Pacific Herring preliminary data summary for Prince Rupert District 2020

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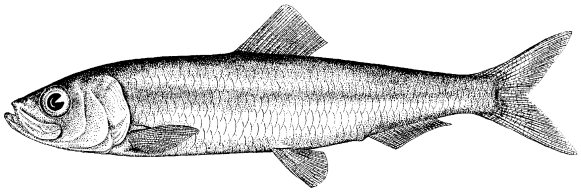
July 28, 2020



Pacific Herring (*Clupea pallasii*). Image credit: Fisheries and Oceans Canada.

Disclaimer This report contains preliminary data collected for Pacific Herring in 2020 in the Prince Rupert District major stock assessment regions (SAR). These data may differ from data used and presented in the final stock assessment.

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1 COVID-19 pandemic

The COVID-19 pandemic impacted our ability to collect and analyse Pacific Herring data throughout British Columbia in 2020. The pandemic and associated provincial response changed rapidly during the Pacific Herring field program season. Despite these challenges, surveyors assessed all major observed spawns in the 5 major stock assessment regions (SARs). However, these changes impacted our ability to assess spawn in SARs with later spawns more than SARs with earlier spawns. For example, spawns were surveyed by surface surveys instead of underwater dive surveys in Prince Rupert District and Haida Gwaii.

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Although Pacific Herring biological samples were collected as usual, the pandemic delayed the analysis of biological data for all SARs. This delay is most notable for age data which are analysed at the sclerochronology lab at the Pacific Biological Station. This lab closed on March 16th, and resumed limited ageing analysis on July 6th. This resulted in delayed Pacific Herring ages for 2020, and many other species. To address this backlog efficiently, senior science staff and fisheries managers at DFO are prioritizing species to analyse in the sclerochronology lab. Unfortunately, it may not be possible to analyse all the Pacific Herring age data in time for stock assessments this year. Note that although age data are not required for Pacific Herring stock assessments, they are an important component.

Due to the delay in the analysis of biological data, some tables and figures showing biological data have been omitted from this version of the report. Other tables and figures are included, but they do not have biological data for 2020. We will update data summary reports with 2020 biological data when available. We appreciate your patience and understanding as we continue to work from home in these uncertain and changing times.

2 Context

Pacific Herring (*Clupea pallasii*) in British Columbia are assessed as 5 major and 2 minor stock assessment regions (SARs), and data are collected and summarized on this scale (Table 1, Figure 1). The Pacific Herring data collection program includes fishery-dependent and -independent data from 1951 to 2020. This includes annual time series of commercial catch data, biological samples (providing information on proportion-at-age and weight-at-age), and spawn index data conducted using a combination of surface and SCUBA surveys. In some areas, industry- and/or First Nations-operated in-season soundings programs are also conducted, and this information is used by resource managers, First Nations, and stakeholders to locate fish and identify areas of high and low Pacific Herring biomass to plan harvesting activities. In-season acoustic soundings are not used by stock assessment to inform the estimation of spawning biomass.

The following is a description of data collected for Pacific Herring in 2020 in the Prince Rupert District major SAR (Figure 2). Data collected outside the SAR boundary are not included in this summary, and are not used for the purposes of stock assessment. Although we summarise data at the scale of the SAR for stock assessments, we summarise data at finer spatial scales in this report: Locations are nested within Sections, Sections are nested within Statistical Areas, and Statistical Areas are nested within SARs (Table 2). Note that we refer to 'year' instead of 'herring season' in this report; therefore 2020 refers to the 2019/2020 Pacific Herring season.

3 Data collection programs

In 2020, biological samples were collected by two seine test vessels:

- The "Nita Maria" collected samples in Big Bay for 18 days from March 15th to

April 1st, and

- The "Viking Leader" collected samples in Kitkatla for 18 days from March 16th to April 2nd.

The primary purpose of the test charter vessels was to collect biological samples from main bodies of herring from Big Bay and Kitkatla, identified from soundings. Herring spawn locations were primarily identified using drones, operated from both the "Nita Maria" and the "Viking Leader". Due to COVID-19, the dive charter vessel "Royal Pride" was repurposed as a surface survey charter, successfully conducting surface surveys for a 17 day charter from March 27th to April 12th, surveying spawn throughout the stock area. All three charter vessels were funded by DFO, through a contract to the Herring Conservation Research Society.

4 Catch and biological samples

In the 1950s and 1960s, the reduction fishery dominated Pacific Herring catch; starting in the 1970s, catch has been predominantly from roe seine and gillnet fisheries. The reduction fishery is different from current fisheries in several ways. First, the reduction fishery caught Pacific Herring of all ages, whereas current fisheries target spawning (i.e., mature) fish. Thus, reduction fisheries included age-1 fish which are not typically caught in current fisheries. Second, the reduction fishery has some uncertainty regarding the quantity and location of catch; in some cases this may affect our ability to allocate catch to a specific SAR. For the roe gillnet fishery, all Pacific Herring catch has been validated by a dockside monitoring program since 1998; the catch validation program started in 1999 for the roe seine fishery. Finally, the reduction fishery operated during the winter months, whereas roe fisheries typically target spawning fish between February and April.

Landed commercial catch of Pacific Herring by year and fishery is shown in Table 3 and Figure 3. In addition to annual catch variability, catch varies among Statistical Areas (Figure 4). Total harvested spawn on kelp (SOK) in 2020 in the Prince Rupert District major SAR is shown in Table 4; we also calculate the estimated spawning biomass associated with SOK harvest. See the draft spawn index techincal report for calculations to convert SOK harvest to spawning biomass.

Included herein are biological summaries of observed proportion-, number-, weight-, and length-at-age (Figure 5, Table 7, and Figure 6, respectively). We also show the percent change in weight and length for age-3 and age-6 fish (Figure 7 & Figure 8, respectively). Biological summaries only include samples collected using seine nets (commercial and test) due to size-selectivity of other gear types such as gillnet. Only representative biological samples are included, where 'representative' indicates whether the Pacific Herring sample in the set accurately reflects the larger Pacific Herring school.

5 Spawn survey data

Pacific Herring spawn surveys were conducted at 28 individual locations in 2020 in the Prince Rupert District major SAR (Table 8, and Figure 9). A summary of spawn

from the last decade (2010 to 2019) is shown in Figure 10. Figure 11 shows spawn start date by decade and Statistical Area. Spawn surveys are conducted to estimate the spawn length, width, number of egg layers, and substrate type, and these data are used to estimate the index of spawning biomass (i.e., the spawn index; Figure 12, Figure 13, Figure 14, Figure 15, Table 9, and Figure 16). See the draft spawn index techincal report for calculations to convert SOK harvest to spawning biomass. The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Therefore, these data do not represent model estimates of spawning biomass, and are considered the minimum observed spawning biomass derived from egg counts. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020).

Some Pacific Herring Sections contribute more than others to the total spawn index, and the percentage contributed by Section varies yearly (Figure 15b, Figure 17). For example, in 2020, Section 042 contributed the most to the spawn index (52%). As with Sections, some Statistical Areas contribute more than others to the total spawn index (Figure 15c, Figure 18). An animation shows the spawn index by spawn survey location from 1951 to 2020 (Figure 19).

6 General observations

General observations provide context to the data summary report. The following observations were reported by area DFO Resource Management staff, and DFO Science staff:

- Because of COVID-19 concerns, dive surveys were replaced by surface surveys, and the two seine charters were extended by five days each.
- The extended seine charter allowed for coverage of Hunts Inlet.
- A drone was used to map spawns, which was effective at measuring spawn length and saved costs for flights.
- All major observed spawns were surveyed this year.
- Surface surveys are thought to be effective in the Big Bay area where most of the spawn is intertidal, but may be less effective in Kitkatla where the bathymetry is steeper.
- The seine charter was used to sound and take samples, as well as track spawns. Herring were shallower than usual which facilitated sampling.
- In Kitkatla, soundings estimated a similar abundance of fish as last year.
- Earlier spawn began inside Kitatkla Inlet around Dries Inlet and Camp Creek, with the later spawn concentrated on the outside of the Inlet.
- Spawn was significant and continuous outside of Kitkatla Inlet, from Oval Bay south past Joachin Point.

- Substantial spot spawns were observed in Willis Bay.
- Small fish were observed in test samples throughout the Big Bay area; usually small fish are observed in the northern portion of the sampling area.
- In Big Bay, spawn was more intense and prolonged compared to the last two years which generally had spotty, shorter duration spawns.
- Good spawn was observed from Tree Bluff south to Duncan Bay.
- Sea surface temperature was lower than last year, between 5 and 6°C.
- Again this year, there was an increase in observed sea lions and whales, though not as many Humpback Whales were observed as in recent years.

7 Tables

Table 1. Pacific Herring stock assessment regions (SARs) in British Columbia.

Name	Code	Type
Haida Gwaii	HG	Major
Prince Rupert District	PRD	Major
Central Coast	CC	Major
Strait of Georgia	SoG	Major
West Coast of Vancouver Island	WCVI	Major
Area 27	A27	Minor
Area 2 West	A2W	Minor

Table 2. Statistical Areas and Sections for Pacific Herring in the Prince Rupert District major stock assessment region (SAR).

Region	Statistical Area	Section
Prince Rupert District	03	031
Prince Rupert District	03	032
Prince Rupert District	03	033
Prince Rupert District	04	040
Prince Rupert District	04	041
Prince Rupert District	04	042
Prince Rupert District	04	043
Prince Rupert District	04	049
Prince Rupert District	05	050
Prince Rupert District	05	051
Prince Rupert District	05	052
Prince Rupert District	05	053
Prince Rupert District	05	059

Table 3. Total landed commercial catch of Pacific Herring in metric tonnes (t) by gear type in 2020 in the Prince Rupert District major stock assessment region (SAR). Legend: 'Other' represents the reduction, the food and bait, as well as the special use fishery; 'RoeSN' represents the roe seine fishery; and 'RoeGN' represents the roe gillnet fishery. Data from the spawn-on-kelp (SOK) fishery are not included. Note: data may be withheld due to privacy concerns (WP).

Gear	Catch (t)
Other	0
RoeSN	0
RoeGN	0

Table 4. Total harvested Pacific Herring spawn on kelp (SOK) in pounds (lb), and the associated estimate of spawning biomass in metric tonnes (t) from 2010 to 2020 in the Prince Rupert District major stock assessment region (SAR). See the draft spawn index techincal report for calculations to convert SOK harvest to spawning biomass. Note: data may be withheld due to privacy concerns (WP).

Year	Harvest (lb)	Spawning biomass (t)
2010	108,834	162
2011	123,626	183
2012	87,494	130
2013	72,895	108
2014	113,269	168
2015	84,066	125
2016	WP	WP
2017	82,597	123
2018	20,832	31
2019	WP	WP
2020	0	0

Table 5. Number of Pacific Herring biological samples processed from 2010 to 2020 in the Prince Rupert District major stock assessment region (SAR). Each sample is approximately 100 fish. Note that biological sampling data from 2020 are not yet available for distribution; updated tables will be circulated in September.

	Number of samples		
Year	Commercial	Test	Total
2010	28	19	47
2011	38	18	56
2012	27	21	48
2013	31	13	44
2014	30	2	32
2015	45	11	56
2016	33	11	44
2017	40	11	51
2018	17	14	31
2019	2	13	15
2020	0	0	0

Table 6. Number and type of Pacific Herring biological samples processed in 2020 in the Prince Rupert District major stock assessment region (SAR). Each sample is approximately 100 fish. Note that biological sampling data from 2020 are not yet available for distribution; updated tables will be circulated in September.

Type	Gear	Use	Number of samples
NA	NA	NA	0

Table 7. Observed proportion-at-age for Pacific Herring from 2010 to 2020 in the Prince Rupert District major stock assessment region (SAR). The age-10 class is a 'plus group' which includes fish ages 10 and older. Note that biological sampling data from 2020 are not yet available for distribution; updated tables will be circulated in September.

	Proportion-at-age								
Year	2	3	4	5	6	7	8	9	10
2010	0.013	0.336	0.272	0.116	0.207	0.033	0.017	0.003	0.004
2011	0.005	0.361	0.310	0.155	0.061	0.086	0.014	0.006	0.002
2012	0.030	0.095	0.456	0.225	0.098	0.052	0.039	0.004	0.001
2013	0.007	0.418	0.176	0.218	0.118	0.032	0.022	0.009	0.000
2014	0.008	0.079	0.458	0.150	0.176	0.081	0.030	0.013	0.004
2015	0.047	0.531	0.067	0.191	0.060	0.067	0.025	0.009	0.003
2016	0.017	0.162	0.485	0.060	0.165	0.050	0.039	0.016	0.006
2017	0.014	0.151	0.179	0.438	0.063	0.099	0.029	0.020	0.007
2018	0.048	0.413	0.132	0.158	0.189	0.029	0.017	0.009	0.006
2019	0.014	0.527	0.249	0.069	0.081	0.048	0.008	0.005	0.000
2020	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 8. Pacific Herring spawn survey locations, start date, and spawn index in metric tonnes (t) in 2020 in the Prince Rupert District major stock assessment region (SAR). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values (NAs) indicate incomplete spawn surveys.

Statistical Area	Section	Location name	Start date	Spawn index (t)
03	033	Cunningham Pass	April 09	63
03	033	Flewin Pt	March 18	314
03	033	Port Simpson	April 09	147
03	033	Stumaun Bay	April 09	153
04	042	Belletti Pt	March 17	970
04	042	Big Bay	March 18	1,499
04	042	Burnt Cliff Is	March 17	2,213
04	042	Duncan Bay	March 23	1,125
04	042	Mist Is	March 17	194
04	042	Observation Pt	March 23	126
04	042	Pearl Hrbr	April 09	526
04	042	Swamp Is	March 20	3,350
04	042	Tree Bluff	March 18	3,419
04	043	Bass Rock	March 25	NA
04	043	Fan Island	March 25	NA
04	043	Hunt Inlt	March 26	43
04	043	Island Pt	March 26	541
05	051	Joachim Pt	March 27	1,136
05	052	Cape George	March 24	4,110
05	052	Dries Inlt	March 24	2,787
05	052	Freeman Pass	March 17	595
05	052	Goschen Is	March 24	180
05	052	Joachim Spit	March 27	1,514
05	052	Kitkatla Cr	March 24	636
05	052	Nubble Pt	March 24	76
05	052	Serpentine Inlt	April 02	4
05	052	Wilcox Grp	April 02	125
05	052	Willis Bay	March 24	1

Table 9. Summary of Pacific Herring spawn survey data from 2010 to 2020 in the Prince Rupert District major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Units: metres (m), and metric tonnes (t).

Year	Total length (m)	Mean width (m)	Mean number of egg layers	Spawn index (t)
2010	57,950	139	0.7	28,607
2011	52,925	118	0.8	21,097
2012	61,950	115	0.8	22,716
2013	46,500	97	1.0	25,755
2014	60,000	123	0.6	17,125
2015	59,825	105	0.7	17,407
2016	48,525	113	0.6	18,985
2017	45,675	174	0.7	19,235
2018	51,000	106	0.5	14,155
2019	87,125	110	0.6	27,190
2020	59,960	206	1.7	25,845

8 Figures

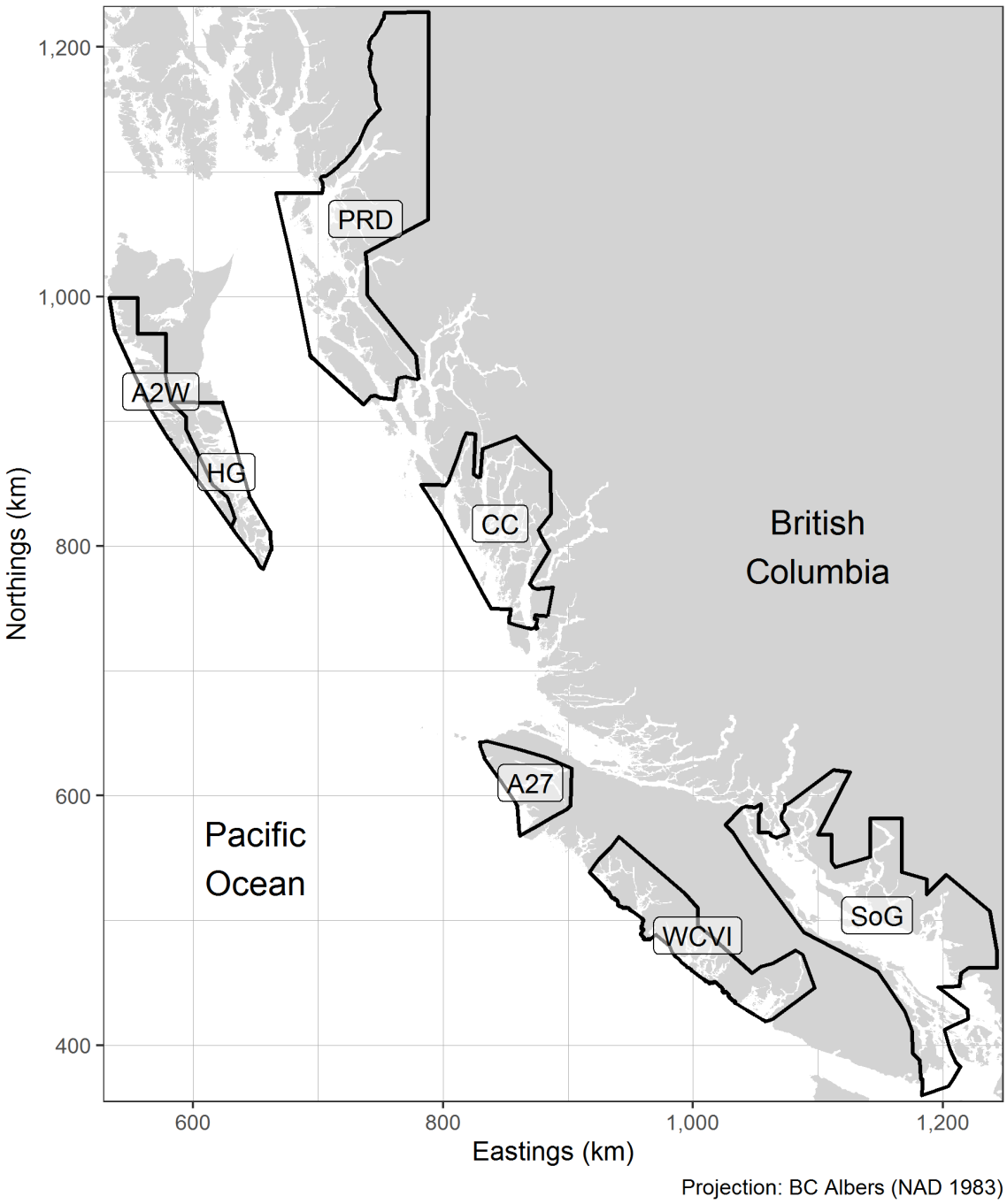

Figure 1. Boundaries for the Pacific Herring stock assessment regions (SARs) in British Columbia. There are 5 major SARs: Haida Gwaii (HG), Prince Rupert District (PRD), Central Coast (CC), Strait of Georgia (SoG), and West Coast of Vancouver Island (WCVI). There are 2 minor SARs: Area 27 (A27) and Area 2 West (A2W). Units: kilometres (km).

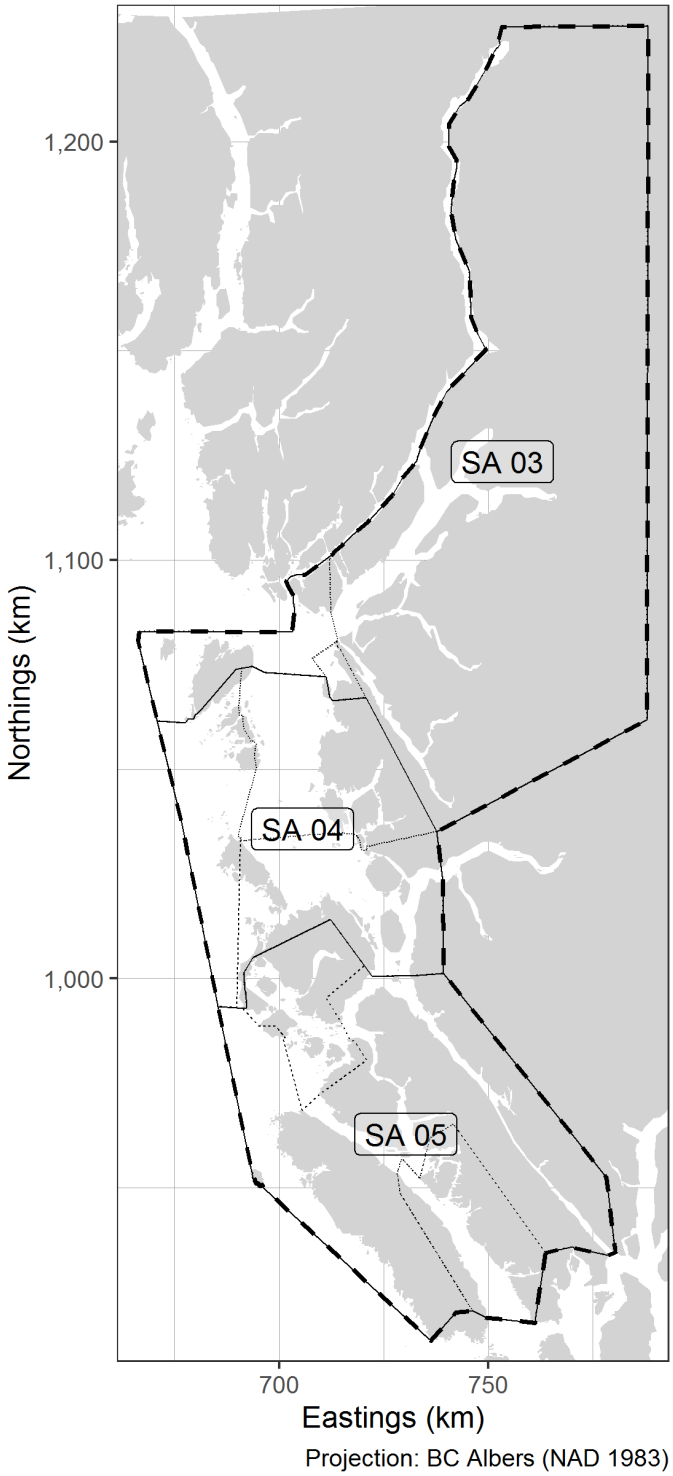

Figure 2. Boundaries for the Prince Rupert District major stock assessment region (SAR; thick dashed lines), associated Statistical Areas (SA; thin solid lines), and associated Sections (thin dotted lines). Units: kilometres (km).

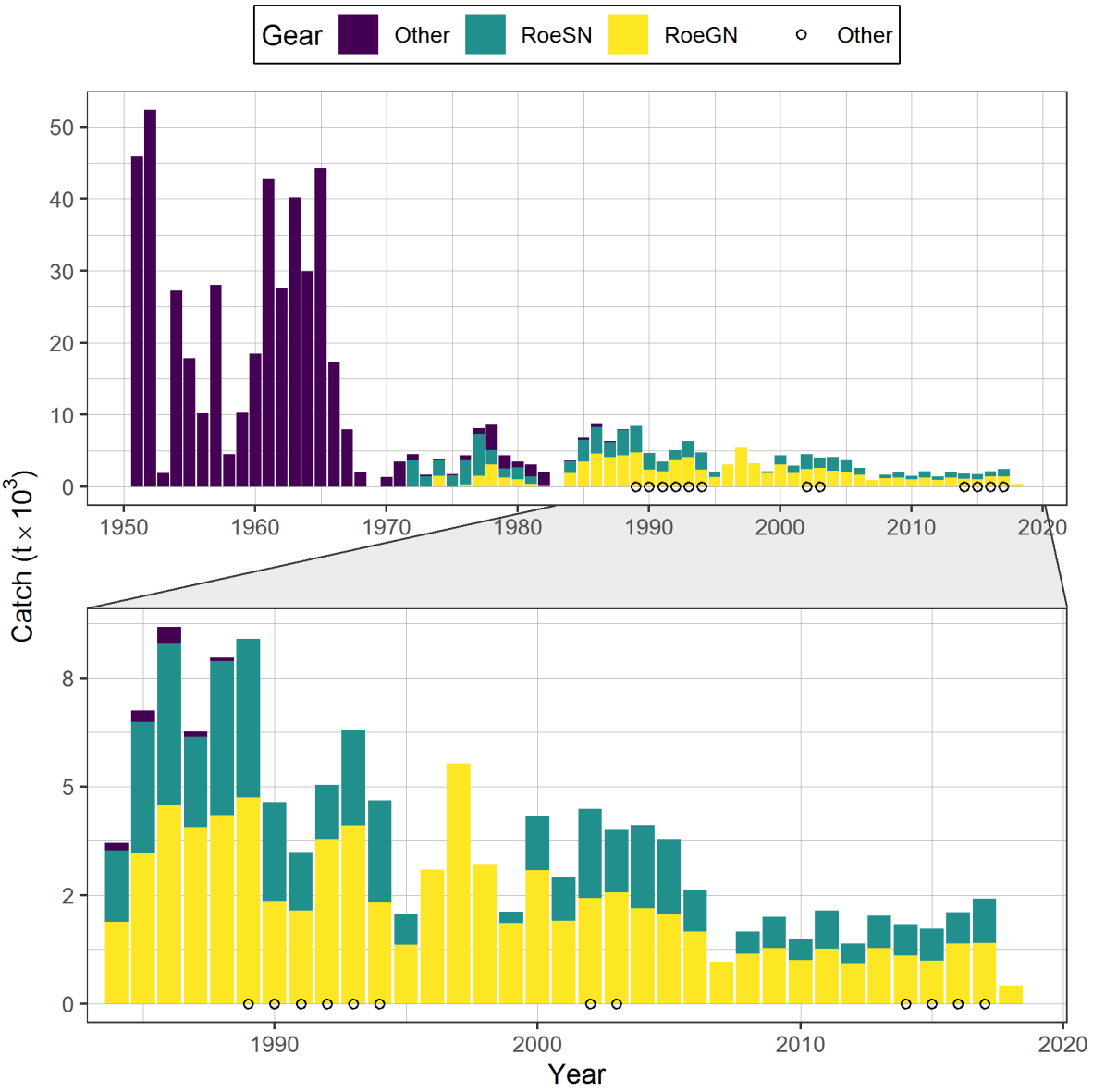

Figure 3. Time series of total landed catch in thousands of metric tonnes ($t \times 10^3$) of Pacific Herring by gear type from 1951 to 2020 in the Prince Rupert District major stock assessment region (SAR). Legend: 'Other' represents the reduction, the food and bait, as well as the special use fishery; 'RoeSN' represents the roe seine fishery; and 'RoeGN' represents the roe gillnet fishery. Data from the spawn-on-kelp (SOK) fishery are not included. Note: symbols indicate years in which catch by gear type (i.e., Other, RoeSN, RoeGN) is withheld due to privacy concerns.

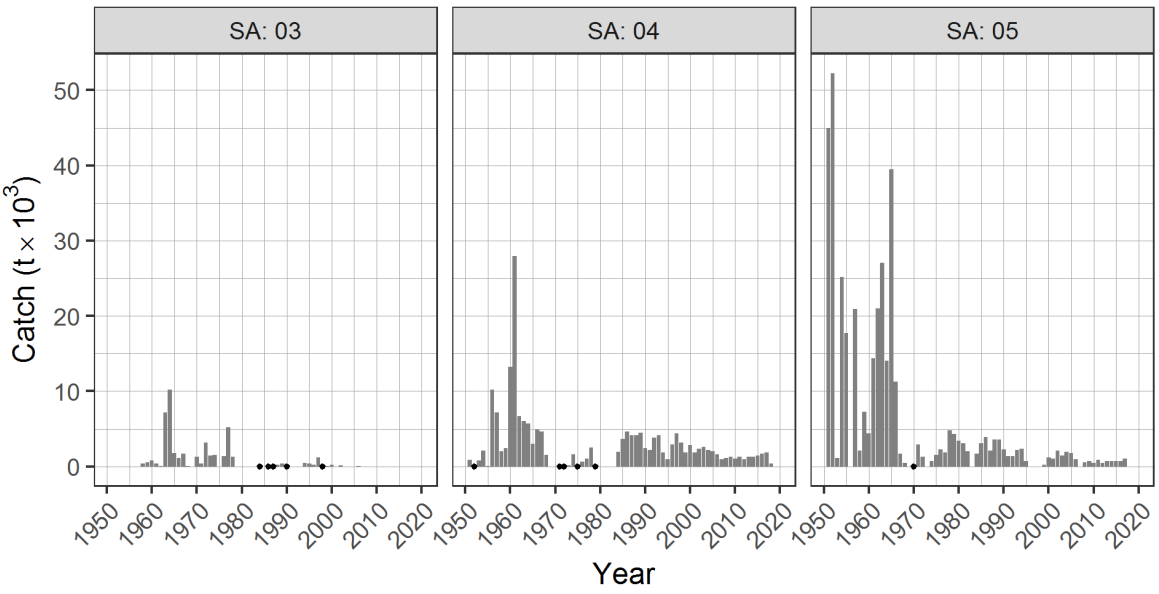

Figure 4. Time series of total landed catch in thousands of metric tonnes ($t \times 10^3$) of Pacific Herring by Statistical Area (SA) from 1951 to 2020 in the Prince Rupert District major stock assessment region (SAR). The year 2020 has a darker bar to facilitate interpretation. Note: symbols indicate years in which catch is withheld due to privacy concerns.

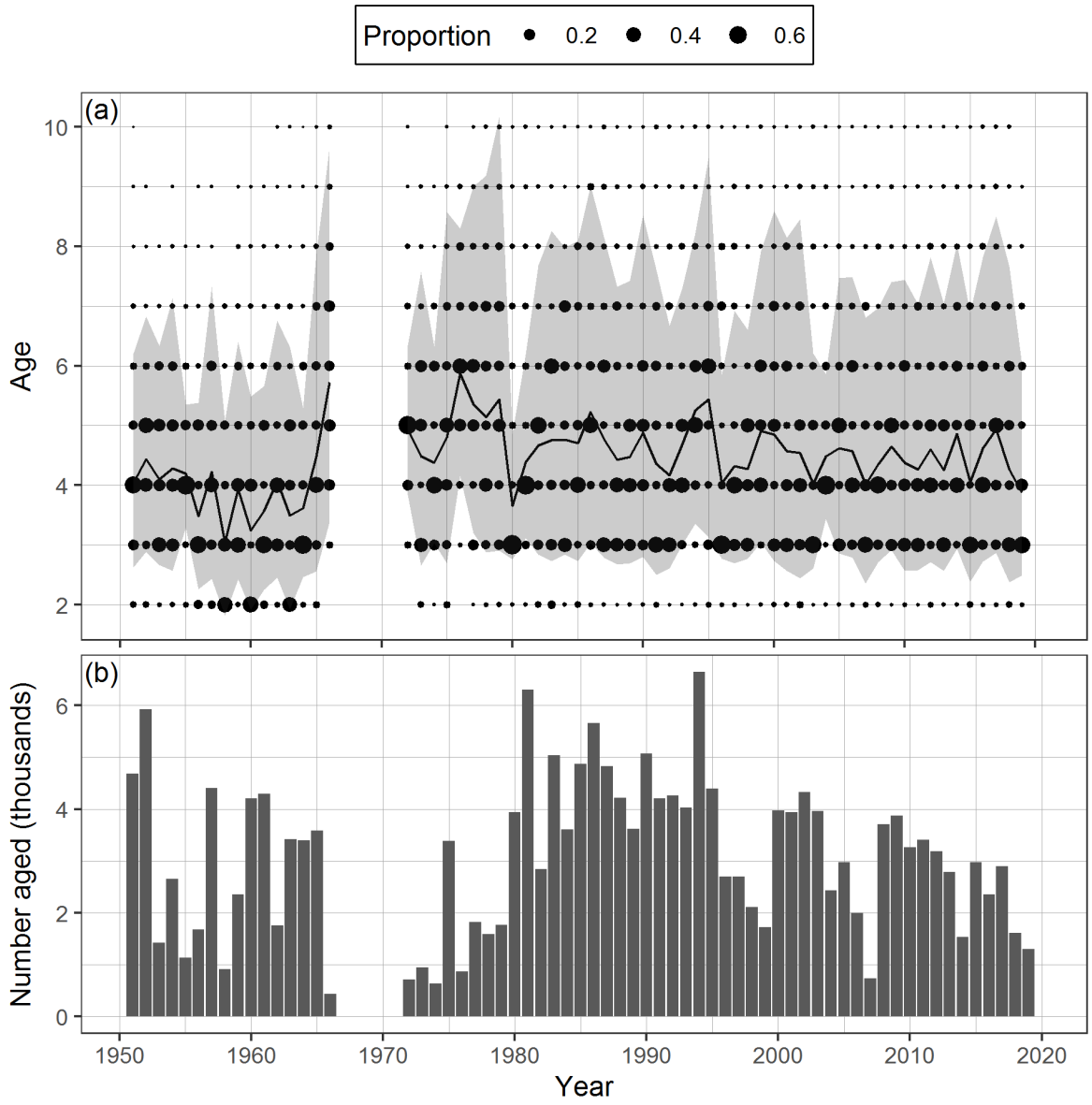

Figure 5. Time series of observed proportion-at-age (a) and number aged in thousands (c) of Pacific Herring from 1951 to 2020 in the Prince Rupert District major stock assessment region (SAR). The black line is the mean age, and the shaded area is the approximate 90% distribution. Biological summaries only include samples collected using seine nets (commercial and test) due to size-selectivity of other gear types such as gillnet. The age-10 class is a 'plus group' which includes fish ages 10 and older.

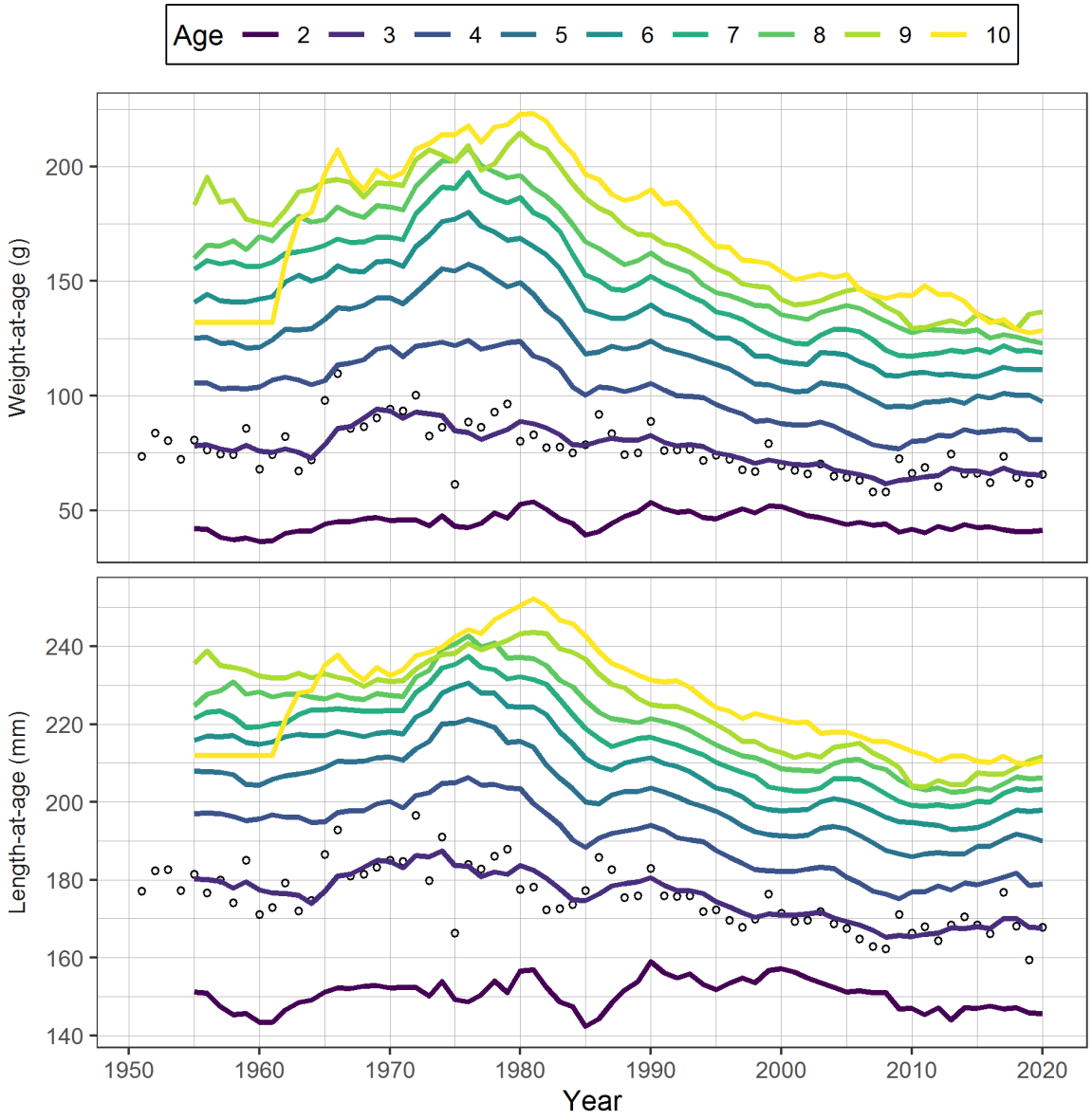

Figure 6. Time series of weight-at-age in grams (g) and length-at-age in milimetres (mm) for age-3 (circles) and 5-year running mean weight- and length-at-age (lines) for Pacific Herring from 1951 to 2020 in the Prince Rupert District major stock assessment region (SAR). Missing weight- and length-at-age values (i.e., years with no biological samples) are imputed using one of two methods: missing values at the beginning of the time series are imputed by extending the first non-missing value backwards; other missing values are imputed as the mean of the previous 5 years. Biological summaries only include samples collected using seine nets (commercial and test) due to size-selectivity of other gear types such as gillnet. The age-10 class is a 'plus group' which includes fish ages 10 and older.

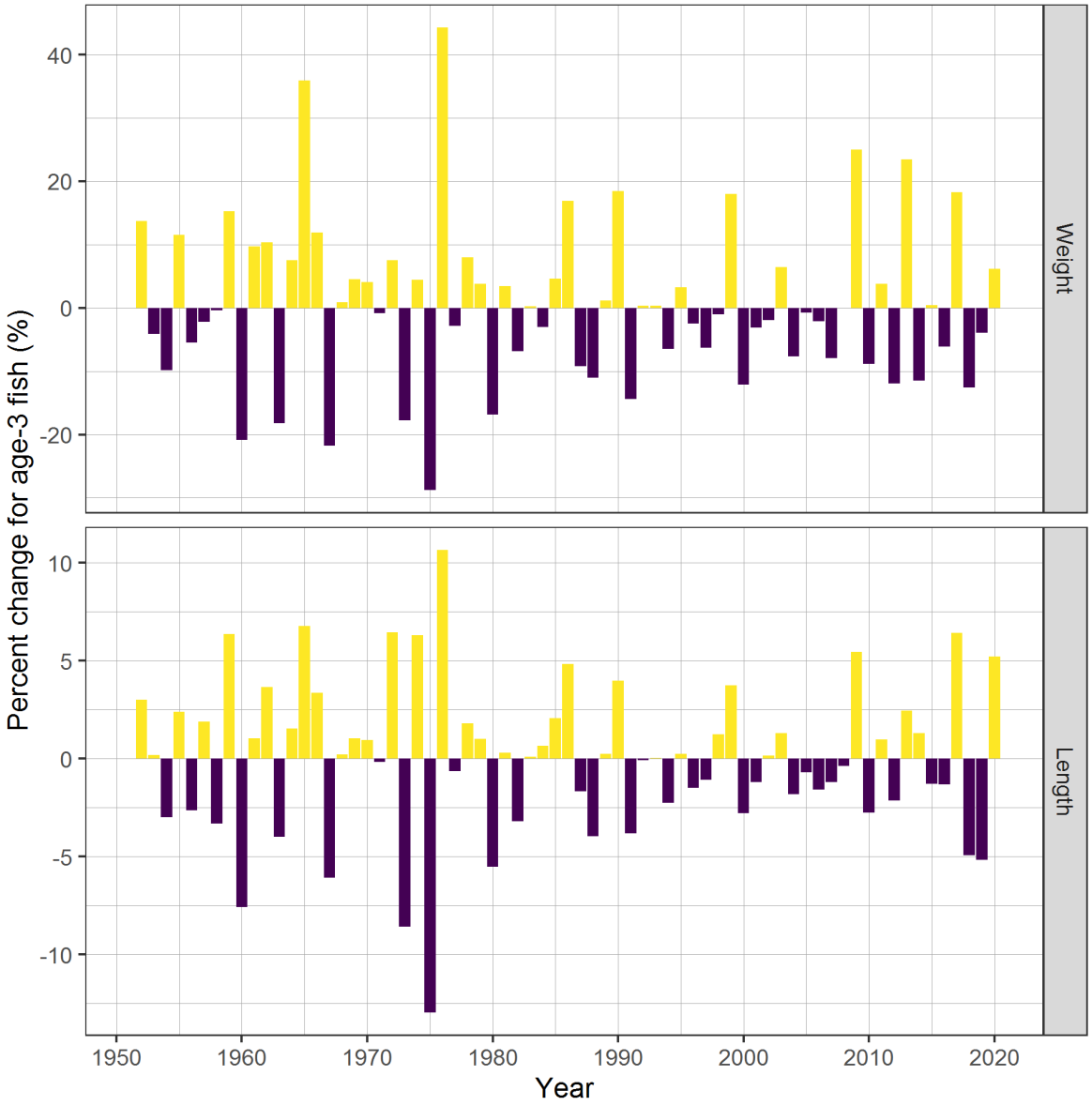

Figure 7. Time series of percent change (%) in weight and length for age-3 fish for Pacific Herring from 1951 to 2020 in the Prince Rupert District major stock assessment region (SAR). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the weight and length of age-3 fish, respectively, in year t. Biological summaries only include samples collected using seine nets (commercial and test) due to size-selectivity of other gear types such as gillnet.

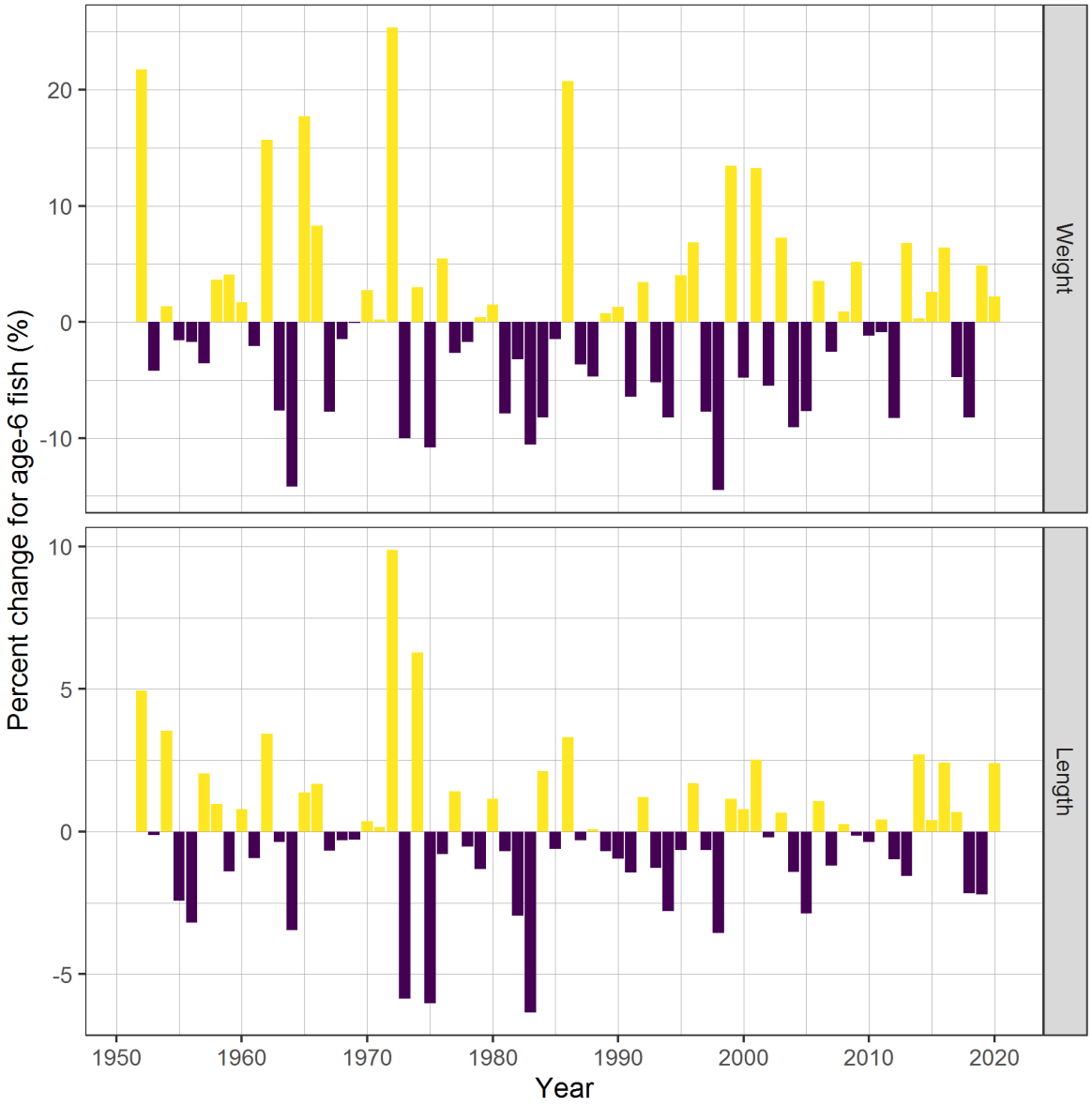

Figure 8. Time series of percent change (%) in weight and length for age-6 fish for Pacific Herring from 1951 to 2020 in the Prince Rupert District major stock assessment region (SAR). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the weight and length of age-6 fish, respectively, in year t. Biological summaries only include samples collected using seine nets (commercial and test) due to size-selectivity of other gear types such as gillnet.

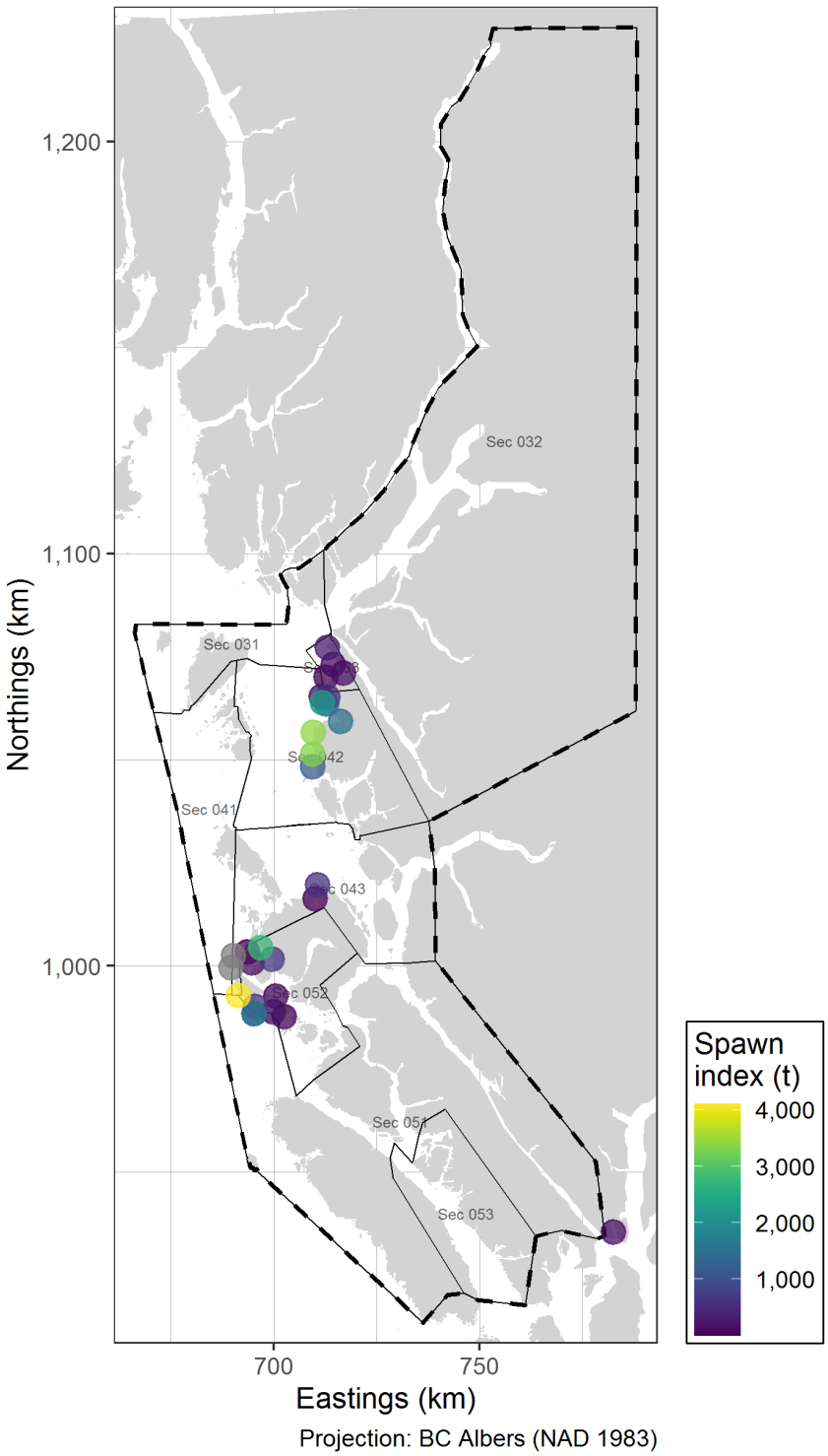

Figure 9. Pacific Herring spawn survey locations, and spawn index in metric tonnes (t) in 2020 in the Prince Rupert District major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values (grey circles) indicate incomplete spawn surveys. Units: kilometres (km).

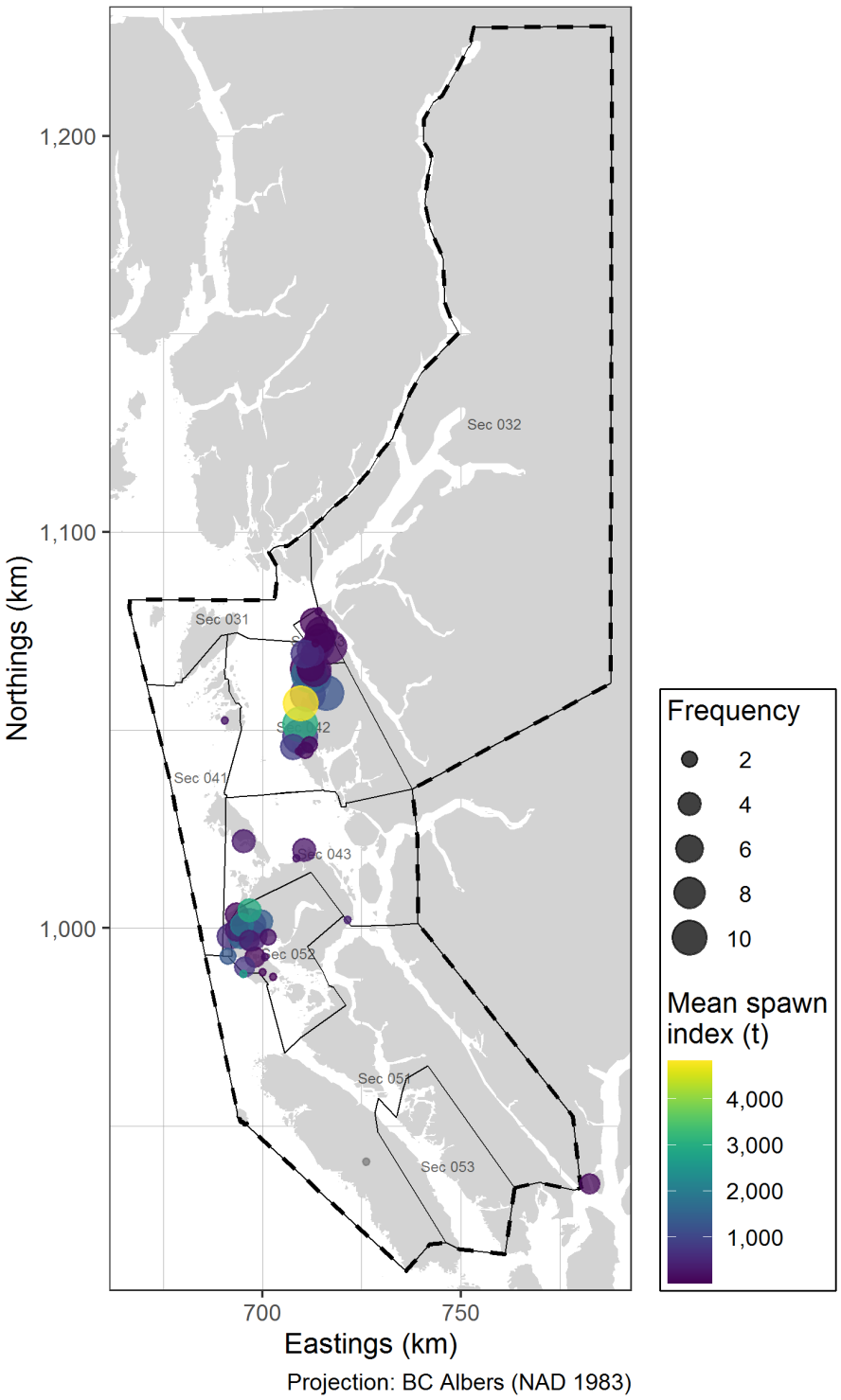

Figure 10. Pacific Herring spawn survey locations, mean spawn index in metric tonnes (t), and spawn frequency from 2010 to 2019 in the Prince Rupert District major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values (grey circles) indicate incomplete spawn surveys. Units: kilometres (km).

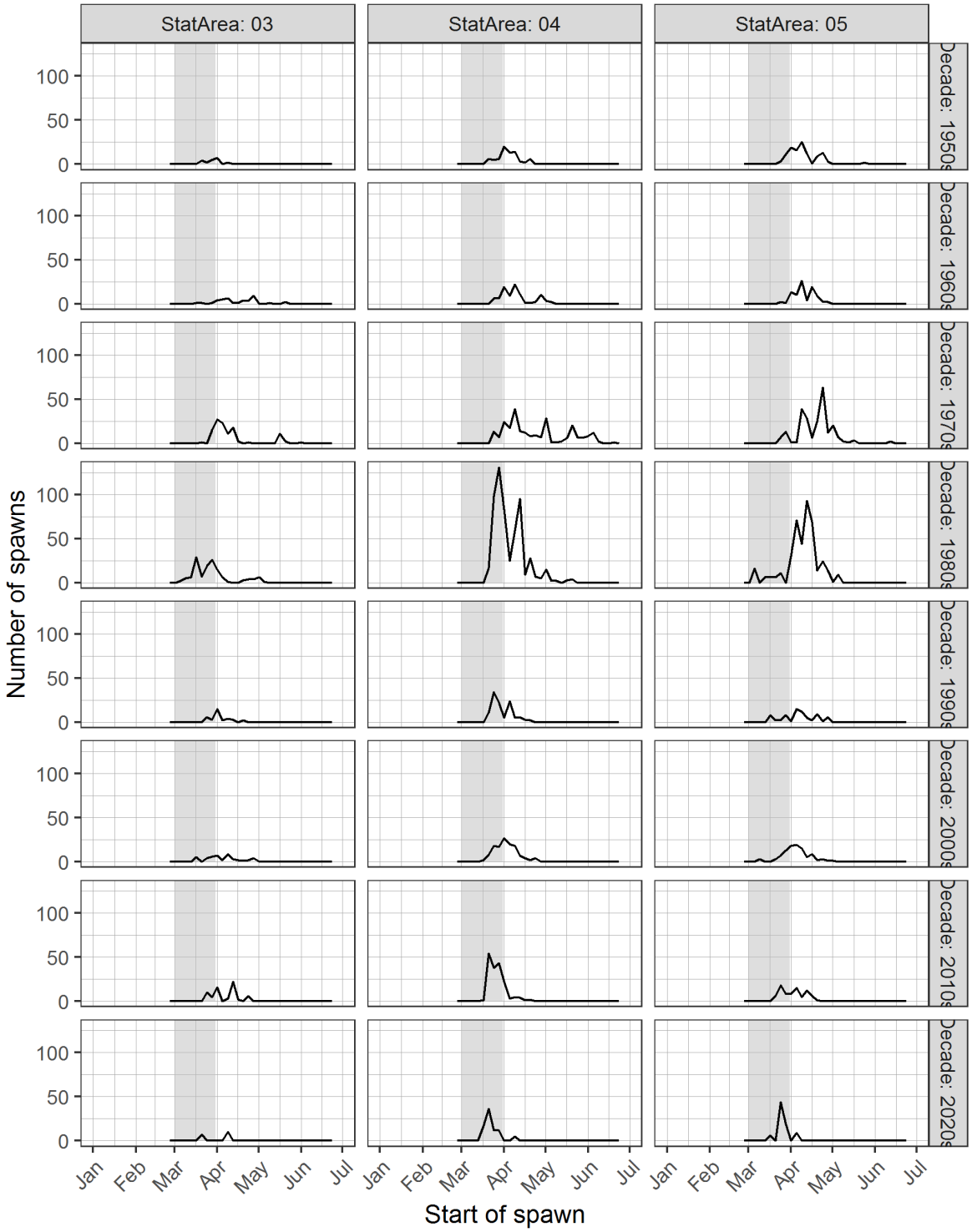

Figure 11. Pacific Herring spawn start date by decade and Statistical Area. Grey shaded regions indicate March 1st to 31st. Note that spawn size and intensity varies; therefore the number of spawns is not directly proportional to spawn extent or biomass.

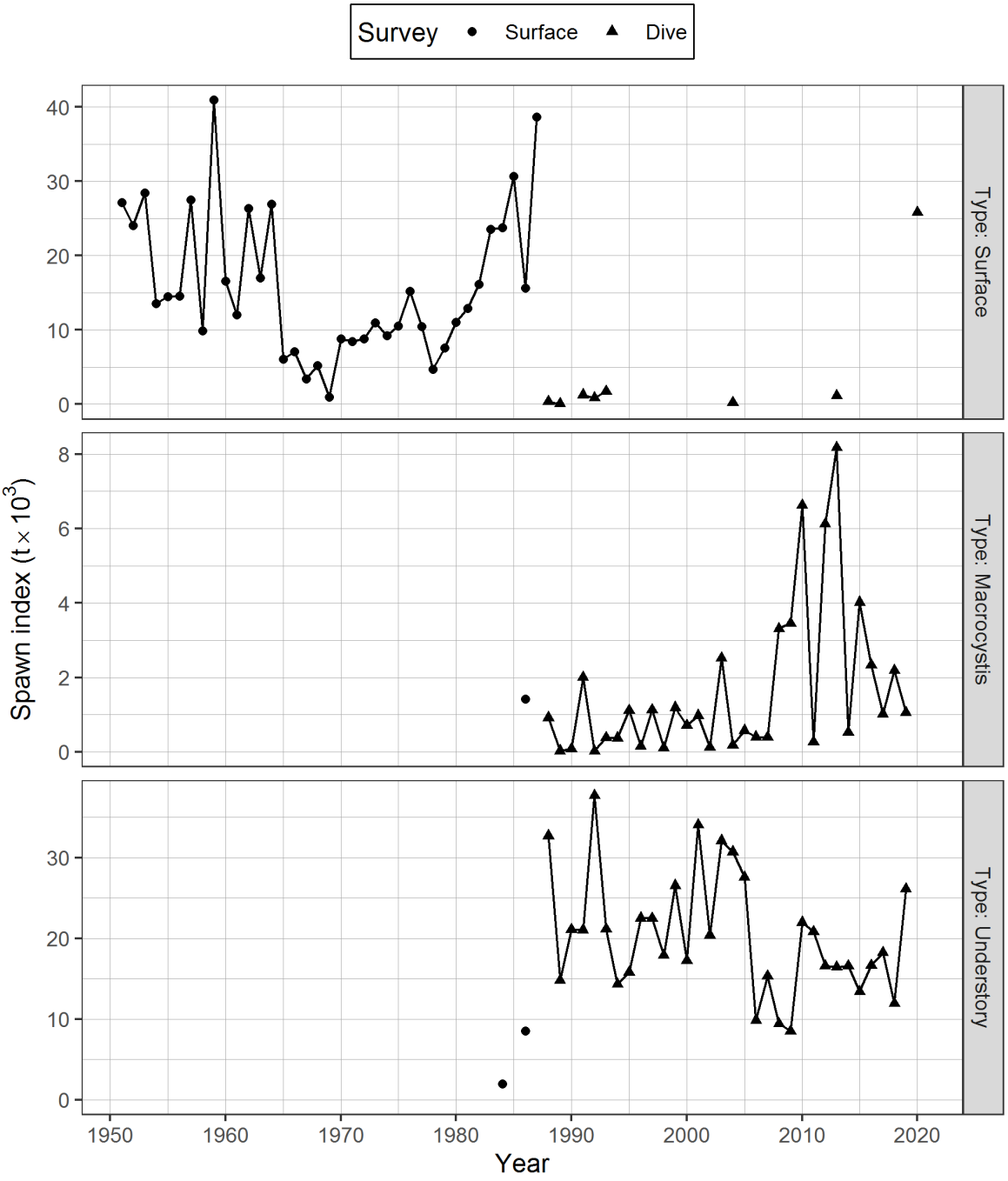

Figure 12. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) by type for Pacific Herring from 1951 to 2020 in the Prince Rupert District major stock assessment region (SAR). There are three types of spawn survey observations: observations of spawn taken from the surface usually at low tide, underwater observations of spawn on giant kelp, Macrocystis (*Macrocystis* spp.), and underwater observations of spawn on other types of algae and the substrate, which we refer to as 'understory.' The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020).

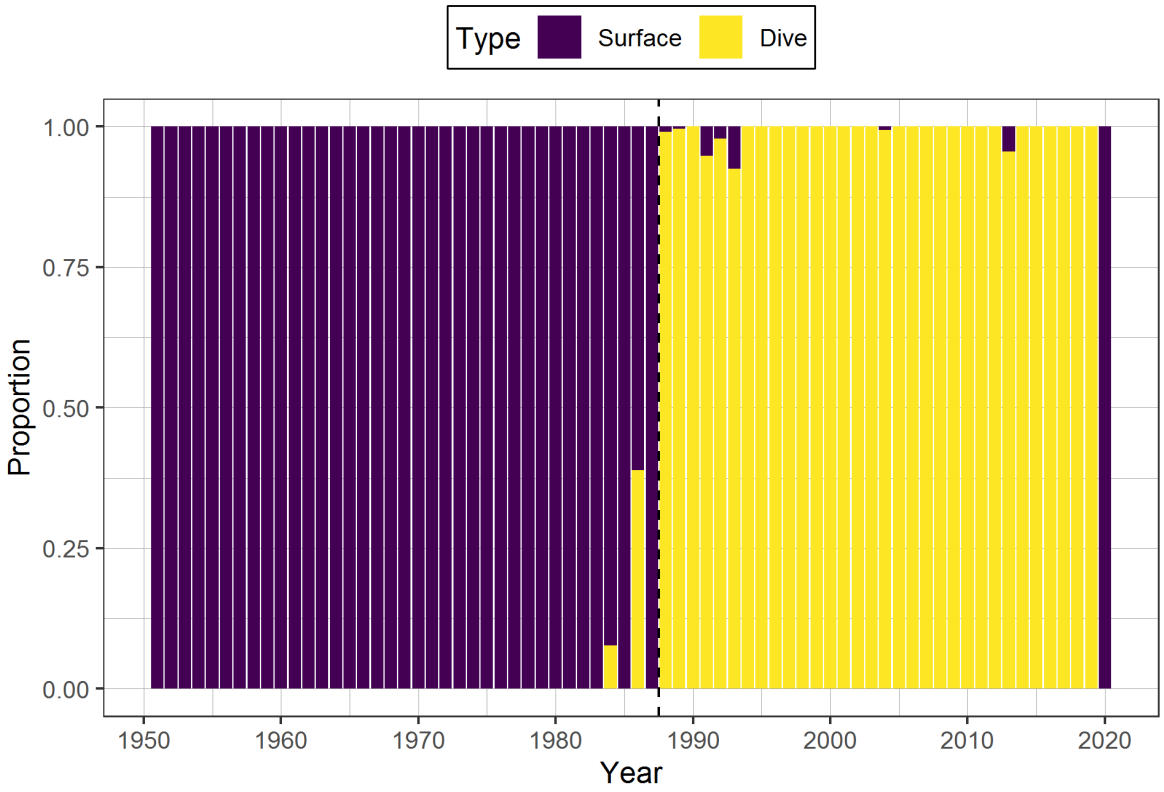

Figure 13. Time series of proportion of spawn index by surface and dive surveys for Pacific Herring from 1951 to 2020 in the Prince Rupert District major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020).

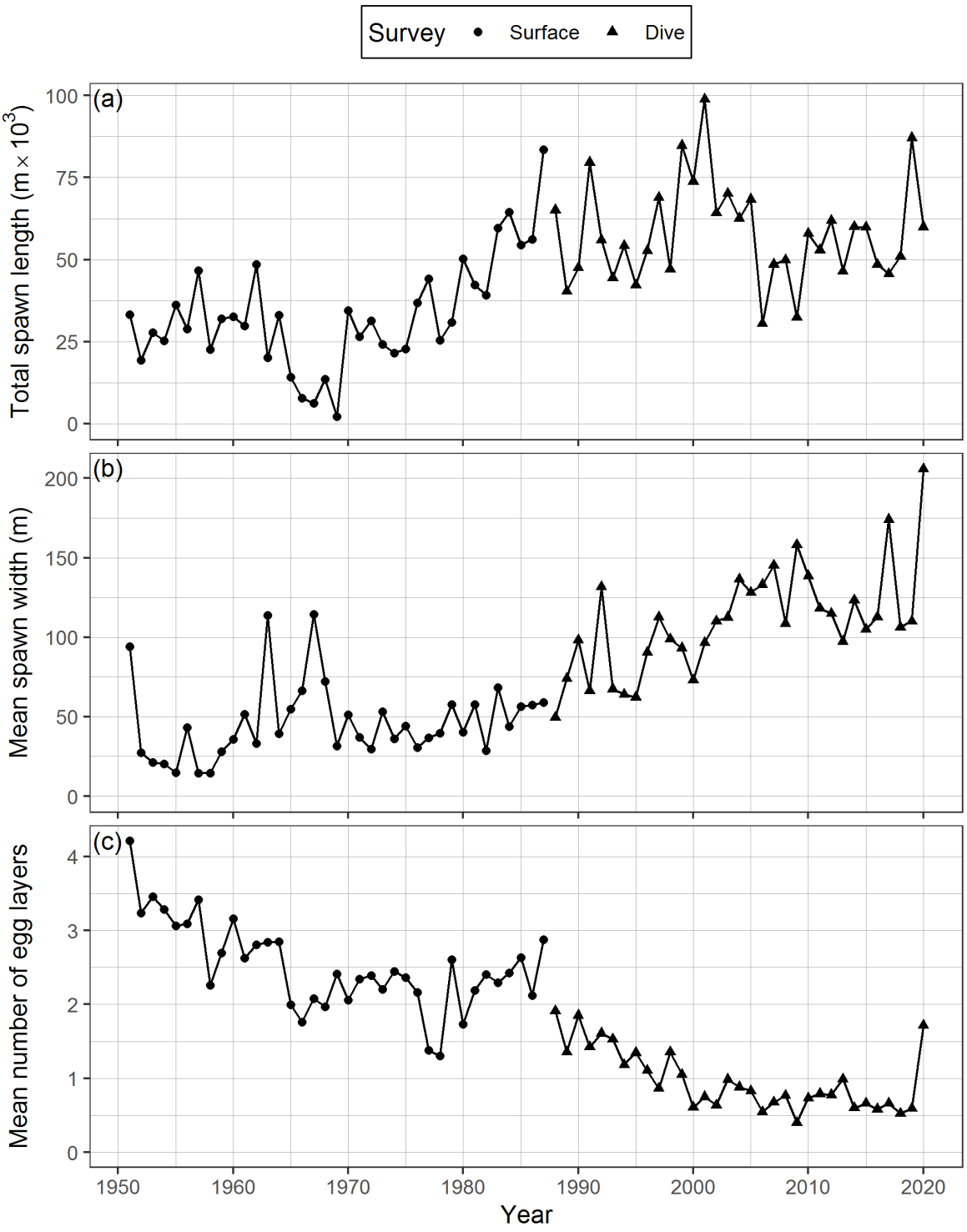

Figure 14. Time series of total spawn length in thousands of metres ($m \times 10^3$; panel a), mean spawn width in metres (b), and mean number of egg layers (c) for Pacific Herring from 1951 to 2020 in the Prince Rupert District major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020).

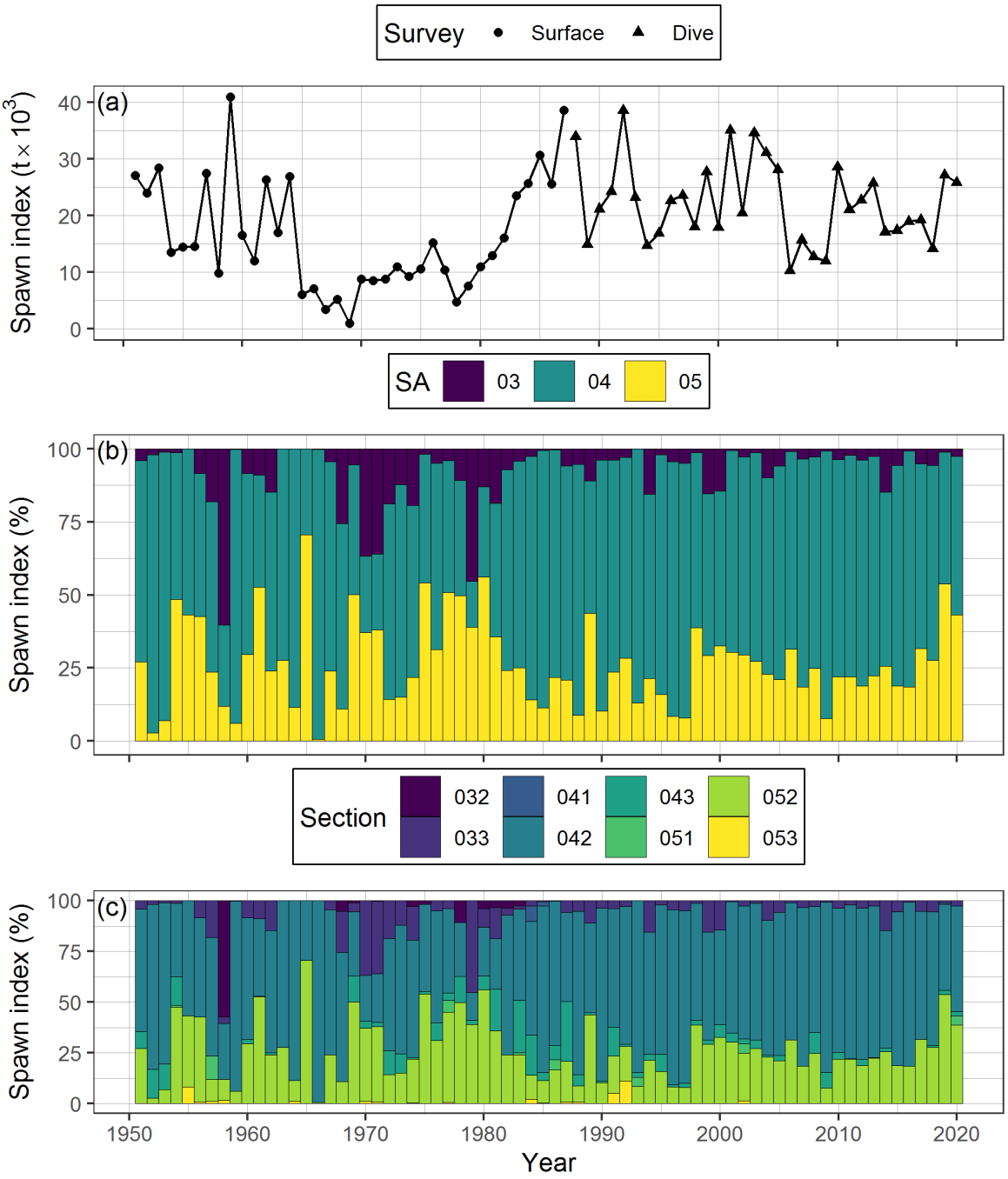

Figure 15. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) for Pacific Herring from 1951 to 2020 in the Prince Rupert District major stock assessment region (SAR; panel a), as well as percent contributed by Statistical Area (SA), and Section (b, & c, respectively). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

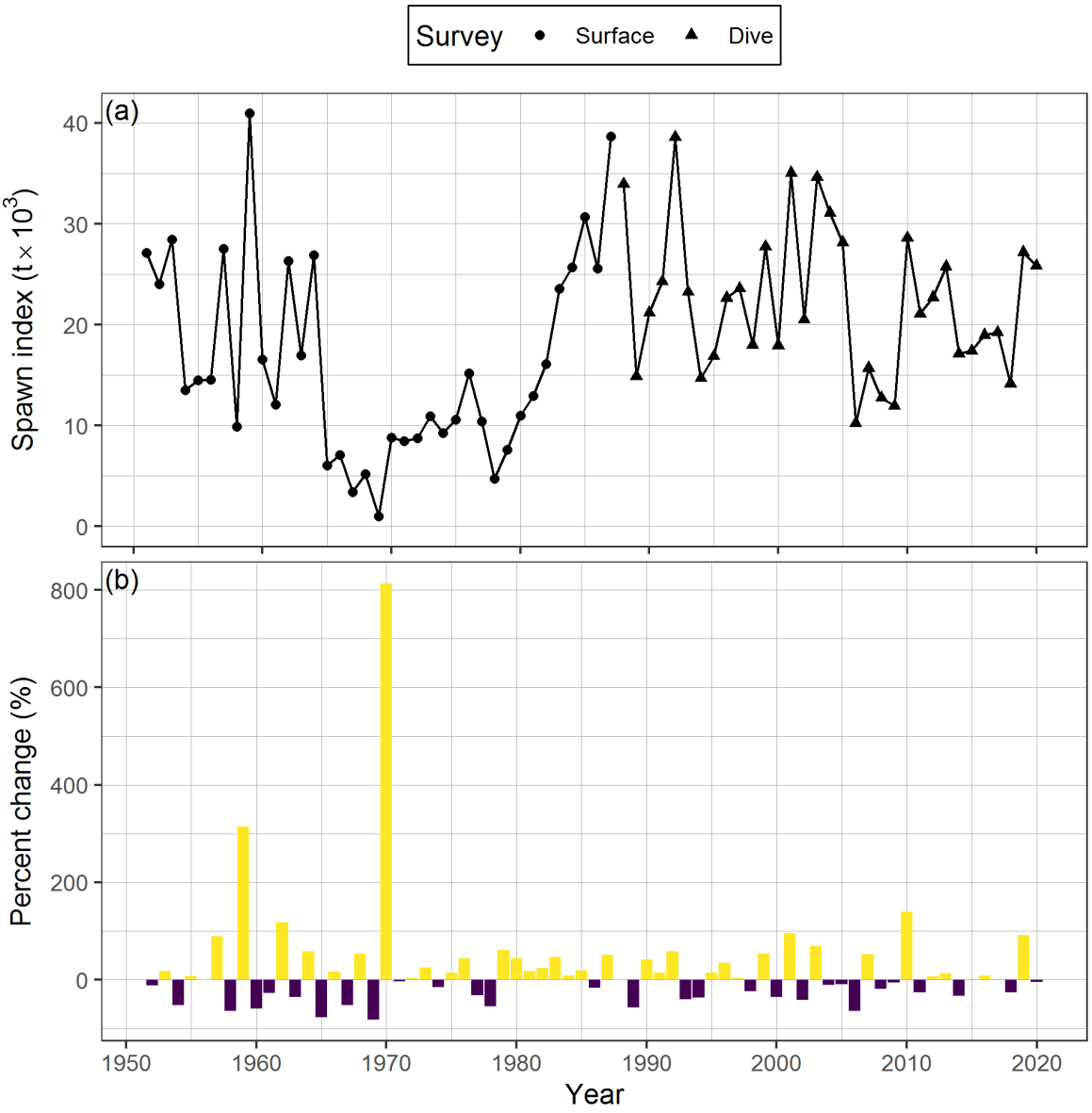

Figure 16. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) for Pacific Herring from1951 to 2020 in the Prince Rupert District major stock assessment region (SAR; panel a), and percent change (b). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the spawn index in year t. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

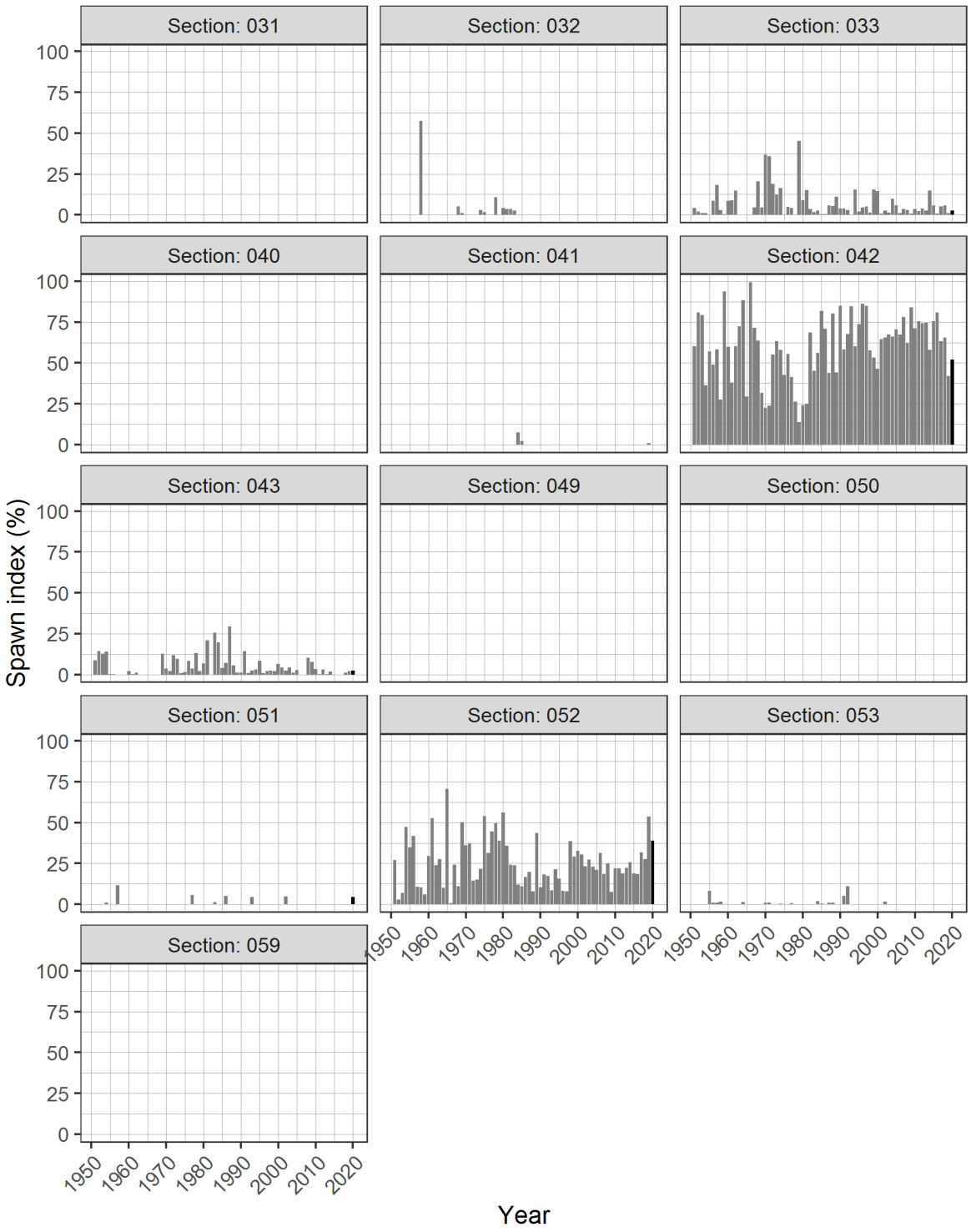

Figure 17. Time series of percent of spawn index by Section for Pacific Herring from 1951 to 2020 in the Prince Rupert District major stock assessment region (SAR). The year 2020 has a darker bar to facilitate interpretation. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

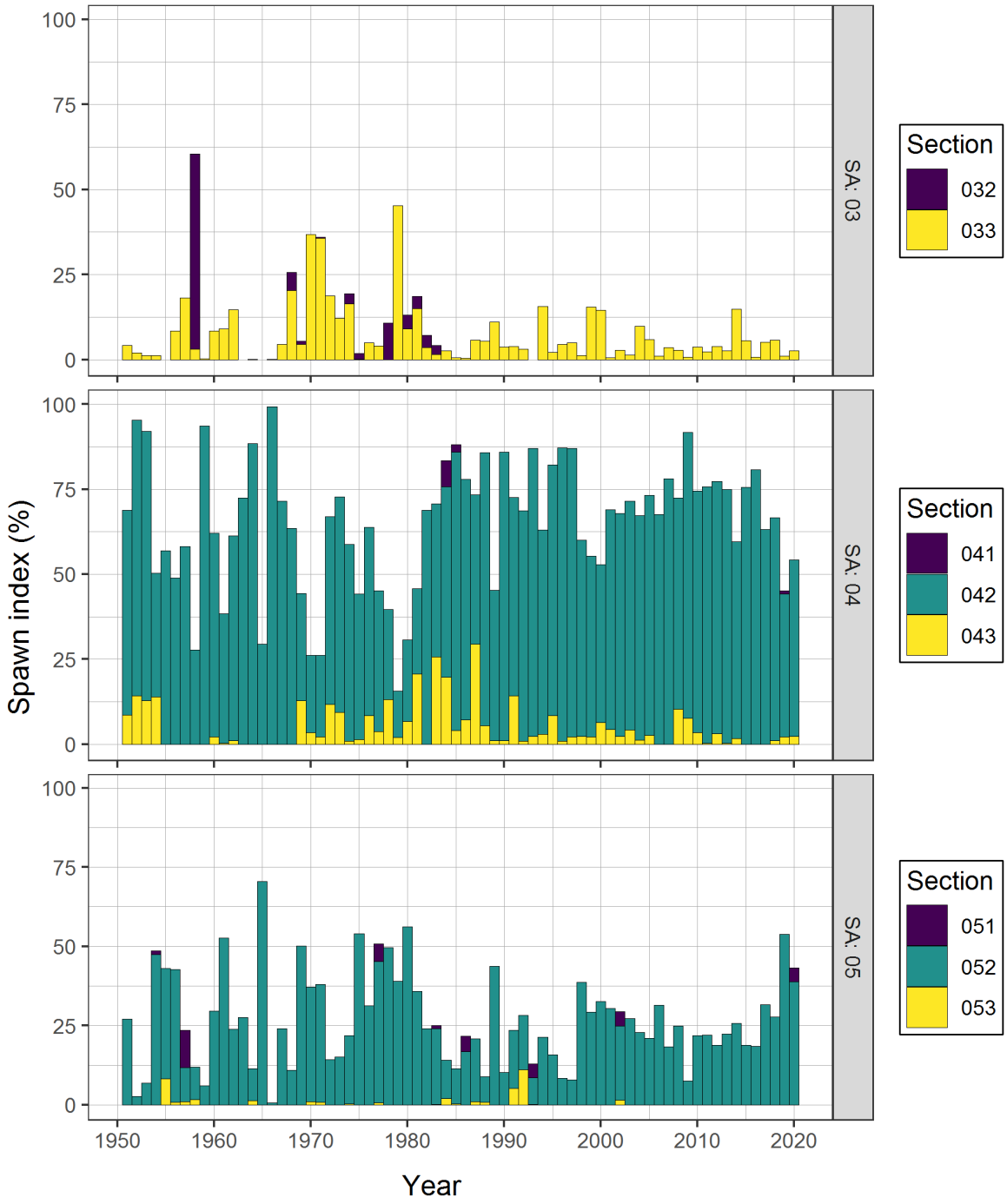

Figure 18. Time series of percent of spawn index by Statistical Area (SA) and Section for Pacific Herring from 1951 to 2020 in the Prince Rupert District major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

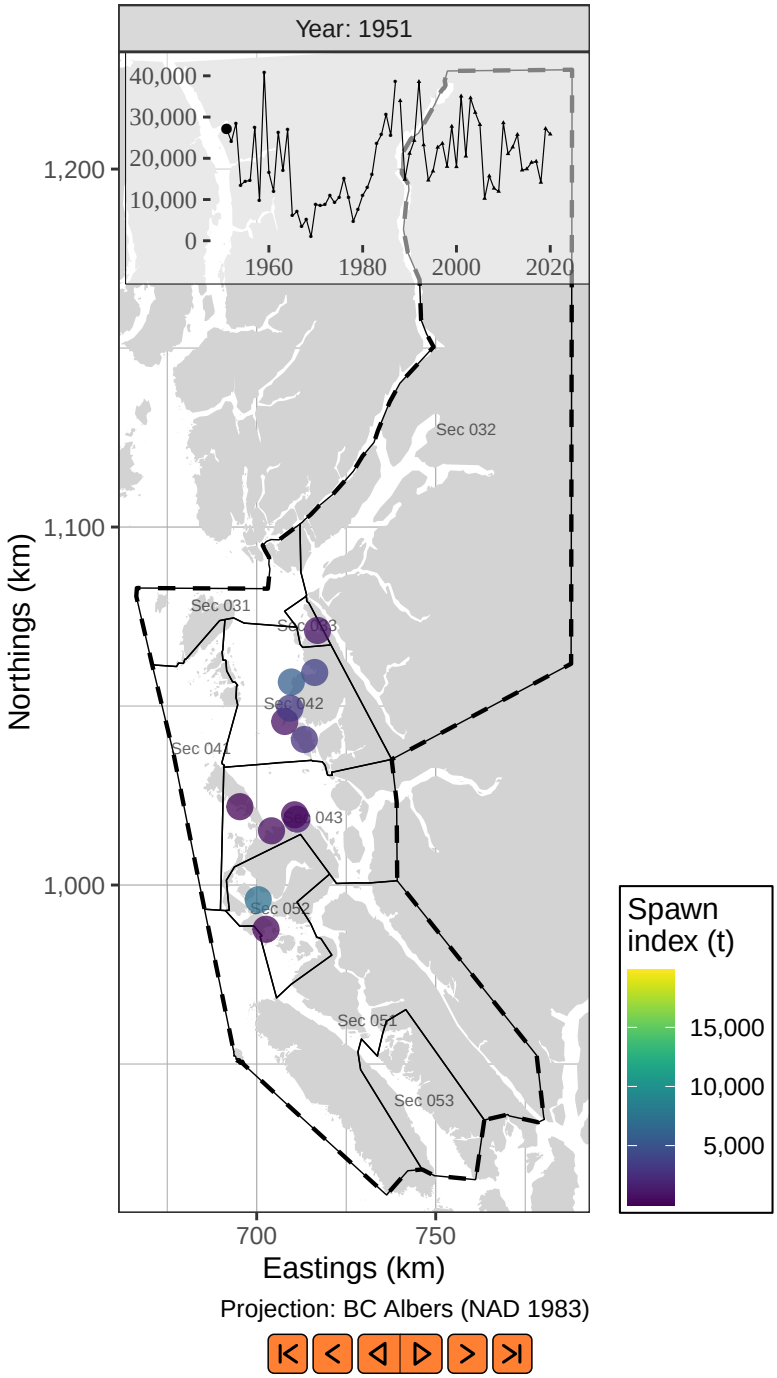

Figure 19. Animation of Pacific Herring spawn index in metric tonnes (t) by Location from 1951 to 2020 in the Prince Rupert District major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values (grey circles) indicate incomplete spawn surveys. Inset tracks time series of total spawn index. Units: kilometres (km).