UPDATE OF MAIN INDICATORS OF STOCK STATUS FOR UNITS 1 AND 2 REDFISH IN 2016

Context

The Units 1 and 2 redfish stocks (*Sebastes mentella* and *Sebastes fasciatus*) were assessed in March 2016 using survey-based indicators after an assessment model framework meeting in December 2015 rejected both assessment model methods proposed. A new model framework meeting proposed for November 2016 was cancelled after investigations of historical catch cast doubt on official catch statistics from the late-1980s and early-1990s, which represented a period of critical leverage in assessment model fitting. A full assessment was expected in March 2017; however, without an accepted model, this could not be conducted. Therefore a Science Response was requested to update the status of Units 1 and 2 redfish in winter 2017 using the latest data. The present work represents an update of the redfish stocks based on the DFO summer trawl survey conducted since 1984 in Unit 1, and the industry (Groundfish Enterprise Allocation Council or GEAC) survey of Unit 2 conducted since 2000.

This Science Response Report results from the Science Response Process of March 16, 2017 on the Updated status of Units 1 and 2 Redfish in 2016.

Background

The important 2011 year classes of both species, and at least two other strong year classes in 2012 and 2013 for *S. mentella,* mean that the status of these stocks are changing quickly. The relative change in status of these stocks is compounded by increasing availability of these year classes to the demersal survey gear over time. More frequent stock status updates for strong year classes are particularly useful when these year classes are in the size window of about 15-25 cm and stock status can change quickly.

Analysis and Response

Both Unit 1 and Unit 2 survey data were analysed for this update. The Unit 1 DFO survey is performed annually in the northern Gulf of St. Lawrence in August, and the Unit 2 industry survey is performed every other year in September. Only the Unit 1 survey has been split into species for this update. Thus, Unit 1 species-specific indicators are presented, while Unit 2 indicators represent species aggregates. Catch data are also included but numbers for the most recent years are preliminary, and the 2016 values in particular are likely to change as catch continues to be received by DFO.

Stock status

Sebastes mentella in the 2016 Unit 1 survey was caught in abundance in almost all sets and all regions covered by the survey (Fig. 1, right column). This contrasts sharply with the catches in

2010 (the year of the COSEWIC status evaluation of this stock), when not all stations caught *S. mentella* and most sets had a relatively low abundance of this species (Fig. 1, left column). Abundance of mature *S. mentella* in 2010 was very similar to total abundance that year as there was only a very low level of recruitment in the previous 20 years. Mature *S. mentella* abundance, estimated by a logistic maturity-at-length relationship applied to the total abundance, was higher in 2016 than 2010 (Fig. 1, lower right). However, total *S. mentella* abundance in 2016 was dominated by juveniles.

The spatial distribution of Unit 1 catches for *S. fasciatus* between 2010 and 2016 is similar to *S. mentella* (Fig. 2). One of the major differences is that abundance of *S. fasciatus* did not drop to the low levels of *S. mentella* nor have recent cohorts been as large. In addition, *S. fasciatus* seems to have a higher level of base recruitment compared to *S. mentella*.

Swept area biomass of Unit 1 *S. mentella* in 2016 was at its highest level since the survey began in 1984 (Fig. 3) while mature biomass was at about 50% of its peak biomass since 1984. The 2016 total biomass was more than $1{,}500 \times 10^3$ t while mature biomass may have been as high as 25×10^3 t. It would be wise, however, to be cautious of mature biomass estimates at present because they are estimated via an application of a logistic maturity-at-length curve. In addition, the survey swept area biomass values should be considered neither minimum nor maximum estimates of absolute stock biomass as previous work has suggested that there is considerable uncertainty about the catchability of redfish in the survey to even suggest that it could be larger than 1. The utility of Fig. 1 is best expressed as a relative comparison of points within time series, such that there is a greater degree of confidence that total biomass *S. mentella* is presently the highest observed level, rather than suggesting that total biomass is actually $1{,}500 \times 10^3$ t.

Swept area biomass and abundance of Unit 1 *S. fasciatus* also increased in recent years but declined somewhat in 2016 compared to 2014 (Fig. 3). This is because only one large year class (2011) was observed for *S. fasciatus* while several strong successive year classes were observed for *S. mentella*. Nevertheless, mature biomass and abundance can be expected to increase for *S. fasciatus* over the next few years as the important 2011 year class grows into maturity.

Total swept area biomass of *Sebastes* spp. in 2016 over the entire Units 1 and 2 survey area was estimated at almost 2.5 million t (Fig. 4). This is the highest biomass observed in Unit 1 since 1984, and in Unit 2 since the beginning of the survey in 2000. Most of this 2016 biomass is found in Unit 1 and dominated by *S. mentella* (Fig. 3). The Unit 2 survey indicated that redfish biomass in this region has more than doubled between 2014 and 2016.

The 2011-2013 year classes of *S. mentella* in the 2016 Unit 1 survey are very abundant and apparently much larger than the previous strong year class of 1980/81 (Fig. 5, 7). The 2011 year class of *S. fasciatus* is also one of the largest observed, but is of similar magnitude to other good year classes (e.g., 1980/81; Fig. 5, 7). The 2016 Unit 2 survey, though not split by species, shows a large peak at 18 cm which corresponds well to the abundant 2011 year classes (Fig. 6). This suggests that the 2011 year class is now spreading throughout the stock area. Genetic analysis of the 2011 year class of both species indicates that these are Units 1 and 2 origin fish and a good year class of Units 1 and 2 fish of either species has not been observed since 1980/81.

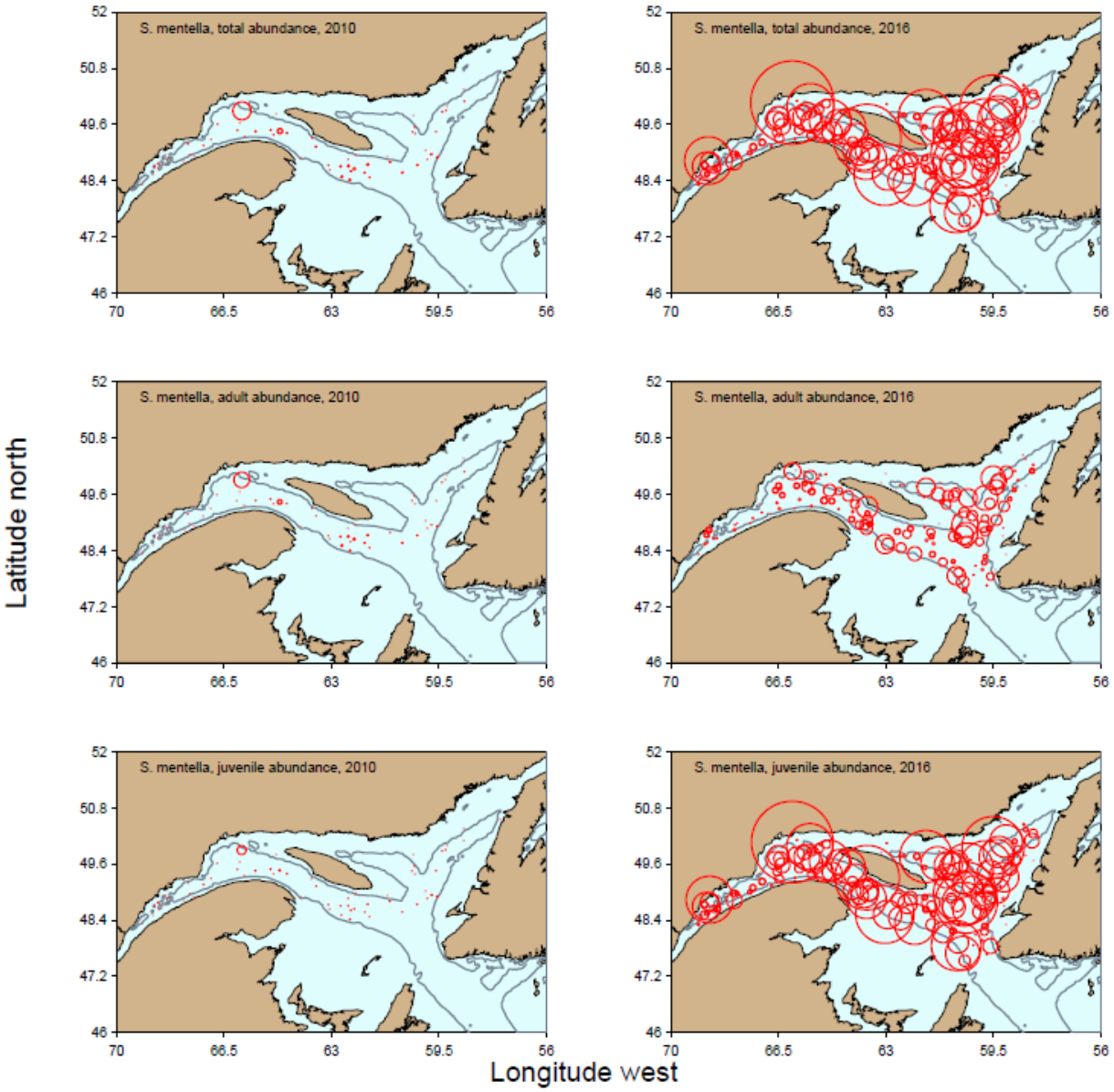

Figure 1. Captures of S. mentella in the DFO summer survey of Unit 1 in 2010 contrasted with 2016. Circle diameter is proportional (not linear) to the size of catch in a tow. Circle diameter scaling is preserved between maps as an indicator of relative abundance. 2010 was the year of release of the last COSEWIC assessment for this stock.

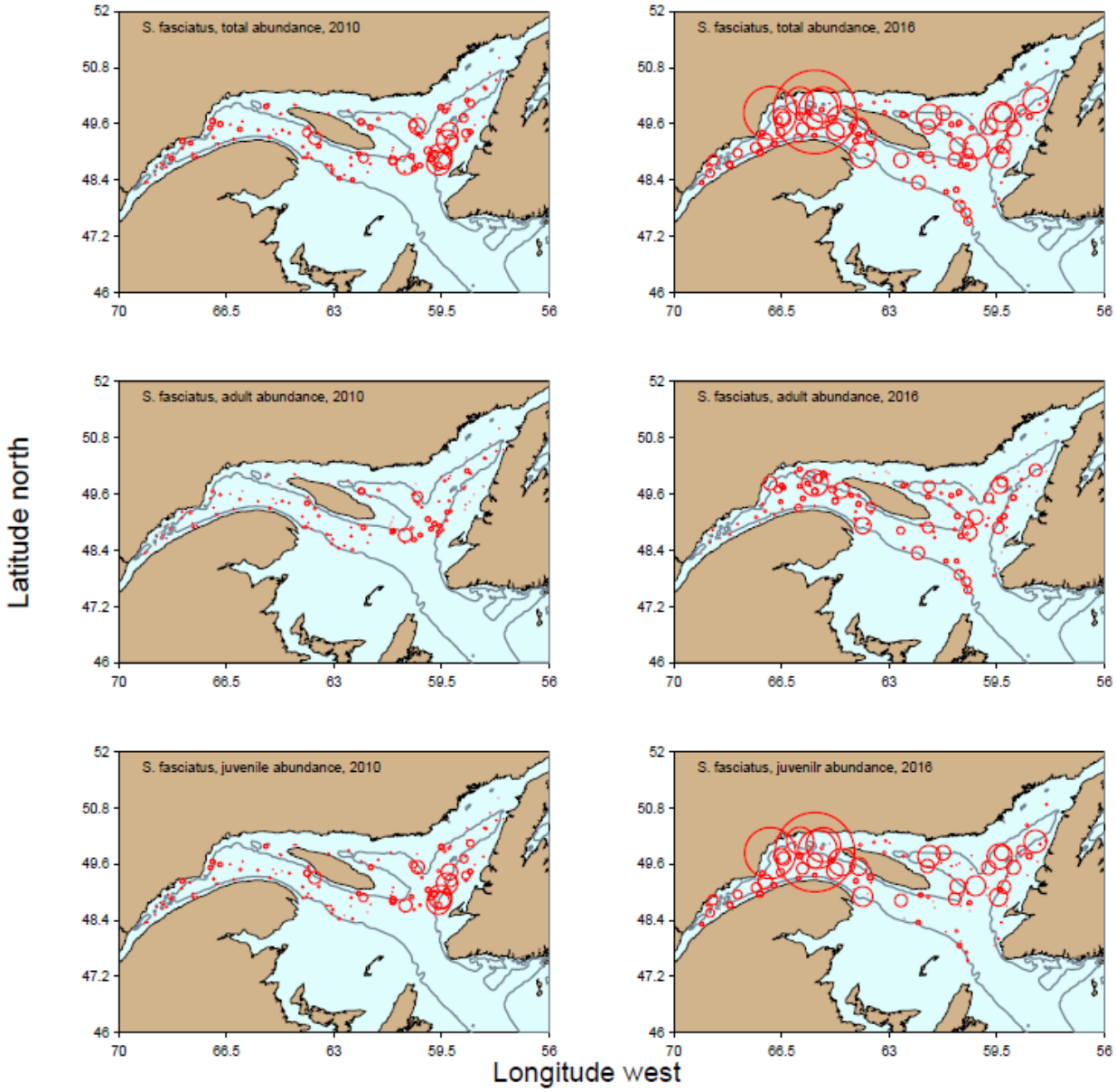

Figure 2. Captures of S. fasciatus in the DFO summer survey of Unit 1 in 2010 contrasted with 2016. Circle diameter is proportional (not linear) to the size of catch in a tow. Circle diameter scaling is preserved between maps as an indicator of relative abundance. 2010 was the year of release of the last COSEWIC assessment for this stock.

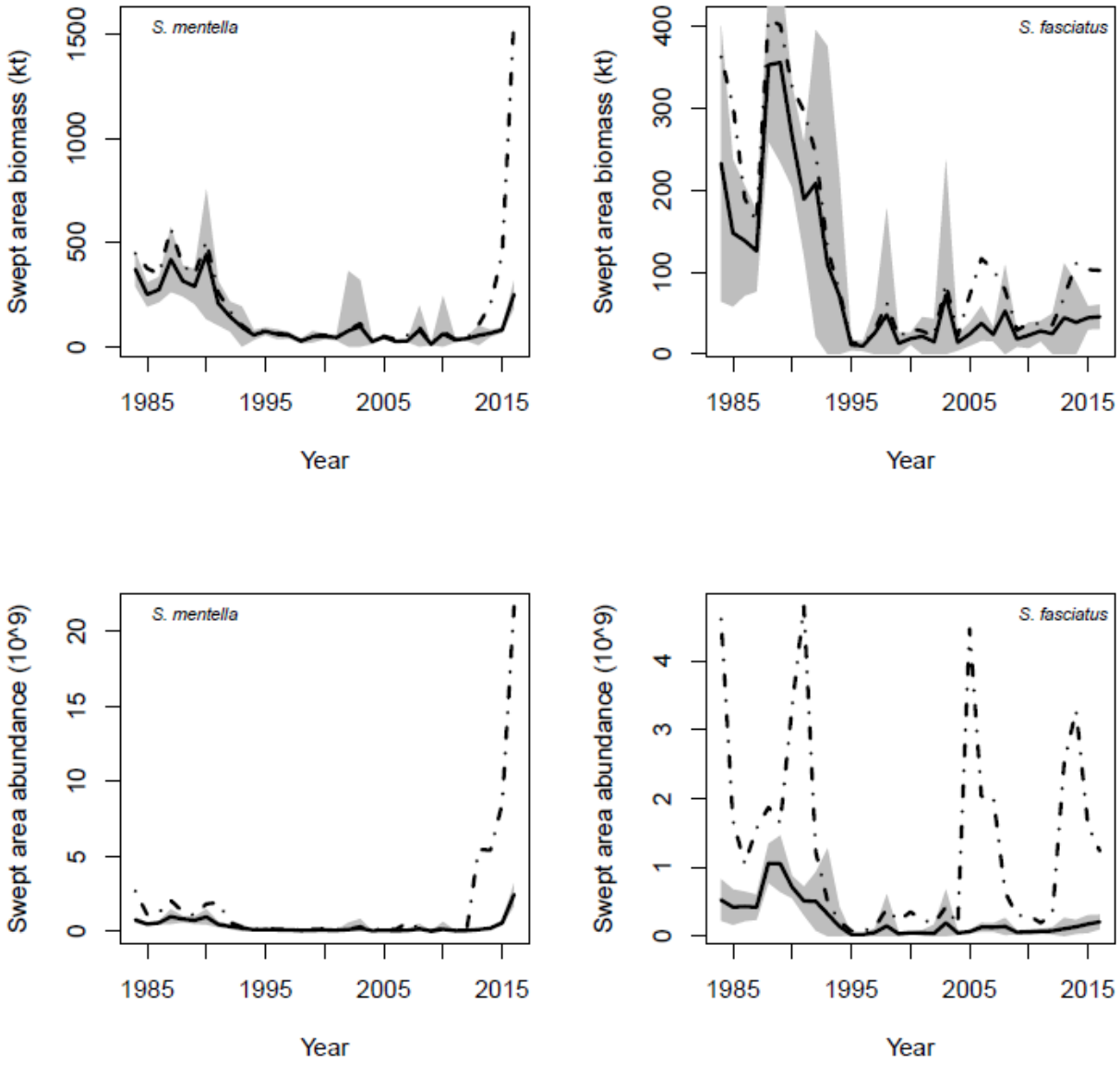

Figure 3. Unit 1 survey swept area biomass and abundance, by species. Dashed lines (always the highest line) represent total biomass or abundance while adult (mature) is represented by the solid lines. 95% confidence intervals are shown around adult biomass and abundance.

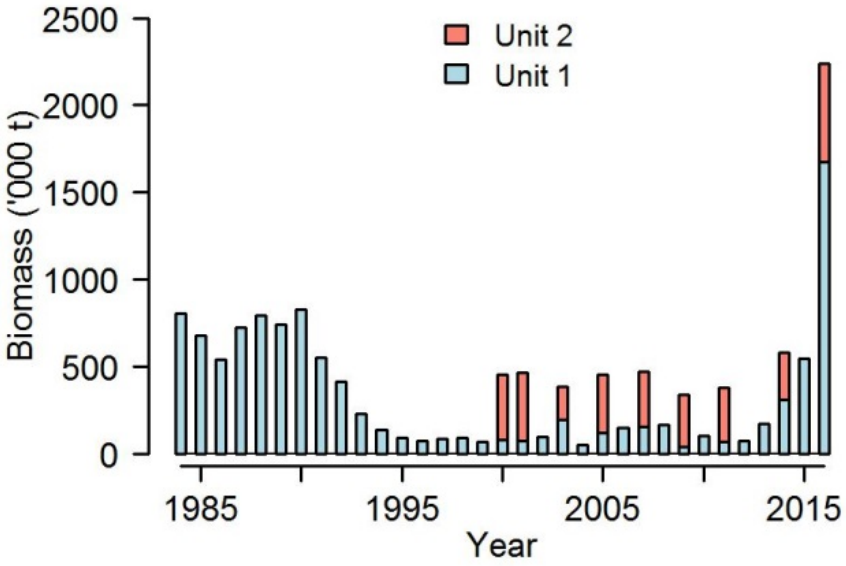

Figure 4. Survey estimates of species-aggregated swept area total biomass for Units 1 and 2 redfish (Sebastes spp.).

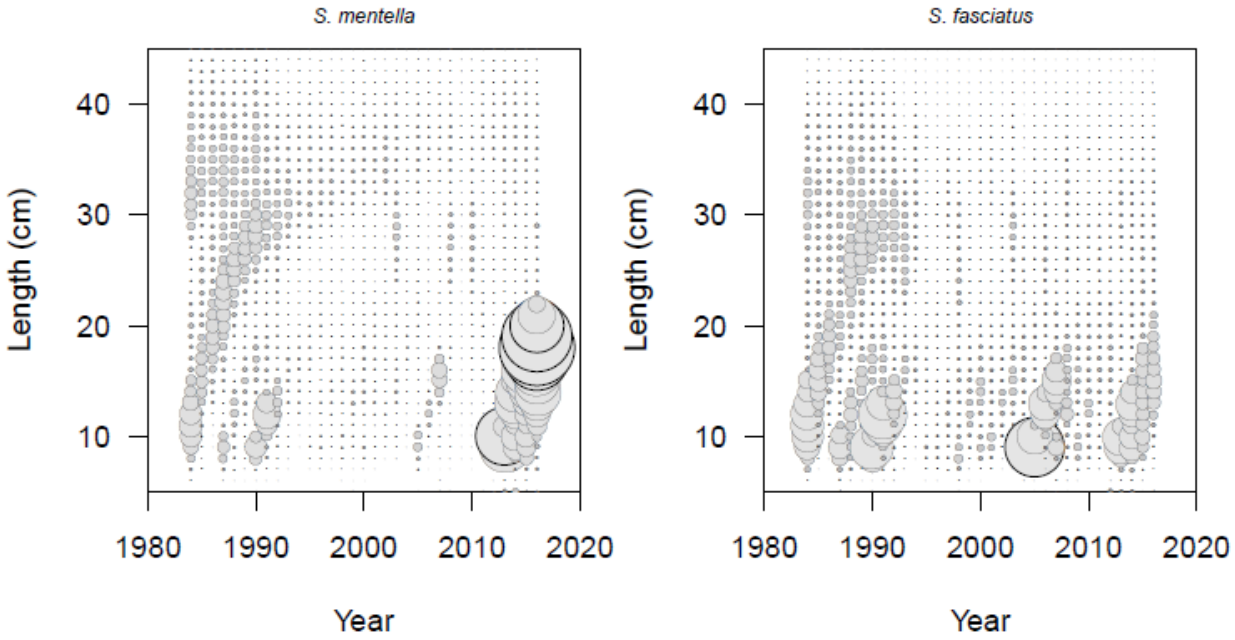

Figure 5. Unit 1 redfish year class strength at size and abundance over time. Circle diameter is proportional (not linear) to abundance per set and circle size scaling is preserved between panels. Thus circle sizes are comparable between panels.

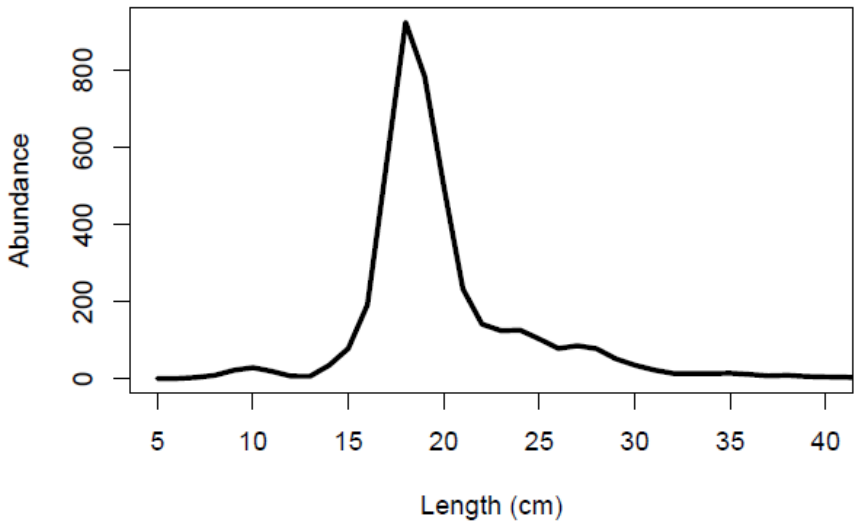

Figure 6. Abundance at length of species-aggregated redfish (Sebastes spp.) from the Unit 2 industry-conducted survey in 2016.

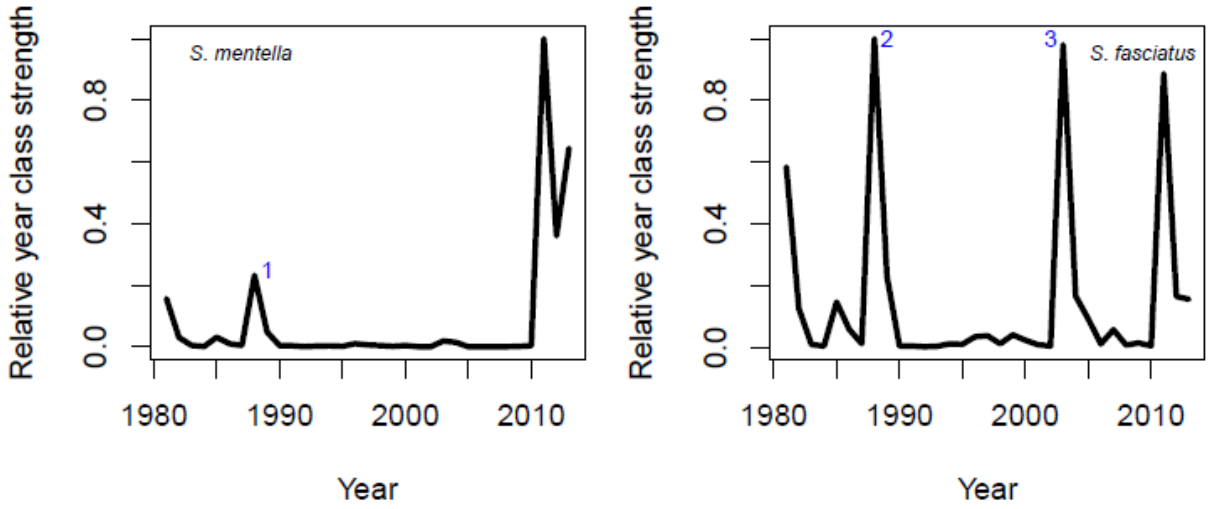

Figure 7. Relative year class strength of the two redfish species in Unit 1, observed at age 3. These are calculated from the abundance of 13 cm fish which is the center of the 3-year-old length distribution. Year class strength is standardized but different between species, and is therefore not quantitatively comparable between panels. Point 1: this increase is a result of imperfect splitting of species in the survey and the increase is mostly attributable to S. fasciatus. Points 2 and 3: the 1988 year class of S. fasciatus was made up of fish with the Grand Bank genetic signature and not that of either Units 1 or 2 stocks – these have been termed the "disappearing cohorts" as most of the individuals left the Units 1 and 2 area before reaching maturity. The early 1980s and the 2011, 2012 and 2013 cohorts have the genetic signature and/or meristic characteristics of Units 1 and 2 redfish.

The Unit 1 and Unit 2 fishery

The annual reported landings of the redfish fishery in Units 1 and 2 are below quota (Fig. 8). Numbers for 2015-2016 are preliminary as information on catch is still being reconciled. This is particularly true for the most recent year (2016). Therefore, catch is expected to be higher than shown in Figure 8 but still unlikely to surpass the quota.

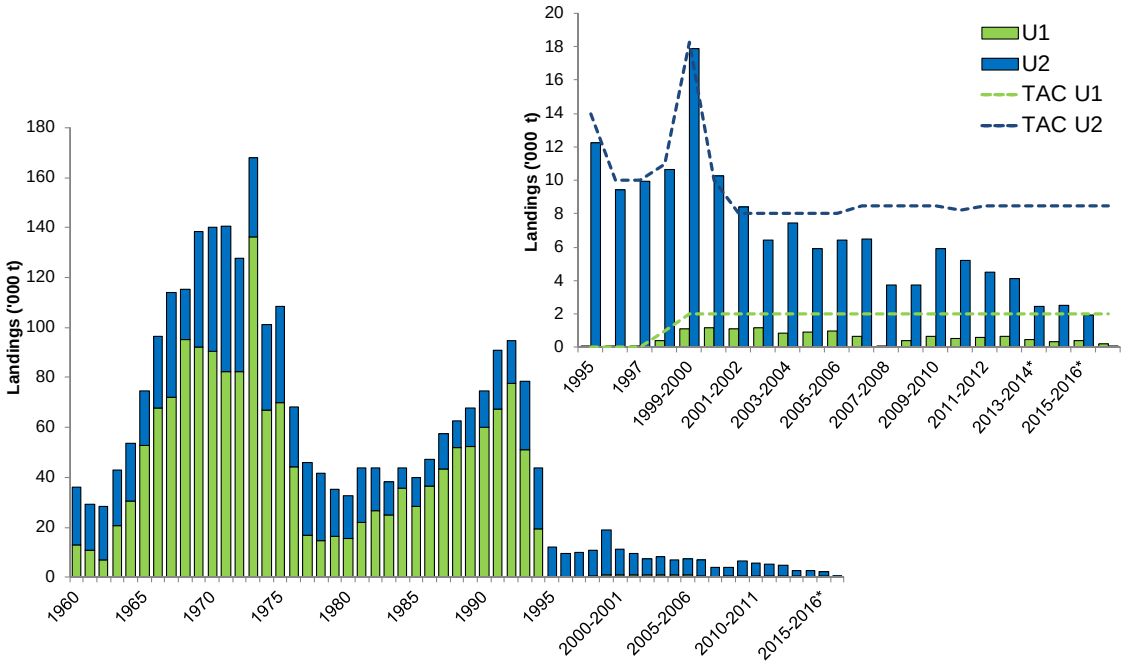

*Figure 8. Reported landings of redfish in Units 1 and 2 and quota (Total Allowable Catch or TAC). The catch represents the total catch of both redfish species in the area and is reported for the management years from May 15 of the current year to May 14 of the following year for Unit 1 and from April 1 to March 31 for Unit 2.Other work (Duplisea 2016) has also indicated that reported catches in the late 1980s and early 1990s may be largely underestimated. *Recent values are preliminary.*

Previous work (Duplisea 2016) has suggested that redfish reported catch shown in Fig. 8 may have been considerably underestimated in the late-1980s and early-1990s. In addition, the composition of the catch may have included many more small fish (< 20 cm) than reported and which are considered to make up only a very small proportion of reported catch. Indeed at present, there is a large discrepancy between the length-frequency distributions of commercial catch as observed by at sea observers vs port samplers. At-sea sampling shows that in recent years (e.g. 2015 and 2016) a large portion of the catch (more than 20% in number) in the directed redfish fishery could be constituted by fish < 22 cm while port sampling shows < 1% of the catch made up of fish < 22 cm. It is important for future modelling efforts that catch reporting does not simply reflect landings but reflects total fishing mortality regardless if the fish were landed or not.

Conclusions

- Survey biomass of *Sebastes* spp. in 2016 over the entire Units 1 and 2 survey area was the highest estimated since 1984 in Unit 1 and since 2000 in Unit 2. Most of this biomass is

found in Unit 1 and is dominated by *S. mentella*. The Unit 2 survey indicated redfish biomass has more than doubled between 2014 and 2016.

- The 2011 year class of *S. mentella* is probably the largest ever observed for this species, while the same year class for *S. fasciatus* is also strong. Genetic analysis confirms that this year class for both species consists of Units 1 and 2 origin fish.
- Individuals from the 2011 cohort were about 18 cm in late summer 2016 and will recruit (22 cm) in force to the fishery in 2018.
- The recent strong cohorts have been observed in Unit 1 survey since 2013 and in the 2016 Unit 2 survey, there was a strong presence of corresponding fish (modal size of 18 cm) but in lower abundance than in Unit 1.
- There are presently several large cohorts of undersized (< 22 cm) redfish in the water and these will be vulnerable to directed fishing and by-catch in fishing operations in 2017.
- Given the increasingly improved status of Units 1 and 2 redfish in August 2016, the prognosis and science advice for these stocks produced in March 2016 remains valid.

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Sources of information

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