Fisheries and Oceans Canada | Pêches et Océans Canada
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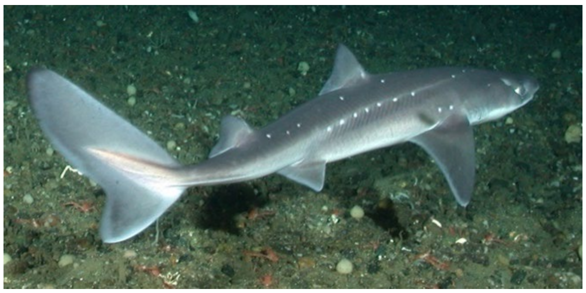
Pacific Region
Canadian Science Advisory Secretariat
Science Advisory Report 2025/032

PACIFIC SPINY DOGFISH (*SQUALUS SUCKLEYI*) POPULATION MODELLING FOR OUTSIDE WATERS OF BRITISH COLUMBIA IN 2024



Pacific Spiny Dogfish (Squalus suckleyi). Source: NOAA, Public Domain.

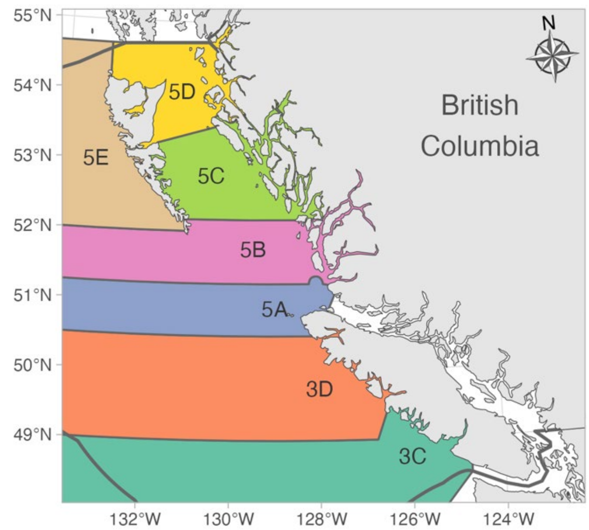


Figure 1. Pacific Marine Fisheries Commission (PMFC) major areas covering the assessed stock area for Pacific Spiny Dogfish in outside waters of British Columbia. Thicker dark grey line denotes the 200 nautical mile exclusive economic zone (EEZ) for the BC coast.

CONTEXT

Pacific Spiny Dogfish (*Squalus suckleyi*; “Dogfish”) is a small, wide-ranging, long-lived, late-maturing shark species. In the Northeast Pacific they are found from Alaska to southern Baja California. The Dogfish population in British Columbia (BC), Canada is assessed as two stocks: an inside stock inhabiting the Strait of Georgia and Johnstone Strait and an outside stock inhabiting remaining coastal areas—this assessment focuses on the outside stock. There is a long history of fishing Dogfish on the BC coast. A commercial fishery for Dogfish oil developed in the 1870s. This fishery later declined in popularity and then a second large fishery developed in the 1930s until 1950 for Dogfish livers to extract vitamin A. The development of synthetic vitamin A, combined with declines in Dogfish abundance, ended this fishery; several smaller fisheries have occurred since. Currently, there is no directed fishery for Dogfish in BC, although they are regularly caught incidentally. The last stock assessment for Dogfish was completed in 2010; however, there was no consensus reached on a scientifically valid approach on which to base yield recommendations. A COSEWIC (Committee on the Status of

Endangered Wildlife in Canada) assessment shortly thereafter designated Dogfish in BC as a species of Special Concern.

This Science Advisory Report is from the regional peer review of October 17–18, 2024, on the Assessment of the Outside Stock of Pacific Spiny Dogfish (*Squalus suckleyi*) in British Columbia. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- Pacific Spiny Dogfish is a long-lived shark species with late maturation and low fecundity resulting in very low productivity. These life-history characteristics require considering historical fishing impacts (e.g., since the 1940s), which constrain recovery potential and extend recovery timelines.
- Dogfish have been commercially fished since the mid-1870s with fishery dynamics varying over the past 150 years. A notable Vitamin A liver fishery in the 1940s peaked at 31,000 t in 1944. From 1950–1980, there was no targeted fishery. Between 1980 and 2009, a targeted commercial food fishery existed, with peak catches of around 4,000 t in 1988, 2004, and 2005. Since 2010, there has been no targeted fishery. Over the past decade, annual discards (greater than 1,000 t) have exceeded landings (less than 400 t).
- This assessment developed a two-sex, age-structured population dynamics model fit to fishery and survey catch, abundance indices, and length composition data for Dogfish in Pacific Marine Fisheries Commission (PMFC) major areas 3CD5ABCDE in British Columbia. Due to the species life history, spawning output (number of pups) was used to characterize stock status rather than spawning biomass.
- The Groundfish Integrated Fisheries Management Plan (IFMP) applies a 6% discard mortality for longline gear and 5% mortality for the first two hours of a trawl tow and an additional 5% mortality prorated for each subsequent hour. These values are lower than those from the literature, so this document considers discard mortality rates from the literature under low, base, and high assumptions: 8–36% for longline, 5–15% for hook and line, 27–86% for gillnet, and 19–56% for trawl. Future work could consider the effectiveness of Groundfish IFMP discard mortality rates in achieving fisheries management objectives.
- The assessment explored uncertainties related to life-history characteristics, natural mortality (M), discard mortality, the representativeness of abundance indices, the stock-recruit curve shape, and the potential increase in M. The assessment considered one base model, 15 sensitivity models with constant M, and five sensitivity models with increasing M.
- All models estimated a sharp decline in the spawning output in the 1940s due to the vitamin A fishery, followed by an increase driven by maturation of untargeted juvenile cohorts. A slower decline continued through to 2010, driven by increased fishing and decreasing reproductive output from aging cohorts.
- Estimated depletion (S/S_0, spawning output over unfished spawning output) by 2023 was largely unaffected by alternative assumptions about growth, maturity, discard mortality, index of abundance inclusion, or stock productivity. Current depletion is inferred mainly from the recent decline in population indices and low catches relative to historical levels.
- Models allowing M to increase stepwise in 2010 fit the steep declines from the Synoptic trawl index, but resulted in a stock that would be unable to replace itself with continued high

M. While an increase in M is plausible, future research is needed to accurately capture this in the model.

- A Limit Reference Point (LRP) of $0.2S/S_0$ and candidate Upper Stock Reference (USR) of $0.4S/S_0$ are proposed based on the shape of the yield curve and approximate equivalence to DFO (2009) provisional reference points 0.4 and $0.8B/B_{MSY}$ (biomass at maximum sustainable yield). The assessment furthermore proposes $F0.4S_0$ (the fishing mortality that would take the stock to 0.4 S/S_0 over the long term) as a candidate Removal Reference rate.
- All models estimated the stock to be below its LRP with very high likelihood (> 0.95 probability), placing the stock in the Critical Zone. The base model estimated S/S0 in 2023 to be 0.09 (0.08–0.09 95% confidence interval, CI). Across all constant M models, the median S/S_0 was 0.09 with 95% CIs ranging from 0.06–0.12.
- The base model estimated $F/F_{0.4S0}$ in 2023 to be 1.5 (1.3–1.6 95% CI). Across all constant M models, the median $F/F_{0.4S0}$ was 1.5 with 95% CIs from 0.7–12.8.
- Spawning output was projected to remain below the LRP with very high likelihood in 2024–2028 across all models and catch levels, including zero catch.
- Projections from 2024 to 2028 carried forward the average dead catch (landed Dogfish plus those assumed to die from discard mortality) ratios among the fleets calculated over the last five years. The maximum dead catch with ≥ 95% probability of $F < F_{0.4S0}$ ranged from 0 t (low productivity scenario) to 250 t (high productivity scenario). In the base scenario, the maximum dead catch to maintain ≥ 95% probability of $F < F_{0.4S0}$ was 150 t.
- Applying the low, base, and high discard mortality rates to average reported catch (~ 861 t) over the last five years resulted in 160 t, 315 t, and 423 t of dead catch per year.
- The limited productivity of Dogfish, estimated population size, and steep declines in two of three survey indices suggest that catches should be lower than the current 12,000 t total allowable catch to increase spawning output and achieve a high probability of $F < F_{0.4S0}$.
- Key challenges in modeling Outside Dogfish population dynamics included a lack of early stock indexing data, difficulty estimating density-dependence in the stock-recruit curve, uncertainty in discard mortality rates, and differing rates of decline in three major survey indices.
- It is suggested that the assessment is revisited in approximately five years, with stock monitoring through population indices in the BC groundfish data synopsis reports in the interim.

INTRODUCTION

Pacific Spiny Dogfish (*Squalus suckleyi*; “Dogfish”) are a wide-ranging, long-lived shark species. Tagging data suggest it exists as one offshore stock in the northeast Pacific, extending from Baja California to Alaska (Ketchen 1986), and two coastal stocks: one in the Strait of Georgia and another in Puget Sound (McFarlane and King 2003, 2009). Because of this, the Dogfish population in British Columbia (BC) is assessed as two stocks: an inside stock inhabiting the Johnstone Strait (DFO Statistical Area 12) and Strait of Georgia (DFO Groundfish Management Area 4B) and an outside stock inhabiting remaining coastal areas. This assessment focused on the outside stock (Figure 1).

Dogfish have been fished on the BC coast for centuries. First Nations are believed to have fished them for skin, meat and oil as far back as 5,000 years ago (Ketchen 1986). Commercial fishing began in the 1870s (Anderson 1878) and initially targeted their liver oil for industrial use from 1870–1916 (Ketchen 1986). Peak exploitation occurred from the late 1930s to 1950, when Dogfish livers were used to supplement soldiers' vitamin A intake (Ketchen 1986) (Figure 2). A shift to synthetic vitamin A, combined with declining Dogfish abundance, ended this fishery (Ketchen 1986), though smaller directed fisheries have occurred since. Currently, there is no directed Dogfish fishery in BC, although they are regularly caught incidentally in groundfish fisheries.

The previous Dogfish stock assessment was completed in 2010 (DFO 2010, 2012; Galluci et al. 2011); however, there was "no consensus reached on a scientifically valid approach on which to base yield recommendations" (DFO 2010). Model output suggested there was insufficient contrast in the stock index data to estimate productivity and scale given the surplus production model assumptions and concluded there was no immediate conservation concern given the perceptions on stock status and lack of a directed fishery. As a result, quota for the outside stock remained at 12,000 t total (8,160 t for the Dogfish Sector and 3,840 t for the Trawl Sector; Fisheries and Oceans Canada 2024) with catches well below this quota.

In 2010, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) categorized Dogfish as Special Concern due to their "low fecundity, long generation time, uncertainty regarding trends in abundance of mature individuals, reduction in size composition, and demonstrated vulnerability to overfishing" (COSEWIC 2011). While a decision by the Governor in Council to list Dogfish species under the *Species at Risk Act* (SARA) is still pending, a new COSEWIC review is pending as COSEWIC is required to review each species at risk classification every 10 years (s.24 of SARA).

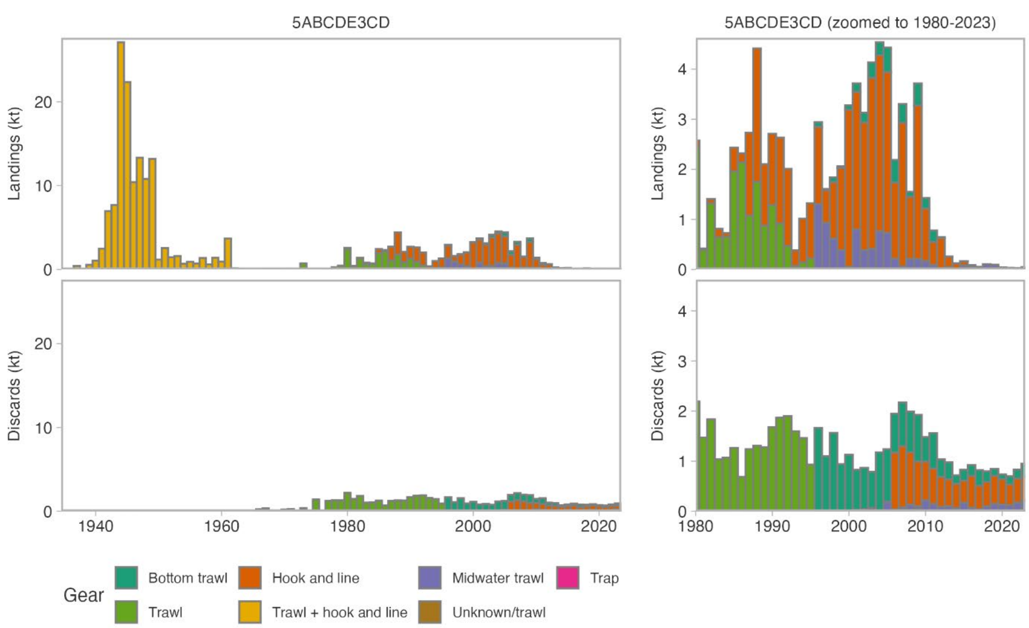


Figure 2. Reconstructed landings and discards of outside Dogfish from commercial sources. The right panels magnify the data from 1980–2023 with a smaller y-axis upper limit. Hook and line (longline) discards 2006 onwards are illustrated here as weight based on an assumed average weight of 3.07 kg/Dogfish but were modelled as counts. Hook and line discard data prior to 2006 were not recorded and are therefore not shown.

ASSESSMENT

This assessment used a two-sex, age-structured population model to reconstruct historical abundance of outside Dogfish by fitting to fishery (Figure 2) and survey catch, abundance indices or biomass from standardized commercial trawl catch per unit effort (CPUE) and scientific surveys (Figure 3), and length composition data from both fisheries and scientific surveys. Stock Synthesis (SS3; Methot and Wetzel 2013) was used to develop the models. The base model estimated unfished recruitment and selectivity parameters for fisheries and surveys, with biological parameters for growth, maturity, and fecundity estimated separately, but with uncertainty captured through alternative sets of parameters. No recruitment deviations were estimated due to lack of cohort strength information evident from the size composition data. The assessment also explored uncertainties related to natural mortality (M), discard mortality, the representativeness of various indices of abundance, the shape of the stock-recruit curve, and possible time-varying M. In total, one base model, 15 models with constant M, and five models with time-varying M were considered, with 13 used in reference point calculations. The other models were either sensitivity tests, had convergence issues, or estimated implausible biomass trajectories.

Delayed effects of the 1940 vitamin A fishery were apparent in the model-reconstructed abundance at age (Figure 4). The fishery rapidly reduced the abundance of older females (30+ years) by the 1950s, while the younger fish (age 20) were less impacted. The lack of pups born during or immediately after the fishery resulted in a low-abundance cohort that progressed through time (Figure 4). Young cohorts, which were invulnerable to the early fishery, were estimated to have eventually rebuilt the abundance of older females in the 1970s–1980s. However, low recruitment during the late 1940s, due to fewer older-aged females, led to a lack of older age classes, and reduced spawning output by the mid-1970s (Figure 4).

All constant M models estimated a large, steep decline in the spawning output in the 1940s due to the vitamin A fishery (Figure 5). This was followed by an increase in spawning output and a slower decline through 2010. Since then, the spawning output has remained relatively constant at low levels. In contrast, the total stock biomass gradually declined at varying rates since the 1930s.

The models fit the declines in three population indices but were unable to fit the steeper declines in two modern survey-based indices: the Outside Hard Bottom Longline survey and the coastwide Synoptic trawl survey (Figure 3). Year-to-year variability in length composition data, likely due to low sample sizes and opportunistic sampling, were challenging to fit and thus less informative about stock depletion, but did inform gear selectivity estimates.

Estimated depletion S/S_0 (spawning output over unfished spawning output) by 2023 was largely insensitive to alternative assumptions about growth, maturity, discard mortality, indices of abundance inclusion, and stock productivity. Models that allowed M to vary in recent decades estimated steep increases in M. Models that allowed M to increase (linearly since 1990 or stepwise beginning in 2005) resulted in implausible stock trajectories where the 1940s vitamin A fishery had little impact. Models allowing M to increase stepwise in 2010 fit the steep declines from the Synoptic trawl index, but resulted in a stock that would be unable to replace itself with continued high M.

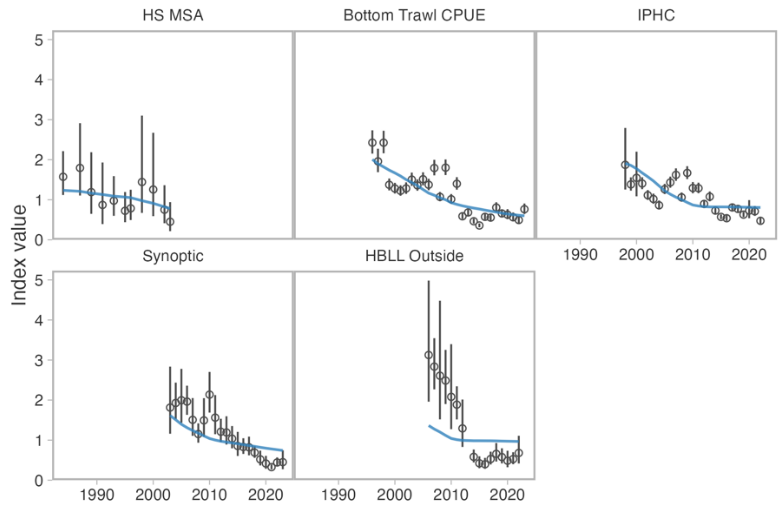


Figure 3. Standardized indices of abundance and biomass density for outside Dogfish. Dots represent mean estimates and vertical line segments represent 95% confidence intervals derived from spatiotemporal modelling. Blue lines illustrate fits to the data from the base model. The indices are based on area-weighted expansions of predicted density on respective survey domain grids. All indices have been scaled to have a geometric mean of one. Bottom Trawl CPUE: commercial bottom trawl catch per unit effort. HBLL Outside: Hard Bottom Longline Outside Survey; HS MSA: Hecate Strait Multispecies Assemblage Survey; IPHC: International Pacific Halibut Commission Fisheries Independent Setline Survey; Synoptic: Synoptic Bottom Trawl Surveys.

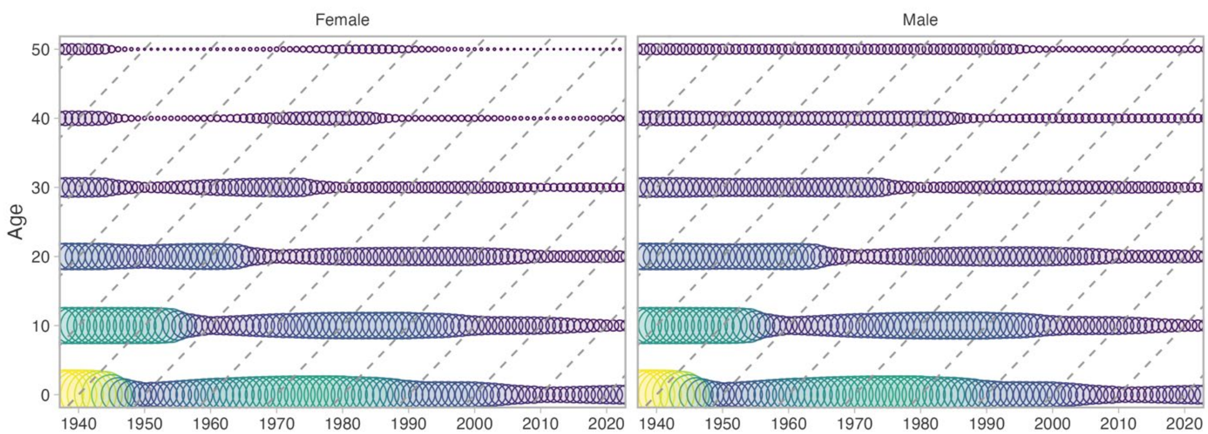


Figure 4. Abundance at age for six age classes from the base model illustrating the lagged effects of fishing on the age structure of the population for females and males. Circle area and colour (yellow = high, blue = low) represent abundance for a given year-age combination. Diagonal lines track 10-year cohorts through time.

Reference Points

The assessment defined 0.2 S/S_0 as a biological Limit Reference Point (LRP) and proposed 0.4 S/S_0 as a candidate Upper Stock Reference (USR) based on the shape of the yield curve and approximate equivalence to the provisional reference points 0.4 and 0.8 B/B_{MSY} recommended in policy (DFO 2009). It also proposed $F/F_{0.4S0}$ (fishing mortality over the fishing mortality that would take the stock to 0.4 S/S_0 over the long term) as a candidate Removal Reference rate. Spawning output, rather than spawning biomass, is often used to develop reference points for long-lived low-fecundity species such as sharks as it directly measures stock productivity (e.g., Rice et al. 2013; Taylor et al. 2013; Gertseva et al. 2021). For teleost fish, spawning biomass is typically used as a proxy for spawning output (egg production) when fecundity data are unavailable; however, Dogfish fecundity is comparatively well understood and was modelled as a linear function of length (Ketchen 1972).

All models estimated the stock was below its LRP in 2023 with very high likelihood (> 0.95 probability, Figure 5). The base model estimated S/S_0 in 2023 to be 0.09 (0.08–0.09 95% confidence interval, CI). Across all constant M models , the median S/S_0 was 0.09 and the range of lower and upper 95% CIs was 0.06–0.12. The base model estimated $F/F_{0.4S0}$ in 2023 to be 1.5 (1.3–1.6 95% CI) (Figure 6). Across all models with constant M, the median $F/F_{0.4S0}$ was 1.5 and the 95% CIs from 0.7–12.8. Excluding an outlying scenario with low productivity, the median $F/F_{0.4S0}$ was 1.5 and the 95% CIs were 0.7–2.4. Models with increasing M starting in 2010 estimated that M was too high by 2023 to sustain the population, even without catch.

Dead catch included Dogfish both landed and assumed to die after being discarded. Applying the low, base, and high discard mortality rates to average reported catch (landed plus discarded) over the last five years resulted in dead catch estimates of 160 t, 315 t, and 423 t per year (dashed lines Figure 8). Projections from 2024 to 2028 with constant catch levels carried forward the average dead catch ratios among the fleets calculated over the last five years. These projections illustrate the probability of spawning output exceeding the LRP (Figure 7) and fishing mortality remaining below the candidate Removal Reference (Figure 8) over five years.

Even with zero catch, all models estimated a very high likelihood (≥ 0.95 probability) that the stock would remain below the LRP from 2024–2028 (Figure 7). The probability that $F < F_{0.4S0}$ varied by model (Figure 8). Assumptions about stock-recruit productivity and discard mortality most affected the probability of $F < F_{0.4S0}$ (Figure 8). The maximum dead catch that maintained a ≥ 95% probability of $F < F_{0.4S0}$ ranged from 0 t in the low productivity scenario to 250 t in the high productivity scenario (Figure 8). In the base scenario, the maximum dead catch for a ≥ 95% probability of $F < F_{0.4S0}$ was 150 t (Figure 8). These values also apply to a ≥ 75% probability threshold due to the steep transition in probability within any one assessment model (Figure 8).

Projections illustrate the recovery timeline for each model, with various fixed dead catch levels (Figure 7, Figure 8). Under the assumption of a closed population, constant environmental conditions, constant biological parameter values, and near zero catch, most models predict recovery above the LRP within 50–150 years only with dead catch estimates between 0 and 100 t with the exception of the most optimistic model (high productivity) (Figure 9, Figure 10).

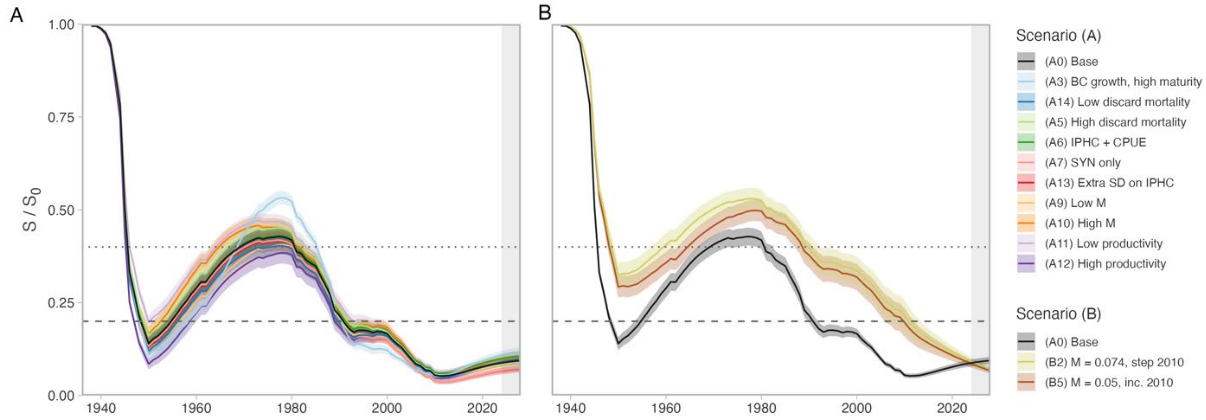


Figure 5. Depletion (spawning output over unfished spawning output; S/S_0) over time across models. Panel A illustrates scenarios without increases in natural mortality (M). Panel B illustrates scenarios with step or linear increases in M starting in 2010. Lines represent means and ribbons represent 95% confidence intervals. The dotted line indicates 0.4 S/S_0 (a candidate USR) and the dashed line indicates 0.2 S/S_0 (the LRP). The grey shaded rectangle at the right represents a 5-year projection (2024–2028) at $F_{0.4S0}$ (fishing mortality that would be expected to achieve $0.4S_0$ over the long term) calculated based on conditions prior to any changes in M in panel B.

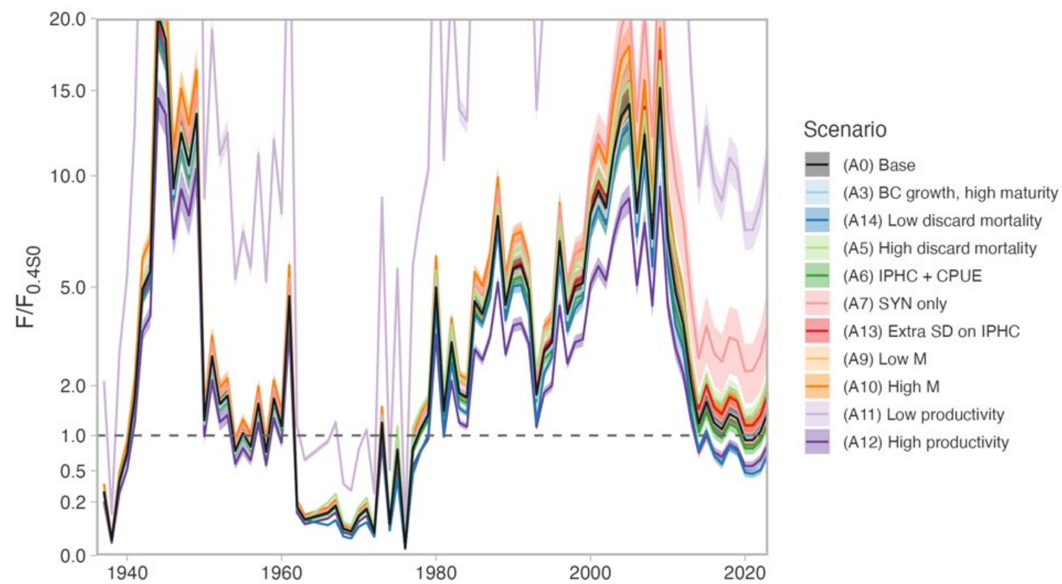


Figure 6. Fishing mortality divided by fishing mortality at $F_{0.4S0}$ (the fishing mortality that would be expected to achieve 0.4 unfished spawning output over the long term) across models. Lines represent means and ribbons represent 95% confidence intervals. $F_{0.4S0}$ is a candidate removal reference rate. A value of 1 (dashed line) represents values at this candidate removal reference rate. Scenarios with increases in M are not shown in this figure since the models predict the population would be unable to sustain itself in the long-term if those changes to M persisted.

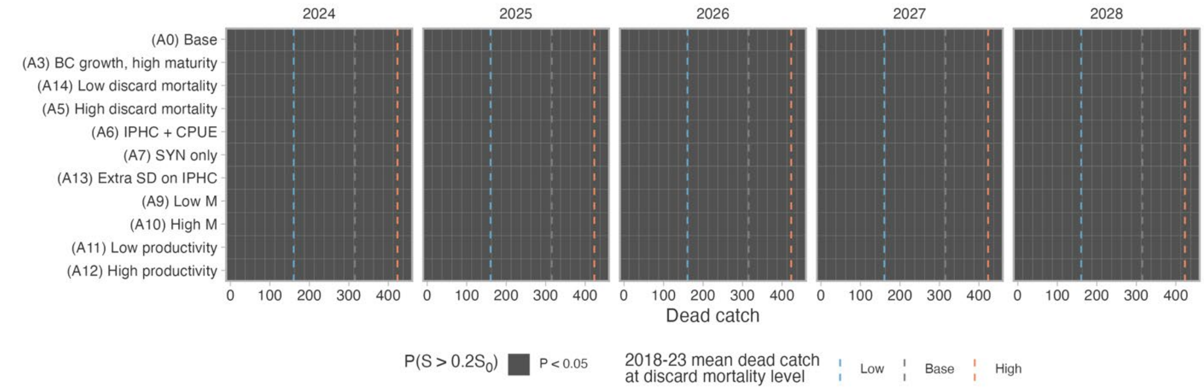


Figure 7. Illustration of probability that S > $0.2S_0$ across models and dead catch levels (25 t increments). The dashed vertical lines indicate average total dead catch over the last five years calculated using low, base, and high discard mortality rates. All models and all catch levels result in a very low likelihood (P < 0.05) that S > $0.2S_0$ in 2024–2028. A visualization of the probability that S > $0.4S_0$ (the candidate Upper Stock Reference Point above which the stock is considered in the Healthy Zone) looks identical and so is not shown.

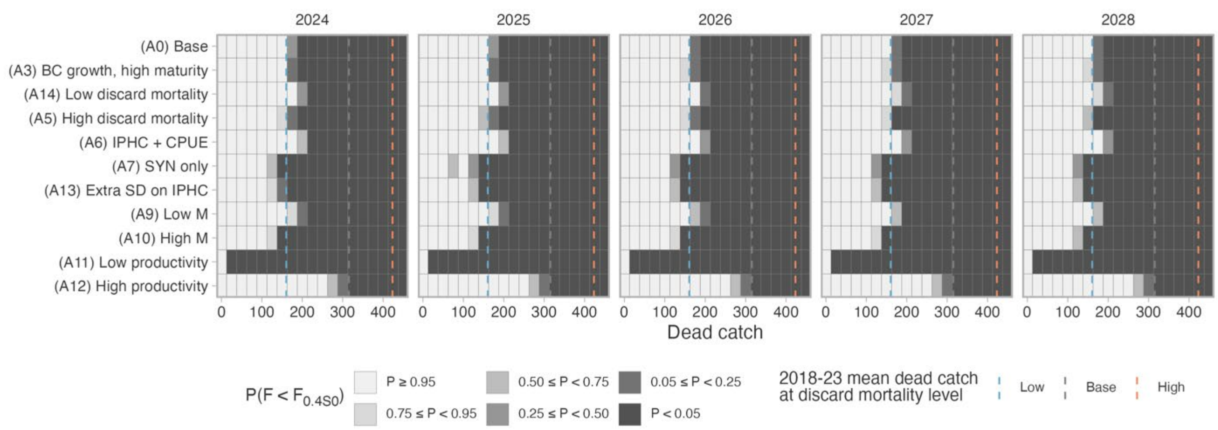


Figure 8. Illustration of probability that F < $F_{0.4S0}$, where $F_{0.4S0}$ is a candidate removal reference rate, across models and catch levels (25 t increments). The dashed vertical lines indicate average total dead catch over the last five years calculated using low, base, and high discard mortality rates.

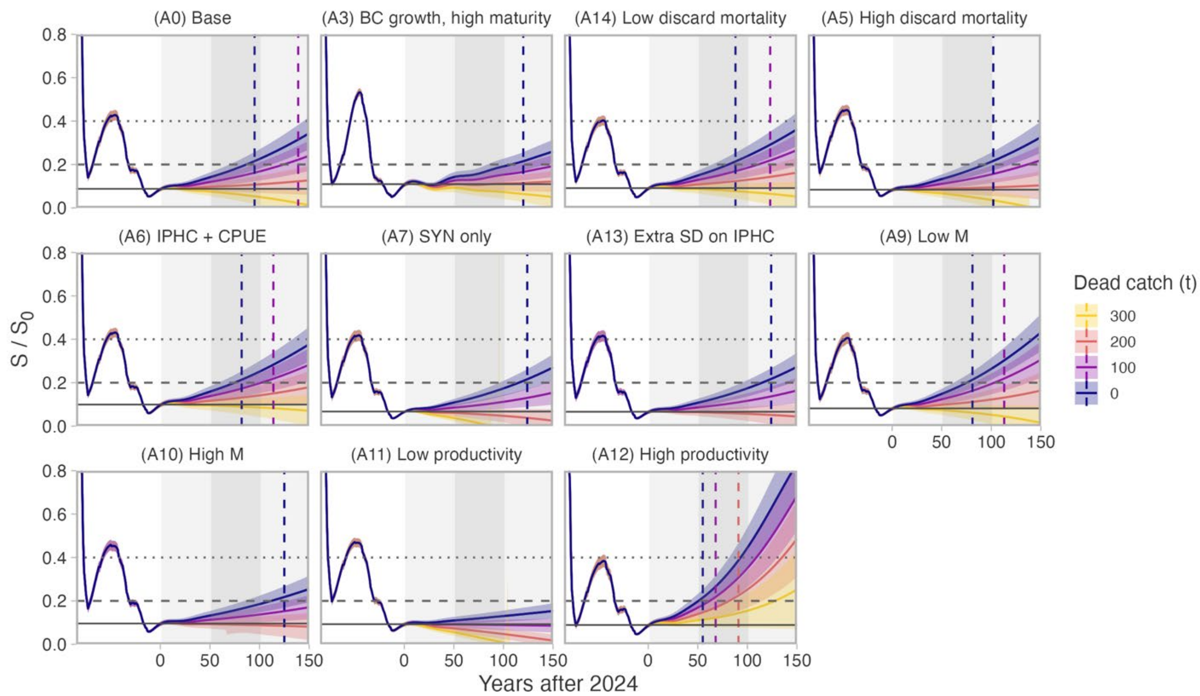


Figure 9. Timeline to build the stock above 0.2 S/S_0 at fixed catch levels conditional on the various models. Solid lines represent means and shaded ribbons represent 95% confidence intervals. Horizontal dashed and dotted lines indicate the LRP and a candidate USR. Horizontal solid lines represent S/S_0 in 2024 to facilitate evaluating which catch levels correspond to long term growth in spawning output. Vertical dashed lines indicate the year there is a ≥ 0.75 probability that $S > 0.2\ S_0$. Vertical shaded blocks represent 50-year intervals (approximately one generation). These projections assume a closed population and stationary environmental conditions.

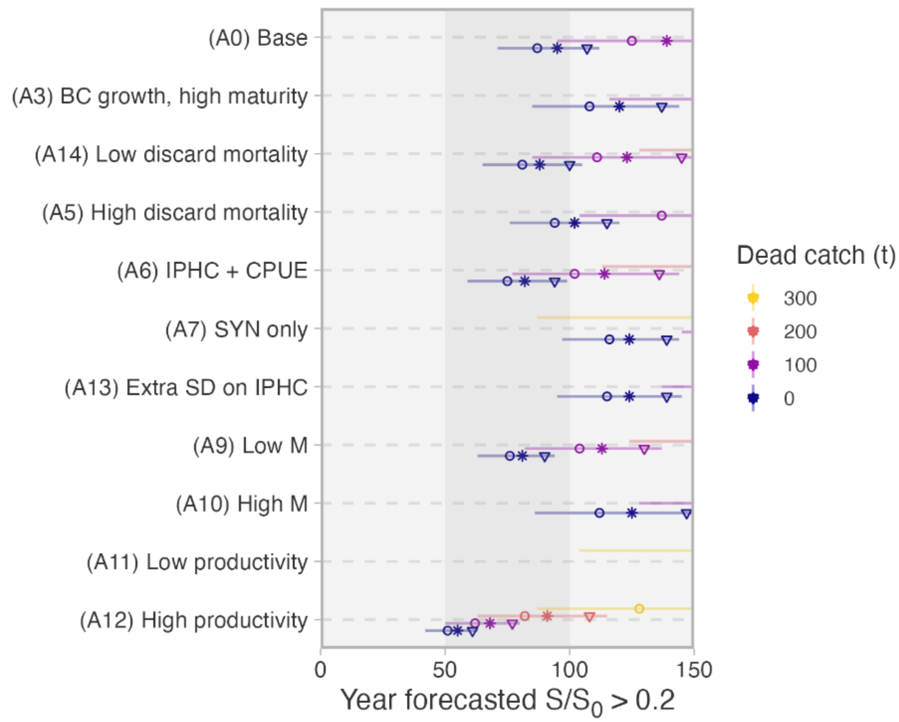


Figure 10. Timeline to build the stock above 0.2 S/S_0 at fixed catch levels conditional on the various models. Open circles represent the year the mean estimated $S > 0.2\ S_0$. Line segments represent the years the upper and lower 95% confidence intervals cross 0.2 S/S_0. The asterisks and triangles on the right side of the line segments indicate the year that there is ≥ 0.75 and ≥ 0.95 probability that the stock is above 0.2 S_0, respectively. Vertical shaded blocks represent 50-year intervals (approximately one generation). Several model and dead-catch combinations result in values that exceed the right side of the figure. These projections assume a closed population and stationary environmental conditions.

Ecosystem Considerations and Climate Change

Environmental effects were not explicitly included, although time-varying M scenarios were considered. These scenarios could arise from changes in predation or ecosystem shifts. Analyses of commercial trawl CPUE, as well as comparisons between survey indices conducted at different depths, suggested that outside Dogfish declines may be steeper in shallower waters. However, attributing population or demography changes to environmental conditions is challenging for long-lived species like Dogfish, which experience conditions over several decades (Taylor and Gallucci 2009).

Other analyses in the literature have explored environmental drivers of Dogfish population and distribution change. A recent analysis of BC groundfish species found some correlation between Dogfish distribution and local bottom temperature changes (English et al. 2021). In US West Coast waters, Taylor and Gallucci (2009), observed demographic changes in Dogfish, though the majority occurred before recent temperature shifts. Survey indices in the Gulf of Alaska and US West Coast waters have also declined on average over the past two decades, suggesting possible shared drivers for population dynamics.

Sources of Uncertainty

Structural and parameter uncertainty that could not be included within a single model was captured through fitting several alternative assessment models. Estimates of S/S_0 over time were relatively insensitive to a wide range of model assumptions. Estimates of $F/F_{0.4S0}$, on the other hand, were more sensitive to model assumptions. The ratio $F/F_{0.4S0}$ was most sensitive to which population indices were included, assumptions about discard mortality rates, and assumptions about productivity in the stock-recruit relationship.

This assessment encountered several challenges related to population dynamics modelling of outside Dogfish. These challenges included a lack of survey or other index data over the historical period when the bulk of Dogfish fishing occurred, differing rates of decline in three major survey indices, the inability to fit steep rates of declines in two indices without an external factor such as changes to M, the inability to estimate stock-recruit parameters defining density dependence, length composition data that were weakly or uninformative about depletion, a lack of age composition data, and uncertainties around discard mortality.

Future Research

Current streams of data, although important, are unlikely to notably improve our understanding of outside BC Dogfish population dynamics in the near future. Additional streams of data such as diet data from potential predators, age composition data, close-kin mark-recapture methods, and collaboration with nearby regions (US West Coast and Gulf of Alaska) may provide improvements to outside BC Dogfish population modelling.

The Groundfish IFMP applies a 6% discard mortality for longline gear and 5% mortality for the first two hours of a trawl tow and an additional 5% mortality for each subsequent hour. These values are low relative to the literature and therefore this document considers discard mortality rates from the literature under low, base, and high assumptions: 8–36% for longline, 5–15% for hook and line, 27–86% for gillnet, and 19–56% for trawl. Future work could consider the effectiveness of Groundfish IFMP discard mortality values in achieving fisheries management objectives.

CONCLUSIONS AND ADVICE

Despite these sources of uncertainty, and regardless of the cause of the observed declines, the limited productivity of Dogfish, the estimated population size, and steep declines in two of the three survey-based population indices over the last two decades suggest the current total allowable catch of 12,000 t should be reduced to increase the spawning output and achieve a high probability of $F < F_{0.4S0}$.

It is recommended this assessment be revisited within approximately five years. The stock is estimated to be below its LRP with very high likelihood (in the Critical Zone) and two population indices show steeper declines over the last one to two decades than population models could explain. Since 2021, two survey-based population indices show slight increases, and there was a minor increase in the frequency of small Dogfish sampled in the Synoptic trawl survey, possibly indicating a recruitment pulse. However, due to the life-history characteristics of Dogfish, no major changes to the population trajectory are expected within five years. In the interim, the stock can be monitored for deviations from this expectation through the scientific surveys used in this stock assessment and presented in the groundfish synopsis report (Anderson et al. 2019, 2020, 2024a, 2024b, DFO 2022).

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SOURCES OF INFORMATION

Anderson, A.C. 1878. Report of the Inspector of Fisheries for British Columbia for the year 1877. *In*: Tenth Annual Report of the Minister of Marine and Fisheries for the Year, 1877, Supplement No. 5. Department of Marine and Fisheries, Ottawa. pp. 287–309.

Anderson, S.C., Dunic, J.C., Keppel, E.A., and Edwards, A.M. 2024a. A data synopsis for British Columbia groundfish: 2022 data update. Can. Tech. Rep. Fish. Aquat. Sci. 3624: viii + 267 p

Anderson, S.C., Dunic, J.C., Keppel, E.A., and Edwards, A.M. 2024b. A data synopsis for British Columbia groundfish: 2023 data update. Can. Tech. Rep. Fish. Aquat. Sci. 3641: viii + 262 p.

Anderson, S.C., Keppel, E.A., Edwards, A.M. 2019. A reproducible data synopsis for over 100 species of British Columbia groundfish. DFO. Can. Sci. Advis. Sec. Res. Doc. 2019/041. vii + 321 p.

Anderson, S.C., Keppel, E.A., and Edwards, A.M. 2020. Reproducible Visualization of Raw Fisheries Data for 113 Species Improves Transparency, Assessment Efficiency, and Monitoring. Fisheries. 45(10): 535–543.

COSEWIC. 2011. COSEWIC assessment and status report on the North Pacific Spiny Dogfish *Squalus suckleyi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 45 pp.

DFO. 2009. A fishery decision-making framework incorporating the precautionary approach.

DFO. 2010. Assessment of Spiny Dogfish (*Squalus acanthias*) in British Columbia in 2010. DFO. Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/057.

DFO. 2012. Proceedings of the Pacific Region Science Advisory Process for spiny dogfish (*Squalus acanthius*) in British Columbia, Canada, May 17, 2010. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/071.

DFO. 2022. A data synopsis for British Columbia groundfsh: 2021 data update. DFO Can. Sci. Advis. Sec. Sci. Resp. 2022/020.

English, P.A., Ward, E.J., Rooper, C.N., Forrest, R.E., Rogers, L.A., Hunter, K.L., Edwards, A.M., Connors, B.M., and Anderson, S.C. 2021. Contrasting climate velocity impacts in warm and cool locations show that effects of marine warming are worse in already warmer temperate waters. Fish Fish. 23(1): 239–255.

Fisheries and Oceans Canada. 2024. Groundfish Integrated Fisheries Management Plan 2024/25.

Galluci, V., Taylor, I., King, J., McFarlane, G.A., and McPhie, R. 2011. Spiny Dogfish (*Squalus acanthias*) Assessment and Catch Recommendations for 2010. DFO. Can. Sci. Advis. Sec. Res. Doc. 2011/034. xii + 69 p.

Gertseva, V., Taylor, I.G., Wallace, J., and Matson, S.E. 2021. Status of the Pacific Spiny Dogfish shark resource off the continental U.S. Pacific Coast in 202. Pacific Fishery Management Council, Portland, OR.

Ketchen, K.S. 1972. Size at maturity, fecundity, and embryonic growth of the spiny dogfish (*Squalus acanthia*) in British Columbia waters. J. Fish. Res. Bd. Can. 29: 1717–1723.

Ketchen, K.S. 1986. The spiny dogfish (*Squalus acanthias*) in the northeast Pacific and a history of its utilization. Dept. of Fisheries and Oceans, Ottawa.

McFarlane, G.A., and King, J.R. 2003. Migration patterns of spiny dogfish (*Squalus acanthias*) in the North Pacific Ocean. Fish. Bull. 101: 358–367.

McFarlane, G.A., and King, J.R. 2009. Re-evaluating the age determination of Spiny Dogfish using oxytetracycline and fish at liberty up to 20 years. *In*: Biology and Management of Dogfish Sharks. Gallucci, V.F., G.A. McFarlane, and G.G. Bargman. (Eds.) Am. Fish. Soc. 153–160.

Methot, R.D., and Wetzel, C.R. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. Fish. Res. 142: 86–99.

Rice, J., Harley, S., Maunder, M., and Da-Silva, A.A. 2013. Stock assessment of blue sharks in the north Pacific Ocean using Stock Synthesis. Western and Central Pacific Fisheries Commission.

Taylor, I.G., and Gallucci, V.F. 2009. Unconfounding the effects of climate and density dependence using 60 years of data on spiny dogfish (*Squalus acanthias*). Can. J. Fish. Aquat. Sci. 66(3): 351–366.

Taylor, I.G., Gertseva, V., Methot, R.D., and Maunder, M.N. 2013. A stock–recruitment relationship based on pre-recruit survival, illustrated with application to spiny dogfish shark. Fish. Res. 142: 15–21.

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