

Debunking claims of sustainability

High-seas bottom trawl red herrings*

** red herring: a false claim in which an irrelevant topic is presented in order to divert attention from the original issue*

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Introduction

The Deep Sea Conservation Coalition (DSCC), a combined force of more than 40 conservation groups from around the world, is calling on the United Nations General Assembly to secure a moratorium on high-seas bottom trawling until a regime to protect deep-sea fisheries and biodiversity is developed and implemented. In an effort to fight this conservation measure, the fishing industry has made numerous fictitious claims aimed at downplaying the detrimental effects of bottom trawling on deep-sea ecosystems. These claims are easily refuted by the staggering amount of scientific evidence demonstrating the harmful impacts and unfortunate expansion of the bottom-trawling fishery from the shallow continental shelf to deeper and more distant waters beyond national jurisdiction. This document presents a compilation of the claims offered by the fishing industry, each followed by a powerful rebuttal based on the best available science.



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Lizardfish (*Bathysaurus mollis*).

This 15-20 cm lizardfish was caught near the equator. It is one of the smaller predators on seamounts and the deep-seafloor, eating other fish and invertebrates.

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Bottom trawling impacts on ocean habitats and foodwebs

CLAIM

There is no scientific evidence that bottom trawling affects the seabed.

FACT

There are numerous scientific studies demonstrating the harmful effects of trawling on the seabed. The US National Academy of Sciences' National Research Council¹ comprehensively analyzed the ecological impacts of trawling. Dozens of studies² demonstrate that trawling alters seabed communities and reduces habitat complexity, productivity, and biological diversity. Scientists have recorded conclusive visual evidence of trawling impact in the form of images of deep gouges and sand clouds caused by trawl gears raking the seafloor.³

CLAIM

There is no evidence that bottom trawling causes negative impacts to marine life.

FACT

There is compelling scientific evidence of bottom-trawl damage to seafloor habitats. Biogenic and geologic structures on the seafloor, such as corals, sponges, worm tubes, mussels, boulder fields, and rocky reefs, provide refuges for marine species and enhance fish survivorship.⁴ Trawling gear degrades and removes these complex structures,⁵ including deep-sea coral reefs, and exposes juvenile fish to predators. Bottom trawling also greatly reduces the biomass of benthic species,⁶ alters the composition of the marine community,⁷ re-suspends sediment and disrupts bio-geochemical cycles that support ecosystem function,⁸ decimating fragile structures such as live corals and sponges up to 1,800 years old and reefs formed 8,000 years ago.⁹ Because many bottom-dwelling organisms are very slow growing, even a single trawl can cause damage that may not be reversed for decades or centuries.¹⁰ This is particularly true on seamounts, whose benthic communities are often dominated by suspension-feeding invertebrates such as corals and sponges.¹¹

CLAIM

Opponents of bottom trawling use photographs that rely on shock value.

FACT

Images of coral reduced to rubble by trawling gear are indeed alarming – all the more so because they are real.

Photographs of trawl damage have been recorded as part of scientific field studies.¹² Videos of habitat damage due to trawling are also available from many sources including government websites such as the Alaska Fisheries Science Center website.¹³ The images and videos appear shocking because the affected areas are so widespread and the destruction so complete. Most people are not aware of the dramatic changes made to the ocean floor by trawling gear because these changes are hidden hundreds of meters below the surface. Figure 1 presents four pairs of images from northwestern Australia, Tasmania (Australia), Florida (USA), and Norway taken by marine scientists that show untrawled and trawled spots in the same ecosystems. These images leave no doubt that trawling is devastating to seafloor communities.

CLAIM

No fishing method is ultimately good or bad in itself.

FACT

From the fishing industry to academia, there is consensus that bottom trawling is the most destructive of all fishing methods. A recent comprehensive study, *Shifting Gears*, examined the relative impacts of 10 different commercial fishing gears on marine ecosystems.¹⁴ This study used survey responses from academic and industry experts to rank fishing methods based on the degree of collateral damage they cause to non-target species and seafloor habitat. Different groups of experts unanimously agreed that bottom trawling did the most damage to the seabed of all fishing methods discussed. The severity and extent of bottom-trawling damage are far greater than those of any other fishing method. Another study demonstrating that bottom trawling has the greatest adverse impact on the seabed, in particular the deep sea, was conducted by the International Council for the Exploration of the Seas (ICES).¹⁵ ICES reviewed available information on the impacts of gillnets, longlines, and bottom-trawl gear on deep-water habitats. ICES concluded that while all deep-water fishing gear has some impact on the seabed, bottom-trawl fishing was by far the most damaging to deep-water corals and other vulnerable species. ICES concluded by advising that “the most effective way of mitigating the effect of trawling on these habitats is to close such areas to [bottom-trawl] fishing” and “the only proven method of preventing damage to deep-water biogenic reefs from fishing activities is through spatial closures to towed gear that potentially impacts the bottom.”



CLAIM

Bycatch discarded from bottom trawlers benefits scavengers by providing them with an additional food source.

FACT

The net impact of bottom trawling on benthic ecosystems is reduced productivity, diminished biodiversity, and a lowering of mean trophic level.¹⁶ Bycatch species in the trawl fishery include crabs, corals, marine mammals, sharks, and endangered sea turtles.¹⁷ Sacrificing these species to benefit scavengers (most commonly sea stars and hermit crabs) makes little sense, and is akin to tearing down ancient forests to feed worms and beetles.

CLAIM

The removal of adult fish through trawling may allow juvenile fish in the fished population to mature faster and become larger due to reduced competition.

FACT

Removing older fish is often detrimental to the population. Older female fish of a variety of benthic species produce eggs with higher nutrition content, resulting in larger offspring that have much higher chances of survival during their planktonic stage.¹⁸ Older, larger females also tend to produce more eggs. Contrary to current management, these results strongly support conserving older fish, not removing

them. The overly simple notion that fishing increases overall population biomass comes from the outdated fisheries management paradigm of maximum sustainable yield, which has been roundly criticized for decades.¹⁹ Scientists, experts,²⁰ and blue-ribbon national panels²¹ now recommend

ecosystem-based fishery management, emphasizing protection of ecosystem structure, functioning, and key processes. Bottom trawling is totally inconsistent with these goals.

CLAIM

The re-suspension of nutrients during trawling can aid photosynthesis and increase fish food organisms.

FACT

While trawling agitation may temporarily increase nutrient availability for scavengers and opportunistic species, this phenomenon is accompanied by various negative impacts, including increased

susceptibility to predation and hypoxia, altered community structure, and disrupted ecosystem processes.²² Excess nutrients can deplete oxygen in the benthic community.²³ In addition, trawling increases sedimentation on deep reefs, smothering corals and preventing larval settlement.²⁴

CLAIM

Bottom trawling is like farming: it “tills” benthic sediments, enhancing overall productivity.

FACT

Bottom trawling is more closely analogous to forest clearcutting than to farming because both practices completely remove habitat structures that can take centuries or more to regrow.²⁵ Besides removing target species, trawling scrapes away corals, sponges and other organisms that provide spawning grounds and nurseries for juvenile recruitment into adult fish stocks. Without high seas regulations there is no attention given to sustaining the productivity of fishing grounds and no incentive to keep trawlers from stripping an area clean and then moving on to the next most productive area. Serial depletion of fish populations by fishermen using bottom trawls and other gears is a widely recognized phenomenon in national and international fisheries.²⁶

CLAIM

Bottom trawling impacts local areas only; it does not impact the ecosystem.

FACT

Dragging heavily weighted nets across the seafloor destroys local ecosystems. The broader significance of this impact is determined by the cumulative levels of fishing and natural disturbance and by the spatial and temporal distribution of impacts in relation to the distribution of species.²⁷ On isolated seamounts, where there is little if any natural disturbance and where endemism levels can reach 30 to 50 percent,²⁸ one trawl pass can remove centuries-old organisms such as corals that will take centuries or more to recover, if they recover at all. Similarly, the low resilience of many deep-sea fish populations will result in decade- to century-long recovery times.²⁹ Because fish landings from the continental shelf have declined and the fishing power of deep-sea trawlers has increased, most shallow seamounts within the reach of current fishing techniques have already been exploited.³⁰ The trend towards increasing fishing effort in the deep sea³¹ will result in escalating cumulative impacts to deep-sea ecosystems.



D. Kesling/OAR/NURFP

Spotted moray eel (*Gymnothorax moringa*) slithers among the reef growth. Tropical Atlantic Ocean, Florida Keys.



Economic aspects of bottom trawling

CLAIM

Bottom trawling is an efficient method of fishing that provides large quantities of animal protein for human consumption. Switching gears would simply waste energy.

FACT

Bottom trawling in general is far from an efficient fishing method. Its low selectivity results in high bycatch. Much energy is wasted on hauling in bycatch rather than target species. Kelleher³² reported that 50 percent of all bycatch in the world is produced by trawl fisheries in general, which account for only 22 percent of the total world landings. Thus, bottom trawling is inherently less efficient than many other methods of fishing.

Furthermore, according to a recent comparison of fishing gear efficiencies, trawling in general has the highest ratio of liters of fuel spent per ton of fish landed.³³ In the cod industry, trawling (at an efficiency of 530 liters/ton) fared significantly worse than seine netting (440 liters/ton) or longlining (490 liters/ton). In terms of the energetic return on investment, the edible protein energy content of all

of the fish landed in the general trawl fishery amounted to less than 10 percent of the fuel energy that was burned. Inefficiency has been exacerbated by the emergence of "supertrawlers" – vessels that can exceed 100 meters in length and have propulsive engines well in excess of 10,000 horsepower.³⁴

CLAIM

The fishermen are the species most in danger of extinction. The number of fishermen has been decreasing.

FACT

UN Food and Agriculture Organization (FAO) statistics show that 77 percent of the world's fish stocks are exploited at or beyond their maximum sustainable levels.³⁵ As stocks become overfished and populations decline in every ocean,³⁶ the number of fishermen that fish stocks can support naturally decreases. If there are no fish, there are no fishermen. Fishing is an economically and culturally important profession; preserving it requires conserving fish.

From another perspective, maximizing the number

of fishermen requires shifting away from bottom trawling. As bottom trawling and bycatch reduce fishery productivity, traditional, smaller-scale fishermen cannot compete with the greater labor efficiency and catching power of larger boats with longer ranges. Overfishing limits the potential of stocks to recover in the future, further limiting employment options for fishermen.

CLAIM

All human activities entail environmental risks and invariably alter the balance of habitats, but we are not going to ban traveling by plane or stop breathing on the basis that we contaminate the atmosphere, so trawling shouldn't be halted.

FACT

This is a specious claim that compares the effects of two very different activities. But since this analogy was chosen, a look at the latest FAO figures³⁷ raises an interesting question. FAO reports that 25 percent of world fish stocks for which statistics are available have collapsed or are overexploited. We recognize that all human activities entail risks, but we doubt that many people would willingly invest their money or lives in an activity with a failure rate of 25 percent. A more appropriate analogy for the ecological damage resulting from bottom trawling is that resulting from forest clearcutting on land. Modern forest management has increasingly embraced ecosystem-based management and now greatly restricts clearcutting. Fisheries managers need to likewise severely curtail bottom trawling in order to recover and better manage marine ecosystems for continued sustainability.

CLAIM

If my country restricts access to bottom trawling on the high seas, other nations will expand their fleets and exploit the fishing grounds.

FACT

This is exactly why a multilateral moratorium on high-seas bottom trawling is necessary. If the moratorium is adopted, it will force the international community to work together to develop a rational regime that protects the interests of all countries, not just those that fish, and level the playing field for all high seas fishing fleets. Further discussions of multilateral actions necessary to protect deep-sea ecosystems on the high seas, including a moratorium on high seas bottom trawling, are underway and will continue at the 60th United Nations General Assembly from September until November 2005.

Bottom trawling in general is far from an efficient fishing method. Its low selectivity results in high bycatch. Much energy is wasted on hauling in bycatch rather than target species.

The scale of bottom trawling

CLAIM

Bottom trawling occurs only in small, selected areas.

FACT

The selected areas where trawling occurs are among the most productive and ecologically sensitive habitats in the ocean. Nearly all trawling occurs either on the continental shelves and slopes, which are among the most biologically diverse marine habitats and rival the diversity of the rainforests,³⁸ or on seamounts, mid-ocean ridges, and undersea banks, which are often hotspots of biodiversity, centers of evolutionary radiation, and homes to endemic and fragile species.³⁹ Inside the Exclusive Economic Zones (EEZs), trawling efforts have increased to the point that virtually all continental shelves are now trawled, with some areas trawled several times a year. For instance, it is estimated that the entire floor of

the high seas such as seamounts are increasingly being exploited by trawlers. Russia, for example, has announced its intention to expand high seas fishing by 33 percent over the next five years.⁴⁴ The unchecked increase in individual fishing vessels' capability to exploit the deep sea enables the fleet to kill more marine life and destroy more marine habitats without expanding the number of trawl vessels. The appropriate statistic is not the number of trawlers but their fishing power. Larger vessels armed with more sophisticated technologies are much more effective at finding the last populations of exploitable fishes and eliminating them.

CLAIM

Fishing takes place generally in similar areas each year. New areas are not being fished.

FACT

Fishing grounds are expanding. Pauly and colleagues⁴⁵ and Roberts⁴⁶ demonstrated the worldwide trend of fishing operations metastasizing into waters increasingly farther offshore and at increasing depth. Koslow and colleagues⁴⁷ found seamount fishing to be expanding worldwide. Researchers studying New Zealand seamount fisheries found clear evidence of fishery expansion.⁴⁸ In the late 1970s, New Zealand's seamount fishing was concentrated on only one seamount, but now almost 250 seamounts are fished. The New Zealand orange roughy trawl fleet increased to expand onto the high seas between 1988 and 2001, first into the Tasman Sea and the Southwest Pacific, then the Southern Indian Ocean, and ultimately into the North Atlantic. During that same period, the catch of orange roughy within the New Zealand EEZ fell by approximately 75 percent. Fishermen move on to new fishing grounds once they have depleted the resources in existing ones. Fisheries biologists call this "serial overfishing." FAO data⁴⁹ also reveal that high-seas fisheries worldwide almost tripled from a total catch of 3 million tons in 1976 to 8.5 million tons in 2000.

As demand for fish products rises and continental-shelf species decline, bottom trawl fleets have moved into deeper waters both within EEZs and on the high seas. Estimates of the number of seamounts range from 14,000 to 100,000.

Georges Bank is trawled nearly four times every year.⁴⁰ As demand for fish products rises and continental-shelf species decline, bottom trawl fleets have moved into deeper waters both within EEZs and on the high seas. Estimates of the number of seamounts range from 14,000 to 100,000. In one recent report, Kitchingman and Lai, based on satellite-derived bathymetry, located roughly 14,000; of these, roughly one quarter are within the maximum reach of bottom trawl gear (Figure 2).⁴¹ It is unlikely that many of the world's seamounts within the reach of current fishing techniques remain unfished.⁴² The combined area affected by bottom trawling is already too large, yet technology is still rapidly enabling trawlers to access deeper ecosystems.

CLAIM

Trawling as a fishing practice is declining. There are no signs of growth in the trawler fleet worldwide.

FACT

As nearshore fisheries continue to collapse, commercial fishing is expanding into deeper, more distant waters,⁴³ and previously unfished habitats on

Bottom trawling gear: design and deployment

CLAIM

Coral-covered seabeds are incompatible with traditional bottom trawling, because of potential gear loss. Fishermen take great care to avoid habitat damage in order to protect their equipment.

FACT

Instead of avoiding coral beds, the industry has modified its gear to enable it to fish in structurally complex bottom habitats, including those covered by corals. Using rockhoppers and “canyon busters,” bottom trawlers are now dragging their massive gear through habitats that were once rugged refuges for benthic species. In one study of coral bycatch, the US agency, NOAA Fisheries, estimated that 81.5 metric tons of coral are removed yearly from the seafloor by commercial fisheries in Alaska, with over 87 percent caught in bottom trawls.⁵⁰ On several seamounts on the South Tasman Rise in international waters adjacent to Australia’s EEZ, observers found that fisheries targeting orange roughy caught an estimated 1.6 tons of coral for each hour of towing a trawl net during the first year of the fishery (1997-1998). Over 10,000 tons of coral were estimated to have been brought on board in that year, whereas the orange roughy catch was only 4,000 tons.⁵¹ This suggests that fishing is no longer constrained by rough seabed habitats.

CLAIM

Trawl gears have been improved so that they make contact with the seafloor even less.

FACT

If trawling gear did not make contact with the seafloor, rollers, rockhoppers, and “canyon busters” would not be needed. On the contrary, however, their use has increased for the past two decades. Rockhoppers profoundly disturb the benthic ecosystem. They run through structures (for example, corals and sponges) that offer little resistance, and collide with and override larger, heavier structures (outcroppings and large boulders). Rockhoppers can snare heavy boulders and drag them for long distances across the seafloor, grinding off the life on them and leaving deep gouges in the seafloor. Groundlines are usually weighted and made of heavy chains which can drag large rocks and topple hard structures, and net bottoms are lined with thick materials which prevent chafing when dragging over rocks and hard substrates. Bottom-trawl doors can also contact and be dragged along the seafloor: they can weigh as much as 6,000 kg each and a fully-rigged rockhopper bottom-trawl net can weigh 4,800 kg.⁵² These gear modifications have profound effects on seafloor ecosystems and reduce their chances of survival. Around Tasmania, trawling

has reduced benthic biomass on seamounts by 83 percent and destroyed virtually all of the coral cover.⁵³ The bottom trawl gear could not have produced this damage without contacting the seafloor.

CLAIM

The industry is working on making lighter footrope gear.

FACT

Lighter footropes do not alter the fundamental fact that bottom trawling still causes significant and irreversible damage to deep-sea corals and other vulnerable species. Living structures such as deep-sea corals and sponges can be easily damaged by even the lightest bottom trawling gears. Less destructive fishing methods are the only means of protecting vulnerable deep-sea habitats.

Feather duster worms, a type of annelid worm, and more specifically, tube-dwelling polychaete worms. The “arms” are actually tentacles or “radioles” at the anterior end of the worm. Most of the worms’ bodies are hidden within the tubes they have constructed. Pacific Ocean, offshore Hawaii.





Right: Lobate ctenophores (*Bolinopsis infundibulum*) are translucent and give off a bioluminescent glow.

CLAIM

Bottom trawls are not used on most of a seamount's surface because it is too steep.

FACT

Like mountains on land, different seamounts have different shapes. Slopes can be gentle or steep. The majority of bottom trawling takes place on seamount summits, which may be the areas of highest coral abundance.⁵⁴ But trawling can also occur on slopes and flanks, as evidenced by marks left by trawls on seamounts off New Zealand.⁵⁵ In some cases, up to 50 percent of the surface area of seamounts is impacted by trawling.⁵⁶

CLAIM

In fisheries for species such as orange roughy, which aggregate above seamounts, properly deployed gear only skims just above the seafloor to avoid damaging fishing gear.

FACT

This claim is directly refuted by scientific studies that document high coral bycatch rates in orange roughy fisheries.⁵⁷ In the first year of the orange roughy fishery on the Tasmanian Rise off New Zealand, observers

estimated that 1.6 tons of coral were caught each hour, with over 10,000 tons of coral estimated to be caught in just one year.⁵⁸ The tendency of schools of orange roughy to swim downward away from predators and fishing nets also increases the chance of

net contact with the bottom as the net is further lowered to catch fish.⁵⁹ If it were possible to avoid the bottom, fishermen would have no objection to eliminating rollers, rockhoppers, "canyon busters", and other gear which is specifically designed to enable contact with the seabed. But even if it were possible to completely avoid the bottom, there is no means of effectively enforcing such a practice on the high seas.

CLAIM

In New Zealand, seamounts are only fished in one direction, providing an inbuilt refuge for the ecosystem.

FACT

Clark and O'Driscoll⁶⁰ showed that trawls are dragged in many different directions on many seamounts in New Zealand. On certain seamounts where the bottom-trawl vessels deploy the trawls in a single

Photographic and video evidence has clearly documented the devastating effect of bottom-trawl gear to deep-water corals and other seafloor structures.



OAR/NLURP

direction, they do so because of geographical and technological constraints rather than out of any intention to avoid destroying habitats. On those seamounts where a high proportion of trawls occur in the same direction, the seafloor is nonetheless heavily marked with gouges from trawl doors and bobbins, and there are few large species left attached to the seafloor.⁶¹

Only a very few surveys have been conducted on seamounts that are heavily fished by bottom trawls. Two of these surveys (one in New Zealand waters, the other in Australian waters) indicated that between 90 and 98 percent of the coral cover of the heavily fished seamounts was removed by bottom trawling.⁶² While some areas of some seamounts may be too deep, steep, or rugged to fish using current technology, it is important to recognize that deep-water fishing technology is constantly improving. Many deep-sea areas that currently cannot be fished are likely to become fishable by bottom-trawl gear in the future.

CLAIM

Trawl gear approaches neutral buoyancy when it is pulled behind a boat; therefore, the downward pressure applied by the gear is actually less than it would be if the boat was not moving.

FACT

Fishing gear damages corals and other seabed habitats mainly by snagging and pulling corals and rocks, rather than by exerting direct downward crushing forces. Thus, reducing these downward forces does little to lessen the damage caused by trawling. Photographic and video evidence has clearly documented the devastating effect of bottom-trawl gear to deep-water corals and other seafloor structures.

Natural and anthropogenic threats other than high seas bottom trawling

CLAIM

Natural forces can exert pressures that are more powerful than those applied by trawling gear, and therefore harm the seafloor and corals more.

FACT

As Watling and Norse⁶³ and others have shown, severe natural disturbances are scarce below depths of 80 meters or so. In marked contrast, trawling occurs down to depths of 1,500 to 2,000 meters below the sea surface. Because the deep sea is rarely disturbed,⁶⁴ deep-sea fauna do not have the resilience and evolutionary adaptations to counter the magnitude and frequency of human-induced trawl disturbance, and hence are especially vulnerable to the destruction caused by fishing gears.⁶⁵

FACT

Overwhelming scientific evidence suggests otherwise, particularly on the high seas. Fishing has by far the greatest impact on marine communities.⁶⁶ Mineral and oil prospecting are more limited in the areas they affect and therefore produce much more localized disturbance. In fact, an estimated 95 percent of the damage inflicted on seamounts is due to bottom trawling.⁶⁷ Freiwald and colleagues⁶⁸ identified trawling as causing the greatest and most irreversible damage in the deep sea.

CLAIM

Bottom trawling within EEZs is a much greater threat to deep-water biodiversity than trawling on the high seas, so high seas bottom trawling should not be regulated.

FACT

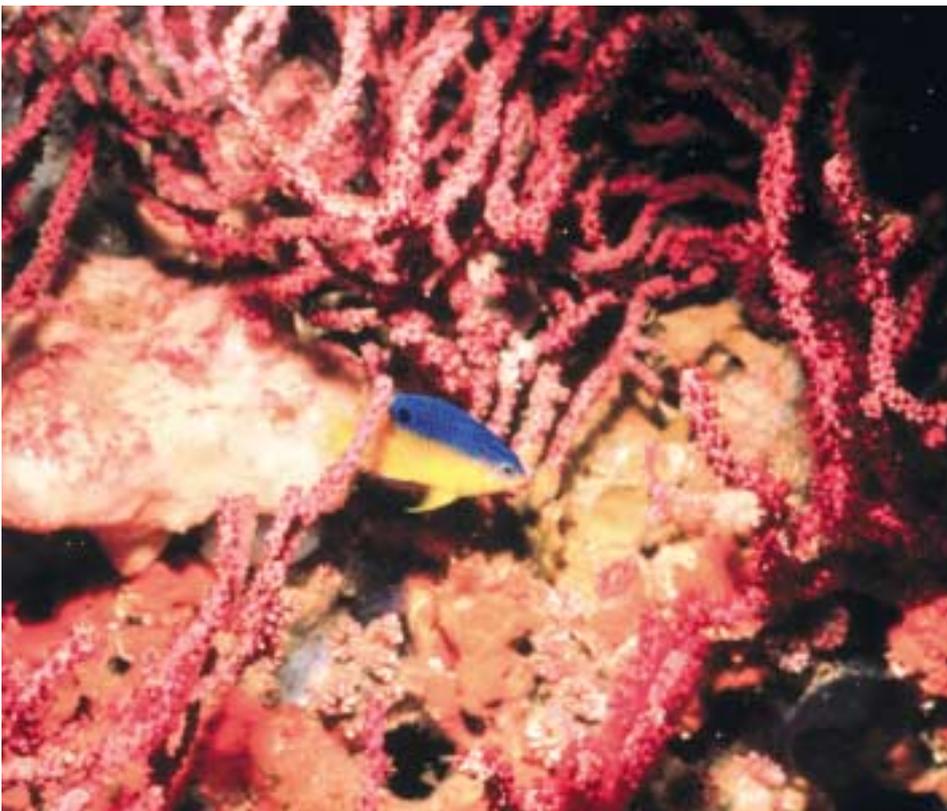
Indeed, bottom trawling has resulted in extraordinary damage to undersea areas under national jurisdiction. For example, trawling off the coast of Florida has destroyed 90 to 99 percent of the unique *Oculina* coral reefs there.⁶⁹ On the other side of the Atlantic Ocean, trawling has destroyed 30 to 50 percent of the cold-water coral reefs in Norway.⁷⁰ Nonetheless, within the EEZs, national authorities have the legal tools to protect biodiversity if they choose to use them. For example, Norway has closed all known cold-water coral reefs within its EEZ to bottom trawl fishing, and recently the United States decided to close large areas of deep-water habitat in Alaskan waters to bottom trawling and monitor closures with vessel monitoring systems (VMS). In contrast, most areas of the high seas lack any management authority or mechanisms to protect sensitive habitats and species from bottom trawling.

About half of the world's seamounts are estimated to lie in international waters (Figure 2), and fishing in most areas of the high seas is completely unregulated. A moratorium on high-seas bottom trawling until effective management regimes can be put in place is the most effective means to protect seamounts and other vulnerable high seas habitats from trawling.

This temperate reef off North Carolina has hard corals and tropical fish. Coastal North Carolina.

CLAIM

Other human activities, including oil and mineral prospecting and pollution, have greater impact on marine environments than bottom trawling.





Geographic scope of the moratorium

CLAIM

The geographic scale of a world-wide high seas moratorium is out of proportion with the small number (100 to 200) of trawl vessels on the high seas, which can't be doing that much damage.

FACT

There has been a marked trend toward the development of deeper-water bottom trawl fisheries inside EEZs over the past two to three decades and a progressive movement by these fleets into the international waters of the Northeast Atlantic, Indian Ocean, and Southwestern Pacific, among other areas, as a result of the overfishing inside EEZs.⁷¹ As fisheries in domestic waters decline all over the world, exploitation of living resources on the high seas will certainly increase.⁷² To address the growing risk posed by deep-water trawl fleets on the high seas, there must be regulations in place to ensure that the destruction does not simply move further offshore. Furthermore, a moratorium on high-seas bottom trawling will increase pressure on states and vessels to fish sustainably in national waters, as they will no longer assume they can shift to the high seas once deep-sea fish stocks are overexploited and habitats destroyed by their actions at home.

CLAIM

Not all areas on the high seas have fragile and delicate bottom habitats requiring protection.

FACT

While the vast majority of the seabed located on the high seas consists of muddy abyssal plains, these areas are located at depths of 3-6 kilometers, well below the depths where there are significant concentrations of saleable fishes and where trawlers currently can fish. However, significant numbers of fishes concentrate on seamounts that rise to within 2 kilometers of the surface, and it is often in these rare and fragile locations that fish communities thrive and trawlers concentrate.⁷³ In such hotspots, species are extremely vulnerable, owing to their high endemism, specific habitat requirements, limited recruitment, and extreme longevity.⁷⁴

CLAIM

It would take millions of years for a fleet of 100 vessels to cause even the slightest damage on the 200 million square kilometers of the high seas.

FACT

This argument is hyperbole at its finest. The rock lobster on Vema Seamount and the pelagic armourhead in the Southeast Emperor-Northern Hawaiian Ridge system are just two examples of seamount stocks severely depleted by fishing within 10 years of the onset of their respective fisheries.⁷⁵ The fishing industry underplays its efficiency in driving deep-sea species into commercial extinction. Fishermen do not have to cover the entire ocean before marine species are decimated. In addition to fish, sessile epifauna such as deep-sea corals and sponges are also vulnerable to trawling impact. They are fragile, long-lived species with infrequent recruitment. They may be nearly exterminated by a single passage of a trawl and are unlikely to recover within the foreseeable future.⁷⁶ Of the 14,000 known seamounts in the world (Figure 2), approximately 1,800 are in international waters within 2 kilometers of the sea surface.⁷⁷ This is a very conservative estimate of the total number of seamounts, as other studies estimate as many as 100,000, and it has already been suggested that almost all shallow seamounts within the reach of current fishing techniques have been fished.⁷⁸ Furthermore, current estimates suggest that less than four percent of the high seas may consist of seamounts, ridges, and canyons, which offer special hard-bottom habitats for the richly diverse and extensive marine life than prevails on the more common abyssal plain.⁷⁹ It will not take long for the trawlers to destroy these rare habitats, if they are allowed.

CLAIM

It is not worthwhile to protect areas that are no longer pristine.

FACT

There is reason to believe that marine species that have not been driven to extinction are capable of recovering, and corals may be able to regenerate even in areas where they have been reduced to rubble. However, regeneration will not occur unless habitat areas can be left undisturbed by fishing gear for an extended period of time. Among slow-growing corals such as ivory tree corals, restoration efforts by conservation biologists have met with some success.⁸⁰ However, continued trawling would prevent the restoration of corals in their original habitat.

CLAIM

The moratorium on high-seas bottom trawling is too broad a remedy for the protection of deep-water ecosystems.



FACT

A blanket moratorium covering the high seas simplifies monitoring, control and enforcement. No state would be able to license its vessels to bottom trawl on the high seas, thus any vessel entering a port with bottom-trawl equipment onboard, or carrying fish that would normally be caught by bottom trawling, would have the burden of proof to show enforcement officials that they had not been bottom trawling on the high seas.

Knowledge of deep-sea communities – how they function, how species recruit, how they recover from disturbance – is only beginning to emerge.⁶¹ Wherever scientists have surveyed in the deep seas, they have found themselves outpaced by fishermen and benthic

structures already destroyed by fishing.⁶² A moratorium will allow the time needed for scientists to build a better understanding of the deep sea and for fishery managers to formulate policies and regulations based on this understanding in order to determine whether fishing on the high seas can be sustainable. It is a short-term measure which will provide much-needed protection for vulnerable marine ecosystems (including seamounts and cold-water coral reefs) until a scientifically and economically thorough assessment can be undertaken and an effective high seas management regime put into place. A moratorium, or “time-out,” would ensure that deep-sea fisheries do not follow the path of the world’s other fisheries towards serial depletion and collapse.

ENDNOTES

1. NRC (National Research Council) (2002). *Effects of trawling and dredging on seafloor habitat*. National Academy of Sciences, Washington DC.

2. For example, Auster, P.J. and R.W. Langton (1999). *The effects of fishing on fish habitat*. pp 150-187 in L.R. Benaka, ed. *Fish habitat: essential fish habitat and rehabilitation*. American Fisheries Society, Bethesda, Maryland (USA); Barnette, M.C. (1999). Gulf of Mexico fishing gear and their potential impacts on essential fish habitat. NMFS, NMFS-SEFSC-432, St Petersburg, FL; Berkeley et al (1985). *Bait shrimp fishery of Biscayne Bay*. Florida Sea Grant College Program Technical Paper No. 40; Bradstock, M. and D.P. Gordon (1983). Coral-like bryozoan growths in Tasman Bay, and their protection to conserve commercial fish stocks. *New Zealand Journal of Marine and Freshwater Research* 17: 159-163; Bridger, J.P. (1970). Some effects of the passage of a trawl over the seabed. Gear and Behavior Committee, ICES C.M.: 254-259; Collie et al (2000) Photographic evaluation of the impacts of bottom fishing in benthic epifauna. *ICES Journal of Marine Science* 57: 987-1001; de Groot, S.J. (1984). The impact of bottom trawling on benthic fauna of the North Sea. *Ocean Management* 9: 177-190; Engel, J. and R. Kvitek (1998). Effects of otter trawling on a benthic community in Monterey Bay National Marine Sanctuary. *Conservation Biology* 12: 1204-1214; Freese et al (1999). Effects of trawling on seafloor habitat and associated invertebrate taxa in the Gulf of Alaska. *Marine Ecology Progress Series* 182: 119-126; Guillen et al (1994). Anti-trawling reefs and the protection of Posidonia oceanica (L.) dille meadows in the western Mediterranean Sea: Demand and aims. *Bulletin of Marine Science* 55: 645-650; Jennings, S. and M.J. Kaiser (1998). The effects of fishing on marine ecosystems. pp 201-352 in Blaxter et al, eds. *Advances in Marine Biology*. Academic Press Limited, London; Jennings et al (2001). Impacts of trawling disturbance on the trophic structure of benthic invertebrate communities. *Marine Ecology Progress Series* 213: 127-142; Kaiser, M.J. and B.E. Spencer (1996). The effects of beam-trawl disturbance on infaunal communities in different habitats. *Journal of Animal Ecology* 65: 348-358; Kaiser et al (2000). Chronic fishing disturbance has changed shelf sea benthic community structure. *Journal of Animal Ecology* 69: 494-503; Kenchington et al (2001). Effects of experimental otter trawling on the macrofauna of a sandy bottom ecosystem on the Grand Banks of Newfoundland. *Canadian Journal of Fisheries and Aquatic Sciences* 58: 1043-1057; Meyer et al (1999). Effects of live-bait shrimp trawling on seagrass beds and fish bycatch in Tampa Bay, Florida. *Fishery Bulletin* 97: 193-199; Moore, D.R. and H.R. Bullis (1960). A deep-water coral reef in the Gulf of Mexico. *Bulletin of Marine Science of the Gulf and Caribbean* 10: 125-128;

Sainsbury, K.J. and R.A. Campbell (1997). Experimental management of an Australian multispecies fishery: Examining the possibility of trawl induced habitat modifications. pp 107-112 in Pikitch et al, eds. *Global Trends: Fisheries Management*. American Fisheries Society, Bethesda, MD; Schwinghamer et al (1998). Effects of experimental otter trawling on surficial sediment properties of a sandy-bottom ecosystem on the Grand Banks of Newfoundland. *Conservation Biology* 12: 1215-1222; Smith, E.M. and L.L. Stewart (1985). *A study of lobster fisheries in the Connecticut waters of Long Island Sound with special reference to the effects of trawling on lobsters*. Connecticut Department of Environmental Protection Marine Fisheries Program, University of Connecticut, Hartford, CT; Thrush et al (1998). Disturbance of the marine benthic habitat by commercial fishing: Impacts at the scale of the fishery. *Ecological Applications* 8: 866-879; Tilmant, J. (1979). *Observations on the impact of shrimp roller frame trawls operated over hard bottom communities, Biscayne Bay, Florida*. National Park Service, Biscayne National Monument, Series No. P-553, Homestead; Tuck et al (1998). Effects of physical trawling disturbance in a previously unfished sheltered Scottish sea loch. *Marine Ecology Progress Series* 162: 227-242; Van Dolah et al (1987). Effects of a research trawl on a hard bottom assemblage of sponges and corals. *Fisheries Research* 5: 39-54; Watling, L. and E.A. Norse (1998). Disturbance of the seabed by mobile fishing gear: a comparison with forest clear-cutting. *Conservation Biology* 12: 1189-1197.

3. Clark, M. and R. O'Driscoll (2003). Deepwater fisheries and aspects of their impact on seamount habitat in New Zealand. *Journal of Northwest Atlantic Fisheries Science* 31: 441-458; DeAlteris et al (1999). The significance of seabed disturbance by mobile fishing gear relative to natural processes: A case study in Naragansett Bay, Rhode Island. *American Fisheries Society Symposium* 22: 224-237; Friedlander et al (1999). Sidescan-sonar mapping of benthic trawl marks on the shelf and slope off Eureka, California. *Fishery Bulletin* 97: 786-801; Koslow et al (2001). Seamount benthic macrofauna off southern Tasmania: community structure and impacts of trawling. *Marine Ecology Progress Series* 213: 111-125; Main, J. and G. Sangster (1981). *A Study of a multi-level bottom trawl for species separation using direct observation techniques*. Marine laboratory Aberdeen, Aberdeen; photograph by Auster on p. 28 of Dayton et al (2002). *Ecological Effects of Fishing in Marine Ecosystems of the United States*. Pew Oceans Commission, Arlington, VA; photos by Krautter, Sainsbury, Gilmore, and Horn on the MCBI Website: www.mcbi.org/DSC_statements/coral_images.html

4. Auster et al (1995). Management implications of mobile fishing gear alterations to benthic habitats in the Gulf of Maine:

science program summary. NOAA's National Undersea Research Center, Groton, CT; Auster, P.J. (1998). A conceptual model of the impacts of fishing gear on the integrity of fish habitats. *Conservation Biology* 12: 1198-1202; Langton et al (1995). A spatial and temporal perspective on research and management of groundfish in the Northwest Atlantic. *Reviews in Fisheries Science* 3(3): 201-229; Stein et al (1992). Fish-habitat associations on a deep reef at the edge of the Oregon continental shelf. *Fishery Bulletin* 90: 540-551; Tupper, M. and R.G. Boutilier (1995). Effects of habitat on settlement, growth, and postsettlement survival of Atlantic cod (*Gadus morhua*). *Canadian Journal of Fisheries and Aquatic Sciences* 52: 1834-1841; Yoklavich et al (2000). Habitat associations of deep-water rockfishes in a submarine canyon: an example of a natural refuge. *Fishery Bulletin* 98: 625-641.

5. Auster et al (1996). The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. *Reviews in Fisheries Science* 4: 185-202; Koenig et al (2000). Protection of fish spawning habitat for the conservation of warm-temperate reef-fish fisheries of shelf-edge reefs of Florida. *Bulletin of Marine Science* 66: 593-616; Koslow et al 2001, see note 3.

6. Jennings et al 2001, see note 2; Kenchington et al 2001, see note 2; Koslow et al 2001, see note 3.

7. Sainsbury, K.J. (1988). The ecological basis of multispecies fisheries and management of a demersal fishery in tropical Australia. pp 349-382 in J.A. Gulland, ed. *Fish Population Dynamics*. John Wiley & Sons, Ltd.

8. Auster and Langton 1999, see note 2; Mayer et al (1991). Effects of commercial dragging on sedimentary organic matter. *Marine Environmental Research* 31: 249-261; NRC 2002, see note 1.

9. Freiwald et al (2004). Cold water coral reefs: *Out of sight – No longer out of mind*. UNEP World Conservation Monitoring Center, Cambridge, UK; Hall-Spencer et al (2002). Trawling damage to Northeast Atlantic ancient coral reefs. *Proceedings of the Royal Society of London, Series B: Biological Sciences* 269:507-511; Jones, J. (1992). Environmental impact of trawling on the seabed: a review. *New Zealand Journal of Marine and Freshwater Research* 26: 59-67; Koslow et al 2001, see note 3. Druffel, E.R.M., S. Griffin, A. Witter, E. Nelsen, J. Southon, M. Kashgarian, and J. Vogel. 1995. *Gerardia*: Bristlecone pine of the deep-sea? *Geochimica et Cosmochimica Acta*, 59 (23): 5031-5036.

10. Freiwald et al 2004, see note 9.

11. Koslow et al 2001, see note 3.

12. Collie et al 2000, see note 2; Clark and O'Driscoll 2003, see note 3; Dayton et al 2002, see note 3; Koslow et al 2001, see note 3; MCBI website; Roberts, S. and M. Hirshfield (2004).

- Deep-sea corals: out of sight, but no longer out of mind. *Frontiers in Ecology and the Environment* 2: 123-130.
13. Underwater Habitat Footage, Alaska Fisheries Science Center: http://www.afsc.noaa.gov/race/media/videos/vids_habitat.htm
14. Chuenpagdee et al (2003). Shifting Gears: Assessing collateral impacts of fishing methods in US waters. *Frontiers in Ecology and the Environment* 1: 517-524; Morgan, L.E. and R. Chuenpagdee (2003). *Shifting Gears: Addressing the Collateral Impacts of Fishing Methods in U.S. Waters*. Island Press, Washington, DC.
15. ICES (2002) Report of the ICES Advisory Committee on Ecosystems, 2002. ICES Cooperative Research Report No. 254. International Council for the Exploration of the Sea, December 2002. pgs 28-33.
16. Collie et al (1997). Effects of bottom fishing on the benthic megafauna of Georges Bank. *Marine Ecology Progress Series* 35: 159-172; Jennings et al 2001, see note 2; Kaiser et al 2000, see note 2; Pauly et al (1998). Fishing down marine food webs. *Science* 279: 860-863.
17. Jamir, T.V.C. (1999). *Revisions to the estimates of incidental sea turtle capture aboard commercial shrimp trawling vessels*. Gulf and South Atlantic Fisheries Foundation, Inc, Tampa; Kelleher, K. (2004). *Discards in the world's marine fisheries: An update*. FAO Fisheries Technical Paper No. 470; Morgan and Chuenpagdee 2003, see note 14.
18. Berkeley et al (2004). Maternal age as a determinant of larval growth and survival in a marine fish, *Sebastes melanops*. *Ecology* 85: 1258-1264, and references therein
19. see Larkin, P. (1977). An epitaph for the concept of maximum sustained yield. *Transactions of the American Fisheries Society* 106: 1-11.
20. e.g., the UN Food and Agriculture Organization; see FAO (2004). *The state of the world fisheries and aquaculture 2004*. United Nations Food and Agriculture Organization, Rome.
21. e.g., Pew Oceans Commission (2003). *America's Living Oceans: Charting a Course for Sea Change*. A Report to the Nation. Pew Oceans Commission, Arlington, Virginia; UK Royal Commission on Environmental Pollution (2004). *Turning the Tide: Addressing the Impact of Fisheries on the Marine Environment*. Royal Commission on Environmental Pollution, London; US Commission on Ocean Policy (2004). *An Ocean Blueprint for the 21st Century- Final Report of the U.S. Commission on Ocean Policy*. US Commission on Ocean Policy, Washington, DC.
22. NRC 2002, see note 1.
23. Livingston, M. and K. Rutherford (1988). Hoki wastes on west coast fishing grounds. *Catch* 15: 16-17.
24. Rogers, A.D. (1999). The biology of *Lophelia pertusa* (LINNAEUS 1758) and other deep-water reef-forming corals and impacts from human activities. *International Review of Hydrobiology* 84: 315-406.
25. Watling and Norse 1998, see note 2.
26. Clark, M. (1999). Fisheries for orange roughy (*Hoplostethus atlanticus*) on seamounts in New Zealand. *Oceanologica Acta* 22: 593-602.
27. Jennings et al 2001, see note 2.
28. Parin, N.V. et al (1997). Biology of the Nazca and Sala y Gomez submarine ridges, and outpost of the Indo-West Pacific fauna in the Eastern Pacific Ocean: Composition and distribution of the fauna, its communities and history. *Advances in Marine Biology* 32:145-242, cited in Stone et al (2004). Seamount biodiversity, exploitation and conservation. pp. 41-70 in L.K. Glover and S.A. Earle, eds. *Defying Ocean's End: An Agenda for Action*. Island Press, Washington, DC. Please see also other references cited on p.50 of Stone et al 2004.
29. Merrett, N. and R. Haedrich (1997). *Deep-Sea Demersal Fish and Fisheries*. Chapman and Hall, London.
30. Stone et al 2004, see note 28.
31. Pauly et al (2003). The future for fisheries. *Science* 302: 1359-1361.
32. Kelleher 2004, see note 17.
33. Tjedmers, P. (2004). Fisheries and Energy Use. In C. Cleveland, ed. *The Encyclopedia of Energy*. Academic Press/Elsevier Science.
34. *ibid*.
35. FAO (2004, see note 20) reported that 52 percent of major fish stocks have reached their maximum sustainable limits; 25 percent are overexploited, significantly depleted or only recovering; and the percentage of underexploited and moderately exploited fisheries resources has declined.
36. Christensen et al (2003). Hundred-year decline of North Atlantic predatory fishes. *Fish and Fisheries* 4: 1-24; Hutchings, J.A. and J.D. Reynolds (2004). Marine fish population collapses: Consequences for recovery and extinction risk. *Bioscience* 54: 297-309; Myers, R.A. and B. Worm (2003). Rapid worldwide depletion of predatory fish community. *Nature* 423: 280-283.
37. FAO 2004, see note 20.
38. Grassle, J.F. and N.J. Maciolek (1992). Deep-sea species richness – regional and local diversity estimates from quantitative bottom samples. *American Naturalist* 139: 313-341.
39. Stone et al 2004, see note 28.
40. Auster et al 1996, see note 5.
41. Wessel, P. (2001). Global distribution of seamounts inferred from gridded Geosat/ERS-1 altimetry. *Journal of Geophysical Research* 106(B9):19431-19441, this study suggests that the total number of seamounts in the world is on the order of 100,000; Kitchingman, A. and S. Lai (2004). Inferences on potential seamount locations from mid-resolution bathymetric data. pp. 7-12 in T. Morato and D. Pauly eds. *Seamounts: Biodiversity and Fisheries*. Fisheries Centre, University of British Columbia, Vancouver, Canada; Freiwald, A. (2003). Reef-forming cold-water corals. pp.365-385 in Wefer et al eds. *Ocean Margin Systems*. Springer-Verlag, Berlin, this study states that bottom trawling can operate at a depth of 2,000 m.
42. Stone et al 2004 (see note 28), this study uses 1,400 m as the maximum depth of fishing.
43. Glover, A.G. and C.R. Smith (2003). The deep-sea floor ecosystem: current status and prospects of anthropogenic change by the year 2025. *Environmental Conservation* 30: 219-241; Pauly et al 2003, see note 31; Roberts, C.M. (2002). Deep impact: the rising toll of fishing in the deep sea. *Trends In Ecology & Evolution* 17: 242-245.
44. Interfax (2004). Russia plans 33 percent hike in high seas fisheries by 2010. December 20, Seafood.com News, Moscow
45. Pauly et al 2003, see note 31.
46. Roberts 2002, see note 43.
47. Koslow et al 2001, see note 3.
48. Clark, M. and R. O'Driscoll 2003, see note 3; Gianni, M. (2004). *High-seas bottom fisheries and their impact on the biodiversity of vulnerable deep-seas ecosystems: options for international action*. IUCN.
49. FAO (2002). *The state of the world fisheries and aquaculture 2002*. United Nations Food and Agriculture Organization, Rome.
50. NMFS (National Marine Fisheries Service) (2004). *Final programmatic supplemental environmental impact statement for Alaska groundfish fisheries*. U.S. Department of Commerce, NOAA, NMFS, Alaska Region, Juneau, Alaska.
51. Anderson, O.F. and M.R. Clark (2003). Analysis of bycatch in the fishery for orange roughy, *Hoplostethus atlanticus*, on the South Tasman Rise. *Marine and Freshwater Research* 54: 643-652.
52. Merrett and Haedrich 1997, see note 29.
53. Koslow et al (2000). Continental slope and deep-sea fisheries: implications for a fragile ecosystem. *ICES Journal of Marine Science* 57: 548-557.
54. Clark and O'Driscoll 2003, see note 3; De Vogelaere et al (in press). *Deep-sea corals and resource protection at the Davidson Seamount, California, U.S.A.*; Genin et al (1986). Corals on seamount peaks provide evidence of current acceleration over deep-sea topography. *Nature* 322: 59-61.
55. Clark and O'Driscoll 2003, see note 3.
56. *ibid*.
57. Anderson and Clark 2003, see note 51; Clark, M. (2001). Are deepwater fisheries sustainable? - the example of orange roughy (*Hoplostethus atlanticus*) in New Zealand. *Fisheries Research* 51: 123-135; Koslow et al 2001, see note 3; Probert et al (1997). Benthic invertebrate bycatch from a deep-water trawl fishery, Chatham Rise, New Zealand. *Aquatic Conservation: Marine and Freshwater Ecosystems* 7: 27-40.
58. Anderson and Clark 2003, see note 51.
59. FAO (2002). *Predictive modeling of demersal fish distribution in the southern Indian and Southern Oceans, UN FAO Report of the Second Ad Hoc Meeting on Management of Deepwater Fisheries Resources of the Southern Indian Ocean – Fremantle, Western Australia, 20-22 May 2002*. UN FAO, Bureau of Rural Sciences Australia, FAO Fisheries Report No 677, Rome; Grehan et al (in press). Fishing impacts on Irish deepwater coral reefs. *American Fisheries Society Symposium* 41.
60. Clark and O'Driscoll 2003, see note 3.
61. *ibid*.
62. Clark and O'Driscoll 2003, see note 3 ; Koslow et al 2001, see note 3.
63. Watling and Norse 1998, see note 2.
64. Glover and Smith 2003, see note 43.
65. Collie et al (2000). A quantitative analysis of fishing impacts on shelf-sea benthos. *Journal of Animal Ecology* 69: 785-798; Dayton et al 2002, see note 3; Lake, P.S. (1990). Disturbing hard and soft bottom communities: A comparison of marine and freshwater environments. *Ecology* 15: 477-489; NRC 2002, see note 1.
66. Freiwald et al 2004, see note 9; Glover and Smith 2003, see note 43; Jackson et al (2001). Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293: 629-638; Myers and Worm 2003, see note 36; Pauly et al (2002). Towards sustainability in world fisheries. *Nature* 418: 689-695.
67. Freiwald et al 2004, see note 9.
68. *ibid*.
69. Koenig et al in press, cited in Roberts and Hirshfield 2004, see note 12.
70. Fosså, J.H. and P.B. Mortensen (2000). The deep-water coral *Lophelia pertusa* in Norwegian waters: distribution and fishery impacts. *Hydrobiologia* 417: 1-12.
71. Pauly et al 2003, see note 31; Roberts et al 2002, see note 43.
72. Glover and Smith 2003, see note 43.
73. *ibid*.
74. Clark, M. and R. O'Driscoll 2003, see note 3; Koslow et al 2000, see note 53; Probert et al 1997, see note 57; de Forges et al (2000). Diversity and endemism of the benthic seamount fauna in the southwest Pacific. *Nature* 405: 944-947; Rogers, A.D. (2004). *The Biology, Ecology and Vulnerability of Seamount Communities*. IUCN, Cambridge.
75. Rogers, A. (1994). The biology of seamounts. *Advances in Marine Biology* 30: 305-350.
76. Probert et al 1997, see note 57.
77. Kitchingman and Lai 2004, see note 41; 2 km is the maximum depth of bottom trawl operations, states Freiwald 2003, see note 41.
78. Stone et al 2004, see note 28; Wessel 2001, see note 41.
79. Glover and Smith 2003, see note 43.
80. Koenig, C.C. (2001) *Oculina Banks: Habitat, fish populations, restoration, and enforcement*. Report to the South Atlantic Fishery Management Council 24 pp. <http://www.uncwil.edu/oculina/koenig.pdf>
81. Clark and O'Driscoll 2003, see note 3; Glover and Smith 2003, see note 43; Koslow et al 2000, see note 53; de Forges 2000, see note 74.
82. FAO 2004, see note 20; Freiwald et al 2004, see note 9 and references therein.



Figure 1. Before and after bottom trawling

Tony Koslow



Seamount benthic community (untrawled), Tasmania, Australia.



Tony Koslow

Former seamount benthic community (trawled), Tasmania, Australia.

R. Grant Gilmore



Deep-sea *Oculina* coral reef (untrawled), Florida.



Christopher Koenig

Former deep-sea *Oculina* coral reef (trawled), Florida.

Figure 1 (cont'd)



Keith Sainsbury

Coral-sponge community (untrawled), NW Australia.



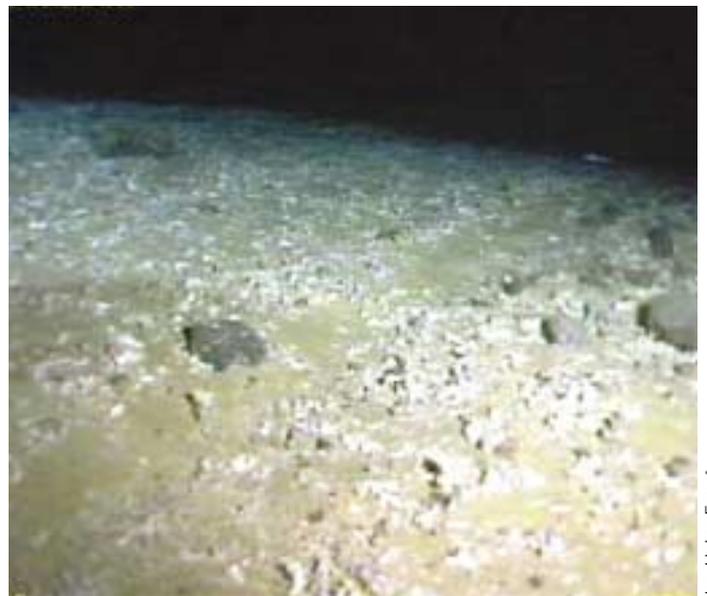
Keith Sainsbury

Former coral-sponge community (trawled), NW Australia.



Jan Helge Fosså

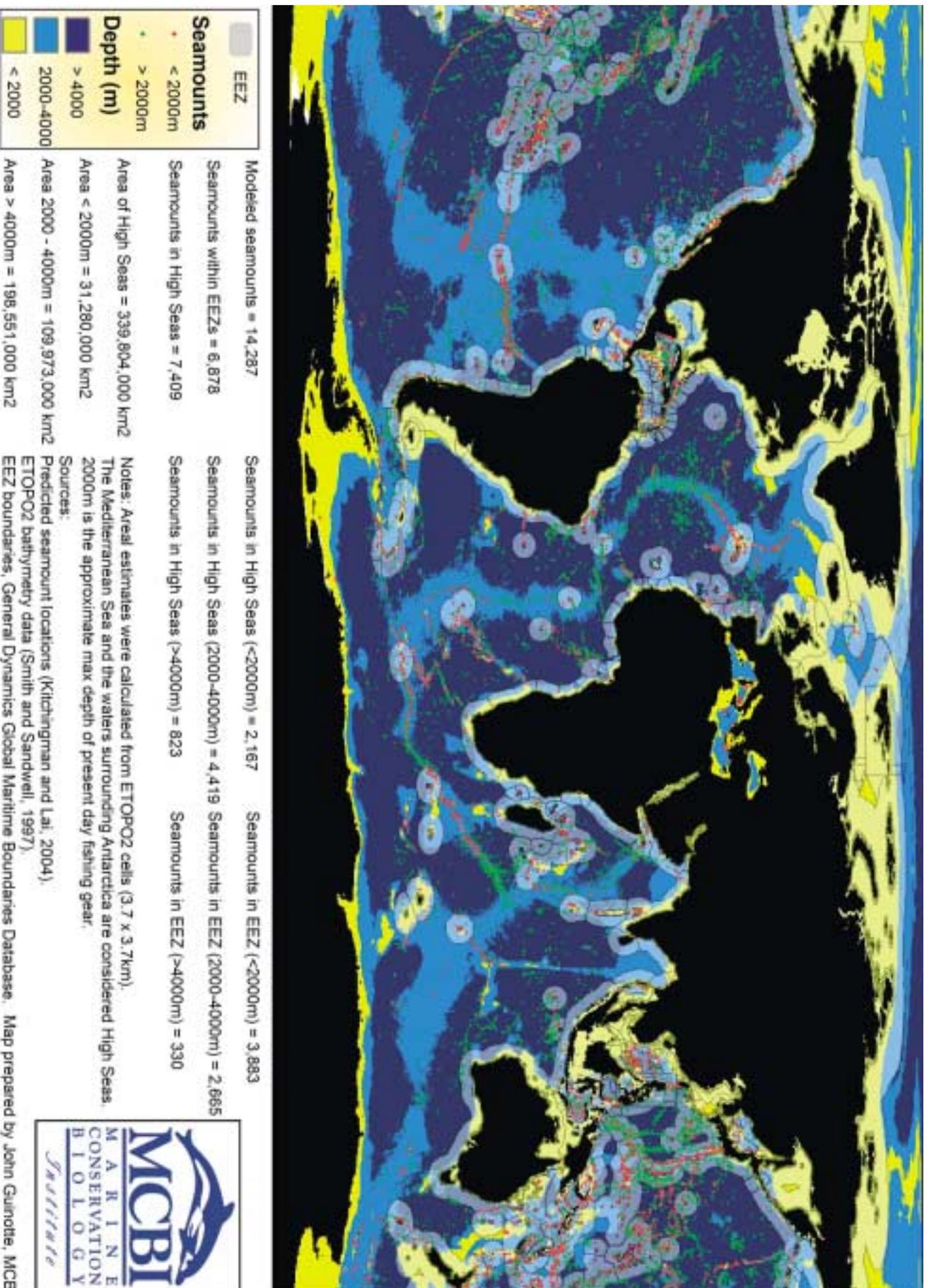
Deep-sea *Lophelia* coral reef (untrawled), Norway.



Jan Helge Fosså

Former deep-sea *Lophelia* coral reef (trawled), Norway.

Figure 2. Global seamount distribution



DSCC for a moratorium before it's too late

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The Deep Sea Conservation Coalition, an alliance of over 40 international organizations, representing millions of people in countries around the world, is calling for a moratorium on high seas bottom trawling.

For further information about the Coalition visit:
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