

Seabird feeding associations with fish shoals:

Analysis of zooplankton samples collected 2020-2021

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LILY KOZMIAN-LEDWARD, CHRIS GASKIN,
ANDREW JEFFS



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Koheru school, Navire Rock, Mokohinau Islands.

Objectives

- To better understand the relationship between the diet of sea-surface foraging seabirds, and prey items associated with fish workups.
- Present a summary of the analysis of zooplankton samples collected in the 2020-2021 sampling season and their relationships with different types of seabird-feeding events.



Larval fish in a 'sea' of krill.

Project background: overview

- Notable feature of NE North Island waters are large numbers of seabirds feeding on zooplankton and small fish at “workups”.
- Greater knowledge required on the processes that drive workup formation and the multi-species interactions.
- Purse-seine fisheries target fish species associated with workups, potentially indirectly affecting prey availability for seabirds.
- Continuation of the fish school and zooplankton research conducted 2017-2019 (POP2017-06, POP2019-02).

Project background: seabird feeding events



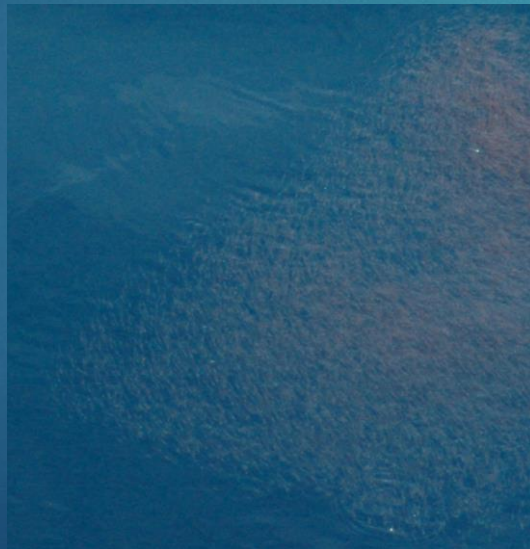
Mixed Fish School



Kahawai School



Koheru School

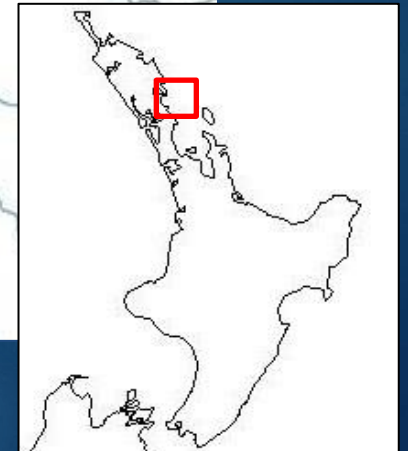
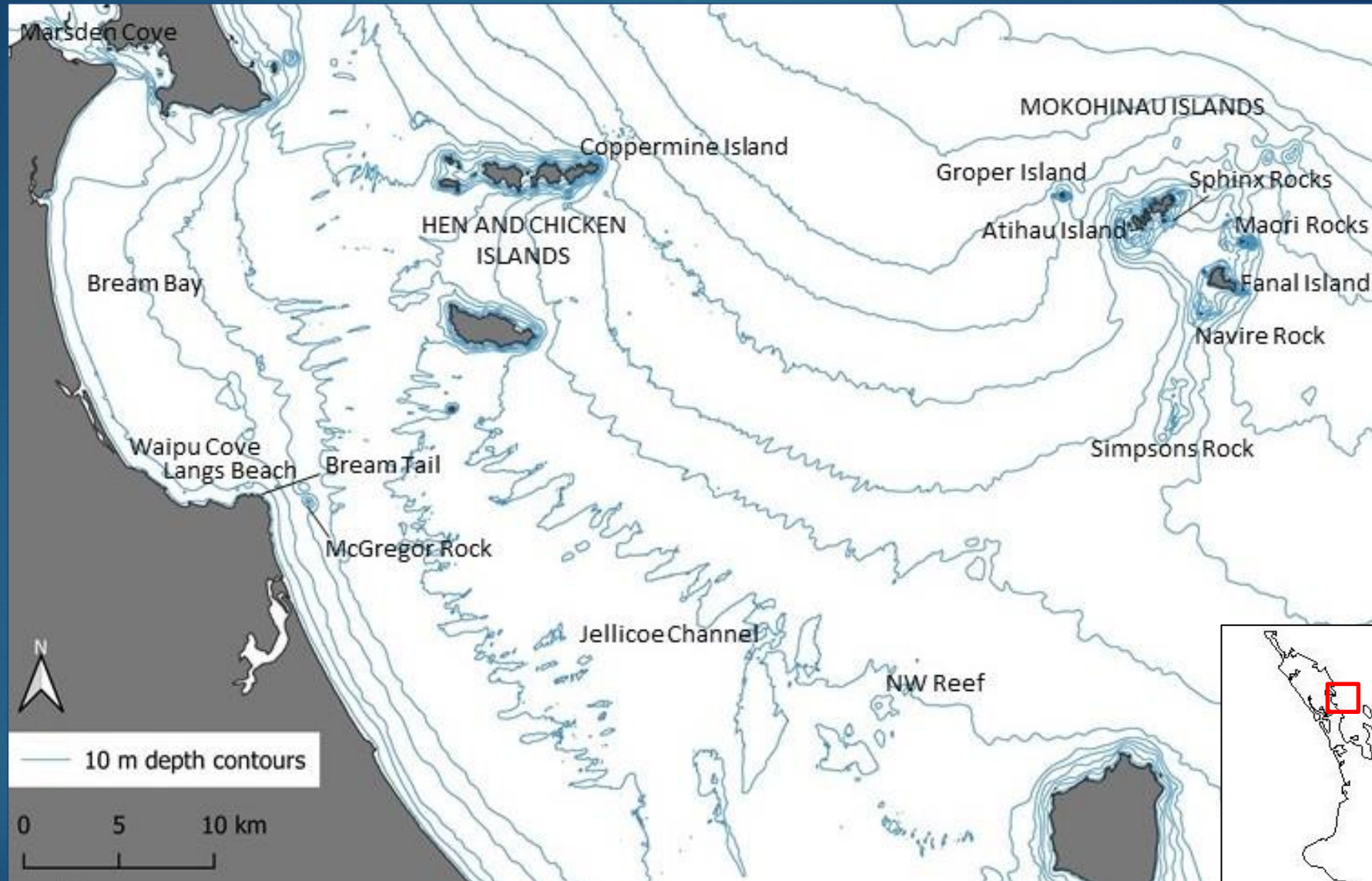


Krill Swarm



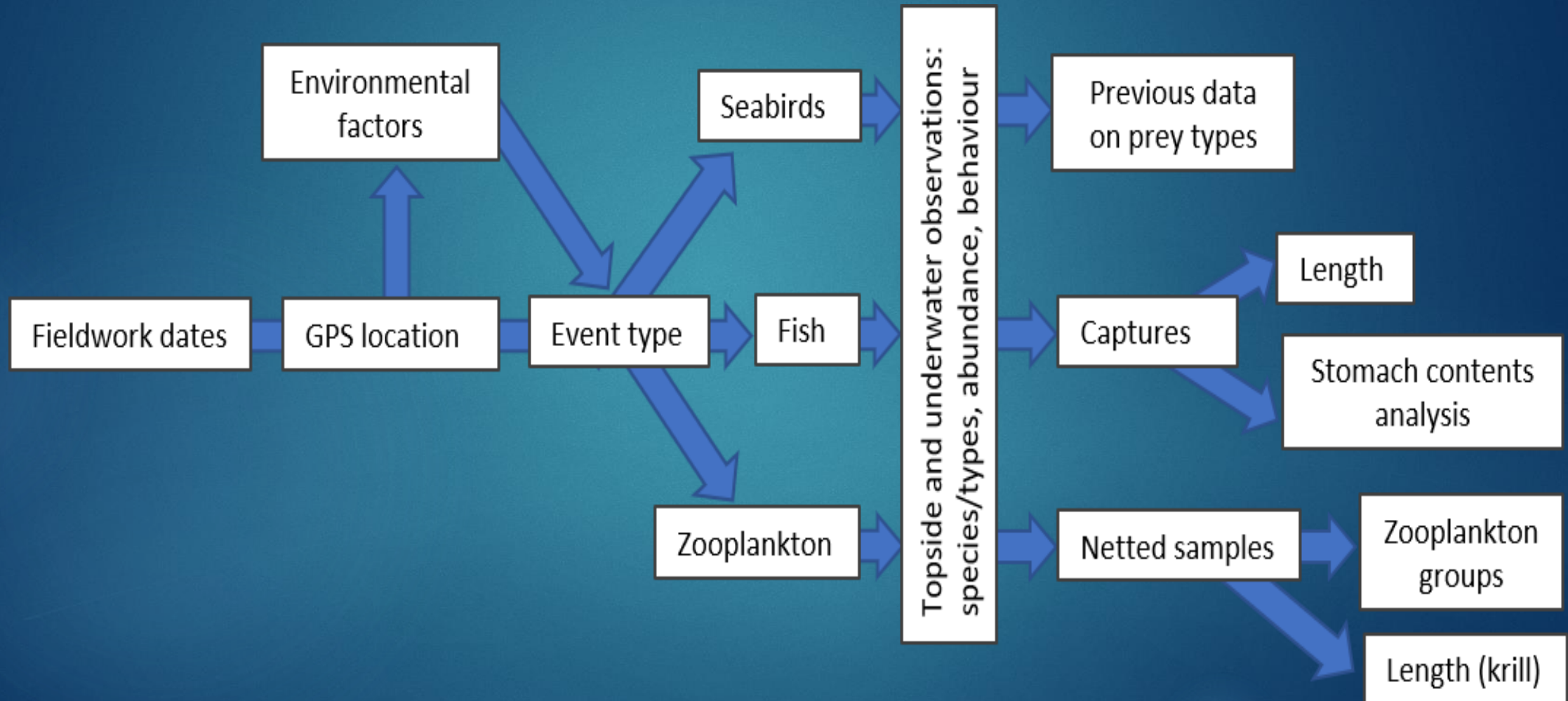
Current Line

Study area



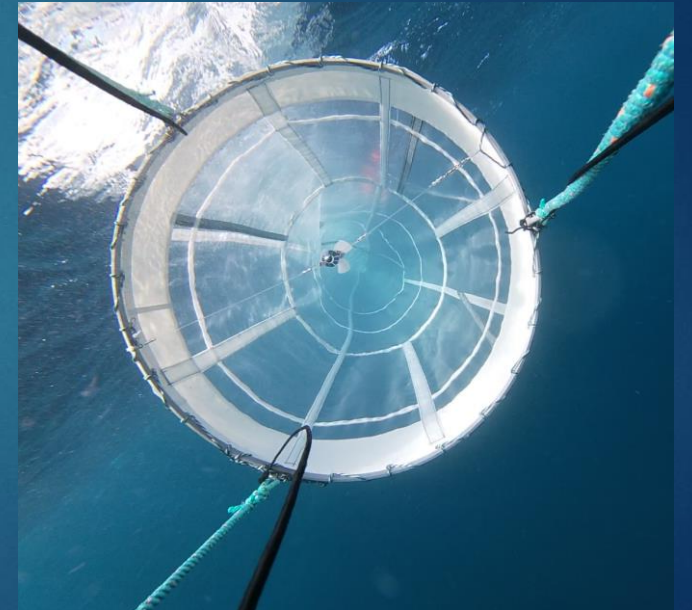
Map of the study area in the wider, northern Hauraki Gulf

Methods: overview



Methods: zooplankton sampling & analysis

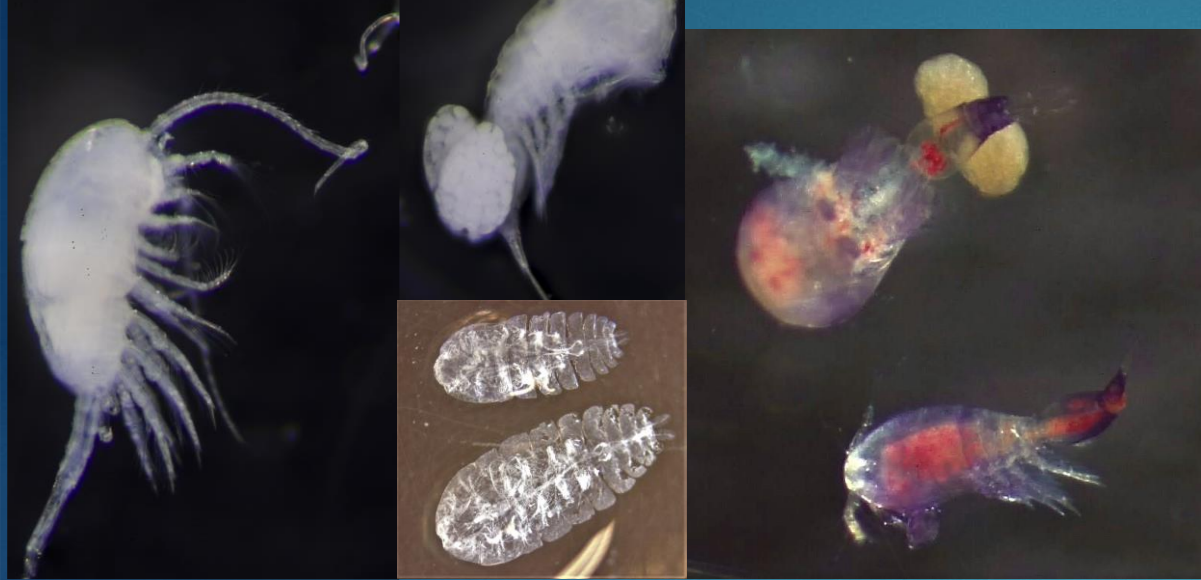
- Horizontal, surface zooplankton net tows. 1.3 mm mesh size; tow speed 3 kts.
- Sampling conducted mainly at fish school events, also at control and current line events.
- Zooplankton types identified and counted into seven groups (Copepoda, Malacostraca (ex. krill), Krill, Thaliacea, Larval Fish, Fish eggs, Other).
- Number of zooplankton per m³ water filtered by net calculated for each zooplankton group.
- 50 krill lengths measured from each sample where available.



Zooplankton net

Methods: zooplankton groups (I)

Copepoda



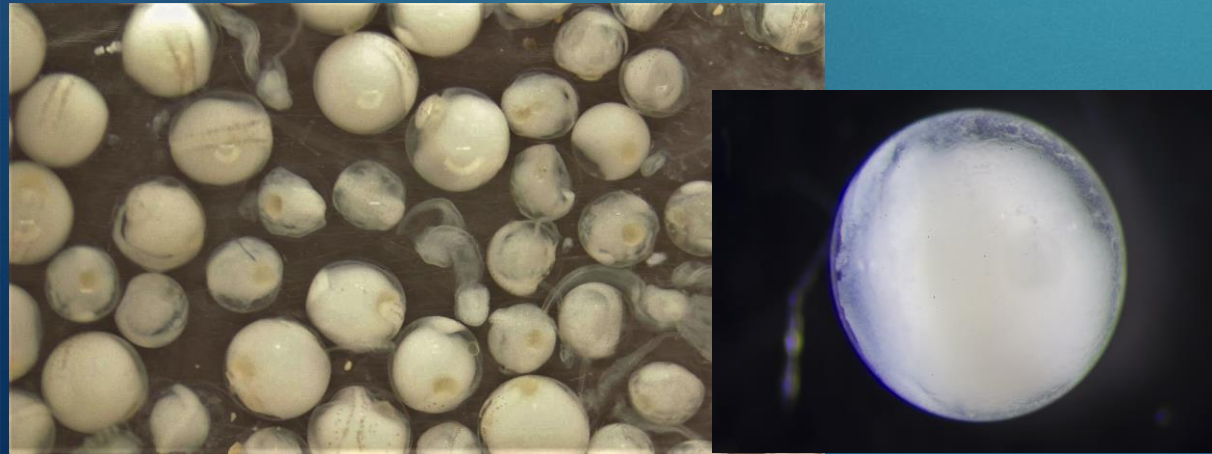
~0.5 – 4.0 mm

Malacostraca (ex krill)



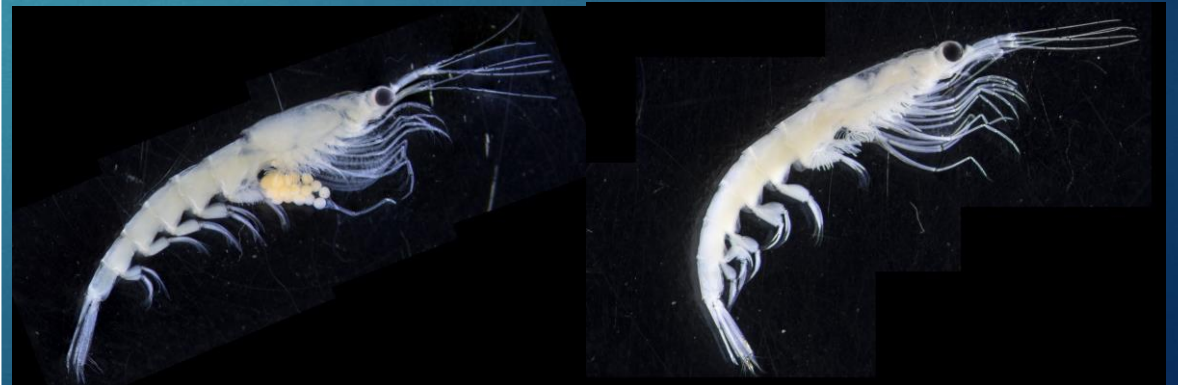
~1.3 – 18 mm

Fish eggs



~ 0.7 – 1.4 mm

Krill



Up to ~ 20 mm

Methods: zooplankton groups (II)

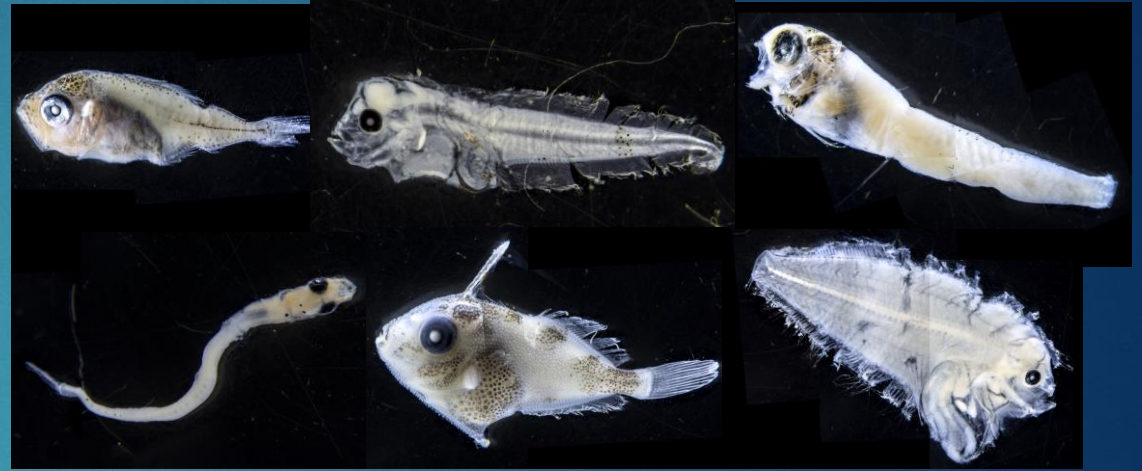
Thaliacea

~1.5 – 13+ mm



Larval Fish

~2 - 23 mm

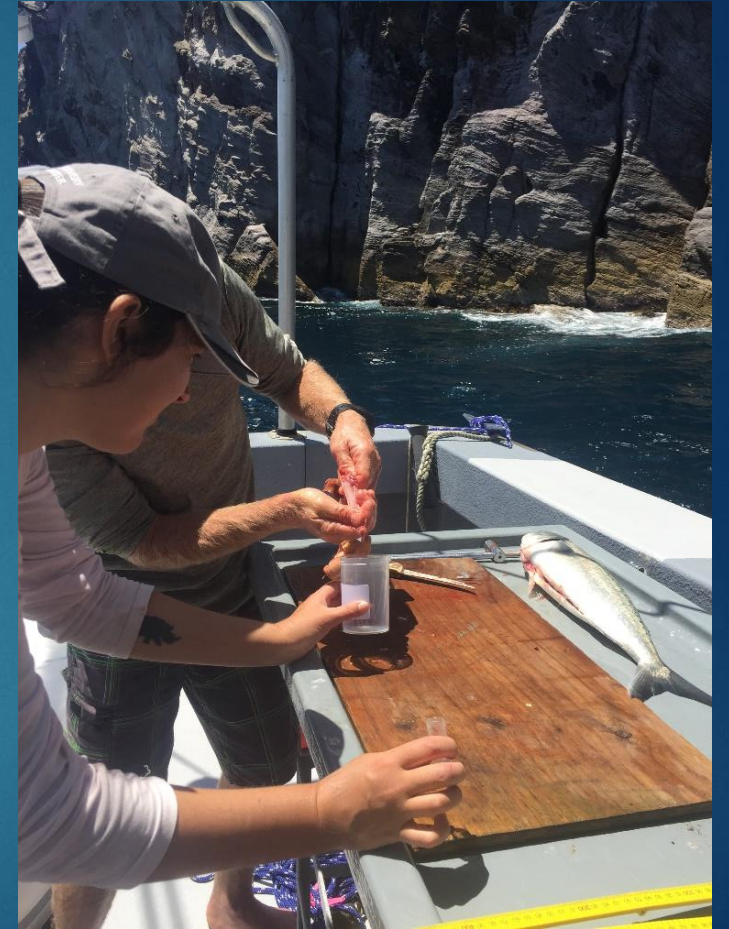


Other



Methods: fish sampling & analysis

- Fish caught from workups using rod and line.
- Species and fish length recorded.
- Gut contents removed: identified and enumerated into the seven zooplankton groups.
- 50 krill lengths measured where available.



Obtaining gut contents from a kahawai

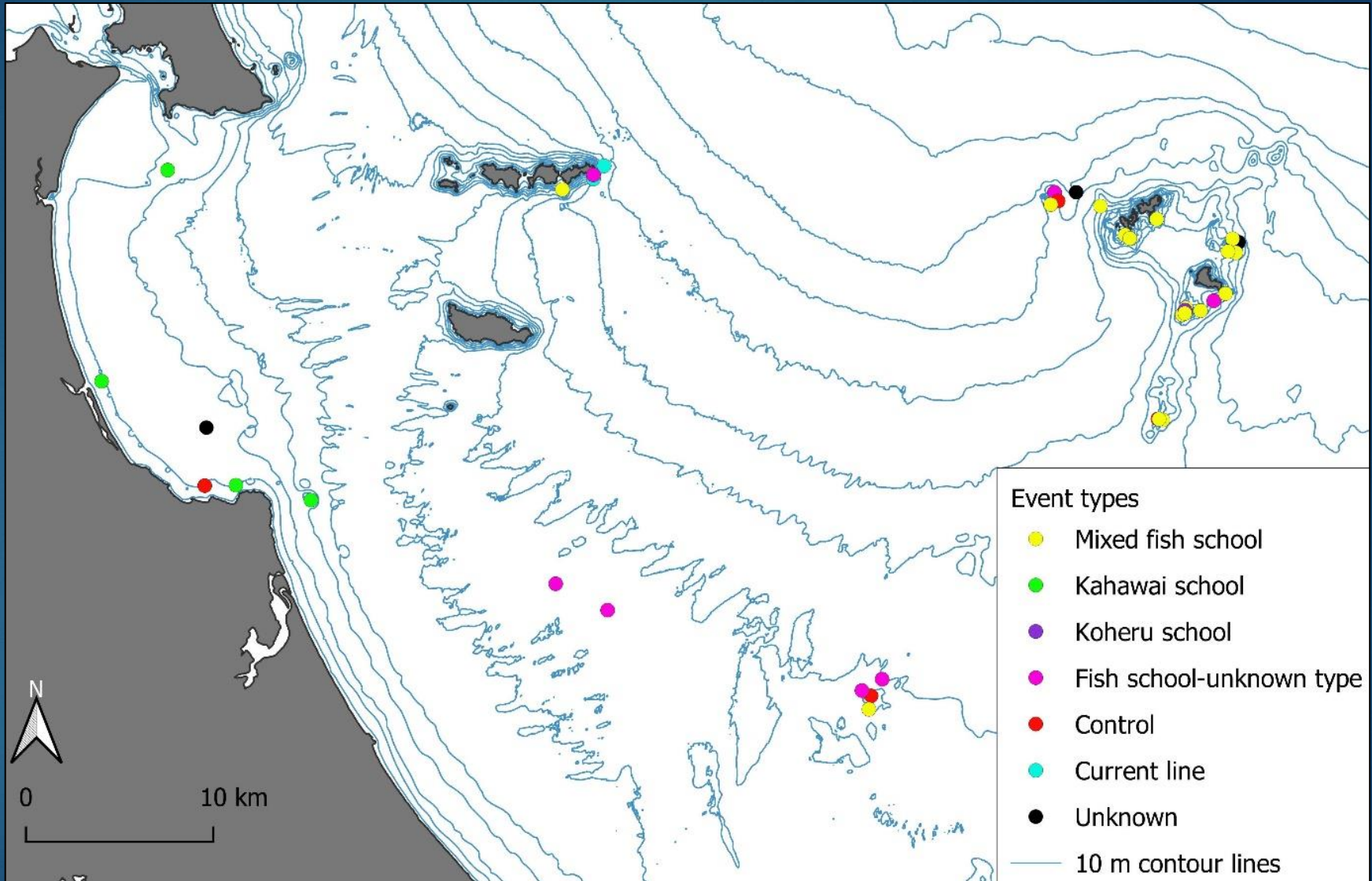
Methods: underwater videography

- Floating camera rig deployed into fish schools / workups.
- Assisted determination of fish species present and krill.
- Behavioural observation of species involved in the workup recorded.



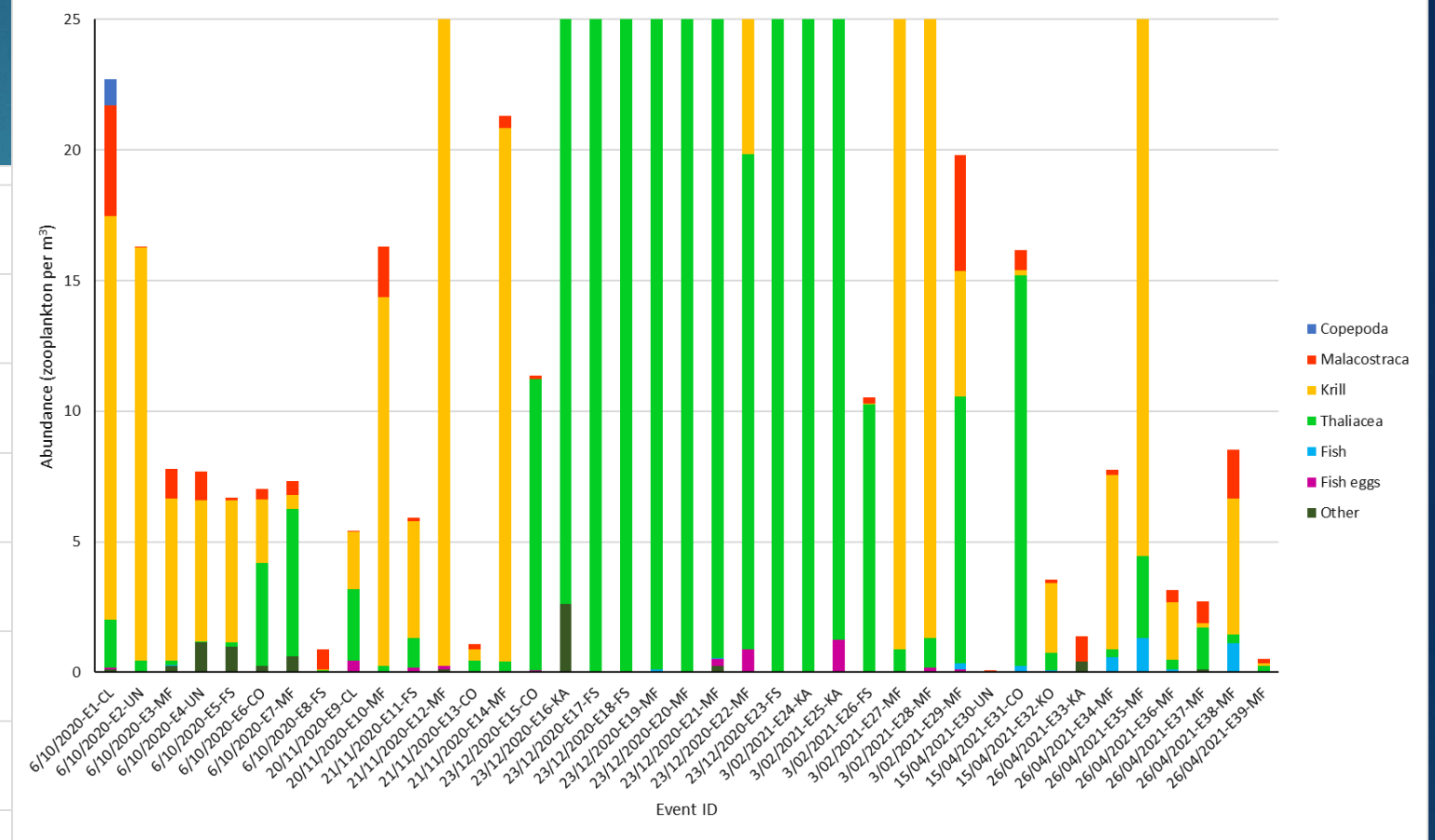
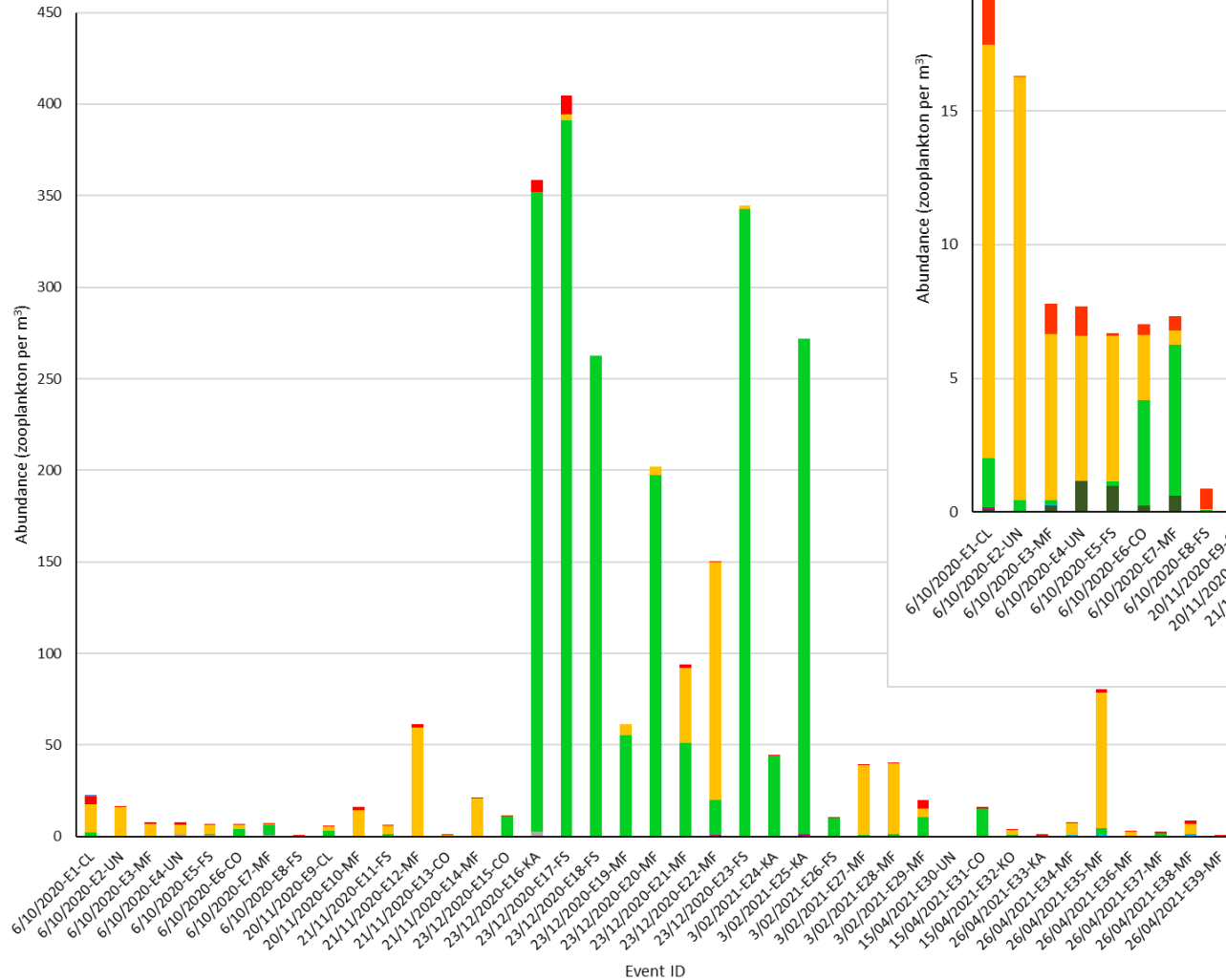
GoPros on floating camera rig

Results: seabird feeding events



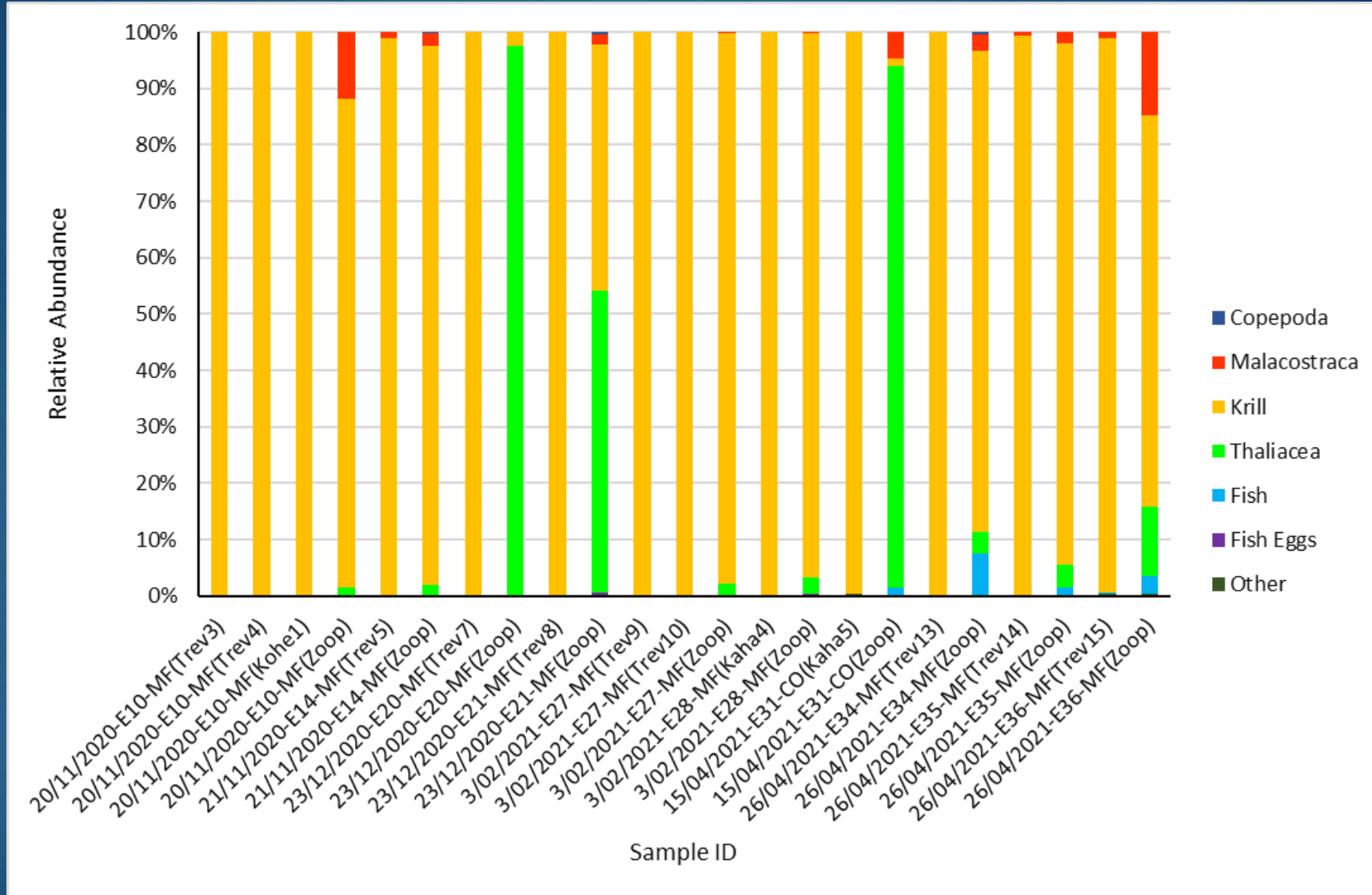
Sampling locations and event types.

Results: zooplankton abundance



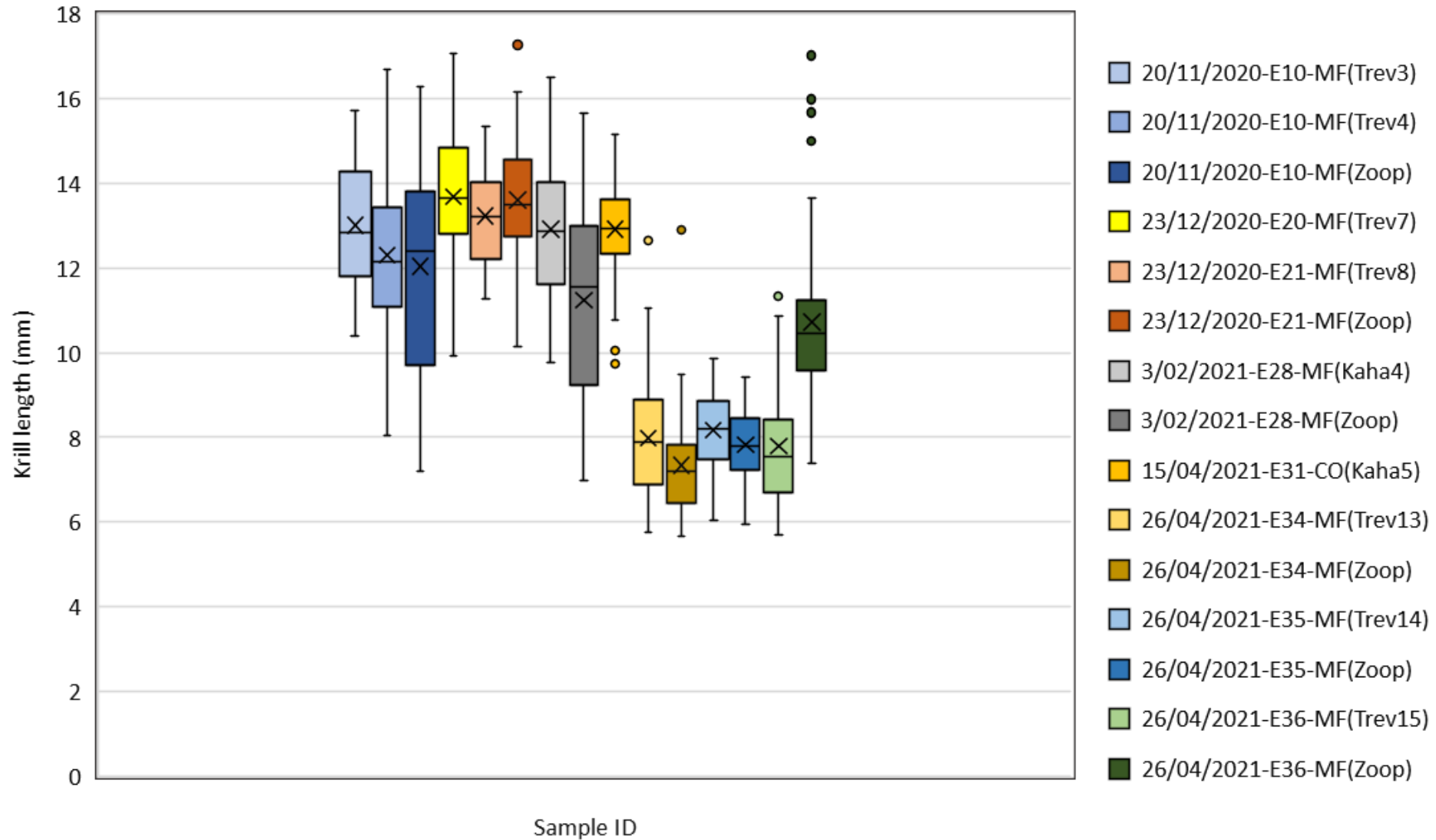
Abundance of zooplankton per group, per sample from zooplankton tows

Results: fish gut contents



Relative abundance (%) of zooplankton in fish gut contents and comparative zooplankton tows

Results: krill length



Krill body lengths in fish gut samples and corresponding zooplankton sample

Discussion: fish school events

➤ Mixed Fish School events:

- Zooplankton samples either dominated by Krill or Thaliacea.
- Fish gut samples dominated by Krill.
- Mokohinau Islands key location.

➤ Kahawai school events:

- Zooplankton samples generally dominated by Thaliacea
- Located near mainland coast.

➤ Koheru school event:

- Navire Rock
- Zooplankton sample and koheru gut contents dominated by Krill

➤ Unknown fish schools

- Unable to determine a fish school type.
- Limitations to underwater video in determining fish species present.

Discussion: non-fish school events

- Control locations
- Variable results

- Current Lines events:
 - Near Coppermine Island
 - Malacostraca or Thaliacea dominant

- Unknown events:
 - Mokohinau Islands
 - No fish seen but birds feeding
 - Zooplankton samples dominated by Krill

- Krill patches:
 - None viewed during the fieldwork for this research year

Discussion: zooplankton prey availability for seabirds

- Krill important prey for FLSH, BUSH, FAPR and RBGU feeding in association with fish schools.

Do fish schools:

- Concentrate krill and other prey at the surface making them more readily available to seabirds?

OR

Krill aggregate naturally at or near the surface in areas of upwelling or current flow which fish schools target, providing visual and olfactory cues to seabirds?

Or some other dynamic?

Recommendations

Due to the importance of krill and potentially other zooplankton types in the diet of various seabird species in the wider Hauraki Gulf region, more research is recommended on the distribution, lifecycle, behaviour, effects of environmental factors, and whether commercial fishing of planktivorous fish species has a positive or negative effect on krill/zooplankton abundances.