

# Investigating Vulnerable Marine Ecosystems (VMEs) from Korean distant-water fisheries

Doo Nam Kim, Jae Bong Lee, Kyu Jin Seok and Dong Woo Lee

National Fisheries Research and Development Institute



# Vulnerable Marine Ecosystem (VME)

- Vulnerable = exposed, easily disturbed, and slow to recover
- The definition of VME should incorporate the spatial extent of the disturbance process (e.g. fishing effort) and the expected ability of the ecosystem to recover, implying that the results of a completed impact assessment are a necessary prerequisite for defining a VME
- Criteria for identifying VMEs include uniqueness or rarity of species or habitats, their functional significance, fragility, and structural complexity as well as life histories that limit the probability of recovery

**Information necessary to assess whether bottom fishing activities would have significant adverse impacts (SAIs) on vulnerable marine ecosystems (VMEs) including seamounts, hydrothermal vents and cold water corals**

Significant Adverse Impacts = Degrades long term ecosystem productivity, impairs (>20 years) recovery of biodiversity or habitat

- The spatial expanse of the impact
- The sensitivity of the ecosystem to impact
- Magnitude of allowable change of ecosystem function
- Magnitude of allowable decline in habitat and biodiversity and loss of indicator species
- The duration of time required for recovery
- The level of uncertainty associated with the above information needs

## **Information needs to survey seamounts for refugia**

- Observer-based Monitoring of Trawl Catch
- Location Records of Trawl Hang-ups
- Multibeam and Side-Scan Sonar Surveys
- ROV, Drop-Camera, Submersible Surveys

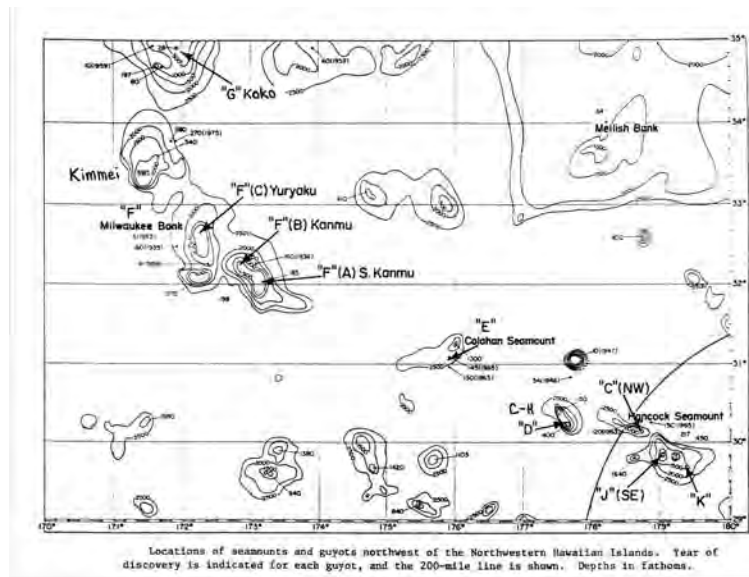
## Background

- Due to the shortage of data and information to define Vulnerable Marine Ecosystem Encounter, scientific observer aboard fishing vessel collect them in the North Pacific High Sea
- Major target fish species, such as alfonsin and amorhead, expect to be decided as management species for bottom trawl fishery around seamount in FAO 61 area, after North-western Pacific Bottom Fisheries Management Organization be established

# Purpose

- From deployment by international onboard observer to the distant-water fisheries in the North Pacific Ocean, data and information on all by-catch species and total quantity of VME-indicator organisms, such as corals, sponges and benthos, will be contributed to develop the process to estimate the cumulative impact of fishing activity on individual vulnerable taxa in the deep-sea region.
- At each step VMEs are displayed in tabular form and combined to derive an estimate of total cumulative impact by bottom fisheries.

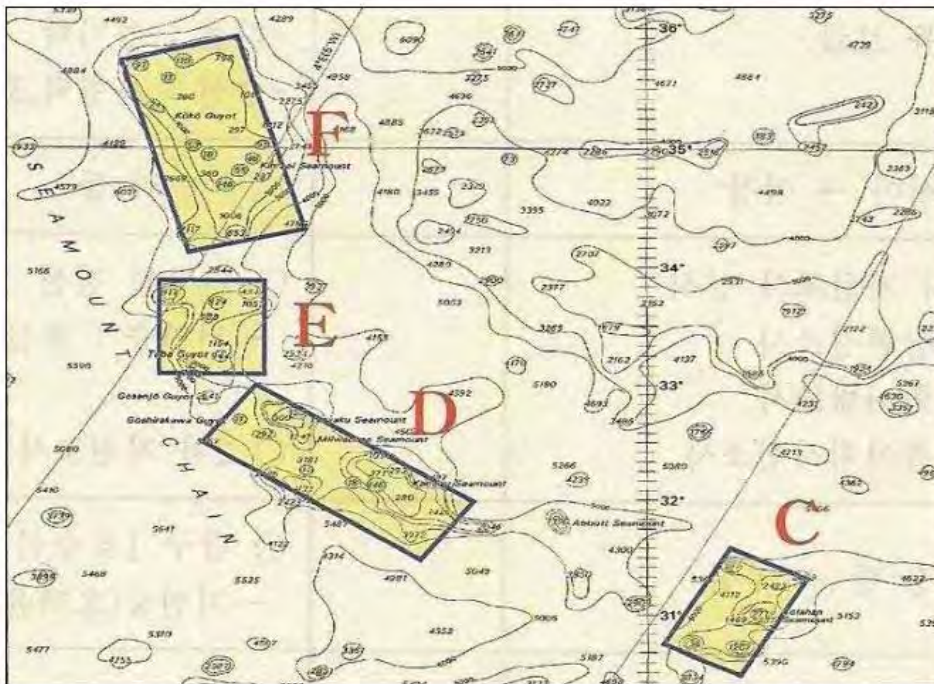
# Summary of Korean bottom trawl fisheries in North Pacific



Year	Trawl (no. of vessel)	Fishing day	Catch(kg)		Fishing ground
			N. Pacific Armorhead	Spkendid Alfonsin	
2001	0	0	0	0	-
2002	0	0	0	0	-
2003	0	0	0	0	-
2004	2	90	185	16	Jingu; Ojin; Koko; Milwaukee; Colahan; C-H
2005	1	146	141	513	Koko; Kinmei; Milwaukee; Colahan
2006	2	99	139	289	Koko; Kinmei; Milwaukee; Colahan
2007	1	164	89	325	Koko; Kinmei; Milwaukee; Colahan
2008	2	256	892	121	Koko; Milwaukee; Colahan
2009	2	164	100	31	Koko; Milwaukee; Colahan

# 2010 onboard survey

- Period: Feb. 25. – Jun. 23. 2010
- Area: Midway, North Pacific



- C Area : 31°03N/175°53E ~ 31°03N/175°55E  
31°00N/175°52E ~ 31°00N/175°52E
- D Area : 32°20N/172°42E ~ 32°20N/172°55E  
31°55N/173°07E ~ 31°55N/173°13E
- E Area : 32°43N/172°16E ~ 32°43N/172°19E  
32°40N/172°16E ~ 32°40N/172°19E
- F Area : 35°45N/171°00E ~ 35°45N/172°00E  
34°52N/171°45E ~ 34°52N/172°00E



# Vessel

- Name : # 96 Oyang
- Radio signal : DTBP6
- Gross/ Net tonnage/ Power : 360 ton /393 ton / 2900 HP
- Length (LOA): 60.53M / Width: 11M / Depth: 6.65M
- Volume : 687.66m<sup>3</sup>
- Fish Bond : 46.23m<sup>3</sup>
- Crew : Captain Yang-Woo Lee and 40 crews (Korean 10, Indonesian 18 , Philippine 12)

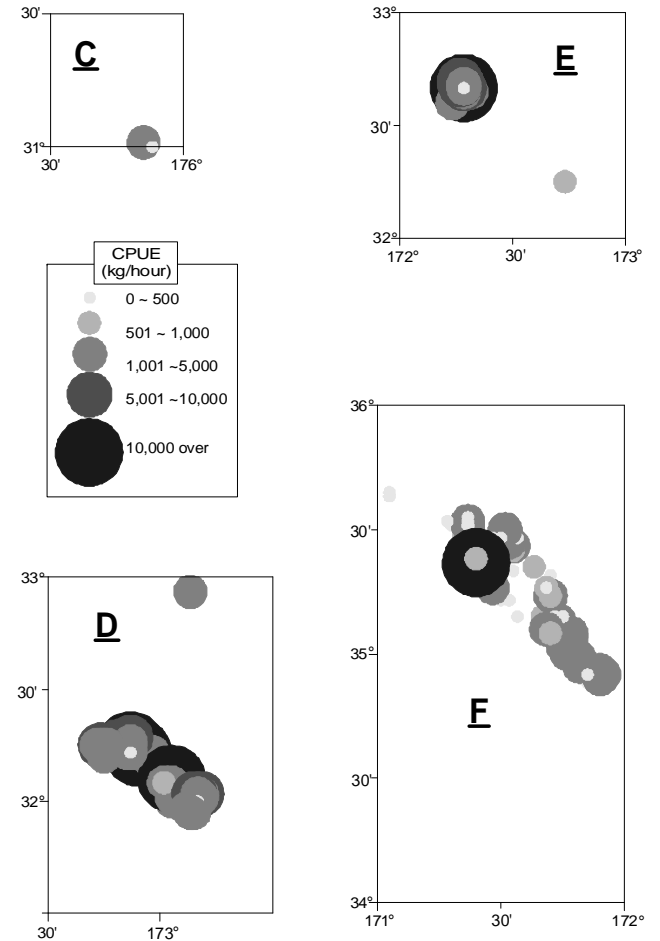
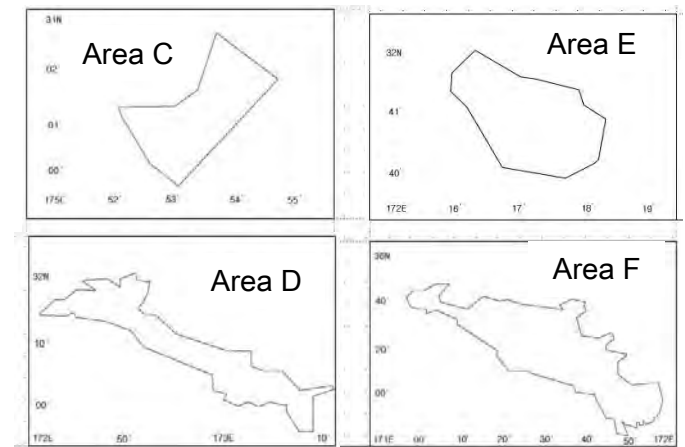
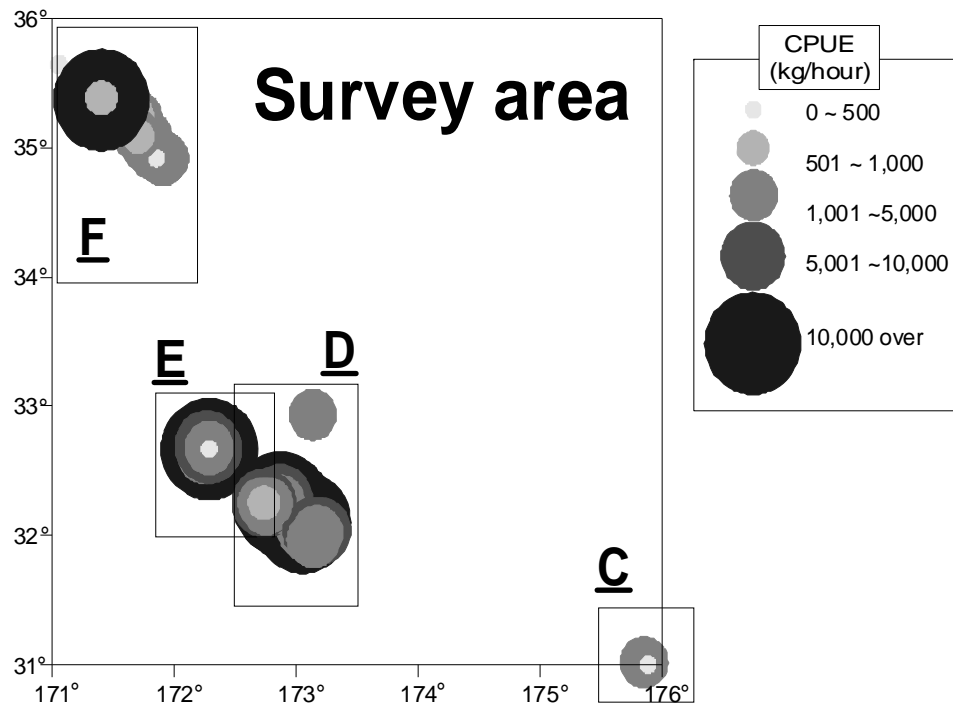


## Fishing gear • Bottom trawl

Part	Size	Part	Size
Net length	90.2m	Otter board weight (in air)	7100kg
Net body	77.37m	Otter board weight (in water)	6177kg
Net circumference	29.02m	Otter board size	3000 x 4700mm
Codend	20.3m	Chain weight (in water)	m/7.77kg
Net height (max/min)	11m/6m	Main warf	36mm
Net width (max/min)	240mm/120mm	Headrope	36.5m

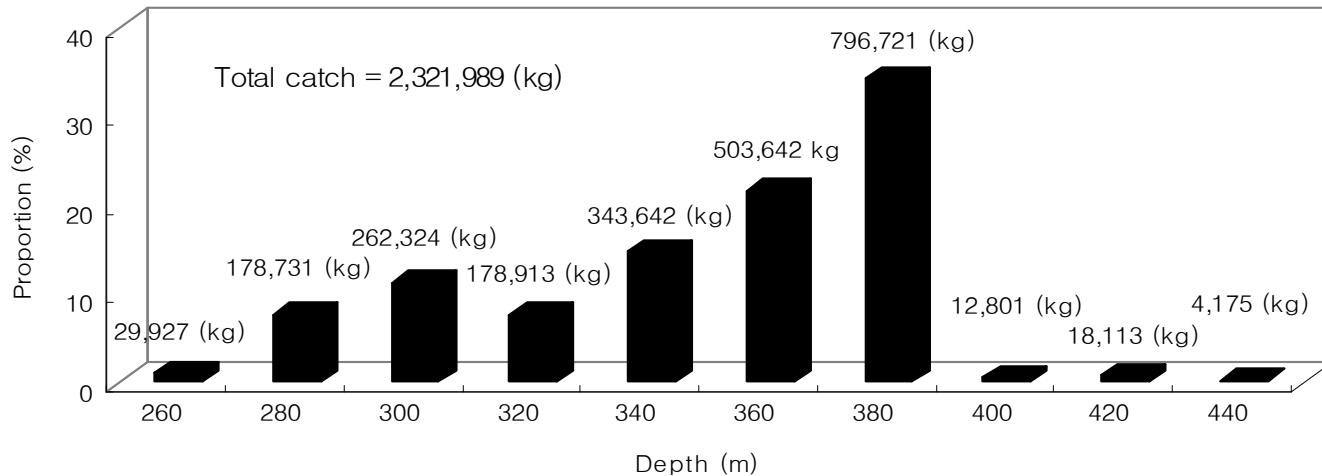
# Spatial pattern

CPUE (kg/hour) by area

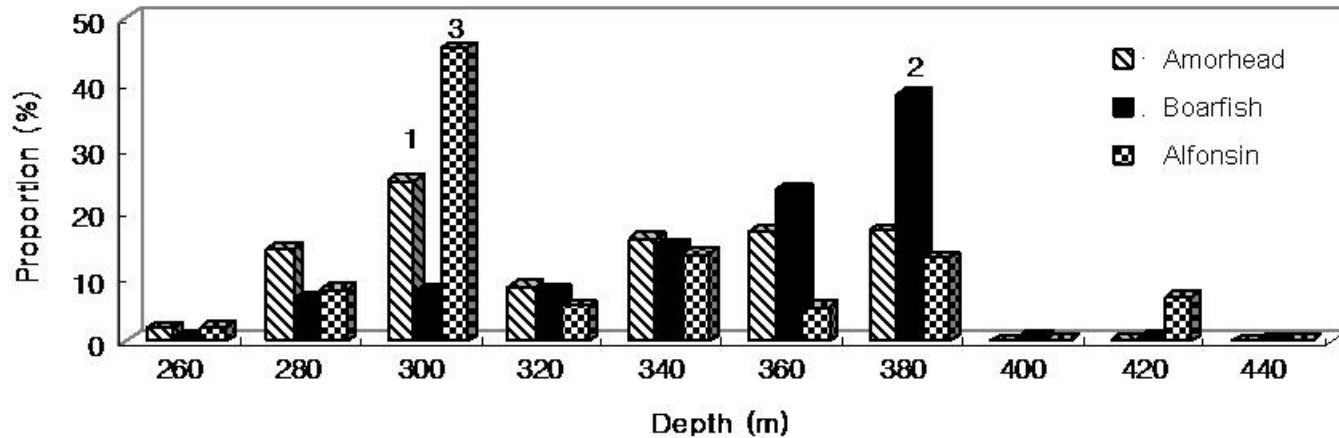


# Catch by depth (m)

## Total catch by depth



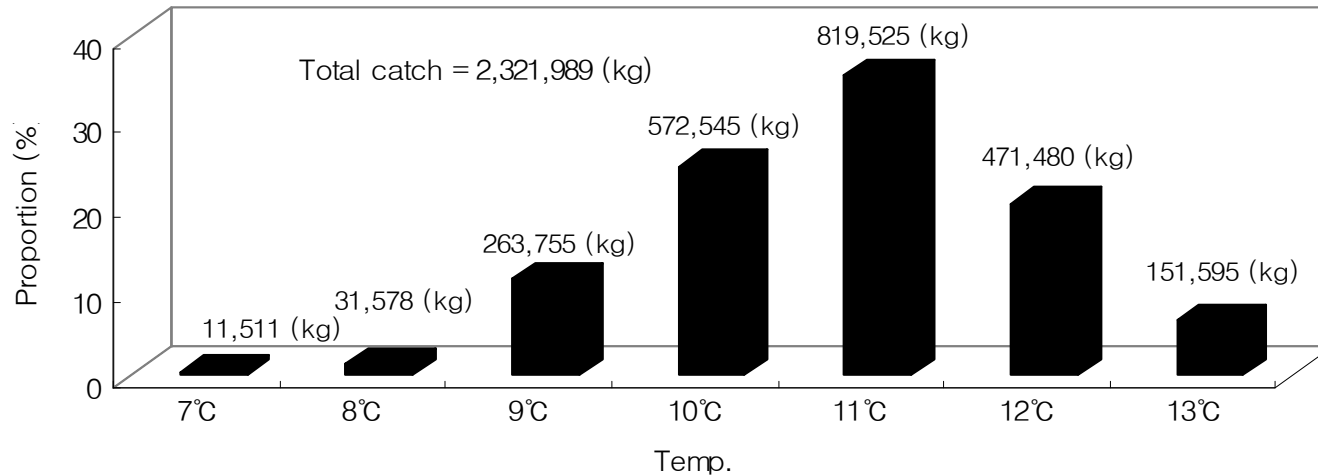
## Catch of target species by depth



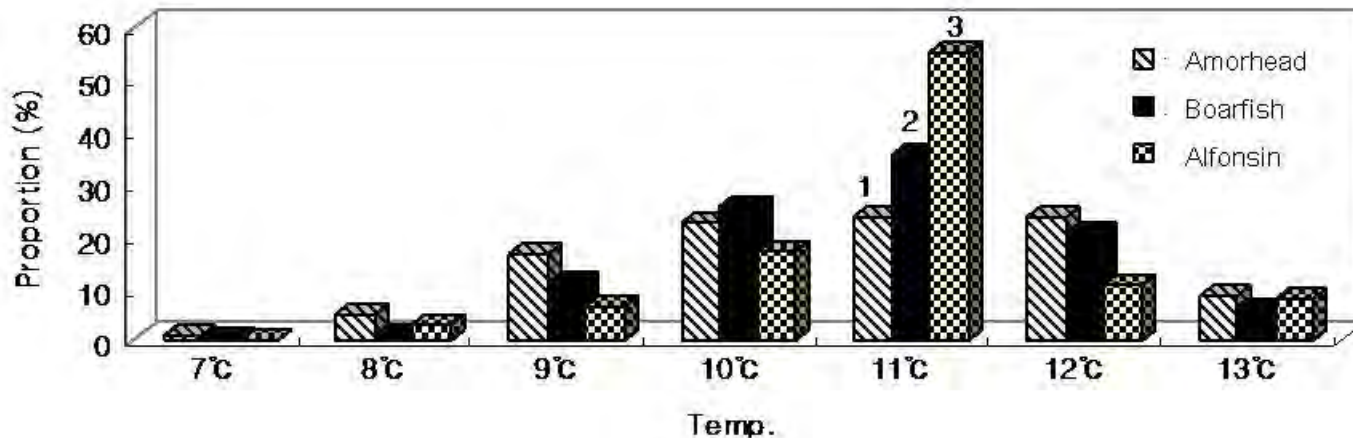
# Catch by temp.(°C)

- Unusually this year, catch was higher and seawater temperature was lower during fishing operation*

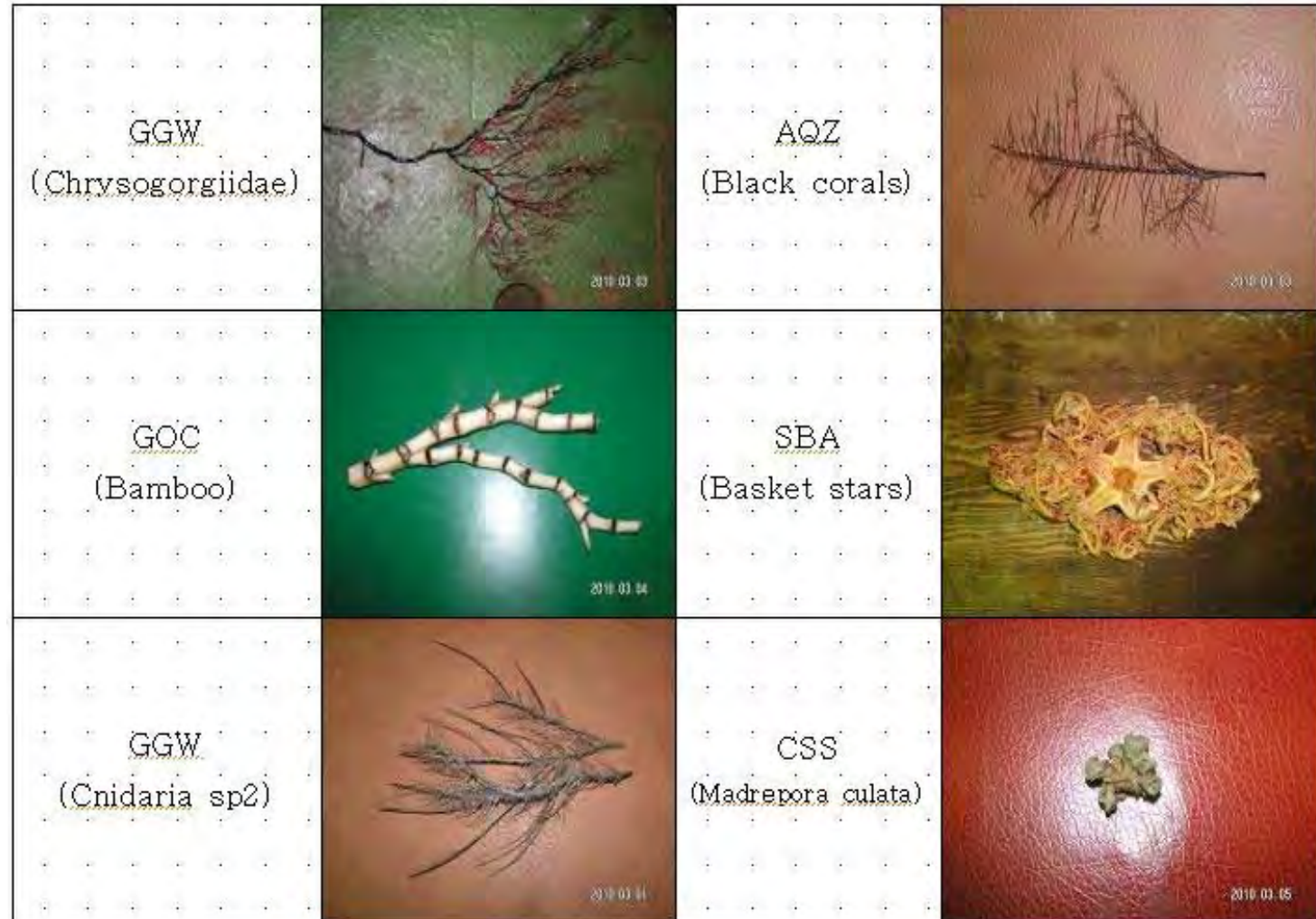
## Total catch by temp.



## Catch of target species by temp.

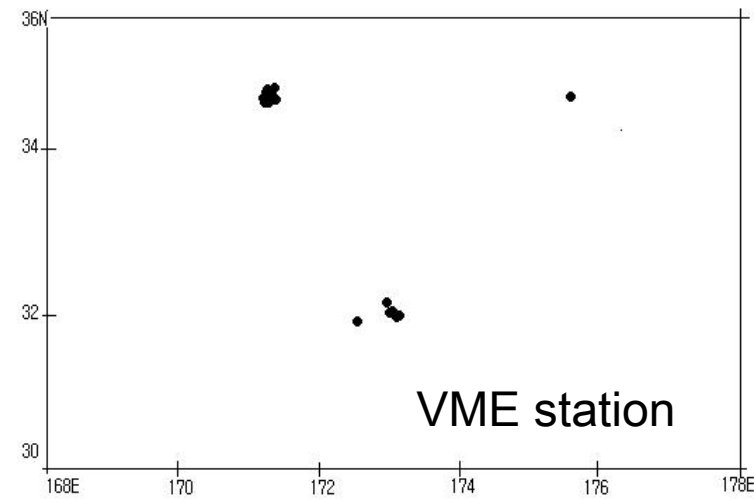


# Vulnerable Marine Ecosystem (VME)



# VME position and weight

- Coral was found from 224 hauls in total, but small amount



Haul #	Mid point (S. E)		GOC	GGW	AQZ	CSS	AQZ	SBA
			kg	kg	kg	kg	kg	kg
6	72°42'	176°29'		1				
6	72°35'	176°16'			0			
15	76°36'	176°13'		0.04				
15	71°43'	177°37'			0			
18	71°59'	173°1'	0.1					
20	71°58'	173°18'				0.04		
33	75°45'	170°53'				0.06		
70	75°56'	170°31'					0	
73	76°44'	170°35'					0.02	
81	76°46'	170°38'		0.1				
81	76°56'	171°48'		0				
120	77°00'	172°24'		0.02				
194	76°55'	172°25'		0				
198								500



Phylum	Gorgonacea (Order)					Cnidaria (CNI)		Porifera (PER)	
Code	GGW					AZN	AXT	CSS	AQZ
Level	Gorgonacea (Order)					Anthothecatae (Order)	Stylasteridae (Family)	Scleractinia (Order)	Antipatharia (Order)
Taxon	Isididae (Bamboo)	Corallidae (Red / precious)	Plumoidae (Bottle brush, sea fans)	Paragorgiidae (Bubblegum)	Chrysogorgiidae (Golden)	Hydroisellina (sub class) Hydroids	Stylasteridae (Hydrocorals)	Stony corals	Black corals
Form, size									
	Solid calcified trunk with brown nodes (nodules), ring in section, branching 20 or 30, fine tips, tree-like branch tips	Calcified, dense, no spines, thick, stubby stems with fine side branches	Dark or metallic tree-like stems, flexible	Large (up to 2 m), red, thick stems, breaks when flexed	Grid, black or green metallic luster. Semi-rigid, single, main axis with semi-soft tissue cortex. Small specimens can be feathery-like hydroids or bushy-like black coral	Entire organism small, <30 cm, flexible and plant-like, often feathery, no soft tissue covering	Calcified, no rings in section, often pink or white. Often unipinnate, side branches lattice from obviously thicker main stems	Branching matrix-forming stony corals have not been observed south of 50°S	Semi-rigid, woody, not very dense, dark brown or black skeletons, can be large (>2 m). Branch tips can look like hydroids or small gorgonians
Detail (texture, colour, polyps)									
	Can scrape off surface tissue. Smooth (not sandpaper) with knobby ends. No pores on skeleton	Can scrape off surface tissue. Skeleton surface smooth between nodes	Can scrape off surface tissue. Smooth (not sandpaper) with knobby ends. No pores on skeleton	Can scrape off surface tissue. Skeleton surface smooth between nodes	Can scrape off surface tissue. Smooth (not sandpaper) with knobby ends. No pores on skeleton	Can scrape off surface tissue. Smooth (not sandpaper) with knobby ends. No pores on skeleton	Can scrape off surface tissue. Smooth (not sandpaper) with knobby ends. No pores on skeleton	Can scrape off surface tissue. Smooth (not sandpaper) with knobby ends. No pores on skeleton	Can scrape off surface tissue. Smooth (not sandpaper) with knobby ends. No pores on skeleton
Commonly mistaken for other groups, such as									
	Other gorgonians if small pieces, but won't break easily	Soft corals, but have soft stems. Corallidae have nodules	Hydroisellina (sub class) Hydroids	Hydroisellina (sub class) Hydroids	Hydroisellina (sub class) Hydroids	Hydroisellina (sub class) Hydroids	Hydroisellina (sub class) Hydroids	Hydroisellina (sub class) Hydroids	Hydroisellina (sub class) Hydroids

# Classification guide for VME

- CCAMLR guide (2009)
- New Zealand SPRFMO guide (2008)
- Australia guide for scientific observers aboard fishing vessels (2009)

Code	BRQ	PBQ
Level	Brachiopoda (Phylum)	Pterobranchia
Taxon	Lamp shells	Acorn worms
Form, size		
	Values enclose the body dorsally and ventrally rather than laterally. Ventral valve typically larger than the dorsal. Attached species have a short stalk emerging from the hinge area of the valves	Tube dwelling marine worms. Each tube (larvae) is about 15 mm diameter. Forms large clumps, somewhat conical. Typically sub-Antarctic distribution
Detail (texture, colour, polyps)		
	Valves enclose the body dorsally and ventrally rather than laterally. Ventral valve typically larger than the dorsal. Attached species have a short stalk emerging from the hinge area of the valves	Valves enclose the body dorsally and ventrally rather than laterally. Ventral valve typically larger than the dorsal. Attached species have a short stalk emerging from the hinge area of the valves
Commonly mistaken for other groups, such as		
	Reversible (larval) mollusks but not valves are much larger, and overhangs the ventral valve	Reversible (larval) mollusks but not valves are much larger, and overhangs the ventral valve

Phylum	Porifera (PER)		Cnidaria (CNI)		Chordata (CZR)	Bryozoa (BZN)	Chemo...
Code	DMO	ATX	AJZ	NTW	SSX		
Level	Demospongiae (Class)	Actinaria (Order)	Alcyonacea (Order)	Pennatulacea (Order)	Ascidacea (Class)	Bryozoans (Phylum)	Chem...
Taxon	Sponges	Anemones	Soft corals	Sea pens	Sea squirts	Lace corals	Chem...
Form, size							
	Yellow central chamber, egg-shaped with hairy recombined tubular	Many variety: fans, spheres, solid masses, tubes, and encrusting	Rubbery bottom with single polyp with lots of tentacles. Usually in retracted hardened cylinder form when captured	Can be mushroom shaped. Floppy or soft, leather-like surface texture. Usually multiple large polyps, body not symmetrical, no foot or stalk	No tentacles or polyps. Stalked, stalk-like or encrusting over substrate	Typically small, (<30 cm). Variable form. Can be hard or soft. Most commonly hard, branching, lace-like, or coralline shaped, calcified, and brittle, surface cannot be scraped off	Chem...
Detail (texture, colour, polyps)							
	Yellow central chamber, egg-shaped with hairy recombined tubular	Many variety: fans, spheres, solid masses, tubes, and encrusting	Rubbery bottom with single polyp with lots of tentacles. Usually in retracted hardened cylinder form when captured	Can be mushroom shaped. Floppy or soft, leather-like surface texture. Usually multiple large polyps, body not symmetrical, no foot or stalk	No tentacles or polyps. Stalked, stalk-like or encrusting over substrate	Typically small, (<30 cm). Variable form. Can be hard or soft. Most commonly hard, branching, lace-like, or coralline shaped, calcified, and brittle, surface cannot be scraped off	Chem...
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of the total Invertebrate taxa encountered as fishery by-catch, and therefore additional processes are still required to collect information on non-VME taxonomic groups. Typically, invertebrate identification is not done at sea because it requires specialised tools. The format of the VME guide is a 'compare and contrast table', using photographs and key characteristics to correctly assign VME taxa to the appropriate grouping. It also highlights commonly confused groups. Symbols representing non-VME groups are listed in the top right-hand margin.

The guide is organised into columns, each describing a taxonomic group and colour coded by phylum. Those groups that appear similar have been placed next to each other where possible. The top row for each column is a parent column that identifies the phylum for the vulnerable groups below. The FAO 3-letter taxonomic code for each group is provided at the top of each column and for the parent group. Below the codes are the scientific and common names for each group. The first row contains photographs and brief descriptions of the overall size and shape of specimens for each group. The next row then provides details of the specimen's appearance, such as texture, colour, or polyp characteristics, and also includes close-up images as examples. A final row (with a yellow background) has images and descriptions of specimens representing other phyla. This row shows how these specimens can be commonly mistaken for other taxa and flags details on what to look out for during classification. Text in this row should be read beginning with the phrase in the row heading to aid in clarity.

Photographs of Antarctic specimens have been used where possible to aid in the identification of VME groups. The guide has been linked through colour coding to phyla in the 'Guide to common deep-sea invertebrates in New Zealand waters' (Tracey et al. 2007), the 'SPRFMO VME taxa guide' (Tracey et al. 2008), and the 'Field identification guide to Head Island and McDonald Island (HIMI) benthic invertebrates' (Hibberd and Moore, 2009). Invertebrate specimens that cannot be identified with confidence need to be identified to the lowest taxonomic level possible, retained on board, and returned frozen as biological specimens for formal identification.

### Acknowledgments

Developers: S. Parker<sup>1</sup>, D. Tracey<sup>2</sup>, E. Mackay<sup>3</sup>, S. Mills<sup>4</sup>, P. Marnon<sup>5</sup>, G. Anderson<sup>6</sup>, K. Schmalzer<sup>7</sup>, D. Bowdler<sup>8</sup>, M. Kelly<sup>9</sup>, S. Lockhart<sup>10</sup>

<sup>1</sup>National Institute of Water & Atmospheric Research Ltd (NIWA)

<sup>2</sup>Private Bag 14901, Wellington, New Zealand

<sup>3</sup>US Antarctic Marine Living Resources Program

<sup>4</sup>Antarctic Ecosystem Research Division

<sup>5</sup>NOAA Southwest Fisheries Science Center

<sup>6</sup>La Jolla, CA 92037, USA

<sup>7</sup>Corresponding author: sparker@niwa.co.nz

<sup>8</sup>Photographs Protected by copyright: either of National Institute of Water & Atmospheric Research Ltd, Land Information New Zealand, the New Zealand Ministry of Fisheries, New Zealand Department of Conservation, the US Antarctic Marine Living Resources Program or Peter Batson: www.deepseaphotography.com. Photographs were also contributed by CCAMLR fishery observers

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### References cited

Tracey, D.M., Anderson, G.E., Haycox, J.L. (Comp.) 2007. A guide to common deep-sea invertebrates in New Zealand waters. New Zealand Aquatic Environment and Fisheries Report No. 10. 282 p.

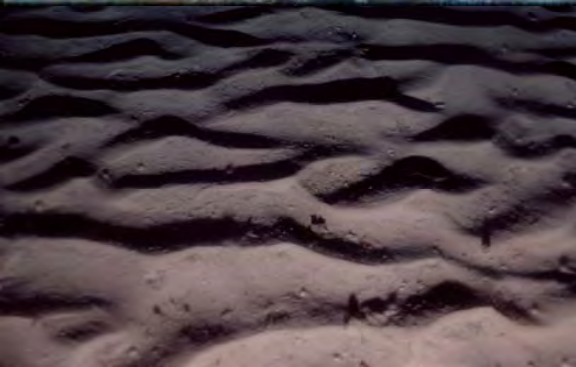
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Hibberd, E., Moore, K. (2009). Field identification guide to Head Island and McDonald Island (HIMI) benthic invertebrates: a guide for scientific observers aboard fishing vessels. Department of Environment, Water, Heritage, and the Arts, Australian Antarctic and the Fisheries Research and Development Corporation. 158 p.

## Summary and Discussion

- Unusual high catch was recorded in 2010 since Korean trawl fishery began after 2004 in the North Pacific high seas
- In 2010 higher catch maybe related to lower seawater temperature during fishing operation
- Diverse coral branch was found from every haul, but a little. The small amount of VME, esp. coral in the NP high sea, could be caused by accumulated fishing activities for long-term bottom trawl fishery.
- Prior to assessment of SAIs on VMEs, Additional Interim Measures
  - ✓ Fishing on Large Seamounts only in Restricted Areas
  - ✓ Modify Trawl Gear to Fish Off-Bottom
  - ✓ Close Fishing on Small & Peaked Seamounts
  - ✓ These Measures also Promote Sustainable Fishery Management





**Thank you  
for your attention**