Department of Conservation
Te Papa Atawhai

NIWA
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Ageing methods for protected deep-sea corals: a review and recommendation for an ageing study

This presentation meets the reporting requirements for Year One of the Conservation Services Programme (CSP), Department of Conservation (DOC) Project POP2017-07 Objective to "Develop a methodology to determine the age and growth characteristics of key high risk New Zealand deep-sea (cold-water) coral species".

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Impetus

- Risk assessment highlighted data paucity on coral productivity. This relates directly to the “recoverability” of corals from disturbance, - a key factor in developing more robust ERAs for protected corals in NZ waters and to

- A key priority in filling this information gap is research to determine the age and growth & growth rates) of key NZ protected deepsea coral species such as black corals (e.g., *Bathypathes* spp) as well as octocoral groups highlighted as high risk, e.g., the primnoid seafan, and species in the bubblegum coral genus *Paragorgia*.

Ageing project (DOC18303)
Objectives to help address these knowledge gaps

- ❑ **Year 1 completed**

Section 1: 'Ageing methods for protected deep-sea corals: A literature review'
Section 2: 'Recommendations' and describes the proposed study to determine the age and growth characteristics of a key high risk New Zealand deep-sea coral species

- ❑ **Year 2** will focus on obtaining age data from the selected coral group samples

1. Literature Review

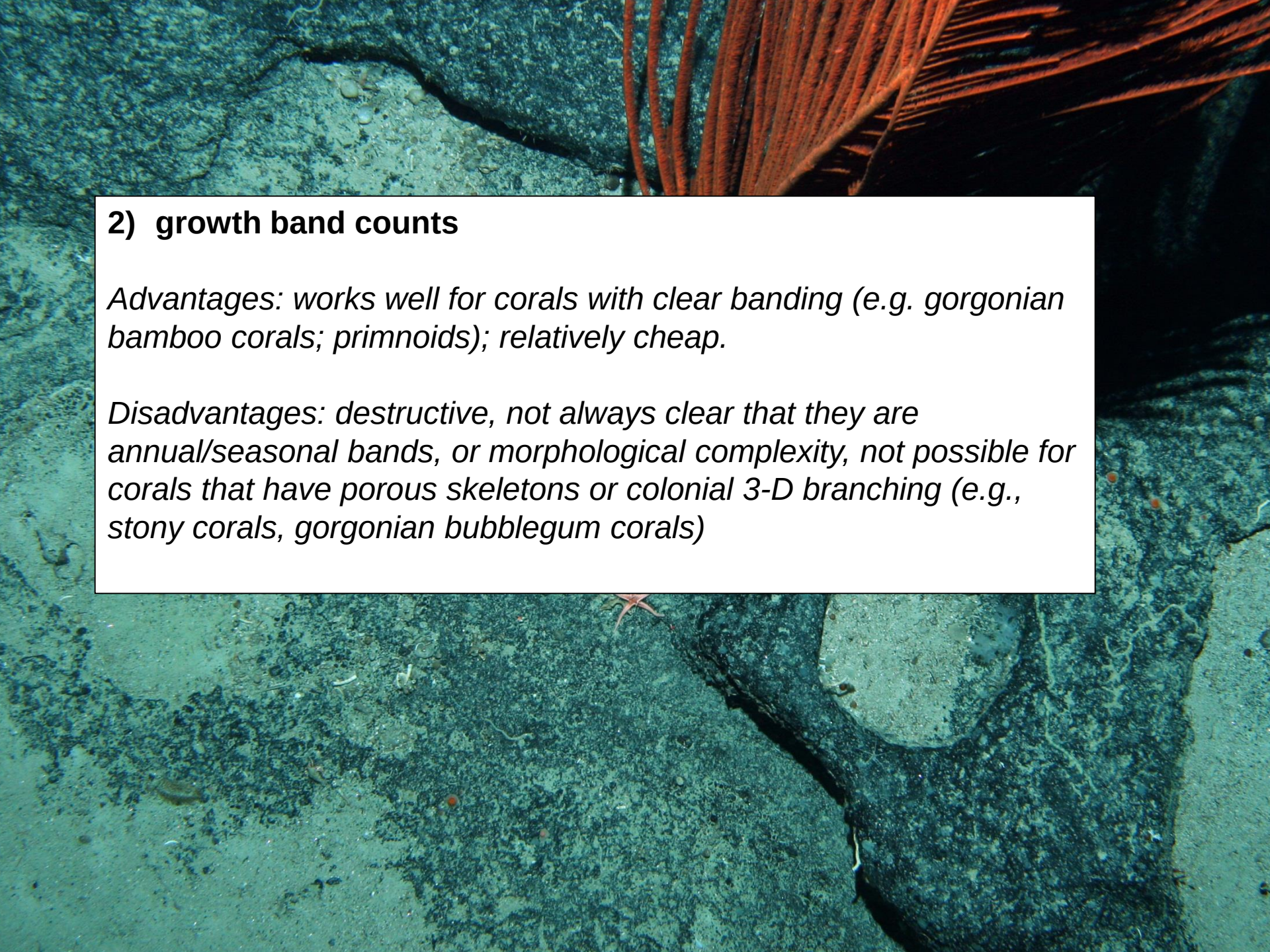
Main methods to study age & growth of deep-sea corals include:

1) **direct observation studies – *in situ*, *in aquaria,***

Advantages: real time studies, direct, opportunistic (e.g. growth on manmade infrastructure).

Disadvantages: few studies due to time constraints and cost; evident that species grow faster *in aquaria* than *in situ*.

The advantages and disadvantages of each method are highlighted in DRAFT Report (**Year 1,** DOC18303)



2) growth band counts

Advantages: works well for corals with clear banding (e.g. gorgonian bamboo corals; primnoids); relatively cheap.

Disadvantages: destructive, not always clear that they are annual/seasonal bands, or morphological complexity, not possible for corals that have porous skeletons or colonial 3-D branching (e.g., stony corals, gorgonian bubblegum corals)

3) radiometric analyses

A) ^{14}C

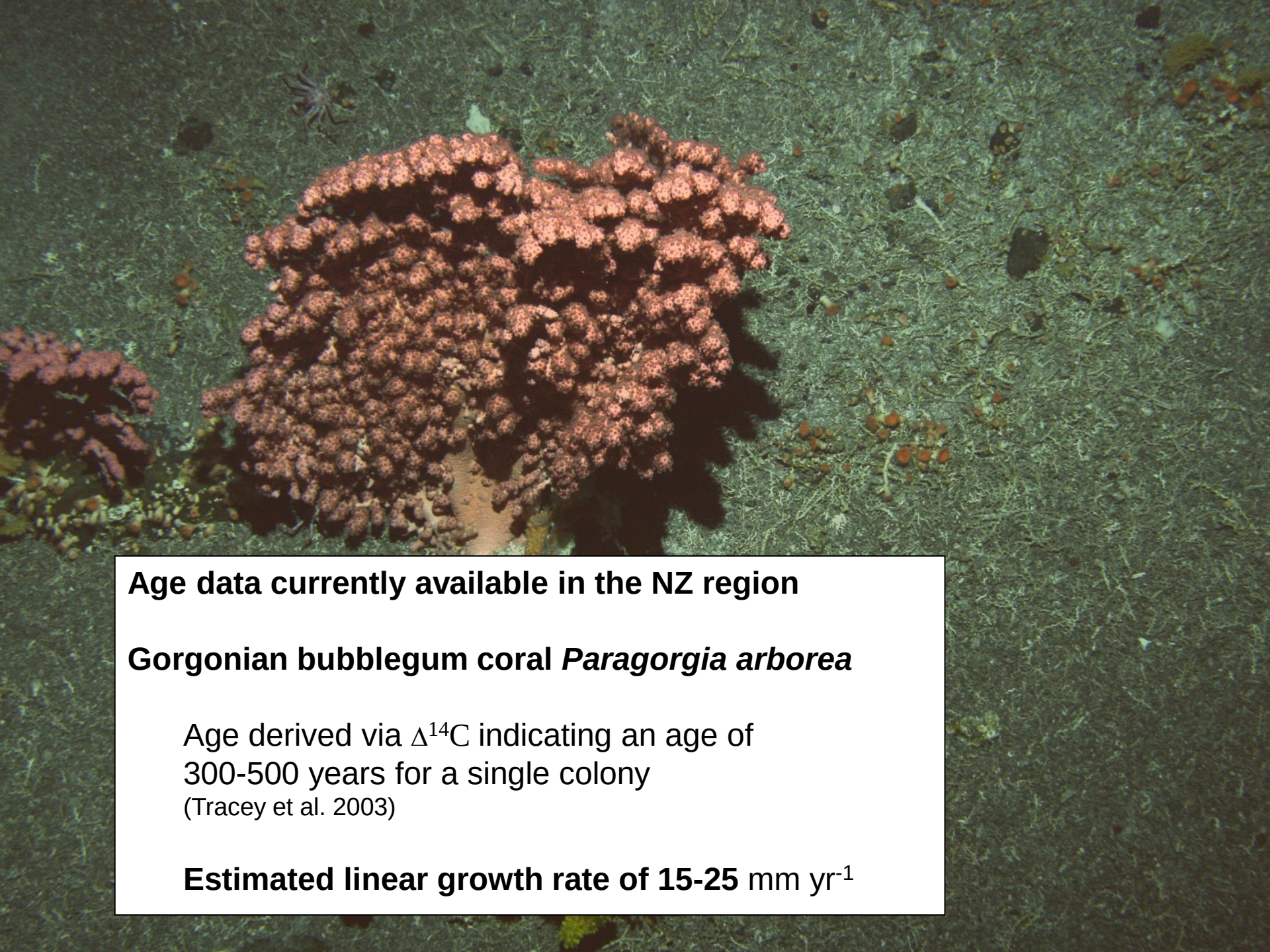
Adv - can be done on any coral with carbon in the skeleton, most commonly done, can be used to date corals up to 50,000 years old.
Disadv – helpful to know what the coral is eating, ^{14}C reservoir age of water, ocean circulation changes, bomb ^{14}C variations. expensive

B) **^{210}Pb**

Adv – High precision
Disadv - restricted to the last 120 years, depends on the local environment, assumes a constant rate of ^{210}Pb uptake, needs a number of samples to determine the decay rate.

C) **U/Th**

Adv – no reservoir age, high precision, can date older corals beyond 40,000 years
Disadv – Only successful so far in aragonite corals – more U in these corals, expensive.

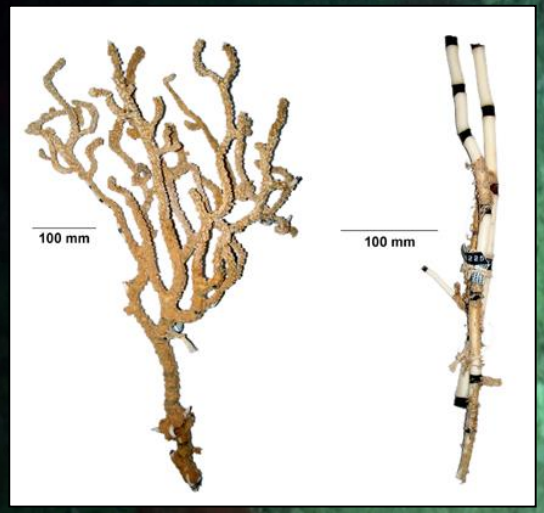


Age data currently available in the NZ region

Gorgonian bubblegum coral *Paragorgia arborea*

Age derived via $\Delta^{14}C$ indicating an age of 300-500 years for a single colony
(Tracey et al. 2003)

Estimated linear growth rate of 15-25 mm yr^{-1}



Bamboo corals *Keratoisis* spp. (n=5)
(*Lepidisis sample in Tracey et al. 2007 subsequently revised to Keratoisis)*
Lead-210 (^{210}Pb) dating in combination with growth zone counts
Average radial growth rates of **0.15 – 0.32** mm yr^{-1}
Single linear extension rate of **21 – 57** mm yr^{-1}

Estimated longevity of a single colony of several centuries (Tracey et al. 2007).

Scleractinian, *S. variabilis*

Linear measurement and radiocarbon content ($\Delta^{14}C$) to estimate

Average linear extension

0.4 – 1.6 mm yr^{-1} Chatham Rise Graveyard Knolls (Neil et al. in review)

0.25 – 0.9 mm yr^{-1} Louisville Seamount Chain (Neil et al. in review)

0.84 –1.25 mm yr^{-1} Tasmanian Seamounts (Fallon et al. 2014)

~657-2000 years to build a diameter of 1 metre

In aquaria study linear growth
0.53 – 3.07 mm yr^{-1} Louisville Seamount Chain
(Gammon 2016; Tracey et al. 2016;
Gammon et al. submitted)

2. Recommendation: selection of study species and method

Species Antipatharian black coral genus Bathypathes (Family Schizopathidae). Species *B. alternata* or *B. patula*.

Selection based on:

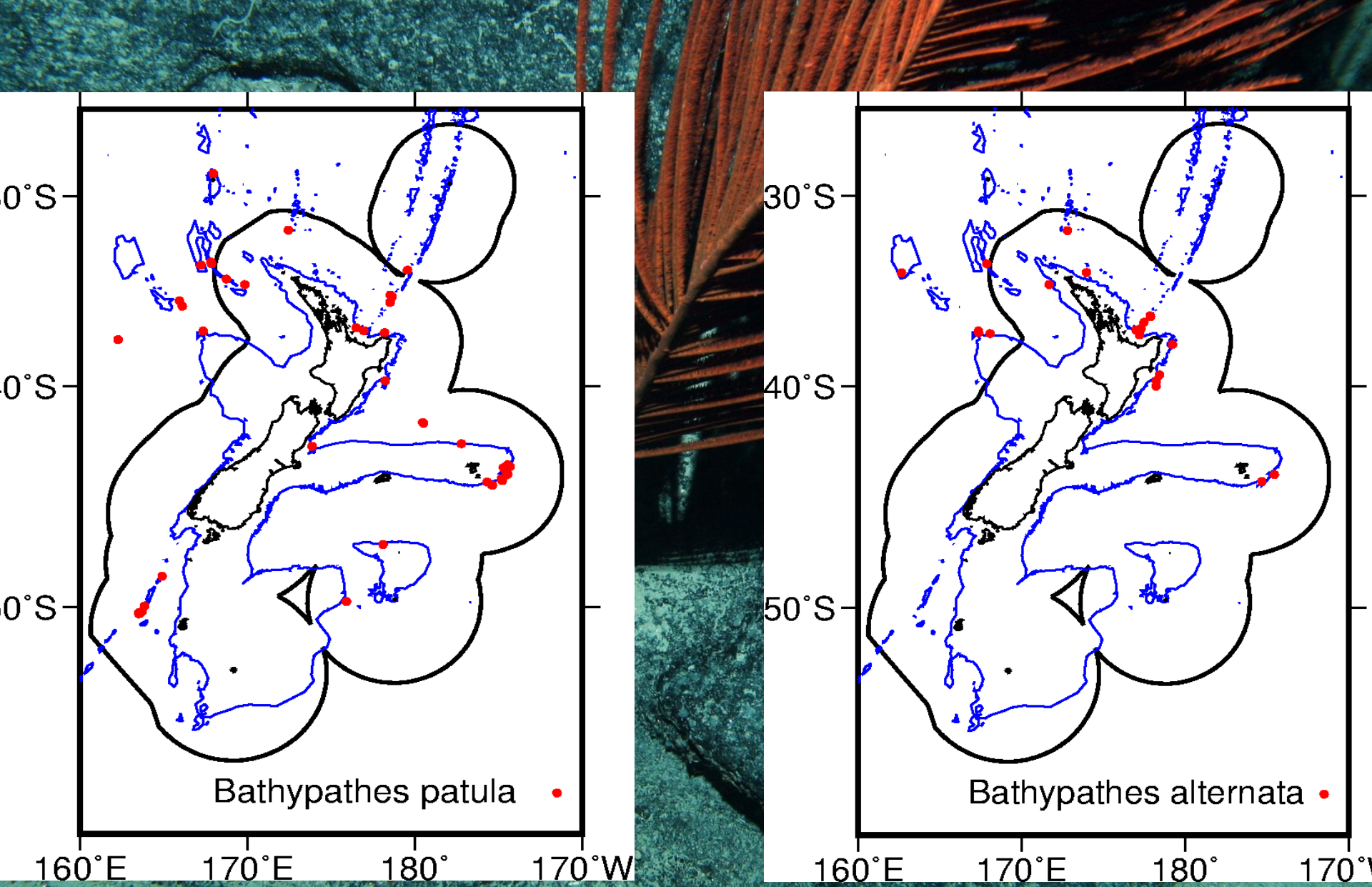
- what were previously determined ‘High Risk’ coral species
- availability of samples numbers
- location - Chatham Rise and Bay of Plenty

Analytical method

Growth ring counts (n= ~10 basal sections)

^{14}C dating (n=2 colonies; x 4 dates per colony; base and growing tip)

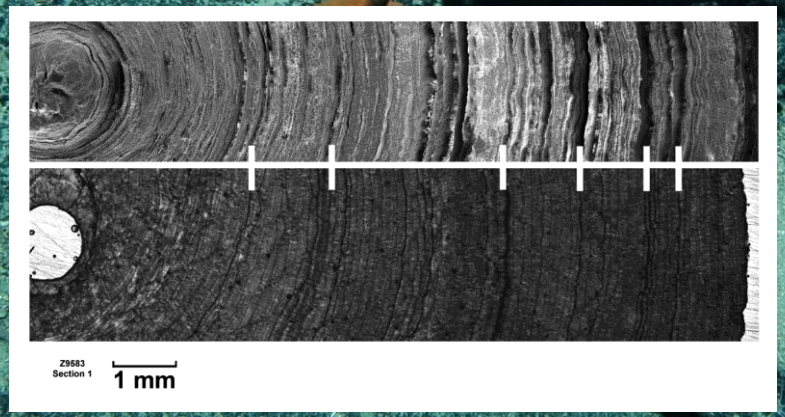
The micro-milling of material, and the interpretation of results will be funded in Year 2 of the Project.

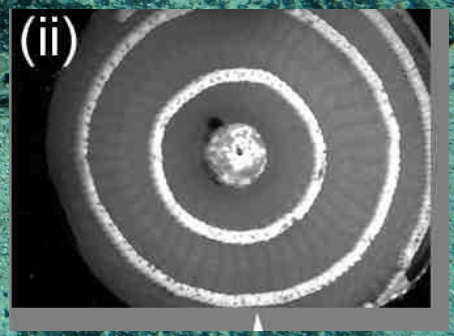


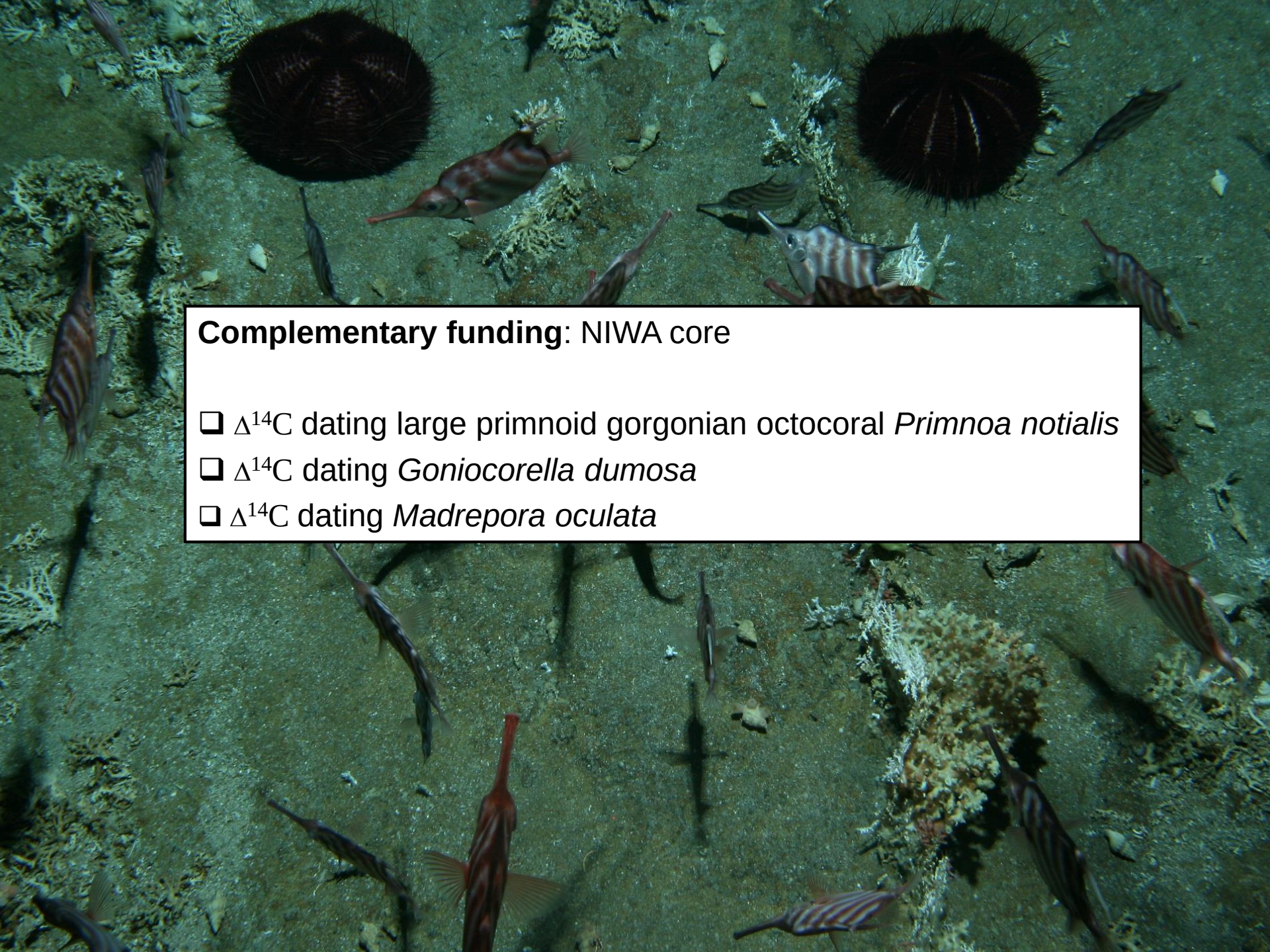
Distribution map for the New Zealand region of the two black coral species proposed to be aged: *Bathypathes* species, *B. patula* and *B. alternata*. Aided selection

Methods: will follow Tracey at al 2007 (bamboo corals); Sherwood & Edinger 2009 (black coral), i.e.,

- sectioning
- obtaining zone counts visible on thin x-sections
- milling material for ^{14}C







Complementary funding: NIWA core

- ❑ $\Delta^{14}C$ dating large primnoid gorgonian octocoral *Primnoa notialis*
- ❑ $\Delta^{14}C$ dating *Goniocorella dumosa*
- ❑ $\Delta^{14}C$ dating *Madrepora oculata*

- Also complemented by Marsden project : *Corals, currents, and phytoplankton: Reconstructing 3000 years of circulation and marine productivity in the world's largest ocean gyre,* (NIW1602). NIWA and Victoria University of Wellington are carrying out the paleoclimate study and thus far the bases of the black coral colonies have been cut and sampled for ^{14}C dates.

- Preliminary results showed the uncalibrated age ranges from the inner to outer zone of 3250 to 1173 ^{14}C years — approximately 2000 years old (sample 35104); and from 1960 to 506 ^{14}C years — approximately 1500 years old (sample 64334), (Neil H, Sinclair D, Hitt N unpubl. data).

- Marsden includes ^{14}C dating and ageing of five large black coral specimens (species are) from contrasting water masses north and south of NZ.

Summary

The combination of all of these age and growth research projects, with previous data, will provide the region with a significantly improved dataset of age data for key high risk New Zealand deep-sea coral species

Year 2 will focus on obtaining age data from the selected coral group samples

Acknowledgements

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