NORTHWEST ATLANTIC SPINY DOGFISH STOCK STATUS UPDATE REPORT

Context

Campana et al. (2007) presented an overview of all available information on the stock structure, migration patterns, abundance trends and status of the Canadian portion of the Atlantic Spiny Dogfish population. During the 2010 Transboundary Resources Assessment Committee (TRAC) Spiny Dogfish Benchmark and Assessment meeting (TRAC 2010), Canada and the United States (US) failed to reach an agreement on a population model for the Northwest Atlantic Spiny Dogfish and subsequently proceeded to independently develop Spiny Dogfish stock and population models. Following the 2010 TRAC meeting, Canada developed a forward-projecting stage-based, spatially explicit population dynamics model, which was accepted as a DFO framework model and is used in the current update. The stage-based model was also used to estimate the likely consequences of various exploitation scenarios on stock status, which provided a foundation for deriving reference points for Spiny Dogfish.

Since a formal data sharing agreement does not currently exist between Canada and the US, attempts to update the population status of dogfish were compromised by difficulties in obtaining US data inputs. In 2014, an assessment was conducted by creating proxies for 2011-2013 US data from summary statistics in US assessments (Fowler and Campana 2015). This required a number of assumptions about population and catch compositions related to sex and maturity stage. For this update, US survey data and incomplete US catch composition data were obtained.

The objective of this science response is to review and evaluate fishery landings from previous years, provide research vessel survey biomass and length composition, and describe biomass and exploitation in relation to adopted reference points.

This Science Response Report results from the Science Response Process of December 4, 2015, on the Stock Status Update of Dogfish in Northwest Atlantic Fisheries Organization (NAFO) Fishing Areas 4VWX5.

Background

Biology

Spiny Dogfish (*Squalus acanthias*) are small cold-temperate squaloid sharks that exhibit both demersal and pelagic habits. In the Northwest Atlantic, Spiny Dogfish are common from North Carolina to southern Newfoundland, and can be found further to the south and north.

Spiny Dogfish migrate seasonally, their distribution shifting between US and Canadian waters as many migrate south in winter and north in summer, with the Gulf of Maine roughly corresponding to a centre of distribution in the Northwest Atlantic (Figure 1).

A long-lived, slow-growing, low-fecundity ovoviviparous species, Spiny Dogfish are characterized by low productivity. Females usually do not mature until they are 14 (11-17) years of age, so only a small proportion of females live to maturity.

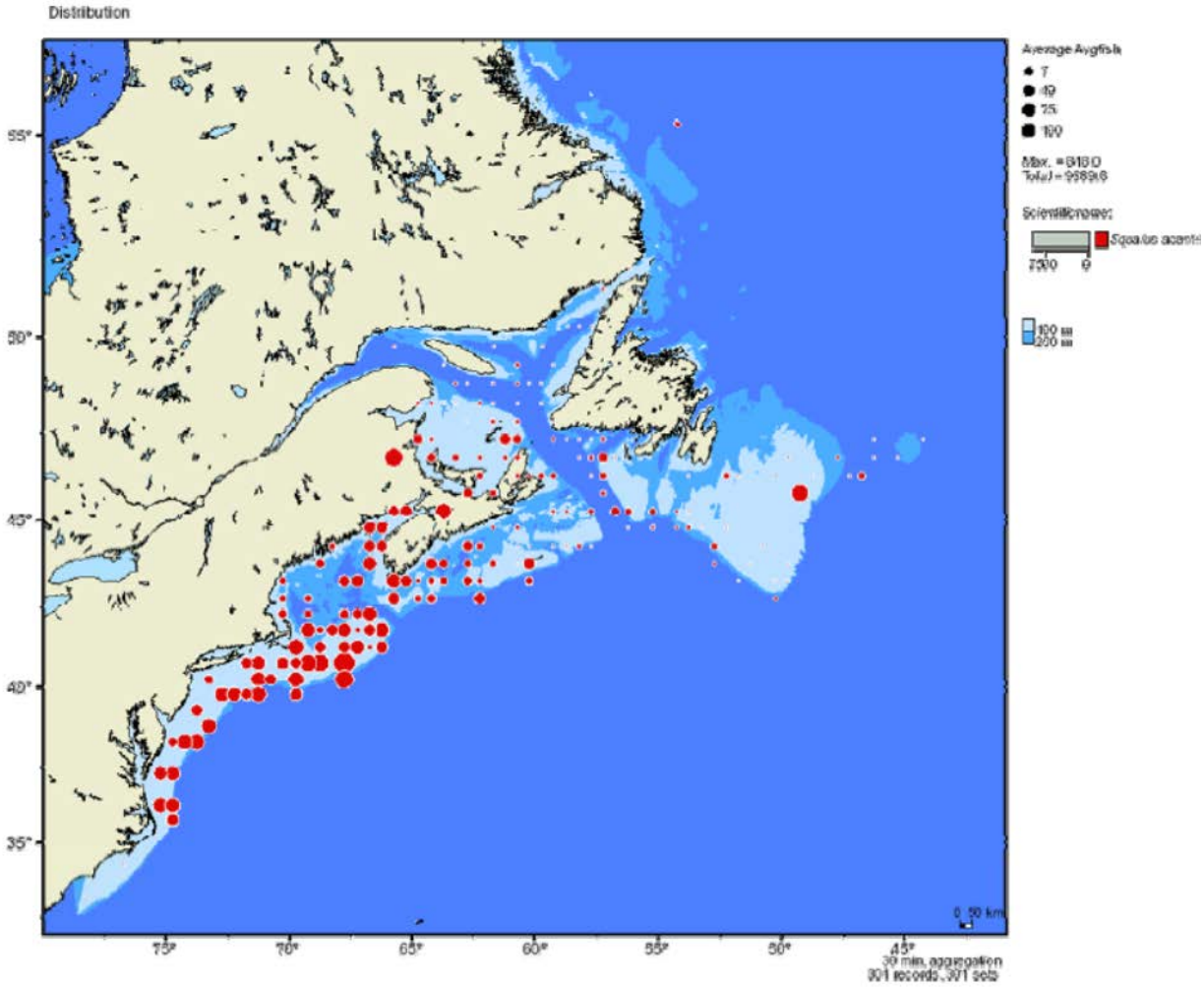

Figure 1. Distribution of Spiny Dogfish along the eastern coast of North America as recorded in East Coast of North America Strategic Assessment Project (ECNASAP in 2007).

Description of the Fishery

Historically, Spiny Dogfish have been of minor commercial importance in North American waters, although discard mortality in groundfish fisheries was significant. With the decline in traditional fish stocks in recent decades (since the 1980s) commercial interest in Spiny Dogfish increased. No serious markets for dogfish exist in North America, but they do in Europe, such that Spiny Dogfish became commercially significant in the mid-1990s, shortly after moratoriums on cod and haddock were established. In about 2009, European markets became constrained by a requirement for Marine Stewardship Council (MSC) certification, causing Canada to lose access to that market.

Most Atlantic Canadian landings of Spiny Dogfish are taken in directed handline, longline, and gillnet fisheries. Catches were unrestricted prior to 2002, when precautionary directed catch

quotas based on past catches were put in place for the Scotia-Fundy Region. The total allowable catch (TAC) from 2004 through 2013 was set at 2500 metric tons (mt) (Table 1). Following the 2014 assessment (Fowler and Campana 2015), a 10,000 mt TAC was set for 2015. However, Canadian landings have never exceeded 200 mt since access to European markets was lost, so the Canadian TAC has not been restrictive in recent years.

Since the US Atlantic Spiny Dogfish fishery obtained MSC certification in 2012, US landings of Spiny Dogfish have increased from 1,400-5,800 mt from 2002 to 2010 to 7,400-10,900 mt since 2011. This shifted the relative magnitudes of fishing mortality from discarding to directing in US waters, with associated changes in catch composition. Thus, the catch composition since 2010, the last year of detailed US catch composition data used in the 2014 assessment, and current update is expected to be highly relevant to gauging population status.

Table 1. Landings, dead discards and Canadian total allowable catch (TAC) (thousands mt) of Northwest Atlantic (4VWX5YZ6ABC) Spiny Dogfish.

	Canada			USA	
Year	TAC	Landings	Dead Discards	Landings	Dead Discards
1922-1939		0.0	0.0	0.0	3.6
1940-1955		0.0	0.8	0.1	10.3
1956-1970		0.4	1.3	2.5	33.3
1971-1980		3.9	1.3	13.8	16.6
1981-1990		0.5	1.9	6.1	19.6
1991-2001		1.1	1.0	17.4	8.5
2002		3.4	0.7	3.0	5.9
2003		1.3	0.7	2.1	4.4
2004	2.5	2.3	0.7	1.4	6.5
2005	2.5	2.3	0.6	1.6	5.7
2006	2.5	2.4	0.4	1.8	6.2
2007	2.5	2.4	0.4	3.6	6.9
2008	2.5	1.5	0.4	3.9	5.1
2009	2.5	0.2	0.4	5.2	5.8
2010	2.5	0.0	0.4	5.8	5.2
2011	2.5	0.1	0.4	9.8	4.8
2012	2.5	0.1	0.4	10.9	4.9
2013	2.5	0.0	0.3	7.4	5.0
2014	2.5	0.1	0.1	10.7	5.8

Analysis and Response

Full details of the accepted framework are provided in Fowler and Campana (2015).

The model developed for Atlantic Spiny Dogfish is a forward-projecting stage-based (juveniles and adults, males and females), spatially explicit (two regions – Canada and US) population dynamics model, with two time steps (November-April and May-October) in each year. This model is used to gauge stock status by tracking the exploitation and abundance of adult females relative to MSYssn, the optimal sustainable abundance of adult females.

All US East Coast waters are included in the US zone. The Canadian zone is defined as the eastern waters of the Gulf of Maine, the Bay of Fundy and the Scotian Shelf (NAFO Divisions 4VWX5YZ), comprising the largest proportion of Spingy Dogfish in Canadian waters (Campana et al. 2007). Spiny Dogfish stock components in the Gulf of St. Lawrence and Newfoundland are not included.

Population components are observed by the US Spring survey (1968-2014) and Canadian Summer survey (1970-2014). Fishing mortalities by component are observed by Commercial Landings + Dead Discards (1922-2014). The model predicts the population components via recruitment, transition between juvenile and adult stages (theta), migrations between US and Canadian waters, natural mortality, and fishing mortality (Figure 2)

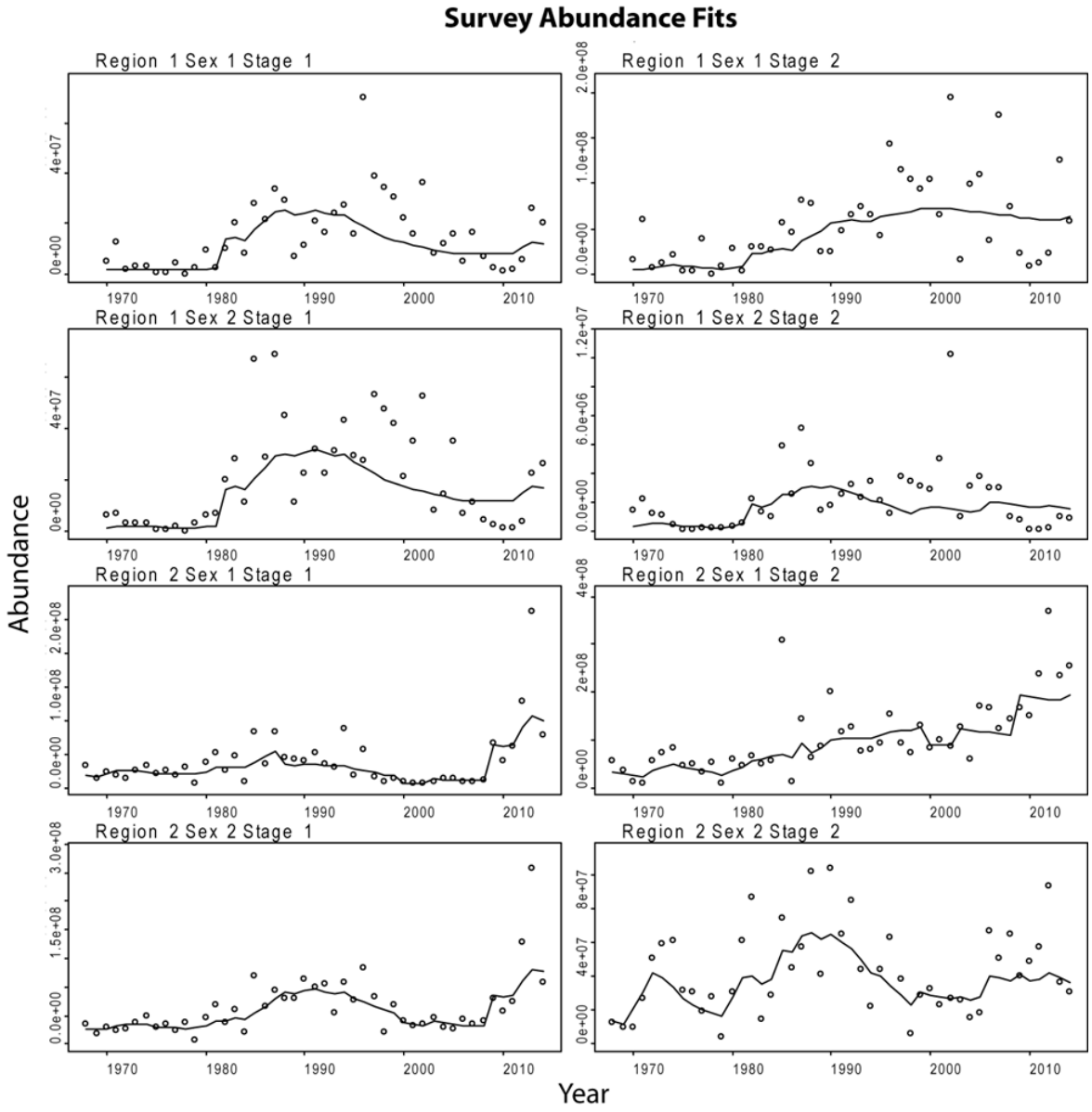

Figure 2. Fits (lines) to survey abundance estimates (points) of the updated stage-based model. Region 1 = Canada (1970-2014), 2 = US (1968-2014); Sex 1 = Males, 2 = Females; Stage 1 = Juveniles, 2 = Adults.

Fishery and Survey Data

Fishery and survey length frequency data are aggregated by region, year, time-step, fishery or survey, and sex.

Two surveys, the US Spring survey and the Canadian Summer survey, were used to track Spiny Dogfish abundance. This update replaces uncalibrated estimates from the US survey (2009-2010) with calibrated estimates, and adds estimates for 2011-2014. The 2014 Spring estimates, derived from an incomplete survey (vessel breakdown), were not used in the US assessment due to concerns that lower estimates in 2014 might be associated with critical areas that were missed. However the completed 2015 Spring survey (not in the update model), posed even lower estimates, so the 2014 estimates were included in this update.

Fishery discard catches at length are converted to numbers of dead fish by assuming discard mortalities for each fishery type. The assumed mortalities were derived from a joint Canada and US TRAC meeting in 2010 (Fowler and Campana 2015).

Fishery components (landings and discards in numbers at length by domestic otter trawl, longline, gillnet, foreign otter trawl, recreational, scallop dredge, and other) are aggregated by region, year, time step, sex and maturity stage. US fishery data (2011-2014) with information to permit partitioning by time step could not be obtained, so a 50:50 seasonal split in catches was assumed. Also, the US landings data was not partitioned by fishery, so only overall annual length compositions could be applied to the US annual total landings for 2011-2014. The catch compositions for 2011-2013 in the 2014 assessment (Fowler and Campana 2015) were based entirely on assumptions applied to total catch weights, so these were replaced. The revised catch compositions removed more adult females and fewer adult males from the population in these years (Figure 3).

It is not assumed the partitioning assumptions for 2011-2014 will produce a true depiction of removals by season, sex and maturity stage in these years. This uncertainty is addressed by associating these components with large error assumptions (log standard deviations of 1.0) in the model.

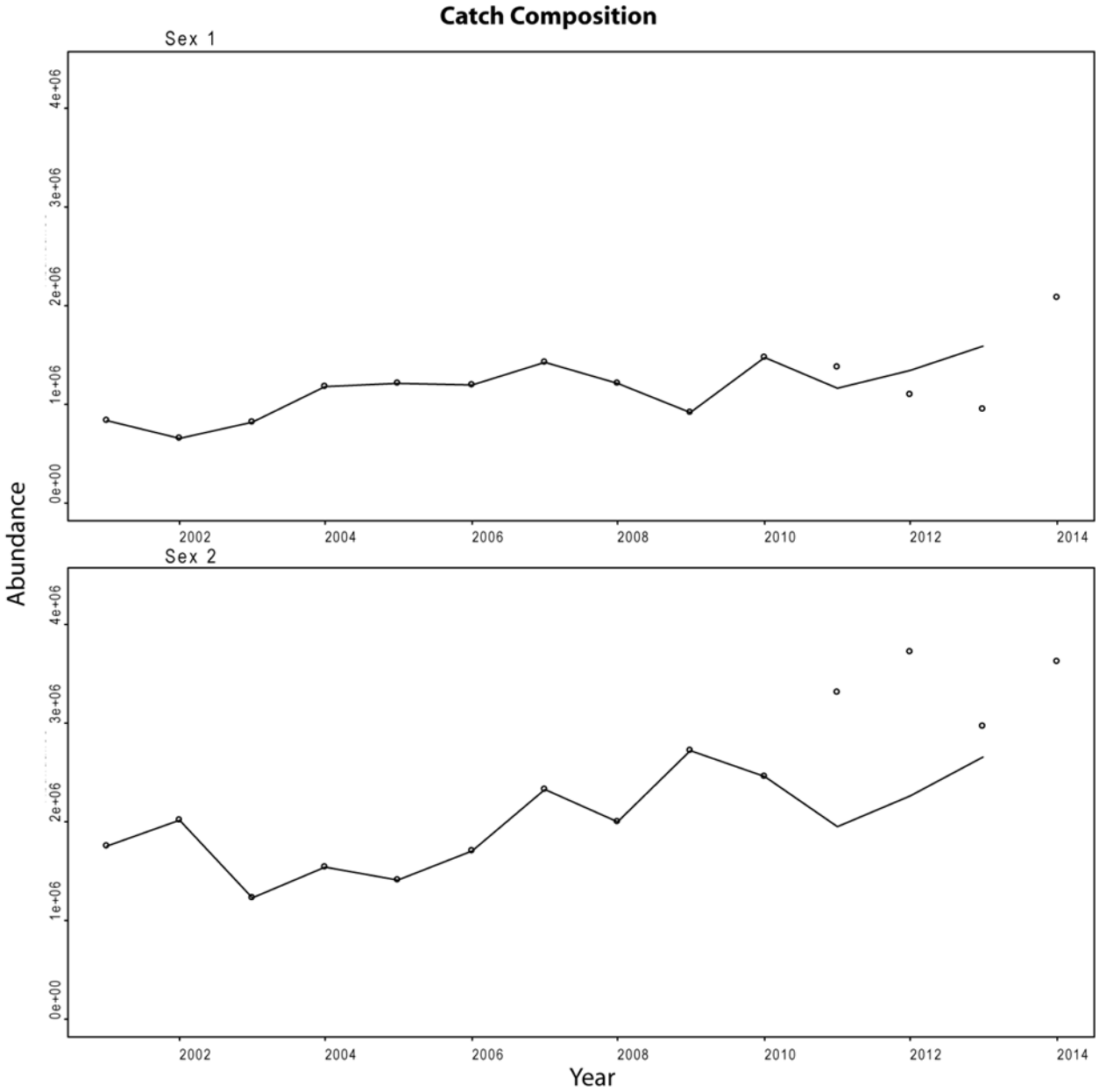

Figure 3. Total landings and dead discards of adults (Sex 1 = Males, Sex 2 = Females) in numbers of Spiny Dogfish across all fisheries for the US since 2001. The US data from the 2014 assessment is plotted as a line to show changes in assumed removals for 2011-2013.

Population Model Update

It was not possible to fit the update model with the same parameters as the framework model. An updated framework model hit too many bounds on parameter estimates, most notably on estimated catchabilities for adult females and juveniles of both sexes in the US survey during the recent period (2009-2014) with the new vessel (*Bigelow*) and trawl. The update model contends the US survey has over-estimated abundance in recent years. The latest US assessment (Rago and Sosebee 2015) encountered the same type of problem, and it considered the possibility that distributional shifts may have altered the availability of Spiny

Dogfish to the survey in the recent time period. However, high estimates could also reflect problems with the *Bigelow* calibrations. Size-dependence may vary between the previous survey vessel (*Albatross*) and the *Bigelow*, as the calibration did not consider length effects. In this model, high estimates could also be an artefact of the assumptions required to represent fishery removals during 2011-2014 (missing information in US catch composition data).

The most relevant difference posed by the current update model is its contention of fewer adult females when they peaked in 2006, followed by a decline in subsequent years. The 2014 assessment had determined that adult females were more abundant in 2006 and had remained near this abundance during 2007-2013.

The 2015 US assessment (Rago and Sosebee 2015) suggests 24,247 mt as the 2016 overfishing limit (OFL). A decline of 41% occurred in the 2015 US OFL relative to the OFL of the 2014 assessment. The US TAC for 2016 has not been finalized, but meeting minutes from the Mid-Atlantic Fisheries Management Council on October 15, 2015, indicate that 11,486 mt was initially proposed. This was derived from the OFL using a probabilistic risk adjustment to 16,765 mt and subtracting assumed Canadian landings of 65 mt and US discards of 5,214 mt. The Scientific and Statistical Committee ultimately recommended a TAC of 18,144 mt.

Population Model Results

Allowing for a herding adjustment to estimated catchabilities (upper bound raised from 1.0 to 1.22) for the *Bigelow* and estimating natural mortality (M) (possible range of 0.09 to 0.15) achieves a fit so long as there is no attempt to estimate variability in US-to-Canada migration to improve the fit to the Canadian Summer survey (Figure 3). The herding adjustment is just serving as a calibration or availability adjustment. The M estimation could be compensating for faulty removal assumptions, as it leaves adult males at 0.1 (the prior) while pushing every other component to the upper bound. Estimating annual variability in migration just explains the Summer survey estimates in Canadian waters. In the absence of a serious Canadian fishery it does not play a role in modelling population dynamics, so is not required to gauge population status.

Compared to the 2014 framework model (terminal year 2010) and 2014 assessment (terminal year 2013), the population estimates in the current update model agree from the start of the surveyed period in 1968 until approximately 2005, but not since 2006 (Figure 4). Natural mortalities are constants, and letting them be estimated to better fit the recent period changes the model burn-in, such that it no longer provides a likely depiction of the population at the onset of industrial fishing in the 1950s.

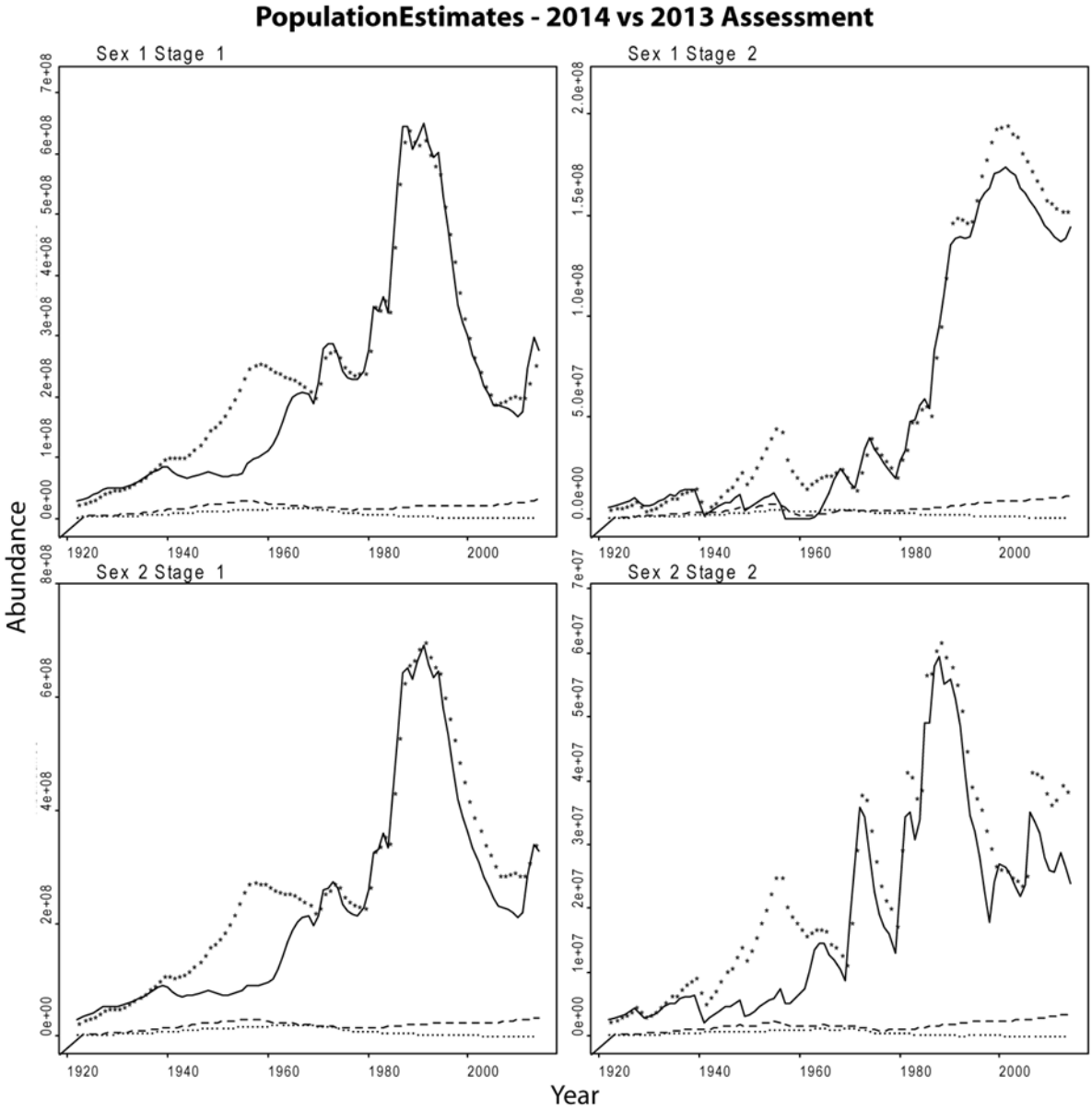

Figure 4. Abundance estimates (end of March) of population components from the updated 2014 model (straight line for US, dashed line for Canada) overlaid on estimates from the 2013 update model (asterisks for US, points for Canada). Population components are plotted separately by sex (1 = males, 2 = females) and maturity stage (1 = juveniles, 2 = adults).

Conclusions

It is suspected that due to calibration issues with the *Bigelow*, population abundance has been overestimated. In particular, the estimated abundance of adult female dogfish in recent years is lower than reported in previous assessments. Harvest Control Rules for Spiny Dogfish are based on adult female abundance, and this change will have implications for the understanding of the status of the population in relation to our reference points. A review of the calibration is warranted.

Additional information (season and fishery) associated with the US catch compositions for 2011-2014 is required to confirm the catch compositions since the development of the directed fishery in US waters. It is especially important to determine if fishery removals of adult females have exceeded the expectations of the catch compositions used in projections to establish Harvest Control Rules.

Given these issues with data inputs, TAC advice for 2016-2017 cannot be provided and previous TAC advice was likely optimistic.

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