HOW DO WE ASSESS BENTHIC FISHERIES IMPACTS IN NEW ZEALAND ?

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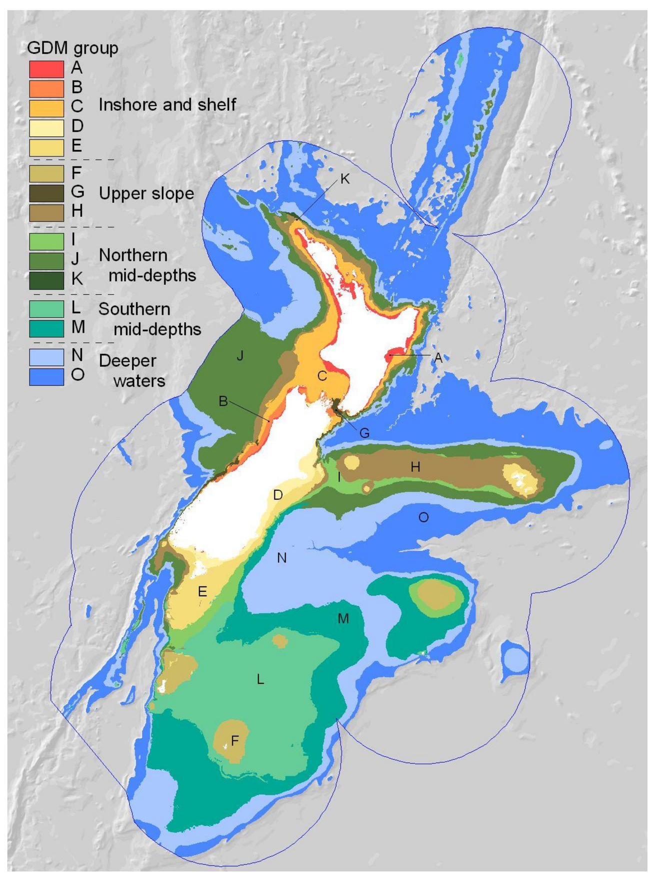
WHERE ARE THE DIFFERENT HABITATS?



The table right and the figure above show the characteristics and spatial distribution of the BOMEC classes when applied across the EEZ at a 15 class level

From: Leathwick *et al.* 2009.

- Distributional data for eight taxonomic groups have been used to train an environmental classification for those parts of New Zealand's 200 n. mile Exclusive Economic Zone (EEZ) with depths of 3000 m or less.
- A variety of environmental variables were used as input to this process, including estimates of depth, temperature, salinity, sea surface temperature gradient, surface water productivity, suspended sediments, tidal currents, and seafloor sediments and slope.
- These variables were transformed using a function that indicates relationships between species turnover and environment for each species group.
- Groups at a fifteen group level of classification appropriate for use at a whole-of-EEZ scale are described here.

Group	Extent (km^2)	Depth (m)	Temperature	Salinity (psu)	SST Gradient	Productivity ($mgC\ m^{-2}\ d^{-1}$)	Tidal current ($m\ s^{-1}$)	Sediment size (mm)	Orbital velocity (dm s-1)	Sediment resuspension	Suspended pm. (arbitrary units)	Dissolved org. matt. (arbitrary units)	Seabed Relief
A	21 603	25.6	2.59	35.35	0.015	1 333.6	0.2	1.66	317.5	-2.7	1.63	0.22	4
B	10 852	63.9	0.74	35.05	0.027	1 490.7	0.26	0.43	123.7	-2.7	0.83	0.2	6.7
C	71 553	104.7	2.06	35.27	0.018	950.7	0.28	0.56	36.9	-3.3	0.23	0.07	4.1
D	26 006	38.6	-2.07	34.65	0.02	888.7	0.3	1.97	269.1	-2.9	0.83	0.15	4.1
E	61 870	136.3	-1.26	34.65	0.03	500.1	0.5	2.46	50.8	-3.6	0.18	0.06	6.3
F	45 657	178.1	-2.96	34.43	0.007	299.4	0.45	2.88	50.1	-4.2	0.15	0.04	5.2
G	5 652	230.5	1.02	34.93	0.026	1 060.6	0.51	0.88	20.2	-6.1	0.34	0.1	45.1
H	121 749	337	1.27	34.75	0.026	674.5	0.26	0.6	0.4	-7.8	0.17	0.06	10.8
I	53 098	559.8	-0.47	34.41	0.033	452	0.21	0.42	0	-9.9	0.17	0.05	11.4
J	265 262	834.4	0.95	34.51	0.015	574.3	0.15	0.22	0	-10	0.15	0.04	15.9
K	881	1 018.3	1.2	34.91	0.051	691.8	0.46	0.61	0	-9.1	0.14	0.04	92.5
L	239 967	531	-0.38	34.42	0.007	230.5	0.17	0.43	0	-9.2	0.12	0.02	3.5
M	282 114	883.7	-0.64	34.35	0.009	234.2	0.12	0.08	0	-10	0.12	0.02	5.9
N	468 651	1 397.5	0	34.53	0.011	379.4	0.1	0.13	0	-10	0.13	0.03	18.1
O	765 030	2 343.7	0	34.67	0.011	469.9	0.08	0.13	0	-10	0.13	0.03	27.7

For the Table above the units are: Temperature = from World Ocean Atlas, normalised to depth, SST gradient = (^{O}C km-1), Tidal curent ($m\ s^{-1}$), Sediment resuspension = from wave and current models, Seabed relief = Standard deviation of depths in a 3 by 3 km neighbourhood.

WHERE DOES FISHING IMPACT THE BENTHOS?

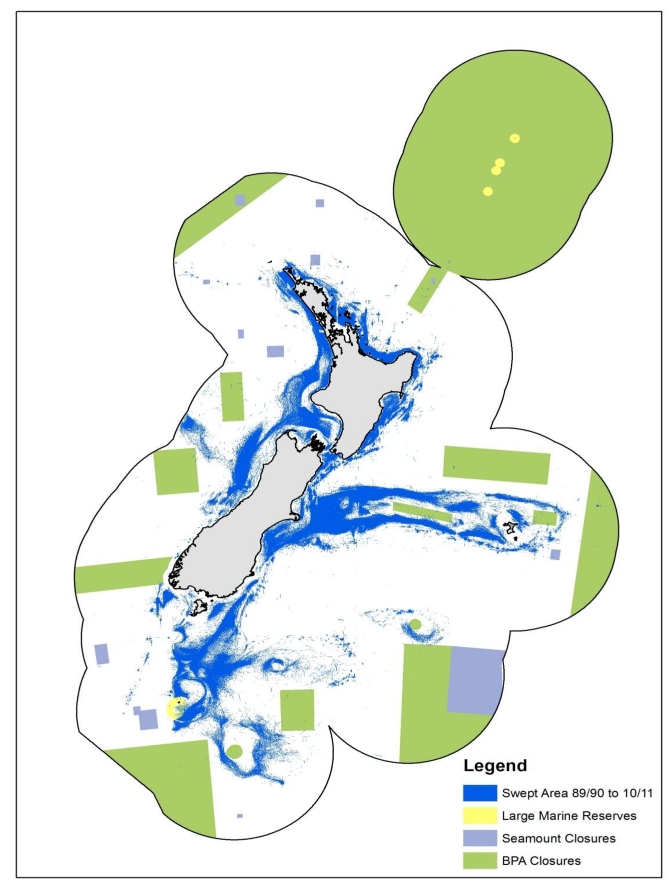
From: Black *et al.* 2013

•New Zealand's deepwater trawl footprint over the time period 1989/90 to 2010/11 has been mapped.

• Deepwater fisheries which incorporate most (but not all) of the effort for: eleven key target species (hake, hoki, jack mackerel, ling, orange roughy, oreo-dory, scampi, southern blue whiting, squid, barracouta and silver warehou) were analysed separately and in aggregate.

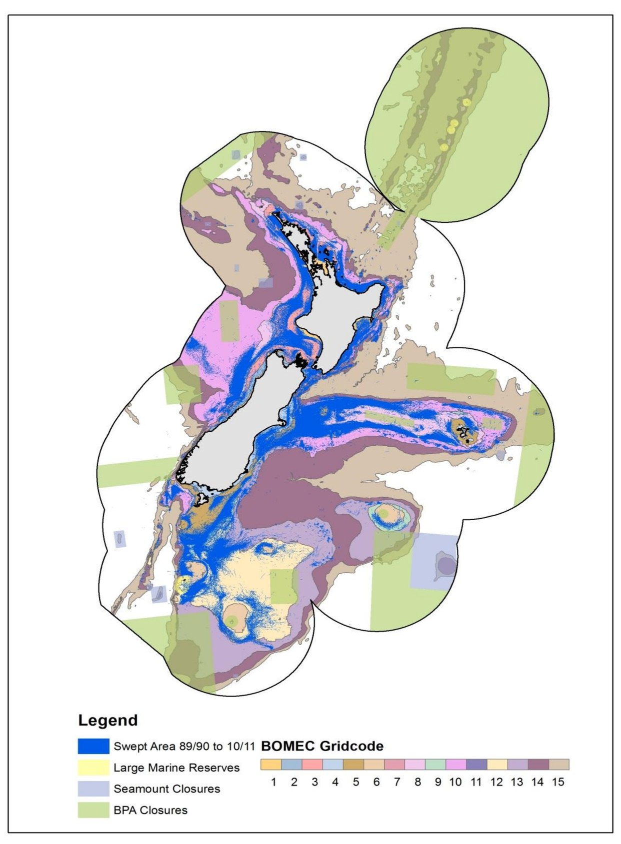
• The EEZ was divided into 5 km by 5 km cells and the number of tows and area of sea floor contacted by bottom fishing were estimated for each cell.

•The total swept area for all species from 1989/90 to 2010/11 is estimated to be 387,990 km^2 (about 9% of the EEZ and Territorial Sea).



Estimated total area of sea floor contacted by bottom trawling, 1989/90 to 2010/11 showing large fishing restrictions.

WHAT IS THE LEVEL OF OVERLAP BETWEEN HABITATS AND FISHERIES?



BOMEC code	Area (km^2)	Swept Area (km^2)	Swept Area (%)
1	27,557	12,484	45.30%
2	12,420	3,331	26.82%
3	89,710	58,234	64.91%
4	27,268	9,675	35.48%
5	60,990	26,781	43.91%
6	38,609	6,787	17.58%
7	6,342	3,056	48.18%
8	138,551	68,922	49.74%
9	52,224	38,300	73.34%
10	311,361	71,912	23.10%
11	1,289	14	1.10%
12	198,577	55,181	27.79%
13	233,825	18,737	8.01%
14	493,034	11,453	2.32%
15	935,315	2,459	0.26%
TOTAL	2,627,073	387,325	15%

The BOMEC classification and trawl footprint for all species, 1989/90 to 2010/11 (left) and associated area and swept area (km^2) statistics (above).

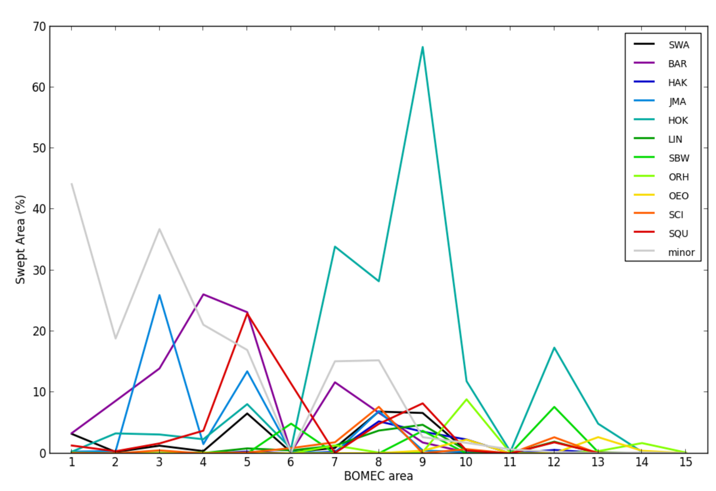
From: Black *et al.* 2013

• The trawl footprint area from the 21 years of analysis is estimated to be 27% of the area available for bottom trawling.

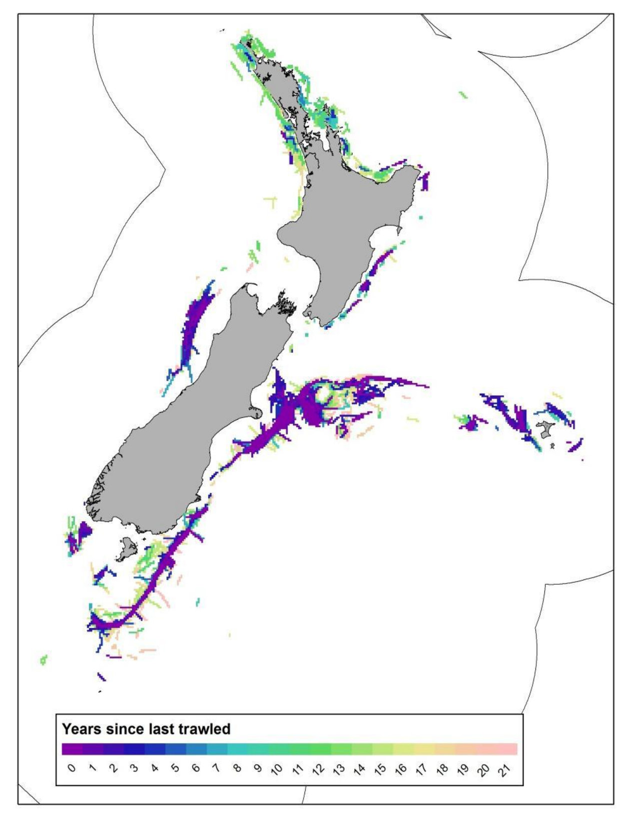
• The 15 BOMEC classification areas cover the area shallower than 3000m (2,627,073 km^2), approximately 63% of the EEZ and TS.

•The total swept area for all species is estimated to be about 15% of all the BOMEC zones, but differs between 0.3 and 73 percent per BOMEC zone.

•Almost 85% of the trawled area in this period was in the depth ranges 0-400 m (46%) and 400-800 m (38%).



Percentage of BOMEC areas swept by trawls for each of the 11 major species and the grouping of minor species considered by this report for fishing years 1989/90 to 2010/11.

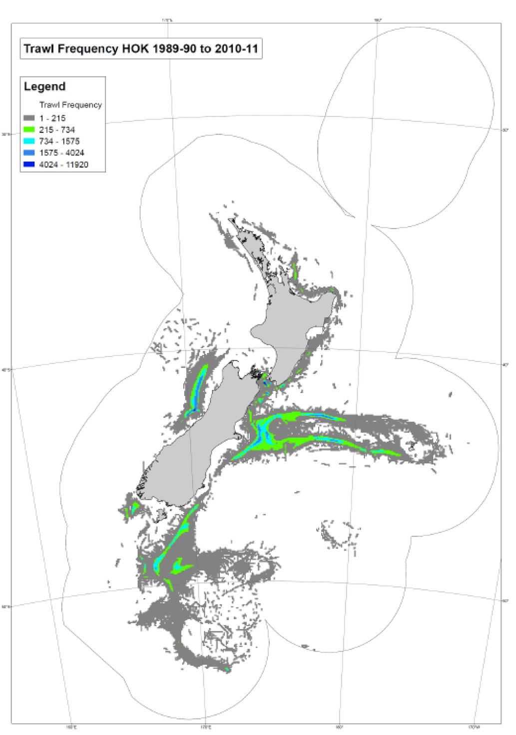


Years since last trawled in the silver Warehou fishery

WHAT IS AN ACCEPTABLE IMPACT ?

THIS WILL DEPEND ON SOCIETAL/POLITICAL PREFERENCE INFORMED BY ...

INTENSITY OF EFFECT



From: Black, *et al.* 2013.

•How management can best use this is an area for further development

•Statistics like below can be generated (relating to Hoki all years (figure left).

•Area trawled (including overlap) 1,657,046 km2

•11.8% of all cells contacted

•Highest trawl frequency 11,920 per cell

SENSITIVITY AND RECOVERABILITY

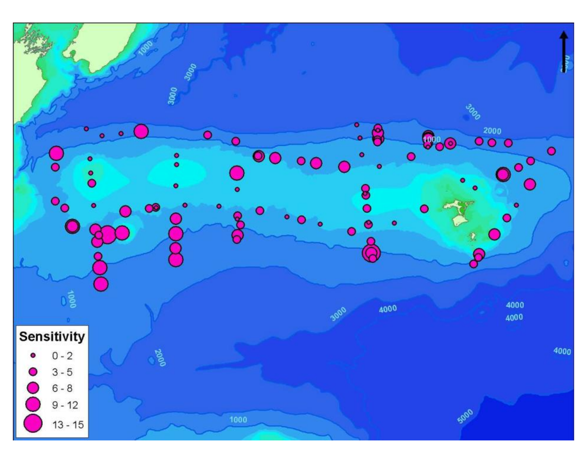
From Hewitt *et al.* 2011

•Both sensitivity and recoverability can be approached using trait-based analysis of community members (see the example table below).

•This can then be applied where species composition is known to get an indication of sensitivity to different levels of impact (figure) and to inform modelling approaches.

ATTRIBUTE	TRAITS	RESPONSE TO DISTURBANCE AND RATIONALE
Feeding	Scavengers and predators	Positive; Provision of additional food source
	Suspension, deposit, grazers	Neutral; this is a conservative interpretation as variability in the magnitude of positive or negative effects is likely to be dependent on location, disturbance regime and individual traits
Habit	Erect	Negative; liable to breakage
	All others	Neutral; other habits are encompassed in the analysis by attributes related to living position
Mobility	Sedentary	Strongly negative; Unable to move away from approaching disturbance
	Limited	Negative; may be able to move away
	High	Neutral; able to move away from (or bury below) approaching disturbance
Living position	Sediment surface	Strongly negative; will be disturbed
	In top 2cm of sediment	Negative or neutral dependent upon depth of disturbance
	Deeper than 2cm in sediment	Negative or neutral dependent upon depth of disturbance
Fragility	Very fragile	Strongly negative; Will be damaged/killed if disturbed
	Fragile	Negative; Will be damaged if disturbed
	Robust or not known	Neutral

The table above lists biological traits that define sensitivity to physical disturbance.



This graphic shows the number of taxa showing sensitivity to a light surface disturbance across the Chatham Rise.

CONNECTIVITY OF HABITATS

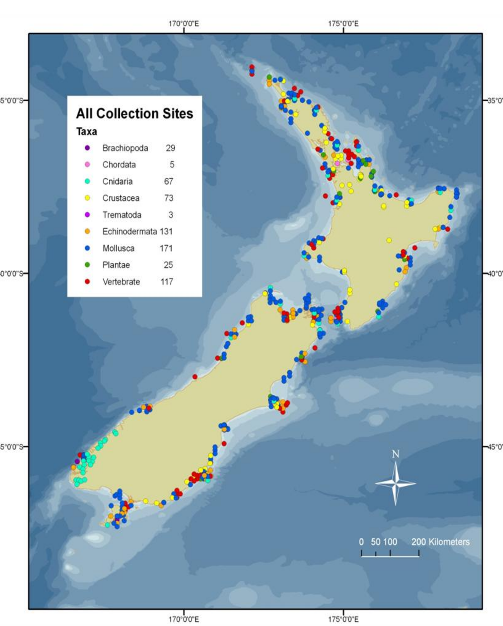
From: Gardner *et al.* 2010

• A literature review of New Zealand coastal genetic connectivity was completed and recommendations for future research made. Of the 58 species studies:
  - 20 of 58 species show a North-South Island split.
  - 16 of 58 species show no genetic structure.
  - 12 of 58 species show divergence within or among sites in an island
  - 9 of 58 species show increasing genetic isolation with increasing distance.
  - 1 of 58 species shows an East-West divergence.

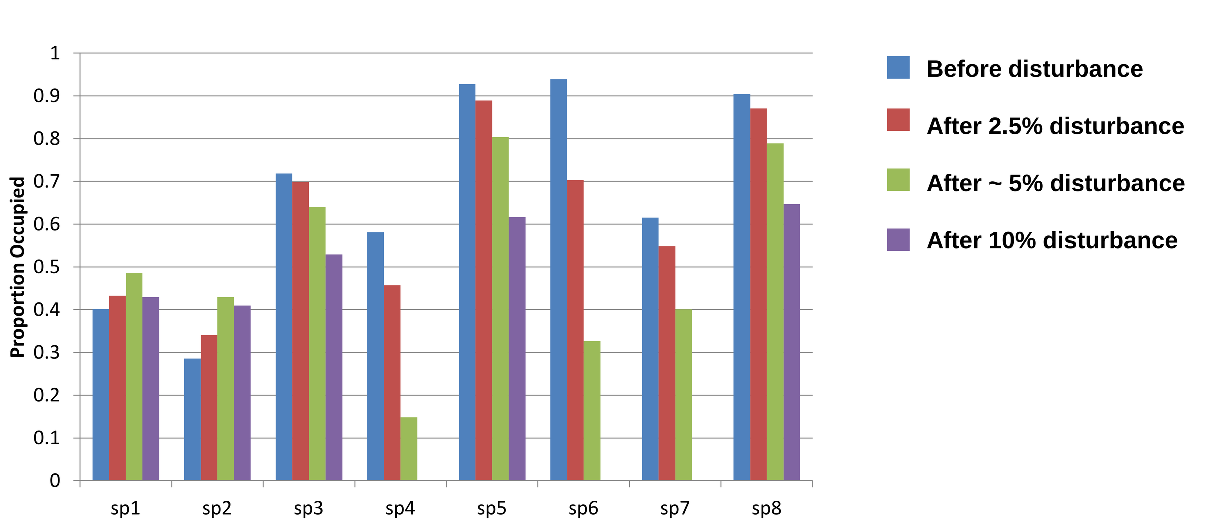
•Estuarine species were under-sampled and two species were suggested to address this gap.

The figure (right) shows the mix of taxa and locations reviewed in this study.

Connectivity in the deepwater is less well known



ONGOING WORK



Graphic showing the modelled response in terms of space occupied of 8 different functional groups of species (sp1-8) to increasing rates of disturbance (From Lundquist *et al.* 2013)

•Work on the vulnerability of different habitats to fishing disturbances

•Testing habitat predictions for inshore areas

•Ongoing bottom-contact footprint quantification

•Developing species distribution predictions for comparison with trawl footprints

•Benthic risk assessments to target mitigation or research

•Using modelling approaches to investigate potential impacts from different management options, using what is known above as inputs (see the graphic on the left for an example).

• Ongoing multivariate analyses of community structure show gradients of fishing intensity explain 15 to 54% of the explained variance in different soft-sediment communities.

References (available on request)

Black, J., Wood, R. 2013. AEWG Final Presentation for project DAE2010-04 (year 2) "Monitoring New Zealand's trawl footprint for deepwater fisheries" March 18th, 2013.

Gardner, J., Bell, J., Constable, H., Hannan, D., Ritchie, P., Zuccarello, G., 2010. Multi-species coastal marine connectivity: a literature review with recommendations for further research, New Zealand Aquatic Environment and Biodiversity Report. No. 58, 47 p.

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