INT2022-03 Identification, storage and genetics of cold-water coral bycatch specimens

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Climate, Freshwater & Ocean Science

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Background

- Deep-sea protected coral samples taken as bycatch in commercial fishery operations are physically collected and / or photographed by government Observers on observed commercial fishing vessels
- NIWA receives the samples, facilitates their ID
- Physical samples or digital images are identified and counted by experts to the lowest taxonomic level
- Data loaded into databases (*niwainvert; COD*)
- This information, along with associated fishing data including fishing method, fishery area, and target fish species, is presented to CSP
- Data from this research:
  - helps to better characterise interactions between protected corals and commercial fishing activities
  - provides baseline information that can help to better inform research underpinning marine protection planning from habitat suitability modelling, benthic risk assessments, & management of benthic marine protected species
  - paves the way towards a more comprehensive mitigation framework to be implemented to protect cold-water corals in New Zealand waters.

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Background

NIWA carries out:

- the identification of protected coral specimens
  - Antipatharia (black coral)
  - Scleractinia (cup corals and stony corals)
  - Stylasteridae (hydrocoral)
  - gorgonian octocorals previously belonging to order Alcyonacea (plexaurid, acanthogorgid, primnoid sea fans, bamboo corals, bubblegum corals, golden corals etc.)

- the identification of protected coral specimens shown in digital images, the georeferencing and digital storage there-of

- the sub-sampling of protected coral tissue material for genetic studies

- application & testing of genetic methods for protected species bycatch identification/confirmation

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Background – coral taxonomy changes

Octocoral taxonomy has recently been revised by McFadden et al. (2022). Alcyonacea is no longer accepted as an order. Octocorallia has been elevated to class, and protected corals fall into two new orders: Scleralcyonacea and Malacalcyonacea.

Summary of higher-level changes to Anthozoa group phylogeny.

Name	Old taxonomy	Current taxonomy
Anthozoa	Class	Sub-Phylum
Hexacorallia	Subclass	Class
Octocorallia	Subclass	Class
Malacalcyonacea	(Alcyonacea+Gorgonacea)	Order
Scleralcyonacea	(Alcyonacea+Gorgonacea)	Order
Alcyonacea	Order	(Malacalcyonacea+Scleralcyonacea)
Gorgonacea	Order	(Malacalcyonacea+Scleralcyonacea)
Pennatulacea	Order	Super-Family Pennatuloidea (w/in O. Scleralcyonacea)

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Objectives

To determine which protected cold-water coral species are captured in commercial fisheries, and the mode of their capture, and build a coral collection for future research

Specifically:

1. **To confirm or update identifications of coral bycatch reported by Fisheries Observers to the lowest taxonomic level (i.e., to assign codes to coral specimens at the species level wherever possible, or to genus or family level if not possible).**
2. **To record all identified coral specimens and their metadata (including haplotype/genetic data) and ensure storage of the physical specimens in an appropriate taxonomic collection.**
3. **To update relevant government coral identification and observer databases.**
4. **To determine whether genetic taxonomic assessment of coral ID is an efficient means to determine or improve image-based or morphological coral ID, and to use genetic data to better understand coral bycatch.**
5. **To update and provide input into coral-relevant resources for Fisheries Observers, including reference material and material for observer training.**

Here we report on all corals identified by specimens and images bycaught during the period 1 July 2022 – 30 June 2023

Methods – Objective 1 & 2, Physical specimens

Tasks under FNZ Data Custodian Services project DAT2016-01P:

- Protected coral samples sorted & identified to a coarse level
- Data entered into NIWA Observer Samples Database (OSD)
- Specimens fixed in ethanol
- Subsample taken for genetics from all live-collected protected coral samples
- Data from OSD uploaded into NIWA Invertebrate Collection (NIC) Specify database *niwainvert*

Tasks under INT2022-03:

- Experts identify corals to lowest possible level
- Assign a three-letter MPI code where possible
- Source position and fishing data from *COD*
- COD updated with expert/updated IDs
- Specimens stored in the NIWA Invertebrate Collection with updated IDs

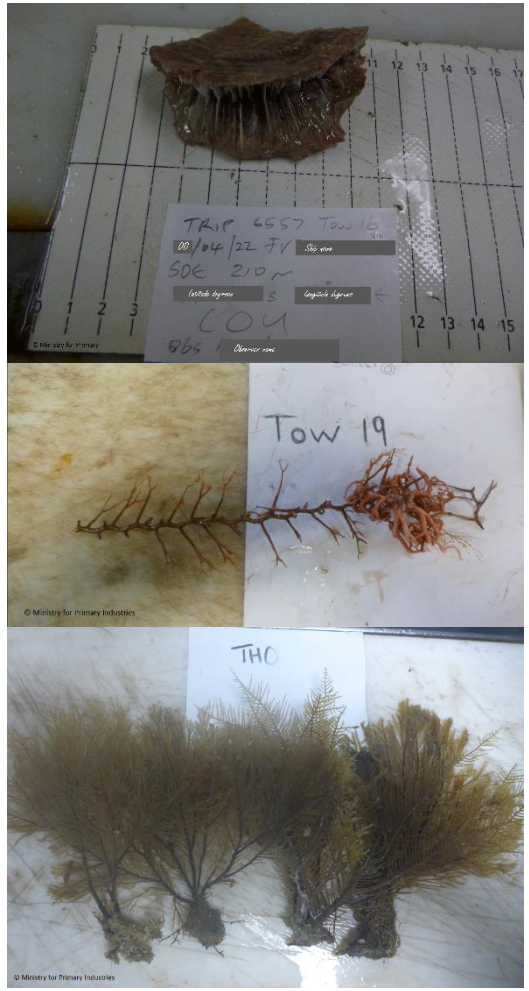
Expert	Affiliation	Taxon Group
Di Tracey	NIWA	Scleractinia, gorgonian octocorals
Peter Marriott	NIWA	Stylasteridae, Coralliidae
Rob Stewart	NIWA	Antipatharia
Jaret Bilewitch	NIWA	Plexauridae, Acanthogorgiidae, other gorgonian octocoral groups
Dr Marcelo Kitahara	Universidade Federal de São Paulo, Brazil	Scleractinia
Dr Stephen Cairns	Smithsonian Institution, USA	Primnoidae
Michelle Taylor	University of Esses, UK	Primnoidae
Dennis Gordon	NIWA	Bryozoa
Caroline Chin	NIWA	Hydrozoa (excluding Stylasteridae)
Diana Macpherson	NIWA	Hydrozoa (excluding Stylasteridae)

Methods – Objective 1, Specimens from digital images

- Images taken during reporting period sent to NIWA by CSP for processing and ID by experts

- Firstly, they are sorted: only process images of coral taxa taken from within NZ EEZ.
    - Non-coral taxa are not processed, however non-coral specimens that have been ID'd by the Observer as a coral **are** processed as it may have been entered into *COD* as a coral taxa and this needs correcting (note: requires a label with the Observer ID 3-letter code on it, otherwise we can't tell what the Observer called it).
    - Accompanying spreadsheet shows which trips were conducted outside of NZ's EEZ

- Images processed, spreadsheet created to hold metadata, some metadata also embedded in image file, includes:
    - expert ID in the form of taxonomic name (species, genus or family level)
    - trip and tow number (tow number usually not shown in photo despite Instructions to Observers document, as such separate efforts are made to determine this)
    - initial Observer ID and expert ID (3-letter MPI species code)
    - specimen count
    - specimen comments
    - keywords relevant to the subject of the image
    - the NIC catalogue number (where applicable)
    - image rating (where the best rating is 1 (very good quality) and the worst is 5 (very poor quality))



Methods – Objective 1, Specimens from digital images cont'd

- *COD* data sourced and added to spreadsheet, including:
  - position (the start and end coordinates of the tow that sampled the photographed coral)
  - depth (minimum and maximum depths)
  - collected date
  - fishing method
  - target species
  - Fisheries Management Area

- When tow number not available (due to lack of label showing in image) separate efforts are made to determine this
  - Use file date time stamp to find tow number immediately previous to that date time using *COD* data (assumes specimen was collected in previous tow - not accurate)
  - Use Observer forms (such as the 'Photos' tab of the MPI worksheet) to find best match

- Images distributed out to experts for ID

- Metadata spreadsheet updated with expert ID's and delivered at reporting milestones

Methods – Objective 3, Updating FNZ Centralised Observer Database (*COD*)

Physical specimens

- Expert IDs extracted from *niwainvert* database provided to *COD* managers for loading & table updates. Initial Observer three-letter MPI species ID codes and MPI sample numbers retained to aid with matching and the expert ID code is added.

Images

- Expert ID codes will be loaded into *COD* benthic tables following submission of final annual report.
- A spreadsheet will be provided to *COD* managers for loading and table updates. Initial Observer three-letter MPI species ID code retained, the expert ID code is added and the MPI image file name is added to *COD* tables.

Methods – Objective 4, Assess Genetic Identification

- Consult with CSP on annual focus:
  - further investigation of tentative new family identified in BCBC2020-26 (study of Primnoidae on Chatham Rise)
  - supplement INT2023-05 with additional *Acanthogorgia* specimens (study of Paramuriceidae Chatham Rise *vs*. Challenger/Bounty)

- Genomic ('UCE') sequencing of 8 'new family' specimens + 8 reference specimens + 5 *Acanthogorgia*

- Analysis of genomic relationships to known protected octocoral groups

Methods – Objective 5, Observer training and reference material

- Respond to Observer training needs as requested by CSP and / or MPI, including, but not limited to:
    - Review online Observer training materials focusing on Benthic Materials
    - Host hands on workshops for new and returning MPI observers through direct purchase contract with MPI.
    - Provide corrections and updates to printed coral guides
- Continue to provide feedback to Observers on their data collection quality and IDs, based on the images and physical specimens we receive and process.

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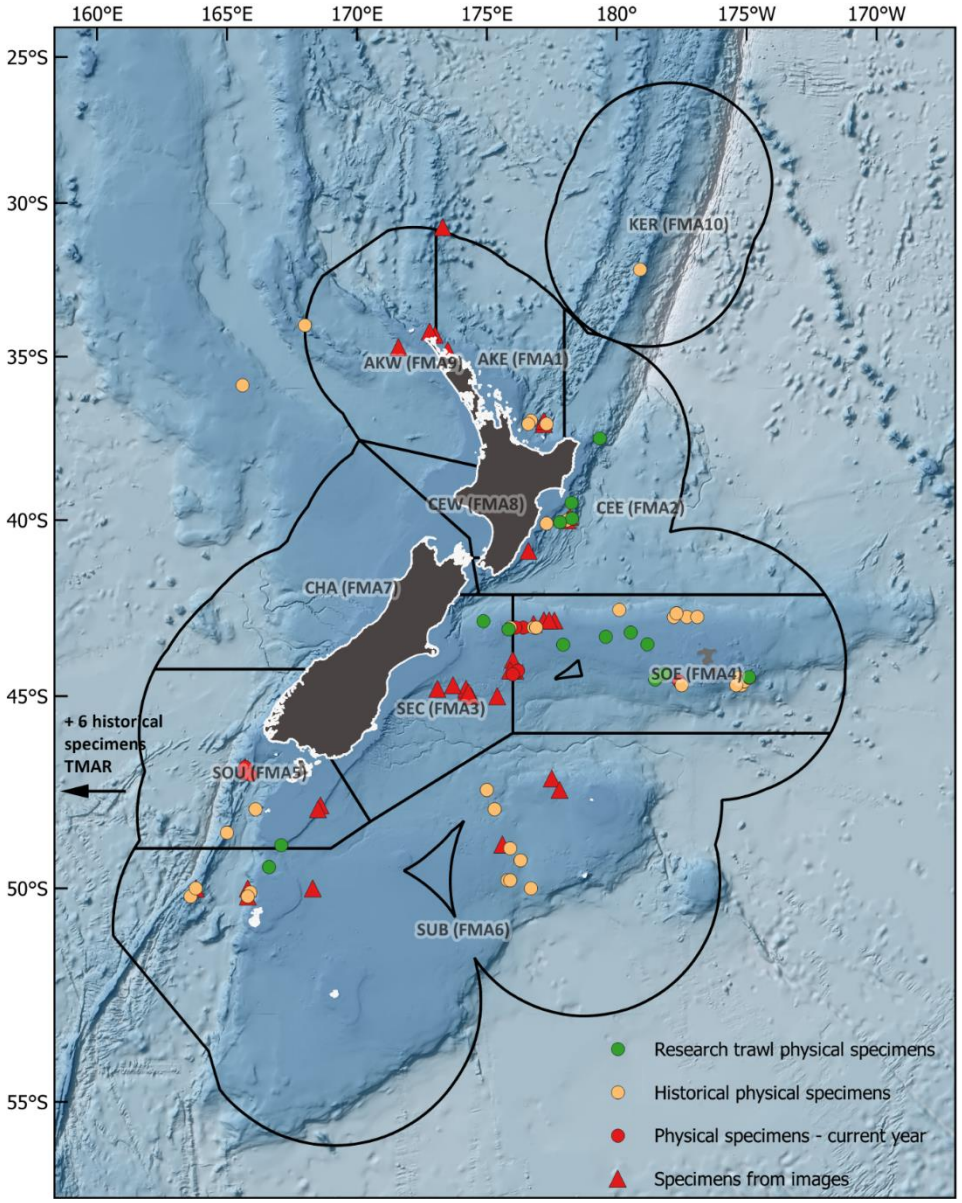
Results – Physical specimens (Objectives 1-3)

- 11 observer collected samples (12 specimens)
- 49 historical* observer collected samples (67 specimens)

*(i.e., collected prior to the current reporting year)

- 19 research trawl survey samples (20 specimens) collected between 1995 and 2014



Results – Physical specimens (Objectives 1-3)

- 11 observer collected samples (12 specimens)

- A range of species identified in all protected coral groups
  - 1 species of black corals
  - 2 species of stony coral
  - 2 species of hydrocoral
  - 1 species of Anthothelidae
  - 4 species of Scleralcyonacea

Phylum	Class	Order	Family	Genus	Species	No. of specimens
Cnidaria	Hexacorallia	Antipatharia	Schizopathidae	*Telopathes*	*tasmanienesis*	2
		Scleractinia	Caryophyllidae	*Solenosmilia*	*variabilis*	1
			Flabellidae	*Flabellum*	*knoxi*	2
	Hydrozoa	Anthoathecata	Stylasteridae	*Conopora*	*verrucosa*	1
				Errina	*chathamensis*	1
	Octocorallia	Malacalcyonacea	Alcyoniidae	Anthothelidae		1
		Scleralcyonacea	Coralliidae	*Paragorgia*		1
			Keratoisididae	*Jasonisis*		1
				Keratoisis		1
			Primnoidae	*Metafannyella*	*chathamensis*	1
Grand Total						12

Results – Physical specimens (Objectives 1-3)

- Tissue sub-samples taken from 9 live-caught specimens
- Accumulated protected coral tissue sub-samples retained for future genetic studies now = 165
- All physical specimens are registered and stored in the NIWA Invertebrate Collection (NIC) in Wellington and all associated specimen metadata is registered in the NIC Specify database, *niwainvert*.

Results – Physical specimens (Objectives 1-3)

Data summaries

- Protected corals identified from physical specimens in this period were collected from SOE South-East Chatham Rise (FMA4) and SOU Southland (FMA5) bottom trawl operations and most samples from fisheries targeting orange roughy

Summary of protected coral samples by Fisheries Management Area (FMA) for Observer collected protected coral samples.
Collected during the current reporting year (1 July 2022-30 June 2023)

FMA	Description	Count of samples	No. of specimens
SOE	South-East (Chatham Rise) (FMA4)	6	7
SOU	Southland (FMA5)	5	5
Total	All areas	11	12

Historical samples identified in this reporting period but collected prior to July 2022

FMA	Description	Count of samples	No. of specimens
AKE	Auckland East (FMA1)	3	3
CEE	Central East (FMA2)	2	2
KER	Kermadec (FMA 10)	1	1
SEC	South-East (Coast) (FMA3)	1	1
SOE	South-East (Chatham Rise) (FMA4)	18	29
SOI	Southern Offshore Islands – Auckland & Campbell Is. (FMA 6A)	2	7
SOU	Southland (FMA5)	2	2
SUB	Subantarctic incl. Bounty Is and Pukaki Rise (FMA 6)	13	14
HOWE	Lord Howe Rise (ET)	1	1
TMAR	Tasmanian Ridge (ET)	5	6
WANB	Wanganella Bank (ET)	1	1
Total	All areas	49	67

Count of tows and specimens by fishing method and target fishery for physical specimens.
BT = Bottom Trawl
Samples collected in the current reporting year (1 July 2022–30 June 2023)

Target Fishery (common name)	FNZ Code	Fishing method	Count of tows	Count of samples	No. of specimens
Orange roughy	ORH	BT	1	4	4
Arrow squid	SQU	BT	2	3	4
Scampi	SCI	BT	2	2	2
Ling	LIN	BT	1	1	1
Smooth oreo	SSO	BT	1	1	1
Total			7	11	12

Historical samples identified in this reporting period but collected prior to July 2022

Target Fishery (common name)	FNZ Code	Fishing method	Count of tows	Count of samples	No. of specimens
Black oreo	BOE	BT	2	2	2
Oreos	OEO	BT	9	12	13
Orange roughy	ORH	BT	22	24	38
Scampi	SCI	BT	4	6	9
Smooth oreo	SSO	BT	4	4	4
Tarakihi	TAR	BT	1	1	1
Total			30	49	67

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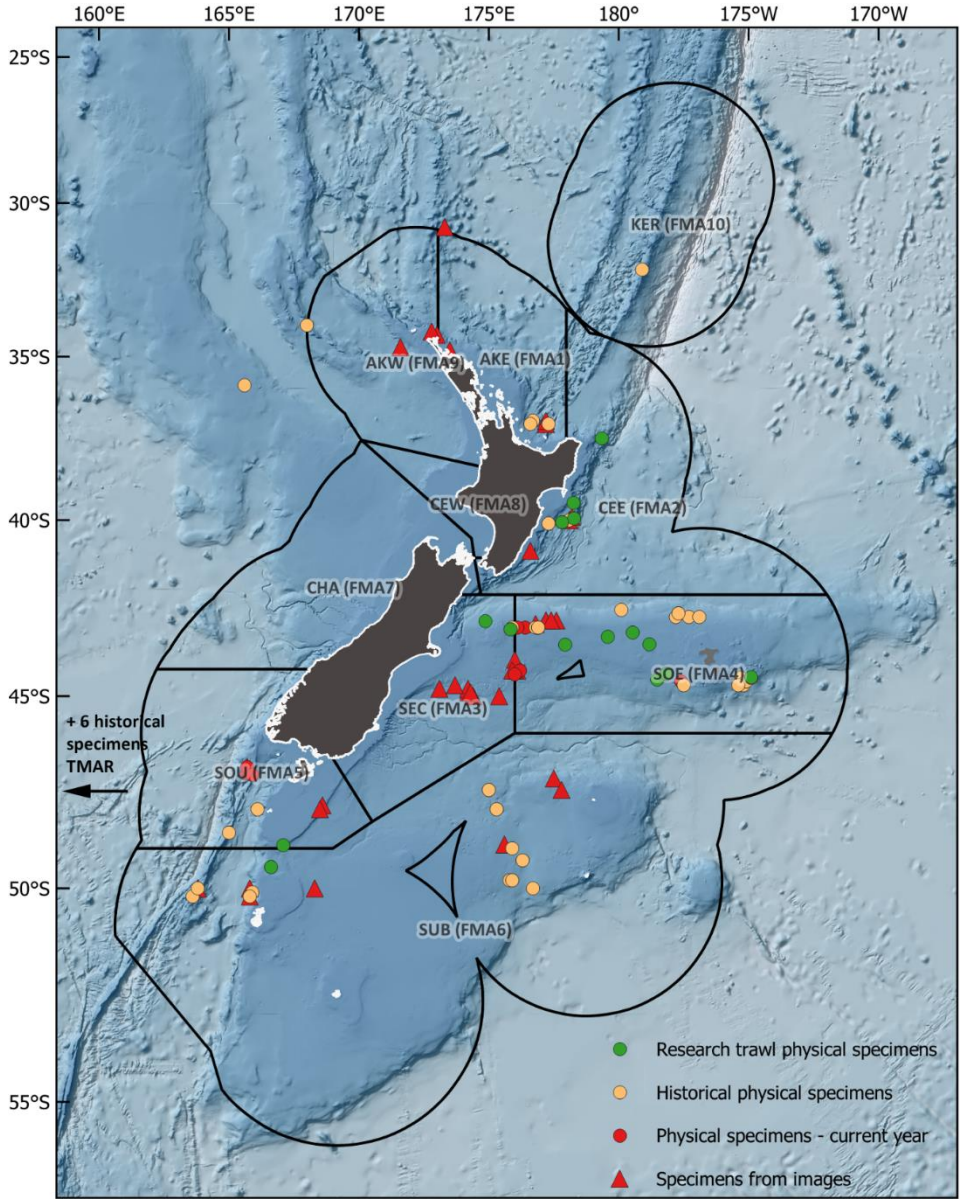
Results –Specimens from images (Objective 1 & 3)

- NIWA received 382 digital images – all were processed.
- 2854 specimens identified from the 382 images
- Of 2854 specimens, 2595 were protected coral taxa, and all were able to be georeferenced. The remaining 259 specimens were determined non-protected taxa
- Specimen counts were dominated by three large catches of protected corals, estimated at 1000, 1000 and 300 individuals.
- Observers provided a label showing trip and tow number information for **172 of the 382 processed images.** Tow numbers for the remaining images determined using methods described earlier.



Results –Specimens from images (Objective 1 & 3)

- Specimen counts were dominated by three large catches. The taxa with the highest specimen count was the stony branching coral *Solenosmilia variabilis* (n = 1098)
- The next two highest specimen counts were the stony cup coral *Desmophyllum dianthus* (n = 1013) and the stony branching coral *Goniocorella dumosa* (n = 329)
- The stony cup coral *Flabellum* sp. (n = 47) had the next highest specimen count and the bubblegum coral genus *Paragorgia* followed with a specimen count of 14
- A diverse range of Antipatharia (black corals), Primnoidae (sea fans, sea whips) and Scleractinia (stony corals) were present
- Protected corals were identified from a total of 13 different families within four orders.

Results –Specimens from images (Objective 1 & 3)

Data summaries

- The FMAs with the highest number of protected coral bycatch specimens were the SOE South-East (FMA4, Chatham Rise) and SEC South-East Coast (FMA3) regions. Most were taken by bottom trawl targeting orange roughy & scampi.

Summary of imaged specimens by Fisheries Management Area (FMA)

Area	Description	Total no. of specimens
SOE	South-East (Chatham Rise) (FMA4)	2491
SEC	South-East Coast (FMA3)	30
SUB	Subantarctic (FMA6)	29
SOU	Southland (FMA5)	19
AKE	Auckland East (FMA1)	8
AKW	Auckland West (FMA9)	4
CEE	Central East (FMA2)	3
SOI	Southern Offshore Islands – Auckland & Campbell Is. (FMA 6A)	3
	No FMA recorded	3
Total		2590

Count of tows by fishing method and target fishery for imaged specimens.
BT = Bottom Trawl; PRB = Precision Seafood Harvesting Bottom Trawl

Target Fishery (common name)	FNZ code	Fishing Method	Count of Tows	Total no. of specimens	Remarks
Orange roughy	ORH	BT	28	2123	
Scampi	SCI	BT	6	338	
Squid	SQU	BT	5	63	
Smooth oreo	SSO	BT	14	54	
Black oreo	BOE	BT	2	3	
Tarakihi	TAR	PRB	2	2	
Ling	LIN	BT	2	2	
Snapper	SNA	PRB	1	1	
Barracouta	BAR	BT	1	1	
No target fishery provided			1	3	No gear type
All			**62**	**2590**	

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Results –Specimens from images (Objective 1 & 3)

Data summaries

- Bubblegum coral (*Paragorgia* spp.) was caught in the highest number of different tows, followed by the stony branching coral *Solenosmilia variabilis.*
- 27% of the tows where Observers photographed corals, more than one coral taxa photographed

Count of tows across which a coral taxon was caught.

Taxon of coral	Fisheries code	Number of tows caught in
Paragorgia spp.	PAB	13
Solenosmilia variabilis	SVA	10
Keratoisis spp.	BOO	8
Desmophyllum dianthus, Goniocorella dumosa	DDI, GDU	7
Flabellum spp.	COF	4
Primnoa spp., stony corals	PMN, SIA	3
Metafannyella spp., *Madrepora oculata*, Black corals, *Bathypathes* spp., *Caryophyllia* spp., Primnoidae, Bamboo corals, *Anthothela* spp., *Tylopathes* spp.	MEF, MOC, COB, BTP, CAY, PRI, ISI, ANB, TYL	2
Dendrobathypathes spp., True coral (unidentified), Stylasterids (hydrocorals), Stony cup corals, *Dendropathes* spp., *Jasonisis*, *Telopathes tasmaniensis*, *Leiopathes* spp., *Saropathes* spp., *Culicia rubeola*, *Iridogorgia* spp., *Callogorgia* spp., *Enallopsammia rostrata*, *Errina* spp.	DEN, COU, COR, CUP, DDP, JAS, TEO, LEI, SRO, CUR, IRI, CLG, ERO, ERR	1
Total		63

Count of tows by number of coral taxa photographed

Number of different taxa of coral	Number of tows
1 taxon of coral was photographed	46
2 taxa of coral were photographed	12
3 taxa of coral were photographed	3
4 taxa of coral were photographed	2
Total	63

Results – Observer ID accuracy

While no formal 'analyses of accuracy' have been carried out between Observer / NIWA expert identifications, a summary of the accuracy of Observer ID is presented & will be useful for on-going Observer training exercises

Physical specimens

Observers correctly identified 6 of the 11 samples, two correctly identified to genus level, two to family or family group level. This indicates a **55% accuracy** of Observer code use overall for the physical samples, regardless of the taxonomic level of the ID.

Images

Observers correctly assigned genus or species codes to 79 images (25% accuracy). In addition to this, 140 (45%) images were correct to the level of order. No protected coral images received were recorded with non-coral codes (e.g. black corals coded as feathery hydroids). Sixty-five images (20%) that Observers gave coral codes were identified by experts as not corals.

Note that in some cases codes are only available to higher levels for some taxa.

Accuracy has varied year to year through previous coral bycatch identification projects, which may be for a variety of reasons: e.g., level of observer experience, encountering different species that are trickier to identify etc.

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Results – Data loaded into *COD* (Objective 3)

Physical specimens

- Revised identifications from *niwainvert* provided for uploading into *COD*
- Of the 60 rows of Observer-collected physical specimen data (11 current year, 49 historical):
  - 26 rows able to be matched to the catch record for the specimen & were updated
  - 34 rows not able to be matched to the catch record for the specimen & so inserted as new records
    - mainly split lots, or historical data with no link to original data. It is noted that sample matching is improving over time and this high number reflects the recent efforts to register and identify a historical backlog of corals in the NIWA collection under another CSP project.

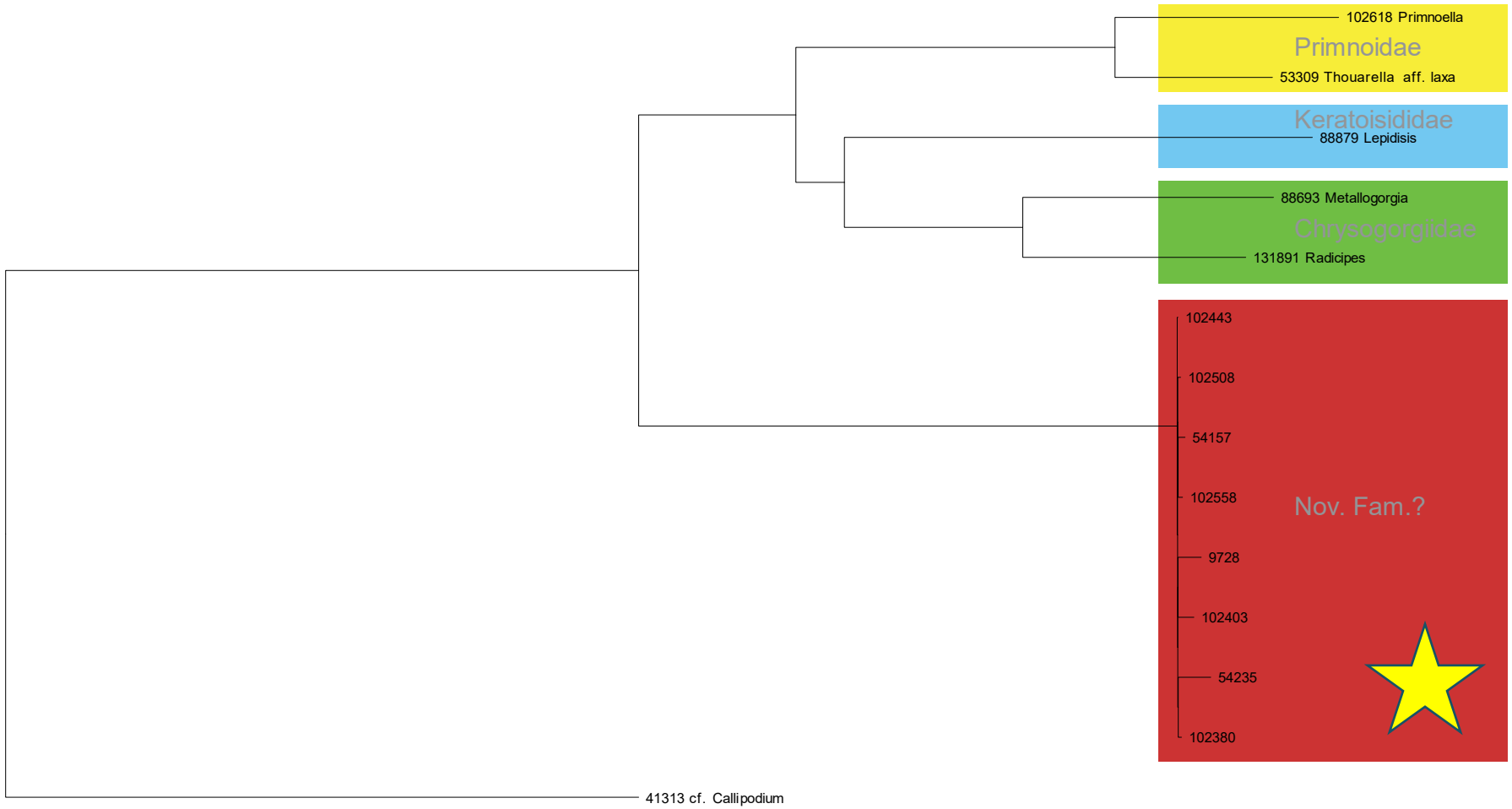
Images

- This is the first year that expert ID codes will be loaded into COD benthic tables. A spreadsheet will be supplied to COD managers following the submission of the final annual report in June.

Results – Objective 4, Assess Genetic Identification

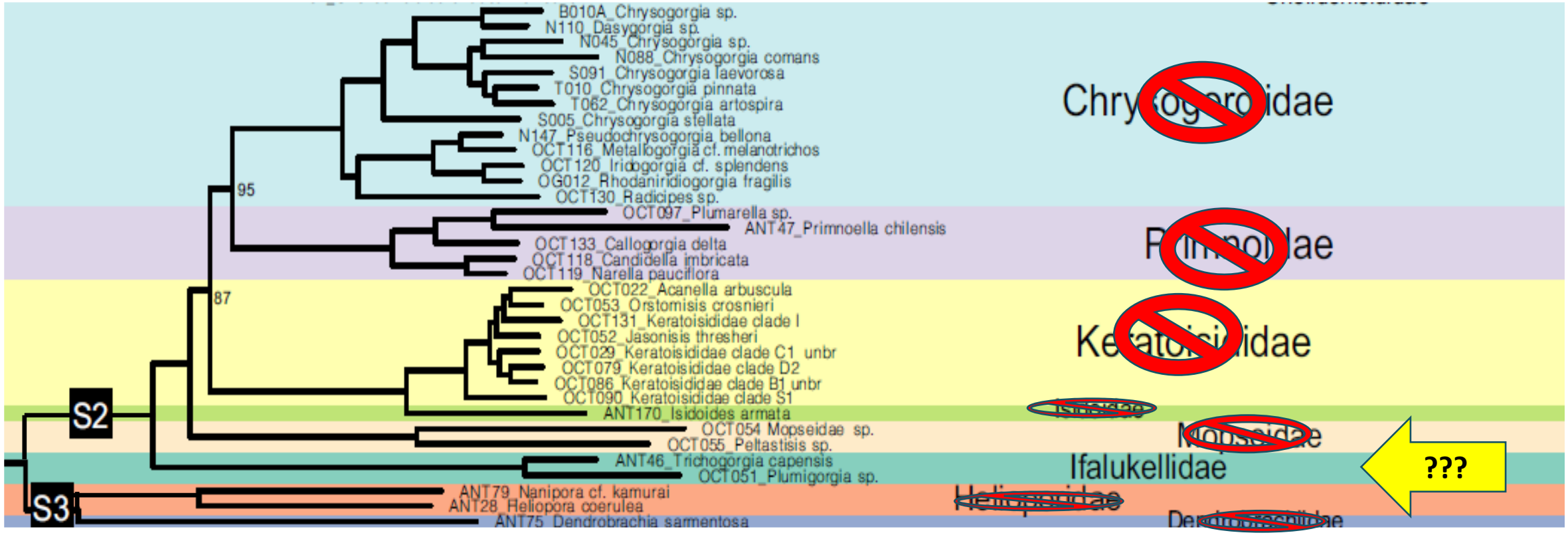
- 8 ‘new family’ specimens + 7/8 reference specimens + 5 *Acanthogorgia* specimens sequenced successfully
- *Acanthogorgia* results treated in reporting for INT2023-05
- other 15 specimens produced >1.5 billion basepairs of DNA sequence data
- one additional reference specimen produced low amount of data -> excluded
- assembly and matching of contigs to UCEs = average 1746 loci/sample; average UCE length 619bp
- alignment resulted in >200,000 bp of informative variation

Results – Objective 4, Assess Genetic Identification



- not part of any of common NZ protected gorgonian families
- another <u>described</u> family of gorgonians?

Comparison to other studies



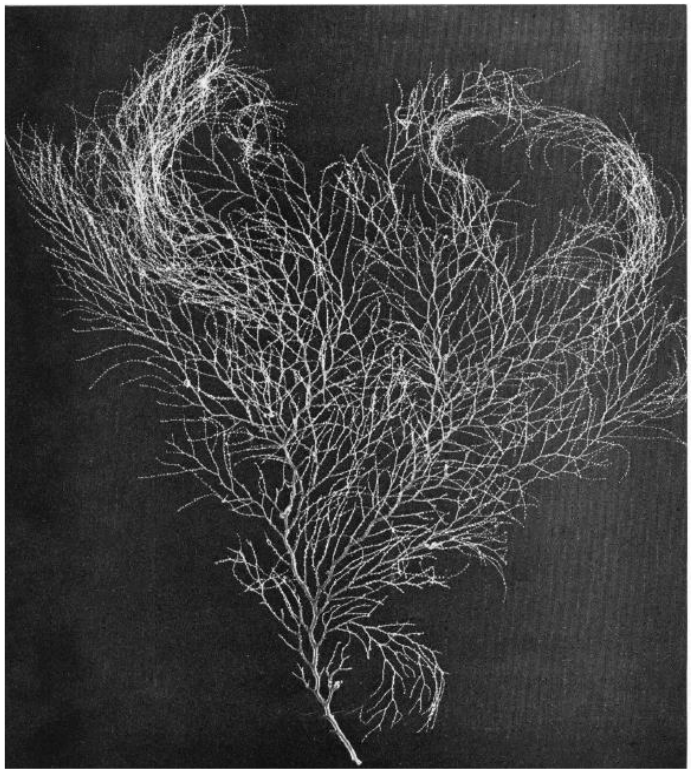
McFadden, C.S., Van Ofwegen, L.P., Quattrini, A.M. (2022) Revisionary systematics of Octocorallia (Cnidaria: Anthozoa) guided by phylogenomics. Bulletin of the Society of Systematic Biologists, 1(3). 10.18061/bssb.v1i3.8735

Need morphological comparison to known genera

Trichogorgia

Plumigorgia

Ifalukella



Stephanogorgia

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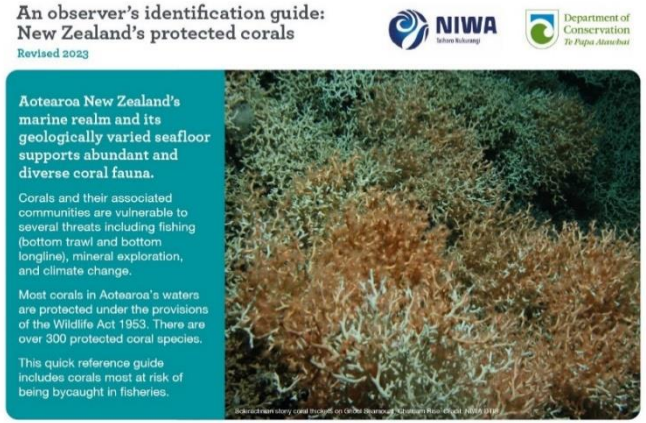
Objective 5, Assist with Observer training resources

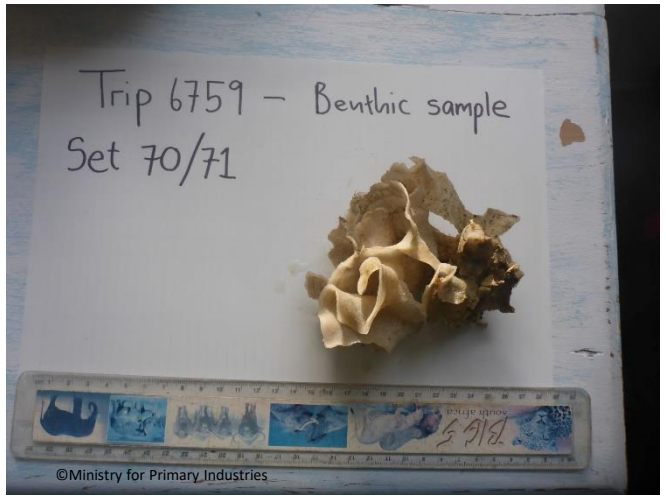
- Provided review and comments to MPI on their new, online Observer Training module on Benthic Materials (with a large section focusing on coral identification and reporting).
- Recommendations highlighted in Client reports
- Collating corrections and revisions to the 2023 Coral Identification Guide to provide to CSP for inclusion in the next revision of the guide.
- Through direct purchase from MPI, provided four in-person invertebrate identification training workshops for new and returning Observers. These workshops included a large focus on coral identification and reporting.



Recommendations

Acknowledge workload placed on Observers at sea, recommendations are made on their at-sea data collection methods, specifically labelling specimens and images with comprehensive information

- Images need to be taken with a label showing in the frame that includes trip and tow numbers and the Observers initial ID species code
- The coral specimen, or a sub-sample of the specimen, needs a label including the trip & tow numbers, MPI sample number, Observers initial ID - species code
- Samples need to be designated to a single tow/set



MPI observer:	Photo number(s):
Trip:	Tow/Set:
Observer Benthic Materials Form MPI sample ID:	(write in pencil) MPI Species Code:
Comments:	
(NIWA use only) NIWA ID:	
OSD:	Specify:

Recommendations cont'd

MPI sample number and the initial Observer three-letter identification code are crucial components in the data matching process used for updating *COD* with the expert ID of the physical specimens.

- We reiterate the recommendation that the initial MPI sample number and three-letter code written on the specimen label corresponds to the sample number and code used on the benthic form.
- If Observers decide to change their identification code later while filling out electronic or paper catch forms, we ask that they please provide a comment in the benthic form if they are not able to amend the specimen labels to match the benthic forms.
- Observer comments on photo logs etc. are extremely valuable where a match cannot be made with sample numbers or codes alone.

Summary

- 1st year in a new 3-year project, which follows previous projects (INT2015-03 – DOC16307 and INT2019-04 – DOC0303 *Identification and storage of cold-water coral bycatch specimens)*.
- 12 physical specimens in 11 samples collected by Observers identified during the reporting period
  - Additionally, 49 historical physical samples collected by Observers, 19 research trawl-collected samples with revised higher-level identifications made during the reporting period.
- 9 tissue samples taken from live-collected specimens
- Genetic characterisation of unknown protected corals has confirmed new record/family (TBD)
- 2854 specimens identified from 382 digital images - 2595 were protected coral taxa
- Database updates made for physical specimens, soon to be done for imaged specimens
- Georeferencing of images can be challenging due to lack of labelling by Observers
- Most protected coral samples were taken by bottom trawl targeting orange roughy, or from the South-East (Chatham Rise) (FMA4), and South-East Coast (FMA3).
- Brief summaries of accuracy provided – *Note: no formal analysis*
  - Stony cup corals, some gorgonian octocorals and bubblegum coral IDs accurate to genus or species level
  - Other taxa remain problematic, some confusion with hydroid, bryozoan and sponge identification
- We continue to make recommendations for Observers to improve their labelling (specimens and images)

Ngā mihi

Acknowledgements

We thank:

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Various coral experts who provided identifications for this reporting period are acknowledged. Our international experts willingly give their time to verify our identifications & contribute to guide updates & revisions, and this is hugely appreciated

NIWA Invertebrate Collection team, particularly Dean Stotter, for preserving specimens and providing on-going curatorial support.

Finally, our thanks to Caroline Wood and Shaun Carswell (NIWA) for updating *COD* and providing data extracts, and report reviewers Owen Anderson, and Judy Sutherland (NIWA)