Environmental Factors Associated with Hydrates Extraction; Physical and Chemical Mitigation for a Marine Consent*

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Search and Discovery Article #80731 (2020)**
Posted September 21, 2020

*Adapted from oral presentation given at 2019 AAPG Asia Pacific Region Geosciences Technology Workshop, Gas Hydrates – From Potential Geohazard to Carbon-Efficient Fuel?, Auckland, New Zealand, April 15-17, 2019
 DOI:10.1306/80731Bromfield2020

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Abstract

Gas Hydrate is a valuable potential alternative energy resource, but exploration of this resource faces significant environmental risk. This paper will discuss the fact that hydrates likely play a role in stabilising the sea floor, and drilling therefore has the potential to destabilise this environment, causing sediment to be disturbed on varying scales and with varying impact on marine life. This impact may range from suspended sediment in the water column and associated effects on marine life, through to extensive slumping of the marine shelf and associated generation of tsunamis. There are also chemo-synthetic bio-organism colonies associated with gas hydrate deposits that are not well understood or researched. This lack of information is likely to have a bearing on the ability to secure resource consents under the New Zealand EEZ Act. This paper discusses some mitigation options available for consideration during the resource consent process, using international examples, including from Japan. Japan is investigating methane-hydrate development, but is concentrating its efforts on relatively flat stretches of the seafloor off its coast. This acts to minimise the chances of a landslide, according to the Research Consortium for Methane Hydrate Resources. This paper does not consider the role of methane in climate change, as this debate is well covered in other fora, but we discuss the options for recovery of natural gas from CH_4-hydrate deposits in sub-marine environments using injection of CO_2 as a suitable strategy towards net-zero emissions energy production.

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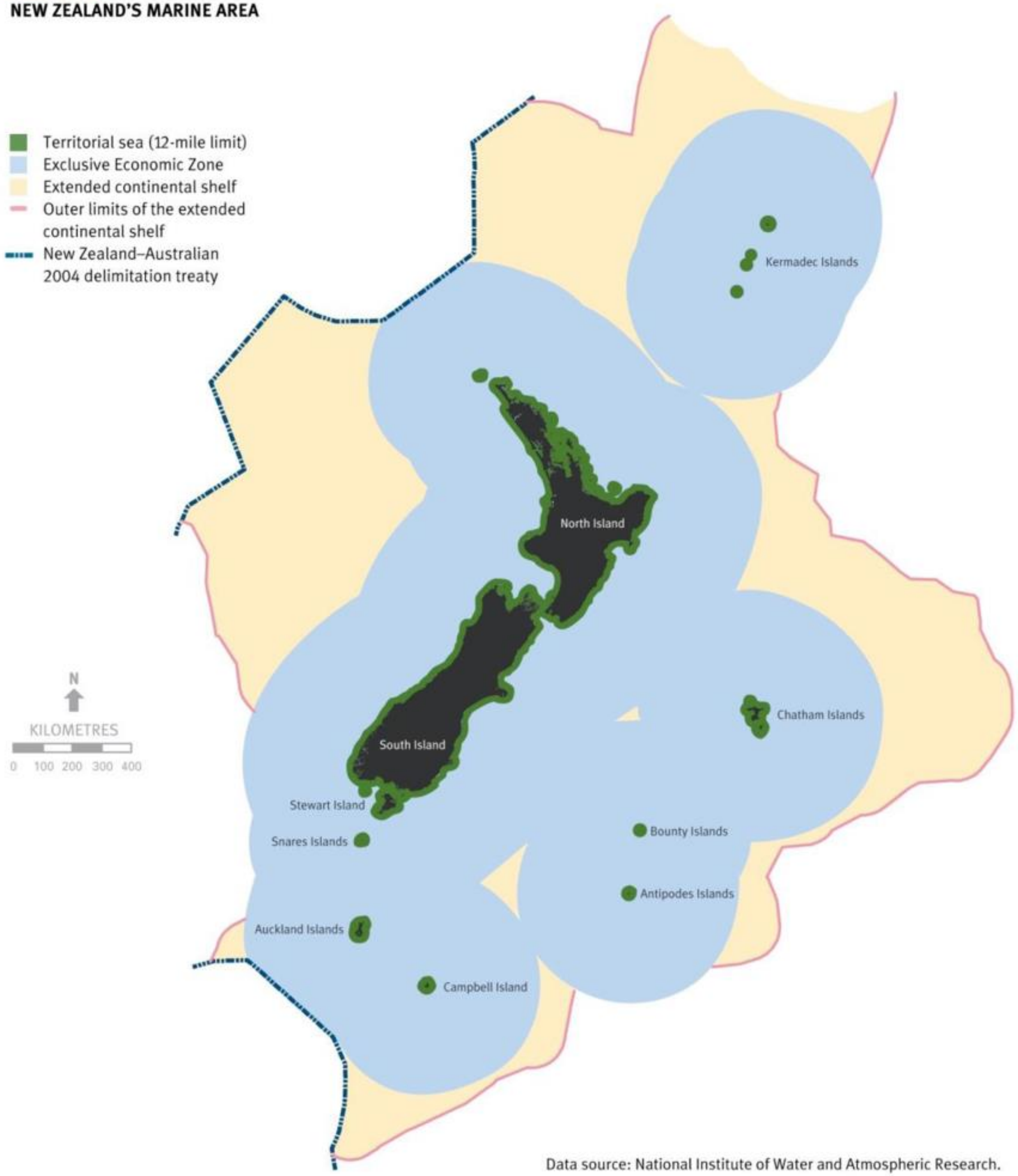
New Zealand Marine Management

RMA covers the coast to the 12 nautical mile mark

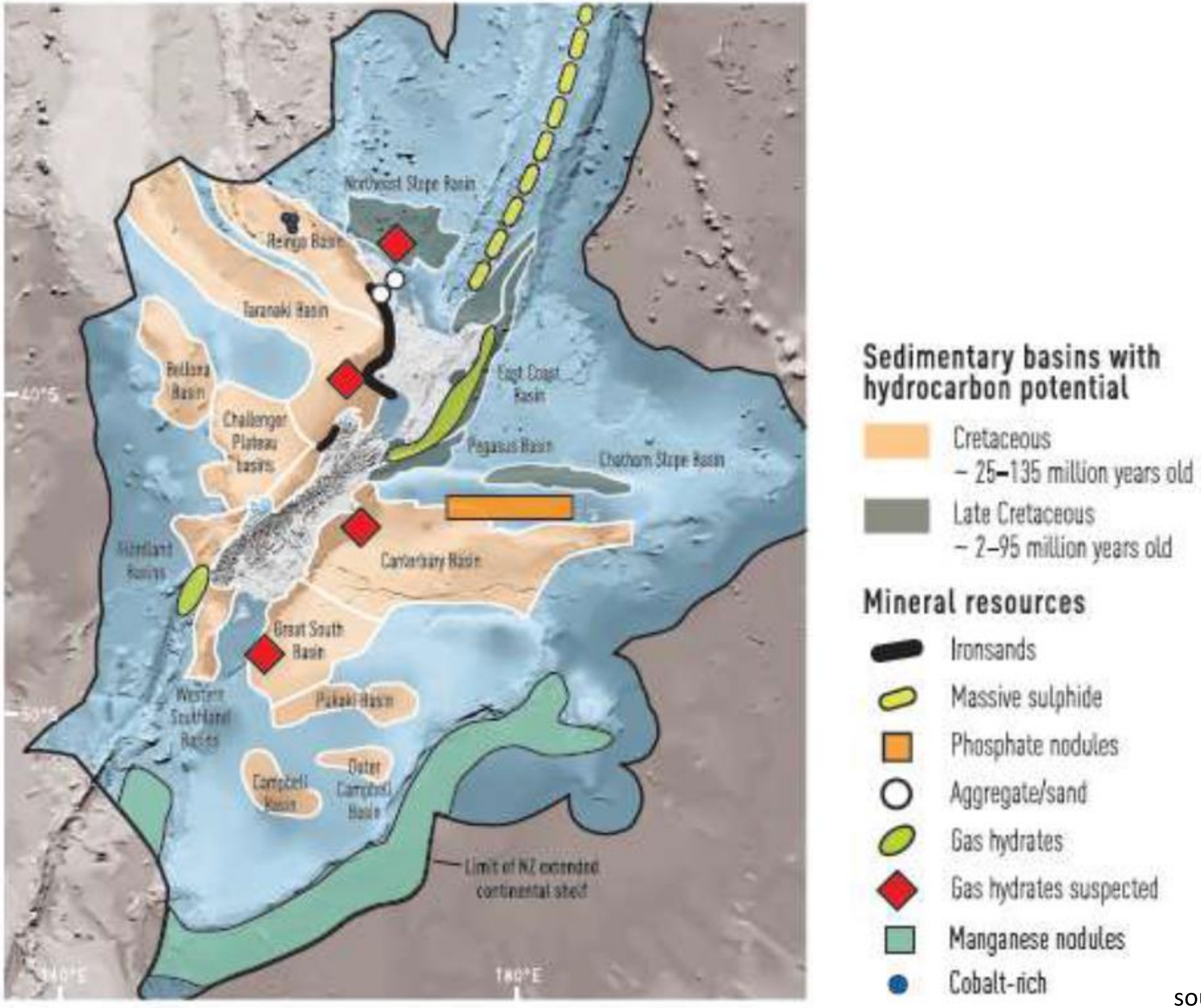
EEZ covers between 12 - 200 nautical miles offshore

+ FIGURE 11.1:
NEW ZEALAND'S MARINE AREA



Data source: National Institute of Water and Atmospheric Research.

source: EPA



Northwest Slope Basin
Reinga Basin
Taranaki Basin
Bellona Basin
Challenger Plateau basins
East Coast Basin
Pegasus Basin
Chatham Slope Basin
Fiordland Basins
Canterbury Basin
Great South Basin
Western Southland Basin
Pukaki Basin
Campbell Basin
Outer Campbell Basin
Limit of NZ extended continental shelf
40°S
50°S
180°E
Sedimentary basins with hydrocarbon potential
Cretaceous – 25–135 million years old
Late Cretaceous – 2–95 million years old
Mineral resources
Ironsands
Massive sulphide
Phosphate nodules
Aggregate/sand
Gas hydrates
Gas hydrates suspected
Manganese nodules
Cobalt-rich

source: NIWA

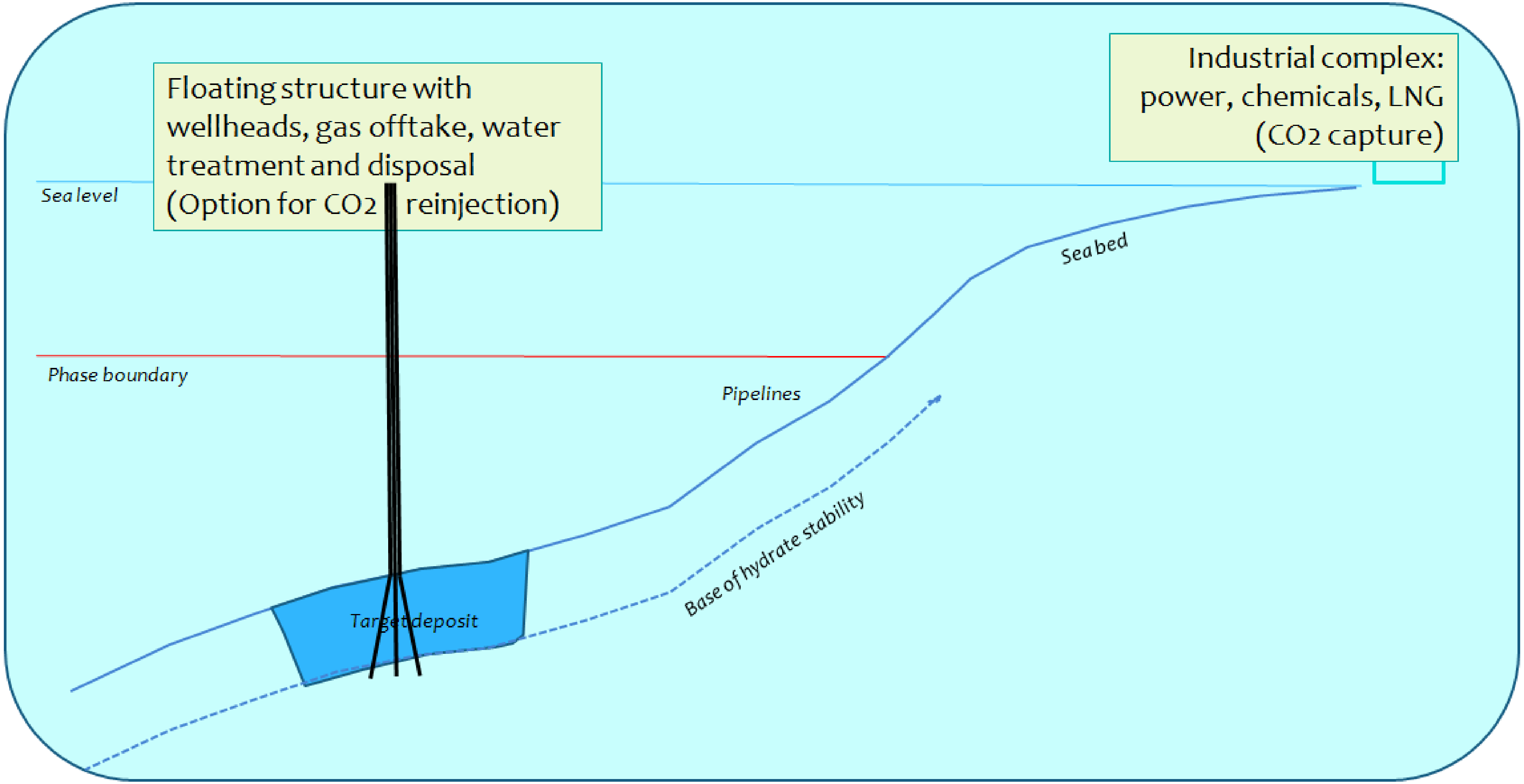
Aspects of an EIA

- Describe the proposed activity and the current state of the area where the proposed activity will be undertaken and its surrounds
- Identify people whose existing interests might be affected, and describe any consultation with those parties

EIA continued

- Identify potential effects on both the environment and on existing interests (including cumulative effects
- Specify alternative locations or methods that would avoid remedy or mitigate any potential effects, as well as the measures intended to avoid, remedy or mitigate the potential adverse effects identified

Our extraction case



A Consent Manages Effects

Effects include:

- Biogenic effects
- Sedimentary plumes
- Slope collapse and tsunami
- Temperature associated with extraction

Trans-Tasman Resources

Commissioned over 35 reports, investigating issues ranging from ecological effects, sediment plume, coastal processes and surf, to fish and fisheries, marine mammals, noise and visual effects.

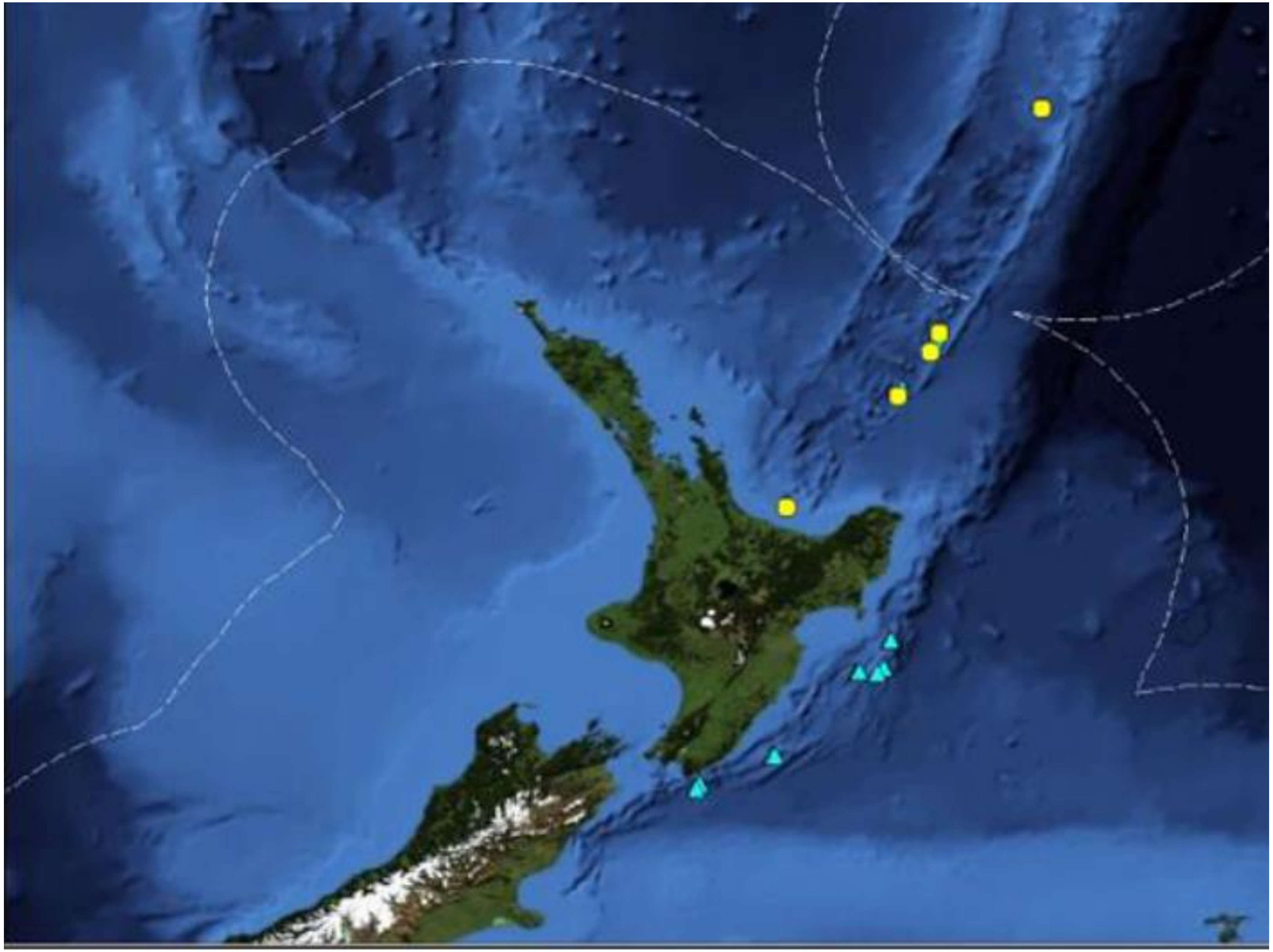
- Impact on the seabed
- Recreational fishing and diving
- Commercial fishing
- Marine mammals
- Sediment plume from mining operations

Biogenic effects

Species associated with hydrothermal vent and cold seep habitats: Indicative species as per Schedule 6 of the EEZ Act are *Siboglinum* spp., *Oasisia fujikurai*, *Lamellibrachia juni*, and *Lamellibrachia* spp.

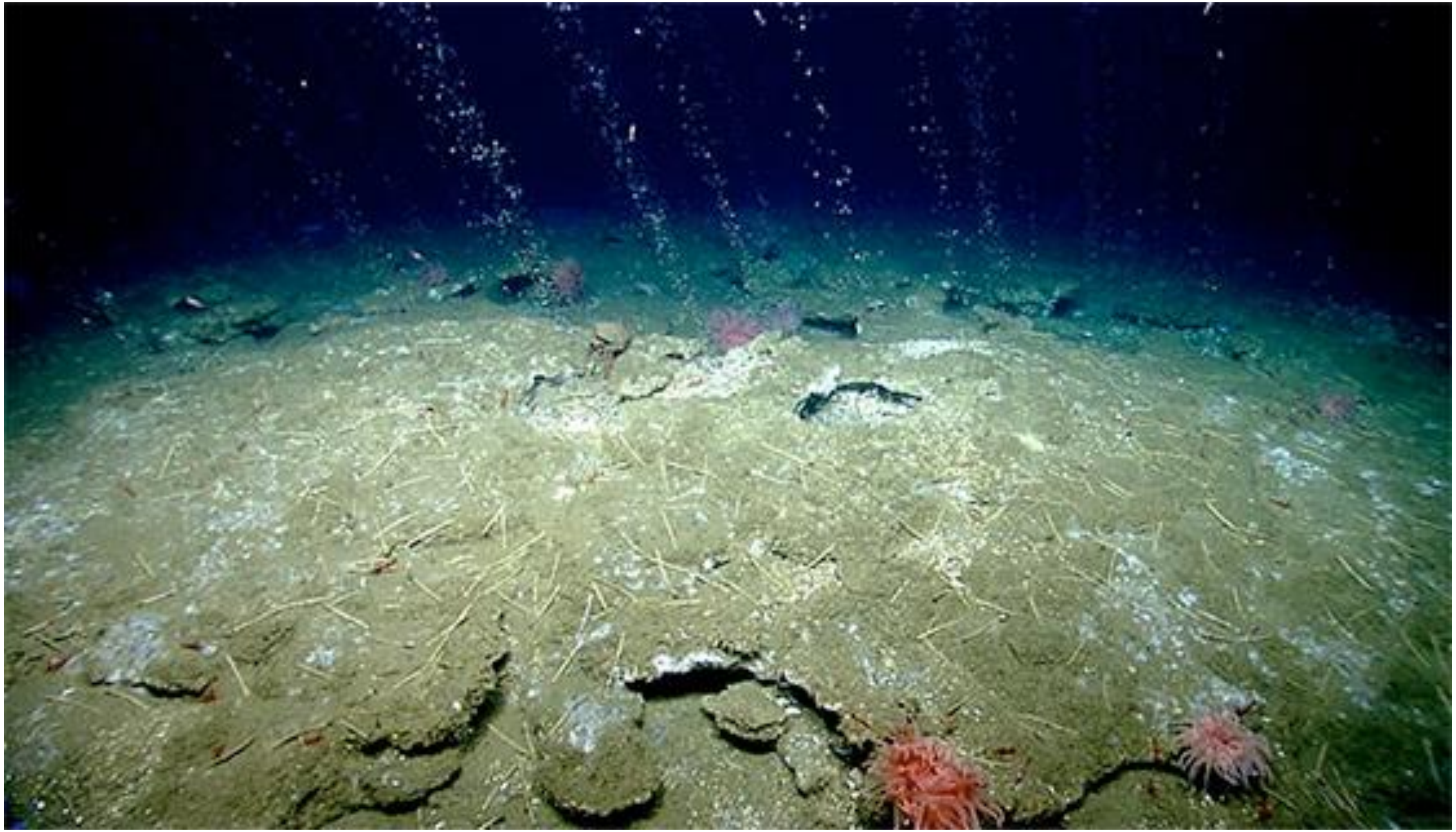
A patch exists if:

- One or more aggregations of multiple tubeworms are visible in a seabed imaging survey of an active vent or cold seep (typically a scale of about 100m2).
- Two or more specimens of a chemoautotrophic species are found in a point sample.
- Two or more specimens of a chemoautotrophic species are found in a sample collected using towed gear.



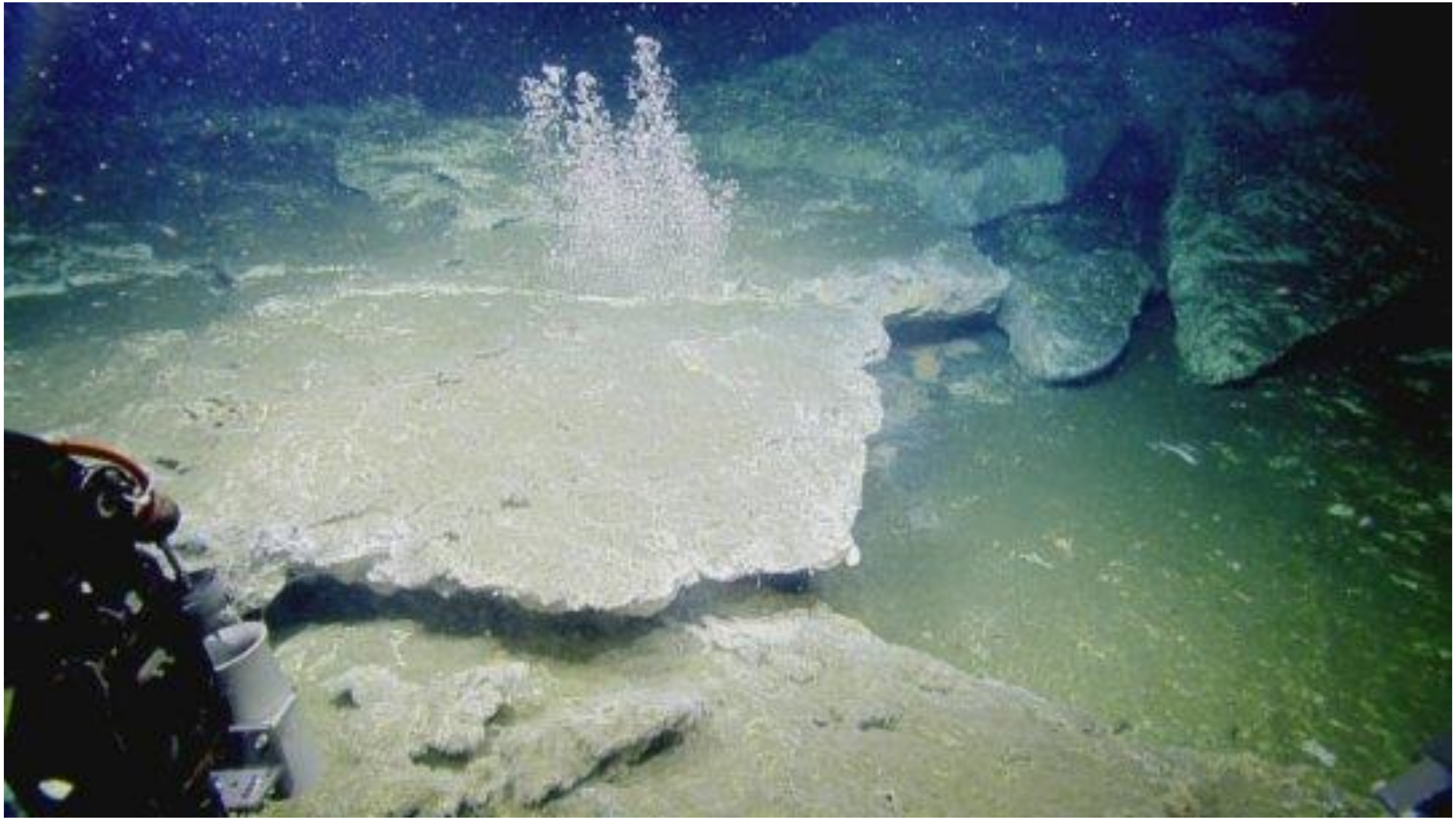
Confirmed records of chemosynthetic siboglinid tubeworms. Blue triangles represent records associated with cold seeps. From “A Review of NZ Key Biogenic Habitats” 2019.

Effects on ecosystems



Source: NOAA

Sedimentary plumes

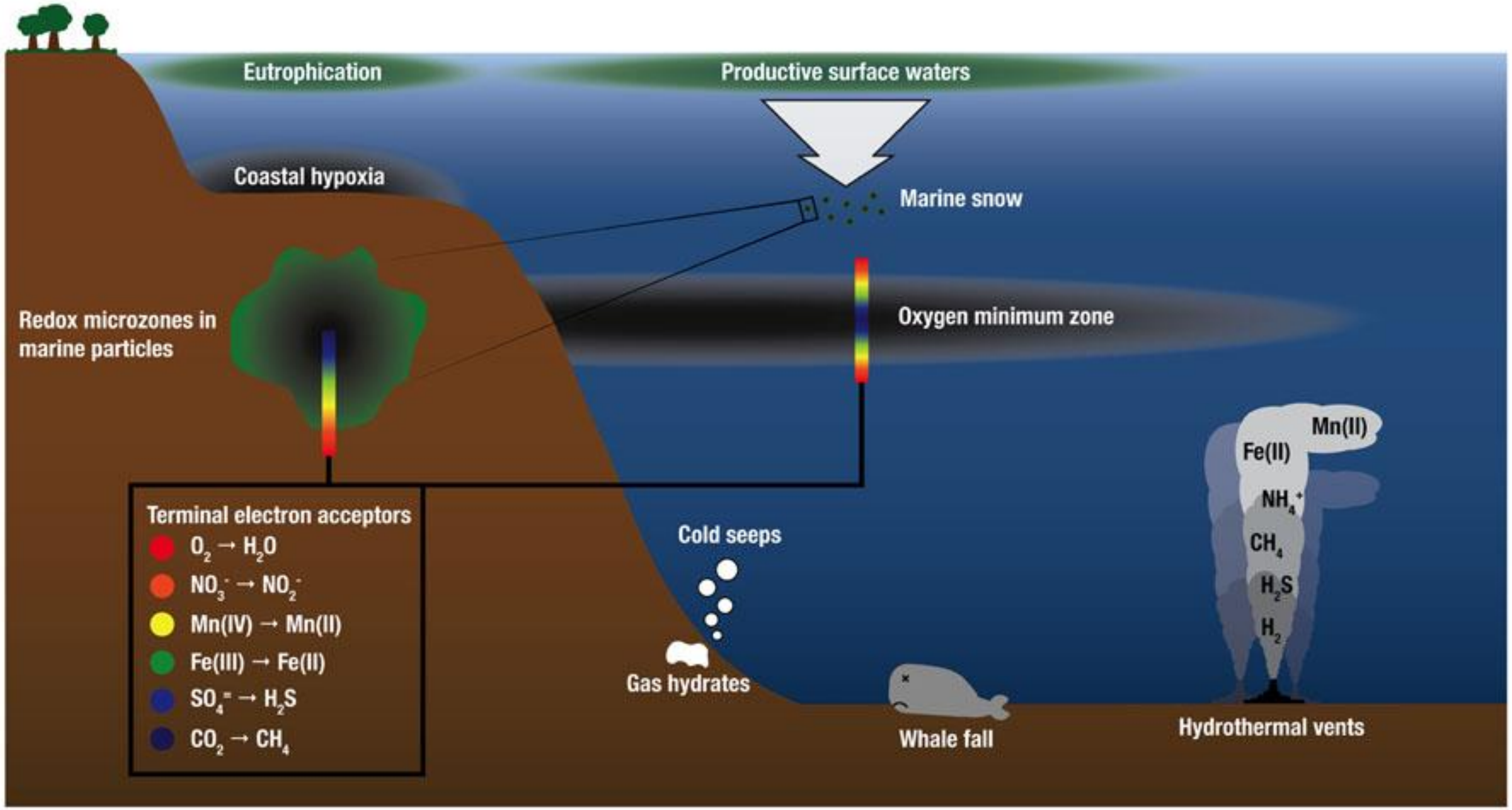


Source: ScienceDaily. Methane seeps off the coast of Oregon

Slope collapse and tsunami

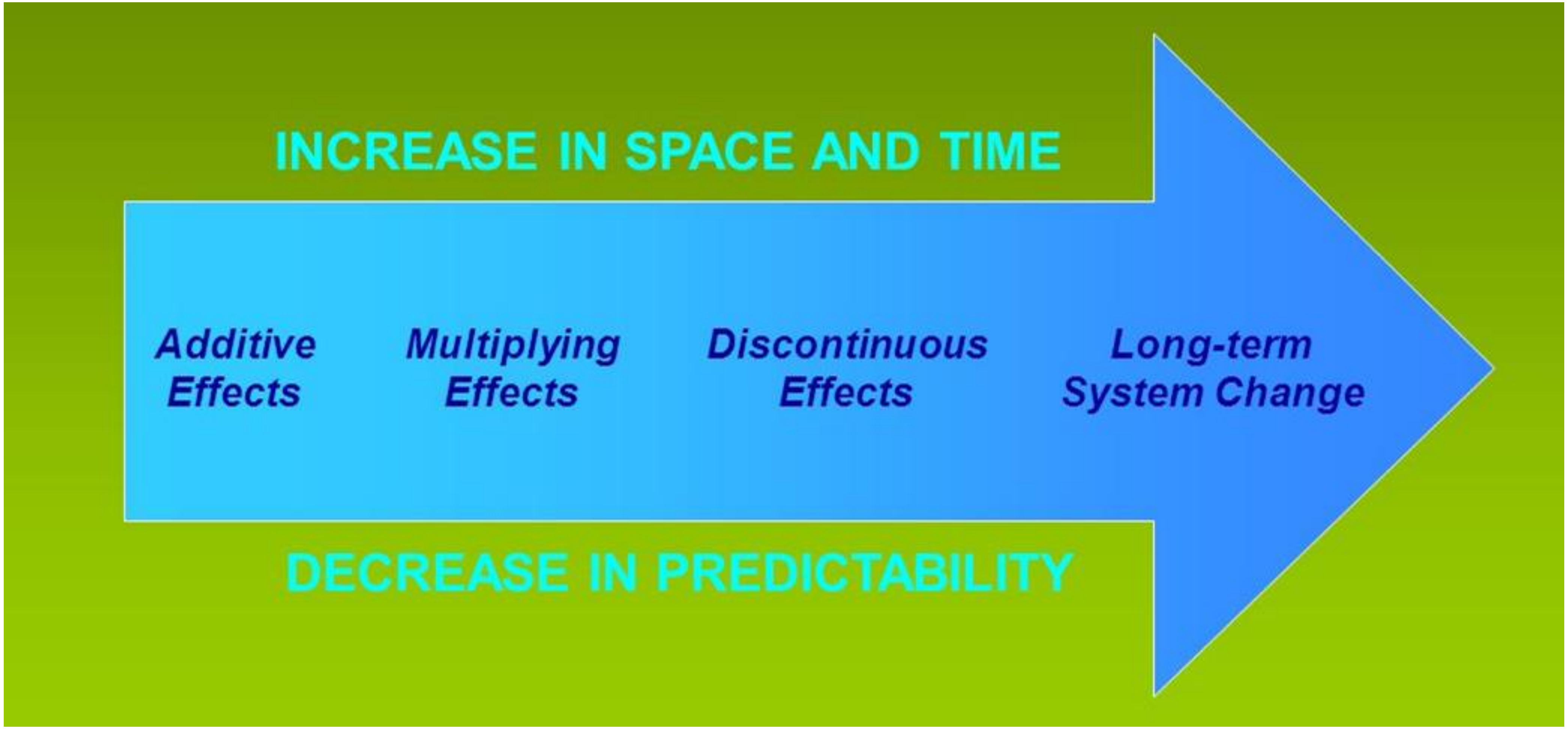
- Changes in hydrate volumes and morphologies during extraction, and the resulting weakening of the sediment mechanical strength may trigger catastrophic seafloor instability.
- Dissociation of gas hydrates will result in the release of large quantities of gas, which could ultimately result in slope failure.

Temperature and Salinity

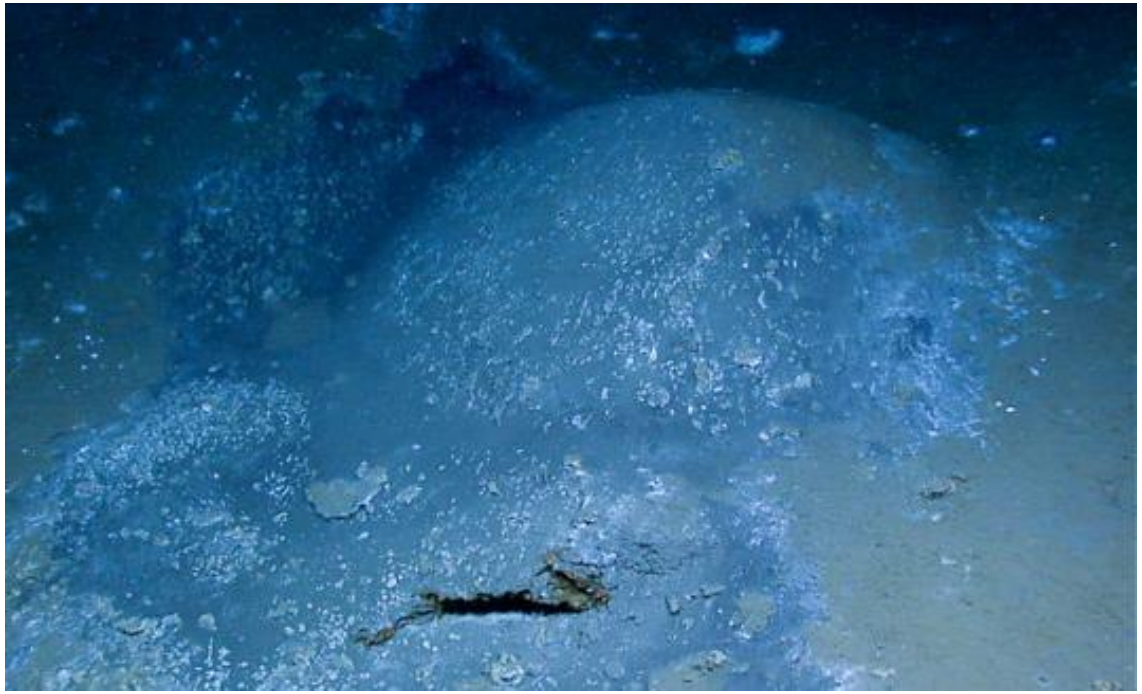


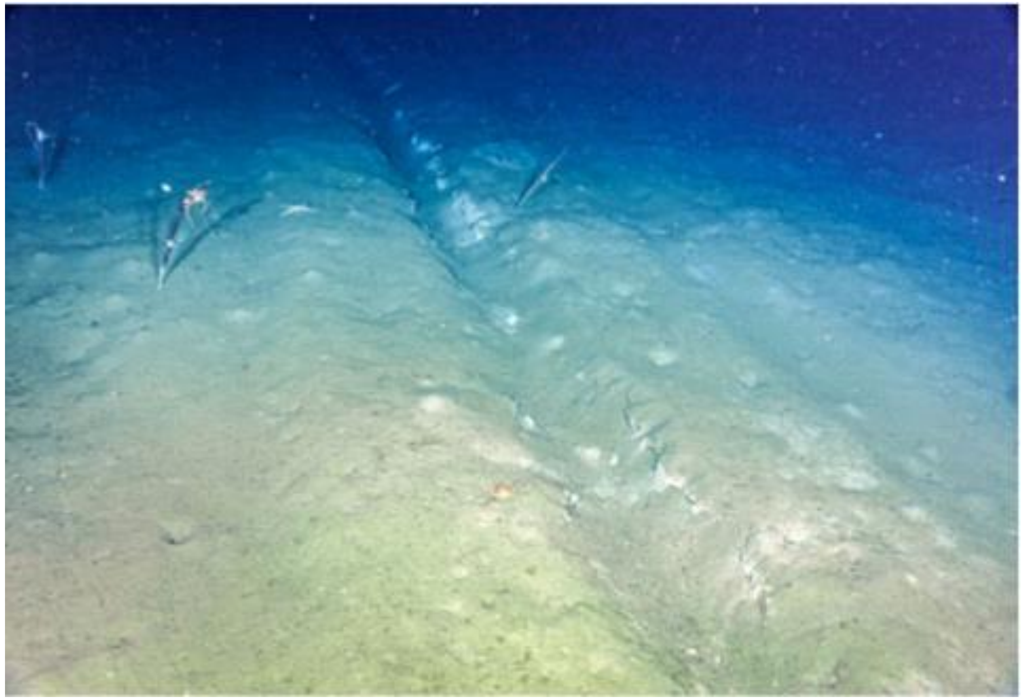
Source: Dick et al., 2013

Cumulative impacts



Cumulative impacts example





Ocean floor methane hydrates (source: NOAA), and bottom trawl scar mark on seafloor.(source: Ocean Networks Canada)

A hierarchy of mitigation

(1) avoidance (such as by establishing protected reserves within which no anthropogenic activity takes place)

(2) minimisation (such as by establishing un-mined biological corridors, relocating animals from the site of activity to a site with no activity, minimising machine noise or sediment plumes)

(3) restoration (as a last resort, because avoidance would be preferable).

A fourth mitigation method is offset, although there is no such framework in place in New Zealand.

Mitigation

Early modeling suggests that shallow water hydrates, in waters shallower than 300m, may lack the conditions to enable a landslide result.

Below 700m, both temperature and pressure may be safely stable despite changes in ocean temperature or changes of ocean depth.

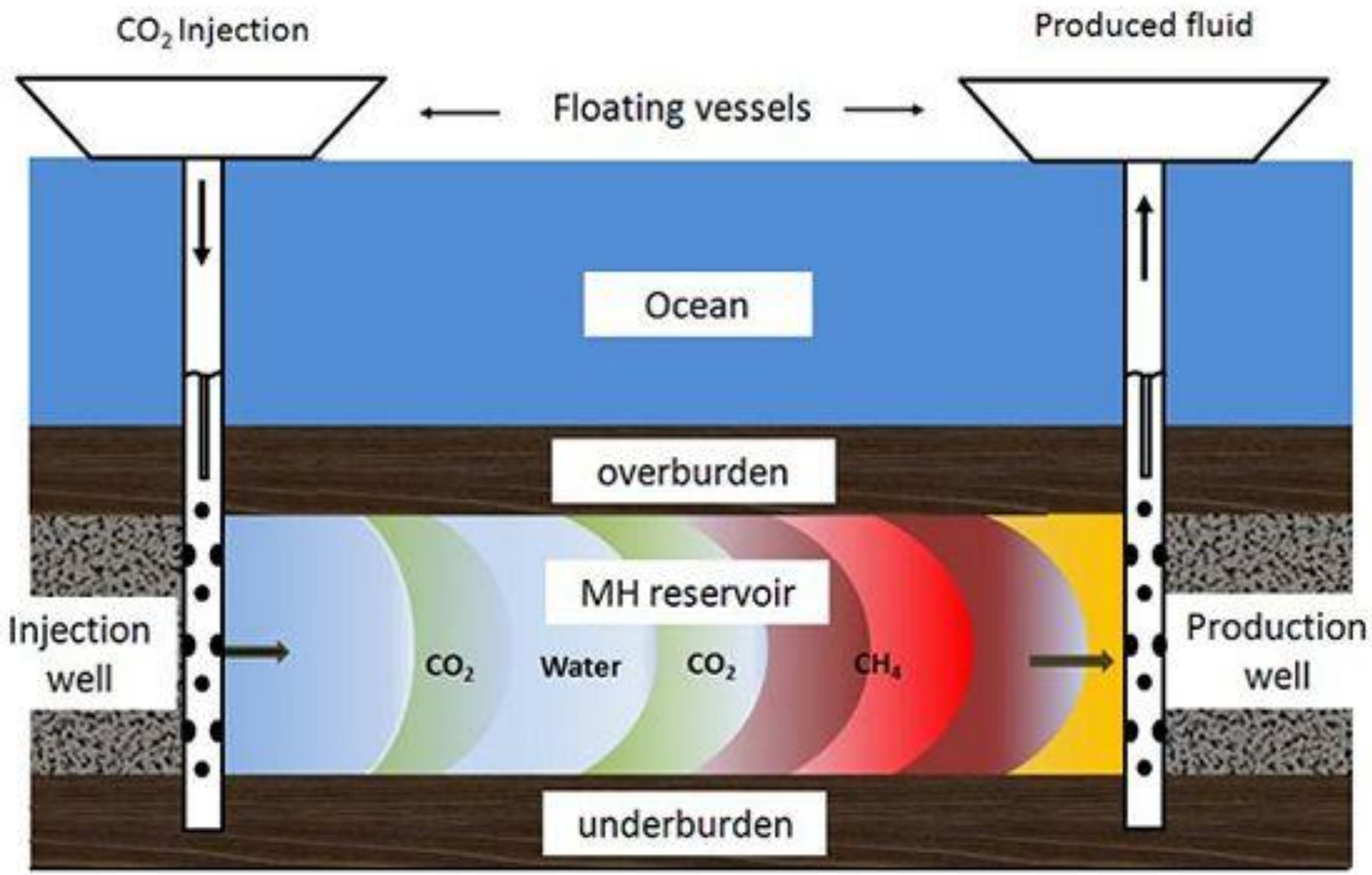
However, in seismically active areas, the risk of landslide may be increased even in these depths…..

Discussion

Economic tipping points

Offshore methane hydrates are expected to soon become price competitive with LNG in general, and may already be price competitive against certain spot prices in that market.

Discussion



Source: Das and Tiwari

Conclusions

THE ZERO CARBON ACT