Food and Agriculture Organization of the United Nations

SponGES POLICY BRIEF

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Threats and impacts on sponge grounds

Sponge grounds or aggregations, are habitats formed by large densities of sponges that can be constituted by either a single species or mixed species assemblages. They are known to occur at all depths and throughout the world. Their extension can range from a few hundreds of m^2 to hundreds of km^2.

Deep-sea sponge grounds (below 200 m), due to their life history, physiology and function are threatened by human activities. As habitat providers, the removal or destruction of sponges will change the biodiversity of the sponge grounds, impacting not only sponge populations, but also the overall functioning of these deep-sea ecosystems.

Human induced threats

With technological developments and the increased demand for natural resources, the exploitation of fish, oil and potential minerals and new chemical substances, has increased in the deep sea. The impacts of these activities can go from direct physical destruction of seafloor habitats through biomass removal, but also through indirect impacts such as the creation of sediment plumes from bottom trawling or mining plumes from deep-sea mining activities.

The particle plumes resulting from trawling (and potentially mining activities) depending on their characteristics, can have a clogging effect on the sponges, reducing their filter/clearance capacity and causing stress (higher oxygen consumption). Also, environmental changes due to climate change may affect sponges.

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Impacts due to fishing activity

Deep-sea sponge grounds are often found in areas of elevated fishing activities that are using a diverse range of bottom-contact gears. These include bottom otter trawls, bottom longlines, deep midwater trawls, sink/anchor gillnets, pots, traps, and tangle-nets.

Sponges are particularly vulnerable to bottom-contact fishing gears through bycatch but also the damage, dislodgement and crushing caused by the gear operation. The gear type is an important factor that determines the extent of impacts to benthic communities. In addition, the severity of the damages largely depends upon the morphology of the species (complexity, size, flexibility, etc.).

Below are a range of examples of fishing impacts.

REMOVAL OF DEEP-SEA SPONGES BY BOTTOM TRAWLING IN THE FLEMISH CAP AREA

The important fishing grounds at the Grand Banks of Newfoundland and the Flemish Cap in the northwest Atlantic have been exploited for centuries. Extensive, dense aggregations of sponges are found at large depths in these areas and have been recognized as vulnerable marine ecosystems (VMEs) by the Northwest Atlantic Fisheries Organization (NAFO). NAFO has closed several areas to protect these ecosystems from bottom fishing. However, portions of the sponge grounds of the Flemish Cap, remain unprotected.

Estimates of sponge removal by the trawling fleet operating in the Flemish Cap area have been made to shed light on the ecosystem effects. Using distribution modelling techniques, it was estimated that about 230 000 tonnes of sponges exist in the area and that every day, these sponges filter about 56 000 million litres of seawater and consume 63 tonnes of organic carbon through respiration, thereby affecting the turnover of several nitrogen compounds. As a result, their removal would likely affect the delicate ecological equilibrium of the deep-sea benthic ecosystem.

However, about 42 percent of sponge biomass is protected by current fisheries closures and the fishers are operating mainly in the same areas, outside of dense sponge grounds. Therefore, the overall magnitude of sponge removals by the commercial fleet is limited and estimated to vary between 0.5 to 2.1 percent of total sponge biomass predicted to occur in the area. However, projections of trawling tracks suggest that the sponge biomass within closures would be wiped out in just one year by the current level of fishing activity, if allowed in these dense sponge areas (Pham *et al.*, 2019).

Management tools, such as fishing closures, are essential to reach conservation goals.

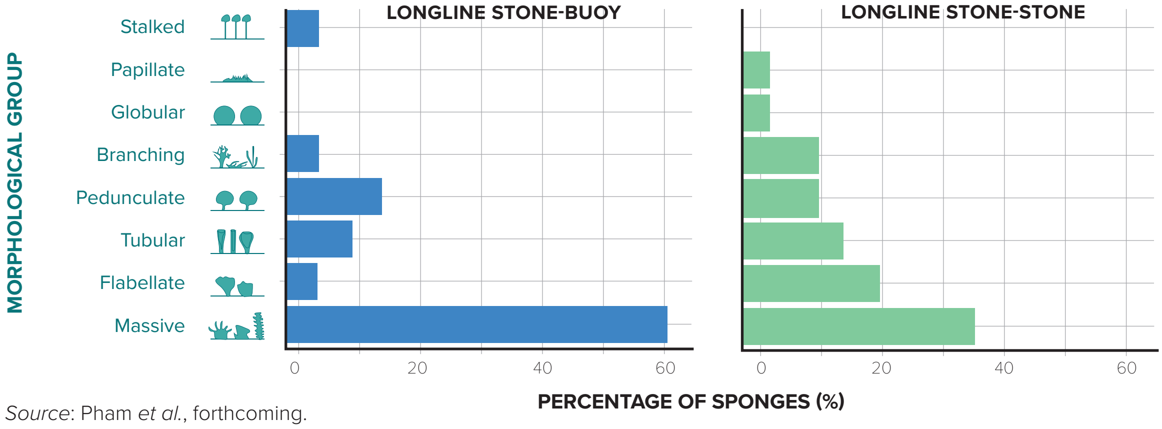
LONGLINE DESIGNS INFLUENCE LEVELS OF SPONGE BYCATCH

The selectivity of different longline designs on deep-sea sponge communities in the Azores has been studied as regards the levels and morphological characteristics of sponge bycatch for three different types of hook-and-line techniques as well as accidental damages (e.g. abrasion and entanglement) of sponges of different morphological characteristics.

Extensive observer data on commercial longlining shows that:

- Deep-sea sponges are occasional bycatch organisms.
- Larger and more morphologically complex specimens are being caught more frequently than smaller individuals with simpler structures (Figure 1).
- Hand lines have little bycatch while the stone-stone longline design increases bycatch levels significantly.
- Underwater imagery reveals additional damages to sponges, notably through entanglement in lost gear.

FIGURE 1 **Percentage of sponges belonging to distinct morphological groups caught by two different longline designs**



Source: Pham *et al.*, forthcoming.

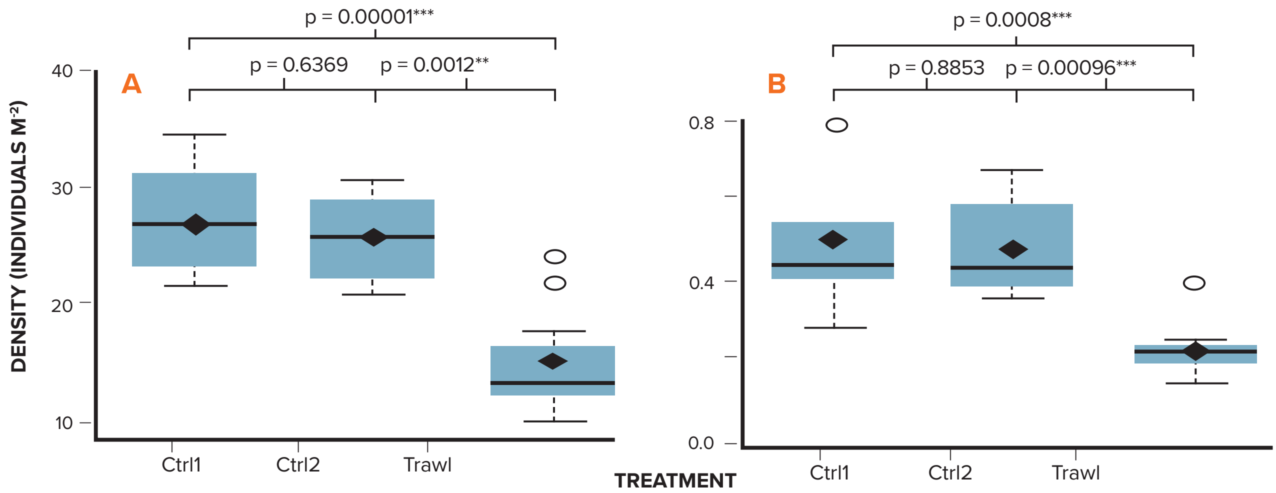
Bottom-contact fishing techniques are directly impacting deep-sea sponge communities through bycatch but also incidental damage. The extent of damage is dependent upon the type of fishing gear but also on the morphological characteristics of the sponges inhabiting the fished site.

POOR RECOVERY AFTER PHYSICAL DISTURBANCE OF AN ARCTIC SPONGE GROUND

The recovery of two distinct benthic communities on the Schulz Bank in the Arctic Ocean was studied by comparing the diversity and abundance of epibenthic megafauna in disturbed versus control areas using video imagery, four years after disturbance by bottom trawling. Results showed that:

- Megafaunal densities of both the shallow (~600 m depth) and deep (~1400 m depth) benthic communities were significantly lower in disturbed areas than in control areas (Figure 2).
- Multivariate analyses revealed a distinct separation between disturbed and control communities for both sites.

FIGURE 2 **Total density of organisms found on A. the summit and B. the flank of Schulz Bank.**



Averages are noted by diamond shapes, "Ctrl" refers to control transects. Four years after trawling, densities on the trawled areas are significantly different from the control transects.

Source: Morrison *et al.*, forthcoming.

Deep-sea sponge grounds require much more time than four years to recover from physical disturbance typical of trawling activities.

SPONGE GROUND COMMUNITIES ARE ALTERED BY TRAWLING ACTIVITY

The influence of trawling activity on sponge grounds has been studied by comparing the community composition of the associated fauna, density of sponges and their size structure in two sites of the Barents Sea with different levels of fishing pressure. Using video footage, the results revealed:

- pronounced differences in the community composition, diversity, macrofaunal abundance and size structure of habitat-forming sponge species between the sites;
- dominance by small specimens of the structuring species *Geodia barretti* in the highly trawled site, and the complete absence of larger individuals;
- differences in the community composition between sites according to multivariate analysis (Figure 3).

Our work shows that chronic trawling activities result in a change in the functional diversity of the system.

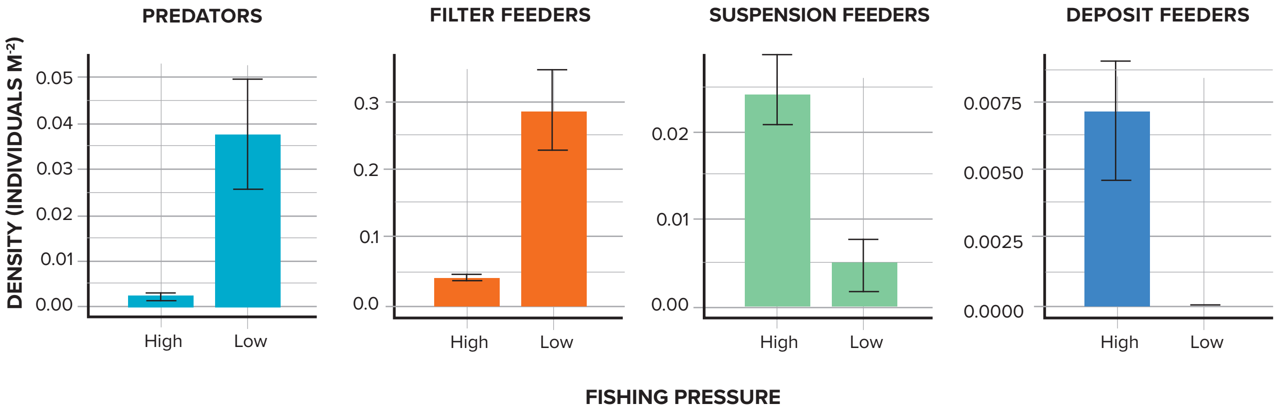
Effects of sediment and climate change on sponge species

DOES EXPOSURE TO SUSPENDED NATURAL SEDIMENT AFFECT SPONGE HEALTH?

Individuals of two common North Atlantic deep-sea sponge species (the glass sponge *Vazella pourtalesii*, Fig 4a, and the demosponge *Geodia barretti*, Fig 4b), were experimentally exposed to suspended natural sediment at concentrations resembling the sediment plumes caused by trawl fisheries. Both species accumulated the sediment particles (Fig. 5).

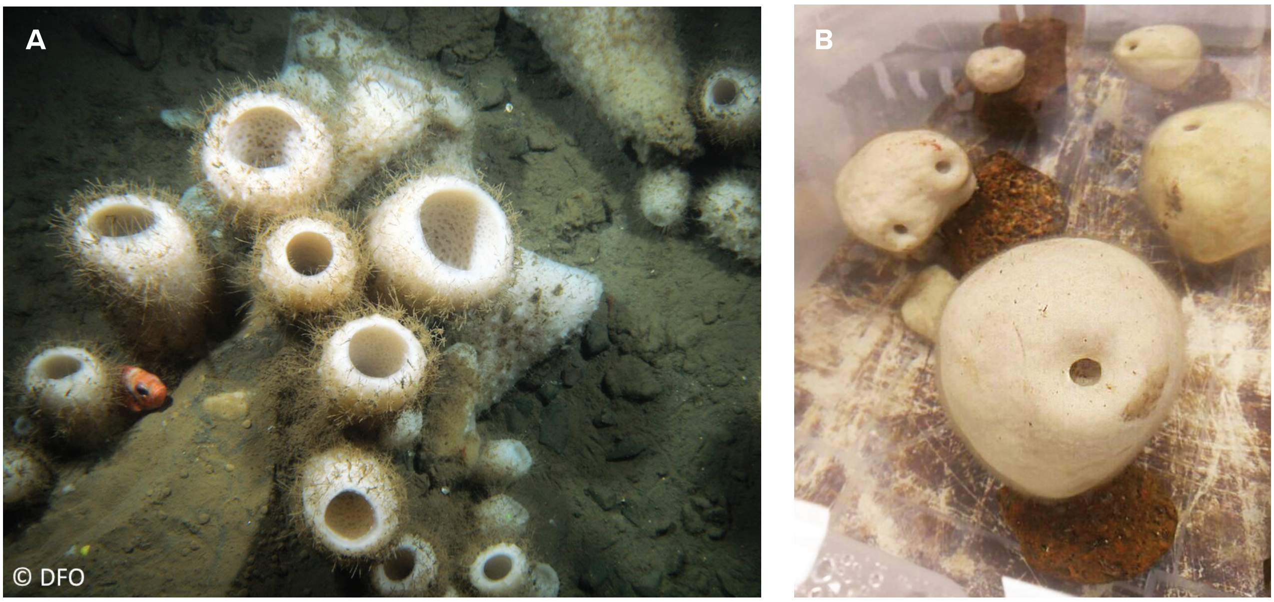
V. pourtalesii was able to efficiently evacuate sediment particles and tissues appeared cleared after three weeks of recovery. Exposure to sediment did not change oxygen consumption in either species, but pumping activity (measured by proxy of bacterial clearance) decreased in *V. pourtalesii* during the second week of exposure (Fig. 6).

FIGURE 3 **Average density (±SE) of different functional groups based on feeding type associated with the *Geodia* spp. grounds at a highly (high) and lightly (low) trawled site in the Barents Sea (*Geodia* is not included here)**



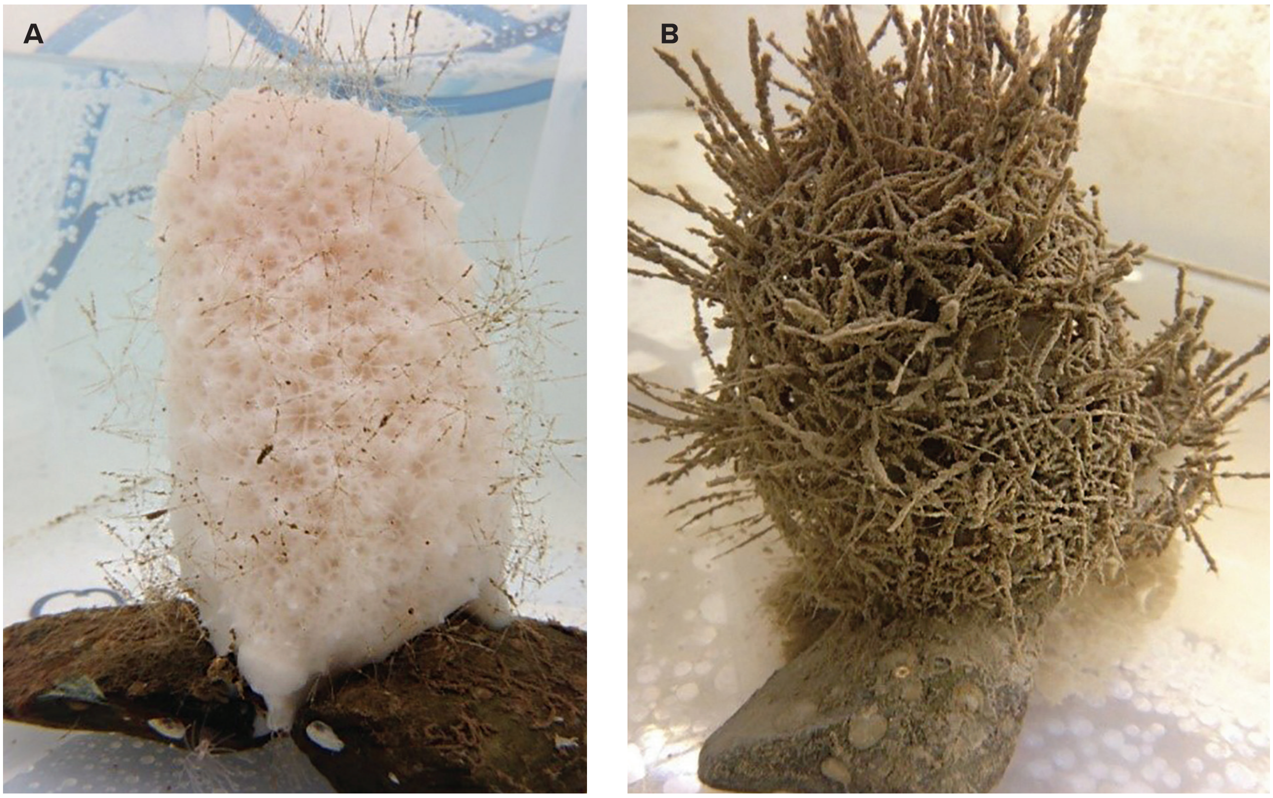
Source: Colaço *et al.*, forthcoming

FIGURE 4 **Examples of the sponge species used for sediment exposure experiments. A. The glass sponge *Vazella pourtalesii*. B. The demospsonge *Geodia barretti***



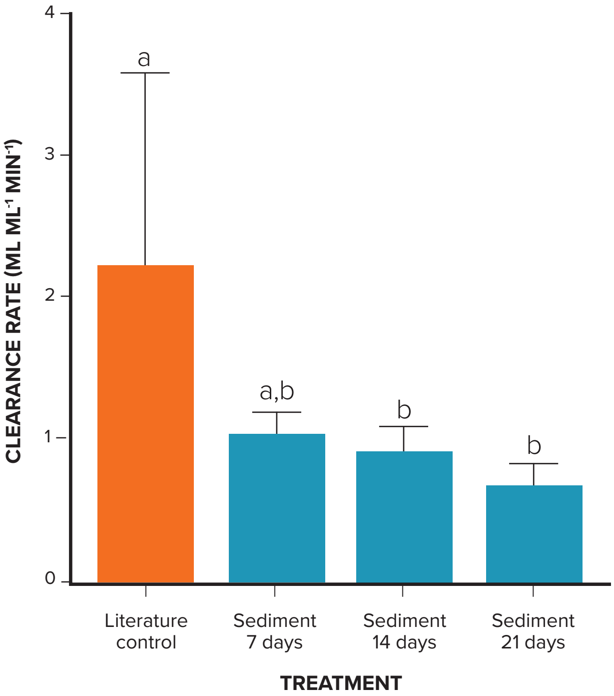
Source: A. ©Fisheries and Oceans Canada, B. ©R.Osinga, WUR

FIGURE 5 **Examples of specimen of A. *Vazella pourtalesii* in clean seawater and B. in seawater supplemented with suspended natural sediment. The specimen on the right is fully covered in sediment. Similar patterns were observed in *Geodia barretti***



Source: ©E. Wurz, WUR, from Wurz *et al.* (forthcoming)

FIGURE 6 **Clearance rate ± SD of *Vazella pourtalesii* exposed to suspended natural sediment over a three-week period compared to unexposed controls.**



Pairs of letters indicate significant differences ($p < 0.05$) among means (n=5 per sediment treatment, n=7 for literature control).

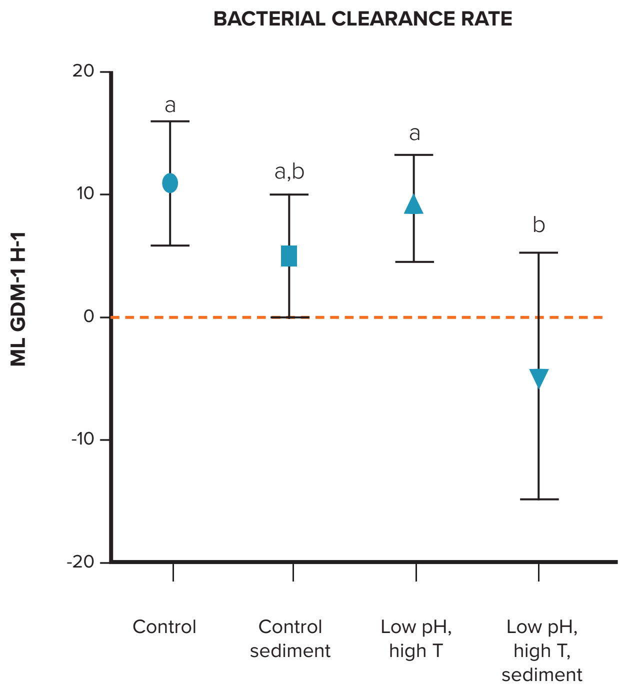
Source: Wurz *et al.* (forthcoming).

Deep sea sponges can cope with exposure to natural sediment, but sediment-stress may impair sponge health if the exposure persists for longer periods.

CAN FUTURE OCEAN CONDITIONS MODULATE EFFECTS OF EXPOSURE TO NATURAL SEDIMENT?

Individuals of *Geodia barretti* (Fig. 4b) were exposed to suspended natural sediments after being pre-exposed for 6 months to seawater conditions that resemble a future climate scenario (i.e. lower pH, higher temperature). The pre-exposure did not cause detectable differences in oxygen consumption rates and pumping activity, which suggests that climate change will not notably affect these sponges. However, pre-exposure to future ocean conditions seemed to change the effect of sediment on sponge physiology. In contrast to current ocean conditions, where pumping activity did not change due to exposure to sediment, the sponges ceased pumping when sediment was supplied under future ocean conditions (Fig. 7). Unfortunately, experiments showed a huge variability in data, which limited statistical exploration of the results.

FIGURE 7 **Bacterial clearance rates (a proxy for pumping activity) for *Geodia barretti* under current ocean conditions (control) and future ocean conditions (low pH and high temperature) with and without exposure for 12 hours per day to 60 mg L-1 natural suspended sediment.**



Characters indicate significant differences, treatments sharing the same character not being significantly different from each other. Error bars indicate standard deviations (n=5).

Source: Wurz *et al.* (forthcoming)[1].

Differences between individuals were substantial, and individuals often showed variable and opposite responses over time. The experiment raises concern about changing responses of sponges to sediment if climate change proceeds.

Experimentally applied climate change conditions indicate that future ocean conditions can exacerbate negative effects of other stressors to deep sea sponges such as exposure to sediment. The decrease in pH and increase in temperature do not seem to affect the respiration rate.

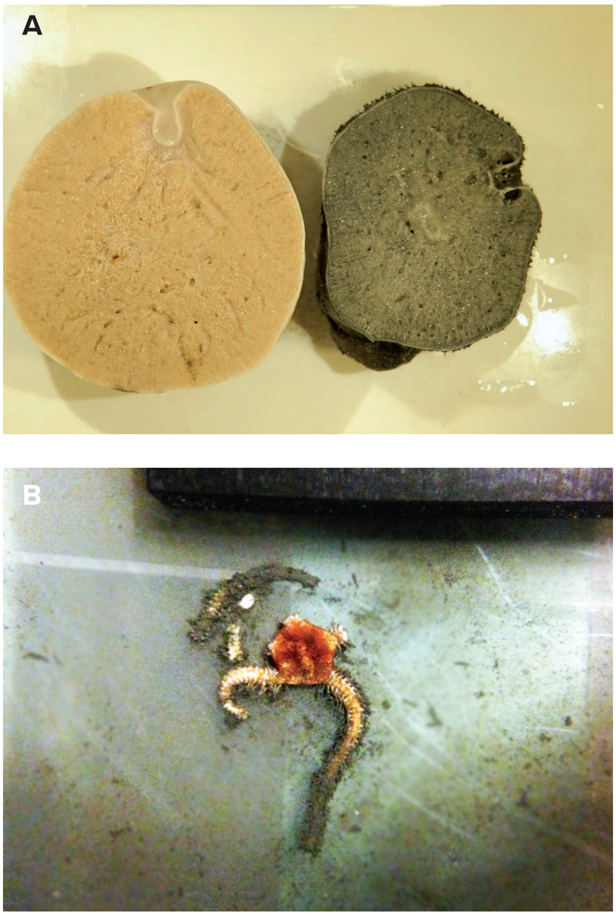
WILL DISCHARGE PLUMES OF DEEP-SEA MINING ACTIVITIES AFFECT SPONGES?

Seafloor Massive Sulphide (SMS) deposits are potential targets for deep sea mining for the winning of valuable metals such as zinc and copper. Exploitation of these deposits will likely be accompanied by discharge of crushed SMS that may affect deep sea sponge grounds.

When individuals of *Geodia barretti* were exposed to field-relevant quantities of crushed SMS deposits, the mortality rates increased (Fig. 8a) and led to a complete arrest of sponge pumping and caused a 100 percent mortality in sponge-associated brittle stars (Fig. 8b), which are assumed to be an important consumer of sponge-produced organic matter.

Uncontrolled discharge of crushed SMS deposits during deep sea mining will have serious impacts on sponges and their associated fauna and may fundamentally change the ecology of deep-sea sponge grounds.

FIGURE 8 **Effects of exposure to crushed SMS deposits on the sponge *Geodia barretti* (A) and associated brittle stars (B). A. Dissection of a non-exposed sponge (left) and a SMS-exposed sponge (right) shows the accumulation of SMS particles in the exposed sponge. Some of the exposed sponges (five out of twenty-one) did not survive the experiment, whereas all non-exposed control sponges did. B. All sponge-associated brittle stars died and disintegrated within a few days after the start of the exposure.**



Source: A and B, ©E. Wurz, WUR, from Wurz *et al.* (forthcoming)[2]

Overall messages

- Sponge grounds are important parts of the deep-sea ecosystem. Their conservation depends on their protection from human direct and indirect related threats.
- However, with our present knowledge and application, fishing management tools such as fishing closures and fishing gear management, and area-based management tools for mining and other pressures that cause direct or indirect impacts, seem to be effective for deep-sea sponge conservation.
- In experimental settings, we did not see direct effects of climate change on deep-sea sponges, but climate change is likely to exacerbate negative effects of other stressors such as exposure to suspended sediment.

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