NIWA

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Climate, Freshwater & Ocean Science

POP2018-06: Protected coral connectivity in New Zealand

INT2019-05: Coral biodiversity in deep-water fisheries bycatch

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Protected corals

Wildlife Act – Schedule 7A

Protects all species in:

- Order Antipatharia (black corals)
- Order ‘Gorgonacea’ (gorgonian corals)
- Order Scleractinia (stony or hard corals)
- Family Stylasteridae (hydrocorals)

Wildlife Act 1953
Public Act 1953 No 31
Date of assent 31 October 1953

Protected corals

Diverse and distantly related assemblage of marine animals

- Cnidaria
  - Cl. Hydrozoa — Fam. Stylasteridae (Hydrocorals)
  - Cl. Anthozoa
    - S.C. Octocorallia — O. Alcyonacea (gorgonian corals)
    - S.C Hexacorallia
      - O. Zoantharia (gold corals)
      - O. Scleractinia (stony/hard corals)
      - O. Antipatharia (black corals)

Protected corals

- Found in fisheries bycatch:
  - bottom trawl
  - bottom longline

- Common target species: orange roughy, oreos, cardinalfish, ling, squid (plus others)

Area	No. observed tows	% observed tows with coral
FMA 1	867	12.9
FMA 2	519	4.2
FMA 3	2 344	7.3
FMA 4	4 712	10.7
FMA 5	2 860	2.8
FMA 6	4 917	7.4
FMA 7	1 787	1.5
FMA 8	716	0.3
FMA 9	610	32.5
CET	614	18.7
HOWE	600	28.5
LOUR	293	46.4
WANB	420	49.5
All areas	21 259	9.9

(Tracey et al. 2011)

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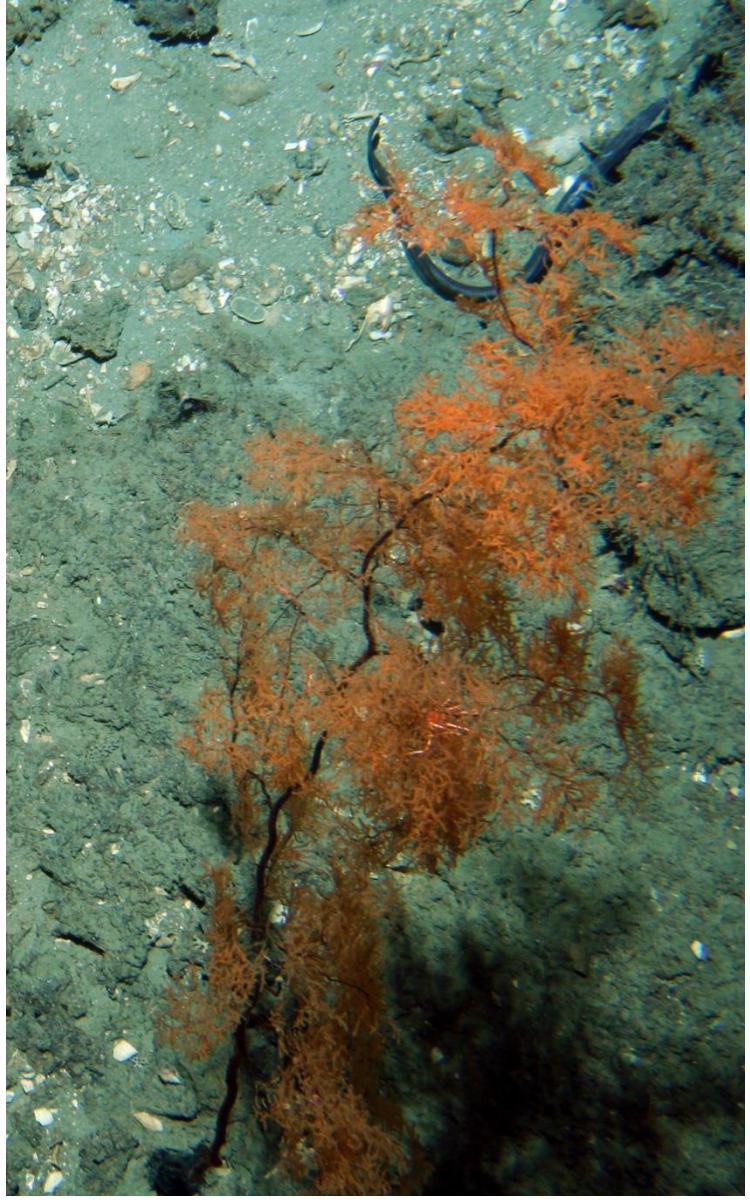
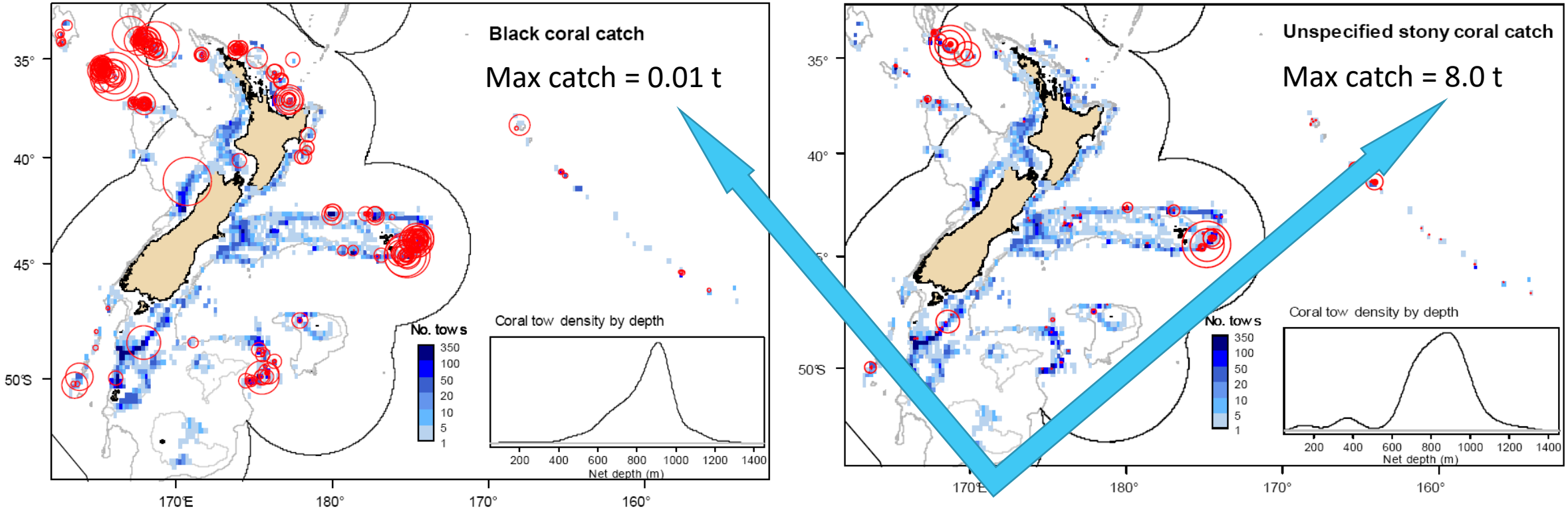
Black corals

- Distributed across EEZ (and beyond - globally)
- Abundant & diverse
- Provide habitat
- Often solitary ‘sentinel’ species within the deep-sea



Black corals

- Fishery interactions (ORH, OEO, CDL)



(From Tracey et al. 2011)

Black corals

- Slow growing – *e.g. Bathypathes*:

  <10mm/yr linear

  <0.1mm/yr radial

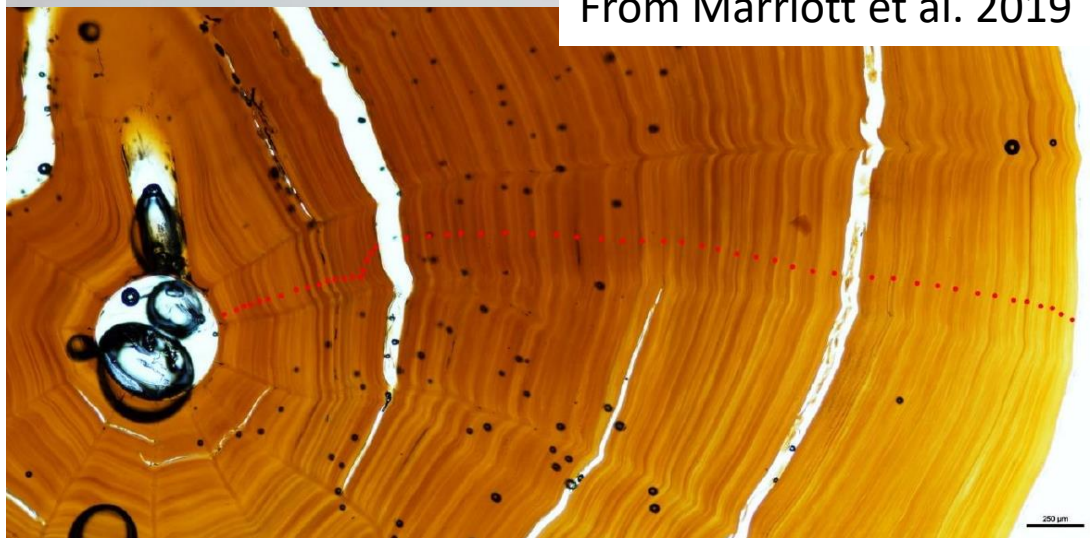
- Old

  to 385y *Bathypathes*

  to 2900y *Leiopathes*

(Marriott et al. 2019, Hitt et al. 2020)

From Marriott et al. 2019



Black corals – Bottom-Trawling Pilot Risk Assessment

High risk of trawl impact due to:

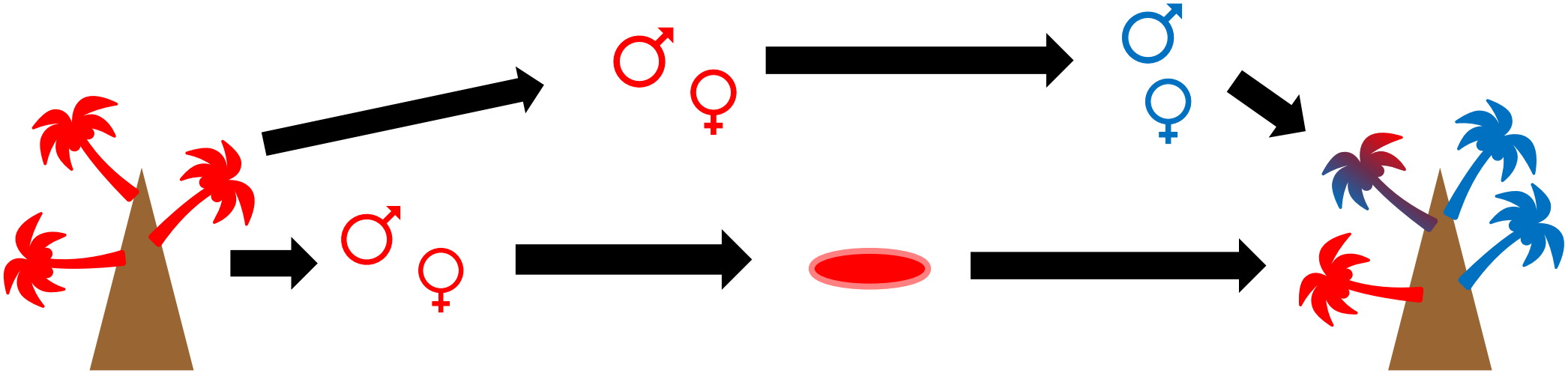
- Depth overlap with fisheries
- High encounter impact
- Erect, delicate growth forms
- Low regeneration (growth rate)
- Low Connectivity?

Coral species	Code	Productivity score (Average)	Susceptibility score (Multiplicative)	Overall Risk Value	Overall Risk Ranking
Solenosmilia	SVA	2.25	1.86	2.92	Med
Goniocorella	GDU	2.50	1.52	2.93	Med
Madrepora	MOC	2.25	1.86	2.92	Med
Oculina	OVI	2.25	1.78	2.87	Med
Enallopsammia	ERO	2.25	1.86	2.92	Med
Black corals	COB	2.75	1.74	3.25	High
Bathypathes	BTP	2.75	1.78	3.27	High
Gorgonians	GOC	2.50	1.67	3.00	Med
Paragorgia	PAB	2.50	2.17	3.31	High
Primnoa	PRI	2.25	1.52	2.71	Med
Bamboo corals	KER-LEP	2.25	1.67	2.80	Med
Metallogorgia	MTL	2.50	1.40	2.86	Med
Cup corals	COF	2.25	1.30	2.60	Low
Cup corals	CAY	2.00	1.33	2.40	Low
Hydrocorals	COR	2.00	1.40	2.44	Low

From Clark et al. 2014

Connectivity

- Corals are sessile as adults, but gametes/larvae are motile



- Increased connectivity = more diversity w/in popn, less b/w popns
- Lowers inbreeding effects, population ‘drift’

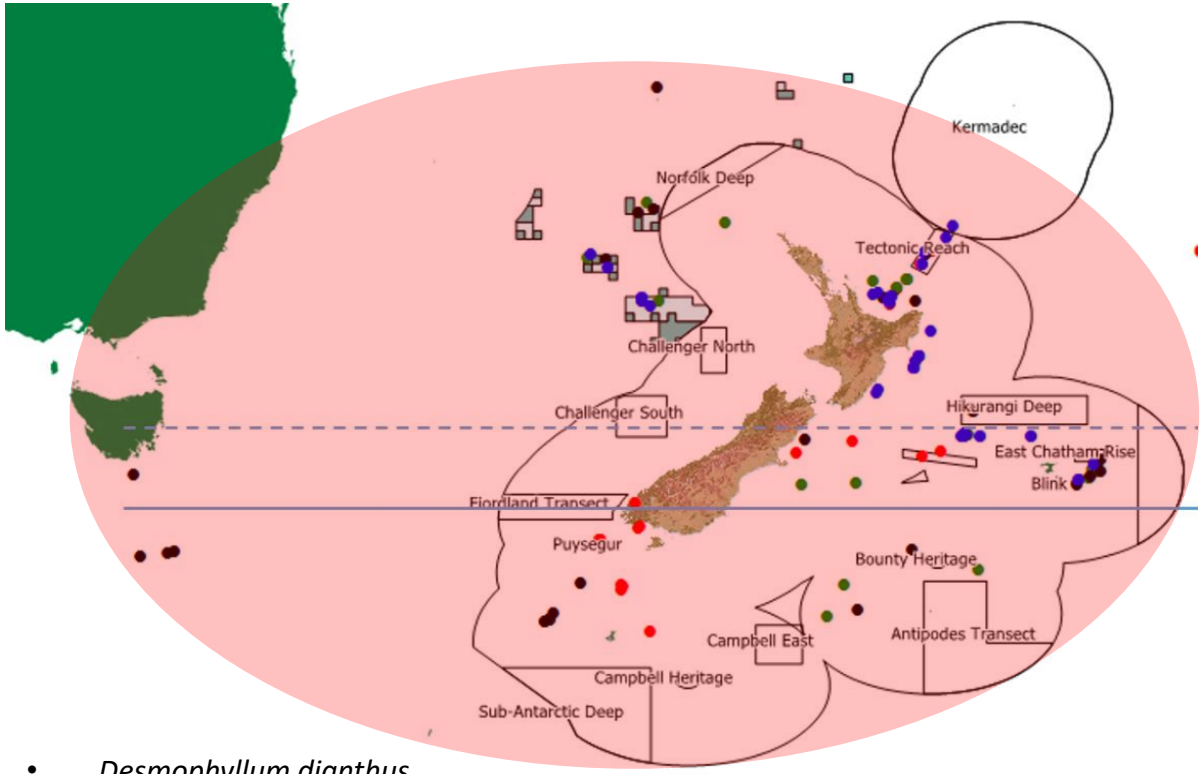
Black corals - past NZ connectivity estimates

- Miller (1998) – Fiord populations → low connectivity in 1/3 populations
- Miller et al. (2010) – 2 spp. deep-sea → connected at 10-100km, not at 100-1000km (small sample sizes, marker issues)
- Holland et al. (2020) – 2 spp. deep-sea → high connectivity for one; broad-scale patterns in other

Black corals - past NZ connectivity estimates

Holland et al. (2020):

- broad-scale patterns in *Bathypathes patula*
    - high local connectivity
    - Antarctic samples distinct
    - preliminary, limited sample size



- *Desmophyllum dianthus*,
- *Enallopsammia rostrata*
- *Bathypathes patula*
- *Leiopathes* spp.

Black corals – current study

- Continue work of Holland et al. (2020) on *Bathypathes patula*

  → increase sample size

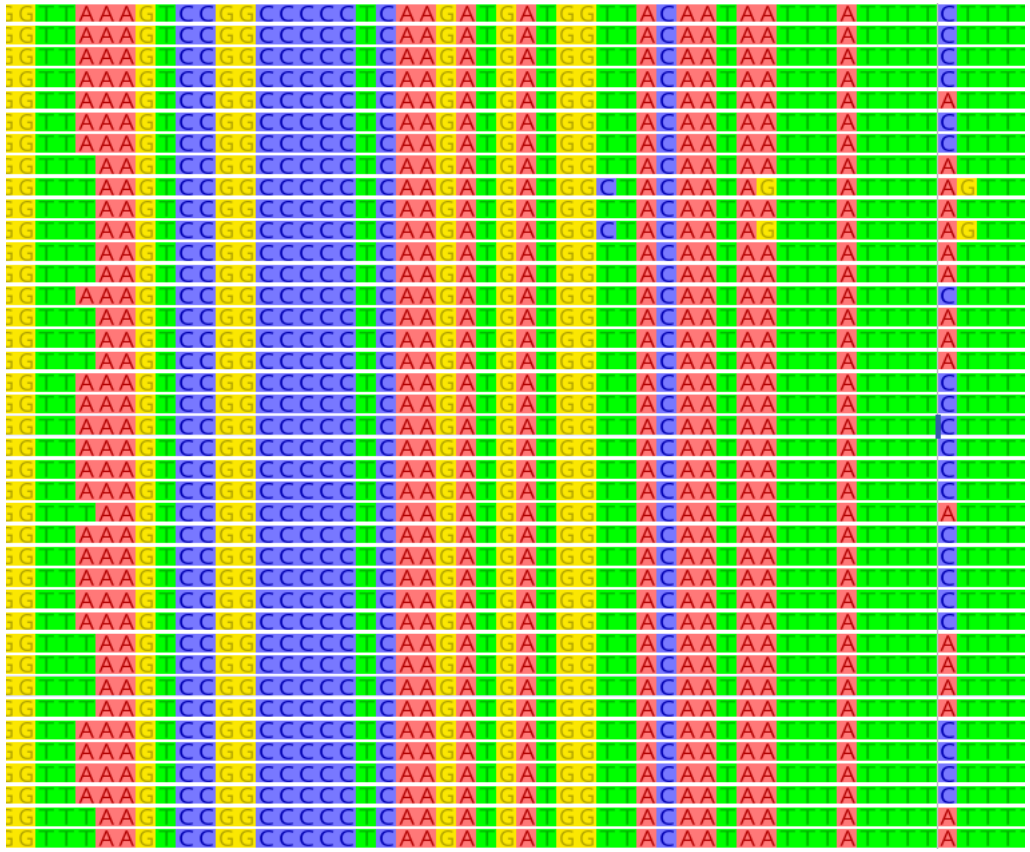
  (specimens & genetic data)

  → connectivity between populations

  → *relationships of specimens to other species*

DNA markers

- Previously three genetic markers (mtDNA):
  - one was redundant (16S)
  - other two had limited info
- Find/develop more markers:
  - ITS rDNA (Bo. et al. 2012)
  - SRP54 (Concepcion et al. 2008)



Results

- DNA sequences for 77 *Bathypathes* specimens
- Also related species: *Lillipathes* and *Telopathes*
- Up to five genetic markers (2150bp of DNA sequence)
- 57 reference sequences from previous studies (GenBank)

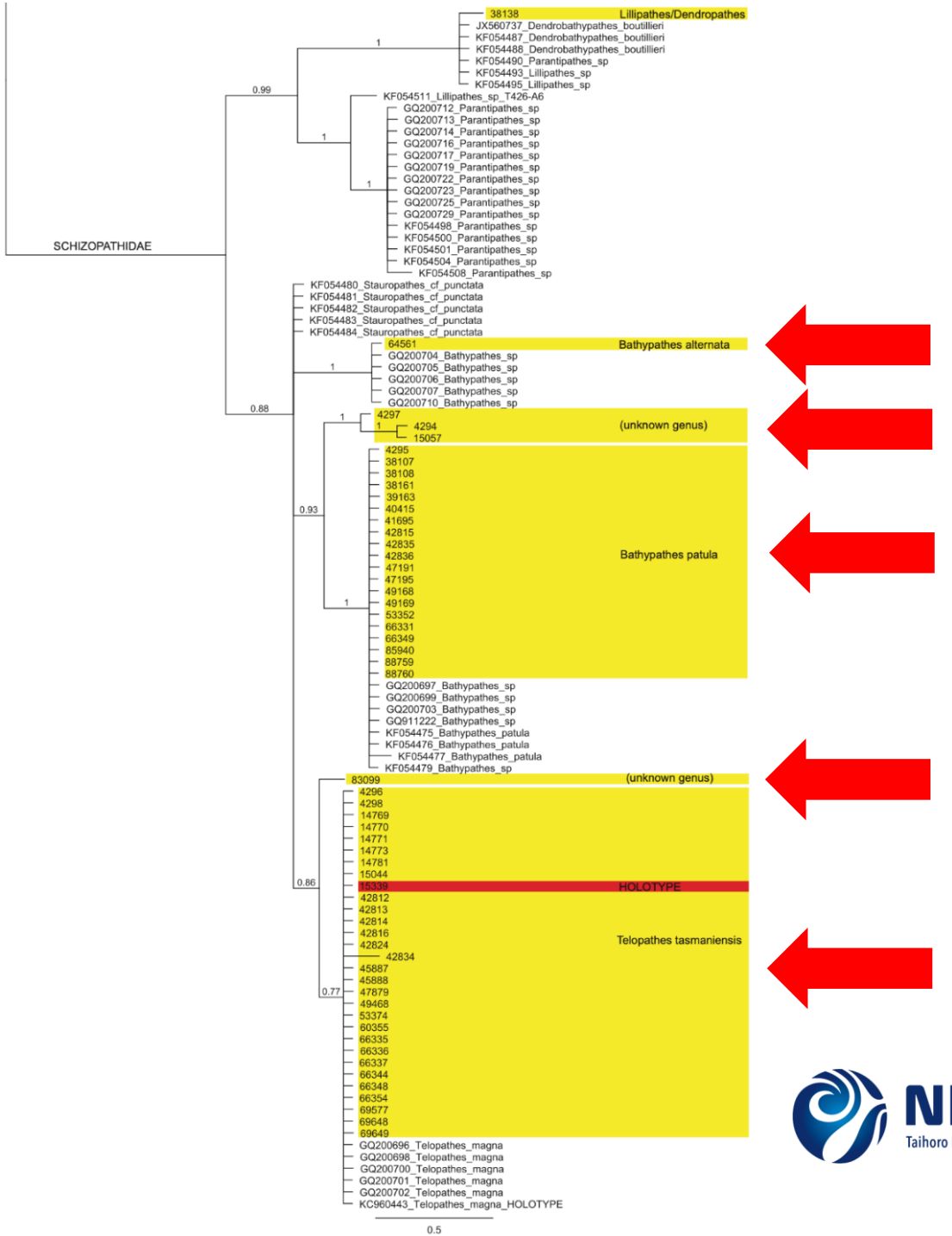
→ Genetic differences of up to 17%

→ **High levels of genetic structuring**

An identity crisis

- Genetic differences not structuring of distinct populations of single species
- Observing evolutionary differences between 5 different genera

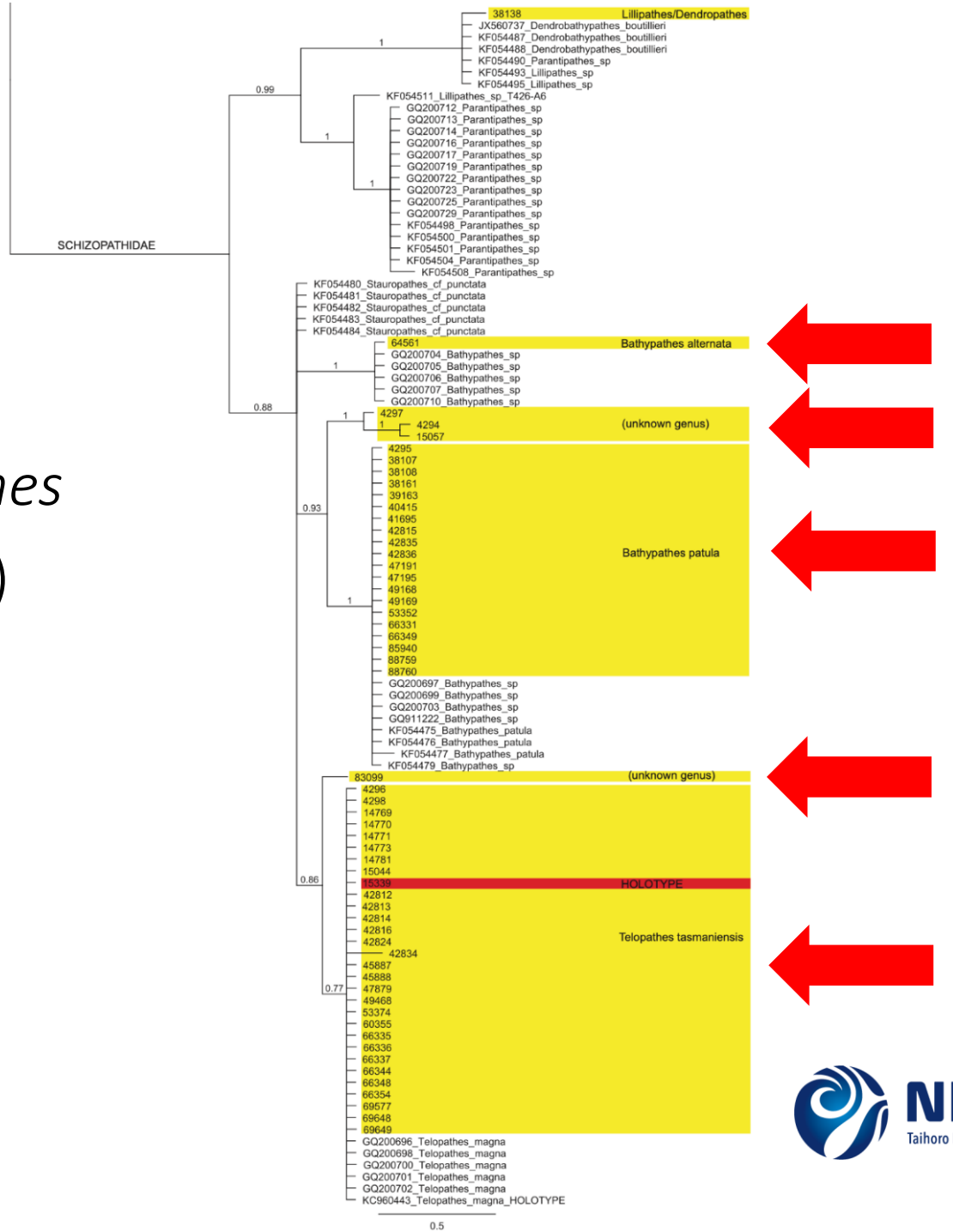
→ Cryptic diversity among specimens thought to be *'Bathypathes'*



Cryptic diversity

- (1 = misidentified *Lillipathes*)
- 1 = different species of *Bathypathes*
- 3 = *Stauropathes*? (or new genus)
- 1 = New genus
- 41 = *Telopathes*

  (probably *T. tasmaniensis*)
- 24 = *B. patula*



Cryptic diversity: plasticity in form / sample condition

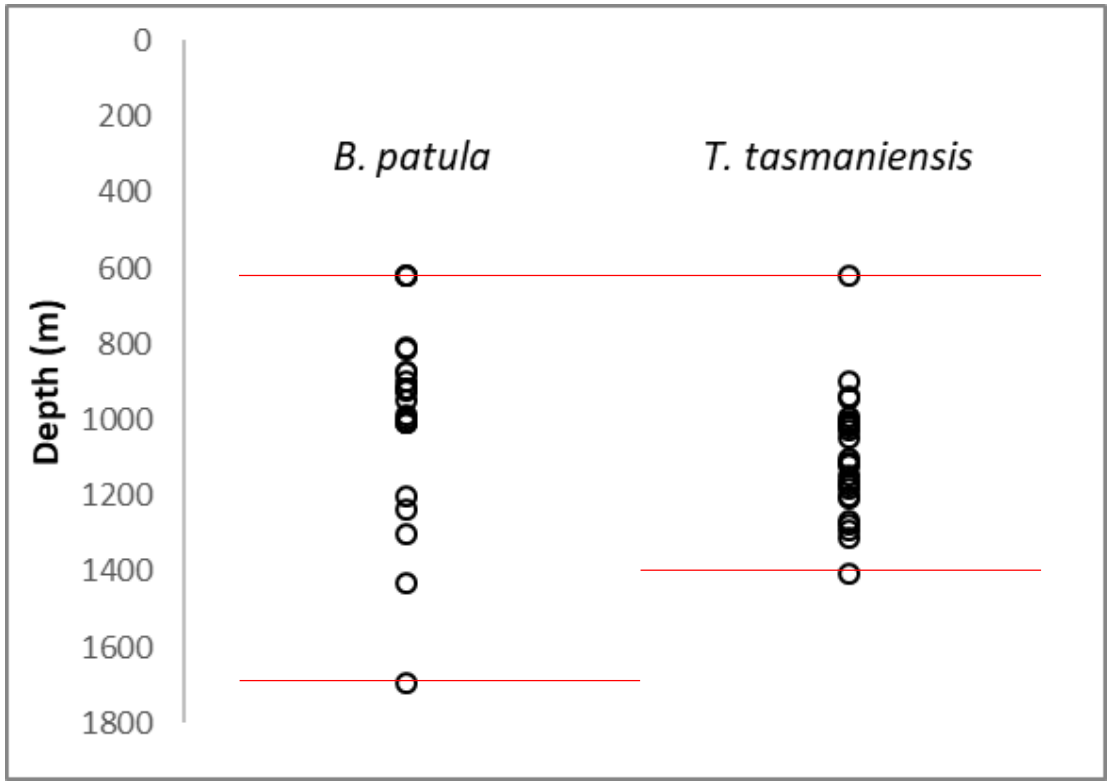
Bathypathes

Telopathes

???

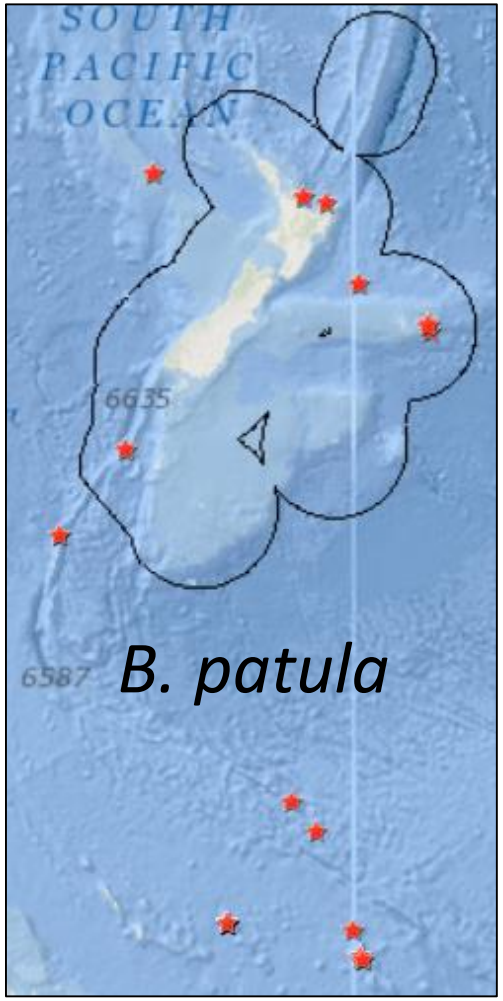
B. patula (n=24) *vs. T. tasmaniensis* (n=41)

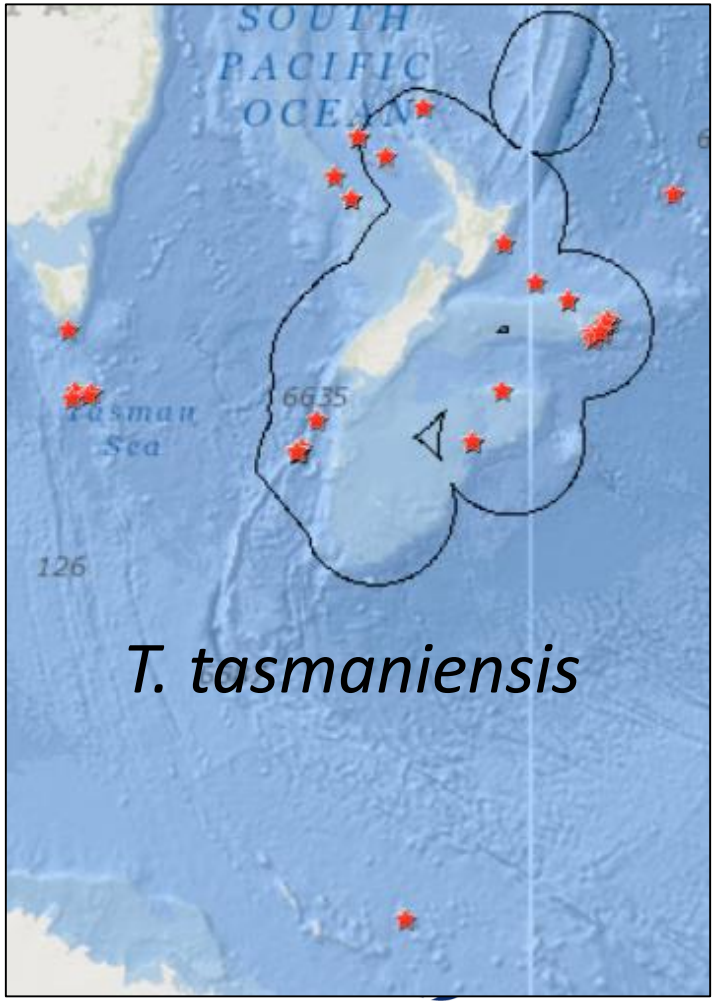
- Morphologically similar
- Other differences?
  - depth range?



B. patula (n=24) *vs. T. tasmaniensis* (n=41)

- Morphologically similar
- Other differences?
  - ~~depth range~~
  - distribution?





Conclusions

- Underestimating diversity of black corals
- Several potential new genera to study & describe
- Genetic barcoding cheap and effective for detection of cryptics

Limitations

- More diversity = unknown impacts
- Still no assessment of population boundaries and connectivity
- No species-level or within-species genetic marker yet
- Even lower sample sizes available for any black coral species

Recommendations

→ Incorporate uncertainty around diversity into research and management

→ Employ higher-resolution genomic methods (UCEs/RADseq)

(>1000X more data for 0.5X the specimens at 20X the cost)

→ Use DNA barcoding for routine screening

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