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Encounter Protocols for Avoidance of Harm to Vulnerable Marine Ecosystems: A global review of experience to 2010

Protocoles en cas de rencontre visant à éviter les dommages aux écosystèmes marins vulnérables : examen global des expériences jusqu'en 2010

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ABSTRACT

United Nations General Assembly (UNGA) Resolution 61/105, of 2006, called for Regional Fishery Management Organizations to develop protocols requiring fishing vessels to move away after encounters with Vulnerable Marine Ecosystems (VMEs) in the high seas. A global review of responses to that demand, through to the end of 2010, is presented. Throughout the Atlantic, Indian and North Pacific oceans, the principal protocols are variants of one originally adopted by the Northwest Atlantic Fisheries Organization (NAFO) in 2008. Quite different protocols have been developed by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), for longliners fishing in the Southern Ocean, and by New Zealand, for its trawlers when fishing in the South Pacific. None of these protocols are intended as stand-alone measures to protect VMEs. Rather, they are “back stops” to long-term closures. To date, each protocol has been adopted only as an interim measure, pending further development. None can be said to be efficient or even effective. Indeed, each may prove to be counter-productive, causing increased harm to VME by displacing fishing effort away from long-impacted areas. None are rigorously science-based but all can be regarded as pragmatic responses to the UNGA Resolution.

Suggestions are offered for the development of more effective encounter protocols, though those would have to be specific to particular fisheries. They would demand considerable research and still would not offer full protection to VMEs – which protection requires avoidance of encounters, not a response to them.

RÉSUMÉ

La résolution 61/105 de l'Assemblée générale des Nations Unies (AGNU), datant de 2006, exigeait l'adoption par les organisations régionales de gestion des pêches de protocoles enjoignant les engins de pêche commerciale à s'éloigner des écosystèmes maritimes vulnérables (EMV) rencontrés en haute mer. La présente contient un résumé global des réponses à cette exigence jusqu'à la fin de 2010. Dans les océans Atlantique, Indien et Pacifique Nord, les principaux protocoles sont des variantes d'un protocole adopté par l'Organisation des pêches de l'Atlantique Nord-Ouest (OPANO) en 2008. La Commission pour la conservation de la faune et de la flore marines de l'Antarctique (CCFFMA) a élaboré des protocoles assez différents destinés aux palangriers qui pêchent dans l'océan Austral. La Nouvelle-Zélande a fait de même pour ses chalutiers qui pêchent dans le sud du Pacifique. Aucun de ces protocoles n'a été mis en place exclusivement en vue de protéger les EMV. Ils constituent plutôt des lignes de défense contre des fermetures à long terme. Jusqu'à présent, chaque protocole a été adopté uniquement comme une mesure provisoire, en attendant les faits nouveaux. Aucun ne peut être qualifié d'efficace, ni même d'efficient. De fait, ils pourraient même s'avérer contre-productifs, ce qui pourrait provoquer l'augmentation des risques pour les EMV en raison du déplacement des activités de pêche loin des zones touchées depuis longtemps. Aucun de ces protocoles ne se fonde rigoureusement sur la science, mais on peut tous les considérer comme des réponses pragmatiques à la résolution adoptée par l'Assemblée générale des Nations Unies.

Des suggestions sont proposées pour l'élaboration de protocoles de rencontre plus efficaces. Bien que ces protocoles devraient viser plus précisément des pêches particulières, ils exigeraient des recherches considérables sans pour autant offrir une protection complète des EMV, laquelle protection nécessiterait une absence de contact et non une intervention faisant suite à un contact.

LIST OF ACRONYMS USED IN THIS REPORT

AFMA:	Australian Fisheries Management Authority
CCAMLR:	Commission for the Conservation of Antarctic Living Marine Resources
CFA:	Crab Fishing Area
DFO:	Department of Fisheries & Oceans, Government of Canada
DSF:	Deep Sea Fishery, as defined in Paragraph 8 of the 2009 FAO *International Guidelines for the Management of Deep-sea Fisheries in the High Seas*
EEZ:	Exclusive Economic Zone, here treated as inclusive of territorial and internal waters, as well as of any contiguous zone
FAO:	Food & Agriculture Organization of the United Nations
ICA:	Salmon Bycatch Intercooperative Agreement – a foundation for application of the VRHS in the Bering sea pollock fishery
ICES:	International Council for the Exploration of the Sea
IPA:	Incentive Plan Agreement – a new form of foundation for cooperative measures to minimize bycatches in the Bering sea pollock fishery
NAFO:	Northwest Atlantic Fisheries Organization
NEAFC:	North East Atlantic Fisheries Commission
PECMAS:	NEAFC Permanent Committee on Management and Science
RFMO/A:	Regional Fisheries Management Organization or Arrangement
SEAFO:	South East Atlantic Fisheries Organisation
SIOFA:	South Indian Ocean Fisheries Agreement
SPRFMO:	South Pacific RFMO – an on-going process to form an RFMO rather than an existing organization
UNGA:	United Nations General Assembly
VME:	Vulnerable Marine Ecosystem
VMS:	Vessel Monitoring System – typically a satellite-based system for monitoring the positions of vessels
VRHS:	Voluntary Rolling Hotspot System – a form of encounter protocol used in U.S. management of the Bering Sea pollock fishery
WGDEC:	ICES NAFO Working Group on Deep-water Ecology
WGDEEP:	ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources
WGFMS:	NAFO Working Group of Fishery Managers and Scientists on Vulnerable Marine Ecosystems

INTRODUCTION

In December 2006, the United Nations General Assembly (UNGA) adopted its Resolution 61/105 which, in Paragraphs 76 to 95, called on States and regional fisheries management organizations or arrangements (RFMO/As) to take steps to protect vulnerable marine ecosystems (VME) in the high seas from significant adverse impacts of fisheries. On its face, the Resolution merely called for reasonable measures needed to protect some exceptional ecosystems from severe harm but it paid scant heed to existing capabilities of either marine science or fisheries management. The resulting challenges posed to RFMO/As that regulate bottom fishing and to their member States were substantially increased by the deadlines for compliance set by the Resolution: 31 December 2008 in regions where an RFMO/A already existed but a year earlier where negotiations to establish an RFMO/A were merely under way.

When the provisions concerning VMEs in Resolution 61/105 were adopted, much of their meaning was unclear and the steps necessary to meet their requirements were unknown; even the operational meanings of such terms as "VME" and "significant adverse impact" were in considerable doubt. The Food & Agriculture Organization (FAO) coordinated two Expert Consultations (November 2006 and September 2007), three Workshops (June and November 2007, and May 2008), and two sessions of a Technical Consultation (February and August 2008) before its *International Guidelines for the Management of Deep-sea Fisheries in the High Seas* were adopted in August 2008. Those *Guidelines* were not formally published until June 2009[1]. In the meanwhile, the RFMO/As and their member States necessarily adopted interim measures to meet the deadlines of the UNGA – measures that were, inevitably, less than ideal if not actually unsatisfactory. Whether through formal commitments to review processes or otherwise, those interim arrangements have been, and will continue to be, reconsidered and revised. The UNGA itself reviewed progress in the implementation of its Resolution 61/105 during its 64th session, with input in the form of a Report of the Secretary General[2]. The conclusions of the UNGA can be found in paragraphs 112 to 130 of its Resolution 64/72 of March 2010.

UNGA Resolution 61/105 was wide-ranging and even its paragraphs 76 to 95 contained much concerning the protection of VMEs in sea areas beyond national jurisdiction. Among that direction was paragraph 83(d):

> To require members of the regional fisheries management organizations or arrangements to require vessels flying their flag to cease bottom fishing activities in areas where, in the course of fishing operations, vulnerable marine ecosystems are encountered, and to report the encounter so that appropriate measures can be adopted in respect of the relevant site.

The FAO *Guidelines* provided little amplification of that requirement but did recommend that paragraph 83(d) be addressed through formal encounter protocols, incorporating reporting

In the present document, footnotes are used for citations of the many management documents referenced, while scientific publications are given conventional citations.

[1] *International Guidelines for the Management of Deep-sea Fisheries in the High Seas*. Rome, FAO, 2009: 73 p.

[2] *Actions taken by States and regional fisheries management organizations and arrangements to give effect to paragraphs 83 to 90 of General Assembly resolution 61/105 on sustainable fisheries, including through the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and related instruments*, Report of the Secretary General to the UNGA A/64/305 [hereafter: "Report of the Secretary General A/64/305"].

requirements and review of management measures, as well as cessation of fishing in the vicinity of an encounter:

> 67. States and RFMO/As should have an appropriate protocol identified in advance for how fishing vessels in DSFs[3] should respond to encounters in the course of fishing operations with a VME, including defining what constitutes evidence of an encounter. Such protocol should ensure that States require vessels flying their flag to cease DSFs fishing activities at the site and report the encounter, including the location and any available information on the type of ecosystem encountered, to the relevant RFMO/A and flag State.
>
> 68. In designing such protocols and defining what constitutes an encounter, States and RFMO/As should take into account best available information from detailed seabed surveys and mapping, other relevant information available for the site or area, and other conservation and management measures that have been adopted to protect VMEs pursuant to paragraphs 70 and 71[4].
>
> 69. States and RFMO/As should, in light of reports (as referred to in paragraph 67), and in accordance with developed protocols and paragraphs 42 to 53[5], adopt or modify management measures, appropriate for the DSF concerned, in regard to the relevant site or area to prevent significant adverse impacts on the VME.

UNGA Resolution 64/72 said little of this encounter issue but did call upon RFMO/as and States to:

> 119(c). Establish and implement appropriate protocols for the implementation of paragraph 83 (d) of resolution 61/105, including definitions of what constitutes evidence of an encounter with a vulnerable marine ecosystem, in particular threshold levels and indicator species, based on best available scientific information and consistent with the Guidelines, and taking into account any other conservation and management measures to prevent significant adverse impacts on vulnerable marine ecosystems, including those based on the results of assessments carried out pursuant to paragraph 83 (a) of resolution 61/105 and paragraph 119 (a) of the resent resolution.

Those various requirements and recommendations have led to the adoption of "encounter protocols" or "move-on rules" amongst the other interim measures adopted by RFMO/As and flag States to address the protection of VMEs – protocols that are now the subject of review, refinement, or replacement. As an aid to Fisheries & Oceans Canada (DFO) in developing science-based protocols for encounters with coldwater corals and sponges, the current document presents a global examination of relevant protocols, as implemented through to the end of 2010, excepting only developments under the Northwest Atlantic Fisheries Organization (NAFO), which were excluded from the terms of reference of this study. For convenience, the

[3] "DSFs" is an FAO acronym for "Deep Sea Fisheries", defined in the *Guidelines* as fisheries that occur in areas beyond national jurisdiction, using gear that is likely to contact the seabed during normal operations and in which the total catch includes species that can only sustain low exploitation rates.
[4] Paragraphs 70 and 71 of the *Guidelines* deal with management measures other than encounter protocols.
[5] Paragraphs 42 to 53 of the *Guidelines* deal with identification of VMEs and assessments of fishery impacts on them.

survey of VME encounter protocols commences in the North Atlantic, proceeding southwards to the Southern Ocean, then east across the Indian Ocean to the South Pacific, before ending with the North Pacific Ocean. It is preceded by a brief examination of encounter protocols designed for other aspects of fisheries management, as an introduction to the approach.

Preparation of this review was greatly facilitated by the work of Gianni (2009) and Rogers & Gianni (2010), as well as by the 2010 report of the United Nations Secretary General. Their surveys of global responses to Resolution 61/105 were at once broader ranging and less detailed than the current document but nevertheless served to identify RFMO/As and States that have developed encounter protocols to address impacts on VMEs. No relevant protocols that were not mentioned in those earlier reviews have been uncovered during preparation of the current summary.

ENCOUNTER PROTOCOLS IN FISHERIES MANAGEMENT

Encounter protocols are a relatively new addition to the "toolbox" of fisheries management but they have been in use for about twenty years and some experience in their application has been gathered. They were perhaps first implemented to aid in minimizing wastage of non-marketable individuals of target species, without the inefficiencies of regulated closures – which of necessity are larger and longer-lasting than any ephemeral concentrations of, for example, small fish on the commercial fishing grounds. Other uses have emerged in minimising bycatch of finfish and avoidance of protected species. In each case, there has been an expectation that the problem of excessive catch of unwanted animals is limited in space and time, hence that it is best addressed through small-scale, real-time adjustments in fishing locations, without requiring substantial case-specific action by a management agency.

Such a protocol is likely to be better implemented in fisheries that have either smaller fleets (in terms of the numbers of participating vessels or the numbers of individual enterprises) and hence better prospects for cooperation, individually larger and more profitable vessels (allowing intensive observer coverage and monitoring of fishing activity with vessel monitoring systems), past histories and present management approaches that foster stewardship among the tactical decision-makers (be they vessel captains, shore-side fleet managers or others), effective incentives promoting conservation (such as annual closures when a bycatch quota is taken) or else some combination of those. Circumstances differ among fisheries but one or more of those factors are likely needed for the successful application of an encounter protocol. Where they do exist, this form of self-management at a tactical level can operate successfully.

Some examples of the approach, which illustrate the breadth of its application outside the VME context, include:

- Beginning around 1990, soft-shell protocols were introduced to the snow crab fisheries of Atlantic Canada. They have evolved through the past two decades and today differ among the management plans for fisheries in the various Crab Fishing Areas (CFAs). However, as they are currently implemented, DFO provides timely reports to the industry of the percentage of soft-shell crab in commercial catches in each portion of a CFA based on observer reports, with observer coverage sometimes being as high as 30%. In some CFAs, voluntary closures are introduced in specific areas as local problems emerge. CFA 19, for example, bases such closures on a defined 5-mile grid (85.75 km^2 per grid cell), while CFAs 23 and 24 use circular closures of 1.5 mile radius (24.24 km^2 area) around positions identified by the Department. The voluntary measures are backed

by mandatory ones: In 2005, the protocol for CFAs 12, 18, 25 and 26 called for closures on a 10-mile grid (343 km^2 per grid cell) when the incidence of soft-shell crab exceeded 20% for 14 consecutive days, the closures being in effect for the remainder of the fishing season. In CFA 19, such a closure is introduced, by variation order, if a sector's catch exceeds 20% soft-shell over a 10-day period. The operation of these protocols is aided by strong industry organizations which provide communication through the fleet and encourage compliance[6].

- Small-fish protocols were introduced to the Gulf of Saint Lawrence groundfish fisheries in the early 1990s and spread to the then-Scotia-Fundy Region in 1993, when a "land-everything" rule replaced the former minimum-size limits in the groundfish fisheries. As the system now exists in Maritimes Region, areas are closed to a particular fleet sector when the proportion of small fish equals or exceeds 15% of the catch of the species in question or when the established limit (varying by fisheries and species) for an incidental catch is breached. An area so closed remains off-limits for at least ten days but can then be re-opened following an industry-funded test fishery, with the regional observer program gathering and analyzing the data to determine whether the proportion of small fish or that of incidental catch has returned to within acceptable limits (Shotton and Patchell 2008).
- In 1995, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) introduced a 5-mile "move-on" rule for bycatch (all non-target species combined) of more than 5% in the fishery for the myctophid fish *Electrona carlsbergi*. The vessel which took a higher bycatch was excluded from the resulting 269 km^2 circle for five days. A very similar rule was introduced for the Patagonian toothfish and Antarctic icefish fisheries later the same year, though in those cases the 5% limit applied only to specified bycatch species. The use of similar rules has since spread within CCAMLR's management of the fisheries of the Southern Ocean, though the 5-mile distance and 5-day duration continue to be invoked, with an explicit statement that they are used pending adoption of more appropriate limits (Shotton and Patchell 2008).
- The companies using catcher-processor vessels in the United States' Pacific hake fishery formed the *Pacific Whiting Conservation Cooperative* in 1997. The vessels exchange information through their Cooperative, allowing them to avoid bycatch "hotspots", as part of a wider suite of efforts to minimize catches of salmon and rockfish[7].
- In 2001, the New Zealand Hoki Fishery Company adopted a voluntary 3-mile "move-on rule" for trawlers which encountered small fish. The rule lapsed after a few years but there was a new industry agreement in 2005 (in the face of a major reduction in allowable catch) which required vessels to move 5 miles if more than 10% (in numbers) of a catch of hoki were under 60 cm in length. For the next 5 days, the vessel in question was not to tow within 5 miles of any part of the tow line which took the small fish, nor within 100 m of the depth of any part of that set. The minimum fish length was selected on the basis of a scientific analysis but the distance to be moved, the depth offset and the period before returning seem to have arisen from fishermen's judgment and experience (Shotton and Patchell 2008).
- Beginning in 2002, commercial interests in the Bering Sea pollock fishery adopted a "voluntary rolling hotspot system" (VRHS), under which industry members provide each other with real-time information on salmon bycatch, allowing vessels to avoid areas with

[6] Information on Atlantic Canadian snow crab management downloaded from http://www.dfo-mpo.gc.ca in October 2009.
[7] http://www.pacificwhiting.org/

high bycatch rates - thus delaying annual closures of Chinook and Chum Salmon Savings Areas. Amendment 84 to the *Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands Management Area*, which was adopted in 2005, established a "salmon bycatch intercooperative agreement" (ICA) exempting vessels that participate in the pollock fishery VRHS from Salmon Savings Area closures. The intent of the ICA was put into effect in 2006 and 2007 through exempted fishing permits, while implementing regulations were approved in 2007 and an ICA followed in January 2008. Under those, the VRHS ICA assigns vessels in a cooperative to certain tiers, based on bycatch rates of vessels in that cooperative relative to a base rate, and implements large area closures for vessels in tiers associated with higher bycatch rates. The VRHS ICA managers monitor salmon bycatch in the pollock fisheries and announce area closures for areas with relatively high salmon bycatch rates. Monitoring and enforcement are accomplished through private contractual arrangements. The efficacy of voluntary closures and bycatch reduction measures are reported annually.

Despite these measures, the bycatch of chinook salmon reached record levels in 2007, leading to adoption of Amendment 91 to the *Fishery Management Plan* in 2009 and the development of matching regulations during 2010. Those regulations will impose a limit on chinook bycatch, divided into transferable allocations for the various sectors of the fishery, with a higher limit if the industry develops and participates in one or more voluntary "incentive plan agreements" (IPA) that will establish incentive programs to minimize chinook bycatch. Those who choose not to participate will be subject to a restrictive "opt-out allocation". Participants will be required to demonstrate through performance and annual reports that their IPA sees each vessel doing its best to avoid chinook salmon and that bycatch is minimized[8].

- In 2003, Amendment 1 to the U.S. *Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks* introduced a requirement for vessels setting bottom longlines for sharks to haul their gear and move at least 1 mile after any encounter with a protected species – a turtle, a marine mammal, or a smalltooth sawfish[9]. That approach does not seem to have been extended to other components of the U.S. highly-migratory species fisheries, nor to other fisheries in U.S. waters.
- NAFO adopted a 10-mile "move-on" rule for vessels that exceed their bycatch allowances in 2006. Should the following tow also exceed the limit, the vessel in question is required to leave the NAFO Division in which it was working and not return for 60 hours (Shotton and Patchell 2008). In a few cases, that requirement might be satisfied by a minor movement across a nominal boundary. In others, it could require a cessation of fishing if the vessel in question had no allocations outside the Division in which it was operating.

All of these applications of "move-on rules" were focused on the avoidance of ephemeral problems involving the presence, on commercial fishing grounds, of concentrations of animals that are not desirable to catch – be they soft-shell crab, undersized groundfish, bycatch species, or protected species. Where such concentrations are both localized and variable in time and space, encounter protocols can offer a swifter and more efficient response than any regulatory action but only if a high degree of compliance with the protocol can be assured in the fishery in question. UNGA Resolution 61/105, or arguably its interpretation in the FAO *Guidelines*, extended the concept to avoidance of VMEs. Much of the vulnerability of those ecosystems stems, however, from the long life-expectancies of the large, sedentary epibenthic species that

[8] United States *Federal Register* Vol. 75, No. 55 (March 23, 2010), pp. 14016-14056.
[9] United States *Federal Register* Vol. 68, No. 247 (December 24, 2003), pp. 74746-74789.

dominate VMEs. Their distributions are thus the antithesis of ephemeral. The application of the encounter protocol approach to that very different task is considered in the sections which follow.

ENCOUNTER PROTOCOLS FOR VME AVOIDANCE: THE ATLANTIC EXPERIENCE

NORTHWEST ATLANTIC FISHERIES OGANIZATION

The adoption by NAFO of an encounter protocol for VMEs in the northwest Atlantic and the scientific discussions underlying that decision, fall outside the scope of the current review. However, the provisional protocol that was adopted by NAFO's Fisheries Commission in September 2008 became a model for other RFMO/As throughout the Atlantic basin and some account of it must be given here.

As originally worded[10], the protocol used a threshold of 100 kg of "live corals" (broadly defined as including antipatharians, gorgonians, cerianthid anemones, the scleractinian *Lophelia* spp., sea pens or "other VME elements") and/or 1,000 kg of live sponges per set – whether that was a trawl tow or a longline or gillnet set and without regard to the length of the set. Should that threshold have been breached, the vessel concerned would have been required to notify her flag State, which in turn would have informed the NAFO Executive Secretary (though there was an option for vessels to notify the Executive Secretary directly). The Executive Secretary would then have notified the other NAFO Contracting Parties, which in turn would have alerted vessels fishing under their flags. Meanwhile, the vessel that breached the threshold would have been required to move at least two miles from the end point of the set in the direction that is, in the words of the protocol, "least likely to result in further encounters. The captain shall use his best judgment based on all available sources of information". The protocol did not specify if or when the vessel might return to within two miles of the end of the offending set.

In the event of an encounter in an "Existing Fishing Area", meaning within the "footprint" of the fishery as documented during 1987–2007, the protocol required that other vessels fishing in the NAFO Regulatory Area be notified of the encounter but did not require them to keep away. Should a threshold have been breached in an area classified as a "New Fishing Area" (i.e. not within the documented "footprint"), however, when notifying the Contracting Parties of the event the Executive Secretary would have requested that each flag State institute a temporary closure of a circle, two miles in radius (43 km^2 in area), centred on the reported position of the encounter – which could have been the end point of the tow or some other position where the captain deemed that the encounter occurred. Such temporary closures were to be referred to the NAFO Scientific Council and could subsequently be made permanent, while an annual process was anticipated to consider all reports of encounters and determine whether any areas should be designated as VME. While permanent area closures would have been a possible response, no particular management measures were mandated following designation. (See Table 1 for a summary of the key features of this and other protocols.)

By summer 2009, NAFO's Contracting Parties agreed that the threshold levels for this protocol had been set too high and some interest groups were proposing very substantial reductions. Even the United States delegation to NAFO is said to have proposed thresholds of 2 kg of corals and 75 kg of sponges (Rogers & Gianni 2010). In September 2009, however, the NAFO

[10] NAFO Conservation and Enforcement Measures 2009. *NAFO FC Doc*. 09/1 Serial No. N5614: Article 5bis - Interim Encounter Provision.

Fisheries Council decided to place primary reliance for protecting VMEs on eight new coral protection zones and six sponge protection zones which were closed to all bottom-fishing activities for a period of two years, effective January 1, 2010, as interim measures pending further review. Together, those closures go some way towards encircling the Flemish Cap at the depths where the large epibenthic growths are most prevalent, while also extending along a considerable portion of the continental slope around the Nose of Grand Bank[11]. Within the waters remaining open to bottom fisheries, the thresholds for the encounter protocol were reduced, again effective January 1, 2010, but only to 60 kg of corals or 800 kg of sponges[12]. Those rather moderate reductions had been recommended by the NAFO Working Group of Fishery Managers and Scientists on Vulnerable Marine Ecosystems (WGFMS) after scaling-up the small catches taken in research-vessel surveys (for which comprehensive data on coral and sponge bycatch are available) to the larger nets and much longer tows typical of commercial fishing in the NAFO Regulatory Area. WGFMS's recommendation was also made in recognition that the encounter protocol was but one part of an integrated response to the requirement for protection of VME[13] – a component that is only required in the event of major unknown concentrations of VME-indicator species being encountered by commercial vessels outside of the closures. While the general issue of VME remained on the agendas of NAFO meetings through 2010, there were no further changes to the encounter protocol to the end of that year.

To date, no set has been reported to the NAFO Executive Secretary as surpassing either the coral or sponge threshold (at the level in force at the time) of this encounter protocol[14]. Whether that absence of reports indicates that the thresholds are still too high, that NAFO has successfully protected almost all VMEs in its Regulatory Area within the closures, or both, remains a moot point. It is at least certain that very large catches of corals and sponges can be taken by trawling through areas of VMEs[15], while recent modeling suggests that the 800 kg limit for sponges will be breached by 0.4% of 15-mile tows and 2.4% of 36-mile tows made on the commercial grounds in the NAFO Regulatory Area, outside the current closures (Cogswell *et al.* 2010). Hence, the protocol may yet have a direct effect on fishing activity.

NORTH-EAST ATLANTIC FISHERIES COMMISSION

Development of the Encounter Protocol

Just as with NAFO, the primary responses to Paragraphs 76 to 95 of UNGA Resolution 61/105 by the North-East Atlantic Fisheries Commission (NEAFC) have involved extensive closures of VME areas to bottom fisheries and mapping of previously-fished areas, followed by restrictions on expansion of fishing activity beyond those bounds – restrictions which appear to amount to *de facto* closures in the eyes of the fishing industry. The formal closures began in 2007, with areas on Rockall and Hatton banks closed to protect corals, while extensive portions of the Mid-Atlantic Ridge were closed in 2009. At its annual meeting in November 2008, however, NEAFC

[11] Interim measures to protect significant coral concentrations. *NAFO FC Doc*. 09/11, Serial No. N5703; Interim measures to protect significant sponge concentrations. *NAFO FC Doc*. 09/12, Serial No. N5704.

[12] Report of the Fisheries Commission and its Subsidiary Body (STACTIC) 31st Annual Meeting, 21–25 September 2009 Bergen, Norway. *NAFO FC Doc*. 09/21, Serial No. N5735.

[13] Report of the Ad Hoc Working Group of Fishery Managers and Scientists on Vulnerable Marine Ecosystems (WGFMS) 17–18 September 2009 Bergen, Norway. *NAFO FC Doc*. 09/6, Serial No. N5693.
The scaling calculation actually suggested a sponge threshold of 1,200 kg. That was arbitrarily reduced to 800 kg as a precautionary measure.

[14] Ms. Barb Marshall, NAFO Secretariat, *pers.comm*.

[15] Research surveys off Alaska and in the northwest Atlantic (both cited by Rogers & Gianni 2010), as well as off Norway (Dr. Odd Aksel Bergstad, Institute of Marine Research, Bergen, *pers.comm.*), have sometimes taken bycatches of coral or, more often, sponges that exceeded the original NAFO thresholds.

also adopted an encounter protocol[16] that was essentially identical in wording to the one that NAFO had selected two months before, save only for the references to the different organizational structures of the two RFMOs and their science-advisory bodies. NEAFC's Contracting Parties, all five of which are also members of NAFO, appear to have been motivated primarily by a desire for consistency, though it could also be said that they saw no reason to re-open debates so recently concluded. The key discussions leading to the adoption of the protocol occurred at a meeting of the Commission's Permanent Committee on Management and Science (PECMAS), held in October 2008[17]. There representatives of Iceland and Denmark (in respect of the Faroe Islands and Greenland) had expressed reservations about including all sponges in the 1,000 kg threshold and proposed deleting sponges from the protocol entirely. That suggestion was not adopted by the Commission.

Following a Heads of Delegations meeting in March 2009, NEAFC approved a proposal which stated that the thresholds adopted the previous November were too high. In its report to the United Nations Secretary General some months later, the European Commission noted that it had proposed an immediate 50% reduction in the thresholds[18], while Rogers & Gianni (2009) suggested to NEAFC that thresholds an order of magnitude lower than those currently in force would be more appropriate. The thresholds and "move-on" provisions of the protocol (especially their operational effectiveness) were, however, referred to PECMAS. In June 2009, that Committee in turn referred the question to the International Council for the Exploration of the Sea (ICES) and it was addressed, out of session, by the members of the Working Group on Deep-Water Ecology (WGDEC) and the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP). In the absence of relevant data (particularly on coral and sponge patch sizes) from the northeast Atlantic, the resulting scientific advice was limited. ICES did warn that a "move-on" requirement may only serve to spread fishing effort across an area of VME, noted that NEAFC had yet not produced an operational definition of VME and pointed out that the NAFO approach to thresholds (1) treated all species of either coral or sponge as equal indicators of the presence of VMEs, (2) assumed that all such species were equally likely to be retained in a net and (3) only used corals and sponges as indicators of the structural habitats of VMEs. ICES further warned that retention of corals and sponges in bottom trawls may be poor, such that large quantities might be destroyed on the seabed before an amount exceeding either of the thresholds then in use was brought to the surface. The advice further noted that an alternative approach would be to simply assume that all unfished areas contain VMEs and hence to prohibit or restrict fishing outside the established "footprint". Finally, ICES advised that, if an encounter protocol was to be used, it should have more precautionary thresholds than the 100 and 1,000 kg of the original NAFO and NEAFC rules[19].

In the absence of more specific scientific advice, PECMAS appears to have relied instead on the then-recent developments within NAFO. Following a proposal by the European Union representative, the Committee thus recommended maintaining consistency across the North Atlantic by reducing the thresholds to 60 and 800 kg respectively, while otherwise leaving the

[16] Recommendation XIII: 2009, see: *Report of the 27th Annual Meeting of the North-East Atlantic Fisheries Commission, 10-14 November 2008, Volume II – Annexes*, p. 57.
[17] *PECMAS Report 28-29 October* [2008].
[18] Report of the Secretary General A/64/305, p. 37.
[19] 9.3.2.4 NEAFC request on vulnerable marine ecosystems (VMEs) concerning move-on provisions and threshold values for key indicator species. Pp. 26-27 *in:* Report of the ICES Advisory Committee, 2009. *ICES Advice, 2009*. Book 9. 113 pp.
The suggestion of simply designating unfished areas as VME implicitly supposes, firstly, that the "footprint" of past fishing can be mapped on an adequately fine scale and, secondly, that fishing within that "footprint" has been sufficiently intensive to effectively remove all value as VME from the entire fished area. The combination of those contentions seems improbable.

NEAFC protocol unchanged – though it was recognized that the coral and sponge *faunae* differ between the two sides of the ocean (notably with there being substantially more of the stony scleractinians in the northeast), such that the thresholds could not be said to have any scientific foundation when used in the NEAFC area[20]. The reduction in the threshold levels was adopted by the Commission at its annual meeting in November 2009[21].

WGDEC returned to the questions surrounding VME avoidance during its meeting in March 2010. While much was said on other aspects of the general topic, there was little progress on encounter protocols beyond noting that none of the threshold levels or required movement distances yet used by any RFMO/A have any basis in science. It was suggested that the various biogeographic regions require different thresholds, since the dominant species within each major taxon differ. It was also noted that the existing NEAFC thresholds only afford some protection to areas containing massive, reef-forming corals (e.g. *Lophelia*), large sponges (e.g. *Geodia*) or possibly to those with very large gorgonians. Areas supporting VMEs comprised of smaller gorgonians, bamboo corals, antipatharians or the more fragile sponges are unlikely to yield bycatches of tens (or, in the case of sponges, hundreds) of kilograms per set, not least because such species are fragile and break up in nets. In its recommendations, WGDEC favoured a risk-based approach when developing encounter protocols, suggested that thresholds should be differentiated by gear type and configuration, biogeographic region and taxonomic group, while calling for full observer coverage and a "real-time closure system" rather than just requiring movements by vessels which take VME-indicator species. WGDEC further favoured an approach which would map "high risk" areas based on habitat-suitability modeling for VME species and that such areas should be closed until non-destructive survey methods show that VMEs is not present, while areas which have historically received considerable fishing effort would be classed as "low risk" and open to fishing under an encounter protocol[22].

The *ICES Advice* books for 2010 are not yet available but the presentation made to NEAFC at its annual meeting contained no summary of WGDEC's thinking on encounter protocols[23]. The Commission did discuss various aspects of VME avoidance but the encounter protocol was only raised by an observer, who was told that PECMAS had not considered WGDEC's thoughts since no formal ICES advice had been ready in time for the Committee's meeting[24]. Hence, management responses are still awaited.

To date, there have not been any reports to NEAFC of any set breaching the thresholds for coral or sponge bycatch during the two years that they have been in force[25].

Commentary

A workshop in October 2009 convened under the *Convention for the Protection of the Marine Environment of the Northeast Atlantic* (OSPAR) considered threats to various marine habitats and species in European waters which were prioritized for action by the OSPAR Ministers, along with appropriate management responses. Amidst much else, the NEAFC encounter

[20] *Permanent Committee on Management and Science PECMAS of the North-East Atlantic Fisheries Commission 28-29 September* 2009 *Report*.
[21] Recommendation XI: 2010, see: *Report of the 28th Annual Meeting of the North-East Atlantic Fisheries Commission, 9-13 November 2009, Volume II – Annexes*.
[22] Report of the ICES/NAFO Joint Working Group on Deep-Water Ecology (WGDEC), 22-16 March 2010, Copenhagen. *ICES CM* 2010/ACOM:26.
[23] Presentation available on the http://www.neafc.org/ website.
[24] *29th Annual Meeting of the North-East Atlantic Fisheries Commission 8-12 November 2010.*
[25] Ms. K. Partridge, NEAFC Secretariat, *pers.comm.*

protocol for avoiding VMEs was dismissed as "likely to be generally ineffective". The workshop participants suggested that it should be replaced, though not by a different protocol. Rather, the workshop recommended substituting a suite of measures based around freezing the "footprint" of the fishery and instituting more and larger closures[26]. Similarly, though for global application rather than specifically for the NEAFC area, Auster *et al.* (2010) declared that "as an additional precautionary measure, large-scale closed or protected areas should also be an integral and precautionary component of each regional fishery management strategy", rather than relying on encounter protocols. Those were curious recommendations, for two reasons. Firstly, UNGA Resolutions 61/105 and 64/72 required NEAFC and the other RFMO/As to institute encounter protocols to move fishing vessels away from areas where they encounter VMEs. Secondly, NEAFC (like NAFO) had already adopted essentially the suite of measures that the OSPAR workshop and Auster *et al.* (2010) desired, including large closed areas, but had added the encounter protocol in addition and in implicit recognition that existing knowledge of the distribution of VMEs is inadequate for their full protection within closures, necessitating some means of swiftly directing fishing effort away from newly-encountered concentrations of VME organisms.

Indeed, the NAFO and NEAFC encounter protocols cannot usefully be considered in isolation but only as components, and secondary components at that, of broader suites of measures for preventing significant adverse impacts of fishing gear on VMEs. The intention behind the UNGA call for an encounter protocol is said to have been that it should be "a measure of last resort" (Gianni 2009), though it might better be described as a "back-stop" to catch significant impacts that slip past the primary measure: long-term closures of VME areas. Since the design of those closures is likely to improve over time, the need for encounter protocols should diminish and, to that extent, they will always be interim measures. While it is necessary that they be effective, it is more important that they be in place than that they be developed to perfection.

In that context, the NEAFC encounter protocol (and hence also the NAFO one) has been criticized for:

- Considering only corals and sponges,
- Ignoring quantities of dead coral skeletal material,
- Using thresholds that are too high,
- Using the same thresholds for all gears,
- Using the same threshold for all corals and another threshold for all sponges,
- Requiring a movement of two miles away from the end of a set rather than from where the set encountered the corals or sponges, and
- Treating new and existing fishing areas differently

(Gianni 2009, Rogers & Gianni 2009, 2010). The first of those objections was strictly false: the NAFO and NEAFC encounter protocols apply the coral threshold to "other VME elements", though they can only be implemented at sea with respect to species that are retained by commercial fishing gear and are recognisable, to an observer, as indicative of VME. In practice, those considerations likely limit the application to coral and sponges. The last of the objections may also be ill-considered: if the "footprint" of past fishing has been effectively mapped at adequate spatial resolution, large catches of VME indicator species taken within that "footprint" should most often signal that an isolated remaining patch of such organisms has been eliminated, leaving nothing nearby to protect and little reason to deflect fishing effort into other

[26] *Report of the OSPAR Workshop on Defining Actions and Measures for the OSPAR List of Threatened and/or Declining Species and Habitats*. OSPAR Commission, London, 126 p. (2010). Quotation is from p. 20.

areas, where more effort and more bottom contact will typically be needed to harvest the sustainable yields of the target species (assuming that fishermen's chosen fishing locations promise higher catch rates than are the norm for surrounding areas). When fishing outside the historic "footprint", in contrast, similarly large catches of indicator species may be expected to point to the presence of extensive areas of VMEs and hence call for swift displacement of future fishing effort.

Rogers & Gianni (2010) called for dead coral skeletons to be included as VME indicators on the grounds that coral reefs are often composed of a thin live layer over a framework of dead coral, a suggestion echoed by Auster *et al.* (2010). While that appears true of *Lophelia* mounds, as it is of the shallow-water reefs in tropical waters, the "forests" of gorgonians, which predominate amongst the corals of the northwest Atlantic and are common in the northeast also, have a quite different structure. Besides, while a live reef may be largely composed of dead coral, it does not follow that a majority of dead coral exists within live reefs. Moving fishing effort away from areas of coral rubble thus risks moving it into areas of live colonies and hence into VME. Potentially, a threshold might be designed which included the weight of dead *Lophelia* if that was accompanied by some proportion of live material (though a low threshold applied to live *Lophelia* alone would achieve the same end) but a blanket inclusion of dead skeletons within the existing encounter protocols would risk being seriously counter-productive.

In contrast, Rogers & Gianni's (2010) objections to the use of only two thresholds, without regard to tow length, gear dimensions, gear type, or species (beyond the broad groupings of "coral" and "sponge") are valid. That simplicity is an obvious weakness of the NAFO and NEAFC approach (cf. Auster *et al.* 2010, Cogswell *et al.* 2010). If the objective of the encounter protocol is to identify the presence of VMEs based on commercial catches of indicator species, and to move fishing activity away from the area in question, then the thresholds should be based (*inter alia*) on the densities of the species which define the presence of a VME and on the catchabilities of the species by the gear in question – catchabilities that are inevitably specific to a gear type and a species. There are, for example, areas of seabed where sea pens or small gorgonians predominate which may class as VMEs but which are most unlikely to ever yield 60 kg per set (Auster *et al.* 2010). In addition, not all corals nor all sponges are indicative of the presence of VMEs (even if all those caught in large quantities perhaps are) and the encrusting sponges or solitary cup-corals might better be removed from consideration in encounter protocols, especially if the thresholds are greatly reduced. The existing simplistic protocols can perhaps be justified as pragmatic interim measures, pending not only the research needed to quantify critical densities and catchabilities but also the establishment of an observer corps trained in the detailed identification of benthic taxa. Such protocols cannot, however, be said to be ideal.

Rogers & Gianni (2010) further objected to the encounter-protocol thresholds being set one or two orders of magnitude above the levels of coral or sponge bycatch taken by research-vessel trawl sets, which were used by NAFO to identify VMEs for closure. As noted above, the offset was based on the ratio of swept areas between short survey tows using small nets and the long tows with large nets typical of the commercial fishery in the NAFO Regulatory Area. Rogers & Gianni (2010), however, correctly argued that such a scaling is inappropriate since the amount of bycatch taken will depend on the number of small patches of VME indicator species encountered, which number would not be expected to increase linearly with swept area. While there are other factors to be considered when setting thresholds, as discussed below, the levels currently used by NAFO and NEAFC may indeed need to be cut further as analyses of the issue advance – though the results of the scaling might be deemed reasonable first approximations, at least for the NAFO area for which they were developed.

The great weakness of the existing NAFO and NEAFC encounter protocols, however, seems to lie in the responses that would be triggered if a threshold was breached. The two-mile movement distance could, perhaps, be buttressed by another appeal to pragmatism, though it is unsupported by any analysis of patch sizes of either VMEs or catch rates[27]. What seems unjustifiable is the drawing of that radius around the end point of a set, when the corals or sponges may have been taken several miles away on a long trawl tow (cf. Rogers & Gianni 2010). As explained below, under equivalent circumstances Australia requires its vessels to move away from all points along the tow track of the set that breached the threshold, not simply from its end point. No less seriously, under the NAFO and NEAFC protocols and when fishing within the established "footprint", only the one vessel which took the coral or sponge is required to leave even the area around the end point of its tow. In an encounter protocol for avoidance of ephemeral concentrations of bycatch, requiring single-vessel responses avoids the need for complex arrangements to institute and announce small, temporary closures. In addition, limiting the response to the one vessel also removes concerns over broadcasting proprietary information about prime fishing spots. It does so without material harm to the resources as the few vessels that might encounter the aggregation of unwanted catch before it disperses or moves are unlikely to take damaging amounts on the single set by each vessel which would trigger its own displacement. However, when dealing with sedentary, long-lived VMEs, even single sets can cause lasting harm and a fleet-wide response to any indication of the presence of VMEs would seem appropriate in most cases – the obvious exception being fisheries in which some sectors within a fleet show promise of fishing with gears or practices that avoid risk to the VMEs present in a local area.

To Roger's & Gianni's (2010) list of criticisms, one more can be added. Should the breaching of a threshold in a "new" fishing area ever trigger a temporary closure under the NAFO or NEAFC protocols, their as-yet-untried response mechanisms, requiring complex communications between vessels, flag States, and the NAFO Executive Secretary or NEAFC Secretary, may prove too unwieldy to be effective.

NORWAY

As with both NAFO and NEAFC, Norway's efforts to protect VMEs within its own Exclusive Economic Zone (EEZ) have emphasized closures of known concentrations rather than the movement of vessels following an encounter. However, national regulations came into force on 1 January 2010 that implemented the NEAFC encounter protocol for vessels fishing within the Norwegian EEZ – though only so as to maintain consistency between the national and international management regimes. The thresholds have since been adjusted to match the lowered NAFO and NEAFC levels[28]. That Norwegian action is, globally, the sole case known to the current author of an encounter protocol designed to protect VMEs being applied within waters under national jurisdiction.

As is the case in NAFO and NEAFC waters, to date no vessel has breached either threshold in the Norwegian EEZ. It has been suggested that the current status of available resources, fleet reductions, plus the management constraints on fishing in "new" areas have combined to focus fishing effort on known grounds, where large corals and sponges are scarce[29].

[27] Besides the obvious relevance of VME patch sizes, if patches of high catch rates are extensive, fishing vessels could make longer movements away from encounter locations without excessive costs than if those patches are small.
[28] Mr. S. Palmason, Directorate of Fisheries, Ministry of Fisheries, Norway, *pers.comm.*
[29] Mr. S. Palmason, Directorate of Fisheries, Ministry of Fisheries, Norway, *pers.comm.*

SOUTH EAST ATLANTIC FISHERIES ORGANIZATION

The South East Atlantic Fisheries Organization (SEAFO) moved to protect VMEs in advance of UNGA Resolution 61/105, with its Conservation Measure 06/06, which was approved in 2006, closed thirteen seamount areas and provided that future exploratory access to them would require notification to the SEAFO Executive Secretary of any encounter with "hard corals". Should such a notification have been received, the Executive Secretary would have implemented a temporary closure pending a decision at the SEAFO Commission's next annual meeting. Those arrangements were replaced at the annual meeting in October 2008, which called for a special workshop to be held in 2009 to "further elucidate on bottom fishing / VMEs" but also adopted Conservation Measure 12/08[30].

Measure 12/08 required mapping of existing bottom-fishing areas, submission of proposals for exploratory fishing in new areas, assessments of bottom-fishing activities, and an encounter protocol. The latter was closely modeled on the NAFO precedent, though it incorporated a requirement that, following the two-mile movement after an encounter: "Any further tows or sets shall be parallel to the tow/set when the encounter was made"[31]. It was explicitly stated of the 100 kg of live coral and/or 1,000 kg of live sponges: "These thresholds are set on a provisional basis and may be adjusted as experience is gained in the application of this measure". Indeed, from the first Measure 12/08 was scheduled for review in 2010, as Measure 06/06 had been.

In the event, the encounter protocol did not survive unchanged even that long. Conservation Measure 17/09 (still explicitly described as "an interim measure") revised the thresholds to accord with the new levels adopted by NAFO and NEAFC (i.e. 60 kg of corals or 800 kg of sponges), which were once again stated to have been "set on a provisional basis"[32]. No justification for those thresholds was offered in the report of the SEAFO Commission's meeting, except that the meeting was informed of recent threshold reductions by both NAFO and CCAMLR[33].

At its most recent annual meeting, in October 2010, SEAFO adjusted the seamount areas closed to fishing[34] but the encounter protocol currently remains unchanged from the version in Measure 17/09. To date, there have not been any reports to SEAFO of any set breaching the coral or sponge thresholds then in force[35].

This application of what is essentially the NAFO encounter protocol in the southeast Atlantic is subject to all of the same criticisms as apply to the NEAFC version but it raises no additional concerns.

THE SOUTHWEST ATLANTIC

As a consequence of the long-standing dispute between Argentina and the United Kingdom concerning the Falkland Islands/Malvinas, there has been no agreement to establish an RFMO/A with responsibility for bottom fishing in the southwest Atlantic. It has therefore fallen to

[30] Presented as Appendix 6 to the *Report of the 5th Annual Meeting of the Commission, 2008*.
[31] A detail that may be of limited value if a vessel can move two miles back along its track and then tow once more down the same line, through a patch of VME.
[32] Conservation Measure 17/09 and other Measures currently in force are available from the SEAFO website.
[33] *Report of the 6th Annual Meeting of the Commission, 2009*.
[34] SEAFO Conservation Measure 18/10.
[35] Dr. B. van Zyl, SEAFO Executive Secretary, *pers.comm.*

individual flag States with vessels fishing in that region to establish their own responses to UNGA Resolution 61/105. To date, only Spain and the Republic of Korea have announced such measures, though Spanish fishing is subject to European Community management and separate requirements have been established.

European Community

In the fall of 2007, the Commission of the European Communities initiated a process leading to Council Regulation (EC) No. 734/2008, which was adopted by the Council of Ministers in July 2008 and came into force the following month[36]. It applies to all European Union vessels fishing the high seas outside areas that fall under the responsibility of an RFMO/A and where there are no interim measures agreed by the Parties that are establishing an RFMO/A – though it was intended mainly for application in the southwest Atlantic and the southern Indian Ocean[37].

The Regulation set up a system requiring a special fishing permit, 100% observer coverage, area closures, and other measures. It also included a protocol for "unforeseen encounters with vulnerable marine ecosystems". As written, that encounter protocol was very simple, merely requiring vessels to cease fishing, move a minimum of five miles from the site of the encounter, and make a report to authorities. VME was given a very broad definition, phrased in scientific terms, but specifically included "reefs, seamounts, hydrothermal vents, cold water corals or coral and sponge beds". Neither an operational definition nor any thresholds were offered in the Council Regulation.

In 2009, the European Commission planned a review of Regulation 734/2008 and its possible amendment during 2010[38]. No evidence indicating progress with that review has been found by the current author.

Spain

In practice, the only known fishing to which Council Regulation (EC) No. 734/2008 might have applied has been by Spanish vessels. That nation has, however, taken a rather different path, which has included mapping of VMEs and freezing the "footprint" of the fishery. With effect from 1 January 2009 and within the established "footprint", Spain implemented an encounter protocol but it followed the NAFO precedent, rather than the European Community regulation. Thus, the threshold was 100 kg of live coral (including antipatharians, gorgonians, cerianthid anemones, *Lophelia* spp. and "feather coral") or 1,000 kg of live sponges per set. In the event of an encounter exceeding the threshold, a captain was required to report the event to the Secretary General for Marine Affairs and to move at least two miles from the end point of the set "in the direction least likely to give rise to further findings. The captain shall use his best judgment based on all available sources of information" [39]. No information on any updating of those requirements has been found by this author.

[36] Council Regulation (EC) No 734/2008 of 15 July 2008 on the protection of vulnerable marine ecosystems in the high seas from the adverse impacts of bottom fishing gears. *Official Journal of the European Union* 30.7.2008, pp. L 201/8 – L 201/13.

[37] The E.U. noted the intended geographic application of Regulation 734/2008 in an undated *Report on Implementation of UNGA Resolution 61/105 OP 83-90 (8 December 2006)*, found on European Commission website but also available amongst the national reports submitted to the U.N. Secretary General. That *Report*'s preparation can be dated on internal evidence as falling between March and June 2009.

[38] E.U. *Report on Implementation of UNGA Resolution 61/105 OP 83-90 (8 December 2006)*.

[39] E.U. *Report on Implementation of UNGA Resolution 61/105 OP 83-90 (8 December 2006)*.

Korea

In 2008, the Republic of Korea implemented an encounter protocol for those of its vessels that fish in the southwest Atlantic or other areas without an RFMO/A. An *Administrative Directive for Implementing International Regulation regarding Bottom Fishing in the High Seas* was issued in December 2008 and was later amended and published as Regulation No. 2009–27. That required vessel monitoring systems, assessments of potential impacts, special licences for bottom fishing on the high seas, and the reporting of VME encounters. It also required that any vessel which encounters VMEs must move at least one mile. The limited information on that protocol available to the current author does not state whether it includes any specified threshold[40].

SUMMARY FOR THE ATLANTIC OCEAN

There is very little high seas bottom fishing in the low-latitude portions of the Atlantic basin (Bensch *et al.* 2008), hence effectively all Atlantic fisheries subject to UNGA Resolution 61/105 fall either under NAFO, NEAFC or SEAFO management or else in the southwest Atlantic, where there is no RFMO/A. With the sole exception of Korean vessels fishing in the latter area, and despite the rather different encounter protocol formally adopted by the European Community, the *de facto* rules in each of the four areas are mere variants of the one adopted by NAFO in September 2008 and modified a year later.

It cannot be said that that protocol is efficient and it may not even be effective. With the partial exception of its application in the NAFO Regulatory Area, it cannot be claimed to be science-based. It can, however, be recognized as a pragmatic, interim measure, necessitated by the deadline set for the RFMO/As and their member States by UNGA Resolution 61/105. Each of NAFO, NEAFC, and SEAFO has chosen to rely on other measures, including freezing the fishery "footprint" and closing extensive areas to any bottom fishing, as the primary means to protect VMEs, with the encounter protocol as a secondary "back stop" in case patches of VMEs should be found on the grounds still open to fishing. For that purpose, their protocols may be adequate, though the thresholds are probably too high, while the steps to be taken if a threshold were breached need further development.

MEDITERRANEAN SEA

The General Fisheries Commission for the Mediterranean (GFCM) has adopted a number of measures that provide protection for VMEs, including a general ban on bottom trawling at depths greater than 1,000 m and various area-based restrictions at lesser depths. However, no encounter protocol for VME protection in the high seas had been introduced in the Mediterranean by mid-2009[41]. No indication of any subsequent introduction was found during the preparation of the current review.

[40] Report of the Secretary General A/64/305, pp. 47-48.
[41] Report of the Secretary General A/64/305, p. 21; cf. Rogers & Gianni (2010).

SOUTHERN OCEAN

DEVELOPMENT OF THE ENCOUNTER PROTOCOL

CCAMLR serves as the RFMO/A for the waters south of the Antarctic Convergence, though its activities fall under the overarching requirements of the Antarctic Treaty, the objectives of which include "preservation and conservation of living resources in Antarctica"[42]. The CCAMLR Convention thus has a declared objective of "conservation of Antarctic marine living resources"[43]. While it goes on to define "conservation" as including "rational use", there is something of a reversal of onus in the management of Southern Ocean fisheries when compared to the objectives of the RFMO/As with responsibility for other oceans.

CCAMLR's principal response to UNGA Resolution 61/105 was provided by its Conservation Measure 22-06 (of 2008)[44], which froze the "footprint" of the longline fishery and called for assessments of all bottom fisheries, 100% observer coverage, reporting of all relevant data to the CCAMLR Scientific Committee and biennial reviews beginning in 2009. The Commission had already prohibited deep-sea gillnetting and bottom trawling in the waters subject to its management, through Conservation Measures 22-04 and 22-05. The remaining fisheries in the Southern Ocean that could impact VMEs were bottom longlining, primarily for Patagonian and Antarctic toothfish or for mackerel icefish, and potting for lithodid crabs. For those, a standard form was introduced for Contracting Parties to use in notifying the Secretariat whenever evidence of VMEs was encountered, the evidence being not merely presence of VME species in a catch but alternatively *in situ* photographs, acoustic profiles or the presence of habitat features (e.g. seamounts, vents, seeps or canyons). The habitat-forming organisms deemed to be of interest included not only sponges and the various types of corals but also crinoids, bryozoans, ascidians, tubeworms, brachiopod beds, bivalve beds and bioturbators. Conservation Measure 22-06 also included a straightforward requirement "to cease bottom fishing activities in any location where evidence of a VME is encountered in the course of fishing operations".

That requirement was, however, swiftly overtaken by Conservation Measure 22-07[45], itself explicitly an interim step, which was adopted later in 2008. Measure 22-07 built on the considerable experience in the use of "move-on" rules for bycatch minimisation that CCAMLR had developed. It applied to both the longline and pot fisheries and to fishing in those parts of the Convention Area south of 60° South latitude, plus one portion of the Convention Area further north, excepting areas that had an established fishery in 2006–07. Within those bounds, all fishing lines were to be clearly marked in "line segments" of 1,000 hooks or 1,200 m, whichever was shorter, with pot lines always marked by length. The amount of benthic organisms taken on the gear was to be quantified in "VME indicator units" per line segment, each such unit comprising either 1 L of any material that will fit into a 10 L container or else 1 kg of material that will not fit into such a container. If five or more indicator units (e.g. 5 L of material) were recovered from the same line segment, the vessel was required to immediately report the location of the midpoint of that segment and the number of indicator units recovered to both the CCAMLR Secretariat and the vessel's flag State. If ten or more units were recovered from the one line segment, the vessel was additionally required to haul all lines within a "risk area" one mile in radius (10.775 km^2 in area) around the midpoint of the segment and, thereafter, not

[42] *The Antarctic Treaty* Article IX.1(f). The *Treaty* defines Antarctica as including everywhere south of 60° South latitude.
[43] *Convention on the Conservation of Antarctic Marine Living Resources* Article II.
[44] CCAMLR Conservation Measure 22-06 (2008) Bottom fishing in the Convention Area.
[45] CCAMLR Conservation Measure 22-07 (2008) Interim measure for bottom fishing activities subject to Conservation measure 22-06 encountering potential vulnerable marine ecosystems in the Convention Area.

to set any more lines within that area. For those purposes, all benthic organisms listed in the CCAMLR *Benthic Invertebrate Classification Guide* were to be included in the determination of the numbers of indicator units recovered from each line segment. The *Guide* (a two-sided card with photographs illustrating identifying features suited to use by at-sea observers) listed sponges, sea anemones, gorgonians, scleractinians, antipatharians, alcyonacean soft corals, sea pens, hydroids, stylasterid hydrocorals, bryozoans, crinoids other than the cornatulid feather stars (which limited the Class to only the stalked crinoids), basket stars (Euryalinida) and ascidacean tunicates (i.e. excluding the pelagic tunicates and the benthic Sorberacea).

On receiving a report of ten or more indicator units taken on the same line segment, the CCAMLR Secretariat was to immediately close the one mile radius risk area and notify both flag States and all vessels in the relevant fishery. Risk areas were to remain closed to commercial fishing (though not to research) until they had been reviewed by CCAMLR's Scientific Committee and a decision on future management made by the Commission. Furthermore, on receiving five reports from any one rectangle of 0.5° latitude by 1° longitude (900 square nautical miles or 3,087 km^2 at 60° latitude), each of at least five indicator units taken on the same line segment, the Secretariat was to notify fishing vessels and their flag States but the vessels were free to continue fishing.

Much of this encounter protocol, though not the provision concerning 0.5° by 1° rectangles, was based on recommendations from the 2008 meeting of CCAMLR's Scientific Committee. The report of that meeting[46] does not detail every step in the development of the ideas but does document concern over the ease of at-sea determinations of amounts of benthos taken, a desire to maintain the flow of information about the benthos from commercial catches through continued fishing, though not at the expense of significant adverse impacts to VMEs, recognition of the value of comparisons among vessels, and the importance of any management measures being fleet-wide, not vessel specific, while allowing some gear-specific variations. The one mile radius of each risk area was selected "to allow for further data to be collected in the vicinity", rather than from any overt consideration of patch sizes or the precision of spatial control over future fishing effort. The five mile radius previously used by CCAMLR for bycatch minimization was rejected as being suited to mobile species, rather than sedentary VMEs[47].

It remains unclear how the important issue of the threshold ("trigger" in CCAMLR terminology) that triggers declaration of a risk area was resolved. The Committee's report said only that the threshold "was derived from the data and experience from fishing in the Ross Sea and the Indian Ocean", with a reference to a working paper that is not publicly available[48]. It was recognized that the encounter protocol may later require taxon-specific thresholds, particularly to accommodate rare and small species or those susceptible to being damaged without being caught. The problem of a quantity of VME organisms being taken at the junction of two line segments, such that neither surpassed the defined threshold, was discussed, as was the possibility that some lines might take near-threshold levels on multiple, adjacent segments without triggering closure of a risk area. However, the Scientific Committee could not agree on

[46] *Report of the Twenty-Seventh Meeting of the Scientific Committee*, Scientific Committee for the Conservation of Antarctic Marine Living Resources, SC-CAMLR-XXVII [hereafter cited as "SC-CAMLR-XXVII"].

[47] SC-CAMLR-XXVII, paragraphs 4.247, 4.248, 4.252, 4.262 & 4.265.
Arguably, that reasoning for the dimensions of a risk area placed scientists' desire for data above conservation and management considerations.

[48] The reference was to CCAMLR-XXVII/26, which was a compilation of preliminary assessments, submitted by CCAMLR members undertaking bottom fishing in the convention area, of known and anticipated impacts of proposed bottom fishing activities on vulnerable marine ecosystems.

solutions to those complications[49]. There is no indication in its report of the reasoning behind the selection of taxa to include as indicators of VMEs. A suspicion must linger that, as a temporary measure, an existing identification guide designed for other purposes was merely adopted as a listing of indicator taxa.

Conservation Measure 22-07 was developed for application during the 2008–09 fishing season, ahead of further discussions, and there was no indication in the Scientific Committee's report of any expectation that the approach adopted was either optimal or suited for long-term use. Rather, there was an express intent to review the Measure during 2009. As that process unfolded, it included a "Workshop on Vulnerable Marine Ecosystems" which considered a wide variety of scientific aspects of VMEs. Points of immediate relevance to the encounter protocol included the sizes and shapes of risk areas for various taxa. The Workshop agreed that the taxonomic resolution of the *Benthic Invertebrate Classification Guide* was sufficient for the purpose of identifying potential risk areas (though finer-scale identifications were desired for data collection), concluded that the existing thresholds were too high for "light" species (though adequate for "heavy" ones), noted that other thresholds may be needed for rare or unique species but concluded that no information was currently available to support any other specified levels[50].

The CCAMLR Scientific Committee, which received the Workshop's report during its meeting in October 2009, primarily determined that the much-elaborated review of VME issues would require a further year for its completion. Most of the other recommendations relating to the encounter protocol were for additional data collection, including a call for data on both the target catch and the indicator units taken on every line segment set, even where the bycatch of VME indicator species was zero. It was noted that the alternative reporting of the benthic bycatch in units of volume or weight would cause difficulties for subsequent analyses[51]. The only substantive change to the encounter protocol that was recommended was the transfer to a new *CCAMLR VME Taxa Classification Guide*[52]. When compared to the previous *Benthic Invertebrate Classification Guide*, the revised version (at double the length) broke out some of the taxa into more and smaller groups. Otherwise, it limited the hydroids to the Order Anthoathecatae, while adding zoantharian corals, chemosynthetic communities (including cold seeps, vents, whale falls and sunken wood), brachiopods, pterobranch hemichordates, serpulid worms, xenophyophores, goose and acorn barnacles of the Family Bathylasmatidae, the Antarctic scallop (*Adamussium colbecki*), and pencil-spine sea urchins of the Order Cidaroida. It is unclear to the current author whether or not scientific preference for the new *Guide* amounted to a requirement for its use at sea, which would have amounted to a re-definition of the CCAMLR encounter protocol.

In 2010, there was further working-group discussion of thresholds and much consideration of other scientific issues relating to VMEs. There were further calls for additional data collection, including a suggestion that systematic mapping of habitats using drop cameras deployed from fishing vessels would be valuable in characterizing the distribution of VMEs. The Scientific Committee, however, made no substantive recommendations to the Commission concerning

[49] SC-CAMLR-XXVII, paragraphs 4.255, 4.257 & 4.260.

[50] Report of the Workshop on Vulnerable Marine Ecosystems (La Jolla, CA, USA, 3 to 7 August 2009). Annex 10 *in*: *Report of the Twenty-Eighth Meeting of the Scientific Committee*, Scientific Committee for the Conservation of Antarctic Marine Living Resources, SC-CAMLR-XXVIII.

[51] A curious objection considering that the reports were intended, under Measure 22-07, for operational rather than analytical use.

[52] *Report of the Twenty-Eighth Meeting of the Scientific Committee*, Scientific Committee for the Conservation of Antarctic Marine Living Resources, SC-CAMLR-XXVIII, paragraphs 4.242 – 4.258.

the encounter protocol itself[53]. That protocol remained in force through the 2010–11 fishing season, unchanged from its form in Conservation Measure 22-07[54] unless perhaps by the modifications to the list of taxa to be treated as VME indicators.

Little has yet been documented concerning experience with this protocol. During the 2008–09 fishing season, a total of 30 reports of commercial bycatch exceeding five indicator units per line segment (in some 14,000 line segments of gear set and hauled by the fleet) were received, from a total of 18 vessels – along with a further 30 reports of VMEs encountered by research vessels. Seven risk areas (each presumably a circle covering 10.775 km^2) were reported to CCAMLR, showing both that the 10-unit threshold can be breached during commercial fishing and that the reporting system can operate effectively. The maximum quantity of VME-indicator species taken on a single line segment was 68.6 units. With the single exception of a report of 5.5 units on one line segment, all of those reports came from CCAMLR Subareas 88.1 and 88.2, which comprise the Ross Sea and other waters south of 60° South between the 150° East and 105° West meridians. Eight of the 30 reports came from a single 0.5° by 1° rectangle, triggering that provision of the protocol[55]. No equivalent information from the 2009–10 season is yet publically available.

COMMENTARY

There is much about the CCAMLR encounter protocol that suggests a primacy of scientific concerns over other issues and especially of conservation of vulnerable benthos over the efficient harvesting of fishery resources – orientations which may be appropriate under the terms of the Antarctic Treaty and the CCAMLR Convention but which would be inconsistent with the objectives of other RFMO/As and which were not been required by UNGA Resolution 61/105. That is not to fault the protocol for its designed purpose but to caution that neither its fundamental structure nor its details should be uncritically adopted for application in other oceans. It is, of course, not suited for application to mobile-gear fisheries.

The CCAMLR encounter protocol remains less than perfect, however, with the Scientific Committee and its subunits having noted unresolved concerns about the range of taxa to be considered and its converse, difficulties in at-sea identification of the bycatch by observers, about the need for taxon-specific thresholds (to be set for "light" species below the current levels) and means to address multiple substantial bycatches from a small area when each of them falls just below the established threshold. To those could be added a need for gear-specific thresholds and a reconsideration of the required "move-on" distance, which is currently just one mile. Rogers & Gianni (2010) did not add any other criticisms of CCAMLR's approach, though they did obliquely recommend the analytical approaches (accumulation curves and GIS analyses) used by NAFO in setting critical values of indicator species for definitions of VMEs and hence, by implication, for setting encounter-protocol thresholds.

[53] *Report of the Twenty-Ninth Meeting of the Scientific Committee*, Scientific Committee for the Conservation of Antarctic Marine Living Resources, SC-CAMLR-XXIX.
[54] Dr. Keith Reid, Science Officer, CCAMLR Secretariat, *pers.comm*.
[55] *Report of the Twenty-Eighth Meeting of the Scientific Committee*, Scientific Committee for the Conservation of Antarctic Marine Living Resources, SC-CAMLR-XXVIII, paragraph 4.243; Rogers & Gianni (2010), p. 80.

INDIAN OCEAN

The South Indian Ocean Fisheries Agreement ("SIOFA"), a nascent RFMO/A with responsibility for much of the high seas portion of the Indian Ocean, was unable to agree on measures to protect VMEs within the time limits set by the UNGA and has not done so subsequently. The challenge of addressing VME protection in the region was therefore passed to the flag States whose vessels engage in high seas bottom fishing in those waters – primarily Australia but also Spain, Namibia, Mauritius, Cook Islands, and China (Bensch *et al.* 2008). However, aside from the European Community and Korean management measures described above (which are applicable to vessels with the relevant flags in any high seas area where there is no RFMO/A), the only known formal response to UNGA Resolution 61/105 for application in the Indian Ocean came from Australia.

AUSTRALIA

Development of the Encounter Protocol

Before the Australian Fisheries Management Authority (AFMA) introduced measures to protect VMEs in the high seas, the members of the South Indian Ocean Deepwater Fishers Association, whose trawlers are responsible for most of the bottom fishing within the SIOFA area, had already undertaken various conservation steps, including voluntarily setting aside 10 "Benthic Protected Areas" specifically for VME protection (Shotton and Patchell 2008). AFMA then added a rule preventing fishing outside the existing "footprint" of the fishery and instituted both a "move-on" rule and 100% observer coverage, all of which are currently imposed as permit conditions. In the Indian Ocean, the encounter protocol had a threshold of 100 kg of corals and sponges combined. Should that limit have been breached, the protocol required a five mile movement and the area within the five mile boundary then remained closed to the vessel which encountered coral or sponge for the duration of its permit but continued to be open to the rest of the fleet. Uniquely, should a bycatch exceeding the threshold be taken on a trawl or longline set, the closure did not take the form of a circle drawn around a single point but rather included the entire area within five miles of all points along the trawl track or all points along a line drawn between the locations where a longline was anchored. The standard wording of the permit condition, as of 2009, was:

> 26. If the take of coral and sponge exceeds 100 kg in any one shot, then the boat specified on this permit must not fish at any point within five nautical miles of that shot for the life of the permit.
>
> A shot is defined as:
>
> a) In the case of trawling, from the location at which the fishing gear was first deployed from the fishing vessel to the location at which the fishing gear was retrieved by the fishing vessel.
> b) In the case of longlining, from the location at which the first anchor of a set was deployed to the location at which the last anchor of that set was deployed.
> c) In the case of droplining or trapping, the location at which the dropline or trap entered the water.

The 100 kg limit was selected as being between the amounts taken by the many sets which take very little coral and the bycatches of those few which take a lot. Observer data showed few

sets taking between 50 kg and 200 kg. Since the introduction of the protocol, there have been sets in the Australian Indian Ocean fishery which have taken bycatch of corals and sponges exceeding the threshold and thus triggered movements of the vessel concerned[56].

It may be noted that this Australian protocol did not specify live coral, as the NAFO version and its derivatives did. Disputes have arisen over whether long-dead coral skeletons should be included but AFMA has ruled that they must be. A further complication has been found when it is sometimes difficult for an observer to distinguish such skeletons from rock.

At the end of 2010, AFMA was considering changing this encounter protocol such that exceeding the threshold would result in an area being closed to all vessels of the particular company involved in the event, all vessels using the fishing method involved or simply to all Australian vessels, pending an assessment to determine whether the area in question constitutes a "vulnerable marine area". There was also a commitment to a broader review of the VME-related management measures during 2011. It has been mooted that that review may lead to a tiered approach (with different measures for areas previously only lightly fished from those which apply in areas already intensively exploited), similar to the New Zealand arrangements described below[57].

Commentary

This Australian encounter protocol has not drawn much attention or comment, not even a note of its close similarity to the NAFO version. The innovative, linearly-extended closures merit consideration by RFMO/As and flag States worldwide but the fact that they are only closed to individual vessels seems a weakness. Including coral rubble within the bycatch to be assessed against the protocol's threshold may be counter-productive, for the reasons outlined above in respect of the NEAFC measures. The 100 kg threshold lacks any science-based foundation but appears pragmatic and effective. The requirement for a five mile movement was as arbitrary as the two miles selected by the Atlantic RFMO/As. While the longer distance places more seabed under closure and increases impediments to fishing, without information on patch sizes it cannot be said that the protection of VMEs is any the greater and might be less. The Australian fishing industry has expressed concern that only limited parts of a typical seamount can be trawled, leaving most of the seabed area at fishable depths as *de facto* VME reserves, yet an unfortunate encounter with a small patch of VME organisms on the limited trawlable bottom could result in a "move-on" order that effectively closed the entire seamount and prevented the harvest of its fishery resources (Shotton & Patchell 2008).

SOUTH PACIFIC

In April and May 2007, the nations participating in negotiations to establish an RFMO/A for the high seas portions of the South Pacific (currently dubbed the "South Pacific RFMO" or SPRFMO) agreed to interim, outline measures to protect VMEs, which included a requirement for vessels to move five miles after an encounter. Development of detailed protocols to meet the agreed outline was, however left to individual flag States. To date, only New Zealand and Australia have reported to the SPRFMO process that they have developed approaches to

[56] Mr. Trent Timmiss, Australian Fisheries Management Authority, *pers.comm.*.
[57] Mr. Trent Timmiss, Australian Fisheries Management Authority, *pers.comm.*.

implement those measures[58] and only the former has presented details of its management measures. New Zealand, however, has done so in a series of papers (Penney *et al.* 2008, 2009; Parker *et al.* 2009) that not only set down the measures themselves but also explained the reasoning and processes which led to them. That unique approach to a response to UNGA Resolution 61/105 is examined below.

The Australian measures applied in the SPRFMO area were almost identical to those outlined above for the SIOFA area, differing only in that the threshold in the South Pacific was set at 50 kg of coral and sponge, rather than the 100 kg that applies in the Indian Ocean. Since the introduction of the protocol, no Australian vessel fishing in the SPRFMO area has breached the 50 kg threshold. Nor has the protocol been altered since its introduction, though the same changes are being considered as noted above for the Australian protocol applied in the Indian Ocean[59].

In 2009, Spain submitted a fishery assessment to SPRFMO covering gillnetting for *Beryx*. The proposed management measures incorporated the same NAFO-derived encounter protocol described above for the southwest Atlantic, with 100 kg and 1,000 kg per-set thresholds, except that the distance to be moved after breaching a threshold was to be five miles – in accord with the distance adopted by SPRFMO[60]. Neither the assessment nor the encounter protocol was well received by SPRFMO's Science Working Group or its Deepwater Sub-Group. Specifically, the thresholds were described as "inappropriate", particularly the 1,000 kg for sponges[61].

Otherwise, since 2007 the Science Working Group has devoted much attention to the details of application of the SPRFMO requirement for assessments of fisheries but much less to encounter protocols. There has been some consideration of area-specific thresholds but, in the absence of scientific justification, it was decided not to proceed with that concept. Potential differences between protocols for longline and trawl fisheries were considered but without conclusions being reached[62]. In 2010, there was agreement that while a "move-on rule" might not be necessary in areas where "appropriate precautionary management and mitigation measures were in place", such a rule will likely be needed in new and exploratory fisheries where there is little prior information and rapid responses to encounters are required. It was also agreed, however, that higher thresholds should not be applied in new fisheries (despite the likely higher bycatch of VME indicator species) because the "move-on rule" will probably be the primary mitigation measure for those fisheries[63].

[58] *International Consultations on the Establishment of the South Pacific Regional Fisheries Management Organization, Seventh International Meeting, Report of the Science Working Group, Lima, Peru, 12 May–15 May 2009.*

[59] Mr. Trent Timmiss, Australian Fisheries Management Authority, *pers.comm.*.

[60] The fisheries of Spain in the Regional Organization of Management of Fisheries in the Pacific South (SPRFMO) during the season 2009/2010: Preliminary assessment of the risk of cause serious damage to the Vulnerable Marine Ecosystems and protocol of action. *SPRFMO paper* SP-08-SWG-DW-02.

[61] Deepwater Sub-Group, Scientific Working Group, 8th International Consultations on the Establishment of the SPRFMP, 5 November 2009, Auckland, New Zealand. Annex SWG-05 *in*: *Eighth International Meeting Report of the [SPRFMO] Science Working Group Auckland, New Zealand 2–6 November 2009*.

[62] Deepwater Sub-Group, Scientific working Group, 8th International Consultations on the Establishment of the SPRFMP, 5 November 2009, Auckland, New Zealand. Annex SWG-05 *in*: *Eighth International Meeting Report of the [SPRFMO] Science Working Group Auckland, New Zealand 2–6 November 2009*.

[63] Report of the Deepwater Sub-Group, Viña del Mar, Chile, 27 October 2010. Annex SWG-05 *in: Report of the 9th [SPRFMO] Science Working Group, Viña del Mar, Chile, 21-29 October 2010.*

NEW ZEALAND

New Zealand's high-seas bottom fisheries include otter trawling, primarily for orange roughy but also for *Beryx*, cardinalfish, oreo, and other species at depths of 200 m to 1200 m, plus longlining for bluenose. The national high seas fleet is, however, very small: between four and eight trawlers, plus three to five longliners, in each of the 2007 to 2009 fishing years. In the latter year, the six active trawlers made a total of 10 high-seas trips between them, including 190 fishing days during which there were 648 sets. Of the 958 tons of fish caught, 928 tons were orange roughy[64].

The New Zealand Ministry of Fisheries responded to the challenges posed by UNGA Resolution 61/105 and the 2007 SPRFMO agreement with an advanced and integrated suite of measures, within which an encounter protocol containing a "move-on rule" was embedded. Those measures were focused on the trawl fishery, as being both the dominant one and the one that has greater seabed impacts, though not entirely to the exclusion of management of the longline sector. (The longline measures did not include an encounter protocol and so are not further considered here.) Despite the considerable effort devoted to their development, the measures adopted were explicitly interim. They came into effect in March 2008 and were due for review during 2010, though that process had not proceeded as far as a public report by the end of the year[65].

The Management Measures

The Ministry of Fisheries divided the high seas areas under SPRFMO jurisdiction into "blocks", 20' of latitude and longitude on each side – hence about 300 square nautical miles (1,000 km^2) in area at the latitudes in question. The Ministry holds georeferenced data on all New Zealand high-seas trawl sets since 2002 – some 11,000 in total. Using those, the blocks were classified into "Heavily Fished', "Moderately Fished", "Lightly Fished" and those not fished at all. Any block that had seen only one or two sets during the five-year period 2002-06 (i.e. an average of <0.5 sets per year) was classed as Lightly Fished and was closed to further trawling for the duration of the interim measures, as were all blocks that had seen no fishing by the New Zealand trawling fleet during the five years. Any block which had seen 50 or more sets during the period (i.e. an average of ≥10 sets per year) was classed as Heavily Fished. Blocks that had seen between three and 49 sets, inclusive, during 2002-06 were classed as Moderately Fished.

In practice, 200 blocks in the SPRFMO area had seen some New Zealand bottom trawling during the five-year period, of which 62 were classed as Lightly Fished. The fishery had expended 95% of its effort (and taken 97% of its orange roughy catch) in the 69 blocks which met the criteria for being Heavily Fished. Eleven of those were closed to further fishing for the duration of the interim measures but the remaining 58 were considered to be open to trawling with no encounter protocol applying. The other 69 blocks were classed as Moderately Fished. Nine of those were closed under the interim measures while 60 were left open to trawling but subject to a five-mile "move-on rule".

Application of a complex encounter protocol was simplified in this fishery because 100% observer coverage was already mandated and it falls to the observers to identify any benthic

[64] New Zealand National Report on Fishing and Research Activities in the SPRFMO Area During 2009. *SPRFMO paper* SP-09-SWG-05.

[65] Except where otherwise indicated, the account which follows is based on the information provided by Penney *et al.* (2008, 2009) and Parker *et al.* (2009).

organisms taken. They were given both specific training and classification guides based on non-technical, visually-apparent characteristics. Even with that level of support, however, no detailed breakdown of the benthos was attempted. Rather, the observers were provided with a simple scoring sheet (see Figure 1) which allowed them to swiftly determine whether a threshold had been breached. The protocol established seven distinct thresholds, exceeding any one of which compelled a move by the trawler. For the bycatch of a single set, they were:

- 50 kg of sponges,
- 30 kg of scleractinian corals,
- 1 kg of gorgonian corals,
- 1 kg of antipatharian corals,
- 1 kg of alcyonacean soft corals,
- 6 kg of hydrozoans, or
- Any amount of any three of eleven named taxa, *viz.*: sponges, sea anemones, scleractinians, antipatharians, alcyonaceans, gorgonians, sea pens, hydrozoans, unidentified corals, crinoids, and/or sea stars of the Order Brisingida.

Once a vessel breached any of those thresholds and was required to move, it had to remain outside a circle of five miles radius drawn around the location of the set for the duration of its current trip. There was no requirement for other vessels to avoid the area and the vessel which exceeded the threshold was free to return to the same tow on subsequent trips.

Areas where thresholds were breached were not thereby automatically designated as containing VMEs but there was a generalised commitment to review the observer data and other pertinent information periodically and to take appropriate management action, including closing additional areas if consistent and significant evidence of the presence of VMEs was found.

Development of the Measures

These management measures were developed through consultations between the fishing industry, environmental non-governmental organisations, and New Zealand's Ministry of Fisheries, Department for Conservation and Ministry for Foreign Affairs and Trade, which discussions lasted from May 2007 until February 2008. While the published accounts of the process provide extensive science-based rationales for the decisions made, they also emphasize the necessity for management choices made in the face of conflicting objectives – some stakeholders aiming to protect all known or likely VMEs from any significant fishing impacts, while others sought access to sufficient areas to support a viable and sustainable fishery. Ultimately, it is unclear to what degree the protocol was a rational outcome of data-driven considerations *versus* a consensus compromise in which scientific advice provided only a rallying point around which disparate interests could gather[66].

The requirement to freeze the "footprint" of the fishery was set by the SPRFMO, and indeed by the UNGA, rather than by New Zealand. The published reports do not offer any explanation for the national-level decision to map that "footprint" by coarse 20' blocks. Having done so, their classification into three groups based on past fishing effort was sensible but the only justification offered for the break points between those classes was that, by averaging their less than three

[66] The latter would not have been inappropriate for swiftly-developed interim measures but might set an unfortunate precedent in the longer term.

tows in five years and rounding to the nearest integer, the Lightly Fished blocks could be said to have seen zero fishing. It may be surmised that the Heavily Fished blocks were similarly those with 10 or more tows per year.

The resulting 200-block "footprint" of the trawl fishery covers only some 0.5% of the entire high-seas area subject to the SPRFMO but encompasses 100% of the area shallower than 200 m, 90% of that between 200 m and 800 m and 22% of the 800 m to 2,000 m seabed – or nearly half of the potentially-trawlable bottom, taking 2,000 m as the practical limit on commercial fishing depths with existing technology. Closing the Lightly Fished blocks substantially reduced the potential impact of the fishery but there was a concern that the seabed in those blocks might not be representative of the habitats in Moderately and Heavily Fished blocks. Hence the 20 additional block closures were deemed necessary to provide "adequate and representative protection" but at an ecosystem or regional level, rather than locally.

The particular Moderately and Heavily Fished blocks selected for closure were spread across eight major fishing areas, though weighted towards those where more of the seabed was classified as Heavily Fished and thus left open to future fishing without an encounter protocol. Some blocks were selected for closure on the basis of being judged "representative", as seen on high-resolution bathymetric data gathered by the fishing industry. It may be noted that none of the decisions on which blocks to close, whether based on past fishing history or representativeness, involved any consideration of empirical evidence of the presence of VMEs – the foundation of the closure designs adopted by NAFO and NEAFC.

In all, 82 of the 200 previously-fished blocks were closed to New Zealand trawling through these interim measures. The net result was that 100% of the SPRFMO area shallower than 200 m was closed, as was 45% of that between 200 m and 800 m depth and 87% of that between 800 m and 2,000 m. Of the 1,450 seamounts known in the SPRFMO area, 97% lie outside the New Zealand bottom-trawl "footprint" and only 18 seamounts lie in Heavily Fished blocks, where they lack the (limited) protection afforded by the encounter protocol.

The use of a five mile "move-on" rule was required by the SPRFMO but its application only to Moderately Fished blocks and the lack of any resulting management action beyond the exclusion of one trawler on one trip were New Zealand decisions. The latter choice was not explained in the published reports but the use of the encounter protocol in Moderately Fished blocks alone was justified by the limited fishing in those areas having been exploratory in nature and largely confined to the flat seabed around the seamounts that bear most of the VMEs. As fishing effort continues in those blocks, it was expected to expand the area impacted and hence to encounter VMEs. The protocol was excluded from the Heavily Fished blocks since the preferred fishing areas within those blocks were thought to have already been substantially impacted, while forcing vessels to move if they should encounter a remaining patch of VMEs would only encourage expansion beyond the formerly-fished area.

Although one might expect that the key question for both VME conservation and the continuation of the fishery would lie in the extent and location of block closures, most of the attention to developing the management approach seems to have been directed towards selecting taxa and defining threshold levels of their catches to control the application of the "move-on" provision in Moderately Fished blocks. Penney *et al.* (2008) and Parker *et al.* (2009) presented contrasting accounts of how the taxa to be considered were selected and it may be that stakeholder consultations influenced decisions alongside the rational arguments that have subsequently been advanced. The process started with the suggestions from the FAO Expert Consultation of September 2007. Those suggestions named as examples of VMEs: corals

(scleractinians, alcyonaceans, gorgonians, antipatharians and stylasterid hydrocorals), sponge grounds, communities of dense emergent fauna, and seep and vent communities. In the New Zealand process, that list was both narrowed by the exclusion of taxa not taken in trawls and widened by the addition of taxa associated with hard substrates in deep water that can serve as indicators of the presence of VMEs, even when no VME organisms are taken. In parallel with that reasoning, or perhaps in explanation of its outcome, taxa were selected on the basis of being (1) fragile to trawl gear, (2) either structure-forming or else providing a unique ecosystem function, (3) unique, rare or endemic to a small area, (4) of low productivity (i.e. slow growth, high longevity, low fecundity or unpredictable recruitment) and[67] (5) known to be retained in trawl gear and readily identifiable at-sea by observers. The necessity for at-sea identification by non-specialists prevented the use of species- or even genus-level taxa and the final choices were seven taxonomic Orders, two Classes, and one Phylum. There was an explicit acceptance that some species within those higher taxa will not have the characteristics of concern.

The final list included all sponges (Phylum Porifera), the corals (Orders Scleractinia, Antipatharia, Alcyonacea, Gorgonacea and Pennatulacea, plus an "Unidentified Coral" category, which were listed as six different taxa), all sea anemones (Order Actiniaria), all hydrozoans (Class Hydrozoa), the crinoids (Class Crinoidea), and one group of starfish (Order Brisingida), for a total of eleven taxa. The inclusion of sponges and corals in the list needs no justification, though the inclusion of all species within the broad taxa, particularly the inclusion of all species of sponges, is a weakness of the approach. The hydrozoans were included because of concerns over hydrocorals of the Family Stylasteridae, particularly the large *Errina* spp. However, the expansion to include all hydrozoans considerably broadened the intent. The sea anemones, crinoids, and brisingid starfish were included as indicators of hard bottom that could potentially support corals, though it is not clear that they are any better suited as indicators (in trawl catches) of such habitat than are the corals themselves – crinoids in particular were noted as "infrequently observed" in catches. There seems to have been some thought that the larger anemones are themselves structure-forming but there is no sign in the published accounts of any awareness of the role of cerianthid anemones in providing three-dimensional structure on soft seabeds. The distinctive species found at hydrothermal vents were not included among the listed taxa since they have yet to be noted in fishery bycatch data – perhaps because the vent systems exist at greater depths than commercial fishing gear reaches.

There was some thought that, even when a trawl contacts an area of VMEs, the amount of benthos recovered in the net is so variable that only presence / absence data could be used in triggering the "move-on" requirement. Relying on the mere presence of such VME organisms would, however, risk unnecessarily spreading fishing effort into new areas, with a net increase in damage to VMEs, and hence it was decided to use quantitative thresholds. However, there was a desire to provide protection to areas of high biodiversity, in addition to those where a single VME species was notably abundant, and hence the hybrid approach was adopted, with a move triggered either by the presence of multiple taxa or by a high catch of any one. It seems that the original idea was to set different relative importances for the various taxa, though the final scheme employed only a single point for the presence in a catch of any of the eleven listed taxa and three points for any of six taxa that exceeded its quantitative threshold – while a total score of three or more points triggered movement of the trawler. The sea pens were not given a quantitative threshold, apparently because they inhabit soft substrates and are not indicative of areas where other corals live but perhaps also because the available observer database did not

[67] Parker *et al.* (2009) wrote "or" but their discussion of the selected taxa makes it clear that the decision-making used "and".

include a field for the Pennatulacea. The "unidentified corals" and the three indicator taxa were also not given quantitative thresholds[68].

There was an appreciation that bottom trawls are inefficient samplers of the species of interest, smashing more than is retained, and hence that quantitative thresholds based on amounts brought aboard (the only routinely-observable quantity) must be set low. In the absence of more-relevant information, the chosen thresholds were based on past bycatch data. In practice, it was decided that they should be equal to the per-taxon median bycatch weights (not corrected for tow duration) observed in the catches of those commercial trawl sets which took at least some coral and/or sponge from deeper than 200 m during the period 1998–2002 (1998–2007 for gorgonians and alcyonaceans, for which data were scarce). Data from sets made inside New Zealand's EEZ and from those on the high seas were included in the analysis. There were 1,603 such observed sets (305 high-seas, 1,298 EEZ), representing about 5% of all deep-water trawl tows in the period (the other 95% having taken no coral or sponge). Thus, the median amounts of coral and sponge bycatch in the "positive" sets were also approximately the 97.5th percentiles of all observed New Zealand deep-water trawl bycatch during 1998–2002.

The many records from 1998–2002 of unidentified corals were assumed to represent scleractinians, though in the deep-water environment it seems likely that much (perhaps most) were gorgonians. That questionable assumption may explain the very different thresholds applied to those two taxa (30 kg *versus* 1 kg).

Experience with the Protocol

During development of the encounter protocol, *post-hoc* analyses were made of the number of five mile trawler movements that would have been required had the protocol been in force when the observer data were collected. Penney *et al.* (2008) reported that 49% of the 1,603 tows from which the thresholds were derived would have triggered the "move-on" rule but that must be in error: Since medians were used in defining the thresholds, 50% of the sets should have exceeded the threshold for "scleractinians" (including unidentified corals) and 50% should have exceeded the one for sponges. In other datasets, those two taxa rarely co-occur in large quantities and indeed only one set of the 1,603 scored six points, indicating that two different thresholds were exceeded. Thus, very nearly all of the "positive" sets should have triggered a vessel movement by exceeding one or the other threshold. It may be that the assumption that all unidentified corals were scleractinians, which was used in defining the thresholds, was not applied when testing how the encounter protocol would have affected the former observed fishing.

Penney *et al.* (2008) further noted that only 27% of the sets made during 2002–07 would have triggered five mile movements, apparently meaning 27% of those which recorded at least some sponge or coral. Parker *et al.* (2009), in contrast, found that 8.6% of all New Zealand bottom-trawl sets in the SPRFMO area during 2003–07 would have triggered action – the two results being consistent if 32% of the sets were "positive" for coral or sponge. Parker *et al.* (2009) additionally reported that a mere 4.7% of the sets in the SPRFMO area in the 2008–09 season would have led to an enforced movement of the trawler, though that percentage included the many sets made in the Heavily Fished blocks, where the encounter protocol does not apply and where VME species are expected to be scarce on the regularly-fished grounds. However, all such comparisons risk being misleading since the existence of the protocol and its accompanying recording form were likely to change observer behaviours. Not only would the

[68] The lack of them for the indicator species reduced their value as indicators of VMEs.

formerly-unidentified corals be broken out by Order (very likely markedly increasing the recorded amounts of gorgonians) but small quantities of the listed taxa, likely previously ignored, would very probably be ticked off on the VME form. Either or both could lead to a substantial increase in the proportion of sets that receive a score of at least three. Conversely, the threat of being compelled to move on will discourage fishing in areas where VME indicator species are anticipated, reducing the number of triggering events, Indeed some New Zealand trawler captains already avoid the Moderately Fished blocks specifically to eliminate the risk of enforced moves[69].

In practice, during 2009 New Zealand trawl vessels made only 14 sets within the Moderately Fished blocks. Nine of those did not result in any reported bycatch of benthos, while four took amounts less than the established thresholds. Only one set (i.e. 7% of those to which the encounter protocol applied) triggered a five mile move. Between January and September 2010, the equivalent figures were 44 sets in Moderately Fished blocks, of which 22 took no reported benthos, 20 took less than the thresholds and two (4.5%) triggered movements[70]. It is not clear whether the greater number of sets made in 2010 that were subject to the encounter protocol indicates that the commercial fleet was learning to live with the resulting uncertainty in its operations or whether there were other causes.

The New Zealand observers have found that completing the VME record form did not present insurmountable problems. Its application at sea did require 100% observer coverage on the trawlers, while vessel operators chose to limit their fishing activity to the working hours of a single observer, in lieu of carrying a second one[71]. Since the fishery depends on targeted trawling (in contrast to the long tows typical of the fishery in the NAFO Regulatory Area), each vessel must spend considerable time searching for spots with suitable bottom and abundant fish. It may have proved efficient to devote the observer's sleeping hours to that searching.

Commentary

New Zealand's approach to avoiding harm to high seas VMEs is without doubt the most highly-developed yet implemented and, as an interim solution, its effectiveness appears comparable to those adopted by the Atlantic RFMO/As. It does, however, have particular characteristics, including some severe weaknesses, which might lead to failure if continued in force for too long and which should be considered before the same approach is used elsewhere.

Overall, for all of the effort expended on analysis of data, the New Zealand approach ultimately rests on a series of arbitrary choices, likely arrived at through consensus among disparate interests[72]. Consensus decisions have an important place in pragmatic fisheries management but, in the absence of empirical foundation, they are very unlikely to lead to optimal, or even near-optimal, outcomes – neither effective protection for VMEs nor efficient access to fishery resources. In the case of the New Zealand management approach, far from being optimal, the

[69] *Management of Deepwater Fisheries by Seafloor Feature in the South Pacific Ocean*. High Seas Fisheries Group, Nelson, New Zealand, 20p. [November 2010 draft of a position paper. Hereafter: *Management of Deepwater Fisheries by Seafloor Feature*.]

[70] New Zealand National Report on Fishing and Research Activities in the SPRFMO Area During 2009. *SPRFMO paper* SP-09-SWG-08.

[71] New Zealand SPRFMO Observer Implementation Report for 2009. *SPRFMO paper* SP-09-SWG-07.

[72] Though the consensus seems to be falling apart, if it was ever as strong as Penney *et al.* (2008, 2009) and Parker *et al.* (2009) implied. At least, the trawler operators have recently objected strongly to any notion that the interim measures be made permanent [*Management of Deepwater Fisheries by Seafloor Feature*].

end result as been described by those subject to its rules as “complex, subjective, and at times apparently incoherent” [73].

At a conceptual level, the initial steps of the approach, mapping the “footprint” of a high seas bottom fishery and preventing expansion (in the short term and pending assessments), were clearly appropriate and have also been taken by the Atlantic RFMO/As. Unless the intent is to emphasize conservation of non-resource species and the maintenance of ecosystems in virgin condition, however, freezing the “footprint” should be only an interim measure. If extended indefinitely, considerable amounts of potentially-exploitable fish biomass will be excluded from human use over the long term.

The greater problem with the New Zealand approach lay in the execution of those steps. The use of 20' blocks represents a very coarse spatial scale for addressing the protection of VMEs from fishing effort, each of which is aggregated over much finer scales. Such coarse management seems unnecessary given that geo-referenced fishing data were available. If continued, it would certainly unnecessarily restrict fishing in some areas while providing inadequate protection to important but small patches of VMEs in blocks open to fishing. Large blocks do facilitate effective enforcement, though New Zealand’s very small fleet of large high seas trawlers, subject to 100% observer coverage, should not pose major enforcement difficulties. Furthermore, identification of the “footprint” across these blocks was restricted to data on the distribution of fishing from 2002 to 2006, apparently for no better reason than that was the period for which a consistent dataset was available. The result was an underestimate of the extent of past fishing by the New Zealand fleet[74].

Once the “footprint” had been mapped, it was sensible to apply different requirements to fishing inside and outside that area, as discussed above for the NAFO and NEAFC encounter protocols. New Zealand, ihowever, opted to sort the 1,000 km^2 blocks into four classes and to apply three different management regimes to them. While different management for areas with different past histories can be appropriate, the New Zealand approach was to close about half of the bottom at fishable depths within the 2002–06 “footprint”, on the grounds that it had been little fished, and yet to remove (contrary to the requirements of both the UNGA and the SPRFMO) even the limited protection of an encounter protocol from any block that had seen more than about 2.5 km^2 swept area (50 of the short tows typical of targeted orange-roughy fishing) in five years – and that despite much of the targeted roughy trawling being along the same closely-defined lines, so that as much as 99.9% of the seabed in a “Heavily Fished” block may never have been contacted by a trawl. Those seem very extreme differences in management for very fine distinctions of past history[75].

The particular type of area closures used in the New Zealand approach, while perhaps fully adequate in an interim measure, will fail if prolonged. Freezing separate ““footprints” for trawlers and longliners is sensible while management is structured by coarse blocks, not because the gear types have different impacts on VMEs but because the two fisheries will tend to work different areas within each block while targeting different species. Freezing separate ““footprints” for the fleets of different nations that pursue the same fisheries, however, would be unwise in the long term. Not only does it unnecessarily restrict each fleet but it encourages the opening of more blocks in total, while promoting expansion of effort within the blocks to which

[73] *Management of Deepwater Fisheries by Seafloor Feature*
[74] *Management of Deepwater Fisheries by Seafloor Feature*
[75] Rogers & Gianni (2010) objected to NAFO and NEAFC applying their encounter protocols differently inside and outside the “footprints” of their fisheries but expressed no concern over New Zealand’s more-complex system, save for noting the absence of encounter provisions in the “Heavily Fished” blocks.

each nation's trawlers are confined, when effort might better be re-directed to blocks that are open to other nations. Closing selected or representative blocks on the prime fishing grounds to the vessels of one nation is particularly apt to be harmful to the fishing industry without benefit to conservation objectives if those same blocks are fished by other fleets. Moreover, closing actively-fished blocks as a temporary measure has little merit, since any VMEs on the known trawl tows in those areas are likely to have been heavily impacted already and will not significantly recover over the few years of interim management. Unless there is a reasonable expectation that the other flag States with trawlers operating in the SPRFMO will eventually adopt the New Zealand closures (an improbable expectation, considering that the closed blocks were largely selected on the basis of a past history of exclusively New Zealand fishing effort), going any further than freezing the "footprint" of the fishery was apt to be an empty gesture – and a costly one to the industry.

Among measures to protect VMEs, the New Zealand encounter protocol is, to date, the sole example globally of an attempt to apply different thresholds to different species, beyond the crude separation of corals and sponges used by the Atlantic RFMO/As. It is also one of only two attempts that explicitly has considered a wider range of taxa – two complexities that have been urged on other RFMO/As by Rogers & Gianni (2010). It is thus interesting that the New Zealand attempt encountered such great difficulty in establishing meaningful levels for the thresholds. None were based on a combination of the densities of animals on the seabed that define VMEs with the catchabilities in trawls of the species in question. Instead, they were selected on the basis of an arbitrary percentile of the bycatches recorded in a data set of doubtful relevance. The decision to use the median of the positive bycatches in that dataset (equivalent to approximately the 97.5th percentile of the entire dataset) was clearly arbitrary and presumably nothing more than a consensus choice of the various parties to the consultations. Had the choice instead been to use the upper quartile of the "positive" sets, the thresholds would have been more comparable to those adopted by the Atlantic RFMO/As: 200 kg of sponges, 100 kg of scleractinians, or 80 kg of hydrozoans. Less obviously, the dataset used was also arbitrarily selected and perhaps chosen for no better reason than that it was the only one available. Not only were three-quarters of the data points drawn from fishing in waters under national jurisdiction but many of the trawl sets inside the EEZ had been directed towards hoki, which are caught in a different depth range and usually on a different habitat type to those fished by the high-seas fishery for orange roughy. Only 530 of the 1,603 sets used in the analysis were roughy-directed. The choice of the 1998–2002 period was justified as being the exploratory phase of the New Zealand deep-water fishery, when VME encounters might be expected to have been frequent. Yet the fishery for both hoki and roughy inside the EEZ was developed in the early 1980s and the grounds where most of the data were gathered may have been depleted of most VME communities by the end of the century – lowering the medians and hence the thresholds. In short, despite the aura of a science-based foundation for the thresholds, their real justification can only be that they were seen by parties to the management consultations as providing an acceptable, if arbitrary, balance between VME conservation and the maintenance of a viable fishery.. The attempt to include scores for high biodiversity was particularly weak, with only selected taxa being considered and those only at the Ordinal level or above, yet those taxa were scored by presence/absence alone. It is doubtful whether a more refined set of thresholds could be applied at sea but the New Zealand attempt at a compromise between pragmatism and complexity seems a warning that simpler thresholds will be better unless and until the data needed to support greater complexity have been gathered.

Nor can it be said that the New Zealand thresholds were appropriate. Requiring that a vessel move five miles if it takes 1 kg of precious corals or 6 kg of hydrocorals may not be unreasonable, but forcing a move because of 1 kg of either gorgonians or alcyonaceans seems

excessive. The use of broad, all-inclusive taxa (notably the Phylum Porifera and the Class Hydrozoa, each of which includes many small species in addition to the few VME-forming ones) risks triggering the "move-on" rule when only small, encrusting species are present. Such animals are unlikely to be taken in sufficient amounts to exceed the quantitative thresholds but one fragment of sponge and some hydroids growing on a cobble could combine with a single sea anemone to reach a "biodiversity" score of three – triggering a move of the trawler, potentially away from the fish but also away from an area with no VME organisms and into a previously unfished area with rich epibenthos. Indeed, compelling a move when any amount of any three of 11 taxa are taken seems likely to generate an excessive amount of movement, even were those taxa narrowly defined – particularly when a single coral colony could be scored as two taxa, one of them being "unidentified" fragments.

Yet, if the thresholds for the selected taxa seem overly cautious, even the expanded range of taxa incorporated into the encounter protocol leaves some types of VMEs without protection. Bryozoan beds or xenophyophores, for example, are not likely to co-occur with large amounts of sponge or coral and yet have no thresholds of their own.,

Worse, the instructions to observers on the standard recording form call for weighing all animals in any of the taxa, whether alive or dead. That would be appropriate if intended to include only those animals killed by the fishing operation which captured them. It is the understanding of the trawling companies, however, that observers also weigh long-dead skeletal material, including coral rubble[76], raising the same concerns as with the similar treatment by AFMA (see above).

Once one of the multiple thresholds has been breached, however, this highly-developed and complex New Zealand protocol requires nothing more than a temporary displacement of a single vessel. That must be counted a serious defect of the approach. In the orange roughy fishery of the SPRFMO area, with its emphasis on targeted trawling on scarce tow lines, a required movement outside a five mile radius circle can be onerous for the vessel concerned, since there may not be an available fishable location beyond that distance which does not require a long steam[77]. Yet, limiting the resulting closure to a single vessel and a single trip robs it of most (if not all) of its conservation value when the objective is avoidance of long-lived, sessile VME species. The New Zealand encounter protocol would prevent a single vessel from concentrating its effort on an area where VME organisms are abundant but it would not prevent the fleet from gradually eroding the margins of an important patch of VME organisms situated adjacent to a favoured trawling ground. Considering the economic costs of a large coral or sponge catch, including damaged fish catch, increased labour on board and possible net repairs, deliberate return to a VME patch is perhaps less of a problem than the long-term accumulation of many small targeting errors, which are not prevented by the New Zealand protocol.

The New Zealand high seas trawling industry, with its very different understanding of the spatio-temporal distribution of its fishing from that used by the Ministry of Fisheries, has called for a radical change in the protocol. The industry, and also the management agency when considering resource conservation, views the fishing grounds in terms of individual "features" (such as seamounts), rather than as a grid of blocks. The seabed has rugged bathymetry and trawling is confined to a few known tow lines. The fishermen estimate that only 5 to 40% of each feature is fishable – a status which requires an absence of large amounts of coral or sponges. Hence, most of the potential VMEs, even on a fished feature, are safe from the impacts of

[76] *Management of Deepwater Fisheries by Seafloor Feature*
[77] *Management of Deepwater Fisheries by Seafloor Feature*

trawling. Yet there are VME indicator species living on every feature, such that a net which strays a little to either side of the intended track may take sufficient bycatch to breach a threshold[78]. Under the present New Zealand encounter protocol, any vessel unfortunate enough to do so is "punished" by an enforced move to another tow line – perhaps a powerful encouragement to take more care in future but otherwise of no conservation value. Should the protocol be changed to provide for meaningful closures where bycatch exceed threshold limits, then a tow line would be closed to the entire fleet whenever one vessel strayed to either side. Neither seems a sensible alternative. Rather, such a targeted fishery may need its "Heavily Fished" areas delimited as individual tow lines, free of any encounter protocol, with attempts to establish new lines being subject to strict thresholds and indefinite closures to the whole fleet if they are breached.

NORTH PACIFIC

Inter-governmental meetings to establish an RFMO/A for bottom fishing in the North Pacific, involving Japan, the Republic of Korea, the Russian Federation, and the United States, began in 2006 and are on-going[79]. The lack of high seas bottom fisheries in the eastern portion of the Ocean has focused negotiations on the northwest Pacific[80]. The existing fishery exploits primarily alfonsino and armourhead by bottom trawling and some gillnetting on certain of the seamounts in the Emperor Seamount Chain. In 2009, there were seven Japanese vessels, nine from Korea and 26 from Russia authorized to take part in the fishery, though the Russian fleet was not active in the region.

Draft interim measures for VME protection in the North Pacific were produced by the 2nd Multilateral Meeting in February 2007. As revised through to October 2008[81], those called on the Participating States to limit their fisheries to existing effort and capacity, to freeze the "footprint" of the fishery and particularly to limit fishing to seamounts south of 45° North latitude (aside from when fishing under an exploratory protocol), to cease fishing in areas where a VME is known to occur (unless measures to prevent significant adverse impacts are in place), to ensure 100% observer coverage, to exchange various forms of information, and to introduce an encounter protocol. The latter required a vessel that encounters "coldwater corals" to cease bottom fishing activities and to move no less than five miles. The encounter, its location and the species encountered were to be reported to the Interim Secretariat, which would then inform the other Participating States "so that appropriate measures can be adopted in respect of the relevant site". The one substantial revision to the protocol during 2008 was an explicitly "tentative" agreement that the term "coldwater corals" includes the Alcyonacea, Antipatharia,

[78] *Management of Deepwater Fisheries by Seafloor Feature*

[79] Much of the information on the North Pacific fishery and the multilateral process presented here was extracted from the latter's website http://nwpbfo.nomaki.jp/.

[80] With little or no bottom fishing outside areas of national jurisdiction in subtropical or tropical latitudes, and equally little in the ice-covered portion of the Arctic Ocean beyond the EEZs of the coastal States, almost all of the fishing that is subject to UNGA Resolution 61/105 falls under the purview of one or another of the existing or emergent RFMO/As considered in the present review or else in the southwest Atlantic. There are, however, two mid-latitude high-seas areas that, despite being intensively fished, appear to have escaped attention to the adverse impacts of that activity on VMEs. Both are located in marginal seas of the North Pacific. They are the Bering Sea "donut hole", between the EEZs of Russia and the United States, and the "peanut hole", which lies in the Sea of Okhotsk, surrounded by the Russian EEZ. There is an RFMO/A for the "donut hole", the Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea, but it is concerned with the Alaska pollock fishery alone.

[81] Fifth Inter-Governmental Meeting on Management of High Seas Bottom Fisheries in the North Western Pacific Ocean, working paper NWPBF5/WP15/Rev3.

Gorgonacea and Scleractinia. The agreed text also stated that the protocol "will be reviewed by the Participating States, and may be modified from time to time as more information becomes available"[82]. Subsequent meetings adopted an exploratory fishery protocol and discussed the application of the interim measures to the northeast Pacific but have not modified the measures agreed in 2008.

Japan introduced a national "tentative protocol" to give effect to the international agreement in 2008. It was modeled rather closely on the NAFO encounter protocol, though it used a single threshold of 50 kg of live coral (with no limit on sponges or other organisms). There was the same two mile "move-on" requirement as is used by the Atlantic RFMO/As, essentially the same reporting requirements, and the same request for other Participating States to institute two mile radius closures around encounters in "new fishing areas"[83]. To date, no set has exceeded the 50 kg threshold[84].

In response to inquiries from the United Nations Secretary General in 2009, Russia reported that it required five mile movements from any of its fishing vessels which encountered VMEs. At the same time, Korea declared that, like Japan, it would use the NAFO protocol for its vessels fishing in the North Pacific[85]. Although both of those nations presented verbal reports on their implementation of the interim measures to the 9th Multilateral Meeting in September 2010[86], neither has yet provided written details.

DISCUSSION

In fisheries where they can be effectively implemented, encounter protocols hold out much promise as an efficient means to achieve avoidance of small-scale, ephemeral concentrations of unwanted catch, be that undersized fish, unmarketable crabs, bycatch of non-target species or a take of protected animals. However, such protocols will inevitably be inefficient, if not actually ineffective or even counter-productive, for protecting VMEs since those are not ephemeral at all. Indeed, much of what makes a typical VME vulnerable is that its key, structural species are very long-lived and sedentary. It will always be better to avoid encounters in the first place, by closing areas before they are fished, rather than moving fishing vessels away after the damage is done. Most VMEs, however, occur in small-scale patches, at such great depths that comprehensive surveys would be unaffordable, while existing scientific knowledge of most kinds of VME is limited, such that interpolation between scattered observations of their occurrence must be highly uncertain. Closures implemented now that protected most existing VMEs would have to be grossly inefficient, in as much as they would necessarily close much seabed that does not support any VME in order to ensure that the small and unknown patches of VMEs were all protected. In practice, it is likely that most, if not all, high seas bottom fisheries would have to be closed entirely. That was not the intention of UNGA Resolution 61/105 and reconciling the dual but conflicting aims of continued seafood production from the high seas and effective protection

[82] *New Mechanisms for Protection of Vulnerable Marine Ecosystems and Sustainable Management of High Seas Bottom Fisheries in the Northwestern Pacific Ocean*. (Adopted 2 February 2007. Revised 26 October 2007, 18 October 2008 & 20 February 2009).
[83] *Report on Identification of Vulnerable Marine Ecosystems in the Emperor Seamount and Northern Hawaiian Ridge in the Northwest Pacific Ocean and Assessment of Impacts Caused by Bottom Fishing Activities on such Vulnerable Marine Ecosystems or Marine Species as well as Conservation and Management Measures to Prevent Significant Adverse Impacts*, Appendix Q: *Tentative protocol for encounter with coral*, Fisheries Agency of Japan, 2008.
[84] Mr. Shingo Ota, Fisheries Agency, Japan, *pers.comm.*
[85] Report of the Secretary General A/64/305, pp. 41–42.
[86] Ms. Cheri McCarty, International Fisheries Affairs Division, National Marine Fisheries Service, *pers.comm*.

of VMEs requires smaller closures, where VMEs are relatively dense, and a means of protecting other VMEs when they are encountered in areas left open to production. The combination of long temporal scales with small spatial ones and large scientific uncertainty means that even inefficient encounter protocols can be valuable adjuncts to the protection of VMEs from direct human impacts, not as primary management measures but as a form of "back stop" to limit damage when fishing gear unexpectedly contacts an unknown patch of a VME – and indeed as temporary "back stops" for use only until the occurrence of VMEs has been effectively mapped.

The alternative would be to reverse the onus and close all high seas areas, or at least those at the depths where VMEs are expected to occur, to bottom fishing until such time as specific areas can be shown not to support any VMEs. While that appears to be the preferred approach of some commentators (e.g. Auster *et al.* 2010, Rogers & Gianni 2010), it is not one that has been endorsed either nationally or internationally, not even by the conservation-oriented CCAMLR. Rather, UNGA Resolution 61/105 expected that high seas bottom fishing would continue and, in effect, demanded the application of encounter protocols. They have been adopted in one form or another as secondary support for other measures by most of the RFMO/As that have responsibility for bottom fisheries in the high seas. In 2007–08, however, there was no foundation of knowledge of how efficient encounter protocols for the avoidance of VMEs should be designed, while the RFMO/As were faced with very restrictive deadlines set by the UNGA. The result was a rash of interim but pragmatic measures, none of which can be said to approach any sort of long-term ideal. It may be noted that there has been little interest, among the world's coastal States, in trying to extend these protocols into waters under national jurisdiction, where the UNGA Resolution does not apply. That is, perhaps, a mute comment on the expected effectiveness of the current generation of encounter protocols for VME protection.

While pragmatism is always important in fisheries management and was necessarily a primary consideration when developing interim encounter protocols to meet the deadlines of UNGA Resolution 61/105, it should be possible to do better. Future development of an efficient protocol for avoidance of VME will require, among others:

- Some understanding of what constitutes VMEs in the region in question and preferably a quantitative operational definition of "VME",
- A means of determining that VME-related species have been encountered during a fishing operation,
- Some threshold to distinguish an encounter with isolated organisms characteristic of VMEs from an encounter with a patch of such significance as to be VMEs,
- A required response to the encounter that minimizes, or eliminates, further adverse impacts to the VMEs, and
- A governance system that ensures that the response is undertaken as intended.

The first of those is outside the scope of the present review, except to note that it has been universally accepted among RFMO/As and their member States, if not by all stakeholders or commentators (e.g. Auster *et al.* 2010), that the mere presence of VME-related organisms is not sufficient to make an area "VME". Protocols must be designed to prevent ongoing contact between fishing gear and more-substantial concentrations of vulnerable organisms without responding to encounters with single coral "trees". It remains to consider the other four requirements.

All existing encounter protocols designed to avoid impacts on VMEs rely on bycatch in commercial fishing gear as the indicator of an encounter. Yet most such gears are, by design,

very poor epibenthic samplers and the exceptions, such as scallop dredges, are unlikely to be allowed anywhere near VMEs. Neither finfish trawls nor longlines can be expected to provide reliable, let alone quantitative indications of the benthos encountered by a set (cf. Auster *et al.* 2010, Rogers & Gianni 2010). Nevertheless, no other indicators are immediately available and it was to be expected that the RFMO/As' initial, interim encounter protocols should rely on bycatch for want of anything better. As those measures are replaced, however, consideration should be given to quite other approaches. With existing technology, it would not be impossible to deploy cameras on the headropes of trawls as a routine matter – an option apparently being considered by the Southern Indian Ocean Deep-sea Fishers Association[87]. Alternatively, it may be possible to detect VMEs acoustically, perhaps using a high-frequency system again mounted on the net during every commercial set. If such technology proves too fragile, some fisheries might routinely deploy small epibenthic dredges, towed behind the otter boards of the trawls, to gather samples for examination on board.

While considering how to observe the benthos, it is also necessary to determine which benthic taxa should be taken into account when evaluating whether or not a VME has been encountered. The interim protocols that have necessarily relied on bycatch in commercial gear have been limited to taxa that can be retained in such gear more than merely occasionally. It is also essential that the taxa to be considered can be recognized at sea by observers, while the list must be further restricted to those taxa which either define VMEs or are confident indicators of their presence – which may require that the chosen taxa are narrowed to groups far smaller than phyla or classes. Conversely, there will usually be multiple types of VMEs within any one region of the ocean and no encounter protocol could be truly effective if it only considered indicators of a subset of those types. Most of the RFMO/A- and national protocols implemented to date have been limited (in practice if not on paper) to considering corals and sponges or just corals alone. New Zealand and CCAMLR have, however, had some success using wider ranges of taxa, and their experience should be examined as new protocols are developed. The New Zealand attempt to incorporate a measure of diversity into its encounter protocol, while of questionable merit as it was implemented, deserves further consideration.

Rogers and Gianni (2010) emphasized the point that encounter protocol thresholds should be related to the densities of the taxa which qualify a concentration of VME-related organisms as being formally "VME". That is certainly correct, since the objective of the encounter protocol under UNGA Resolution 61/105 is to move fishing activity away from VMEs and not simply from VME indicator species. Hence, there is a pressing need to define VMEs in terms of the densities of key taxa and to convert those values into thresholds, taking into account the sampling and recording efficiencies of the gears or instrumentation used. However, only NAFO has yet both used quantitative methods to delineate VMEs and proceeded to thresholds based on that earlier analysis. Even that effort fell short of its objective, since there was no sure way to extrapolate from the magnitude of research-vessel bycatch (which provided the basis for delineating VMEs) to those taken in commercial fishing – to which the encounter protocol thresholds apply. Thus, similarly to those in the New Zealand protocol, the NAFO thresholds are partially consensus-based limits and not strictly empirically founded. Given the existing rudimentary state of knowledge of the relationships between quantities of bycatch and densities of indicator taxa in the area fished, there has been little alternative. Indeed, if the political compromise is reached through discussions which fully incorporate the views of both the high seas bottom fishing industry and ENGOs, a reasonable balance may be struck that is sufficient for an interim measure. Achieving societal goals for oceans management over the long term will, however, require science-based thresholds. Before they can be provided, there will have to be a

[87] Dr. R. Shotton, *pers.comm.*

substantial research program, which cannot be completed swiftly, to calibrate the recordable data (e.g. bycatch in commercial fishing) to the presence or absence of VMEs. In the interim, encounter protocol thresholds will, of necessity, have thresholds that are more arbitrary and pragmatic than they are scientific.

As better-founded thresholds are developed, they would ideally be specific to particular taxa, to particular gear types, and to particular regions – which might be smaller than the region subject to a particular RFMO/A (cf. Auster *et al.* 2010, Rogers & Gianni 2010). There are, however, practical constraints on how far such subdivision can proceed before both at-sea observers and the on-shore management system will be overwhelmed. Besides, until genuinely science-based thresholds can be developed, there seems little point in proceeding very far towards selecting multiple different consensus-based limits, as New Zealand has done, though something more advanced than simply setting one threshold for corals and another for sponges should be possible.

The thresholds might also usefully be related to fishing or sampling effort, such that longer tows would be given higher thresholds (though likely not *pro rata* to tow length). Besides increasing complexity, however, basing a threshold on a bycatch rate, as distinct from a per-set bycatch amount, could leave small but valuable patches of VMEs unrecognized in the bycatch of a fishery that makes long tows. Longline bycatch (as in the CCAMLR case) is different in that the locations along the line where VME organisms were taken can be determined as the gear is hauled, allowing an even scatter to be distinguished from a small, concentrated patch.

There is also scope for considering more developed concepts of thresholds. Outside of the CCAMLR and New Zealand encounter protocols, the existing thresholds seem to have been designed to immediately halt the most egregiously-harmful fishing. Should their levels be lowered to correspond to the minimum densities of organisms that would qualify a particular tow line as “VME”, as Rogers & Gianni (2010) suggest, the result might be multiple, impractically-small closures. Should those subsequently be united into larger closed areas or individually given surrounding buffer zones, the average density of VME-related species within each closure would fall below the marginal levels that define VMEs. Thus, even when thresholds can be related to quantitative definitions of VMEs, they should be set above the defined limits – the optimum spread between those being a function of VME patch size and patch spacing.

A better response for fishing within the defined “footprint” of an existing fishery might be to retain thresholds similar to the current high levels used by the Atlantic RFMO/As as a basis for the immediate movement of vessels but to add a slower, but still rapid, mechanism for closing areas based on average bycatch and much lower per-set limits – such as closing a five mile circle around any point when the average bycatch of VME-indicators within two miles of that point exceeds 5 kg per set, with the averages to be re-examined weekly. To prevent any one vessel from working to the average while destroying VMEs, there could be a per-trip limit for all VME indicator bycatch combined. Any such rule would place considerably more demands on observers and on data-reporting procedures than the current encounter protocols do but such an approach might allow the desired degree of protection for VMEs with the least disruption to the fisheries, potentially justifying increased data-collection costs. CCAMLR has moved some way towards such data gathering. For the other RFMO/As and the fishermen working in their jurisdictions, it would be a major shift in orientation and a substantial increase in management burden – though it would not be a unique one for Canada, which already uses averages across sets in the soft-shell protocols of the Gulf of St. Lawrence crab fisheries.

Once a threshold has been breached, all of the existing protocols meet the requirement of UNGA Resolution 61/105 that fishing cease in the area, at least in selected portions of the fishing grounds. To date, each such rule invokes an arbitrary, or perhaps *ad hoc*, minimum movement distance – be it one, two or five nautical miles. At best, some consensus has been reached that the selected distance is reasonable but the reasonableness has been judged in the absence of knowledge of the scales of VME patch sizes or the distances between them and very possibly in equal ignorance of the spatial scales of fishable bottom, of fish concentrations or even of the spatial precision with which the gears used in the fishery can be targeted. Without better knowledge, the choice of a distance must be based on untested and likely poorly understood assumptions about spatial distributions. Should those assumptions prove to be erroneous, however, the "move-on" requirements risk not merely being inefficient but actually seriously harmful to both VMEs and the sustained viability of fishing operations.

It is too easily supposed that, if fishing has negative impacts on VMEs, then any restrictions on fishing must benefit VMEs. The converse will often be the case, since area-based restrictions serve to displace but not reduce fishing effort. That any enforced movement comes with a cost to the vessel concerned is almost certain: fishermen will have selected their preferred fishing location through some form of optimization and requiring them to move will, with occasional exceptions, increase costs, reduce the value of the catches or both. However, moving fishing effort away from the fishermen's preferred location will typically increase the effort required to land the allowable catch, with a parallel increase in bottom contact. Unless the movement is successfully directed away from VMEs and into less-valuable areas, which is hard to ensure without knowledge of patch distributions, there will be a net increase in adverse impacts. If the movement is away from a small patch of VME within an extensive, long-fished area, there is a substantial risk that the fishing effort will not only increase but will be displaced into areas with richer VMEs (cf. Parker *et al.* 2009, Auster *et al.* 2010). If VME recovery times following fishing-gear impacts were measured in years, one might accept that the fishery could be kept "moving on" until it reached seabed devoid of VMEs. In reality, however, the structural species that characterize VMEs typically have recovery times of decades or centuries and the habitats that some construct (such as the reef structures sometimes formed by *Lophelia pertusa*) may not be replaced for millennia following trawling impacts. It is most definitely not desirable to map such ecosystems by driving fishermen to make one tow per five miles across the seabed. In short, very much more attention to spatial distributions is urgently needed as a foundation for effective encounter protocols.

Whatever the distance required to be moved, it is absurd for the area vacated not to include the location where a set actually encountered VME, as could happen under the NAFO protocol and its derivatives. Rogers & Gianni's (2010) suggested solution was to base the distance to be moved on the precision with which the location of encounter can be determined, which might mean closing a circle, centred on the mid-point of a tow, with a diameter equal to the length of that tow – many miles in the case of the fishery in the NAFO Regulatory Area. The Australian alternative of moving effort out of a strip centred on the tow line of the set which breached the threshold promises to be far more efficient, though also more burdensome for fishery managers. In a longline fishery, of course, it is possible to determine where, along the length of a set, an encounter with a VME happened, removing this particular difficulty (as is illustrated by the CCAMLR protocol). When fishing the continental slope or the flank of a seamount, it might be more effective to require a movement to a different bottom depth, rather than any linear displacement – an option used in the small-fish encounter protocol in the New Zealand hoki fishery (Shotton & Patchell 2008). That would only be a viable option, however, if the target species has a broader depth range in the local area than do the VMEs.

Once the extent of an area to be vacated around a point of encounter has been determined, it seems sure that the only useful management response is to close that area indefinitely to all bottom fishing or at least all bottom fishing similar to the set which breached the threshold. If the area in question is large, then it might be optimal to allow, for example, longlining for one species while banning trawling for a different resource (as seen in the New Zealand block closures), on the grounds that the two fisheries will be differently distributed over fine spatial scales. There is, however, little protection for VMEs to be found in a closure to a single vessel or the vessels of single flag State, unless perhaps such a group comprises a large majority of the total fishery in the area, while the costs of such disturbance to commercial operations can be high. Even though a single trawl tow through a *Lophelia* reef causes severe damage along a narrow swath, the major seabed impacts of fishing gears arise from repeated impacts over broad areas. For long-lived VME organisms, even impacts repeated at intervals of a few years will accumulate into extensive damage. In most fisheries, those impacts will be accidental since the cost of gear damage, of catches damaged by large amounts of corals or sponges in the cod-end and of labour required to clear the benthos from the deck combine to discourage fishermen from contacting areas of rich VME. In coastal waters, however, it has been seen that repeated accidental impacts gradually reduce patches of epibenthos and expand the area of trawlable bottom. The same can be expected with the long recovery times of high-seas VME organisms unless fishing activity ceases after the first encounter. Any indefinite automatically-triggered closures should, of course, be subject to review and either acceptance for continued closure or re-opening. Most of the existing encounter protocols provide for just such a process but the closures should continue until a rational decision is made to delete them, rather than expiring at the end of a trip or a licensing period.

All of the above considerations would be vain if they were not linked to a governance system which ensured that the encounter protocol was applied in practice. That is partly a matter of monitoring at sea, which places a heavy reliance on observers and automated monitoring of vessel locations. Indeed, 100% observer coverage is probably essential to ensure that indicator organisms are correctly identified and quantified. Depending on the particular fishery, the observers may also be necessary to ensure that any breaching of a threshold triggers the intended response. Vessel monitoring systems will likely be equally essential, once recorded encounters lead to the fishing grounds being dotted with multiple circular closures, each a few miles in diameter.

The greater challenge for a governance system, however, will lie in efficiently receiving reports of encounters, promulgating notices of interim closures and then swiftly following with analysis and decisions concerning larger, long-term area closures that encompass multiple encounter locations. The Atlantic RFMO/As nominally have such systems within their encounter protocols but it remains unsure whether they could cope with the stream of reported encounters that would follow if and when their thresholds are markedly reduced. The cumbersome reporting and notification through flag States, along with the burden on scientific advisors, may prove unsupportable. It is at least encouraging that CCAMLR, Australia, and New Zealand have each dealt with breaches of their thresholds and have apparently done so successfully.

It is not expected that there is a single way to answer these challenges that would be optimal for all fisheries. Rather, as with other facets of management, an efficient encounter protocol will need to be tailored to the characteristics of a particular fishery. Not only should a protocol for longlining be different to one for trawling, but trawling with the long tows typical of the NAFO Regulatory Area will need a different protocol from targeted trawling for orange roughy in the South Pacific. It is likely that encounter protocols that are structured around both the spatial patterns of VMEs in the region in question and the fishermen's spatial understanding of their

fishery will be the most effective. Circles of specified radii or blocks defined by the latitude and longitude grid may appear to be obvious choices when considered on paper and may suffice when managing a fishery that operates on a broad fishing bank, but they are unlikely to be efficient if applied to fishing on the steep and broken topography of the continental slopes, submarine canyons and seamounts which are the typical environments of high-seas bottom fisheries.

Finally, it should be well understood that even if these several onerous steps were completed successfully, there is no certainty that an encounter protocol will prevent significant adverse impacts to VMEs in areas open to fishing. While the harvesting of the deep-water, bottom-dwelling fishery resources of the high seas remains an international policy goal, a well designed encounter protocol could reduce the extent and severity of adverse impacts to VMEs. However, any such protocol assumes that encounters will continue and they may well continue at a rate that exceeds the recovery potential of the VMEs. Given that reality, there may be limited benefit in expending resources on the development of an optimal encounter protocol, when a simple and pragmatic one may be almost as effective.

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TABLE

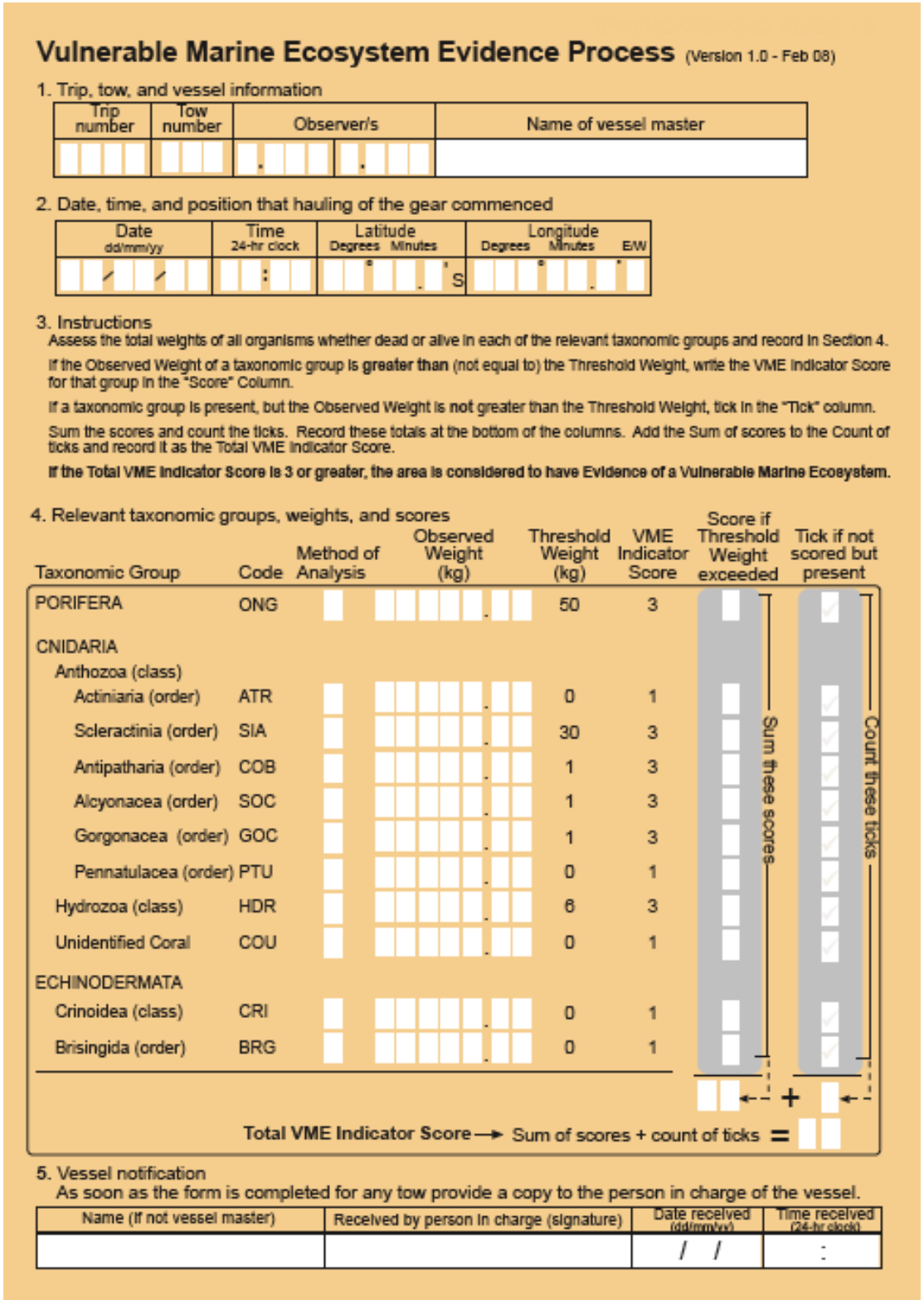
Table 1: Summary of Principal Features of Encounter Protocols Adopted by RFMO/As and Flag States to Address Impacts on VME

Protocol	Indicator	Threshold	Action Triggered	Special Features
NAFO, NEAFC, SEAFO 2008	Live Corals & others Live Sponges	100 kg per set 1,000 kg per set	Move 2 miles from end of set and report. If outside "footprint", temporary 2 mile radius closure to all vessels	SEAFO requires subsequent sets be parallel to one that breached threshold
NAFO, NEAFC, SEAFO 2009	Live Corals & others Live Sponges	60 kg per set 800 kg per set	Move 2 miles from end of set and report. If outside "footprint", temporary 2 mile radius closure to all vessels	Revised thresholds based on extrapolation from NAFO definition of VME for long-term closure
CCAMLR Conservation Measure 22-07	Taxa in *CCAMLR Benthic Invertebrate Classification Guide*	5 Indicator units per line segment	Report	Protocol for longlines and traps only Does not apply in areas with established fishery
		10 Indicator units per line segment	Temporary 1 mile radius closure to all vessels	
Australia Indian Ocean	Live & dead corals & sponges	100 kg per set	Move 5 miles from set and remain away for duration of permit. Area remains open to other vessels	5 mile movement is away from any point on trawl track or on line between locations of longline anchors
Australia South Pacific	Live & dead corals & sponges	50 kg per set	Move 5 miles from set and remain away for duration of permit. Area remains open to other vessels	5 mile movement is away from any point on trawl track or on line between locations of longline anchors

Protocol	Indicator	Threshold	Action Triggered	Special Features
New Zealand South Pacific	Live & dead sponges	50 kg per set	Move 5 miles from set and remain away for duration of trip. Area remains open to other vessels	Only applies to trawl fishery in “Moderately Fished” blocks that are open to fishing
	Live & dead scleractinian corals	30 kg per set		
	Live & dead gorgonian corals	1 kg per set		
	Live & dead antipatharian corals	1 kg per set		
	Live & dead alcyonacean soft corals	1 kg per set		
	Live & dead hydrozoans	1 kg per set		
	11 named taxa, live or dead	Presence of any 3 taxa in catch from one set		
Japan North Pacific	Live Corals	50 kg per set	Move 2 miles from end of set and report. If outside “footprint”, temporary 2 mile radius closure to all vessels	

FIGURE

Figure 1 : New Zealand Encounter Scoring Form



Vulnerable Marine Ecosystem Evidence Process (Version 1.0 - Feb 08)

1. Trip, tow, and vessel information

Trip number	Tow number	Observer/s	Name of vessel master

2. Date, time, and position that hauling of the gear commenced

Date dd/mm/yy	Time 24-hr clock	Latitude Degrees Minutes	Longitude Degrees Minutes E/W
/ /	:	° . ' S	° . '

3. Instructions

Assess the total weights of all organisms whether dead or alive in each of the relevant taxonomic groups and record in Section 4.

If the Observed Weight of a taxonomic group is **greater than** (not equal to) the Threshold Weight, write the VME Indicator Score for that group in the "Score" Column.

If a taxonomic group is present, but the Observed Weight is **not** greater than the Threshold Weight, tick in the "Tick" column.

Sum the scores and count the ticks. Record these totals at the bottom of the columns. Add the Sum of scores to the Count of ticks and record it as the Total VME Indicator Score.

If the Total VME Indicator Score is 3 or greater, the area is considered to have Evidence of a Vulnerable Marine Ecosystem.

4. Relevant taxonomic groups, weights, and scores

Taxonomic Group	Code	Method of Analysis	Observed Weight (kg)	Threshold Weight (kg)	VME Indicator Score	Score if Threshold Weight exceeded	Tick if not scored but present
PORIFERA	ONG		.	50	3		
CNIDARIA							
Anthozoa (class)							
Actiniaria (order)	ATR		.	0	1		
Scleractinia (order)	SIA		.	30	3		
Antipatharia (order)	COB		.	1	3		
Alcyonacea (order)	SOC		.	1	3		
Gorgonacea (order)	GOC		.	1	3		
Pennatulacea (order)	PTU		.	0	1		
Hydrozoa (class)	HDR		.	6	3		
Unidentified Coral	COU		.	0	1		
ECHINODERMATA							
Crinoidea (class)	CRI		.	0	1		
Brisingida (order)	BRG		.	0	1		

Sum these scores

Count these ticks

\+

Total VME Indicator Score → Sum of scores + count of ticks =

5. Vessel notification

As soon as the form is completed for any tow provide a copy to the person in charge of the vessel.

Name (if not vessel master)	Received by person in charge (signature)	Date received (dd/mm/yy)	Time received (24-hr clock)
		/ /	: