BCBC2020-08
Fish shoal dynamics in north-eastern New Zealand

TWG Presentations for BCBC2020-08

Sample collection 2020-2021

- **Chris Gaskin** (with Kerry Lukies, Lily Kozmian-Ledward and Andrew Jeffs)

Nutritional Analysis of Seabird Prey Species from the Hauraki Gulf

- **Andrew Jeffs** (with Stefan Spreitzenbarth, Lily Kozmian-Ledward and Chris Gaskin)

BCBC2020-08 – Project objectives

- Collect zooplankton and other prey foraged by different fish shoal/school species in East Northland, and Hauraki Gulf to later compare with previous data to better understand how interspecific differences in spatial/temporal foraging effects dietary requirements of seabird populations.

  - The current project scope is for sample collection only

- Collation, identification, counting, and analyses was not included in the funding. To be done as funding permits.

Species

Rako Buller's shearwater

Tītī wainui Fairy prion

Pakahā Fluttering shearwater

Tākapu Australasian gannet
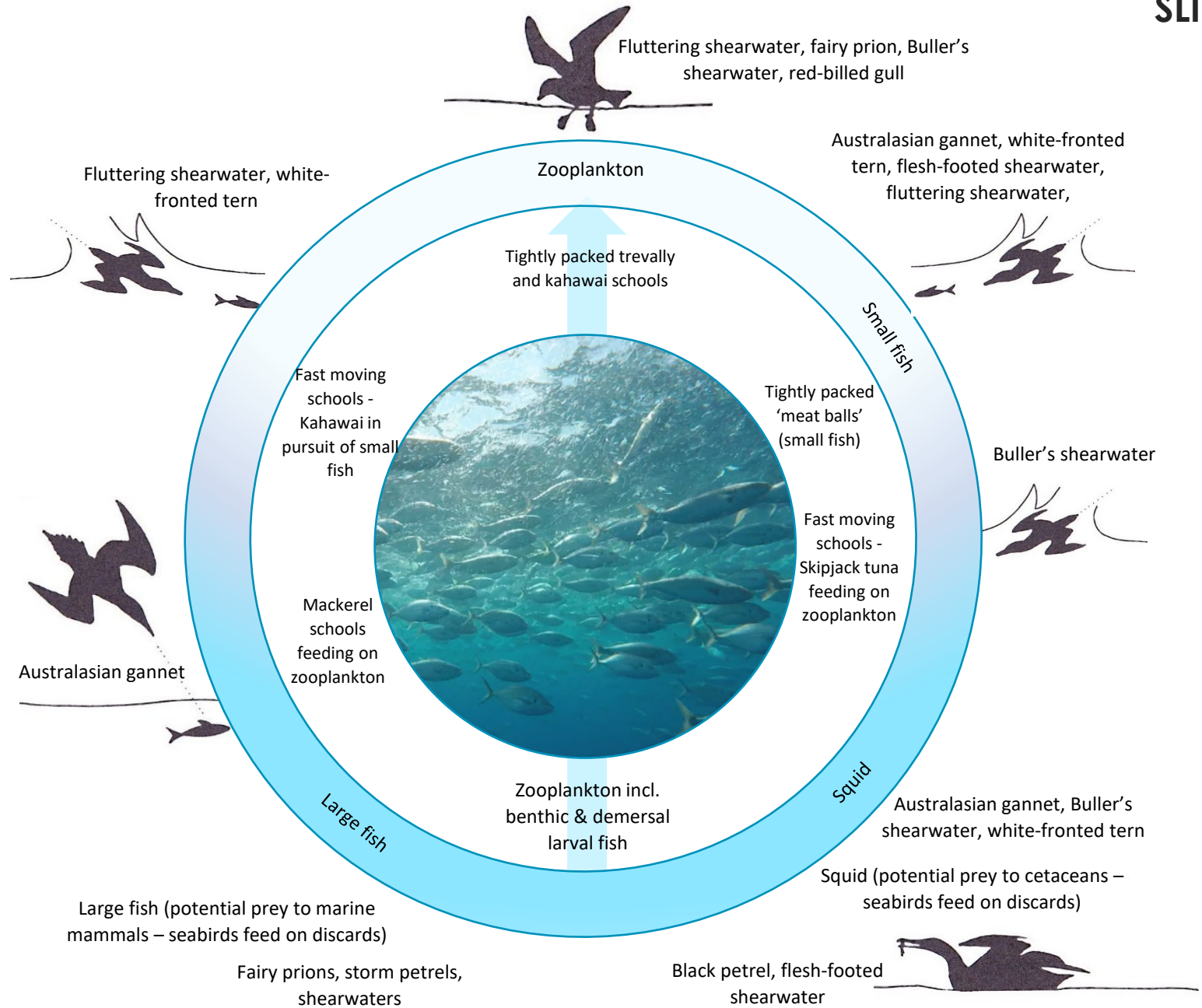
Tara White-fronted tern

Tarapunga Red-billed gull

Taonui Flesh-footed shearwater
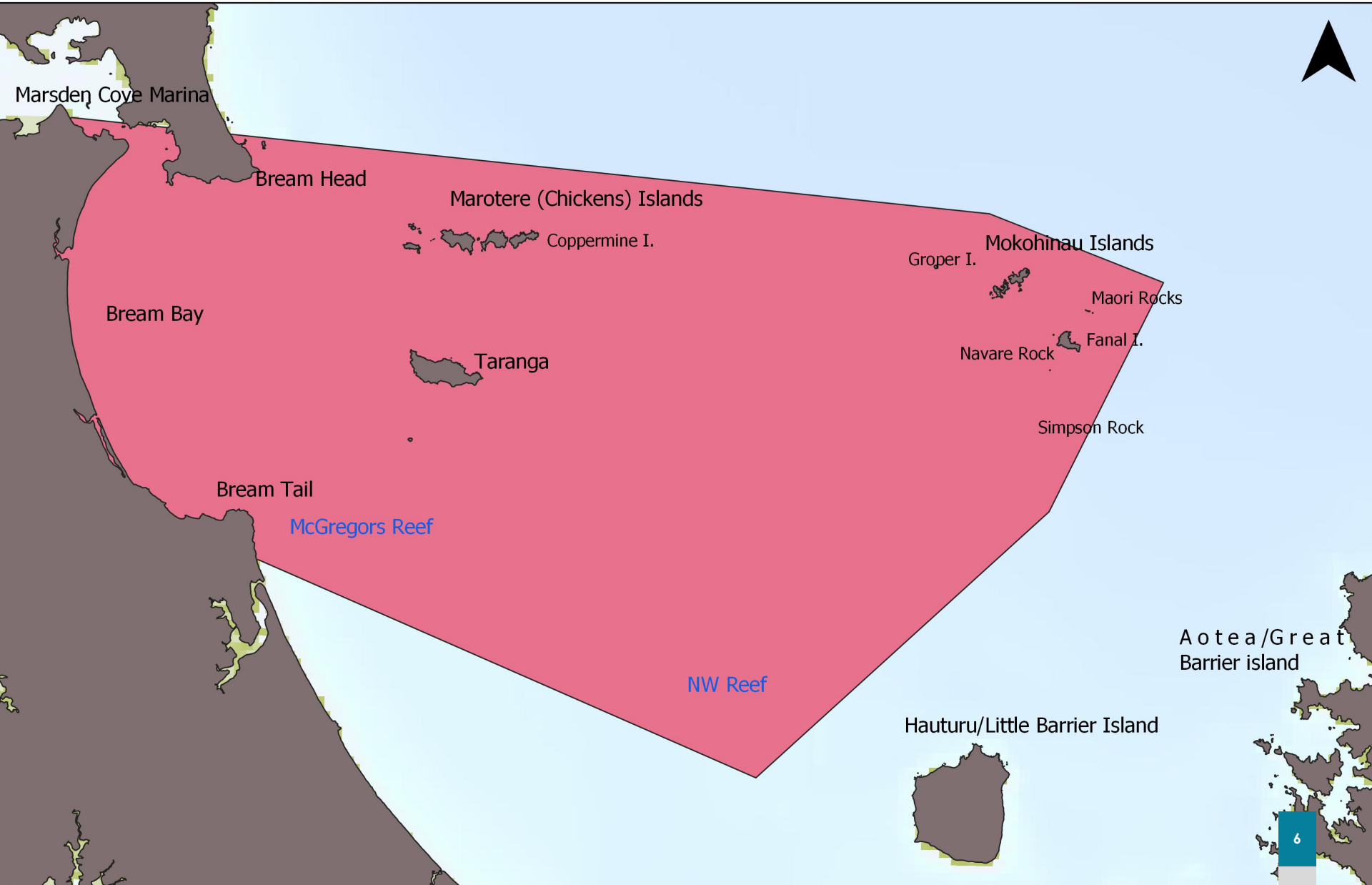
Takahikare White-faced storm-petrel
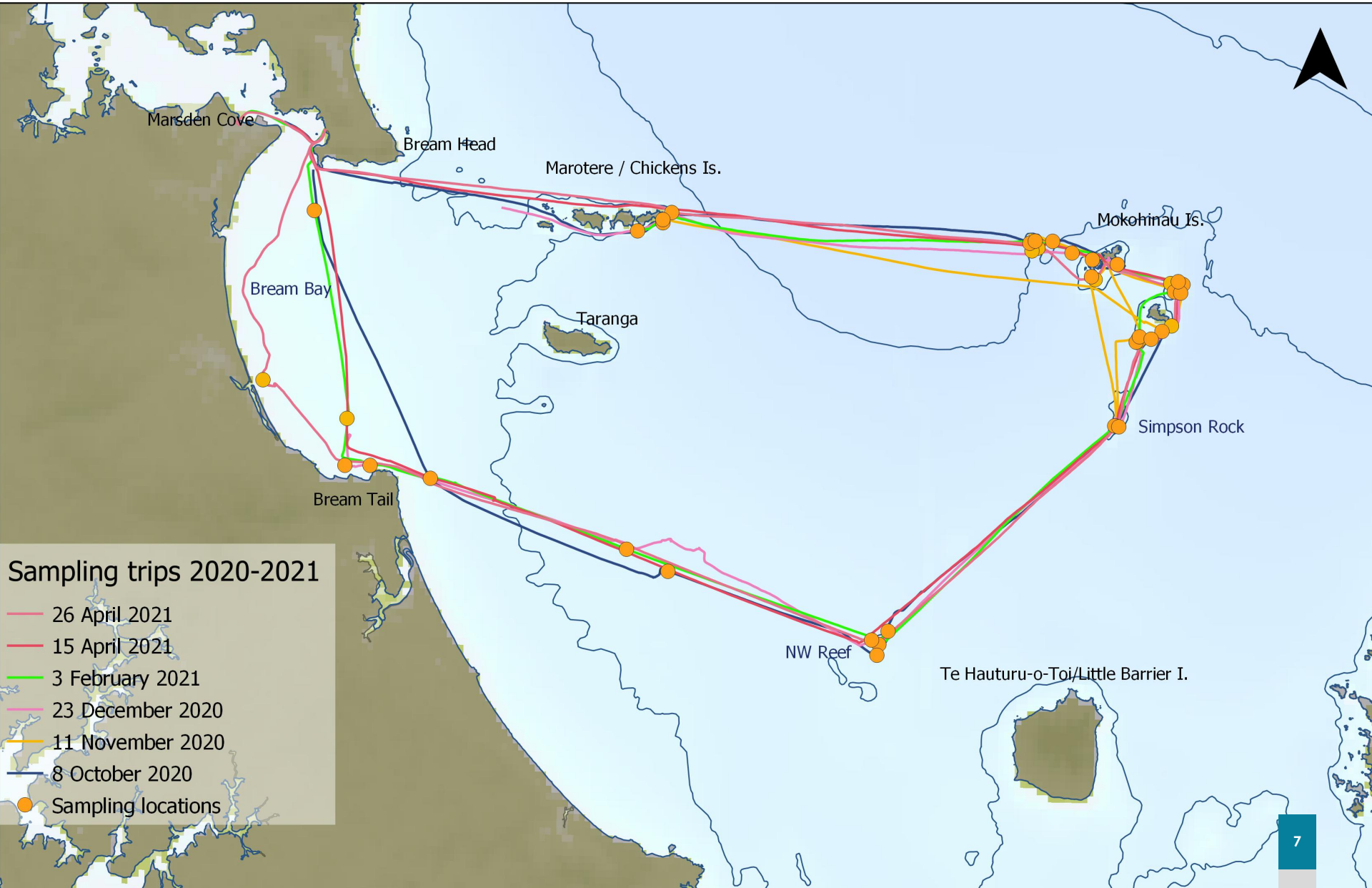
Diversity of fish school activity

Diversity of seabird feeding activity

Fluttering shearwater, fairy prion, Buller's shearwater, red-billed gull

Zooplankton

Australasian gannet, white-fronted tern, flesh-footed shearwater, fluttering shearwater,

Fluttering shearwater, white-fronted tern

Tightly packed trevally and kahawai schools

Small fish

Fast moving schools - Kahawai in pursuit of small fish

Tightly packed 'meat balls' (small fish)

Buller's shearwater

Fast moving schools - Skipjack tuna feeding on zooplankton

Mackerel schools feeding on zooplankton

Australasian gannet

Squid

Zooplankton incl. benthic & demersal larval fish

Australasian gannet, Buller's shearwater, white-fronted tern

Large fish

Large fish (potential prey to marine mammals – seabirds feed on discards)

Squid (potential prey to cetaceans – seabirds feed on discards)

Fairy prions, storm petrels, shearwaters

Black petrel, flesh-footed shearwater

Our study area – 2020-2021

Marsden Cove Marina

Bream Head

Marotere (Chickens) Islands

Coppermine I.

Mokohinau Islands

Groper I.

Maori Rocks

Bream Bay

Navare Rock

Fanal I.

Taranga

Simpson Rock

Bream Tail

McGregors Reef

A o t e a / G r e a t
Barrier island

NW Reef

Hauturu/Little Barrier Island

Sampling trips – 2020-2021

Sampling trips 2020-2021

— 26 April 2021
— 15 April 2021
— 3 February 2021
— 23 December 2020
— 11 November 2020
— 8 October 2020
● Sampling locations

Zooplankton Sampling

Date	Time start	Time stop	Event type	Lat	Long	Location	Description
6/10/2020	9.37	9.43	Current line	-35.88553	174.78914	E. of Coppermine I.	Fish - trevally, kahawai, humpback in vicinity, birds - BUSH, FAPR (dom sp.), RBGU, FLSH
6/10/2020	10.51	10.56	Surface	-35.89826	175.06977	E of Groper I.	Birds only - FAPR 1000s (dom sp.), BUSH 100s, RBGU 50-100, WFTE <10, BBGU 1
6/10/2020	11.30	11.35	Surface	-35.91125	175.11767	Sphinx Rocks	Fish - trevally, kahawai, humpback in vicinity, birds – 200-300 RBGU (dom sp.), c. 100 FAPR, BUSH, FLSH
6/10/2020	12.15	12.20	Surface	-35.92242	175.16630	Maori Rocks	Birds only
6/10/2020	12.50	12.55	Surface	-35.95067	175.15162	S. Fanal I.	Fish - trevally, birds – , 100s FAPR (dom sp.), 10s BUSH, BBGU 1

Locations where sampling was conducted. Event type relates to fish/seabird activity and the nature of the sampling procedure.
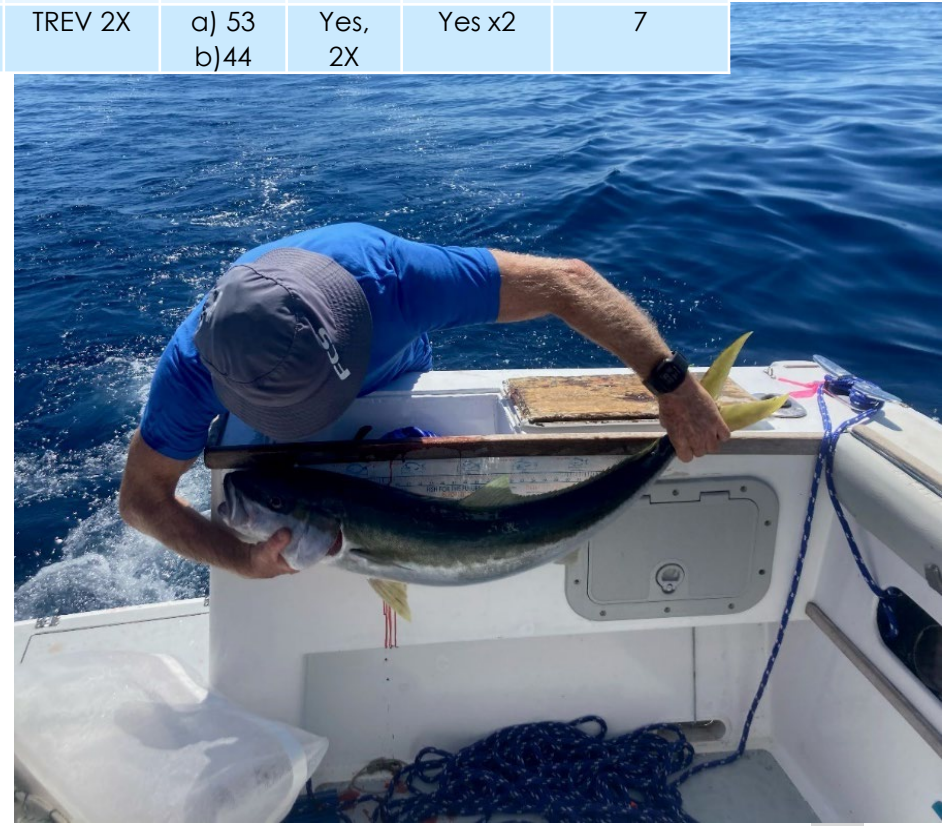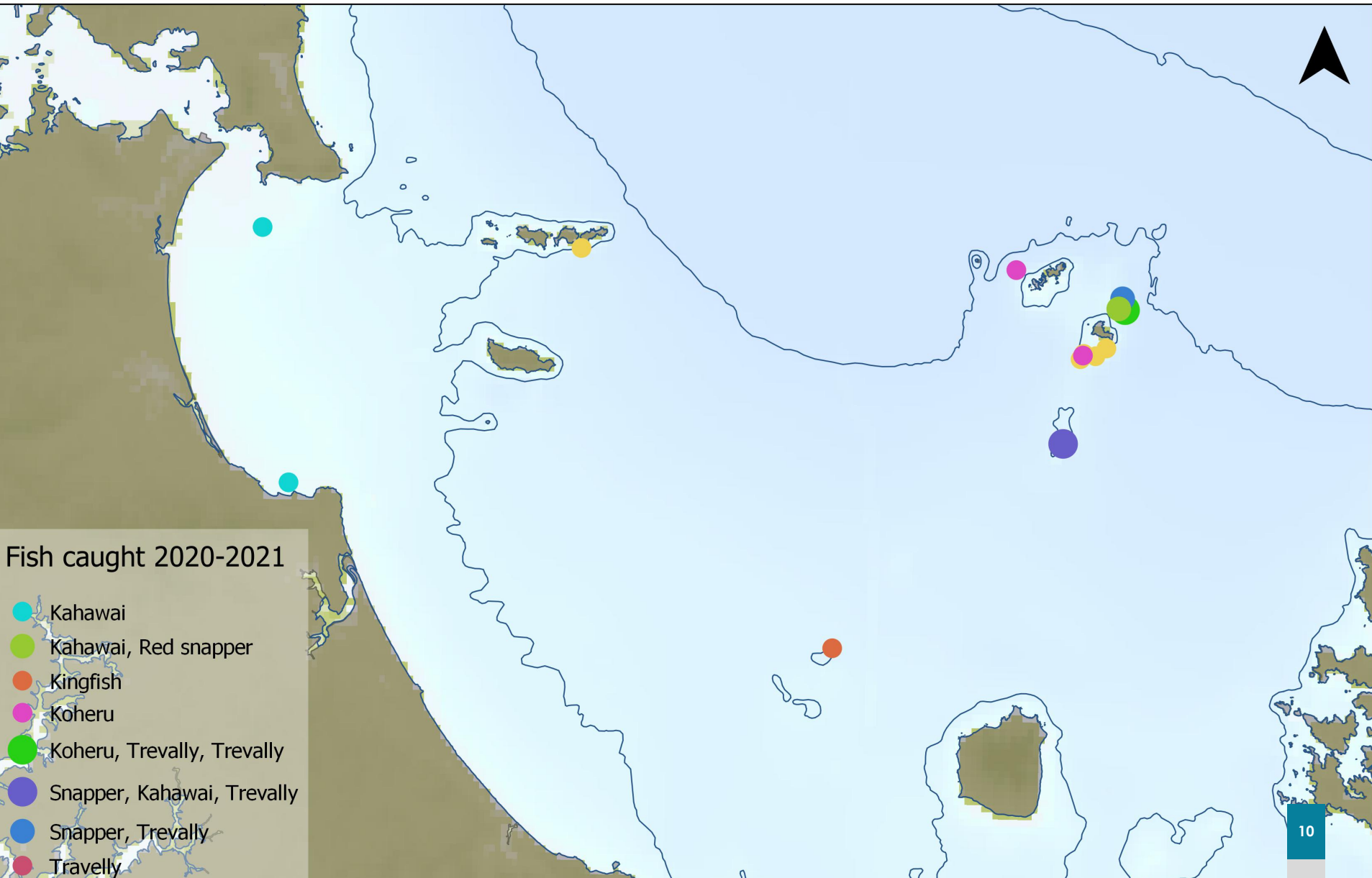
N = 38 events
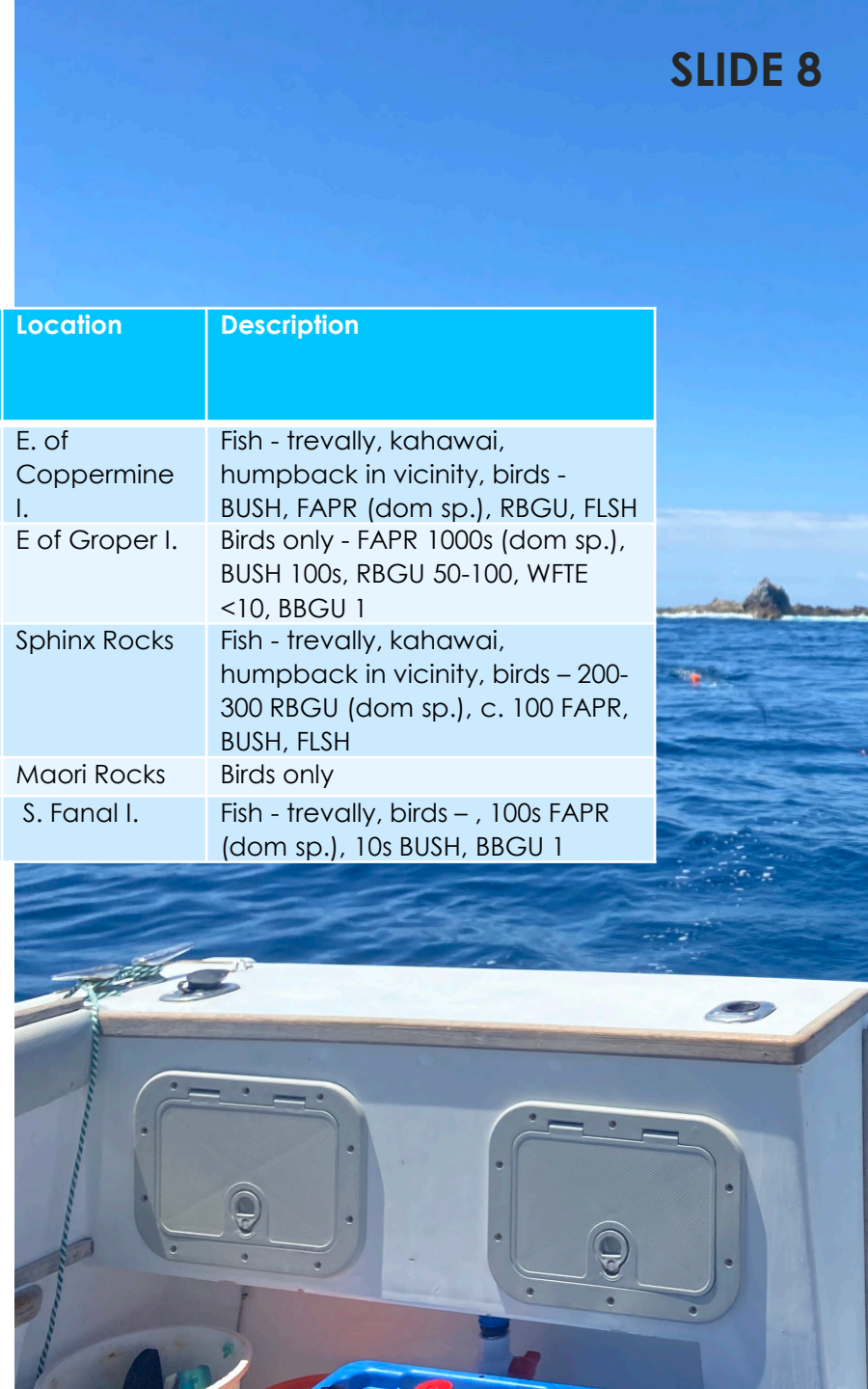
Fish Sampling

Date	Event #	Original total volume (ml)	Pres vol (ml)	Vol disc'd (ml)	Sample label ID	Fish sp.	Fish length (cm)	Fish stom.	Fish muscle sample	Total # samples
6/10/2020	1	210	150	60	1					3
6/10/2020	2	<50	<50	0	2					3
6/10/2020	3	180	150	30	3					8
6/10/2020	4	100	100	0	4					5
6/10/2020	5	120	120	0	5	TREV 2X	a) 53 b)44	Yes, 2X	Yes x2	7

Summary of zooplankton and fish samples collected with 'Original total volume', 'Pres vol' and 'Vol disc'd' representing total volume collected, preserved volume of sample discarded volume respectively. Also, under fish stomach and muscle samples 2X or 3X refers to samples from each separate fish.

Fish captured on 20 occasions, total no. 28

Fish caught

Fish caught 2020-2021

- Kahawai
- Kahawai, Red snapper
- Kingfish
- Koheru
- Koheru, Trevally, Trevally
- Snapper, Kahawai, Trevally
- Snapper, Trevally
- Travelly

Observations

Fish school dynamics

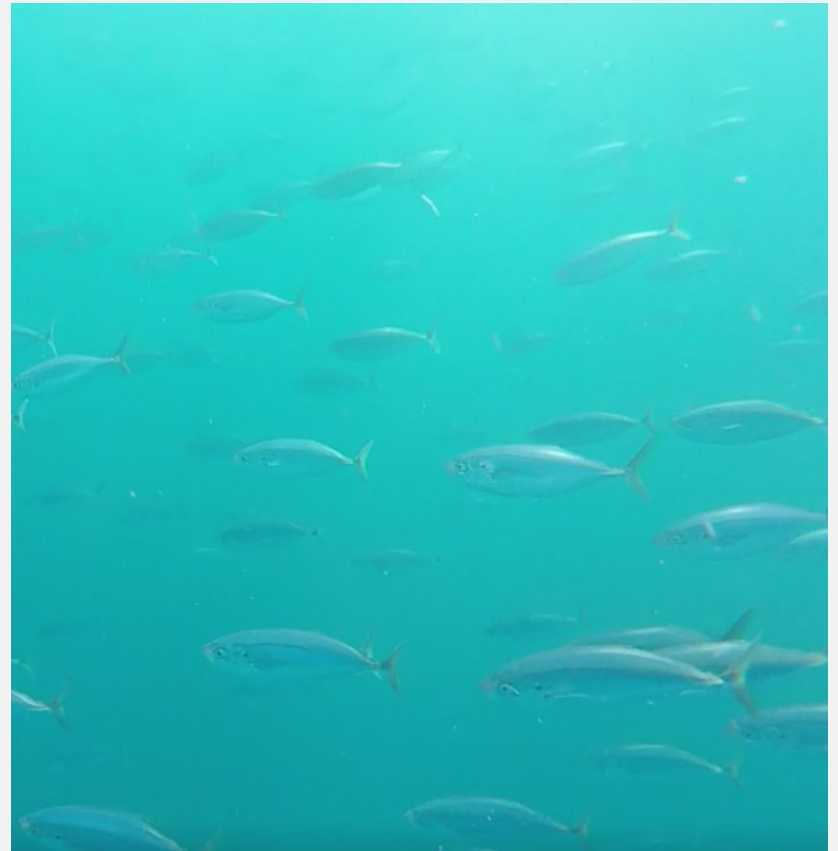**Mixed school of trevally & kahawai – 3 December 2020**

Fish school dynamics

Kahawai – 3 February 2021

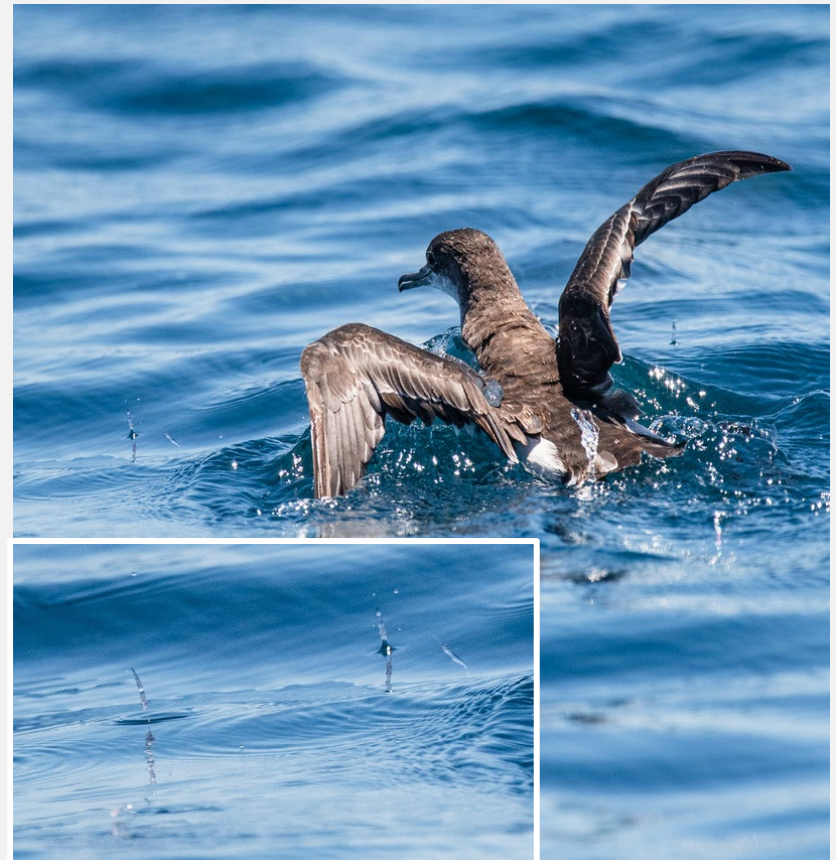**Koheru – 15 April 2021**

Seabird behviours

Seabird behaviours

Gannets following dolphins – mid channel
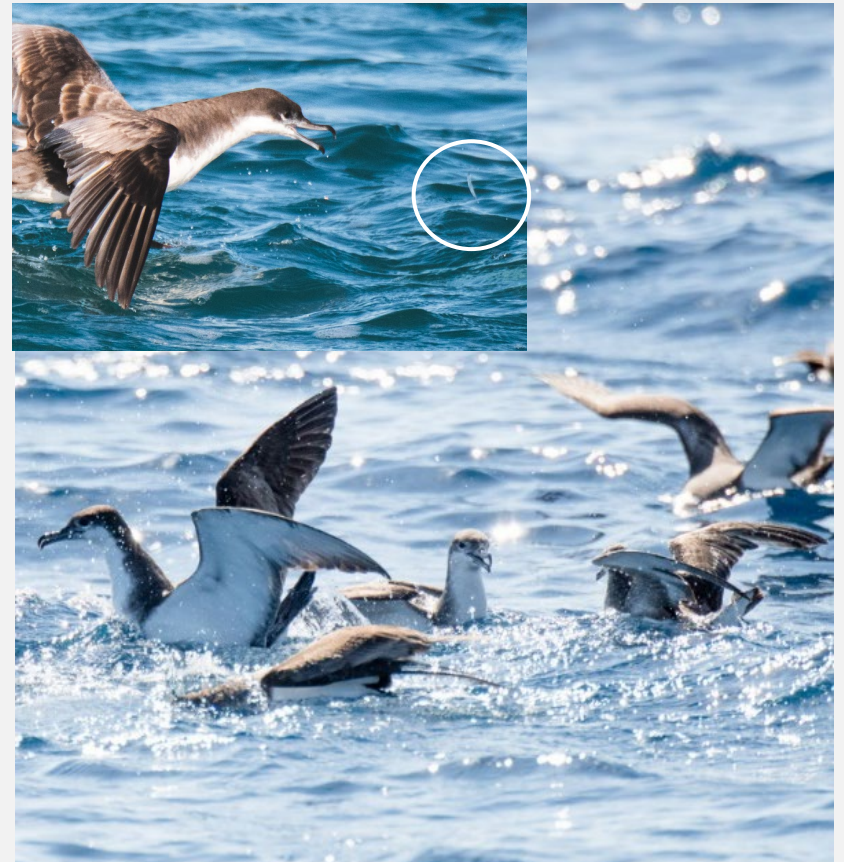
Leaping krill and shearwaters

Seabird behaviours

White-fronted tern, Bream Bay
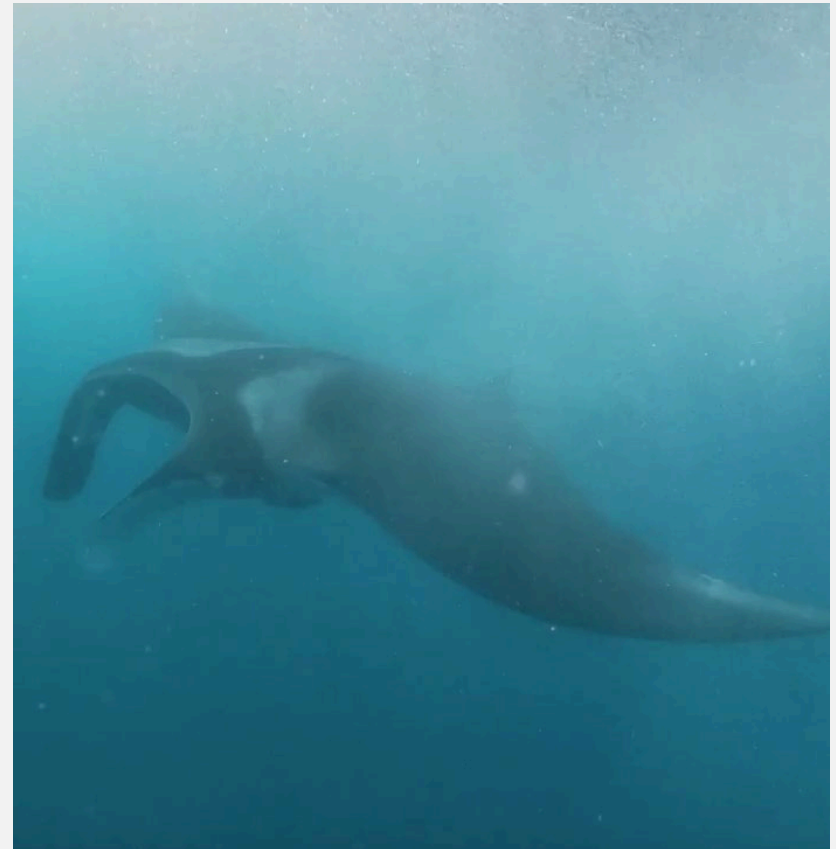
Shearwaters, Bream Bay

Seabird behaviours

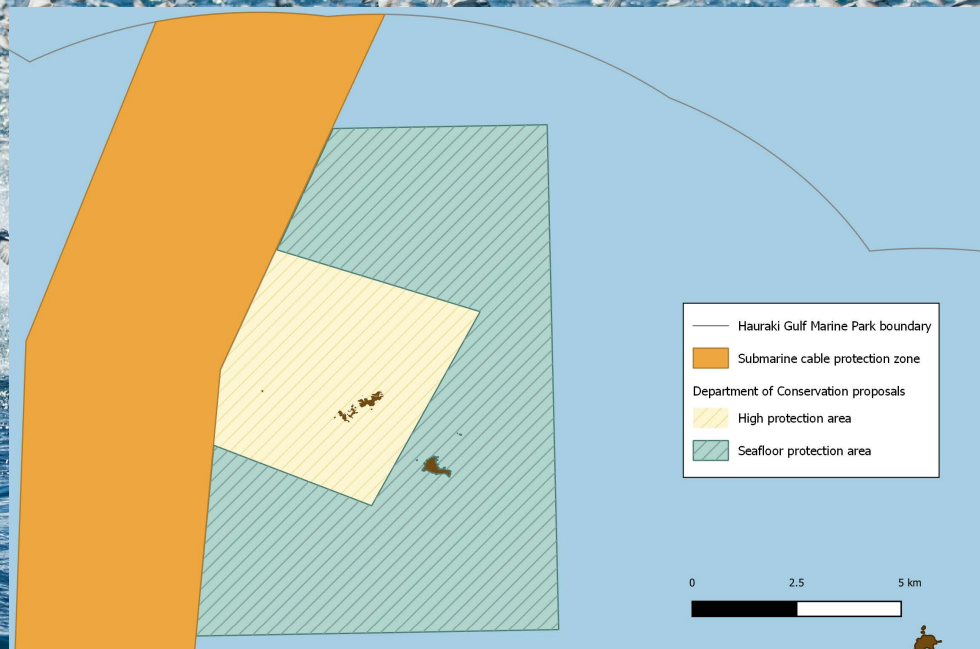Red-billed gulls aggregating outer Hauraki Gulf post-breeding

Other marine megafauna

Bronze whaler shark – multiple occasions

Manta ray

Hauraki Gulf Marine Park boundary
Submarine cable protection zone
Department of Conservation proposals
High protection area
Seafloor protection area

0   2.5   5 km

MPA identification

Revitalising the Gulf – Government Action on the Sea Change Plan

MPA identification – top down, bottom up …

Full recognition of surface to benthic biodiversity should be used to further inform decision making around 'static' MPA as proposed in Government action of the Sea Change Plan.

Priority research identified in the Plan for protected species includes the influence of long-term trends in pelagic primary and secondary productivity on the behaviour, distribution and reproductive success of seabirds and cetaceans inhabiting the Gulf.
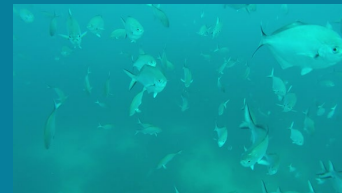
c.-35m

Next stages

The zooplankton samples collected in 2020-2021 need to identified, counted, and a complete analysis undertaken.

All results from POP2019-02 and BCBC2020-08 to be combined for further analysis and possible modelling.
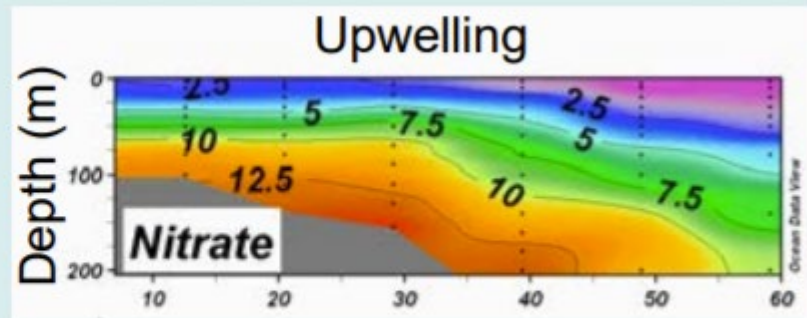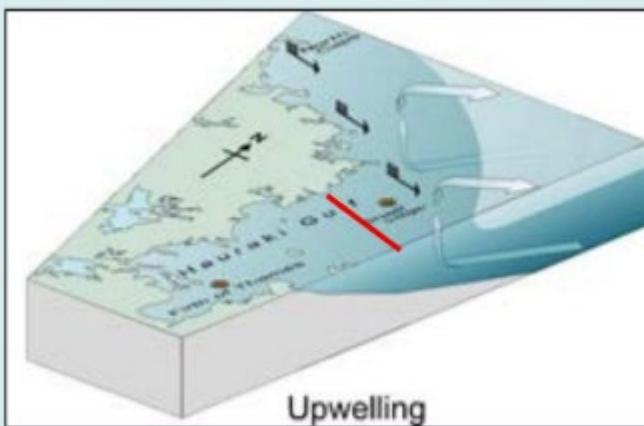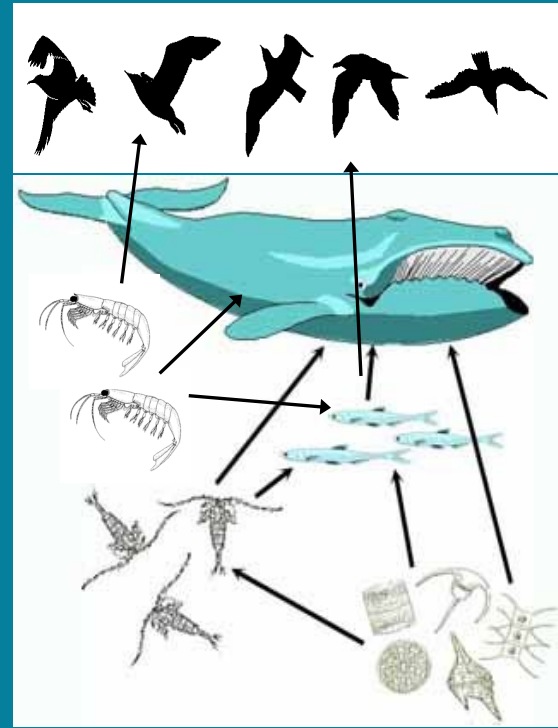
BCBC2020-08 (POP2019-02)
Nutritional Analysis of Seabird Prey Species from the Hauraki Gulf

Hauraki Gulf
Highly productive marine ecosystem

Nutritional composition of seabird prey species

Zooplankton samples 2019-2021 = krill

Gannet regurgitation = pilchard, anchovy, jack mackerel, arrow squid

Mean length of krill

Date of krill capture (Mokihinau Is.)

Krill highly variable in size within and among catches, among locations/times

Nutritional composition of seabird prey species

Zooplankton samples 2019-2021 = krill

Gannet regurgitation = pilchard, anchovy, jack mackerel, arrow squid

Mean lipid/oil content

Seabird prey species

All prey species high in lipid/oil content
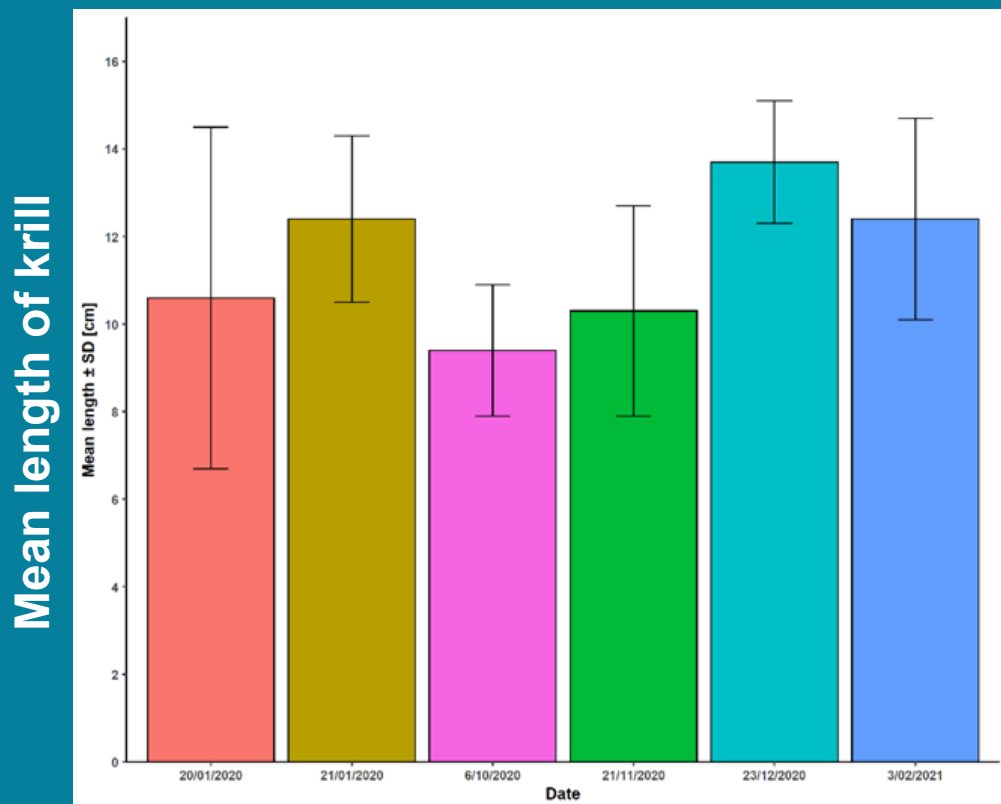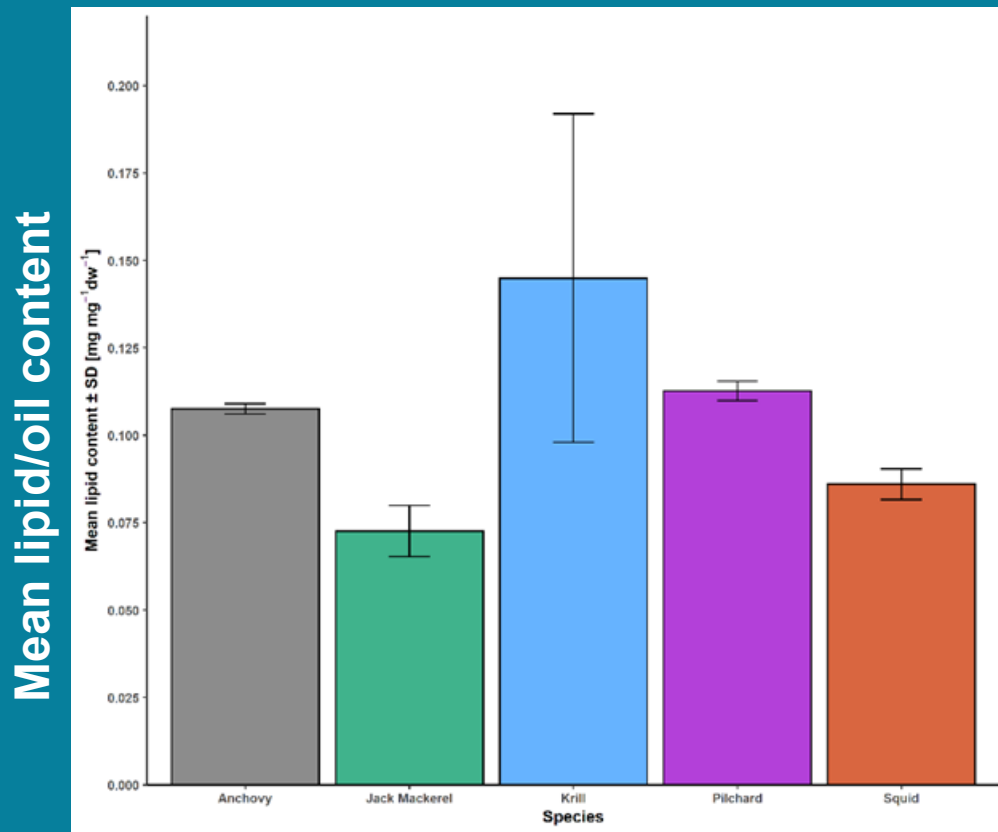
Krill highly variable in lipid

Nutritional composition of seabird prey species

Zooplankton samples 2019-2021 = krill

Gannet regurgitation = pilchard, anchovy, jack mackerel, arrow squid

Mean protein content

Seabird prey species

All prey species high in protein content

Krill highly variable in protein

Nutritional composition of seabird prey species

Zooplankton samples 2019-2021 = krill

Gannet regurgitation = pilchard, anchovy, jack mackerel, arrow squid

All prey species high in energy content

Krill highly variable in energy content

Mean energy content of prey

Seabird prey species

Nutritional composition of seabird prey species

Zooplankton samples 2019-2021 = krill

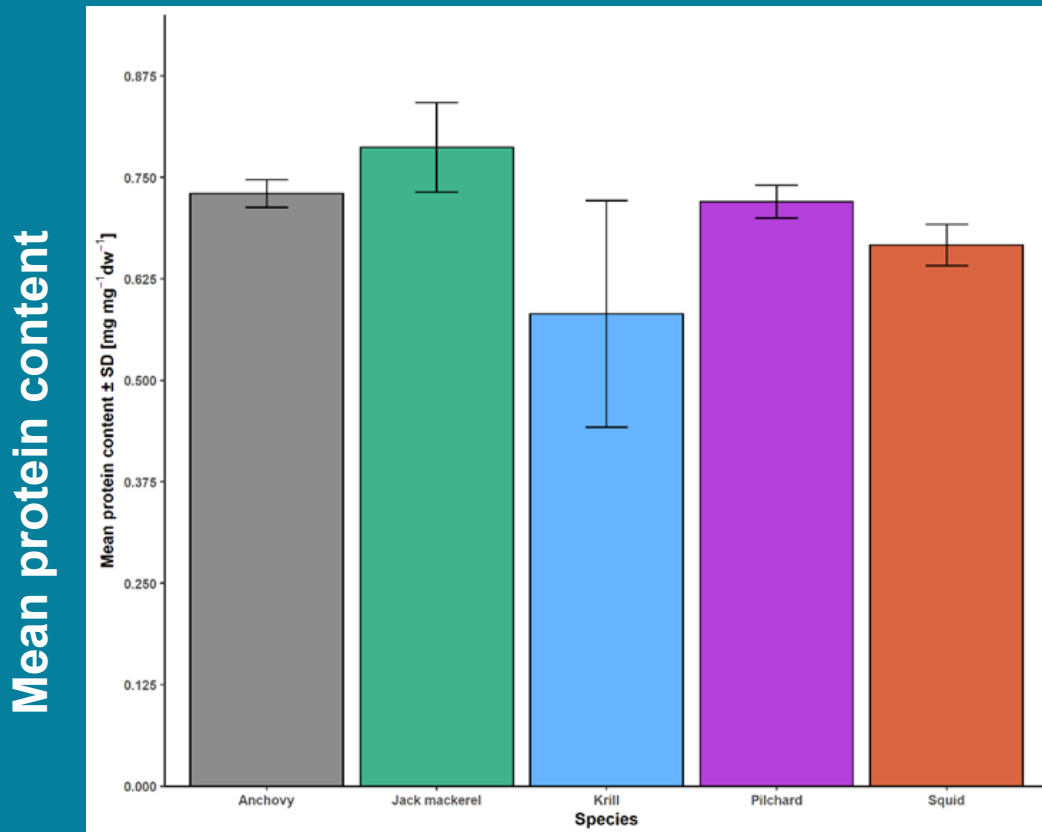**Gannet regurgitation = pilchard, anchovy, jack mackerel, arrow squid**
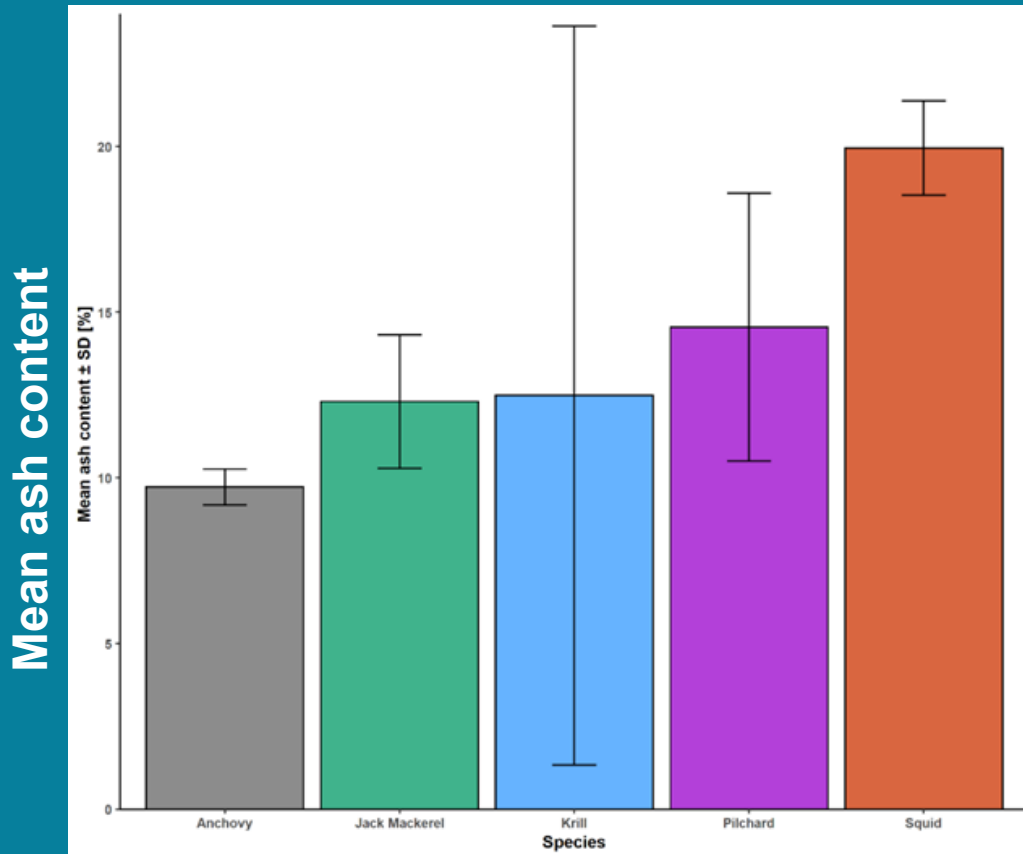
Mean ash content

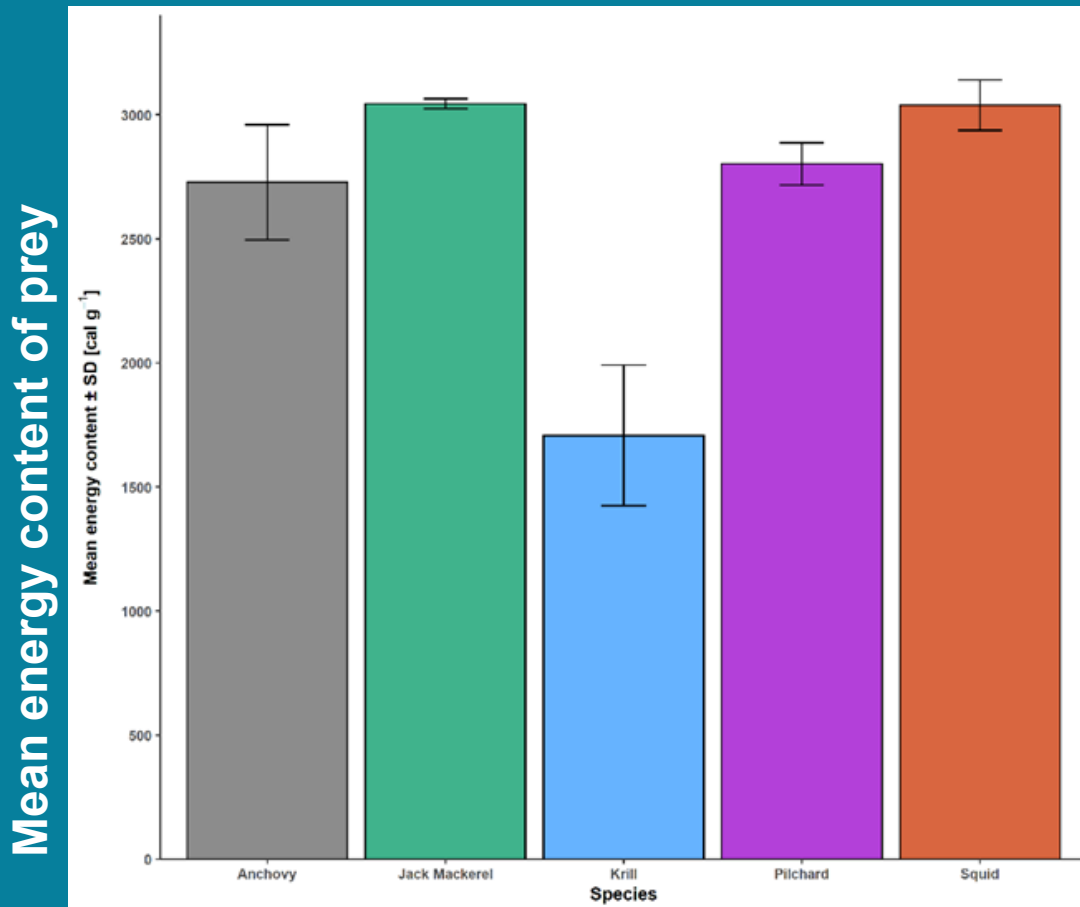**Seabird prey species**

All prey species relative low ash content

Krill highly variable in ash content

Nutritional composition of seabird prey species

Conclusions

Krill

- widely important species – seabirds, pelagic fish, marine mammals
- spatially widespread, but highly patchy – swarming behaviour
- high variability in krill size
- high variability in nutritional quality, but overall high quality
- almost complete lack of knowledge of krill biology in the Hauraki Gulf

Pilchard, anchovy, jack mackerel, arrow squid

- high nutritional value – protein and energy content especially

Change in Gulf sea life since human arrival

Seabirds & shorebirds
-67%

Australasian gannet

Fairy prion, red-billed gull, storm petrels
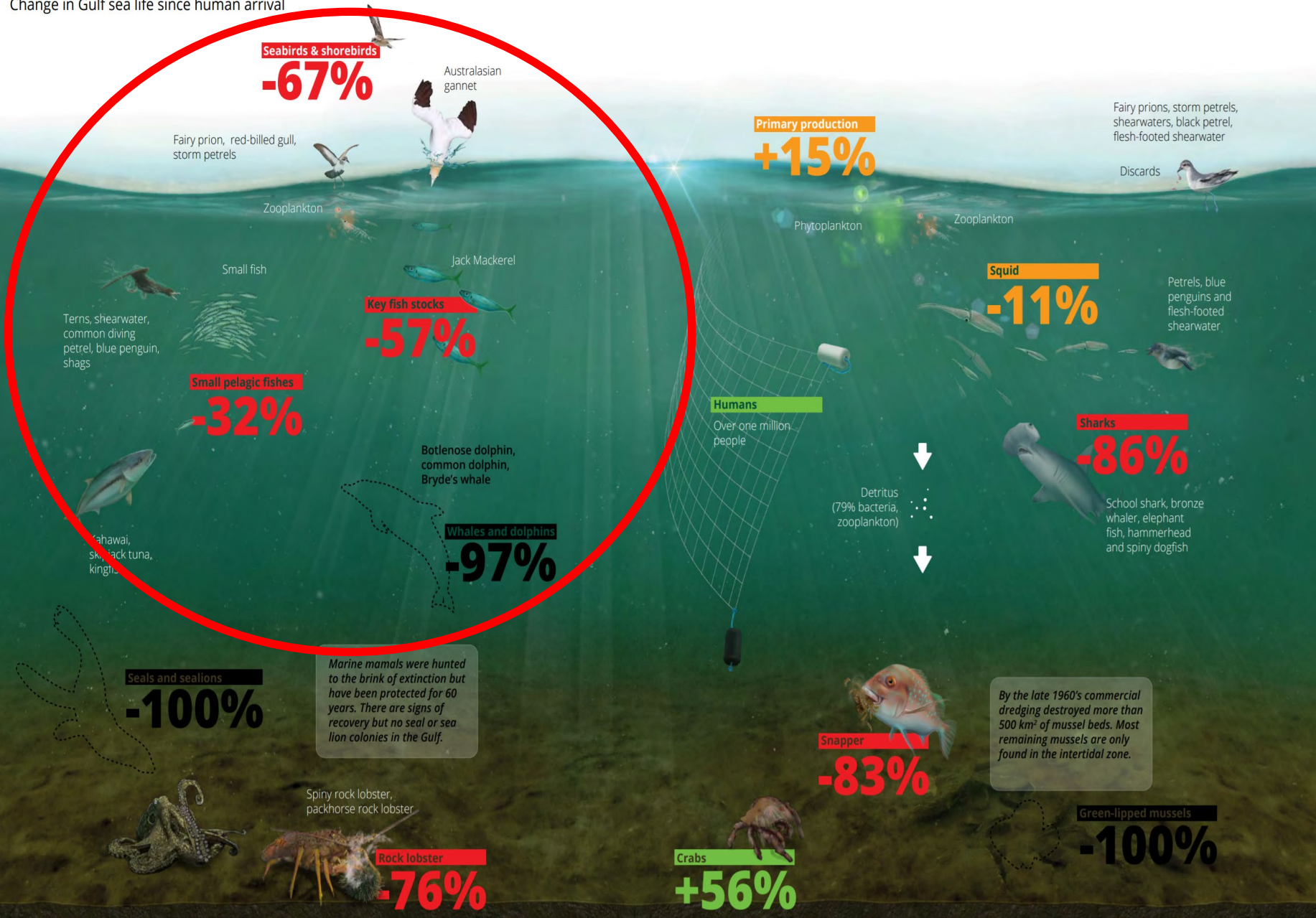
Zooplankton

Primary production
+15%

Phytoplankton

Zooplankton

Fairy prions, storm petrels, shearwaters, black petrel, flesh-footed shearwater

Discards

Small fish

Jack Mackerel

Key fish stocks
-57%

Squid
-11%

Petrels, blue penguins and flesh-footed shearwater

Terns, shearwater, common diving petrel, blue penguin, shags

Small pelagic fishes
-32%

Humans
Over one million people

Sharks
-86%

School shark, bronze whaler, elephant fish, hammerhead and spiny dogfish

Botlenose dolphin, common dolphin, Bryde's whale

Kahawai, skipjack tuna, kingfish

Whales and dolphins
-97%

Detritus (79% bacteria, zooplankton)

Seals and sealions
-100%

Marine mamals were hunted to the brink of extinction but have been protected for 60 years. There are signs of recovery but no seal or sea lion colonies in the Gulf.

By the late 1960's commercial dredging destroyed more than 500 km² of mussel beds. Most remaining mussels are only found in the intertidal zone.

Snapper
-83%

Spiny rock lobster, packhorse rock lobster

Green-lipped mussels
-100%

Rock lobster
-76%

Crabs
+56%

Special thanks to Edin Whitehead (photos) and Trevor Jackson (skipper)

Dr Stefan Spreitzenbarth for running the nutritional analysis

NGĀ MIHI NUI - THANK YOU