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Gully Marine Protected Area Monitoring : Fish and Fishery Resources

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Canada

Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

Of four Indicators proposed in 2010 for monitoring the fish of the Gully MPA, only one that utilizes data from on-going halibut surveys has been implemented. Those data suggest that the ecosystems have been broadly stable since 1998, though subject to regional trends in some species – Atlantic Halibut itself perhaps increasing by about 5% per year. It is recommended that routine sampling continue on the one fixed station of the Halibut survey that falls within the MPA, while more attention be paid to setting the gear at a constant depth. Since 2015, regular Snow Crab trawl surveys have included ten fixed stations around the shallow margins of The Gully. To date, the resulting time series are too short for any conclusions to be drawn but emerging trends suggest that the data may have future value in MPA monitoring, if the surveys continue to work the ten stations. Closer control of the seasonal timing of the sampling there would be an advantage. In contrast, the existing data from stratified-random groundfish-trawl surveys, which have been on-going since 1970, have no value in MPA monitoring. Artifacts arising from the broad variety of depths sampled in different years obscure any temporal trends. Those data are nevertheless summarized here for their contribution to understanding of the biodiversity of The Gully. Lastly, midwater-trawl surveys during 2007–10 have generated data that could provide a quantitative baseline for future monitoring of the micronekton in the MPA but no further sampling has been attempted during the past decade.

INTRODUCTION

Meaningful management of any Marine Protected Area (MPA) requires monitoring of the effectiveness of the measures applied to protect the biota within its boundaries. The Gully MPA, which contains the largest submarine canyon on the eastern continental margin of North America, is no exception, though its offshore location, great depths and rugged bathymetry pose daunting challenges. For that MPA, Kenchington (2010) proposed a monitoring framework, which incorporated a total of 47 indicators. Their application and further development were examined in 2012 (Allard et al. 2015) and again at a January 18-22, 2021 regional peer review meeting, entitled Gully Marine Protected Area Monitoring: Review of Research Activities, Indicators, and Guidance on Next Steps.

Kenchington's (2010) framework suggested four indicators for fish, and fishery resources more generally, based on sampling with (respectively) bottom trawl, bottom longline, trap and midwater trawl gear. Numbered 17 to 20 within the list of proposed indicators, they were:

17. Relative abundances, size distributions and diversity of selected groundfish and trawl-vulnerable invertebrates in Zone 3 of the MPA;

18. Relative abundances, size distributions and diversity of selected longline-vulnerable species in Zones 2 and 3 of the MPA;

19. Relative abundances, size distributions and diversity of selected trap-vulnerable species in Zones 1 and 2 of the MPA;

20. Relative abundances, size distributions and diversity of selected mesopelagic nektonic species in Zones 1 and 2 of the MPA.

Had that proposal been implemented, the four indicators would have, together, encompassed the monitoring of a wide variety of the species present in the MPA, from myctophid lanternfishes to Atlantic Halibut (*Hippoglossus hippoglossus*) and Stone Crab (*Lithodes maja*).

However, monitoring with traps (Indicator #19) was swiftly discarded, when discussions with crab fishermen made clear that the pot-haulers on boats which might have been chartered for the work could not handle strings of large crab traps, unless the length of line between adjacent traps was sufficient that each trap would reach the boat before the next left the seabed. Given the depths in The Gully, that would have meant 1,000 m or more of rope for each trap, which could not be justified in an MPA that provides habitat for multiple cetaceans.

Midwater-trawl monitoring was also never implemented. While it might have been during the years immediately after 2010, when it could have continued a series of surveys conducted during 2007–10 (Kenchington et al. 2009, 2014) at a much-reduced intensity, that work has not been possible due to lack of availability of a Canadian Coast Guard research-trawler for the survey. That was followed by the loss of the staff member proposed for the task, eliminating any prospect of implementing Indicator #20, without a new commitment of substantial resources.

In contrast, Indicator #18 has been monitored, in part, since 1998. As proposed by Kenchington (2010), it was to be based on data drawn from regular, on-going monitoring of the Halibut resource, which then used a combination of a fixed-station survey, index fishing using survey-standard gear but at locations of fishermen's choosing, and logbook records of regular

commercial fishing (Trzcinski et al. 2009). There were already proposals for replacing the fixed-station survey with a stratified-random one, albeit with some fixed stations retained, and Kenchington (2010) suggested that the sole station within the MPA (Station 85) should be retained, while additional ones should be added in the Area. The recommended expansion has not been adopted but the halibut-monitoring at Station 85 has continued, while data from index fishing within the MPA are also available for analysis. Longline gear is, however, species-selective and large-hook Halibut gear set on the Scotian Shelf and Slope takes only a few species in significant numbers. Thus, no useful data on diversity are gathered. Nor are comprehensive length-frequency data available. Thus, Indicator #18 must be reduced to the relative abundances, more exactly the relative biomasses as represented by catch rates, for those few species that are regularly taken by the longlines.

Indicator #17 involves still greater complications. Kenchington (2010) proposed that it rely on the regular summer research vessel groundfish-trawl survey program, which has followed a stratified-random design since 1970 (Halliday & Koeller 1981; Chadwick et al. 2007; Emberley & Clark 2011) – though that program had ceased sampling within the boundaries of the MPA after 2005, in consequence of concerns over the impacts of trawl gear on sensitive habitats. The stratified-random design was, in any case, inappropriate for MPA monitoring: Among-sets variation in survey-trawl catches is notoriously high. Across the 200 and more stations scattered around the Scotian Shelf in a typical summer survey, the variations can be averaged out and the stratified-random approach is well suited to the primary objective of the surveys – the monitoring of groundfish resources. Within the confines of the MPA, however, only a very few sets can be made each year (for reasons of both costs and ecological impacts) and hence detecting temporal change demands minimization of among-sets variation. That in turn demands fixed-station sampling, to minimize the consequences of small-scale spatial patchiness in seabed habitats. Kenchington (2010), therefore, proposed the addition of two fixed stations to each summer survey, one in the portion of the MPA's Zone 3 that lies on Banquereau and the other in that part of Zone 3 that is on Sable Island Bank, the data from those stations being used for MPA monitoring but not resource-wide biomass estimation. That proposal has not been implemented but the stratified-random survey did resume in Zones 2 and 3 of the MPA in 2015. Sets were made in the Area in that year and again in 2016 and 2017, though they occurred in August of each year, whereas the surveys to 2005 had sampled the Area in July. There was no trawling in the MPA during the 2018 survey (which was curtailed by ship problems) nor in 2019.

In previous decades, there were also spring and fall groundfish-trawl surveys, using similar methods to the long-standing and on-going summer surveys. Those ended before they could provide useful monitoring of the MPA but they have contributed data on seasonal changes in its biota.

More recently, an entirely separate trawl survey, designed around the Snow Crab (*Chionoecetes opilio)* resource and using a fixed-station design (Zisserson 2015), was extended into the MPA in 2015 and has been continued annually thereafter. Five stations have been established within the MPA, each with a matched station immediately outside the Area's boundary. There is one station in the northwest of the MPA's Zone 2 and four in its Zone 3 – two of them on Sable Island Bank and the others on Banquereau. Each of those five pairs of stations has been worked in each of the five years for which data are yet available, though with only one set per station per year, hence 50 in all. Although that temporal span is not long

enough to be informative for MPA monitoring, the program has obvious potential as a supplement to, or substitute for, fixed stations appended to the summer groundfish-trawl surveys.
As a contribution to the 2021 review of the monitoring of the Gully MPA, the data from the Halibut, groundfish-trawl and Snow Crab surveys are presented here. Only the first can yet provide any indication of temporal change within the MPA but the others have contributed to a baseline understanding of the biodiversity of the Area.

GROUNDFISH-TRAWL SURVEYS

AVAILABLE DATA

Kenchington (2010) anticipated the challenge imposed by the among-sets spatial variation in survey catches inherent to any stratified-random trawl survey. However, the historic data from what is now the Gully MPA is also subject to a more severe deficiency: the survey strata were originally delineated (in part) by seabed depth but they are formally defined by two-dimensional, areal boundaries. Since the bathymetric data available in 1970 were less than perfect, the mapped strata do not correspond to their nominal depth ranges everywhere. For a Shelf-wide survey, the deficiency is immaterial. For a limited number of sets made around a steep-sided submarine canyon, it can be critical.

Zone 1 of the MPA comprises the steep-walled canyon proper, from its head to beyond the shelf-break. That area is essentially unfishable with bottom trawls and has certainly never seen a survey trawl.

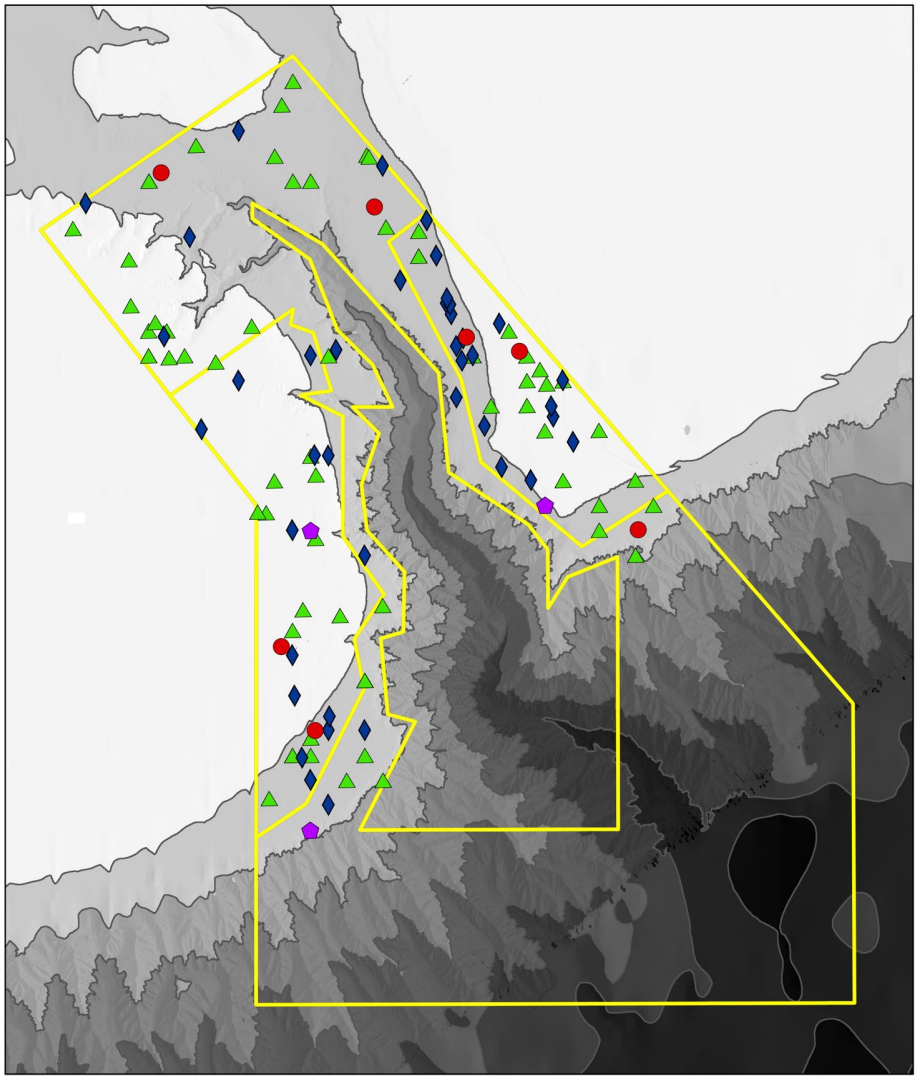

Figure 1. Locations of all groundfish-trawl survey sets made in the Gully MPA since 1970 (green triangles: summer surveys 1970–2005; red dots: August surveys 2015–17; blue diamonds: March surveys; purple pentangles: October surveys; boundaries of the MPA and its Zones are shown in yellow)

Zone 2 comprises almost all of the rest of the MPA. While often thought of as an area of intermediate depth, it actually includes some of the shallowest and all of the deepest water, with bottom depths from < 35 to > 3,500 m. As such, it is a purely management unit, with no biological coherence. Much of Zone 2, particularly the portion towards the south and east, is too deep or too rugged for survey trawls but ten sets have been made near the shelf break within that Zone, rather fewer along the flanks of the canyon to east and west (where Zone 2 is narrow), plus a greater number in the northern portion of the MPA (Figure 1). Even thus restricted, summer-survey sets within Zone 2 have fished at depths from 35 to 402 m (and the former series of spring surveys once down to 472 m). Moreover, as an artifact of the stratification scheme interacting with survey protocols (which include avoidance of untrawlable seabed), the depths of all summer sets (average, not extreme, depths of each set) have fallen into one of two belts: 37–89 m or 199–375 m –hereafter termed the “shallow” and “deep” belts– with none in between (Figure 2). In effect, the limited number of sets made in the Zone have

been spread across two different surveys. Given the strong effect of depth on the composition of fish assemblages, those surveys have sampled different groups of fish, generating non-comparable results. Worse, the few sets made in Zone 2 since the surveys returned to the MPA in 2015 have all been in the deep belt.

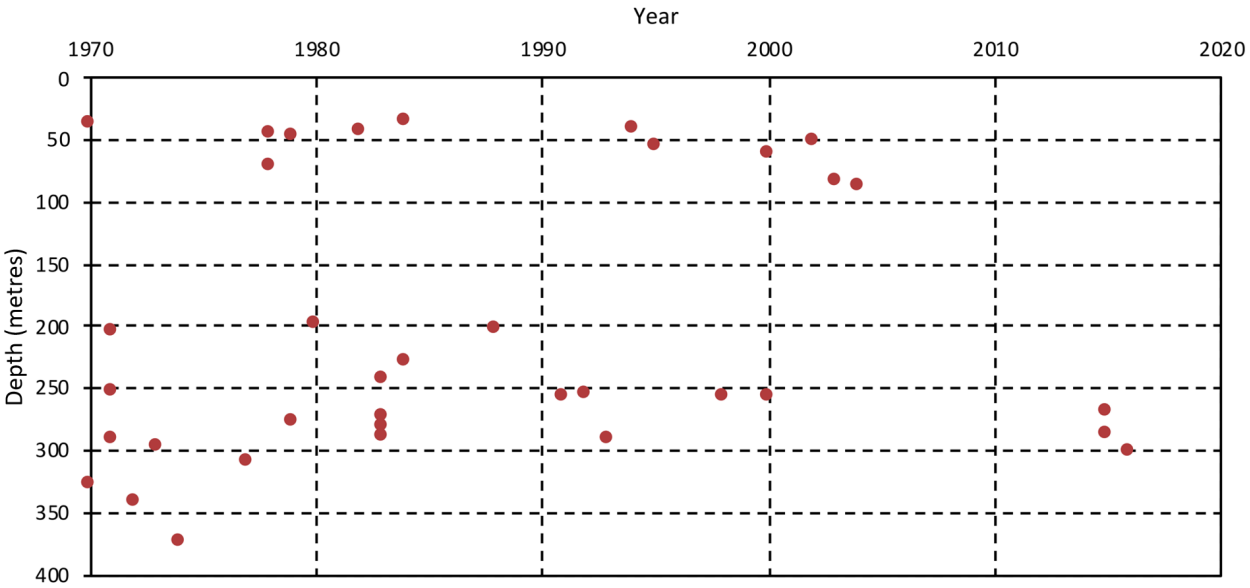

Figure 2. Depths of summer groundfish survey sets made in Zone 2 of the Gully MPA, illustrating their distribution in "shallow" and "deep" belts.

Meanwhile, the MPA's Zone 3 was intended to comprise those shallow portions of Banquereau and Sable Island Bank which fall within the MPA (here termed "Zone 3 (east)" and "Zone 3 (west)", respectively). However, the necessity for regulatory boundaries to follow straight lines has combined with the complex bathymetry around the canyon to leave some areas as deep as 280 m within Zone 3. On Sable Island Bank, survey-trawl sets have been made in the Zone at depths from 39 to 244 m, whereas on Banquereau the shallowest has been at 133 m and the deepest 276 m. While not as extreme as Zone 2, those ranges are still quite enough to cover a broad variety of habitats and hence also of fish assemblages.

Amidst those complexities and limitations, 48 groundfish-trawl survey sets have been made in Zone 2 since 1970, of which 33 were either routine sets of the summer survey series to 2005 or else duplicates conducted during the years when the chartered research vessel *Lady Hammond* ran calibration trials alongside the regular survey ships – first *A.T. Cameron* and then *Alfred Needler* (Table 1). There were, at most, three routine sets in the Zone in any year, while some saw none at all. Zone 3 has seen a similar summer survey effort through the decades, though it has been divided between east and west, just as the Zone 2 sets have been split across the "shallow" and "deep" belts.

Table 1. Summary of numbers of groundfish-trawl survey sets made in the Gully MPA

	Zone 2	Zone 3 (west)	Zone 3 (east)
Total survey sets	48	29	40
Routine summer-survey sets 1970–2005	30	13	17
Per-year range	0–3	0–1	0–3
Calibration-trial sets	3	1	1
Other July sets	0	0	1
Total summer-survey sets to 2005	33	14	19
Summer (August) sets 2015–2017	3	2	2
March surveys 1979–2007	11	12	18
October surveys	1	1	1

All of those sets were made in July, except for two in Zone 3, which were made in the first days of August. In contrast, the seven sets made in the MPA during the 2015–17 surveys were all conducted further into the latter month, raising a possibility of some seasonal change in the data. The former spring surveys (all conducted in the MPA in March) certainly sampled a different seasonal assemblage, as most probably the fall surveys did too, though they only made three sets within what is now the MPA.

Those surveys have been conducted aboard five different trawlers – two of them sister-ships, though one of those two was then significantly modified, not least by being re-engined, making her almost a sixth distinct vessel. Most of the sets were made with Western IIA trawls but the first 25 were by side-trawling with a Yankee #36, while two of the *Hammond*'s sets were made with an Engel net. The three net designs will certainly have fished differently. Whether the catch data have been markedly affected by the different vessels towing those nets is much less clear.

Down the decades, the number of taxon codes used in recording the catches of the sets made in what is now the MPA has increased dramatically (Table 2). However, most of that trend does not represent any change in the biodiversity of The Gully but rather a combination of the occasional capture of rarities (as expected when any dataset on species occurrences is accumulated) with a gradual improvement in the precision of recording of survey catches. Amongst the latter, there were notable advances in 1974, when what had been envisioned as surveys of particular resources came to be seen as of broader potential value, again in the mid-1980s, when the survey protocols were tightened generally, then once more from the mid-1990s onwards, as monitoring of groundfish resources gave way to a more ecosystem-oriented approach (cf. Shackell & Frank 2003).

Table 2. Numbers of species-codes used in recording the catches of groundfish-trawl survey sets made in the Gully MPA

	Zone 2	Zone 3 (west)	Zone 3 (east)
Used in first summer survey	12	9	11
Used before 1980	34	23	25
Used before 1990	47	38	30
Used to 2007	66	64	63
Total taxon codes used to date	86	72	72

Of particular note, most of the taxa recorded in the MPA during only the 2015–17 surveys were benthic invertebrates, which had not been recorded in detail during the surveys to 2007. Only

five additional finfish were added: In Zone 2, there were epipelagic *Scomberesox saurus*, a species which is frequent along the shelf-break in late summer and early fall but scarce or absent in July, three individuals of *Helicolenus dactylopterus*, which had previously been taken in Zone 3, and a single *Peprilus triacanthus*, likely a waif transported in the Warm Slope Water, and another species which had previously been taken in Zone 3. Meanwhile, Zone 3 (west) added one individual of *Chlorophthalmus agassizi* – a species expected at greater depths on the continental slope but unusual in Zone 3. Likewise, Zone 3 (east) added *Arctozenus risso* – an abundant species in midwater within the depths of the canyon (Kenchington et al. 2018, 2020) but unusual in Zone 3.

In short, although additional species may indeed have arrived within what is now the MPA since 1970, the available data can neither confirm nor refute that.

Finally, each of the groundfish trawls used during these surveys can catch pelagic species, as the gear passes through the water column during shooting and haul-back. Some of those have been regularly recorded since the 1980s, if not earlier, but the deep-living pelagics common in The Gully and along the shelf-break were rarely identified to species before the 1990s. Even when recorded, their chance capture precludes their being quantitatively represented in the catches.

Given those assorted complications and limitations, the available data from groundfish-trawl survey sets within The Gully cannot provide any information on temporal trends since establishment of the MPA, nor even a quantitative baseline for future monitoring, which would require data from whatever fixed stations might one day be used. The available are of little value in documentation of either pelagic finfish or the benthos. All that can usefully be extracted from them are:

- A broad-brush “baseline” of demersal finfish (plus the squid *Illex illecebrosus*) present in Zone 3 (subdivided into east and west) and the surveyed portion of Zone 2 in July, during the period before establishment of the MPA, ignoring the differences in nets, ships and precision of catch recording,

- A similar “baseline” for March, though confined to Zone 3, where data from the spring surveys was rather less sparse than it was in Zone 2, and

- Temporal trends in the major species, for which trends might perhaps be detectable. Those are here taken to be species captured by at least one third of the sets in a Zone (a minimum of 11 sets in either Zone in July but 10 for the March surveys of Zone 3). Those trends are here summarized as the mean weight caught per set during each half-decade, beginning in 1970.

  To reduce artifacts arising from temporal change in station locations, the trends are presented for both the entirety of Zone 2 in summer and for its “deep” belt only. For Zone 3, values are given for the entire Zone and for its east and west portions separately, in each case for both summer and March.

It should be understood that, by any reasonable quality-control standard, the available data are inadequate even for such simplistic summaries.

RESULTS

The summer groundfish "baseline" for Zone 2 is presented in Appendix I, in terms of frequency of capture, plus (for those taxa taken by at least four sets) relative biomass and abundance of each taxon, in units of average standardized catches per set. The most widespread species was American Plaice (*Hippoglossoides platessoides*), taken by 26 of the 33 sets. However, as expected when trawling around The Gully, redfish (*Sebastes* spp.) was the characteristic taxon, taken by 22 sets with an average catch of 108 kg and 732 individuals[1]. Atlantic Cod (*Gadus morhua*) showed an even higher average catch weight (246 kg) but that was exaggerated by three exceptional sets, two of which (in 1979 and 1998, respectively) took about 0.5 t each, while the largest (in 1982) took a remarkable 5.8 t – at a time when the resource was relatively rich, soon after the extension of Canadian jurisdiction. There was nothing surprising in the remainder of the assemblage, given the location of The Gully, the depths of the sampling and the nature of the survey trawls, except perhaps for the rather higher frequency of small Marlinspike Grenadier, taken by 13 sets, than might have been expected.

The summer "baseline" for Zone 3 (Appendix II) also shows plaice as the most widespread species, taken by 28 of the 33 sets. The species with the greatest catch weight was, however, Longhorn Sculpin (*Myoxocephalus octodecemspinosus*), which was drawn upwards by a single enormous catch of nearly 5,000 individuals, weighing 830 kg after standardization for tow length. Redfish were abundant in Zone 3 (especially in the west, where one set took 2,000 individuals) but, with the generally shallower depths than those fished in Zone 2, average weights of individuals were low, indicating that Zone 3 is more of a nursery area for that species. *Illex illecebrosus* were also abundant, though the largest catch of them, nearly 1,800 individuals, was taken in the east, where one large Pollock (*Pollachius virens*) catch, totaling more than 1,500 individuals, was also taken. In contrast, the one large catch of Sand Lance (*Ammodytes dubius*), of over 1,000 individuals, was taken in the west. As in Zone 2, there was nothing surprising in the remainder of the assemblage.

There were quite marked differences between the average catches taken in Zone 3 (east) and those in Zone 3 (west). However, most of those seem to have resulted from single "lucky" catches – as should be expected with so few sets. Haddock were notably more frequent in the east (and yielded one large catch there), whereas Atlantic Cod showed the reverse pattern, though those differences too may only have been the effects of chance. For some species, the differences were more explicable: shallow-dwelling Yellowtail Flounder (*Limanda ferruginea*), Sand Lance, Winter Skate (*Leucoraja ocellata*) and Longhorn Sculpin were more abundant in the western-most portion of Zone 3, where the shallowest sets were made, whereas deeper-living Witch Flounder (*Glyptocephalus cynoglossus*) were taken in greater average amounts in the east.

The March assemblage in Zone 3 (Appendix III) showed even less difference between east and west than was seen in summer, despite none of the spring sets in the east fishing shallower than 140 m, whereas in the west five of the 11 sets had average depths between 39 and 121 m.

[1] The version of the survey data available for analysis, during the period of COVID19 restrictions, had the weights of the catch (per taxon, per set) truncated to the next integer kilogram below the measured weight. That will have had no material effect on the records of the more abundant species but will have reduced the apparent importance of those which are both scarce and individually small.

That depth differential was consistent with a pronounced contrast between larger catches of Yellowtail Flounder and Winter Skate in the west than the east, and the reverse trend in Witch Flounder.

Seasonal (spring to summer) differences were also minor. Atlantic Cod and Haddock were notably more abundant (or, just possibly, more catchable) in spring, presumably having overwintered along the shelf-break. So too were White Hake (*Urophycis tenuis*), Witch Flounder, redfish and Winter Skate. Conversely, Longhorn Sculpin was more abundant in summer, while *Illex*, as expected from its migratory behaviour, was almost absent in March.

Table 3. Semi-decadal average catches (in kg per set) of principal species taken in Zone 2 of the Gully MPA by summer groundfish-trawl surveys.

	1970–74	**1975–79**	**1980–84**	**1985–89**	**1990–94**	**1995–99**	**2000–04**	**2015–16**
Shallow sets	**1**	**3**	**2**	**0**	**1**	**1**	**4**	**0**
Deep sets	**7**	**2**	**6**	**1**	**3**	**1**	**1**	**3**
Hippoglossoides platessoides	3.578	108.192	7.461	6.560	1.075	13.625	0.474	0.233
Sebastes spp.	234.859	2.832	32.339	234.060	290.048	1.840	0.532	92.840
Amblyraja radiata	1.066	17.478	2.073	4.380	1.318	1.510	0.000	1.557
Merluccius bilinearis	1.701	3.076	24.216	0.000	2.703	1.040	0.456	2.573
Phycis chesteri	6.075	1.968	0.798	0.000	2.053	0.110	0.000	1.420
Gadus morhua	3.799	98.800	883.015	1.090	4.923	256.505	0.476	0.000
Limanda ferruginea	7.778	91.206	66.393	0.000	0.000	0.575	0.134	0.000
Melanogrammus aeglefinus	0.666	0.000	69.423	100.630	8.893	13.205	2.292	16.230
Urophycis tenuis	6.169	1.434	21.193	28.440	50.685	6.085	0.186	9.423
Glyptocephalus cynoglossus	0.729	0.778	0.823	0.000	1.593	2.555	0.058	1.497
Leucoraja ocellata	17.835	47.764	12.744	29.530	5.678	0.830	0.000	0.000
Nezumia bairdii	0.461	0.194	0.000	0.000	0.258	0.000	0.000	0.157
Illex illecebrosus	0.584	7.794	0.000	0.000	0.243	0.370	0.056	0.000
Myoxocephalus octodecemspinosus	1.580	9.368	3.018	0.000	0.498	0.065	1.392	0.020
Pollachius virens	0.693	0.000	87.883	3.280	16.600	1.015	0.000	0.297

Table 4. Semi-decadal average catches (in kg per set) of principal species taken in Zone 3 of the Gully MPA by summer groundfish-trawl surveys.

Species	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–05	2015–16
Hippoglossoides platessoides	8.397	18.040	0.954	1.863	4.860	0.137	4.892	0.020
Illex illecebrosus	2.750	44.616	5.936	0.000	0.000	0.140	0.164	13.313
Amblyraja radiata	5.310	6.418	0.591	2.697	0.545	0.000	4.346	0.000
Melanogrammus aeglefinus	2.573	3.778	5.441	3.430	18.960	0.003	13.062	23.370
Merluccius bilinearis	4.445	4.514	2.911	17.157	0.000	0.053	1.692	13.848
Sebastes spp.	5.143	1.324	0.092	3.087	58.760	0.000	0.002	3.145
Urophycis tenuis	3.607	2.498	1.653	14.413	7.415	0.000	0.170	6.273
Gadus morhua	4.510	11.666	2.716	3.773	4.070	0.000	0.880	0.000
Hippoglossus hippoglossus	2.568	5.990	5.135	0.000	4.135	0.093	0.000	1.490
Malacoraja senta	0.147	2.706	0.596	0.833	0.000	0.000	0.262	0.000
Glyptocephalus cynoglossus	1.013	0.602	0.080	0.343	1.095	0.060	1.658	0.345
Myoxocephalus octodecemspinosus	0.000	0.452	0.000	0.000	0.000	0.313	166.584	0.170
Limanda ferruginea	0.138	0.234	0.000	0.000	1.095	0.060	0.000	0.025

Temporal change in the summer-survey catches in Zone 2 (“deep” and “shallow” belts combined) is summarized in Table 3, while Table 4 provides equivalent information for Zone 3 (as a whole). Similar tabulations of the changes in the “deep belt” of Zone 2, the east and west portions of Zone 3 in summer and for the spring-survey catches in Zone 3 are in Appendix IV.

Those tabulated values could be interpreted in various ways but all risk imposing external expectations on what are mere random variations in the very limited available data. Catches of some of the commercially-exploited species within the MPA do appear to have tracked wider trends in resource biomasses, as Winter Skate and Smooth Skate catches have followed the declines in those species on the Scotian Shelf generally. However, no MPA-specific trends can be reliably discerned.

CONCLUSIONS

The existing data from five decades of groundfish-trawl surveys within what is now the Gully MPA provide some descriptive information on the assemblage of demersal finfish present in Zones 2 and 3, primarily in summer, though that cannot constitute a quantitative baseline for future monitoring. The available data have been collected across broad depth ranges and thus are not representative of any particular monitoring stations that might be used in future. In short, and as anticipated by Kenchington (2010), the stratified-random groundfish-trawl surveys of the Scotian Shelf cannot provide useful information for monitoring the small area of the Gully MPA. Whether Kenchington’s (2010) proposed fixed-station sampling would have been more successful, had it been implemented *circa* 2012, cannot be known.

SNOW CRAB TRAWL SURVEYS

AVAILABLE DATA

As outlined in the Introduction, the Snow Crab surveys have worked in and around The Gully MPA since 2015, sampling once per year at each of ten fixed stations (i.e., 50 sets in all, up to and including the 2019 survey). The survey design includes one station in the northwestern corner of Zone 2 and two in each portion of Zone 3, plus paired reference stations outside the MPA adjacent to each of those five inside (Figure 3). All of those stations are in, or near, the shallowest parts of the MPA and hence the survey series can only monitor the biota in that depth range.

The Snow Crab surveys use much shorter tows than the groundfish-trawl program does and only a single position is recorded for each set. The maximum offset between any of the 50 recorded positions and the mean (of 5) for the corresponding station was 832 m, while the average was just 190 m. Thus, the stations are firmly “fixed” in space, though it must be acknowledged that the sets do not sample the exact same strip of seabed each year and so may encounter slightly different epibenthos each time.

The stations are not, however, effectively fixed in time. The 2015 and 2016 surveys sampled the Gully stations in late November but the 2017 survey passed through the MPA in late October. Then the 2018 survey worked The Gully in the first days of December and the survey nominally conducted in 2019 was actually in the MPA at the beginning of January 2020. While unlikely to affect records of the attached epibenthic growths large enough to be retained in a crab trawl, that two-month spread across the seasonal cycle may have markedly influenced catches of migrant species.

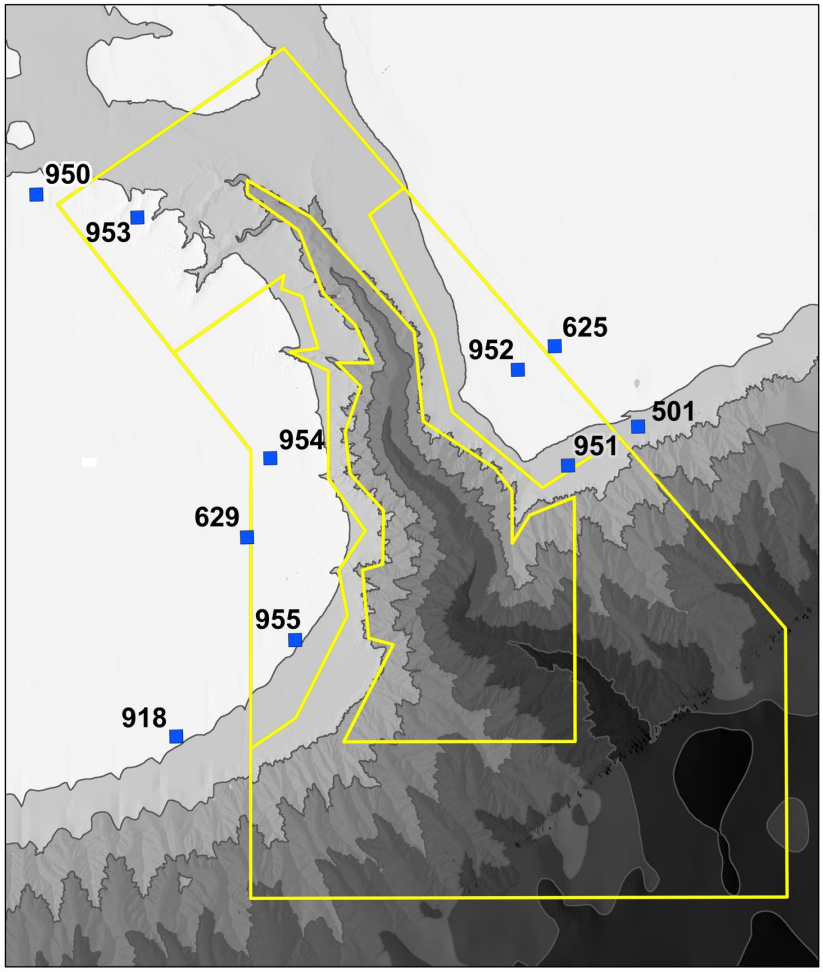

Figure 3. Locations of Snow Crab survey stations in and near the Gully MPA, showing the station numbers (boundaries of the MPA and its Zones are shown in yellow).

The catches of the 50 sets made to date have been recorded using 77 taxon codes. As with the groundfish-trawl surveys, some of those have only involved incidental catches. There have been four records of Atlantic Herring (*Clupea harenus*), three of Alewife (*Alosa pseudoharengus*) and one each of Mackerel (*Scomber scomber*) and Butterfish (*Peprilus triacanthus*), for example. Other records are too generalized to be useful, including three of "unidentified eggs" and six of "seaweed" – which in the MPA must be either drifting *Sargassum* from the Gulf Stream or else broken fragments transported from shallower, rockier areas. The remaining taxa comprise groundfish (plus *Illex illecebrosus*), decapod crustaceans and an assortment of other benthic invertebrates. The frequencies at which they have been recorded at each station are given in Appendices V to VII, in which the ten stations are arranged west (left) to east (right).

RESULTS

With only five years of data from the MPA and its surroundings to date, detectable trends should not be expected but some of the more-frequently encountered species do show hints of them. Notably, catches of the smaller flatfish (Witch, Plaice and Yellowtail Flounder) have all been increasing in recent years (Figure 4), in a trend that has been broadly consistent across each of

the stations where those species are frequent. Conversely, Haddock, Longhorn Sculpin, Snow Crab and Rock Crab (*Cancer irroratus*) have been generally decreasing (Figure 5). Silver Hake had a “good” year at most stations in 2017 and, in the westernmost of them, also in 2016, but they have since fallen back – trends perhaps driven by an interaction between the timing of the surveys and the migration of the fish. Jonah Crab (*Cancer borealis*) yielded much better catches in 2015 and 2019 than in the years between, 2016 being particularly poor. Sea Cucumbers have been increasing at two of the only three stations where they have been regularly taken. The records for other species have been too strongly affected by occasional large catches for any trends to be discernable.

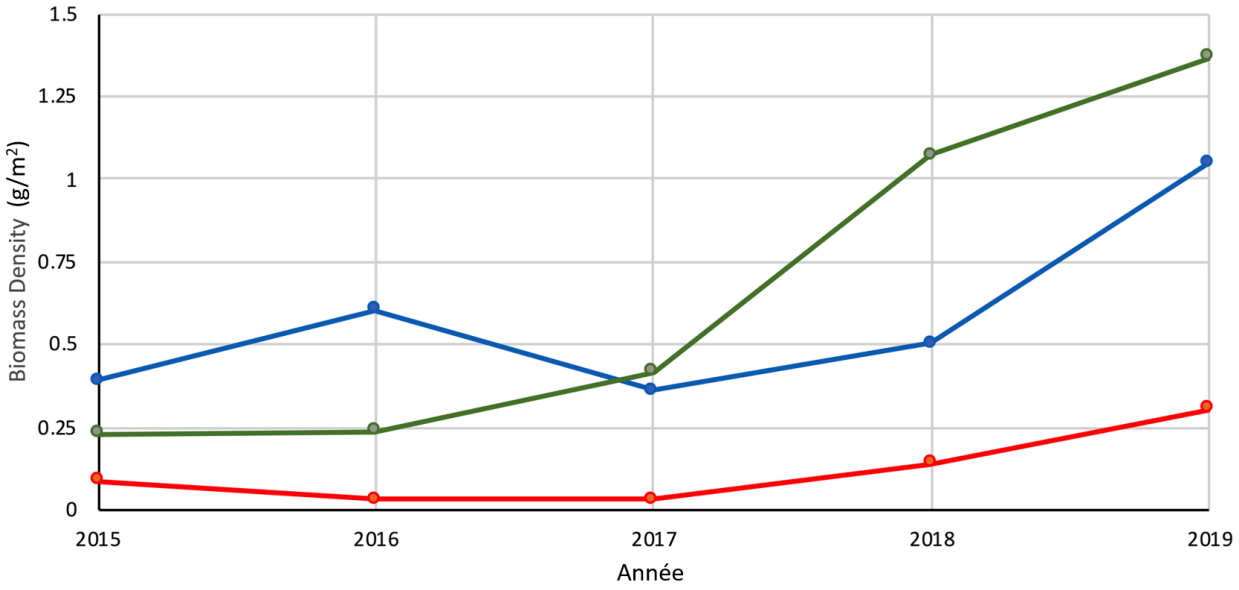

Figure 4. Trends in catches (expressed as biomass densities) of American Plaice (red), Witch Flounder (blue) and Yellowtail Flounder (green) taken by the Snow Crab surveys at stations in and near the Gully MPA where each species has been recorded regularly (Plaice: Stations 950, 953, 629, 954, 955, 952, 625; Witch Flounder: Stations 918, 629, 955, 952, 625, 951, 501; Yellowtail Flounder: Stations 950, 953, 629, 954).

In conclusion, if continued, the Snow Crab surveys appear capable of yielding useful information in the future on some epibenthos of the MPA, though only for its shallowest margins. While monitoring of the MPA must accommodate itself to the greater demands of a survey program designed and supported for quite other objectives, it would be advantageous if future sampling was more tightly constrained in time.

It would also help to have two (or more) sets per year at some (or all) of the stations in and near the MPA, at least for a few years. The present dataset confounds information on set-to-set variability with station-to-station and inter-annual differences. Given enough years of data, those might be teased apart but multi-set sampling would allow direct determination of “sampling error” and hence of the statistical significance of observed trends. That is a requirement for MPA monitoring, based on only ten stations, which does not arise across the entirety of a resource-biomass survey.

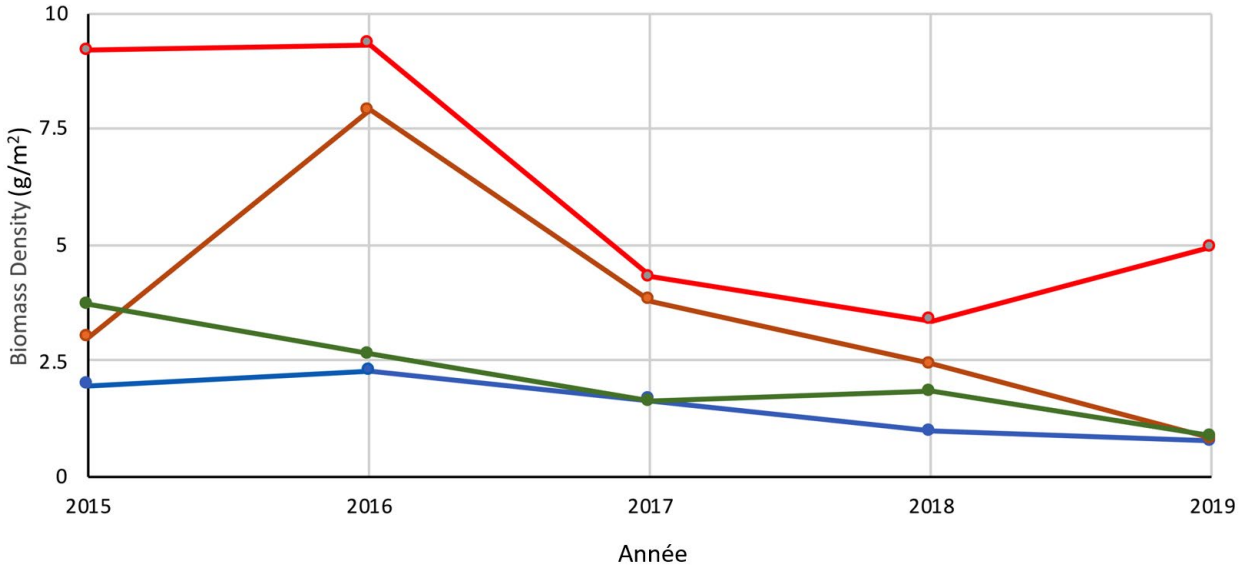

Figure 5. Trends in catches (expressed as biomass densities) of Snow Crab (red), Longhorn Sculpin (brown), Rock Crab (green) and Haddock (blue) taken by the Snow Crab surveys in and near the Gully MPA where each species has been recorded regularly (Snow Crab, Longhorn Sculpin and Rock Crab: Stations 950, 953, 629, 954; Haddock: all Stations except 954).

HALIBUT LONGLINE SURVEYS

AVAILABLE DATA

Since 1998, monitoring of the halibut resource and fishery has included four levels of set-wise, at-sea data collection: a fixed-station science-directed survey, a stratified-random science-directed survey, “index fishing” (using survey-standard effort units but at locations chosen by commercial Halibut captains) and regular commercial fishing. Since the latter can utilize various adaptations of standard Halibut longlines, interpretation of the resulting data involves too many complications to be useful for MPA monitoring. To date, only three stratified-random sets have been made within the MPA and thus they cannot convey useful information on temporal changes either.

The fixed-station survey includes only one station inside the MPA (Station 85), though there are two others (Stations 122 and 129) close outside the Area’s boundaries, such that sets nominally made there sometimes lie inside. However, only eight sets made at Station 122, plus four at Station 129, have done so, and hence only Station 85 data are used here. From the start of the surveys in 1998 until 2020, one set was made each year at that Station, except for 2006 and 2007, when it was not fished at all. Catch weights are available for every principal species (meaning all those frequent enough for temporal changes in catches to be examined) taken by each one of those 21 sets but some counts of individuals (for species other than Halibut) are missing. Hence, only the weights are used here for the bycatch species.

The start positions of sets nominally made at Station 85 have averaged 44°06.9' N 59°10.7' W (Figure 6) but their locations have been more variable than those of the Snow Crab surveys, such that the average displacement away from that central point has been 2.686 km, with a maximum of 7.641 km in 2015. Given the steep seabed slopes in The Gully, that kilometric

imprecision in the horizontal dimension has resulted in considerable variation in the depths fished. Those are only routinely recorded for the beginning and end of each set, not throughout the length of the line but, as recorded at Station 85, have varied from 134 to 520 m – perhaps insignificant in a multi-station survey designed for tracking the abundance of a broadly distributed resource but serious when a single station is used in monitoring an MPA.

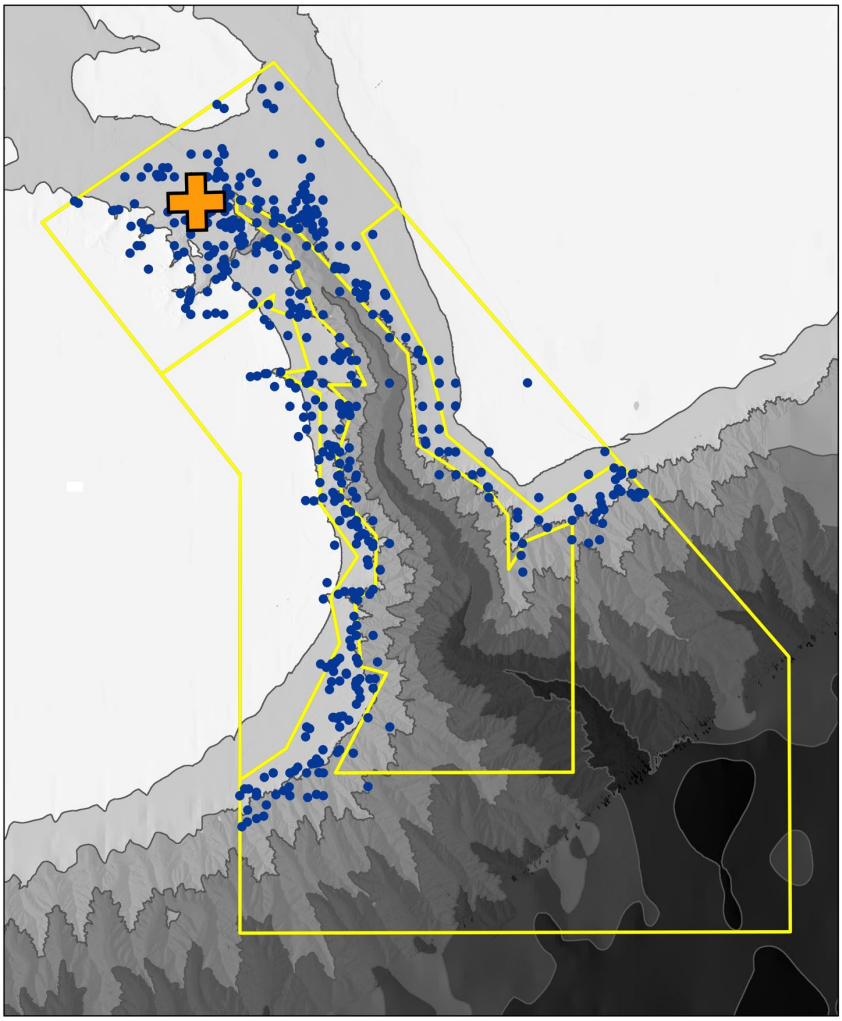

Figure 6. Location of Halibut survey station 85 (cross) and those of index-fishing sets made within the Gully MPA during 1998–2019 (blue dots). The boundaries of the MPA and its Zones are shown in yellow.

By intent, 1,000 hooks are deployed for each set of the fixed-station survey (and when index fishing). Since 2014, the recorded number of hooks set at Station 85 has consistently equaled that target. There was more variation in earlier years, the number deployed varying between 980 and 1080. In longlining, the relationship between numbers of hooks and catch is not expected to be simply proportional and no correction for non-standard numbers of hooks was attempted here. However, the variation is a reminder that a longline is far from being an ideal, standardizable scientific measuring instrument. Thus, the relationship between recorded catches and the number of fish on the Station at the time of the survey set is not a simple one.

Meanwhile, 661 index-fishing sets were recorded within the MPA from 1998 to 2019. Although the entire catch of those sets has often been reported, the data-collection protocols allow for only the catch of Halibut to be recorded, if the numbers taken are so high as to require the crew's full attention. Thus, no quantitative analysis of bycatches taken during index fishing is attempted here.

RESULTS AND DISCUSSION

Species Recorded

Halibut longline gear, with its large hooks set at considerable depths, is species-selective – when compared to bottom trawls, at least. Apart from rare, incidental events, it only takes large-mouthed, bottom-feeding fishes. Nevertheless, a considerable variety of taxa have been recorded in the MPA. The entire list, combining the catches of 698 sets (from fixed and random station surveys, plus index fishing) for which data are available, is presented in Appendix VIII.

There is nothing surprising in that list, given that the sampling was done in The Gully with Halibut longlines. The frequencies of occurrence of the various taxa and the details with which they have been recorded do, however, suggest that the only species or groups worth examining for evidence of temporal change are: Halibut, Cusk (*Brosme brosme*), White Hake, redfish, the wolffishes (as a group), Atlantic Cod, the dogfishes and the skates (the latter two also as groups).

Station 85

The available data suggest that Halibut biomass has been at least stable and perhaps slowly increasing on Station 85 (Figure 7) – though the time series was disrupted by the 2000 and 2015 sets being particularly shallow (165 to 194 m and 134 to 199 m, respectively) and, perhaps in consequence, catching little. The weights recorded during 1998–2020 were correlated to year of capture (Spearman's $\rho = 0.51$, $P < 0.05$), while a linear regression of the data suggest an average rate of increase in catches of 8.9 kg (about 5% of the overall mean catch) per year. Whether that represents a slow increase in the biomass density of Halibut around Station 85 or is merely a consequence of artifacts in the data series remains uncertain.

The numbers of Halibut caught have followed a similar pattern, albeit with visible differences in some years (e.g., more, smaller Halibut taken in 2011 but relatively fewer, larger ones taken in 2017).

That trend is in accord with the experience of the overall Halibut survey, which has found sharply increasing biomass after 2006, as well as with the outputs of an assessment model built, in part, on the survey data (Cox et al. 2016). The increase in the resource appears to have been driven by both above-average recruitment, especially during 2005–11, and by reduced fishing mortality (Cox et al. 2016). The latter resulted primarily from management restrictions imposed during the 1990s but a further decline after 2008 was likely because catch limits increased more slowly than did resource abundance.

Amongst the bycatch species (Figure 8), Cusk have generally been scarce at Station 85, with notable catches only in 2002–04 and again in 2009. The scarcity is not unexpected, Cusk being a species of the western Scotian Shelf more than the eastern, but the apparent temporal trend at Station 85 contradicts wider experience in the Halibut survey, which has found generally

higher catch rates of Cusk during 2007–13 than in 2001–4 (Harris et al. 2018). Whether the apparent decline in The Gully results from mere random variation or reflects some difference in the survey fishing is unsure. The latter is not impossible as other species showed enhanced catches in some of the same years as did Cusk.

White Hake catches at Station 85 were moderate and increasing through the early years but, like Cusk, crashed after 2004. They have, however, recovered well from 2016 onwards. No detailed study has been made of catches of the species in the general Halibut survey for comparison. The groundfish-trawl surveys, which emphasize smaller size-classes than those primarily vulnerable to Halibut longline hooks, tracked a general decline in the Divisions 4VW portion of the population, extending from the mid-1980s until after 2010 – a decline perhaps attributable to intense Grey Seal predation (Guénette & Clark 2016). However, the available, published analysis did not extend beyond 2013 and thus provides neither confirmation or refutation of the post-2016 increase seen at Station 85. In short, the trend in White Hake in the Gully MPA has probably followed regional patterns, with a possible artifact contributing to the apparent crash after 2004.

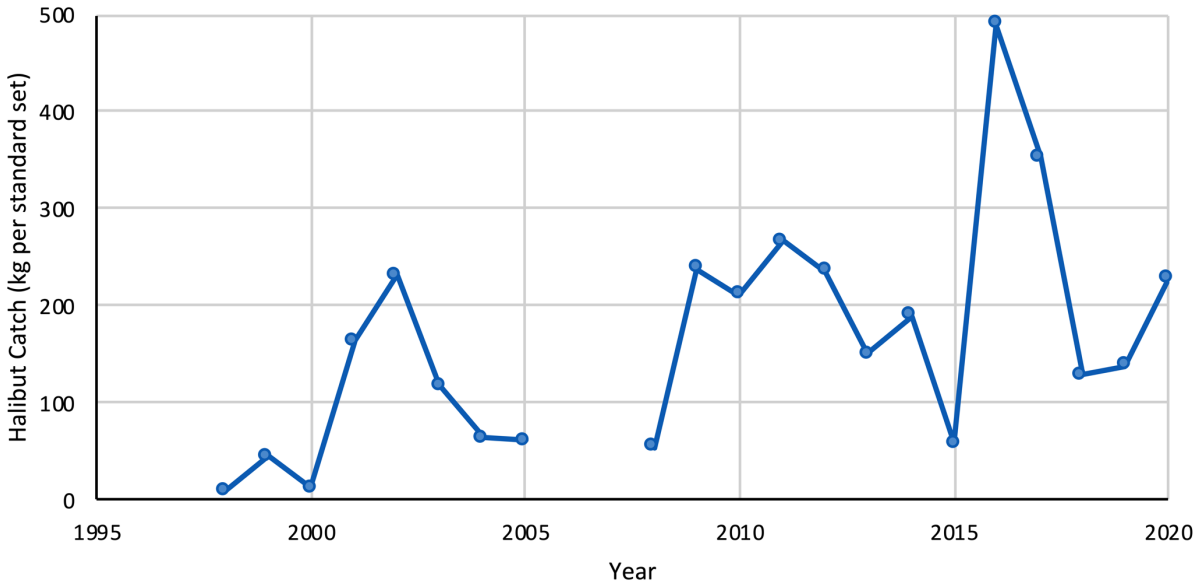

Figure 7. Temporal trend in survey catches of Atlantic Halibut taken at Station 85 by Halibut longline.

Redfish, a resource for which the valleys at the head of The Gully were once renowned, were generally scarce in the catches at Station 85 until 2017 but have since increased. Only a very large redfish is at all likely to be caught on a Halibut hook and, given the slow growth of the species, recent enhanced catches might reflect the presence of a strong year-class spawned in the 1990s. However, it might alternatively be a result of movement of *Sebastes mentella* into The Gully from along the continental slope further to the north and east – large individuals of that species (which reaches greater sizes than the *S. fasciatus* normally found on the Scotian Shelf) are known to occur along the Scotian Slope at times. Unfortunately, there has been no recent assessment of the Scotian Shelf resource to provide a foundation for comparisons.

There was a relatively large catch of the wolffishes in 2011 but they were otherwise rarely taken after 2002–04. In contrast, Atlantic Cod was unknown at Station 85 until 2017. Perhaps the

4VsW resource was finally responding to the fishery closure of 1993 by then. Black Dogfish have only been recorded at Station 85 once, in 2012. Skate catches there were consistently moderate during 2009–12. Both before and since, however, they have been irregular and, in most years, zero.

Overall, the data indicate little detectable change in the ecosystem at the head of the canyon through the last 20 years. Halibut appear to be stable or increasing. Those species known to have suffered recent declines on the Scotian Shelf (Cusk, the wolffishes, some of the skates) may have also declined at Station 85. Catches of White Hake, redfish and Atlantic Cod may be reflecting some post-fishery recovery. Those are weak conclusions but consistent with general maintenance of ecosystem integrity, albeit in the degraded condition following the decades of intense exploitation of groundfish, while any trends are regional, rather than local.

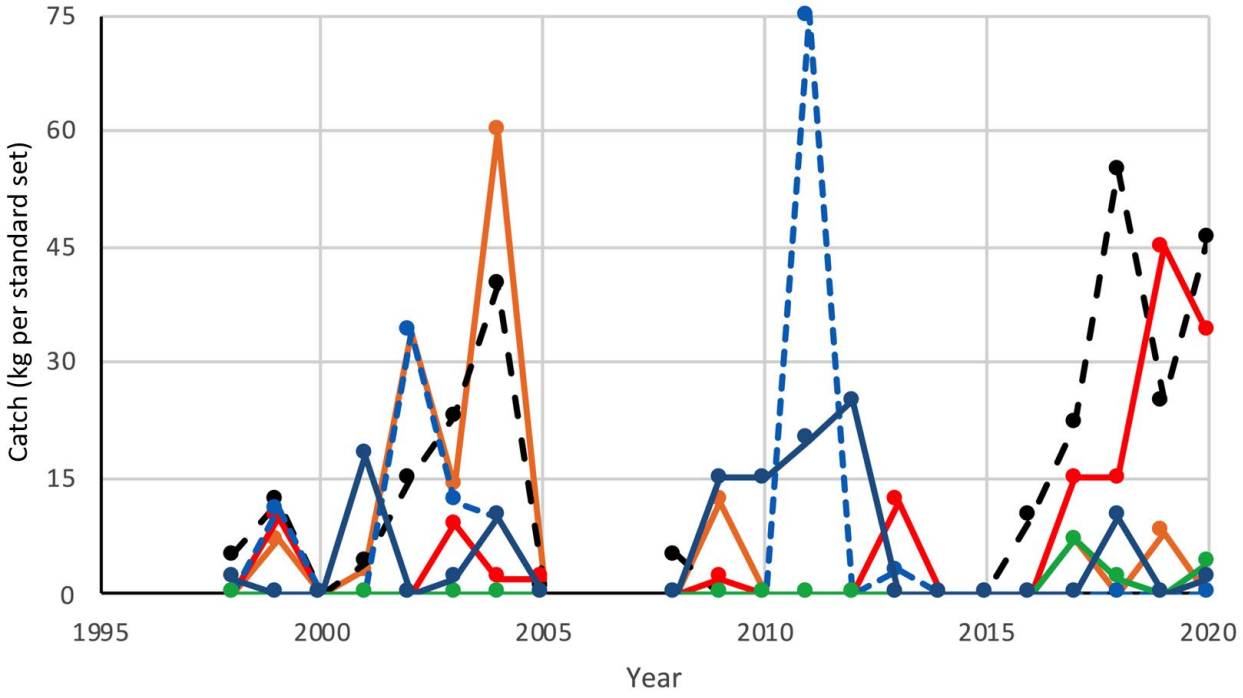

Figure 8. Temporal trend in survey catches of White Hake (black dashes), Cusk (orange), Redfish (red), wolffishes (blue dashes), Skates (blue continuous) and Atlantic Cod (green) taken at Station 85.

Index Fishing

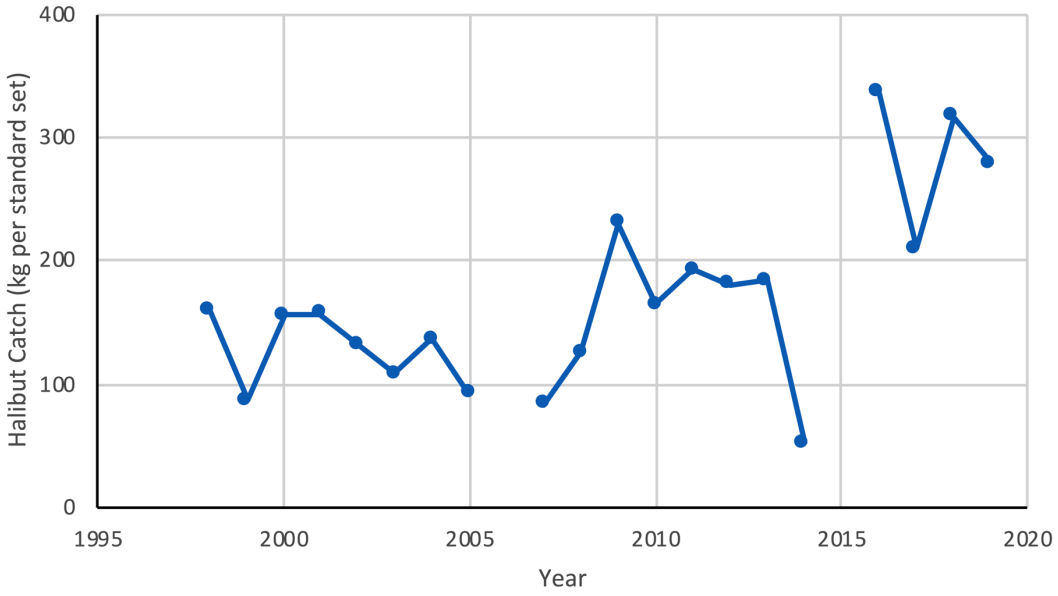

Figure 9. Temporal trend in the Halibut catch rate in index fishing in the Gully MPA.

Most years from 1998 to 2013 saw considerable numbers of index-fishing sets made within the MPA but there were none at all in 2006 or 2015 and ten or less in each of 2005, 2007, 2010, 2011, 2014 or in any year from 2016 onwards. If those years of limited sampling are discounted, Halibut catch rates in the MPA were rather steady at about 100 to 150 kg per standard set from 1998 to 2008 and around 150 to 200 kg during 2009–13 (Figure 9). Alternatively, the full suite of annual average catch rates, from 1998–2019, are correlated to year of capture (Spearman's $\rho = 0.59$, $P < 0.02$), while a linear regression through those data suggests an average rate of increase in catch-per-standard set of 7.1 kg (about 4% of the overall mean) per year. Whether any credence should be given to that apparent increase is doubtful but it is at least consistent with the data from Station 85 and the resource-wide trend found by Cox et al. (2016).

It would be appealing to suppose that the declaration of the MPA drove the increase in annual average catch rates in index fishing after 2008 but it appears to have been a regional phenomenon, not specific to The Gully.

CONCLUSIONS

The only one off the four fish and fishery resource indicators proposed in Kenchington's (2010) monitoring framework that has been implemented has been Indicator 18, utilizing data from Halibut longlining – and that only because it could rely on an existing, on-going program, conducted for quite other purposes. Even then, abundance information from index fishing is only available for Halibut itself, though bycatches are recorded by the fixed-station survey work at Station 85, while there are no adequate data on size compositions from any of the longlining. Since it generates the only extant time-series relating to the demersal biota of The Gully, the Halibut longline surveys should be continued, at least at Station 85, as one component of the

MPA's monitoring program. Closer attention to the location at which the gear is set, or at least the depth, would enhance the value of the data obtained.

Of the other three indicators, midwater trawl surveys during 2007–10 (Kenchington et al. 2009, 2014) have generated extensive data which could form a quantitative baseline for future monitoring of Indicator 20. However, there has been no further fieldwork during the past decade. Conversely, while the groundfish-trawl surveys have been on-going in what is now the MPA since 1970, they have not produced even a useful baseline for MPA-monitoring purposes, let alone any indication of recent trends. The Snow Crab trawl surveys show promise as an alternative means of monitoring Indicator 17, though one confined to the shallowest fringes of The Gully. To date, however, the sampling has only extended over only five years, which is insufficient to be confident of emerging trends in the biota. If that component of the monitoring is to be continued, it would be beneficial to exercise tighter control over the seasonal timing of the fieldwork.

Lastly, Indicator 17 was rejected soon after Kenchington (2010) proposed it, when the impracticality of trap fishing in The Gully became clear.

With those limitations, the monitoring to date can provide little information on the state of the MPA's ecosystems. There is no indication of major change in those systems, neither evident degradation nor much evidence of recovery. Such trends as can be discerned in the fish appear consistent with larger-scale, often regional changes. In particular, Halibut catch rates within the MPA appear to be increasing at a rate of about 5% per year, which parallels a population-wide trend.

REFERENCES CITED

Allard, K., Cochrane, N., Curran, K., Fenton, D., Koropatnick, T., Gjerdrum, C., Greenan, B.J.W., Head, E., Macnab, P., Moors-Murphy, H., Serdynska, A., Trzcinski, M.K., Vaughan, M., and Whitehead, H. 2015. The Gully Marine Protected Area Data Assessment. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/056. vi + 167 p.

Chadwick, E.M.P., Brodie, W., Colbourne, E., Clark, D.S., Gascon, D., and Hurlbut, T. 2007. History of annual multi-species trawl surveys on the Atlantic coast of Canada. AZMP Bull. 6: 25-42.

Cox, S.P., Benson, A., and den Heyer, C.E. 2016. Framework for the assessment of Atlantic halibut stocks on Scotian Shelf and southern Grand Banks. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/001. v + 57 p.

Emberley, J., and Clark, D.S. 2011. Update of the 2011 summer Scotian Shelf and Bay of Fundy research vessel survey. Can. Data Rep. Fish. Aquat. Sci. 1240: ix + 95 p.

Guénette, S., and Clark, D. 2016. Information in support of recovery potential assessment for white hake (*Urophycis tenuis*) from the Scotian Shelf (NAFO Divs. 4VWX5z). DFO Can. Sci. Advis. Sec. Res. Doc. 2016/100.

Halliday, R.G., and Koeller, P.A. 1981. A history of Canadian groundfish trawling surveys and data usage in ICNAF Divisions 4TVWX. pp. 27-41, in: Doubleday, W.G., and Rivard, D. (eds.) Bottom Trawl Surveys. Can. Spec. Pub. Fish. Aquat. Sci. 58: 273 p.

Harris, L.E., Greenlaw, M., McCurdy, Q., and MacDonald, D. 2018. Information on the potential for recovery of cusk (*Brosme brosme*) in Canadian waters. DFO Can. Sci. Advis. Sec. Res. Doc. 2018/002. v + 62 p.

Kenchington, T.J. 2010. Environmental monitoring of the Gully Marine Protected Area: A recommendation. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/075. vi + 59 p.

Kenchington, T.J., Best, M., Bourbonnais-Boyce, C., Clement, P., Cogswell, A., MacDonald, B., MacEachern, W., MacIsaac, K., MacNab, P., Paon, L., Reid, J., Roach, S., Shea, E., Themelis, D., and Kenchington, E.L.R. 2009. Methodology of the 2007 survey of meso- and bathypelagic micronekton of the Sable Gully: Cruise TEM768. Can. Tech. Rep. Fish. Aquat. Sci. 2853: vi + 91 p.

Kenchington, T.J., Benjamin, R., Best, M. Cogswell, A., Cook, A., DeVaney, S., Lirette, C., MacDonald, B., MacIsaac, K., Mallam, P., McIntyre, T., McMillan, A., Moors-Murphy, H., Morton, G., Paon, L., Roach, S., Shea, E., Themelis, D., and Kenchington, E.L.R. 2014. Field methods of the 2008, 2009 and 2010 surveys of meso- and bathypelagic micronekton in The Gully. Can. Tech. Rep. Fish. Aquat. Sci. 3076: vi + 73 p.

Kenchington, T.J., Themelis, D., DeVaney, and Kenchington, E.L.R. 2018. The meso- and bathypelagic fish assemblage in The Gully: Data preparation and species' distributions. Can. Tech. Rep. Fish. Aquat. Sci. 3268: v + 153 p.

Kenchington, T.J., Themelis, D., DeVaney, and Kenchington, E.L.R. 2020. The meso- and bathypelagic fishes in a large submarine canyon: assemblage structure and trophic role of the principal species in The Gully Marine Protected Area. Front. Mar. Sci. 7(181): 21 p.

Shackell, N.L., and Frank, K.T. 2003. Marine fish diversity on the Scotian Shelf, Canada. Aquatic Conserv. Mar. Freshw. Ecosyst. 13: 305-321.

Trzcinski, M.K., Armsworthy, S.L., Wilson, S., Mohn, R.K., Fowler, M., and Campana, S.E. 2009. Atlantic halibut on the Scotian Shelf and southern Grand Banks (NAFO Divisions 3NOPs4VWX5Zc) – Industry/DFO longline survey and tagging results to 2008. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/026. vi + 43 p.

Zisserson, B. 2015. Maritimes Region snow crab trawl survey: Detailed technical description. Can. Tech. Rep. Fish. Aquat. Sci. 3128: v + 38 p.

APPENDICES

Appendix I. Summary of catches taken in Zone 2 of the Gully MPA by summer groundfish-trawl surveys 1970–2005 (- indicates insufficient data).

Species	Common Name	Frequency in 33 sets	Average catch per set	
			Weight (kg)	Number
Hippoglossoides platessoides	American Plaice	26	20.295	51.595
Sebastes spp.	Redfish	22	107.646	731.767
Amblyraja radiata	Thorny Skate	18	3.793	5.261
Merluccius bilinearis	Silver Hake	16	7.209	36.653
Phycis chesteri	Longfin Hake	16	2.220	19.973
Gadus morhua	Atlantic Cod	15	246.202	494.518
Limanda ferruginea	Yellowtail Flounder	15	31.855	106.199
Melanogrammus aeglefinus	Haddock	14	22.266	45.778
Urophycis tenuis	White Hake	14	14.253	17.171
Glyptocephalus cynoglossus	Witch Flounder	13	0.851	3.362
Leucoraja ocellata	Winter Skate	13	16.283	8.571
Nezumia bairdii	Marlinspike Grenadier	13	0.172	3.204
Illex illecebrosus	Short-fin Squid	12	1.383	10.369
Myoxocephalus octodecemspinosus	Longhorn Sculpin	11	2.809	13.770
Pollachius virens	Pollock	11	23.646	8.634
Argentina silus	Argentine	10	1.850	6.899
Hippoglossus hippoglossus	Halibut	10	3.766	1.016
Malacoraja senta	Smooth Skate	9	0.312	0.584
Ammodytes dubius	Sand Lance	8	0.405	24.428
Lophius americanus	Monkfish	8	5.629	1.725
Brosme brosme	Cusk	7	2.982	0.523
Anarhichas lupus	Atlantic Wolffish	6	2.682	1.083
Artediellus uncinatus	Snowflake Hookear Sculpin	5	0	0.563
Merluccius albidus	Offshore Hake	4	0.398	0.663
Triglops murrayi	Mailed Sculpin	4	0.134	0.742
Pseudopleuronectes americanus	Winter Flounder	3	-	-
Aspidophoroides monopterygius	Alligatorfish	2	-	-
Enchelyopus cimbrius	Fourbeard Rockling	2	-	-
Hemitripterus americanus	Sea Raven	2	-	-
Myxine glutinosa	Hagfish	2	-	-
Reinhardtius hippoglossoides	Greenland Halibut	2	-	-
Scophthalmus aquosus	Windowpane Flounder	2	-	-
Cottunculus microps	Polar Sculpin	1	-	-
Dipturus laevis	Barndoor Skate	1	-	-
Liparis atlanticus	Atlantic Seasnail	1	-	-

Appendix II. Summary of catches taken in Zone 3 of the Gully MPA by summer groundfish-trawl surveys 1970–2005 (- indicates insufficient data).

Species	Common Name	Zone 3 (west)			Zone 3 (east)			Zone 3 (all)	
		Frequency in 14 sets	Average catch per set		Frequency in 19 sets	Average catch per set		Average catch per set	
			Weight (kg)	Number		Weight (kg)	Number	Weight (kg)	Number
Hippoglossoides platessoides	American Plaice	11	10.164	40.624	17	2.461	13.343	5.729	24.917
Illex illecebrosus	Short-fin Squid	12	2.876	21.338	16	13.679	113.141	9.096	74.194
Amblyraja radiata	Thorny Skate	7	3.204	7.939	13	2.811	4.838	2.978	6.154
Melanogrammus aeglefinus	Haddock	5	3.886	6.537	12	7.783	24.935	6.130	17.130
Merluccius bilinearis	Silver Hake	7	2.811	24.334	10	5.215	14.233	4.195	18.518
Sebastes spp.	Redfish	7	8.461	170.659	10	2.46	21.442	5.006	84.746
Urophycis tenuis	White Hake	5	1.771	3.341	12	4.462	4.001	3.320	3.721
Gadus morhua	Atlantic Cod	7	7.664	11.930	9	1.532	1.158	4.133	5.728
Hippoglossus hippoglossus	Halibut	6	1.599	0.636	10	4.362	0.943	3.190	0.813
Malacoraja senta	Smooth Skate	5	1.052	3.179	11	0.432	2.581	0.695	2.835
Glyptocephalus cynoglossus	Witch Flounder	5	0.312	1.563	10	0.906	4.748	0.654	3.397
Myoxocephalus octodecemspinosus	Longhorn Sculpin	9	59.593	334.976	4	0.096	0.331	25.337	142.302
Limanda ferruginea	Yellowtail Flounder	9	4.163	26.553	3	0.108	0.486	1.828	11.545
Argentina silus	Argentine	3	0.700	4.345	7	1.356	8.969	1.078	7.007
Ammodytes dubius	Sand Lance	8	1.493	90.333	1			0.633	38.323
Lophius americanus	Monkfish	2	1.016	0.249	6	1.588	0.485	1.345	0.385
Pollachius virens	Pollock	3	5.178	3.164	5	63.671	90.957	38.856	53.711
Phycis chesteri	Longfin Hake	4	0.074	0.629	4	2.942	33.092	1.725	19.320
Leucoraja ocellata	Winter Skate	5	4.948	6.474	2	0.806	0.173	2.563	2.846
Squalus acanthias	Spiny Dogfish	1	0.156	0.078	4	0.28	0.204	0.227	0.151
Nezumia bairdii	Marlinspike Grenadier	1	0.001	0.072	3	0	0.448	0.000	0.288
Brosme brosme	Cusk	2	-	-	1	-	-	-	-
Zoarces americanus	Ocean Pout	0	-	-	3	-	-	-	-
Anarhichas lupus	Wolffish	2	-	-	0	-	-	-	-
Helicolenus dactylopterus	Rosefish	1	-	-	1	-	-	-	-
Myxine glutinosa	Hagfish	1	-	-	1	-	-	-	-

Species	Common Name	Zone 3 (west)			Zone 3 (east)			Zone 3 (all)	
		Frequency in 14 sets	Average catch per set		Frequency in 19 sets	Average catch per set		Average catch per set	
			Weight (kg)	Number		Weight (kg)	Number	Weight (kg)	Number
Urophycis chuss	Red Hake	1	-	-	1	-	-	-	-
Coryphaenoides rupestris	Roundnose Grenadier	0	-	-	1	-	-	-	-
Hemitripterus americanus	Sea Raven	1	-	-	0	-	-	-	-
Pseudopleuronectes americanus	Winter Flounder	1	-	-	0	-	-	-	-
Leucoraja erinacea	Little Skate	1	-	-	0	-	-	-	-
Merluccius albidus	Offshore Hake	1	-	-	0	-	-	-	-
Trachyrincus murrayi	Roughnose Grenadier	1	-	-	0	-	-	-	-

Appendix III. Summary of catches taken in Zone 3 of the Gully MPA by spring groundfish-trawl surveys 1979–2007 (- indicates insufficient data).

Species	Common Name	Zone 3 (west)			Zone 3 (east)			Zone 3 (all)	
		Frequency in 14 sets	Average catch per set		Frequency in 19 sets	Average catch per set		Average catch per set	
			Weight (kg)	Number		Weight (kg)	Number	Weight (kg)	Number
Hippoglossoides platessoides	American Plaice	11	2.723	14.644	16	13.465	68.645	9.168	47.045
Gadus morhua	Atlantic Cod	9	93.667	84.773	16	165.708	265.582	136.892	193.259
Amblyraja radiata	Thorny Skate	7	3.035	5.148	16	11.672	17.243	8.217	12.405
Melanogrammus aeglefinus	Haddock	5	22.812	33.121	18	56.062	84.966	42.762	64.228
Glyptocephalus cynoglossus	Witch Flounder	5	2.685	10.115	16	18.593	80.363	12.230	52.264
Sebastes spp.	Redfish	5	12.454	120.466	15	34.776	512.625	25.847	355.761
Leucoraja ocellata	Winter Skate	8	15.342	23.281	11	7.845	2.138	10.844	10.595
Merluccius bilinearis	Silver Hake	4	9.289	34.505	14	5.687	32.031	7.128	33.021
Hippoglossus hippoglossus	Halibut	5	6.677	2.254	11	4.986	1.656	5.662	1.895
Urophycis tenuis	White Hake	5	5.297	20.756	11	45.466	75.002	29.398	53.304
Limanda ferruginea	Yellowtail Flounder	7	9.853	73.606	8	0.144	0.946	4.028	30.010
Malacoraja senta	Smooth Skate	3	0.530	1.470	12	0.680	2.488	0.620	2.081
Pollachius virens	Pollock	3	46.471	27.021	10	28.183	10.901	35.498	17.349
Myoxocephalus octodecemspinosus	Longhorn Sculpin	4	0.402	2.062	8	2.106	5.744	1.425	4.271
Phycis chesteri	Longfin Hake	3	0.597	6.104	8	0.066	1.820	0.278	3.534
Lophius americanus	Monkfish	2	1.459	0.511	8	2.306	1.589	1.967	1.158
Hemitripterus americanus	Sea Raven	3	0.820	0.857	5	0.468	0.444	0.609	0.609
Squalus acanthias	Spiny Dogfish	2	0.423	0.152	6	101.664	17.069	61.167	10.302
Anarhichas lupus	Atlantic Wolffish	2	1.012	0.207	5	0.463	0.279	0.683	0.250
Nezumia bairdii	Marlinspike Grenadier	1	0.000	0.875	6	0.054	1.037	0.032	0.972
Argentina silus	Argentine	2	0.019	0.172	3	0.077	0.333	0.054	0.268
Cyclopterus lumpus	Lumpfish	2	0.559	0.171	3	1.192	0.279	0.939	0.236
Myxine glutinosa	Hagfish	1	0.023	0.344	4	0.021	0.334	0.022	0.338
Urophycis chuss	Red Hake	1	0.000	0.161	4	1.740	7.535	1.044	4.586
Illex illecebrosus	Short-fin Squid	1	-	-	2	-	-	-	-
Scophthalmus aquosus	Windowpane Flounder	2	-	-	1	-	-	-	-
Zoarces americanus	Ocean Pout	0	-	-	3	-	-	-	-

Species	Common Name	Zone 3 (west)			Zone 3 (east)			Zone 3 (all)	
		Frequency in 14 sets	Average catch per set		Frequency in 19 sets	Average catch per set		Average catch per set	
			Weight (kg)	Number		Weight (kg)	Number	Weight (kg)	Number
Ammodytes dubius	Sand Lance	2	-	-	0	-	-	-	-
Leucoraja erinacea	Little Skate	2	-	-	0	-	-	-	-
Anarhichas minor	Spotted Wolffish	1	-	-	0	-	-	-	-
Citharichthys arctifrons	Gulf Stream Flounder	1	-	-	0	-	-	-	-
Dipturus laevis	Barndoor Skate	1	-	-	0	-	-	-	-
Helicolenus dactylopterus	Rosefish	1	-	-	0	-	-	-	-
Merluccius albidus	Offshore Hake	1	-	-	0	-	-	-	-
Peprilus triacanthus	Butterfish	0	-	-	1	-	-	-	-
Triglops murrayi	Mailed Sculpin	0	-	-	1	-	-	-	-
Urophycis regia	Spotted Hake	1	-	-	0	-	-	-	-

Appendix IV. Semi-decadal average catches (in kg per set) of principal species taken in the Gully MPA by groundfish-trawl surveys

Table IV.1. Semi-decadal average catches (in kg per set) of principal species taken in the "Deep Belt" of Zone 2 of the Gully MPA by summer groundfish-trawl surveys.

Species	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2015–16
Deep sets	**7**	**2**	**6**	**1**	**3**	**1**	**1**	**3**
Hippoglossoides platessoides	2.561	3.705	3.532	6.560	1.433	27.250	1.650	0.233
Sebastes spp.	268.410	6.565	43.118	234.060	386.730	3.680	2.650	92.840
Amblyraja radiata	0.941	1.460	1.620	4.380	1.757	3.020	0.000	1.557
Merluccius bilinearis	0.000	0.485	0.182	0.000	0.363	2.080	0.550	2.573
Phycis chesteri	6.943	4.920	1.063	0.000	2.737	0.220	0.000	1.420
Gadus morhua	2.674	0.000	55.227	1.090	6.563	513.010	2.380	0.000
Melanogrammus aeglefinus	0.761	0.000	10.837	100.630	11.533	26.410	11.460	16.230
Urophycis tenuis	7.050	3.585	28.257	28.440	67.580	12.170	0.930	9.423
Glyptocephalus cynoglossus	0.833	1.945	1.097	0.000	2.123	5.110	0.290	1.497
Leucoraja ocellata	8.160	0.000	0.172	29.530	7.570	1.660	0.000	0.000
Nezumia bairdii	0.527	0.485	0.000	0.000	0.343	0.000	0.000	0.157
Illex illecebrosus	0.667	18.530	0.000	0.000	0.000	0.740	0.000	0.000
Myoxocephalus octodecemspinosus	0.000	0.000	0.000	0.000	0.340	0.000	0.960	0.020
Pollachius virens	0.653	0.000	115.475	3.280	22.133	2.030	0.000	0.297

Table IV.2. Semi-decadal average catches (in kg per set) of principal species taken in Zone 3 (west) of the Gully MPA by summer groundfish-trawl surveys.

Species	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2015–16
Hippoglossoides platessoides	19.215	81.670	3.090	1.250	4.860	0.137	1.547	0.040
Illex illecebrosus	1.250	1.170	17.745	0.000	0.000	0.140	0.230	0.590
Amblyraja radiata	5.075	29.170	0.975	2.500	0.545	0.000	0.000	0.000
Melanogrammus aeglefinus	7.720	0.000	0.515	0.000	18.960	0.003	0.000	13.760
Merluccius bilinearis	13.335	1.170	1.545	0.000	0.000	0.053	2.753	2.260
Sebastes spp.	0.000	0.000	0.460	0.000	58.760	0.000	0.003	5.535
Urophycis tenuis	0.000	0.000	4.985	0.000	7.415	0.000	0.000	0.875
Gadus morhua	8.235	58.330	11.055	0.000	4.070	0.000	0.750	0.000
Hippoglossus hippoglossus	5.370	0.000	1.545	0.000	4.135	0.093	0.000	0.065
Malacoraja senta	0.000	10.500	1.490	1.250	0.000	0.000	0.000	0.000
Glyptocephalus cynoglossus	0.415	1.170	0.000	0.000	1.095	0.060	0.000	0.050
Myoxocephalus octodecemspinosus	0.000	1.170	0.000	0.000	0.000	0.313	277.397	0.045
Limanda ferruginea	0.415	1.170	0.000	0.000	1.095	0.060	0.000	0.050

Table IV.3. Semi-decadal average catches (in kg per set) of principal species taken in Zone 3 (east) of the Gully MPA by summer groundfish-trawl surveys (- indicates no data).

Species	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2015–16
Hippoglossoides platessoides	2.988	2.133	0.420	3.090	-	-	9.910	0.000
Illex illecebrosus	3.500	55.478	2.984	0.000	-	-	0.065	26.035
Amblyraja radiata	5.428	0.730	0.495	3.090	-	-	10.865	0.000
Melanogrammus aeglefinus	0.000	4.723	6.673	10.290	-	-	32.655	32.980
Merluccius bilinearis	0.000	5.350	3.253	51.470	-	-	0.100	25.435
Sebastes spp.	7.715	1.655	0.000	9.260	-	-	0.000	0.755
Urophycis tenuis	5.410	3.123	0.820	43.240	-	-	0.425	11.670
Gadus morhua	2.648	0.000	0.631	11.320	-	-	1.075	0.000
Hippoglossus hippoglossus	1.168	7.488	6.033	0.000	-	-	0.000	2.915
Malacoraja senta	0.220	0.758	0.373	0.000	-	-	0.655	0.000
Glyptocephalus cynoglossus	1.313	0.460	0.100	1.030	-	-	4.145	0.640
Myoxocephalus octodecemspinosus	0.000	0.273	0.000	0.000	-	-	0.365	0.295
Limanda ferruginea	0.000	0.000	0.000	0.000	-	-	0.000	0.000

Table IV.4. Semi-decadal average catches (in kg per set) of principal species taken in Zone 3 of the Gully MPA by spring groundfish-trawl surveys.

Species	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2005–09
Hippoglossoides platessoides	2.285	18.968	24.343	16.973	1.104	4.150	4.640
Gadus morhua	17.865	114.206	348.230	36.273	438.500	6.347	0.360
Amblyraja radiata	4.470	3.324	0.990	12.510	1.496	16.771	9.025
Melanogrammus aeglefinus	12.760	35.526	76.787	51.025	36.270	50.699	3.485
Glyptocephalus cynoglossus	0.000	36.522	19.443	4.633	1.764	12.631	0.460
Sebastes spp.	0.000	10.734	3.733	102.907	0.872	12.476	0.710
Leucoraja ocellata	0.000	8.376	38.603	8.762	0.464	7.864	3.115
Merluccius bilinearis	0.000	22.414	1.943	0.338	5.462	9.503	0.030
Hippoglossus hippoglossus	14.585	14.890	2.917	2.183	0.464	5.121	3.115
Urophycis tenuis	4.375	148.966	0.000	5.047	2.314	12.360	0.000
Limanda ferruginea	0.000	5.410	0.000	0.487	0.000	0.321	0.000
Malacoraja senta	0.000	0.206	0.343	0.505	0.306	1.429	0.990
Pollachius virens	0.000	3.288	82.313	38.105	6.062	77.520	0.000
Myoxocephalus octodecemspinosus	0.000	0.000	0.343	5.023	0.828	0.991	0.245
Phycis chesteri	0.000	1.594	0.000	0.000	0.030	0.033	0.000
Lophius americanus	0.000	1.848	8.297	0.815	1.150	1.076	0.000

Table IV.5. Semi–decadal average catches (in kg per set) of principal species taken in Zone 3 (west) of the Gully MPA by spring groundfish-trawl surveys (- indicates insufficient data).

Species	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2005–09
Hippoglossoides platessoides	2.285	4.677	1.030	2.625	0.000	3.385	-
Gadus morhua	17.865	2.990	520.885	6.710	0.000	12.055	-
Amblyraja radiata	4.470	3.253	0.515	0.000	0.000	8.345	-
Melanogrammus aeglefinus	12.760	0.000	78.235	2.915	0.000	42.965	-
Glyptocephalus cynoglossus	0.000	9.017	0.000	1.460	0.000	1.125	-
Sebastes spp.	0.000	17.890	4.630	0.485	0.000	42.775	-
Leucoraja ocellata	0.000	5.153	53.530	21.195	0.000	9.600	-
Merluccius bilinearis	0.000	36.060	0.000	0.000	0.000	1.640	-
Hippoglossus hippoglossus	14.585	16.010	0.000	1.460	0.000	0.000	-
Urophycis tenuis	4.375	12.350	0.000	0.000	0.000	8.880	-
Limanda ferruginea	0.000	9.017	0.000	1.460	0.000	1.125	-
Malacoraja senta	0.000	0.000	0.515	0.000	0.000	2.665	-
Pollachius virens	0.000	1.060	0.000	11.180	0.000	266.060	-
Myoxocephalus octodecemspinosus	0.000	0.000	0.515	0.000	0.000	1.900	-
Phycis chesteri	0.000	2.333	0.000	0.000	0.000	0.080	-
Lophius americanus	0.000	0.487	4.665	0.000	0.000	0.000	-

Table IV.6. Semi-decadal average catches (in kg per set) of principal species taken in Zone 3 (east) of the Gully MPA by spring groundfish-trawl surveys (- indicates insufficient data).

Species	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2005–09
Hippoglossoides platessoides	-	40.405	70.970	24.148	1.380	4.456	4.640
Gadus morhua	-	281.030	2.920	51.055	548.125	4.064	0.360
Amblyraja radiata	-	3.430	1.940	18.765	1.870	20.142	9.025
Melanogrammus aeglefinus	-	88.815	73.890	75.080	45.338	53.792	3.485
Glyptocephalus cynoglossus	-	77.780	58.330	6.220	2.205	17.234	0.460
Sebastes spp.	-	0.000	1.940	154.118	1.090	0.356	0.710
Leucoraja ocellata	-	13.210	8.750	2.545	0.580	7.170	3.115
Merluccius bilinearis	-	1.945	5.830	0.508	6.828	12.648	0.030
Hippoglossus hippoglossus	-	13.210	8.750	2.545	0.580	7.170	3.115
Urophycis tenuis	-	353.890	0.000	7.570	2.893	13.752	0.000
Limanda ferruginea	-	0.000	0.000	0.000	0.000	0.000	0.000
Malacoraja senta	-	0.515	0.000	0.758	0.383	0.934	0.990
Pollachius virens	-	6.630	246.940	51.568	7.578	2.104	0.000
Myoxocephalus octodecemspinosus	-	0.000	0.000	7.535	1.035	0.628	0.245
Phycis chesteri	-	0.485	0.000	0.000	0.038	0.014	0.000
Lophius americanus	-	3.890	15.560	1.223	1.438	1.506	0.000

Appendix V. Frequency of groundfish and squid in the five catches taken during 2015–19 at each station of the Snow Crab surveys in or near The Gully MPA.

Species	Common Name	Total	Station									
			950	953	918	629	954	955	952	625	951	501
Merluccius bilinearis	Silver Hake	42	4	4	5	3	4	5	3	4	5	5
Melanogrammus aeglefinus	Haddock	40	3	3	5	4	1	5	5	4	5	5
Glyptocephalus cynoglossus	Witch Flounder	33	0	0	5	4	1	5	5	5	4	4
Hippoglossoides platessoides	American Plaice	30	5	5	0	4	5	3	3	4	1	0
Gadus morhua	Atlantic Cod	27	4	5	1	5	4	1	3	3	0	1
Urophycis tenuis	White Hake	23	4	0	4	0	0	3	3	0	4	5
Sebastes spp.	Redfish	20	0	0	3	0	1	4	2	0	5	5
Limanda ferruginea	Yellowtail Flounder	20	4	5	0	5	5	1	0	0	0	0
Myoxocephalus octodecemspinosus	Longhorn Sculpin	20	5	5	0	5	4	0	0	1	0	0
Lophius americanus	Monkfish	18	0	0	5	2	1	2	2	3	2	1
Urophycis chuss	Red Hake	14	1	0	5	0	0	5	1	0	1	1
Phycis chesteri	Longfin Hake	13	0	0	2	0	0	2	0	0	4	5
Malacoraja senta	Smooth Skate	13	3	0	0	1	0	0	2	4	2	1
Amblyraja radiata	Thorny Skate	12	2	0	0	2	1	1	2	3	1	0
Pollachius virens	Pollock	11	0	2	0	0	1	1	0	1	4	2
Citharichthys arctifrons	Gulf Stream Flounder	11	0	0	5	0	0	5	1	0	0	0
Helicolenus dactylopterus	Rosefish	10	0	0	1	0	0	0	0	0	4	5
Hippoglossus hippoglossus	Halibut	9	2	2	1	0	1	1	1	1	0	0
Hippoglossina oblonga	Fourspot Flounder	8	0	0	3	0	0	4	0	0	0	1
Agonidae	poachers	8	4	2	0	0	2	0	0	0	0	0
Illex illecebrosus	Short-fin Squid	8	0	1	2	0	0	1	1	0	1	2
Nezumia bairdii	Marlinspike Grenadier	6	0	0	0	0	0	0	0	0	1	5
Hemitripterus americanus	Sea Raven	5	2	1	0	0	2	0	0	0	0	0
Triglops pingelii	Ribbed Sculpin	4	3	1	0	0	0	0	0	0	0	0
Dipturus laevis	Barndoor Skate	3	0	0	0	0	0	0	0	0	2	1
Leucoraja ocellata	Winter Skate	3	0	0	1	0	0	1	0	1	0	0
Triglops murrayi	Mailed Sculpin	2	1	0	0	0	1	0	0	0	0	0
Zoarces americanus	Ocean Pout	2	0	0	0	0	0	0	0	0	0	2
Squalus acanthias	Spiny Dogfish	2	0	0	0	0	0	0	0	0	1	1
Argentina silus	Argentine	1	0	0	1	0	0	0	0	0	0	0
Liparis sp.	Snailfish	1	1	0	0	0	0	0	0	0	0	0

Appendix VI. Frequency of decapod crustaceans in the five catches taken during 2015–19 at each station of the Snow- Crab surveys in or near The Gully MPA.

Species	Common Name	Total	Station									
			950	953	918	629	954	955	952	625	951	501
Cancer borealis	Jonah Crab	24	0	1	2	3	1	4	3	3	2	5
Chionoecetes opilio	Snow Crab	20	5	5	0	5	5	0	0	0	0	0
Cancer irroratus	Rock Crab	20	5	5	0	4	5	0	0	0	1	0
Paguridae	hermit crabs	19	5	5	1	2	2	0	1	2	1	0
Lithodes maja	Norway King Crab	11	3	5	0	0	0	0	1	2	0	0
Pandalus montagui	Striped Pink Shrimp	6	1	0	0	0	0	0	1	3	1	0
Hyas coarctatus	Arctic Tyre Crab	5	2	3	0	0	0	0	0	0	0	0
Homarus americanus	Lobster	3	0	0	0	0	0	1	0	0	0	2
Crangon sp.	Bay Shrimps	2	1	1	0	0	0	0	0	0	0	0
Pandalus borealis	Northern Shrimp	1	0	0	0	0	0	0	0	1	0	0
Galatheidae	Squat Lobsters	1	0	0	0	0	0	0	0	0	0	1
Munida iris	Squat Lobster	1	0	0	0	0	0	0	0	0	0	1

Appendix VII. Frequency of other benthic taxa in the five catches taken during 2015–19 at each station of the Snow Crab surveys in or near The Gully MPA.

Species	Common Name	Total	Station									
			950	953	918	629	954	955	952	625	951	501
Placopecten magellanicus	Sea Scallop	23	5	4	0	5	4	0	1	4	0	0
Hippasteria phrygiana	Sea Star	21	5	5	0	1	1	0	2	2	3	2
Holothuroidea	Sea Cucumbers	15	5	1	0	4	4	0	0	1	0	0
Clypeasteroida	Sand Dollars	14	5	5	0	0	4	0	0	0	0	0
Asteroidea	Sea Stars	12	1	1	2	0	1	4	1	1	1	0
Anthozoa	Sea Anemones	11	0	2	2	2	3	0	1	0	0	1
Solaster endeca	Purple Sun Star	10	5	5	0	0	0	0	0	0	0	0
Strongylocentrotus droebachiensis	Green Sea Urchin	10	0	5	0	3	2	0	0	0	0	0
Buccinum sp.	Whelk	8	1	2	0	2	2	0	0	1	0	0
eggs of *Buccinum*	eggs of *Buccinum*	4	3	0	0	0	1	0	0	0	0	0
Crossaster papposus	Spiny Sun Star	7	0	0	0	3	3	0	0	1	0	0
Pennatulidae	Sea Pens	7	1	1	0	0	0	0	0	0	2	3
Henricia sanguinolenta	Blood Sea Star	6	2	1	0	0	0	0	1	2	0	0
Porifera	Sponges	5	0	1	0	0	0	0	2	2	0	0
Asterias sp.	Sea Star	3	0	0	0	0	1	0	0	1	1	0
Salpidae	Salps	2	0	0	1	0	0	0	0	1	0	0
Aphroditella hastata	Seamouse	2	0	2	0	0	0	0	0	0	0	0
Nudibranchia	Nudibranch	2	0	1	0	0	0	0	0	0	1	0
Ascidia sp.	Tunicate	1	0	0	0	0	0	0	1	0	0	0
Boltenia sp.	Sea Potato	1	0	0	0	1	0	0	0	0	0	0
Polychaeta	Polychaetes	1	1	0	0	0	0	0	0	0	0	0
C*hlamys islandica*	Iceland Scallop	1	0	0	0	0	1	0	0	0	0	0
Mytilidae	Mussels	1	0	0	0	0	1	0	0	0	0	0
Leptasterias polaris	Polar Sea star	1	0	0	0	0	1	0	0	0	0	0
Psilaster archaster	Sea Star	1	0	0	1	0	0	0	0	0	0	0
Astropecten duplicatus	Sea Star	1	0	0	1	0	0	0	0	0	0	0
Ophiuroidea	brittle stars	1	0	0	0	0	0	0	1	0	0	0
Gorgonocephalidae & Asteronychidae	basket stars	1	1	0	0	0	0	0	0	0	0	0

Appendix VIII. Summary of catches taken by the Halibut survey at Station 85 and by index fishing in the Gully MPA during 1998–2020.

Common Name	Species	Number of Records	
		Total	Station 85
Atlantic Halibut	*Hippoglossus hippoglossus*	709	21
Cusk	*Brosme brosme*	521	9
White Hake	*Urophycis tenuis*	407	13
Redfish	*Sebastes* spp.	185	9
Wolffishes		**152**	**6**
Northern Wolffish	*Anarhichas denticulatus*	65	0
Spotted Wolffish	*Anarhichas minor*	45	0
Atlantic Wolffish	*Anarhichas lupus*	22	0
Atlantic Cod	*Gadus morhua*	123	3
Dogfishes		**121**	**1**
Black Dogfish	*Centroscyllium fabricii*	97	0
Skates		**112**	**10**
Thorny Skate	*Amblyraja radiata*	60	0
Barndoor Skate	*Dipturus laevis*	38	0
Winter Skate	*Leucoraja ocellata*	17	0
Smooth Skate	*Malacoraja senta*	1	0
Greenland Halibut	*Reinhardtius hippoglossoides*	51	2
Spiny Dogfish	*Squalus acanthias*	48	0
Silver Hake	*Merluccius bilinearis*	43	0
Grenadiers		**35**	**3**
Roughhead Grenadier	*Macrourus berglax*	7	0
Marlinspike Grenadier	*Nezumia bairdii*	3	0
Rock Grenadier	*Coryphaenoides rupestris*	3	0
Snow Crab	*Chionoecetes opilio*	35	2
Haddock	*Melanogrammus aeglefinus*	32	0
Red Hake	*Urophycis chuss*	15	1
Sharks		**14**	**0**
Porbeagle Shark	*Lamna nasus*	5	0
Blue Shark	*Prionace glauca*	4	0
Thresher Shark	*Alopias vulpinus*	1	0
Northern Stone Crab	*Lithodes maja*	11	0
Corals		**10**	**1**
Bubblegum Coral	*Paragorgia arborea*	6	0
Red Tree Coral	*Primnoa resedaeformis*	4	0
Deepwater Chimera	*Hydrolagus affinis*	4	0

The table shows the number of records of each taxon in catches of the index and survey fishing in the MPA, summed through the 23 years of the program completed to date, as both a combined total and for Station 85 alone. Some sets have multiple records for the same species but the tabulated figures approximate to the number of sets that have taken the relevant taxon. They are *not* the numbers of individuals caught.

The Wolffishes, Deepsea-Dogfishes (likely *not* including the Spiny Dogfish, *Squalus acanthias*), Grenadiers, Skates and/or Sharks were often identified to species but, for a substantial number of sets, they were not. Thus, the total number of records of members of each of those groups are tabulated here, with the numbers of records for each particular named species also shown. The latter numbers are *included* in the group totals. For convenience, the corals are treated similarly, although each of the few taken were fully identified.

For 15 sets, part of the catch was recorded only as “Hake”. Since that label can be applied to various distantly-related species, all of which were generally fully identified, the Hakes are not here treated as a group and those 15 records are not included in the tabulated figures.