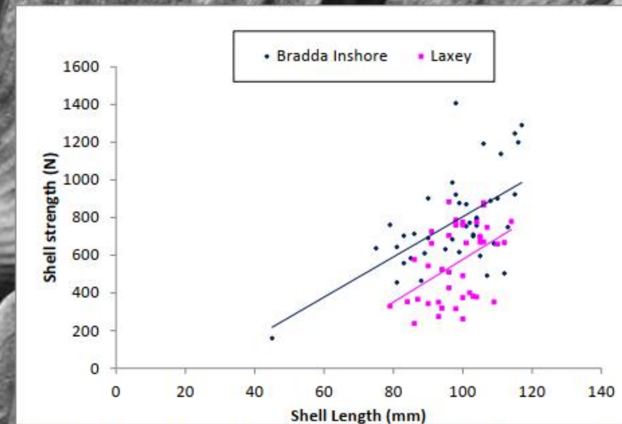


Figure 3. Spatial and ontogenetic variation in the shell strength (Newtons) of *Pecten maximus* on two fishing grounds around the Isle of Man. As measured with a Tinius Olsen machine fitted with a steel rod (see left).

- Damage to both target and non target-species was highly variable, both temporally and spatially but little related to any of the explanatory variables measured
- Lethal damage to king scallops was consistently higher on some grounds than others
- Subsequent analysis of shell strength and structure explained much of the variation in scallop damage levels

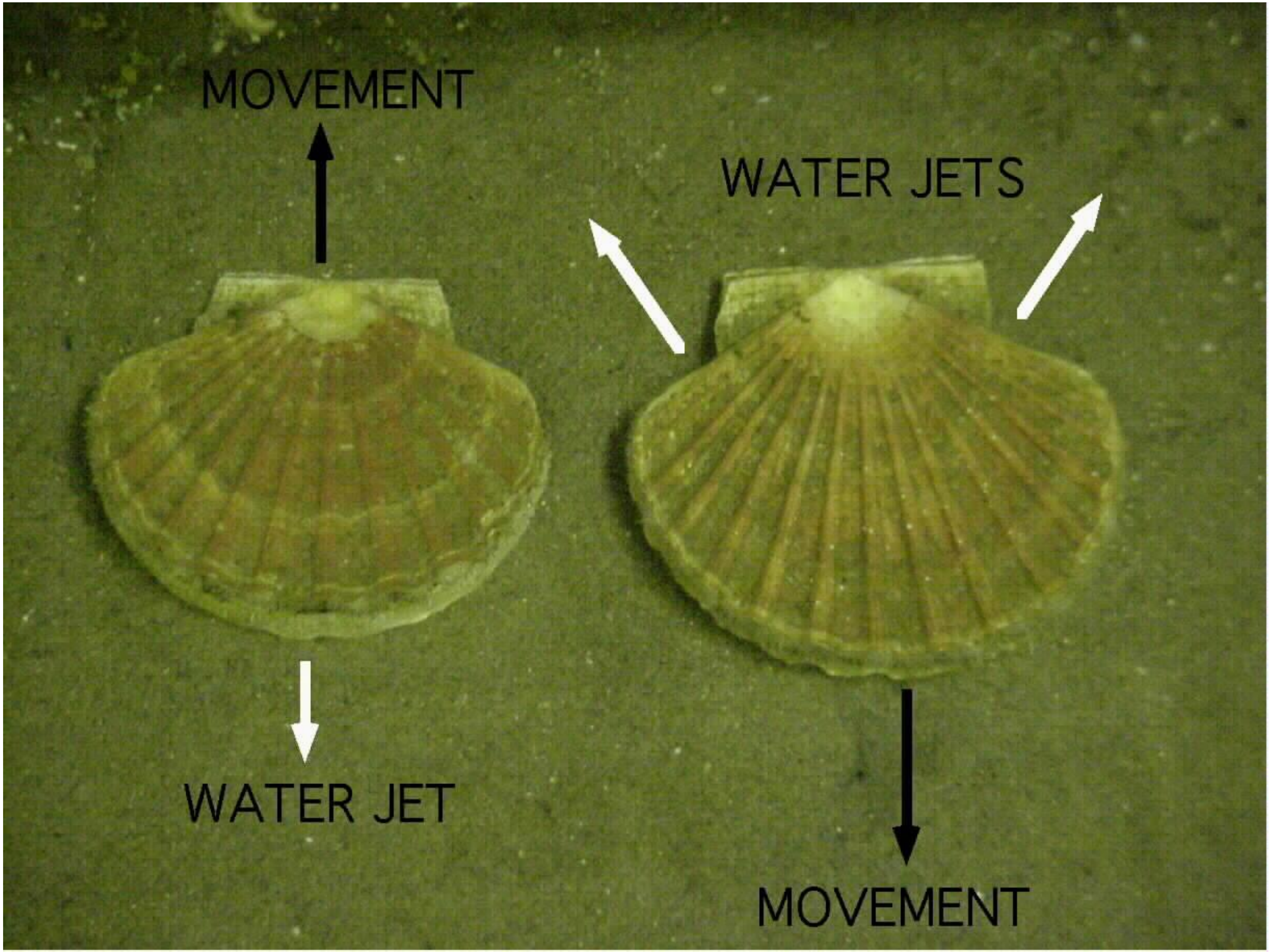
Conclusions

- Variation in **shell thickness, structure and strength** of scallops' shells appeared to be the **principle driver** for variation in **damage** levels
- Majority of the damage occurred during initial impact with the **dredge teeth**
- Variation in shell strength was **not related to factors** such as growth rate, habitat type or water depth
- Possible contamination with heavy metals at the Laxey site

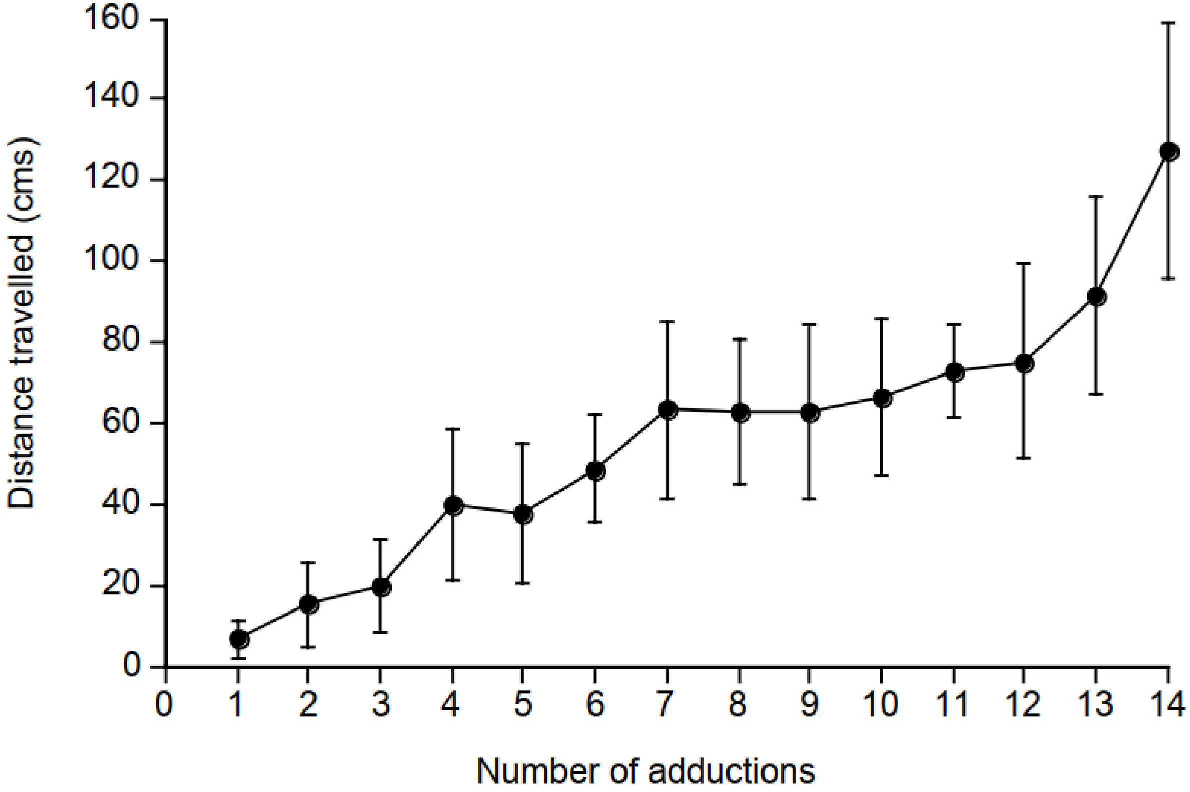
Scallop behaviour

- Experiments to examine the effect of simulated dredging on scallop behaviour
- Swimming defined as four adductions or more
- Scallops bolted to a rock in an experimental tank and stimulated with a starfish arm
- Responses monitored for 24 hours

Scallop escape responses

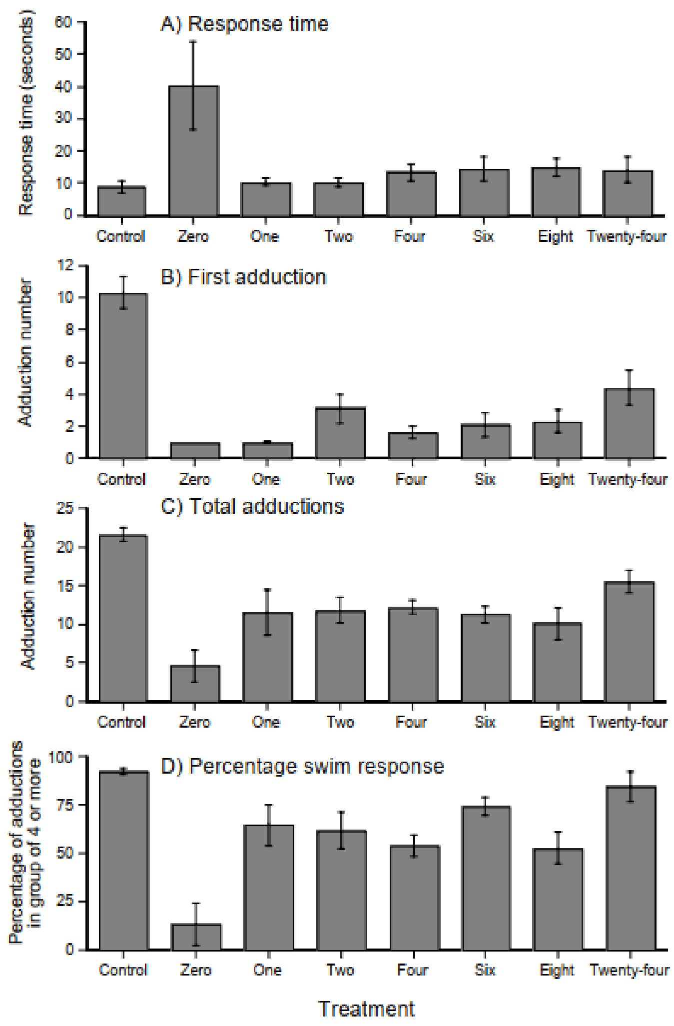


Swim response of scallops
Distance travelled vis number of adductions




3

Responses



A) Response time
Response time (seconds)
60
50
40
30
20
10
0
Control
Zero
One
Two
Four
Six
Eight
Twenty-four
B) First adduction
Adduction number
12
10
8
6
4
2
0
C) Total adductions
Adduction number
25
20
15
10
5
0
D) Percentage swim response
Percentage of adductions in group of 4 or more
100
75
50
25
0
Treatment

Adenylic Energetic Charge (AEC)

AEC = (ATP + 0.5ADP) / (ATP + ADP + AMP)

ATP = adenosine tri-phosphate - maximum energy

ADP = adenosine di-phosphate -intermediate energy

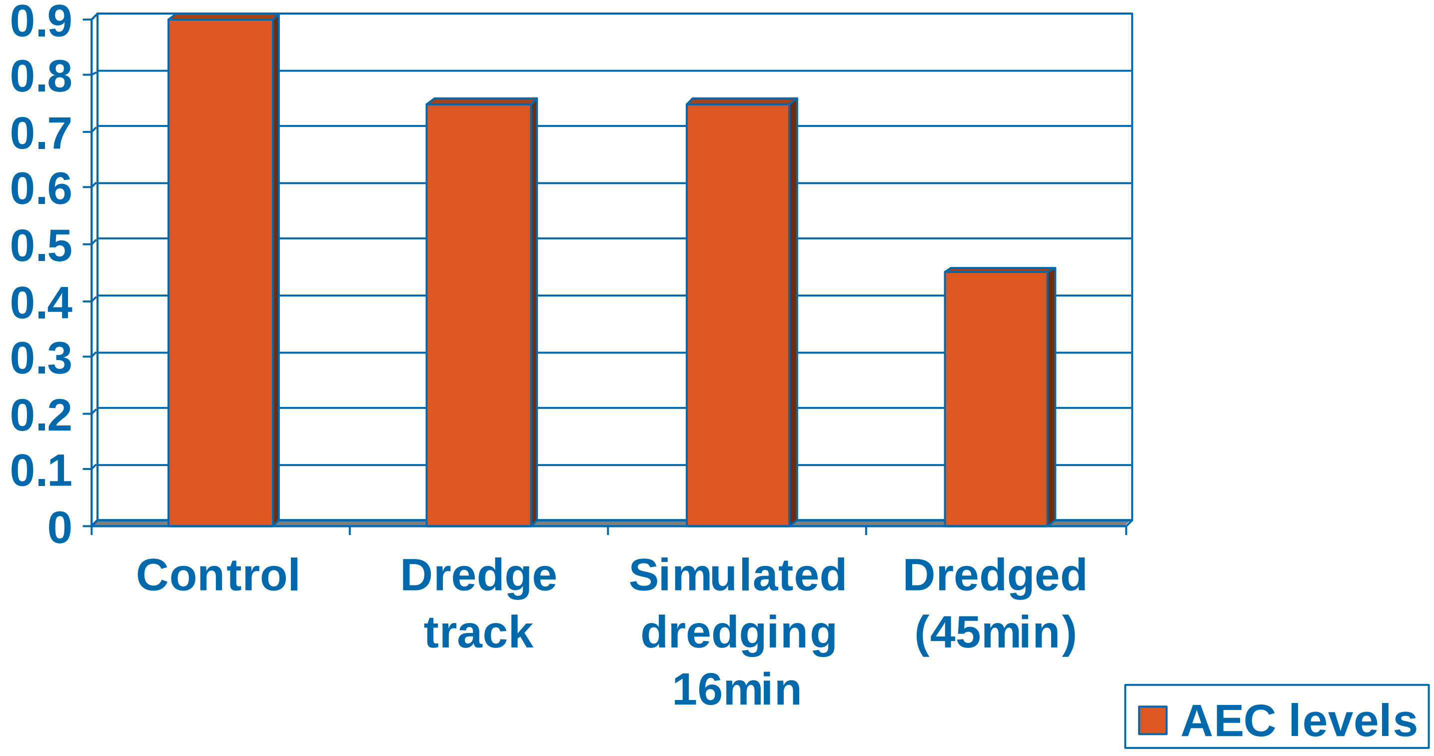
AMP = adenosine mono-phosphate - no energy

AEC = 0 -all nucleotides are AMP;

AEC = 0.4 - High stress

AEC = 1 -all nucleotides are ATP; low stress

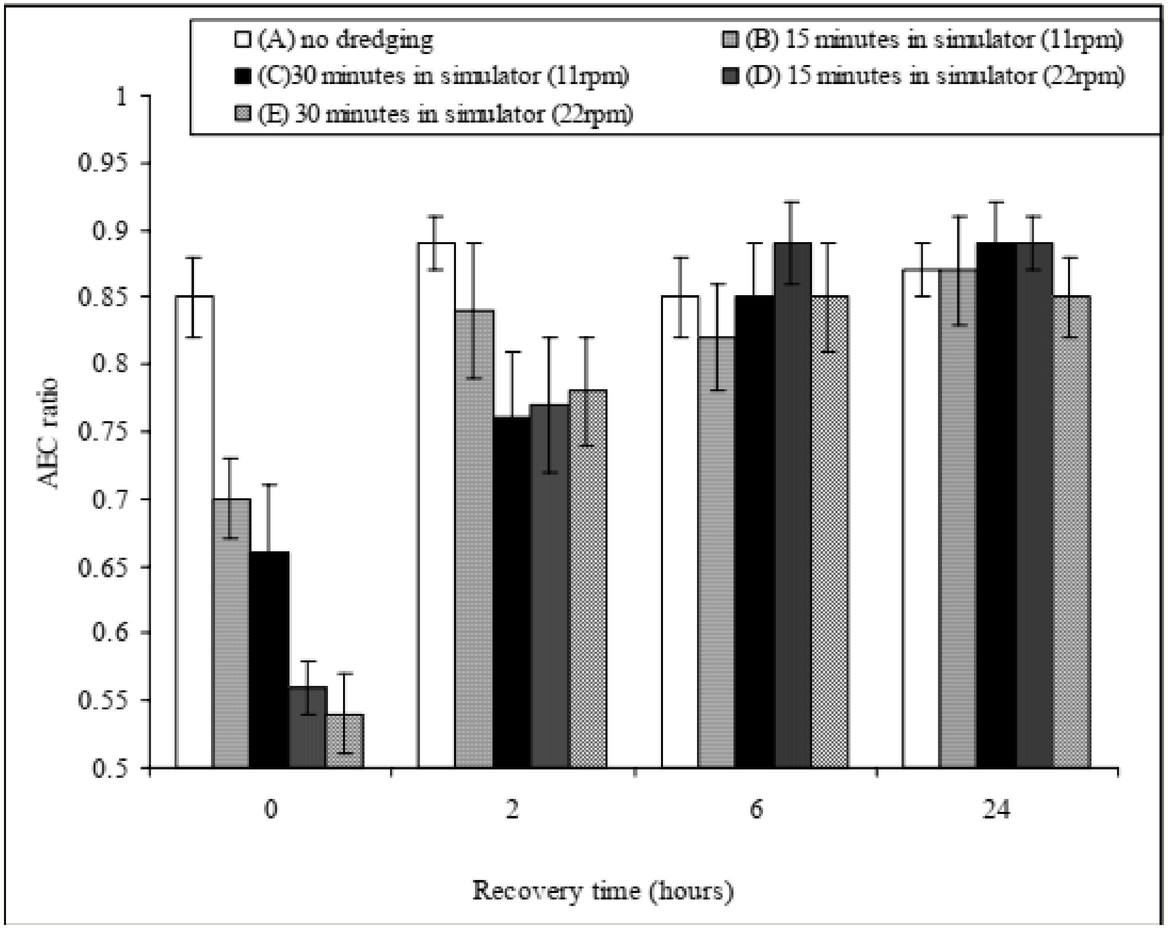
Stress on scallops



Scallops stressed by dredging but can recover; 6 hours

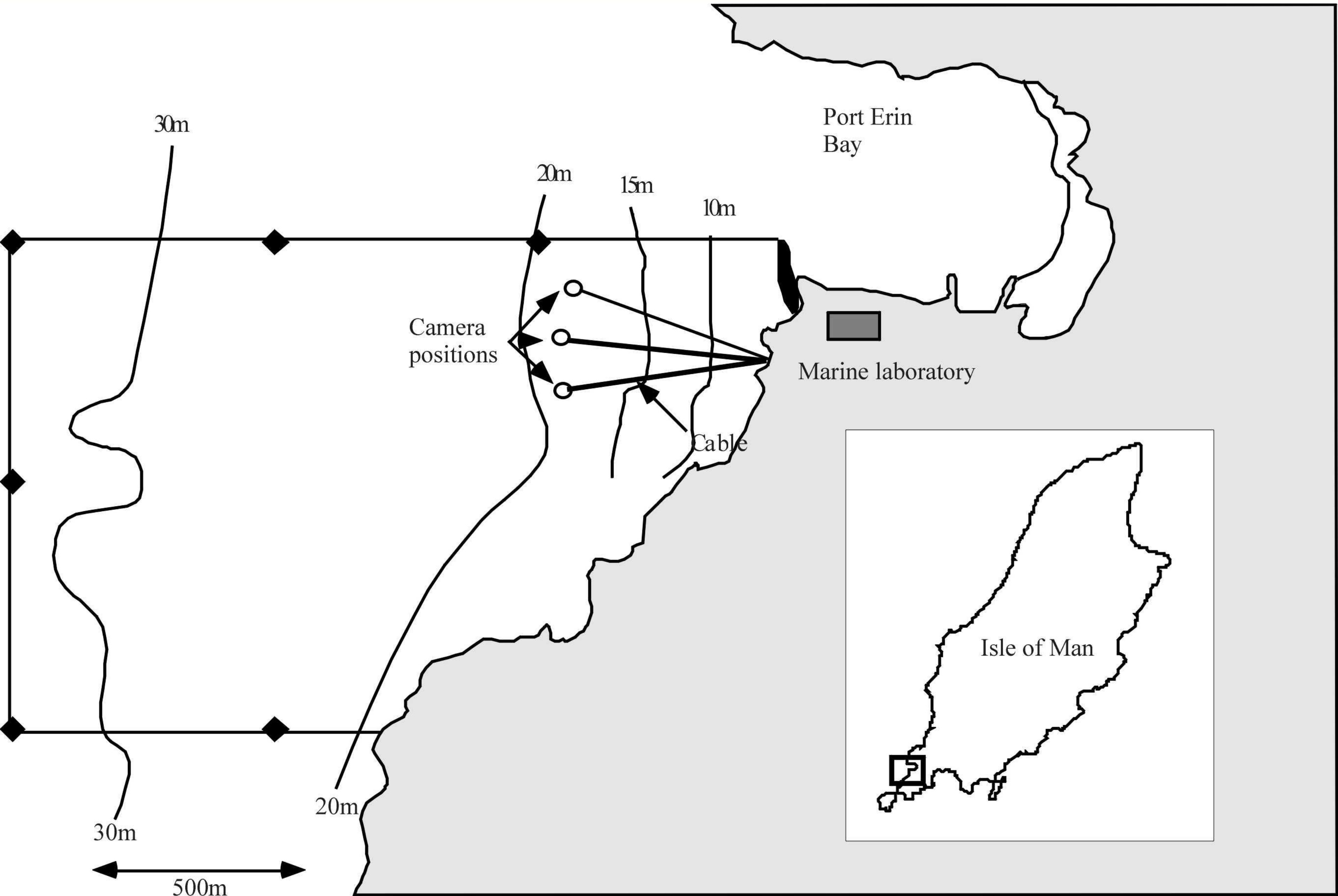
Behaviour in response to predators also altered up to 24 hours

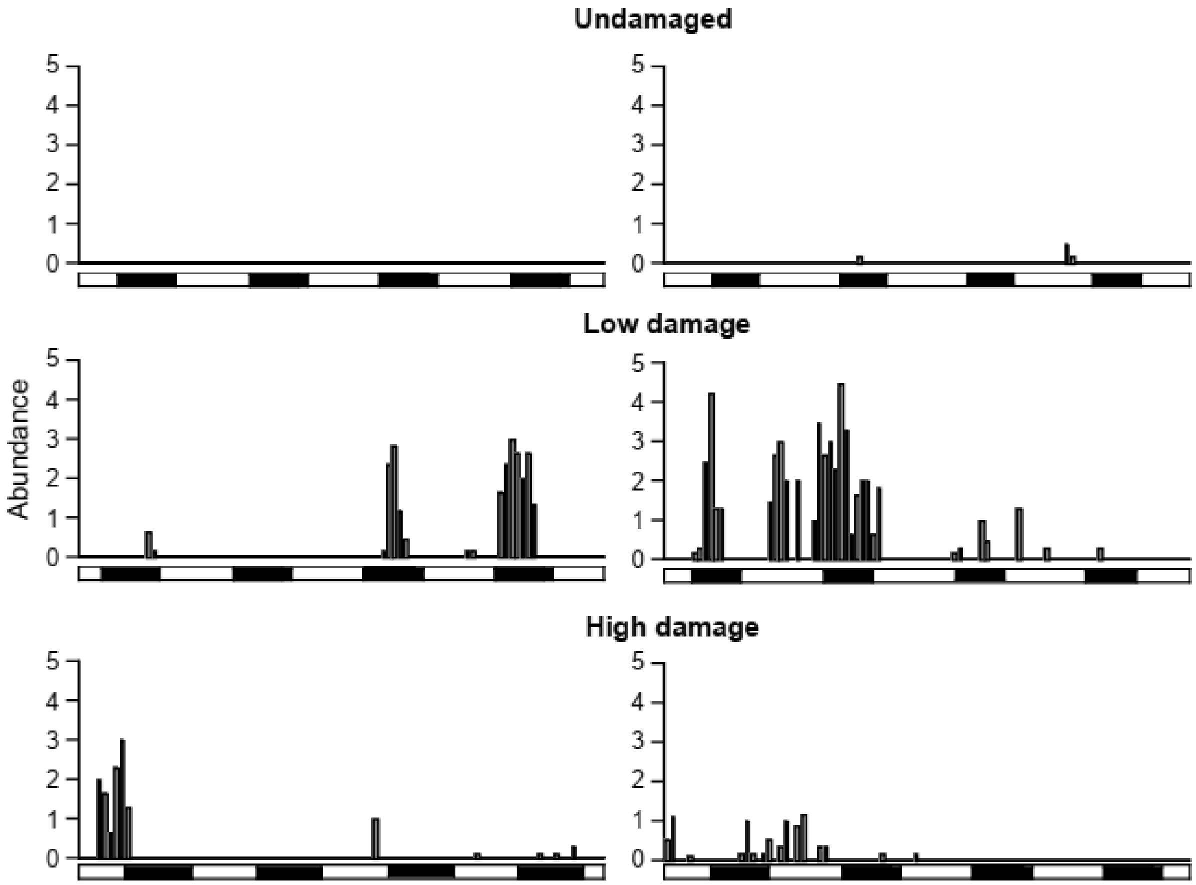
Recovery of AEC after different stress levels



- Do predators aggregate to discarded material?
- What species are involved?
- What are the rates of aggregation?
- Does the level of damage in discards affect aggregation level and rate?
- How does the spatial distribution of discards affect predator aggregation?
- Do predators/scavenger populations benefit?

Position of underwater camera





Mean hourly abundance of *Cancer pagurus* for two replicate periods in each of the three damage treatments. Different predators different dynamics

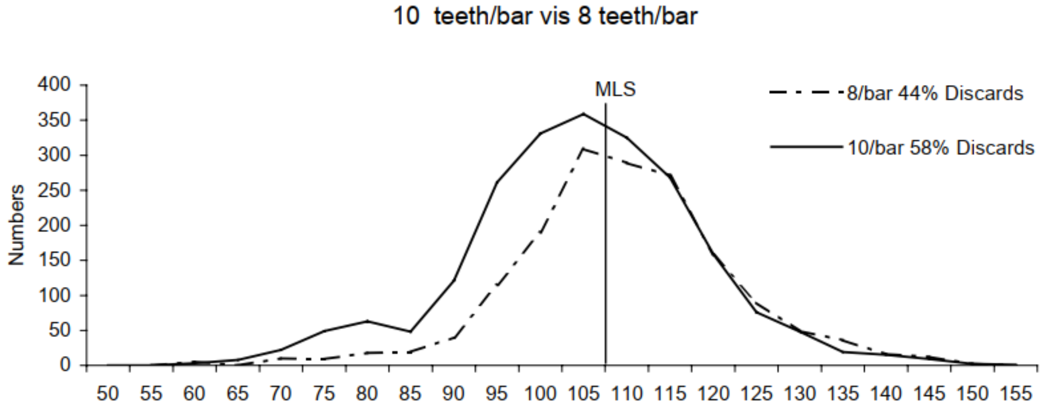
Mortality of scallops

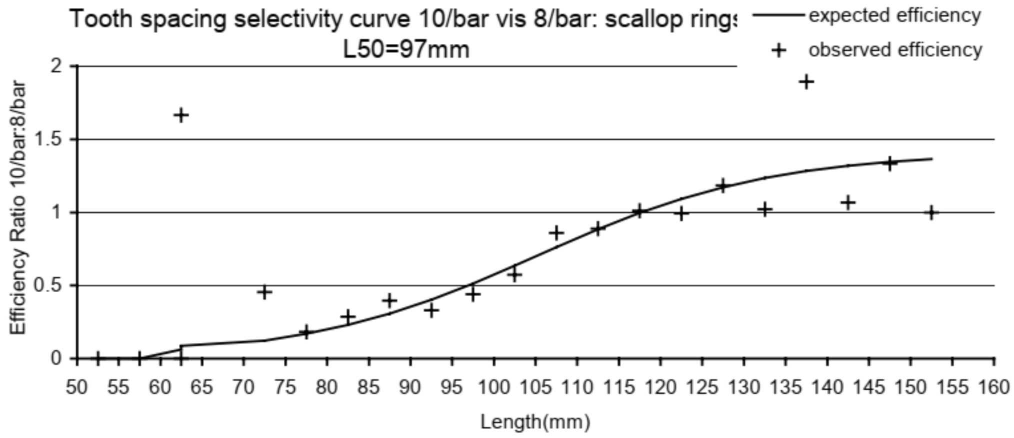
- Density of scavengers at dredged but undamaged bait was equivalent to the density during unabated periods.
- For the damaged scallops there was a significant increase in invertebrate scavenger density over the study period of 96 hours.
- The badly damaged scallops were all eaten within just over 24 hours for each of the 2 replicate periods.
- The scallops that were lightly damaged survived longer, but survival rates differed among replicates.
    - Replicate 1 all scallops survived for 48 hours, and were eaten over the second half of the recorded
    - Replicate 2, half of all scallops were eaten after only 12 hours, but some survived for up to 48 hours
    - Replicate 2; the third baiting event (for which video records were incomplete) nearly half of all tethered scallops survived the full 96 hour period

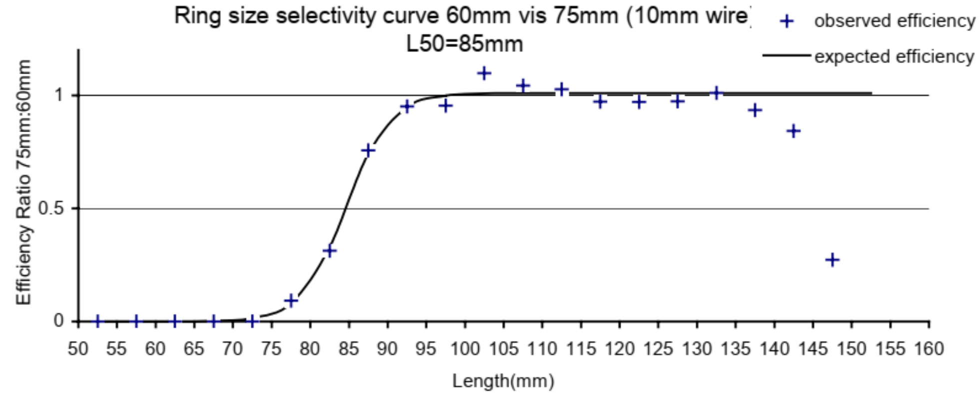
Scallop dredge selectivity

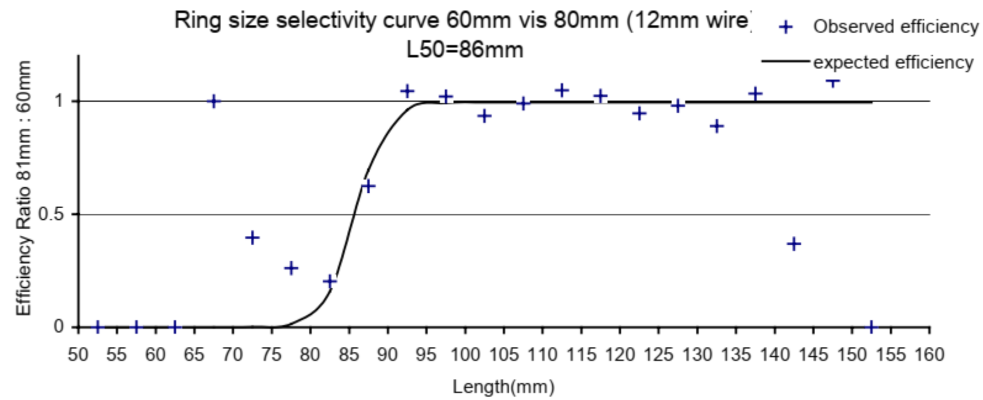
Experiments to examine effect of ring size, tooth spacing on selectivity

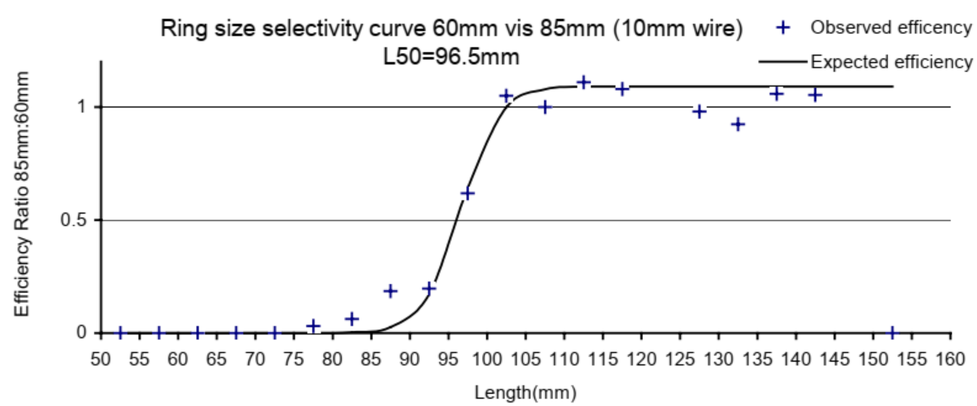
Teeth selectivity






Ring size selectivity curve 60mm vis 75mm (10mm wire)
L50=85mm
observed efficiency
expected efficiency
Efficiency Ratio 75mm:60mm
0
0.5
1
50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160
Length(mm)


Ring size selectivity curve 60mm vis 80mm (12mm wire)
L50=86mm
Observed efficiency
expected efficiency
Efficiency Ratio 81mm : 60mm
0
0.5
1
50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160
Length(mm)


Ring size selectivity curve 60mm vis 85mm (10mm wire)
L50=96.5mm
Observed efficency
Expected efficiency
Efficiency Ratio 85mm:60mm
0
0.5
1
50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160
Length(mm)

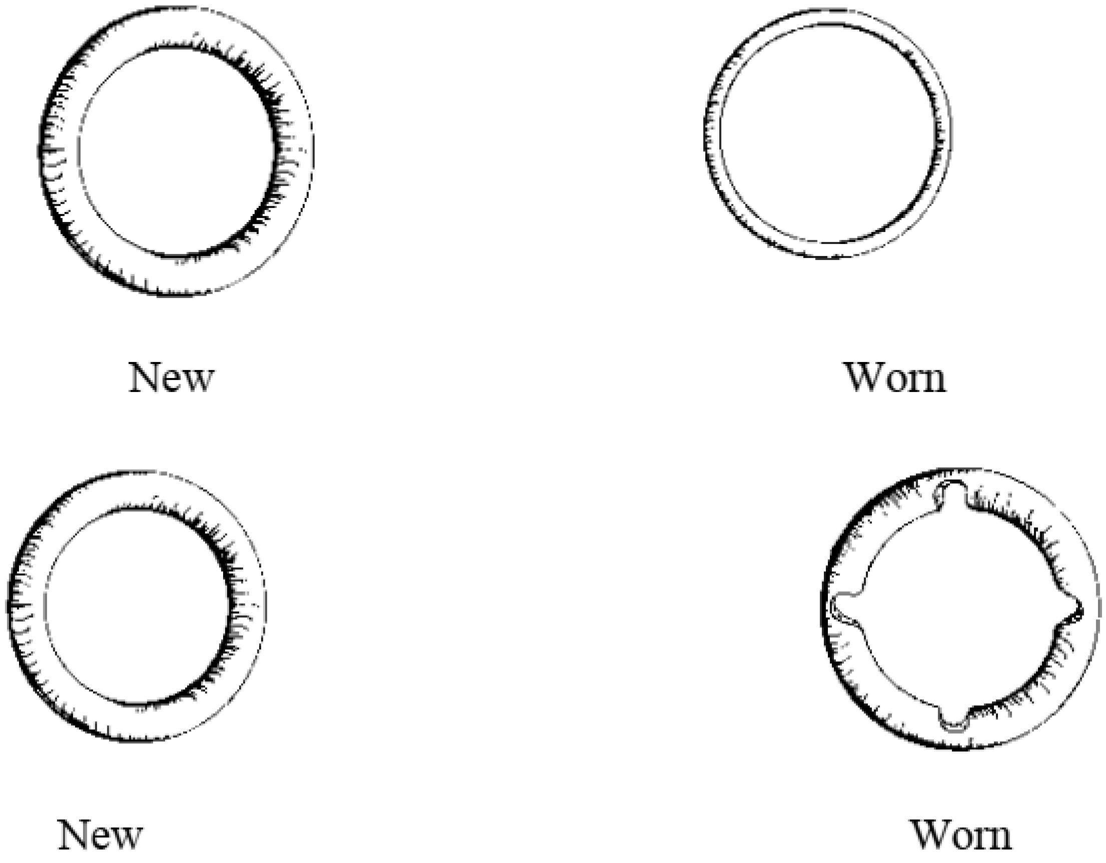
New ring selectivity

Ring dimensions		Estimates of L_{50}, L_{25} & L_{75} (mm)					Selection factor	Maximum asymtotic efficiency			α		
Ring id	Wire od	L_{50}	SD	CV %	L_{25}	L_{75}		Estimate	SD	CV %	Estimate	SD	CV %
75	10	84.6	5.1	6	78	91	0.89	1.0	0.2	15	0.35	0.5	152
85	10	96.6	2.9	3	91	102	0.88	1.1	0.1	10	0.41	0.4	104
92	10	107.6	3.8	4	103	112	0.90	0.8	0.2	22	0.52	1.1	219
80	12	85.8	3.3	4	81	90	0.93	1.0	0.1	12	0.50	0.7	134
85	12	96.7	4.2	4	87	106	0.88	1.2	0.2	14	0.22	0.2	81
88	12	98.3	5.2	5	90	107	0.86	0.9	0.1	17	0.26	0.3	117

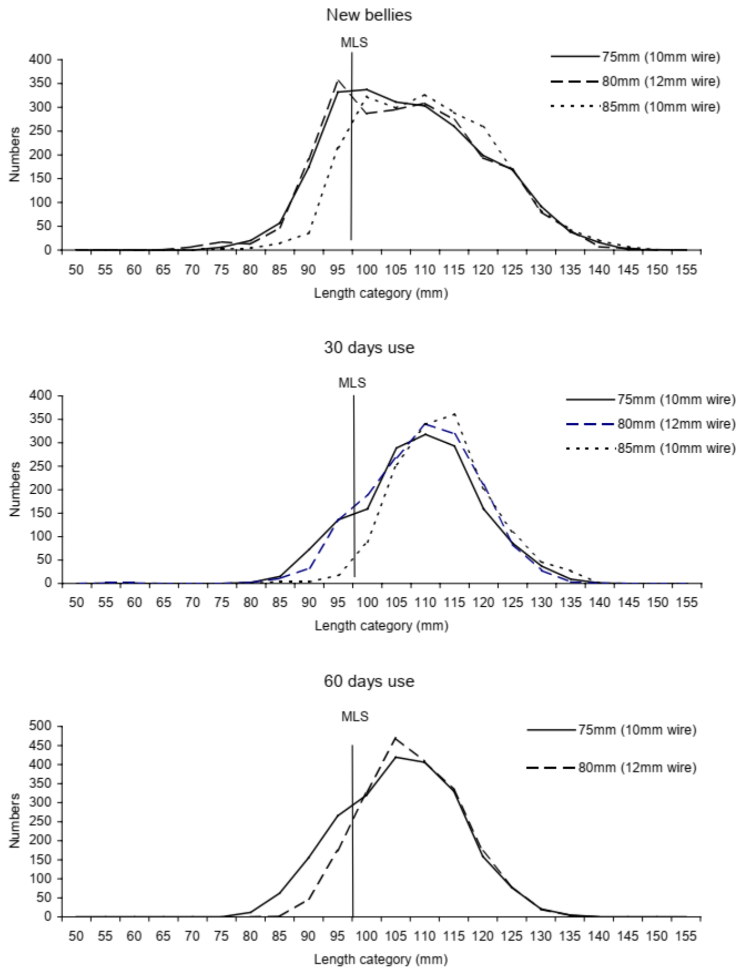
Relative strength of bellies (10mm wire 9 rings across) to a 75mm ring (10mm wire belly 10 rings across)

Ring internal diameter mm	Wire thickness	Relative Strength %
80	12	141
85	10	81
88	12	132
92	10	76

Wear on bellies is an issue for strength and selectivty

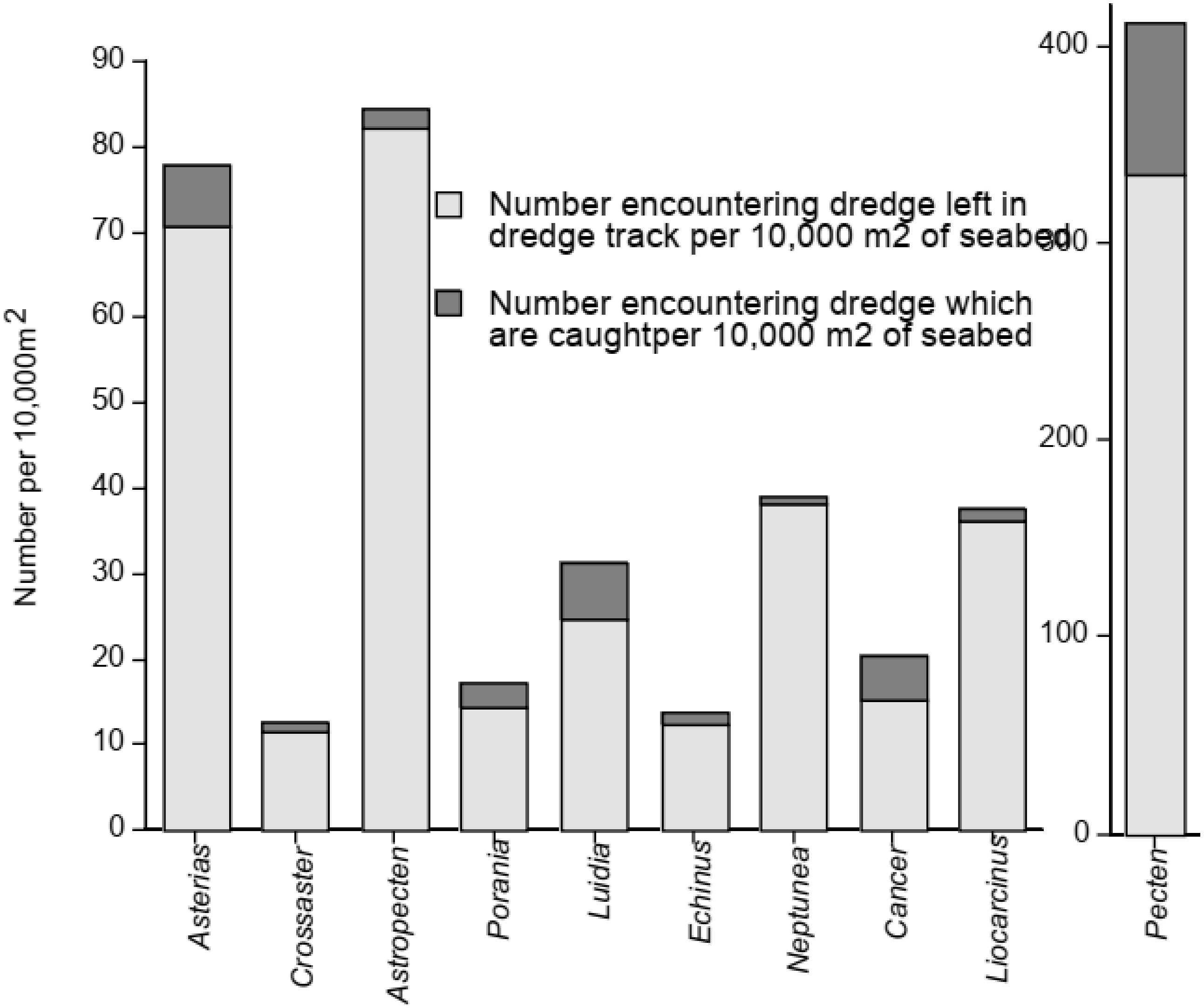


Effect of wear



Bycatch

Observations on dredge efficiency



Bycatch

ICES have it in the ToR of WG Scallop to assemble bycatch information

For further details contact:

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seafish.org.uk

Thank you