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Science | Sciences
Newfoundland and Labrador Region
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RECOVERY POTENTIAL ASSESSMENT OF AMERICAN PLAICE (*HIPPOGLOSSOIDES PLATESSOIDES*) IN NEWFOUNDLAND AND LABRADOR

photo M.J. Morgan

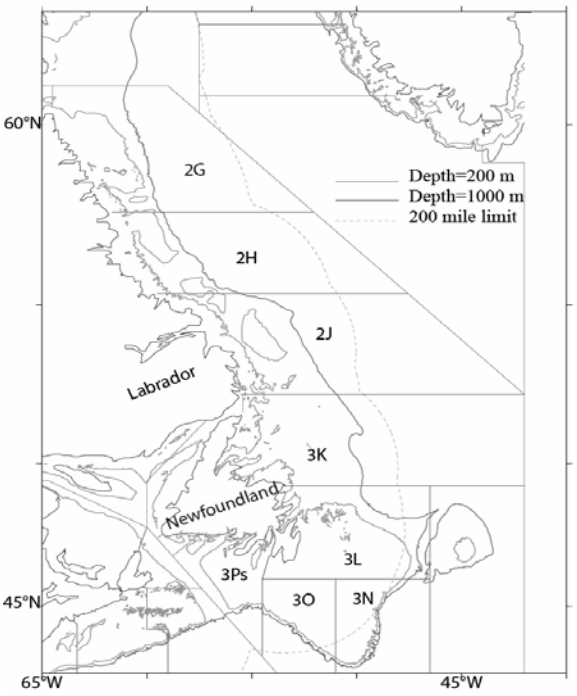

Figure 1: American Plaice stock management areas SA2+Div. 3K, Div. 3LNO and Subdiv. 3Ps that make up the Newfoundland and Labrador designatable unit.

Context

In 2009, Newfoundland and Labrador American Plaice was designated "threatened" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) due to the significant decline in abundance.

A recovery potential assessment (RPA) was introduced by DFO Science to provide the information and scientific advice required to meet various requirements of the Species at Risk Act (SARA), including informing decisions regarding the listing of Newfoundland and Labrador American Plaice under the Act and developing a recovery strategy.

This science advisory report describes the status of American Plaice populations in SA 2+ Div. 3K, Div. 3LNO and Subdiv. 3Ps, which constitute the Newfoundland and Labrador designatable unit. Historic population trajectories and projections are presented. This scientific advice also addresses the major threats to the survival and recovery of Newfoundland and Labrador American Plaice and the limiting factors. The measures that can help its recovery are listed.

SUMMARY

SUMMARY

- Abundance of American Plaice has declined over its entire range. In some parts of its range the decline was over 90% compared to historic population. American Plaice populations have shown some improvement but are still at low levels.

- The greatest threat to the recovery of American Plaice over most of the area is continued fishing mortality. Fishing mortality occurs exclusively as by-catch in other commercial fisheries. In the SA2+Div.3K population productivity remains very low, probably as a result of high natural mortality.

- The results of this RPA are mainly based on projections of stock size over 48 years (3 generations). Long term projections are dominated by process error (uncertainty in recruitment rates, mortality rates, etc.) so that their utility is not in providing probabilities of specific outcomes but rather in defining the uncertainty. The entire range of uncertainty, particularly the lower limits need to be considered in any conclusion.

- Given the results of these projections, there is scope for management action to facilitate recovery through a reduction in fishing mortality.

- For the Newfoundland and Labrador designatable unit (DU) as a whole, results of projections of population biomass over 48 years at current fishing mortality (F) range from an increase of more than 7 times to a decrease in biomass to reach less than 50% of the biomass in 2009. Most of the range encompassed by approximately 95% of the results is above the level of biomass at the beginning of the projection period.

- For Div. 3LNO at current F (0.172), projections of population biomass show that biomass could be from 6.5 times to only 45% of 2009 biomass by the end of the 48 year projection. It should be noted that at current F by the end of the projection period a substantial proportion of the projected spawning stock biomasses (SSB) remain below Blim.

- For SA 2+Div. 3K at current F (<0.001), projections of population biomass show that biomass could increase from 10 to 2400% compared to the biomass in 2009.

- In Subdiv. 3Ps at current F (0.025), projections of population biomass show that biomass could increase from 4 to 9 times the biomass in 2009.

- For the DU as a whole there is a substantial increase in biomass over 48 years with an F=0. All populations in the DU have an increase under the scenario of no fishing. However, for SA 2+Div. 3K there is some possibility of only a small increase in this population even with no fishing. For Div. 3LNO American Plaice the management target of exceeding Blim is also projected to be reached under an F=0 fishing scenario.

- For Div. 3LNO the maximum F for allowable harm is less than F=0.15. At this level of F, most of the range encompassed by 95% confidence intervals shows an increase in biomass and in spawning stock numbers relative to 2009. However, a substantial number of the results do not reach Blim.

- For SA2+Div.3K the maximum F for allowable harm is near F=0.06. At this level of F, most of the range encompassed by the 95% confidence intervals shows increase in

biomass relative to the biomass in 2009. However, some of the projection results showed a more than 30% decline in biomass relative to 2009.

- For Subdiv. 3Ps the maximum F for allowable harm is less than F=0.137. At this level of F, most of the range encompassed by the 95% credible intervals shows increase in biomass relative to the biomass in 2009. However, some of the projection results showed a more than 30% decline in biomass relative to 2009.

- Habitat availability is not considered to be a limiting factor in the recovery of the Newfoundland and Labrador DU of American Plaice.

BACKGROUND

Rationale for Assessment

Considering the sharp decline in the abundance of mature individuals of Newfoundland and Labrador American Plaice (approximately 96% for the Designatable Unit (DU) as a whole) over the last three generations, it was designated as “threatened” in April 2009 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

As part of this "post-COSEWIC" process, scientific information is needed to support the development of social and economic cost assessment scenarios for recovery, to better inform public consultations and to support other entities involved in the decision of adding the species to Schedule 1 of the SARA. Should the American Plaice be listed as threatened under SARA, this information will also inform the development of a recovery strategy, and one or more action plans.

Species Biology and Ecology

The American Plaice is a benthic marine flatfish with an elongated, strongly laterally compressed body. When the young fish hatch from the egg at or near the surface they have the ‘normal’ fish orientation. During development they undergo a metamorphosis resulting in lateral compression and the head twisting so that they swim on their side and both eyes are on the upper side of the body, facing right. The eyed side is typically red to grayish brown and uniform in colour, whereas the blind side is white. The head is generally small but with a relatively large mouth.

The American Plaice is an arctic-boreal to temperate-marine species occurring on both sides of the North Atlantic on the continental shelves of northeastern North America and northern Europe. In the western Atlantic, it is found from Baffin Bay and Davis Strait, south to Labrador and the Grand Bank and the Flemish Cap and southwards to the Gulf of Maine and Rhode Island.

American Plaice are usually considered a cold-water species with reported catches in temperatures from -1.5 to 13^{o}C, but they are most numerous within a temperature range from just below zero to around -1.5^{o}C. Once settled, adults and juveniles frequently inhabit the same areas over depths ranging from 20 to 700 m with a preference for depths in the range of 100 to 300 m. Reports of deeper occurrences are published, including reports of catching American Plaice at depths of 1400 m in Division 3L and reports of concentrations of fish in excess of 700 m, both of which are considered to be anomalies. Although American Plaice have been found

across most bottom types they seem to prefer the firmer sediments and are generally more abundant on substrates of fine sand or gravel. This is somewhat consistent with the topography of the tops of the banks where they occur.

American Plaice are generally a slow growing and moderately long-lived species that exhibit sexual dimorphism in that the females grow faster and are larger than the males for any given age. There have been large changes in maturity at age and size and there are differences between populations. In general in the Newfoundland and Labrador area, females are currently maturing at about age 7-9 (30-40 cm) and males at age 4-4.5 (16-21 cm). They are group synchronous, batch spawners that generally release eggs in batches every few days. Relative fecundity ranged from 117 to 1077 (median = 353) eggs g^{-1} for Divisions 3LNO Plaice and 78 – 1071 (median = 367) eggs g^{-1} for Subdivision 3Ps Plaice. Spawning of American Plaice generally occurs throughout the range the population inhabits, but certain areas are associated with much greater spawning activity, perhaps simply because of a greater abundance of fish rather than selection of spawning grounds. Around Newfoundland and Labrador, spawning has been identified on Hamilton Bank and the Northeast Newfoundland Shelf, and is widespread over the entire Grand Bank and St. Pierre Bank. Spawning and fertilization of the eggs occurs near the bottom. Once fertilized the eggs become buoyant and rise up in the water column to float near the surface. Time to hatching is water temperature dependant and has been reported to be 11 to 14 days at around 4^{o}C with a hatching size of 4 to 6 mm. Adults do not appear to undergo large spawning migrations but may move into slightly deeper, warmer waters in winter.

American Plaice are highly opportunistic feeders throughout their life cycle, feeding on whatever prey items are available in appropriate sizes for ingestion and varying with fish size, locality and season. Adults and juveniles feed on polychaetes, echinoderms, molluscs, crustaceans and fish (capelin, sand lance, other flatfish, etc.). Diet varies with fish size and region. Smaller fish (0 to 9 cm) tend to feed on polychaetes and small crustaceans. By the time the Plaice are 30 to 50 cm in length; other fish comprise upwards of 80% of the diet. Pelagic larvae feed on zooplankton, primarily copepods.

Newfoundland and Labrador Designatable Unit

American Plaice populations that make up the Newfoundland and Labrador designatable unit extend from the northern tip of Labrador to the south coast of Newfoundland. There are 3 populations in the area: SA 2+Div. 3K, Div. 3LNO and Subdiv. 3Ps. SA 2 + Div. 3K is managed exclusively by Canada. Subdiv. 3Ps is managed by Canada with bilateral consultations with France. Div. 3LNO is managed by NAFO.

The Div. 3LNO population of American Plaice is by far the largest in the Newfoundland and Labrador DU, and is considered to have been historically the largest flatfish population in the northwest Atlantic. The survey biomass of the Div. 3LNO population in the mid to late 1980's was 5 times that of Div. 2J3K (data not available for Div. 2GH portion of SA 2+Div. 3K) and 9 times that of Subdiv. 3Ps.

ASSESSMENT

Status and Trends

Abundance and Range

For SA 2+3K, data are only available for Div. 2J and 3K. The number of adults in the survey declined steeply from the mid 1980's to 1995. Decline continued to about 2003. There has been some increase in the number of adults since 2005 but the average of the last 3 years remains at 16% of the 1980-85 average (Figure 2).

For Div. 3LNO, the number of adults in the population model (VPA) declined steeply starting in the mid to late 1980s, reaching a minimum in 2002. The number of adults has increased since then but the number in 2010 is estimated to be 25% of the 1980-85 average (Figure 2).

In Subdiv. 3Ps, the number of adults in the survey declined steeply from the mid 1980's to 1995. There has been some increase since then and the average number of adults in 2007-09 is 30% of the 1983-85 average (Figure 2).

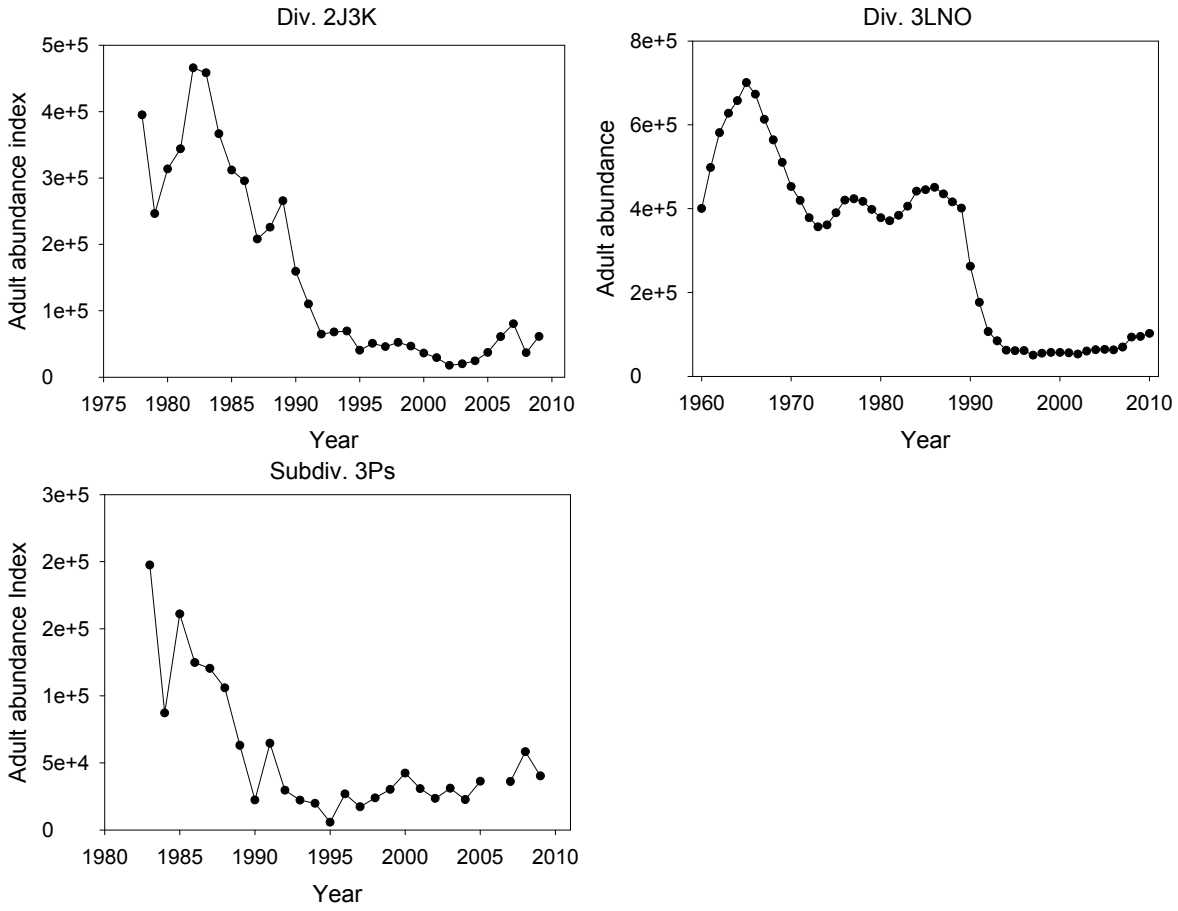

Figure 2: Adult abundance (or abundance index) for American Plaice for each population in the Newfoundland and Labrador DU. Results for Div. 2J3K and Subdiv. 3Ps are from surveys while results for Div. 3LNO are from VPA.

American Plaice in each of the 3 populations were distributed over most of the area surveyed. The smallest proportion was 56% in Subdiv. 3Ps in 1994. Eighty percent or more of the survey area was occupied in most years in all areas and in many years more than 90% of the area was occupied. There is no indication of a trend to decreased area occupied in recent years (Figure 3). On average the SA2+Div. 3K population occupied 156 000 Km^2, the Div. 3LNO population 243 000 Km^2 and the Subdiv. 3Ps population 46 000 Km^2. These analyses are based on common strata surveyed over the whole time series.

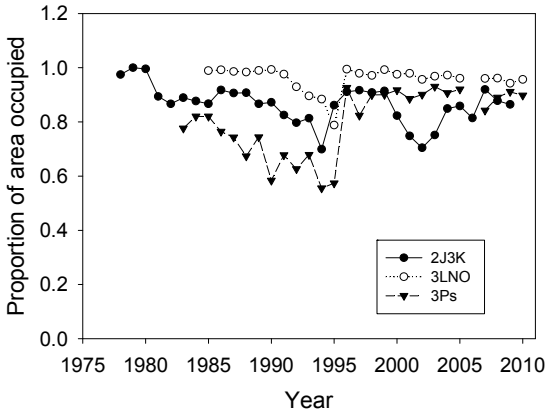

Figure 3: Proportion of survey area occupied by each population of American Plaice in the Newfoundland and Labrador DU. Survey in 2006 in 3Ps and 3LNO was incomplete and not considered representative.

Life History Parameters

Males and females in all 3 populations are maturing at a younger age and a smaller size (Figure 4). In SA2+Div.3K, age at 50% maturity (A50) has declined from just under 11 years to around 7 years of age for females and from around 7 years to just over 4 years of age for males. For males, length at 50% maturity (L50) was about 22 cm at the beginning of the time series and for recent cohorts is about 18 cm. Female L50 declined from about 38 cm at the beginning of the time series to about 31 cm recently. In Div. 3LNO, male A50 was around 6 years at the beginning of the time series and for recent cohorts has been about 4.5 years while for females A50 has declined from about 11 years to about 8 years. At the beginning of the time series female L50 in Div. 3LNO was around 40 cm, but for more recent cohorts it has been about 35 cm. The L50 for males in Div. 3LNO showed most of its decline up to the cohorts of the early 1990's by which time it had declined from 23 cm to less than 15 cm. It has subsequently increased, and male L50 for recent cohorts is only about 1 cm less than for those at the beginning of the time series. In Subdiv. 3Ps male A50 has declined from about 7 to less than 4.5 years, while female A50 has declined from about 11 to just under 9 years. Male L50 in Subdiv. 3Ps has declined from about 27 cm to less than 19 cm and female L50 has declined from about 40 cm to around 36 cm.

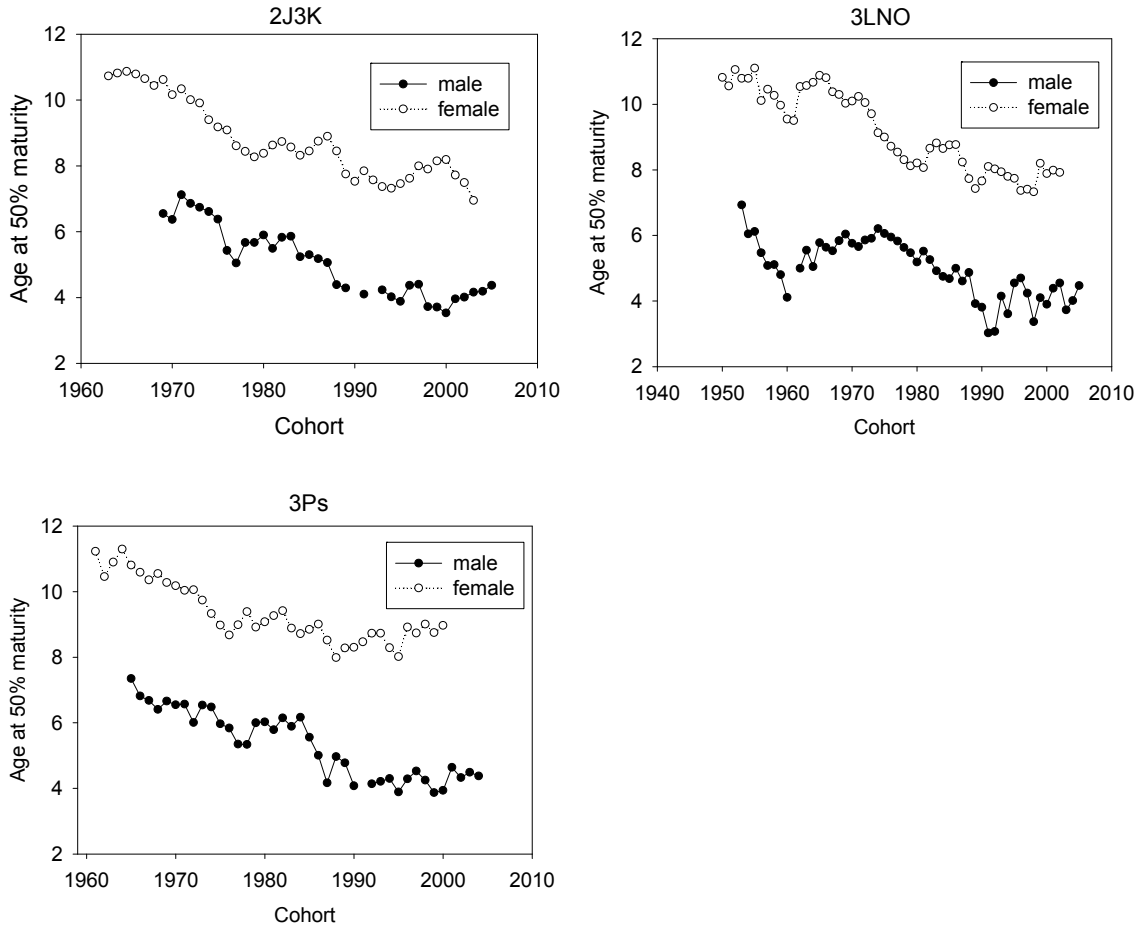

Figure 4: Age at 50% maturity for male and female American Plaice in each population in the Newfoundland and Labrador DU.

Median relative fecundity (the number of eggs per gram of whole body weight) was lower in both areas in the earlier years but there was no significant difference in relative fecundity over time in either Div. 3LNO or Subdiv. 3Ps (Figure 5). Data are not available for SA2+Div. 3K.

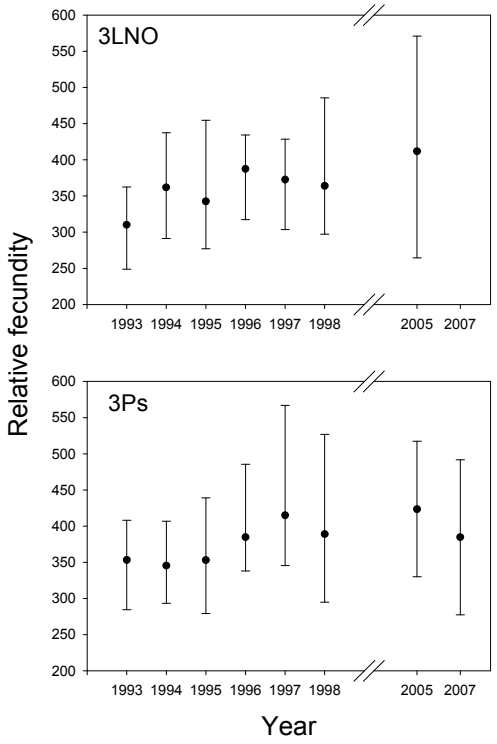

Figure 5: Median relative fecundity (eggs per gram of whole body weight) with interquartile ranges for female American Plaice in Div. 3LNO and Subdiv. 3Ps.

Recruitment

In Div. 2J3K recruitment declined from the mid 1980s to the late 1990s. There has been an increase in recruitment since. In Div. 3LNO there was a long decline in recruitment from the 1970s to the mid 1990s. There has been some increase in recruitment since that time but recruitment remains very low compared to the 1980s. Recruitment declined in Subdiv. 3Ps, from 1980 until 1995. Since then it has increased fairly steadily to reach levels similar to the beginning of the time series (Figure 6).

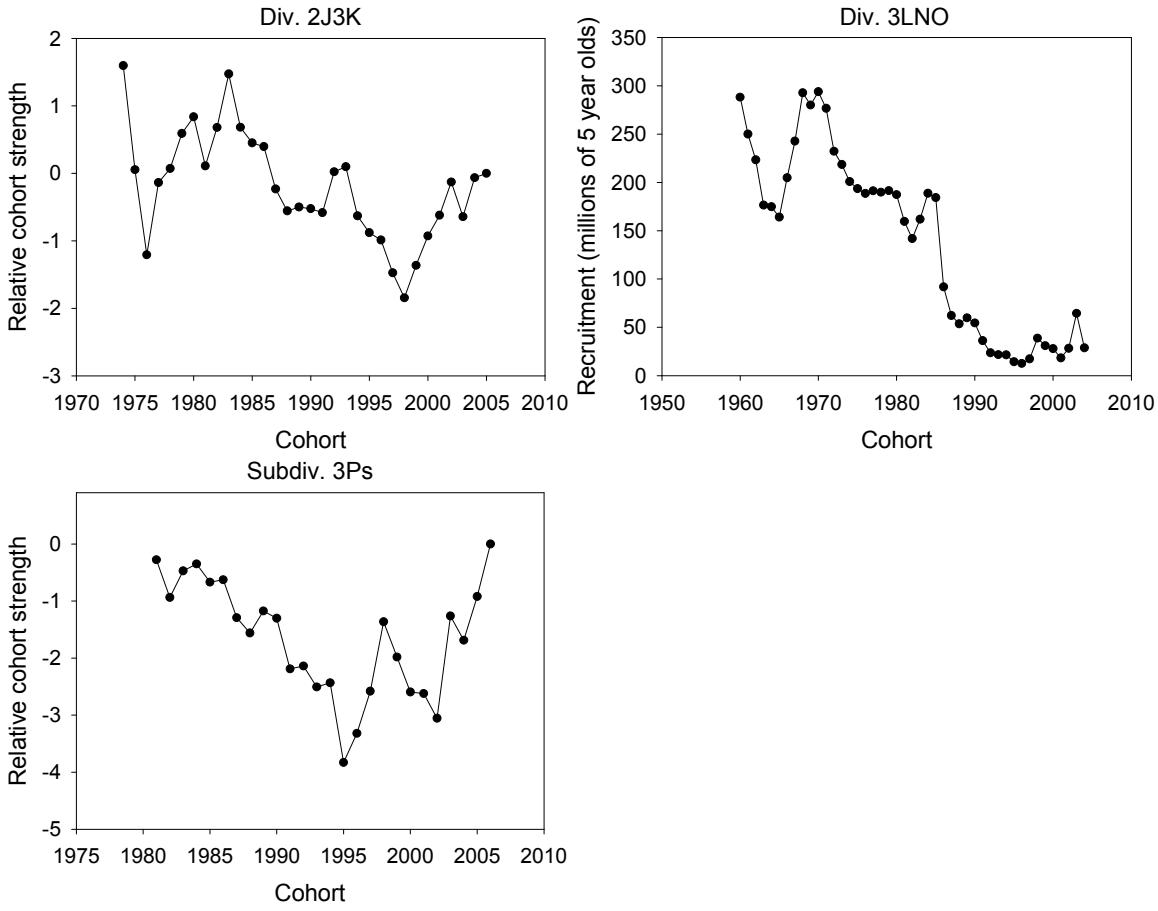

Figure 6: Recruitment as relative cohort strength from research vessel data for American Plaice in Div. 2J3K and Subdiv. 3Ps. Estimates are relative to the 2005 cohort. For Div. 3LNO recruitment as number of 5 year olds from the VPA.

Total Mortality

Total mortality was above average in Div. 2J3K for most of the years since 1989. It has been more variable in recent years because of the presence of at least 2 year effects in the data (when there are more fish at age a+1 in year y+1 than there were at age a in year y) (Figure 7). Catch has been thought to have been low in this area (see Scope for Management to Facilitate Recovery) and such high levels of total mortality may indicate a high natural mortality.

Total mortality in Div. 3LNO was above the series average in most years from the late 1980's to the mid 1990's. Total mortality has been substantially reduced since that period. In Subdiv. 3Ps total mortality was quite variable but it was generally higher in the first half of the time series than in the second half (Figure 7).

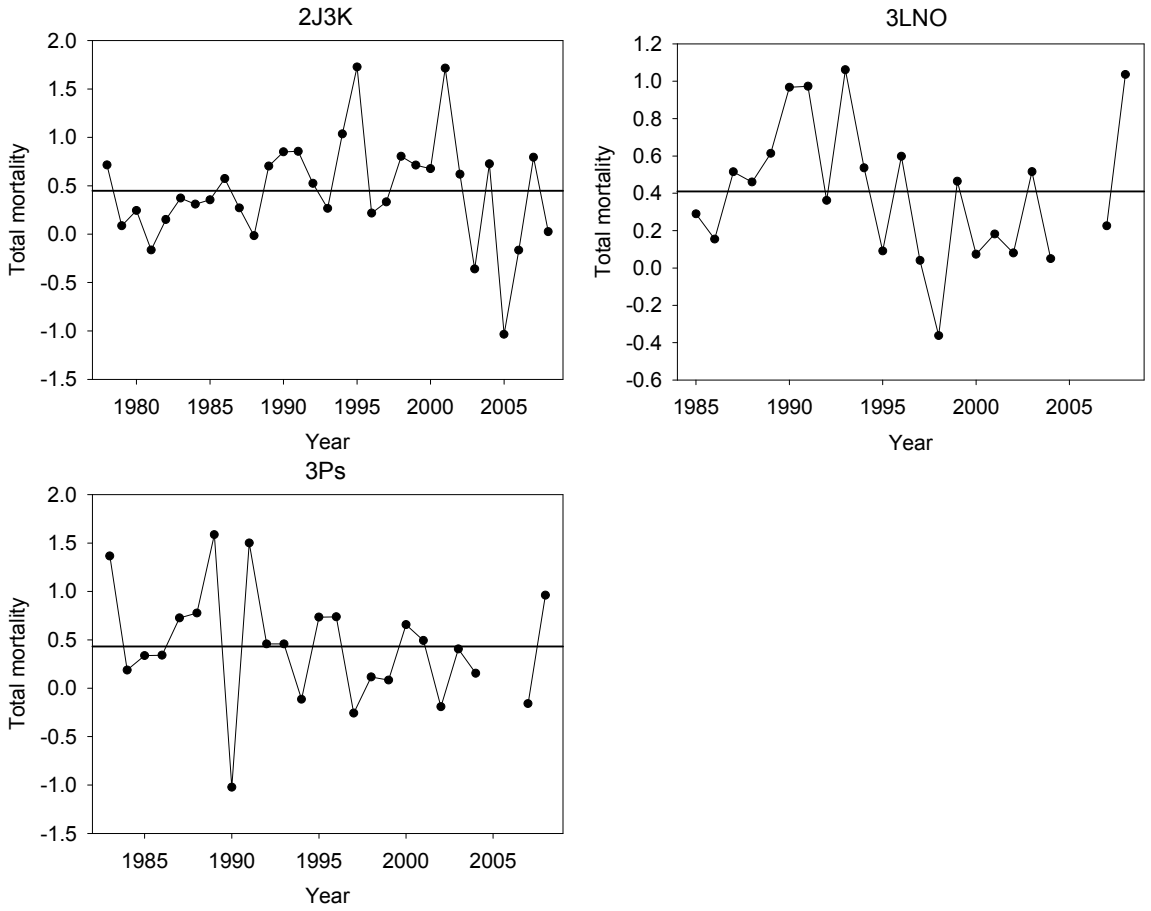

Figure 7: Trends in the annual instantaneous mortality rate (Z) of American Plaice aged 5-7 calculated using data from the research vessel surveys in Div. 2J3K, Div. 3LNO and SubDiv. 3Ps. For example, the value in 1995 is the mortality experienced by the 1988-90 year-classes from ages 5-7 in 1995 to ages 6-8 in 1996. The horizontal line is the time-series average for each area.

SARA and Management Considerations

To be considered fully recovered these populations would need to be in the healthy zone of the precautionary approach framework. However for this RPA we were asked to address the probability of reaching a level where the populations and DU no longer meet COSEWIC's listing criteria for designation as threatened (i.e. downgrade to special concern), and to evaluate these projections relative to PA limit reference points (LRP). The Div. 3LNO population is the only one of the Newfoundland and Labrador DU Plaice stocks that has an established LRP compliant with the PA framework (Blim). This is the level of spawner stock biomass below which serious harm occurs.

One of the COSEWIC criteria for designating a species as threatened is a reduction of total number of mature individuals of ≥30% over 3 generations where the causes of the decline have not ceased or are unknown. For American Plaice a generation (16 years) is defined as age at 50% maturity (A50) plus 1/(natural mortality) where A50 is the pre-exploitation A50 of 11 years. For SA 2+Div. 3K and Subdiv. 3Ps there are no models of number of mature individuals. A proxy is the biomass from surplus production modeling.

The first precautionary approach threshold in rebuilding the stock would be at least Blim. This precautionary approach reference point is only available for the Div. 3LNO population and is 50 000 t of SSB.
Given its broad distribution and lack of change in the distribution of American Plaice (Figure 3), a distributional target is not a concern at this time.

Projected population trajectory given current parameters

Stochastic projections were conducted for each stock and then combined for the DU as a whole. For Div. 3LNO the accepted assessment model (VPA) was the basis for the projections. For Div. 2J3K and Subdiv. 3Ps Bayesian surplus production modeling formed the basis for the projections. Each population was projected 48 years (3 generations) at the fishing mortality (F) estimated for the most recent 3 years. The result for the DU was produced taking a weighted average of the results from each of the populations, where the weightings were based on relative population size during the 1980's. This is the period prior to the major decline in population size for these stocks. An examination of the biomasses in the single population models and in surveys indicated that this would be an appropriate way to combine the populations into the DU.

Population projections over 48 years have very large associated uncertainty. For the DU as a whole results of projections of population biomass over 48 years at current fishing mortality range from an increase of more than 7 times to a decrease in biomass to reach less than 50% of the biomass in 2009. Most of the range encompassed by the 95% confidence intervals is above the level of biomass at the beginning of the projection period. It should be noted that current F varies greatly across the different populations with Fcurrent=0.0005 in SA 2+Div. 3K, 0.172 in Div. 3LNO and 0.025 in Subdiv. 3Ps. There is no Blim for the DU as a whole (Figure 8).

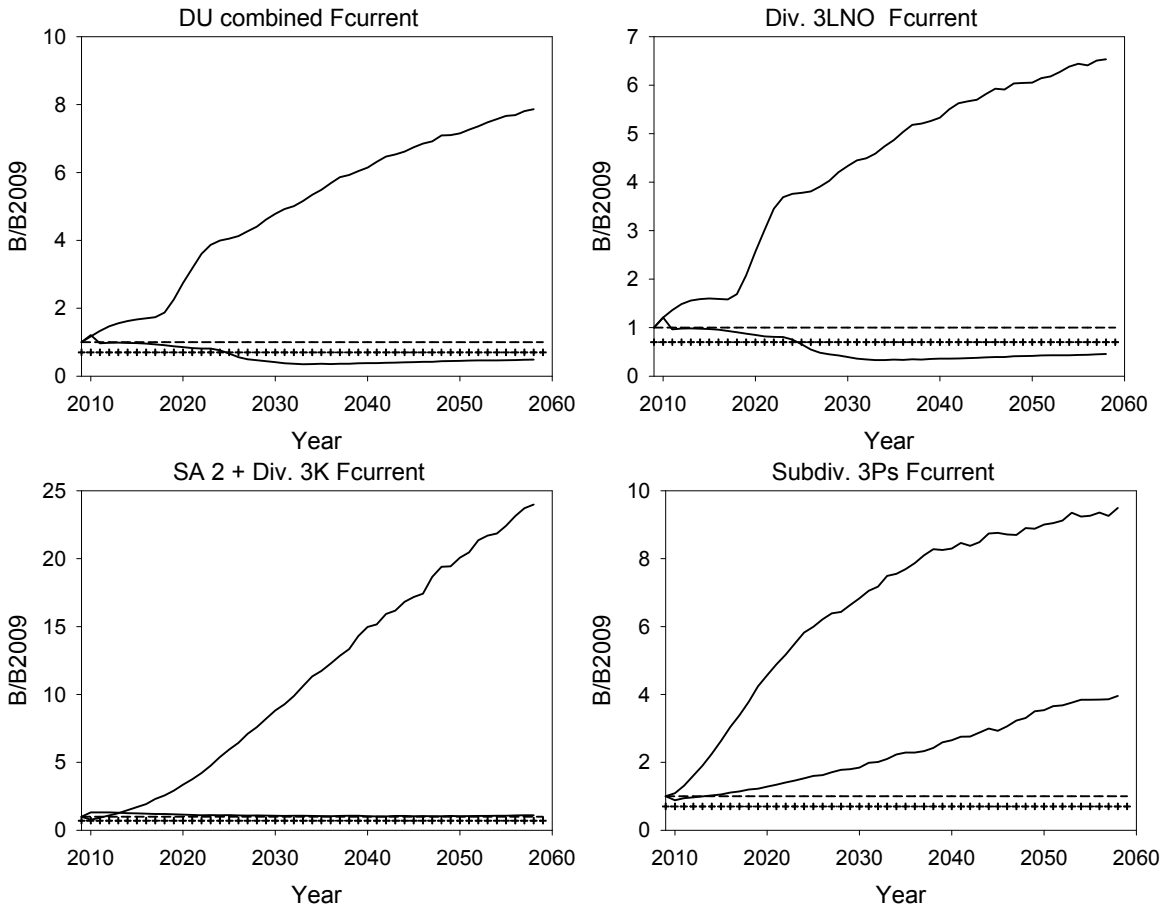

Figure 8: The result of 48 year projections of population biomass at current levels of F for each population separately and then combined for the entire DU. Results are shown relative to the biomass in 2009. The solid lines give the range of approximately 95% of the results of the projections for the DU combined, the upper and lower 95% credible intervals for SA2+Div.3K and Subdiv.3Ps and the upper and lower 95% confidence intervals for Div. 3LNO. The dashed horizontal line shows where biomass is equal to biomass in 2009. The horizontal line of crosses indicates a 30% decrease in biomass relative to 2009.

For Div. 3LNO current F (average of the last 3 years) is estimated to be 0.172. Projections of population biomass show that biomass could be from 6.5 times to only 45% of 2009 biomass by the end of the 48 year projection. This means that there is some possibility that by the end of the projection period biomass will have decreased (Figure 8). For spawning stock numbers (SSN) results of the projection show that most of the range encompassed by the 95% confidence intervals is above the level of SSN in 2009. The distribution of model projected runs is not symmetrical and it should be noted that at current F by the end of the projection period a substantial proportion of the projected spawning stock biomasses (SSB) are below Blim (Figure 9).

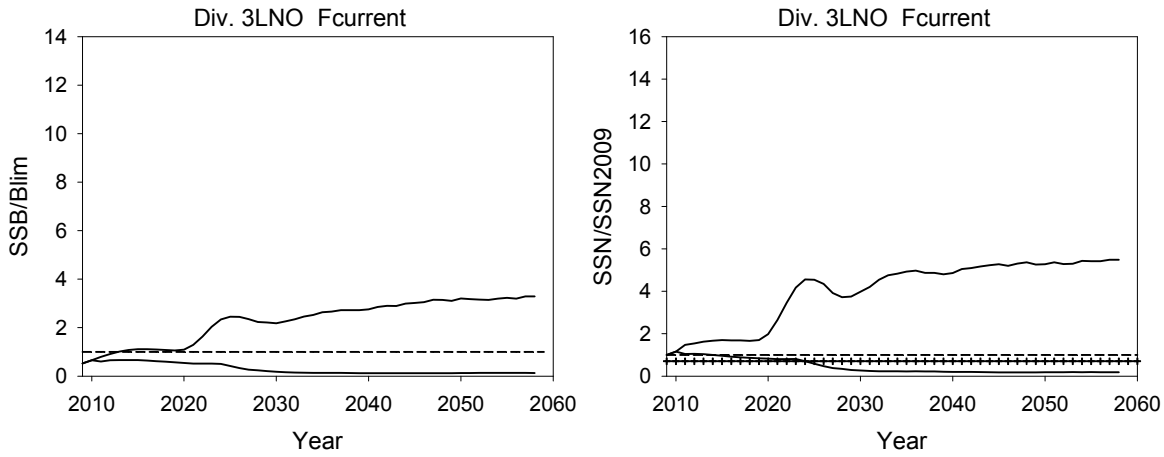

Figure 9: The result of 48 year projections of population biomass at current levels of F for Div. 3LNO. Results for spawning stock biomass (SSB) are shown relative to Blim and for spawning stock numbers (SSN) relative to the SSN in 2009. The solid lines give the upper and lower 95% confidence intervals. The dashed horizontal line shows where SSB is equal to Blim or SSN is equal to SSN in 2009. The horizontal line of crosses indicates a 30% decrease in SSN relative to 2009.

For SA 2+Div. 3K current F is estimated to be very low at 0.0005. At this level of F, the 95% upper and lower confidence intervals are both above 1, indicating an increase in biomass compared to 2009. The range of increase is from 10% to 24 times (Figure 8).

The current F in Subdiv. 3Ps is estimated to be 0.025. At this level of F, the 95% upper and lower confidence intervals are both above 1, indicating an increase in biomass compared to 2009. The range of increase is from 4 to 9 times the biomass in 2009 (Figure 8).

Habitat Use

Residence requirements

Current knowledge does not include any particular residence requirements for American Plaice, as defined in the SARA: "*A dwelling-place, such as a den, nest or other similar area or place that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating".*

Spawning grounds

Spawning of American Plaice generally occurs throughout its range (Walsh, 1994b), but certain areas are associated with much greater spawning activity, perhaps simply because of a greater abundance of fish rather than selection of spawning grounds. Around Newfoundland and Labrador, spawning has been identified on Hamilton Bank and the Northeast Newfoundland Shelf, and is widespread over the entire Grand Bank and St. Pierre Bank.

Eggs and larvae

The eggs and larvae are pelagic, so habitat requirements are probably primarily related to temperature and prey availability. Increased temperature results in increased larval development rate, which could lead to less time spent at the highly vulnerable larval stage.

However, excessive temperature (≥14°C) results in mortality during the egg stage. The primary prey items during the larval stage are diatoms, copepods and other zooplankton.

Juvenile and adult

Juvenile and adult American Plaice are benthic and cryptically coloured. They regularly burrow in the sediment as a means of predator avoidance, and possibly concealment from prey as ambush predators. Thus sediment type is likely an important habitat consideration and might be particularly important for juvenile flatfish. Small juvenile fish are likely only capable of burying in finer sediments. Juveniles on the Grand Bank have been found in highest numbers on sand/shell hash sediments and less abundant on (or in some cases almost absent from) mud, muddy sand, rock/sand and boulder/rock.

The wide range of environmental conditions from which adult American Plaice have been caught suggests the species is a generalist without tightly constrained habitat requirements. Adults commonly bury themselves in sediment, presumably as a predator avoidance behaviour. Under laboratory conditions Plaice have demonstrated a clear preference for gravely sand particles over coarser gravel substrate, continuing to choose the preferred substrate even in temperatures outside of their preference. Larger flatfish can bury themselves in larger sediment particles than smaller individuals. Sediment preference, however, might vary spatially. It is also possible that the sediment type that individuals are collected from may also reflect the preferred habitat of prey animals rather than the fish being studied.

American Plaice typically prefer depths of 100-300 m. There have been reports of catches from greater depths, including concentrations of fish in excess of 700 m and catches as deep as 1400 m in Division 3L but both are considered to be anomalies. Variability in depth distribution of American Plaice on the Grand Bank has normally been associated with spawning and feeding near the shelf edges, where movement between depth strata generally does not require a large lateral movement. Seasonal changes in depth preference are thought to be linked to temperature selection, with fish moving into deeper and warmer waters in winter. On the Grand Bank, juveniles tend to occupy restricted habitats within the range of the adults and are found mostly in the 100 to 200 m depth range in the northern area and in waters less than 100 m in the southern areas.

In the wild, American Plaice are usually found at temperatures ranging from -1.5 to 13^{o}C. Preferred temperature is reported to be -0.5^{o}C to 2.5^{o}C in the Newfoundland and Labrador area. It was reported that Plaice in captivity had a wide temperature tolerance (-1.4^{o}C - 15^{o}C) but that they did not feed and lost weight at very cold temperatures. Plaice on the Grand Bank have been found to move out of areas of colder water (≤ -1.2^{o}C) under some circumstances, resulting in what seems to be a seasonal distribution pattern related to water temperature.

Adult American Plaice do not appear to have stringent salinity requirements. They have been collected at a range of salinities from 31-34 ppt, with a single report of Plaice collected from Hamilton Inlet off Labrador at salinity of 20-22 ppt.

American Plaice are highly opportunistic feeders and are therefore not likely to be dependent on the availability of any single prey item. Common groups of prey items include polychaetes, echinoderms, mollusks, crustaceans and small fish, with spatial differences often existing.

Given the extent of the distribution of American Plaice in the Newfoundland DU, it is likely that, while habitat preference appears to exist for this species, the range of habitats that can be occupied covers the entire area.

It is possible that long-term effects of fishing gear have had an impact on American Plaice due to habitat disturbance. In international studies of fishing gear, dredges and bottom trawls are considered the most damaging (per unit of effort) for populations, communities and benthic habitats. Mobile bottom-impacting gear can decrease the abundance of long-lived species with low turnover rates. However, much of the area inhabited by American Plaice in the Newfoundland and Labrador area is already disturbed by natural forces (e.g. waves and ice scour) and the additional impact of bottom trawling may be negligible.

American Plaice habitat overlaps regions covered by oil and gas development. Threats related to oil drilling include the discharge of oil-based sludge or drill cuttings, drilling fluids, waste from the platform and production waste. Accidental oil spills into the environment, whether from an accident involving an oil tanker or a leak from an oil well, could eventually be a concern.

It is unknown the extent to which various threats can alter the quality and/or quantity of habitat that is available, however, given the wide distribution of American Plaice it is unlikely that threats will alter habitat enough to limit recovery.

It is not known how the biological function(s) that specific habitat(s) provide to the species varies with the state or amount of the habitat. However, American Plaice are widely distributed and it would seem that sufficient habitat exists and habitat availability is not foreseen as a limiting factor in recovery.

There are no known spatial configuration constraints.

Critical habitat for American Plaice in the Newfoundland and Labrador DU has not been defined. Nevertheless, American Plaice are widely distributed and they occupy more than 80% of the surveyed area in most years.

Scope for Management to Facilitate Recovery

Projections at F=0 were conducted as described above, to explore the potential growth of the populations without exploitation to assess the potential for management measures to facilitate recovery. In addition, for Div. 3LNO and Subdiv. 3Ps projections were conducted at half current F. Fishing mortality is so low in SA 2+ Div. 3K that half current F projections were not conducted.

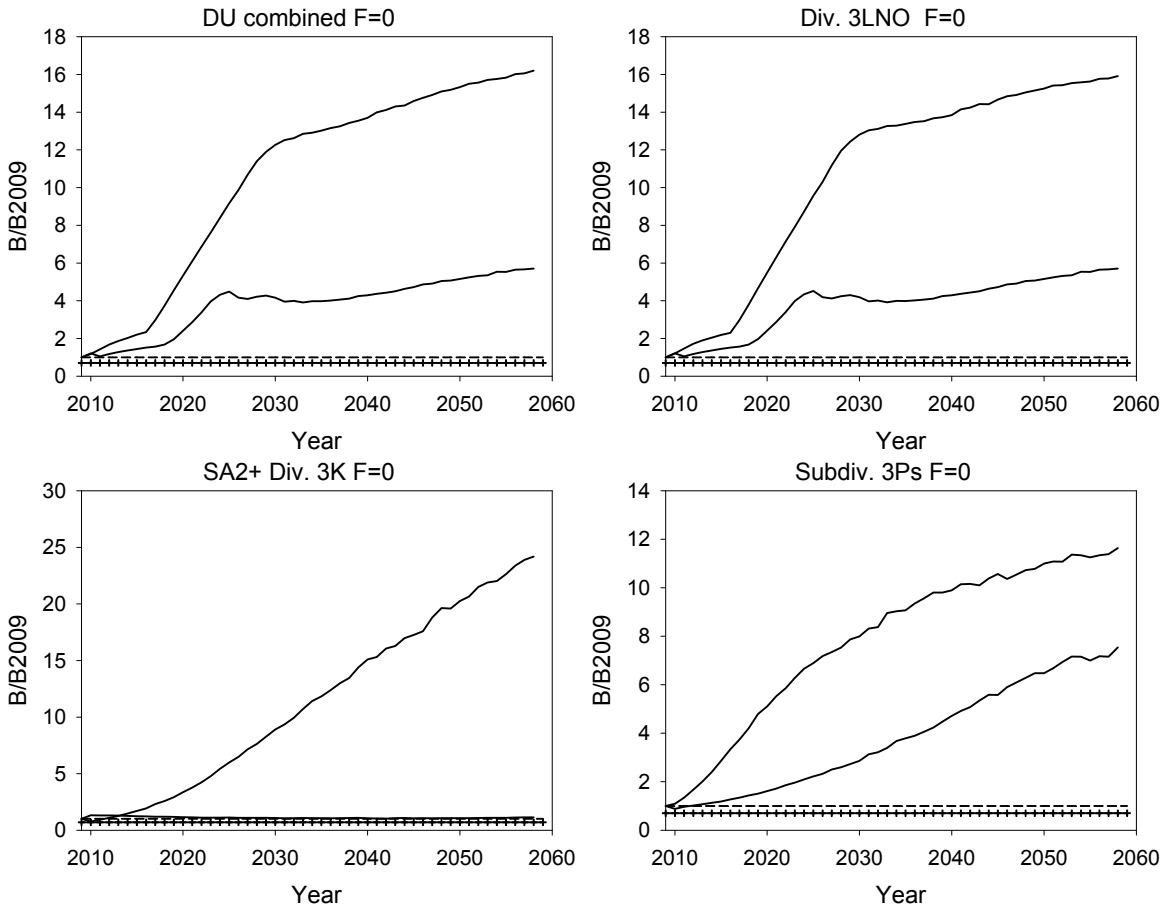

Figure 10: The result of 48 year projections of population biomass at F=0 for each population separately and then combined for the entire DU. Results are shown relative to the biomass in 2009. The solid lines give the range of approximately 95% of the results of the projections for the DU combined, the upper and lower 95% credible intervals for SA2+Div.3K and Subdiv.3Ps and the upper and lower 95% confidence intervals for Div. 3LNO. The dashed horizontal line shows where biomass is equal to biomass in 2009. The horizontal line of crosses indicates a 30% decrease in biomass relative to 2009.

For the DU as a whole there is a substantial increase in biomass over 48 years with an F=0. All populations in the DU have an increase under the no fishing scenario. However, for SA 2+Div. 3K the lower bounds of the 95% credible interval only increase by about 12%, indicating that there is some possibility of only a small increase in this population even with no fishing (Figure 10). For Div. 3LNO American Plaice the management target of exceeding Blim is also projected to be reached under an F=0 fishing scenario and SSN are projected to increase (Figure 11).

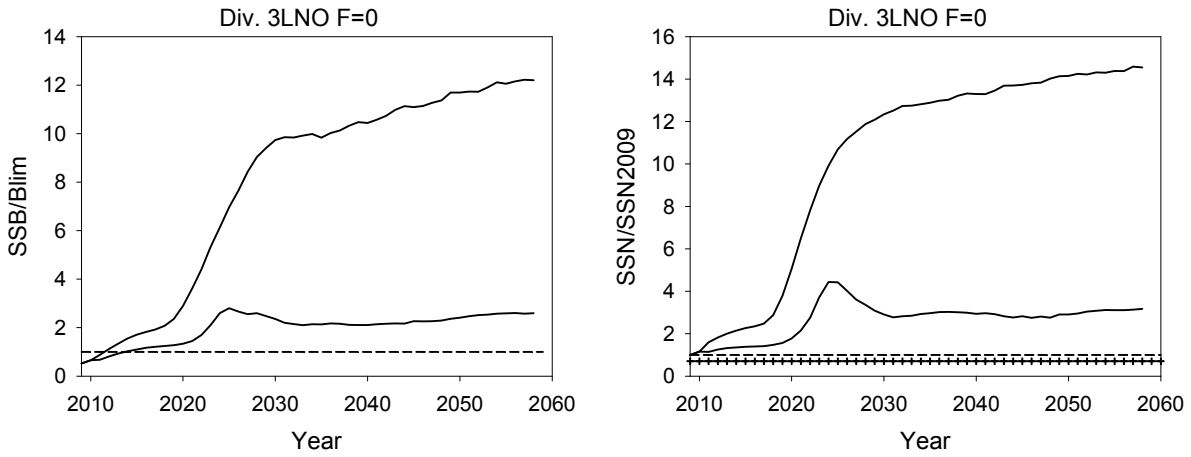

Figure 11: The result of 48 year projections of population biomass at F=0 for Div. 3LNO. Results for spawning stock biomass (SSB) are shown relative to Blim and for spawning stock numbers (SSN) relative to the SSN in 2009. The solid lines give the upper and lower 95% confidence intervals. The dashed horizontal line shows where SSB is equal to Blim or SSN is equal to SSN in 2009. The horizontal line of crosses indicates a 30% decrease in SSN relative to 2009.

For Div. 3LNO American Plaice half of current F is 0.086. At this level of fishing moratlity most results show an increase in population biomass. Most results for SSN are also projected to increase relative to 2009 levels and for SSB most of the area encompassed by the 95% confidence intervals shows SSB to be above Blim, although some of the results show SSB remaining below Blim (Figure 12).

For Subdiv. 3Ps half of current F is 0.0125. At this level of F the biomass of Subdiv. 3Ps American Plaice, the entire area encompassed by the 95% credible intervals, shows an increase in biomass relative to 2009 (Figure 12).

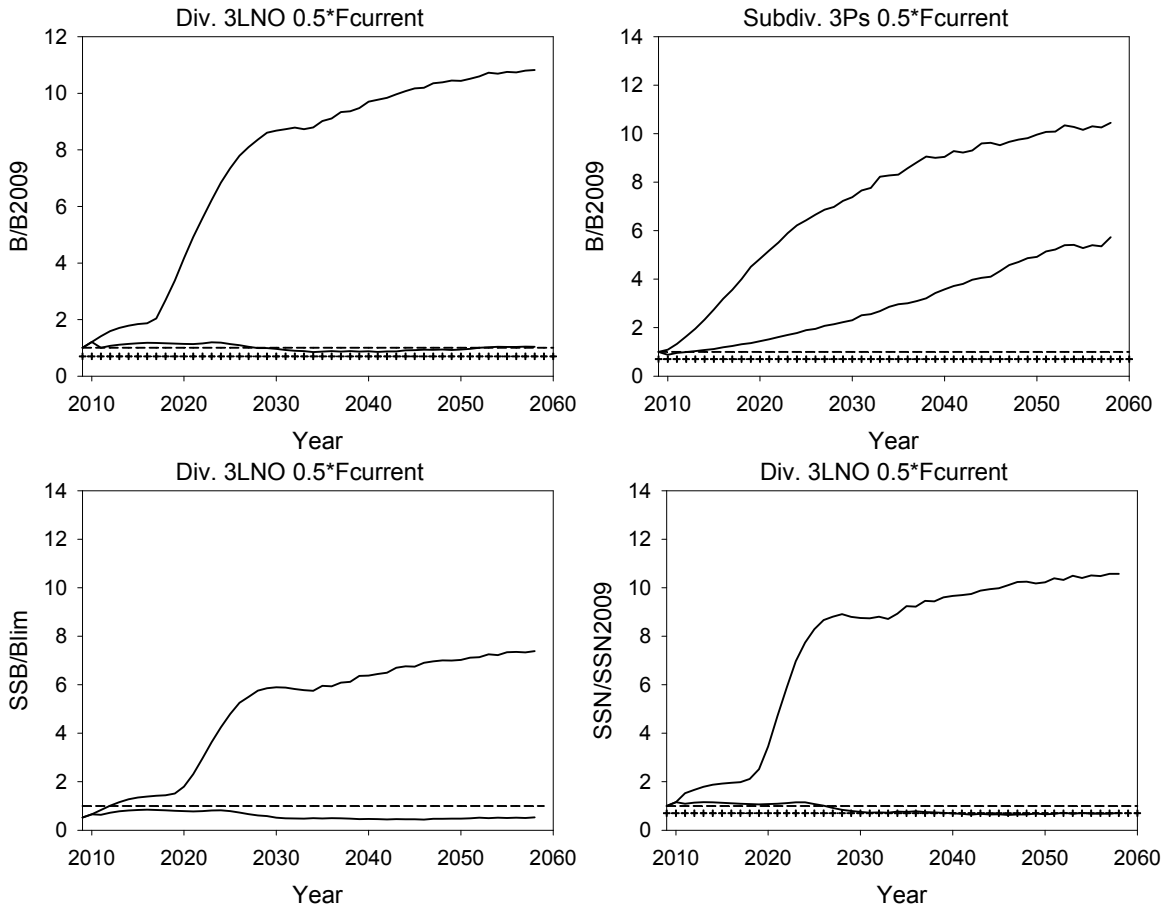

Figure 12: The result of 48 year projections of population biomass at half current F for Div. 3LNO and Subdiv. 3Ps. Results are shown relative to the biomass in 2009, and for Div. 3LNO also relative to Blim and spawning stock numbers (SSN) in 2009. The solid lines give upper and lower 95% credible intervals for Subdiv.3Ps and the upper and lower 95% confidence intervals for Div. 3LNO. The dashed horizontal line shows where biomass or SSN are equal to the level in 2009 or where SSB=Blim. The horizontal line of crosses indicates a 30% decrease in biomass or SSN relative to 2009.

Given the results of these projections there is scope for management action to facilitate recovery through a reduction in fishing mortality.

The primary factor thought to be responsible for the decline of American Plaice stocks is overfishing, although there is some suggestion that increased natural mortality may also have played a role, particularly in Div. 2J3K and Div. 3LNO (COSEWIC 2009).

In SA 2 + Div. 3K bycatch has averaged about 35 tons since the beginning of the moratorium on directed fishing. In 2008 and 2009 bycatch was less than 10 tons, mainly in the Greenland Halibut fishery. In Subdiv. 3Ps bycatch has averaged 575 t over the moratorium period and in 3 years (2001-03) was over 1000 t, mainly taken in the directed cod fishery. Bycatch in Div. 3LNO has been much greater, averaging 3600 t, but from 2000-04 by catch averaged more than 6000 t. Bycatch in Div. 3LNO comes mainly from the directed Yellowtail Flounder, skate and Greenland Halibut fisheries (Figure 13).

Current F for each population was considered to be the average of the last 3 years (2007-09). Current F is estimated to be 0.172 in Div. 3LNO with a catch in the range of 3000 t per year. F

in the other two populations is estimated to be much lower; 0.0055 with a catch of 20 t or less in Div. 2J3K and 0.025 with a catch of around 500 t in Subdiv. 3Ps.

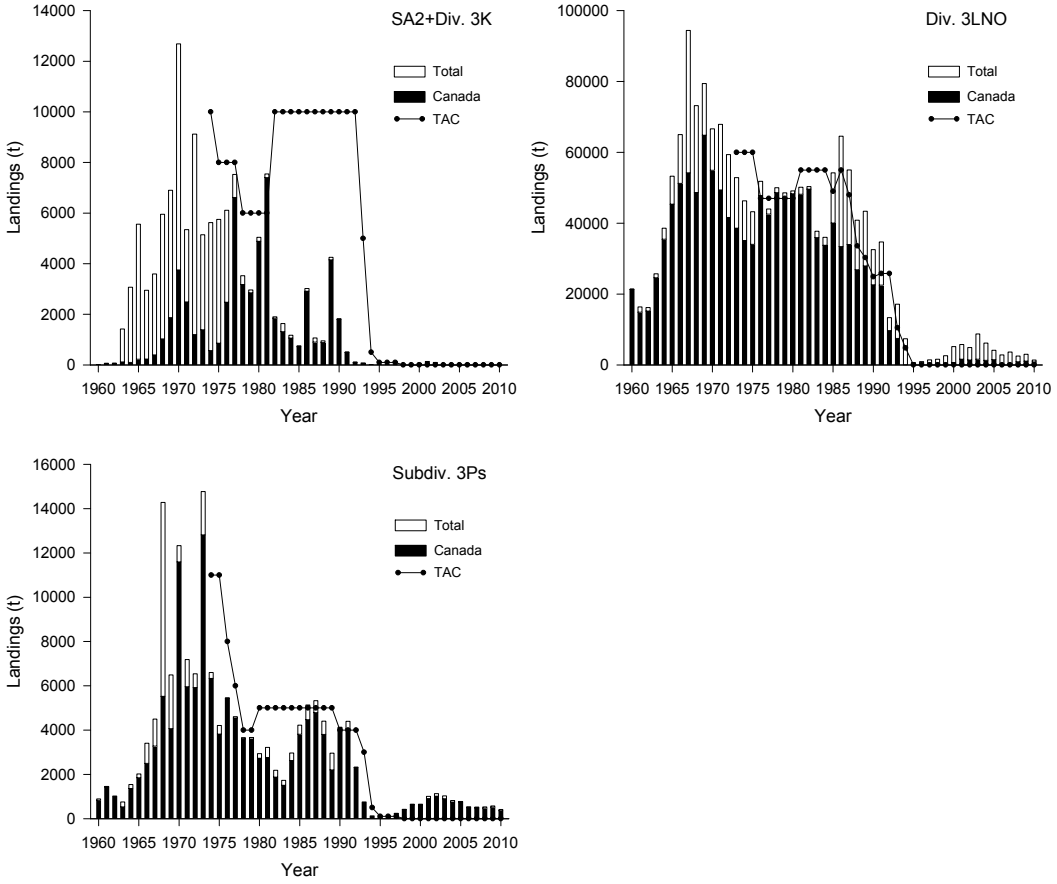

Figure 13: Catch and TAC history for American Plaice in SA2+Div.3K, Div. 3LNO and Subdiv. 3Ps. Catch values for 2010 are preliminary.

American Plaice are widely distributed and they occupy more than 80% of the surveyed area in most years. It is likely that the current quantity and quality of habitat is sufficient to allow population increase and would be sufficient to support a population that has reached its recovery targets.

It is unknown the extent to which various threats have altered the quality and/or quantity of habitat that is available, however, given the wide distribution of American Plaice it is unlikely that threats have altered habitat enough to limit recovery.

Scenarios for Mitigation and Alternatives to Activities

The major threat to American Plaice is continued bycatch. There are several measures that could mitigate this bycatch. These include:

- Application of By-catch Protocol as well as measures included in conservation harvesting plans (such as gear type, mesh size, % or weight of allowable incidental catches per trip in certain areas or during certain time of the year)
- Adopting more stringent requirements, where necessary, for the management, control and monitoring of by-catch in other directed fisheries.

- Increasing observer coverage in directed groundfish fisheries when (and where) the by-catch is likely to be high.
- Conducting a review, in conjunction with industry, of additional measures such as seasonal closures or gear restrictions to address by-catch issues.
- Mandatory hail out
- Completion of log books
- Expansion of the requirement for Vessel Monitoring Systems (VMS)
- Compliance monitoring activities (such as Patrols, Dockside Inspections, At-Sea Inspections and Aerial Surveillance)

Many of these measures are already in place in fisheries where they can be implemented. Some could be expanded and some measures could be made more stringent. The majority of the catch from the Newfoundland and Labrador DU comes from the Div. 3LNO population. This population is managed by NAFO and management measures are mainly determined by that organization. In Div. 3LNO the Yellowtail Flounder full quota has not been taken since 2005. If the full quota is taken, bycatch of Div. 3LNO American Plaice is likely to increase accordingly.

Survivorship can be increased by decreasing bycatch. The amount of increase will depend on the amount of reduction in fishing mortality.

There does not appear to be any serious threat to the habitat of American Plaice.

Projections of population size under different scenarios should follow the procedure outlined in Morgan et al (DFO 2011).

Allowable Harm

To determine maximum allowable harm, projections at various levels of F were conducted and evaluated against the COSEWIC criterion for assessing a species as threatened. Here we have used a decline of $\geq$30% over 3 generations in biomass as this criterion as a proxy for the number of mature individuals.

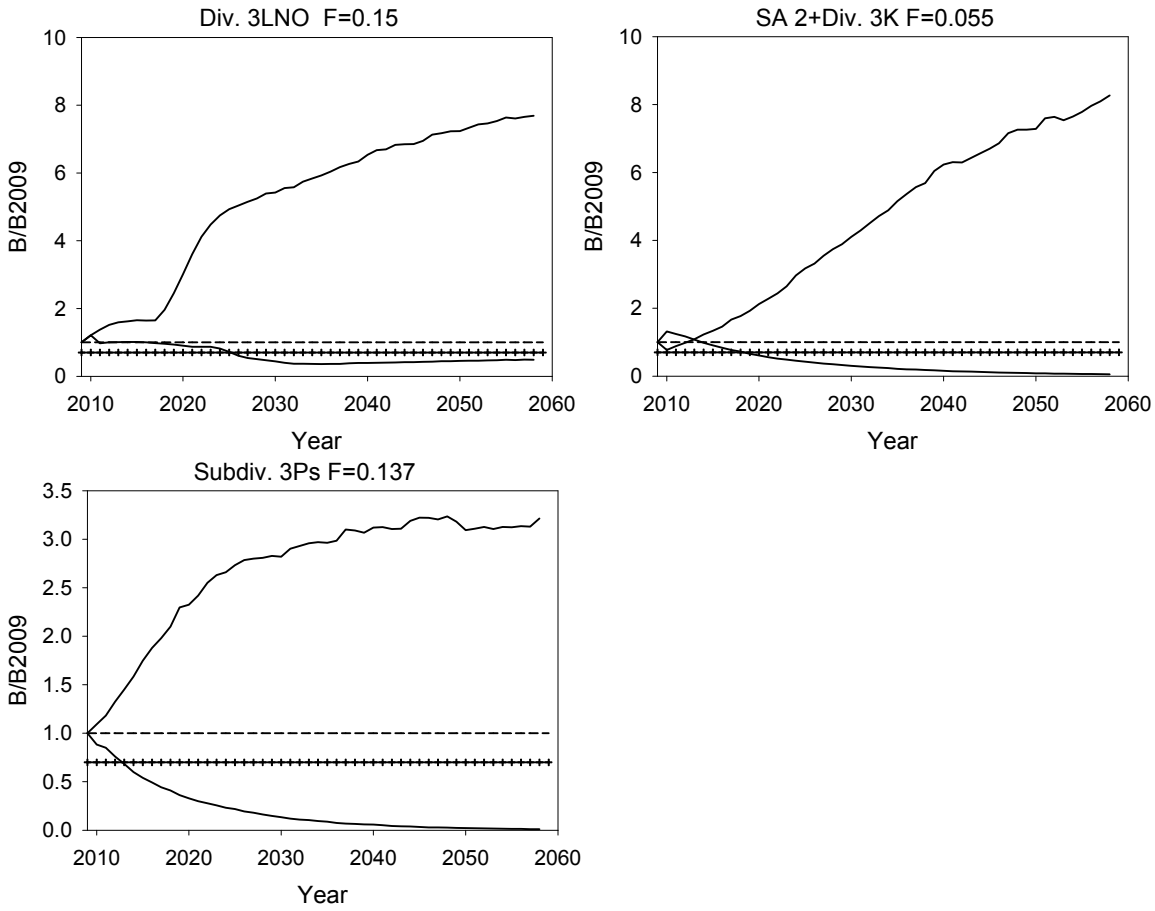

Figure 14: The result of 48 year projections of population biomass at levels of F that could be considered near the 'maximum allowable harm' for each population. Results are shown relative to the biomass in 2009. The solid lines give the upper and lower 95% credible intervals for SA2+Div.3K and Subdiv.3Ps and the upper and lower 95% confidence intervals for Div. 3LNO. The dashed horizontal line shows where biomass is equal to biomass in 2009. The horizontal line of crosses indicates a 30% decrease in biomass relative to 2009.

For Div. 3LNO the maximum F for allowable harm is less than F=0.15. At this level of F, most of the area encompassed by 95% confidence intervals shows an increase in biomass (Figure 14) and in SSN relative to 2009 (Figure 15). However, a substantial number of the results do not reach Blim.

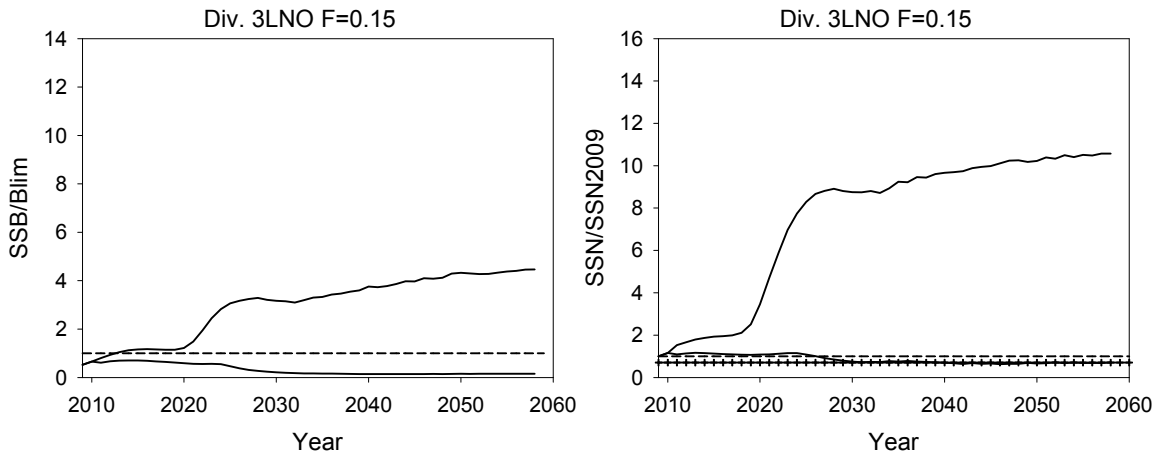

Figure 15: The result of 48 year projections of population biomass at levels of F that could be considered near the 'maximum allowable harm' for Div. 3LNO. Results for SSB are shown relative to Blim and for spawning stock numbers (SSN) relative to the SSN in 2009. The solid lines give the upper and lower 95% confidence intervals. The dashed horizontal line shows where SSB is equal to Blim or SSN is equal to SSN in 2009. The horizontal line of crosses indicates a 30% decrease in SSN relative to 2009.

For SA2+Div.3K the maximum F for allowable harm is near F=0.06. At this level of F, most of the area encompassed by the 95% confidence intervals shows increase in biomass relative to the biomass in 2009. However, some of the projection results showed a more than 30% decline in biomass relative to 2009 (Figure 14).

For Subdiv. 3Ps the maximum F for allowable harm is less than F=0.137. At this level of F, most of the area encompassed by the 95% confidence intervals shows increase in biomass relative to the biomass in 2009. However, some of the projection results showed a more than 30% decline in biomass relative to 2009 (Figure 14).

This exercise was not combined for the DU as the level of F that can be sustained is very different for the different populations.

Sources of uncertainty

The results of this RPA are mainly based on projections of stock size over 48 years (3 generations). Long term projections are dominated by process error (uncertainty in recruitment rates, mortality rates, etc.) so that their utility is not in providing probabilities of specific outcomes but rather in defining the uncertainty. The entire range of uncertainty, particularly the lower limits need to be considered in any conclusion.

The results for the DU combined likely under estimate the true range of uncertainty. The range of results is weighted most heavily to the results for Div. 3LNO which capture only some of the process error.

The effects of large scale environmental change on species productivity and habitat suitability are unknown. The results of the projections would not be robust to such changes.

Although American Plaice are widely distributed and occur over a variety of habitats, the relative quality of various habitats is not known.

SOURCES OF INFORMATION

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, Regional Advisory Meeting of January 24-26th, 2011 on Recovery Potential Assessment (RPA) of American Plaice, Newfoundland and Labrador DU. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

Backus, R.H. 1957. The fishes of Labrador. Bull. Am. Mus. Nat. Hist. **113**: 275-337.

Bowering, W.R., and Brodie, W.B. 1991. Distribution of commercial flatfishes in the Newfoundland-Labrador region of the Canadian Northwest Atlantic and changes in certain biological parameters since exploitation. Neth. J. Sea Res. **27**: 407-422.

Busby, C.D., Morgan, M.J., Dwyer, K.S., Fowler, G.M., Morin, R., Treble, M., Maddock Parsons, D., and Archambault, D. 2007. Review of the structure, the abundance and distribution of American plaice (*Hippoglossoides platessoides*) in Atlantic Canada in a species-at-risk context. CSAS Res Doc 2007/069.

COSEWIC. 2009. COSEWIC assessment and status report on the American Plaice *Hippoglossoides platessoides*, Maritime population, Newfoundland and Labrador population and Arctic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 74 pp.

Dwyer, K.S., Morgan, M.J., Maddock Parsons, D., Brodie, W.B., and Healey, B.P. 2010. An assessment of American plaice in NAFO Div. 3LNO. NAFO SCR Doc. 10/39.

Fahay, M.P. 1983. Guide to the early stages of marine fishes occurring in the western North Atlantic Ocean, Cape Hatteras to the southern Scotian Shelf. J. Northwest Atl. Fish. Sci. **4**: 1-423.

Gibson, R. N., and Robb, L. 1992. The relationship between body size, sediment grain size and the burying ability of juvenile plaice, *Pleuronectes platessa* L. J. Fish Biol. **40**(5): 771–778.

González, C., Roman, E., and Paz, X. 2003. Food and feeding chronology of American plaice (*Hippoglossoides platessoides*) in the North Atlantic. NAFO. SCR. 03/23. 21p.

Houde, E.D. 1987. Fish early life dynamics and recruitment variability. American Fisheries Society Symposium 2: 17-29.

Howell, W.H., and M.A. Caldwell. 1984. Influence of temperature on energy utilization and growth of embryonic and prolarval American plaice *Hippoglossoides platessoides* (Fabricius). Journal of Experimental Marine Biology and Ecology 79:173-189.

Iglesias, S., Paz, J., and de Cardenas, E. 1996. Occurrence of American plaice (*Hippoglossoides platessoides*) at non-habitual depths in the Northwest Atlantic, 1990-93. NAFO SCS. **24**: 91-95.

Johnson, D.L. 2004. American plaice, *Hippoglossoides platessoides*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-187.

Kenchington, E.L.R., Prena, J., Gilkinson, K.D., Gordon, D.C., Jr., MacIsaac K., Bourbonnais, C., Schwinghamer, P.J., Rowell, T.W., McKeown, D.L., and Vass, W.P. 2001. Effects of experimental otter trawling on the macrofauna of a sandy bottom ecosystem on the Grand Banks of Newfoundland. Can. J. Fish. Aquat. Sci. 58: 1043–1057.

Link, J., Bolles, K., and Milliken, C.G. 2002. The feeding ecology of flatfish in the northwest Atlantic. J. Northw. Atl. Fish. Sci. **30**:1-17.

Morgan, M.J. 1992. Low-temperature tolerance of American plaice in relation to declines in abundance. Trans. Am. Fish. Soc. **121**: 399-402.

Morgan, M.J. 2000. Interactions between substrate and temperature preference in adult American plaice (*Hippoglossoides platessoides*). Mar. Fresh. Beh. and Phys. **33**: 249-259.

Morgan, M.J. 2001. Time and location of spawning of American plaice in NAFO Divisions 3LNO. J. Northw. Atl. Fish. Sci. 29: 41-49.

Morgan, M.J., and Brodie, W.B. 1991. Seasonal distribution of American plaice on the northern Grand Banks. Mar. Ecol. Prog. Ser. **75**: 101-107.

Morgan, M.J., and Colbourne, E.B. 1999. Variation in maturity-at-age and size in three populations of American plaice. Ices J. Mar. Sci. **56**: 673-688.

Morgan, M.J., Bailey, J., Healey B.P., Maddock Parsons, D., and Rideout, R. 2011. Recovery potential assessment of American plaice (*Hippoglossoides platessoides*) in Newfoundland and Labrador. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/047. v + 32 p.

Nevinsky, M.M., and Serebryakov, V.P. 1973. American plaice, *Hippoglossoides platessoides* Fabr., spawning in the northwest Atlantic area. ICNAF Res. Bull. **10**: 23-36.

Ollerhead, L.M.N., Morgan, M.J., Scruton, D.A., and Marrie, B. 2004. Mapping spawning times and locations of 10 commercially important fish species found on the Grand Banks of Newfoundland. Can. Tech. Rep. Fish. Aquat. Sci. **2522**: iv + 45 p.

Pepin, P., and R.W. Penney 1997. Patterns of prey size and taxonomic composition in larval fish: are there general size-dependent models? Journal of Fish Biology 51(Suppl. A): 84-100.

Pitt, T.K. 1966. Sexual maturity and spawning of the American plaice, *Hippoglossoides platessoides* (Fabricius), from Newfoundland and Grand Bank areas. J. Fish. Res. Bd. Can. **23**: 651-672.

Pitt, T.K. 1969. Migrations of American plaice on the Grand Bank and in St. Mary's Bay, 1954, 1959, and 1961. J. Fish. Res. Bd. Can. **26**: 1301-1319.

Pitt, T.K. 1973. Food of American plaice (*Hippoglossoides platessoides*) from the Grand Bank, Newfoundland. J. Fish. Res. Bd. Can. **30**: 1261-1273.

Pitt, T.K. 1989. Underwater World: American plaice. Communications Directorate, DFO/4316, Ottawa, ON, K1A 0E6.

Powles, P.M. 1965. Life history and ecology of American plaice (*Hippoglossoides platessoides* F.) in the Magdalen shallows. J. Fish. Res. Bd. Can. **22:** 565-598.

Rideout, R.M., and Morgan, M.J. 2007. Major changes in fecundity and the effect on population egg production for three species of north-west Atlantic flatfishes. J. Fish Biol. **70**: 1759-1779.

Schwinghamer, P., Gordon, D.C., Jr., Rowell, T.W., Prena, J., McKeown, D.L., Sonnichsen, G., and Guigné, J.Y. 1998. Effects of experimental otter trawling on surficial sediment properties of a sandy-bottom ecosystem on the Grand Banks of Newfoundland Cons. Biol. 12(6): 1215–1222.

Scott, J.S. 1982a. Depth, temperature and salinity preferences of common fishes on the Scotian Shelf. J. Northw. Atl. Fish. Sci. **3**: 29-39.

Scott, J.S. 1982b. Selection of bottom type by ground fishes of the Scotian Shelf. Can. J. Fish. and Aquat. Sci. **39**: 943-947.

Shepherd, T.D., Costain, K.E., and Litvak, M.K. 2000. Effect of development rate on the swimming, escape responses, and morphology of yolk-sac stage larval American plaice, *Hippoglossoides platessoids*. Mar. Biol. **137**: 737-745.

Swain, D.P., Chouinard, G.A., Morin, R., and Drinkwater, K.F. 1998. Seasonal variation in the habitat associations of Atlantic cod (*Gadus morhua*) and American plaice (*Hippoglossoides platessoides*) from the southern Gulf of St. Lawrence. Can. J. Fish. and Aquat. Sci., 55: 2548-2562.

Treble, M.A. 2007. Analysis of data from the 2006 trawl surveys in NAFO Division 0A. NAFO SCR Doc. 07/41.

Walsh, S.J. 1994a. Life history traits and spawning characteristics in populations of long rough dab (American plaice) *Hippoglossoides platessoides* (Fabricius) in the North Atlantic. Neth. J. Sea Res, **32**: 241-254.

Walsh, S.J., and Brodie, W.B. 1987. Aspects of American plaice distribution in NAFO Divisions 3L, 3N and 3O. NAFO SCR Doc. 87/47.

Walsh, S.J., Simpson, M., and Morgan, M.J. 2004a. Continental shelf nurseries and recruitment variability in American plaice and yellowtail flounder on the Grand Bank: insights into stock resiliency. J. Sea Res. **51**: 271-286.

Zamarro, J. 1992. Determination of fecundity in American plaice (*Hippoglossoides platessoides*) and its variation from 1987 to 1989 on the tail of the Grand Bank. Neth. J. Sea Res. **29**: 205-209.

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