Pacific Herring preliminary data summary for Area 27 2020

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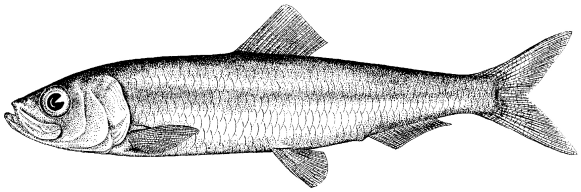

Pacific Herring (*Clupea pallasii*). Image credit: Fisheries and Oceans Canada.

Disclaimer This report contains preliminary data collected for Pacific Herring in 2020 in the Area 27 minor 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 has resulted in delayed provision of age data for Pacific Herring and many other species. To address this backlog efficiently, senior science staff and fisheries managers at DFO prioritized species to analyse in the sclerochronology lab.

We now have biological data for Pacific Herring in 2020. This updated version of the report contains biological data that was absent from the previous version. 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 Area 27 minor 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

Survey activities were not conducted in Area 27 due to COVID-19.

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. Total harvested spawn on kelp (SOK) in 2020 in the Area 27 minor SAR is shown in Table 4; we also calculate the estimated spawning biomass associated with SOK harvest. See the draft spawn index technical report for calculations to convert SOK harvest to spawning biomass.

In 2020, 0 Pacific Herring biological samples were collected and processed for the Area 27 minor SAR (Table 5, Table 6), and a total of 0 Pacific Herring were aged in 2020. Included herein are biological summaries of observed proportion-, number-, weight-, and length-at-age (Figure 4, Table 7, and Figure 5, respectively). We also show the percent change in weight and length for age-3 and age-6 fish (Figure 6 & Figure 7, 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

No spawn surveys were conducted in 2020 in the Area 27 minor SAR. A summary of spawn from the last decade (2010 to 2019) is shown in Figure 8. Figure 9 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 10, Figure 11, Figure 12, Figure 13, Table 8, and Figure 14). See the draft spawn index technical 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 13b, Figure 15). For example, in 2020, Section contributed the most to the spawn index (%). As with Sections, some Statistical Areas contribute more than others to the total spawn index (Figure 13c, Figure 16). An animation shows the spawn index by spawn survey location from 1951 to 2020 (Figure 17).

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:

- There was no commercial spawn-on-kelp harvest in 2020 in Area 27. Licence holders did not set up and no harvest took place in 2020.
- The spawn reconnaissance flight path does not typically include Area 27.
- A herring spawn was reported to DFO by Winter Harbour residents on March 1st but divers were not able to survey this spawn within the necessary time period. No other dive surveys were carried out in Area 27 this year.

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 Area 27 minor stock assessment region (SAR).

Region	Statistical Area	Section
Area 27	27	270
Area 27	27	271
Area 27	27	272
Area 27	27	273
Area 27	27	274

Table 3. Total landed commercial catch of Pacific Herring in metric tonnes (t) by gear type in 2020 in the Area 27 minor 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 Area 27 minor stock assessment region (SAR). See the draft spawn index technical 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	WP	WP
2011	WP	WP
2012	WP	WP
2013	WP	WP
2014	WP	WP
2015	0	0
2016	0	0
2017	0	0
2018	0	0
2019	0	0
2020	0	0

Table 5. Number of Pacific Herring biological samples processed from 2010 to 2020 in the Area 27 minor stock assessment region (SAR). Each sample is approximately 100 fish.

	Number of samples		
Year	Commercial	Test	Total
2010	3	0	3
2011	3	0	3
2012	7	0	7
2013	6	0	6
2014	0	0	0
2015	0	0	0
2016	0	0	0
2017	0	0	0
2018	0	0	0
2019	0	0	0
2020	0	0	0

Table 6. Number and type of Pacific Herring biological samples processed in 2020 in the Area 27 minor stock assessment region (SAR). Each sample is approximately 100 fish.

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 Area 27 minor stock assessment region (SAR). The age-10 class is a 'plus group' which includes fish ages 10 and older.

	Proportion-at-age								
Year	2	3	4	5	6	7	8	9	10
2010	0.054	0.126	0.554	0.090	0.129	0.022	0.025	0.000	0.000
2011	0.022	0.389	0.237	0.274	0.030	0.037	0.007	0.004	0.000
2012	0.040	0.172	0.503	0.120	0.134	0.016	0.013	0.000	0.002
2013	0.078	0.471	0.094	0.235	0.054	0.065	0.002	0.000	0.002
2014	NA	NA	NA	NA	NA	NA	NA	NA	NA
2015	NA	NA	NA	NA	NA	NA	NA	NA	NA
2016	NA	NA	NA	NA	NA	NA	NA	NA	NA
2017	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019	NA	NA	NA	NA	NA	NA	NA	NA	NA
2020	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 8. Summary of Pacific Herring spawn survey data from 2010 to 2020 in the Area 27 minor 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	11,270	32	0.7	846
2011	4,900	26	1.3	547
2012	13,310	38	0.3	744
2013	12,500	38	0.4	914
2014	7,575	102	0.9	1,307
2015	9,800	38	1.1	2,169
2016	11,375	52	0.4	814
2017	350	45	0.4	26
2018	6,350	101	1.0	1,045
2019	5,250	50	0.2	192
2020	NA	NA	NA	NA

8 Figures

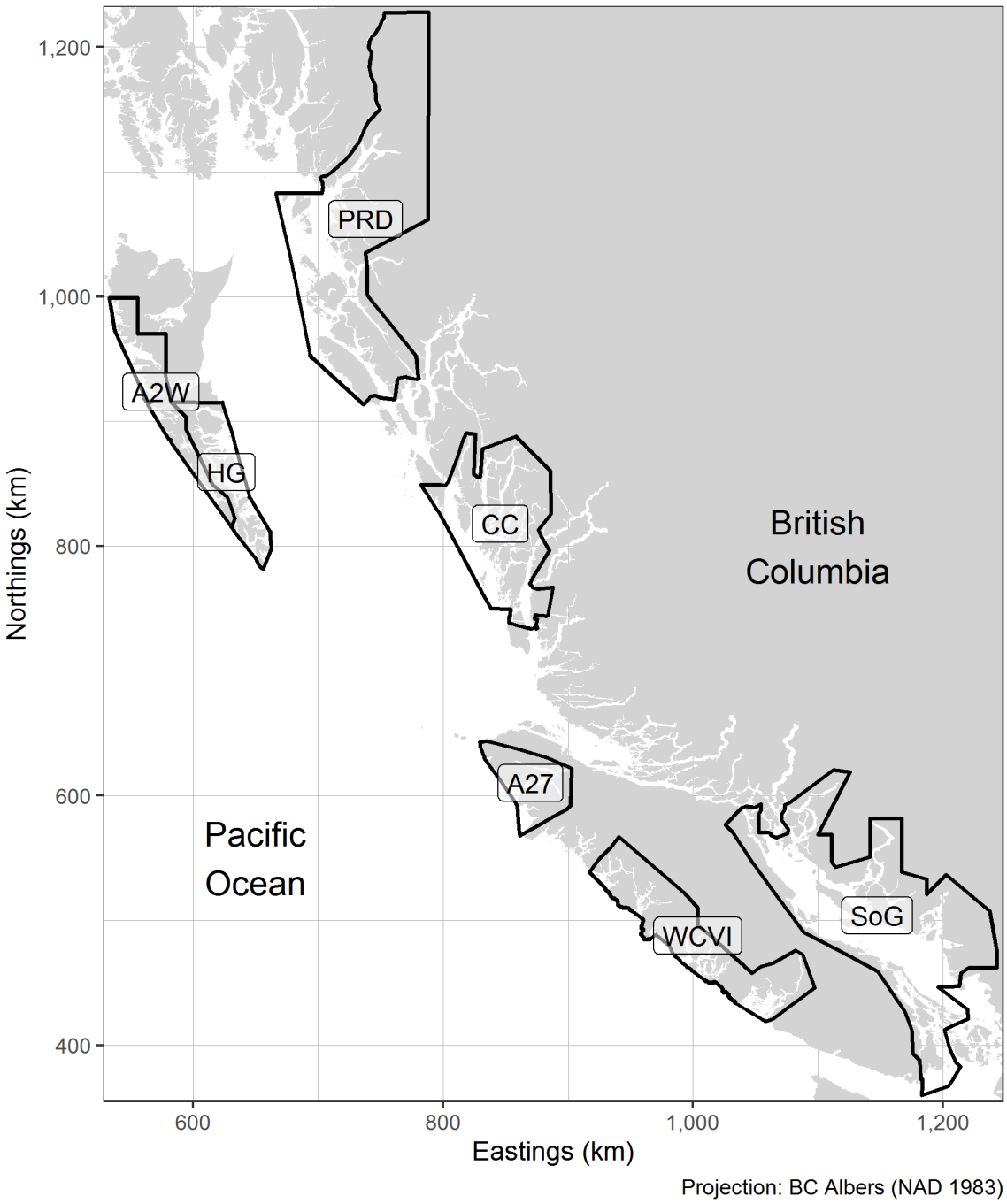

Figure 1. Boundaries for the Pacific Herring stock assessment regions (SARs) in British Columbia. There are 5 major SARs: Haida Gwaii (HG), Prince Rupert District (PRD), Central Coast (CC), Strait of Georgia (SoG), and West Coast of Vancouver Island (WCVI). There are 2 minor SARs: Area 27 (A27) and Area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

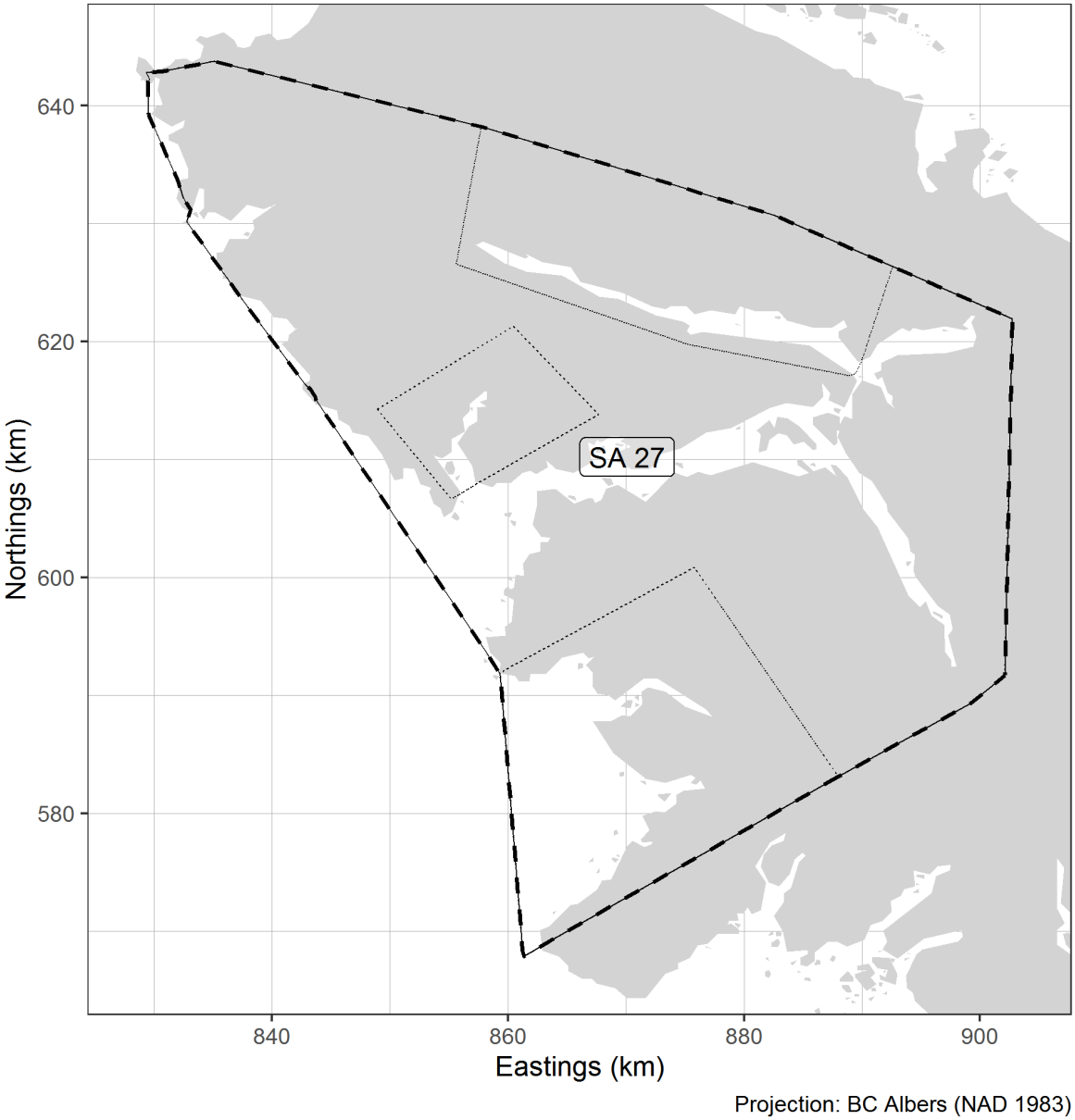

Figure 2. Boundaries for the Area 27 minor stock assessment region (SAR; thick dashed lines), associated Statistical Areas (SA; thin solid lines), and associated Sections (thin dotted lines). Units: kilometres (km).

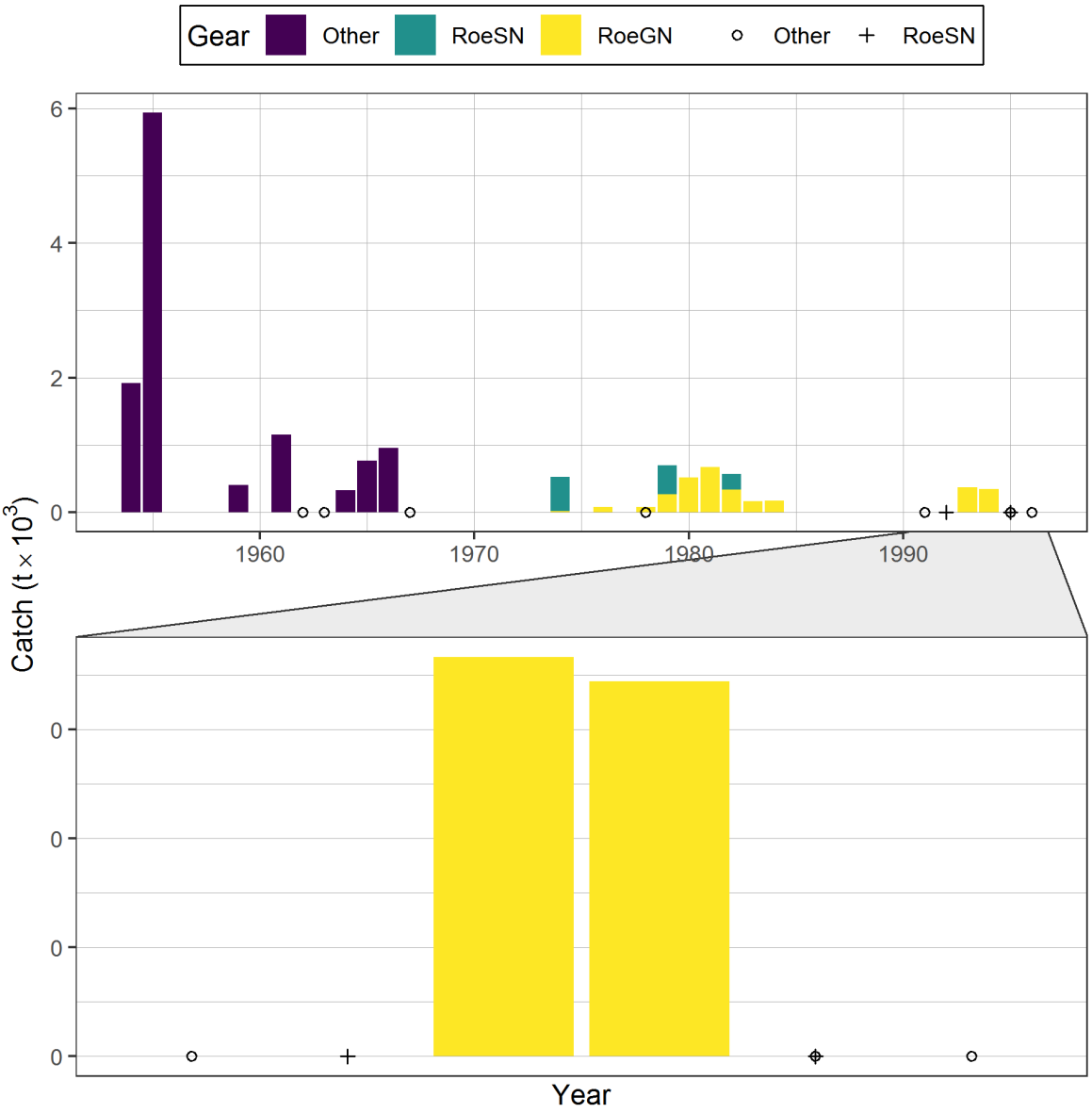

Figure 3. Time series of total landed catch in thousands of metric tonnes ($t \times 10^3$) of Pacific Herring by gear type from 1951 to 2020 in the Area 27 minor stock assessment region (SAR). Legend: 'Other' represents the reduction, the food and bait, as well as the special use fishery; 'RoeSN' represents 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.

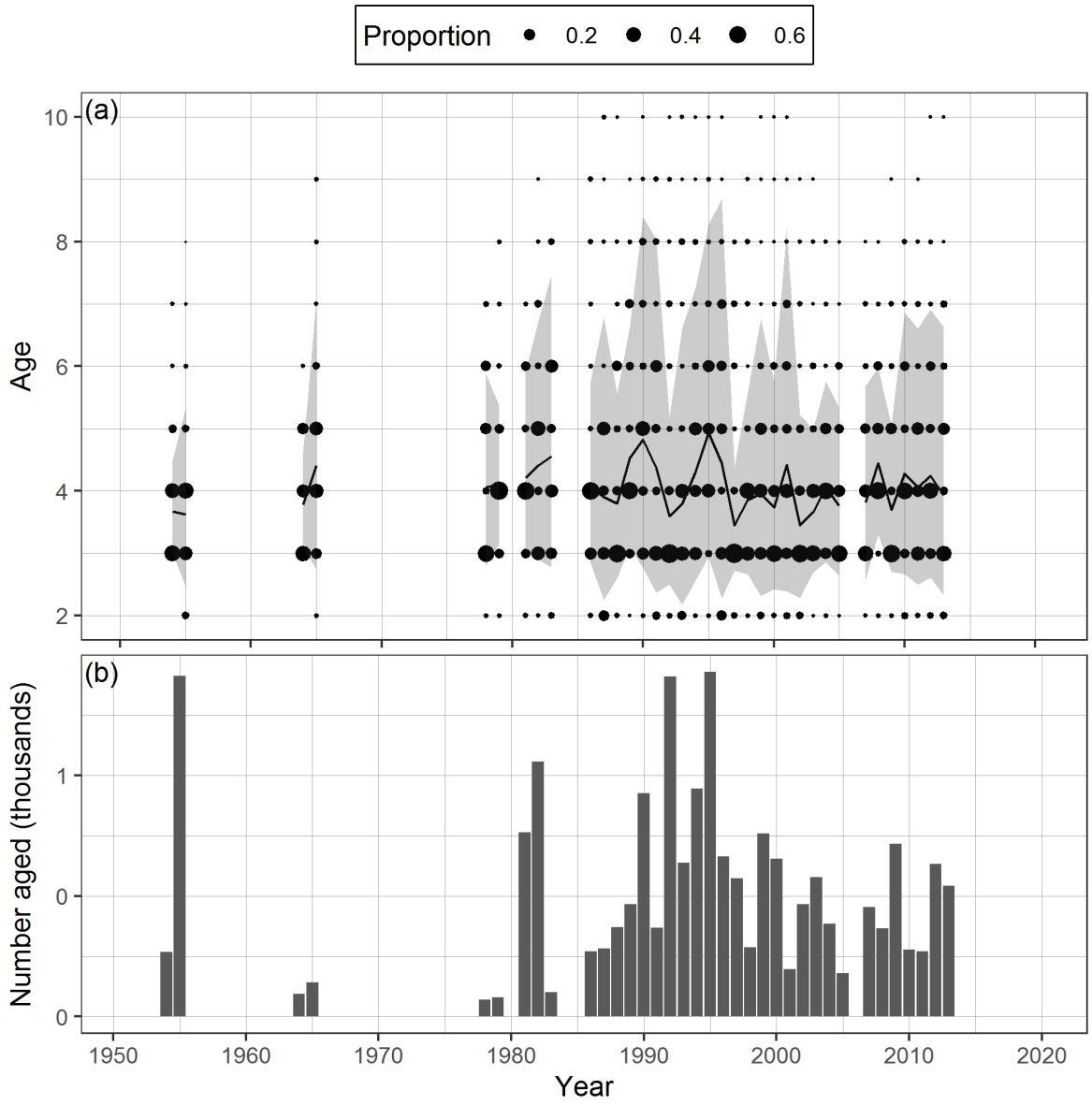

Figure 4. Time series of observed proportion-at-age (a) and number aged in thousands (c) of Pacific Herring from 1951 to 2020 in the Area 27 minor stock assessment region (SAR). The black line is the mean age, and the shaded area is the approximate 90% distribution. Biological summaries only include 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.

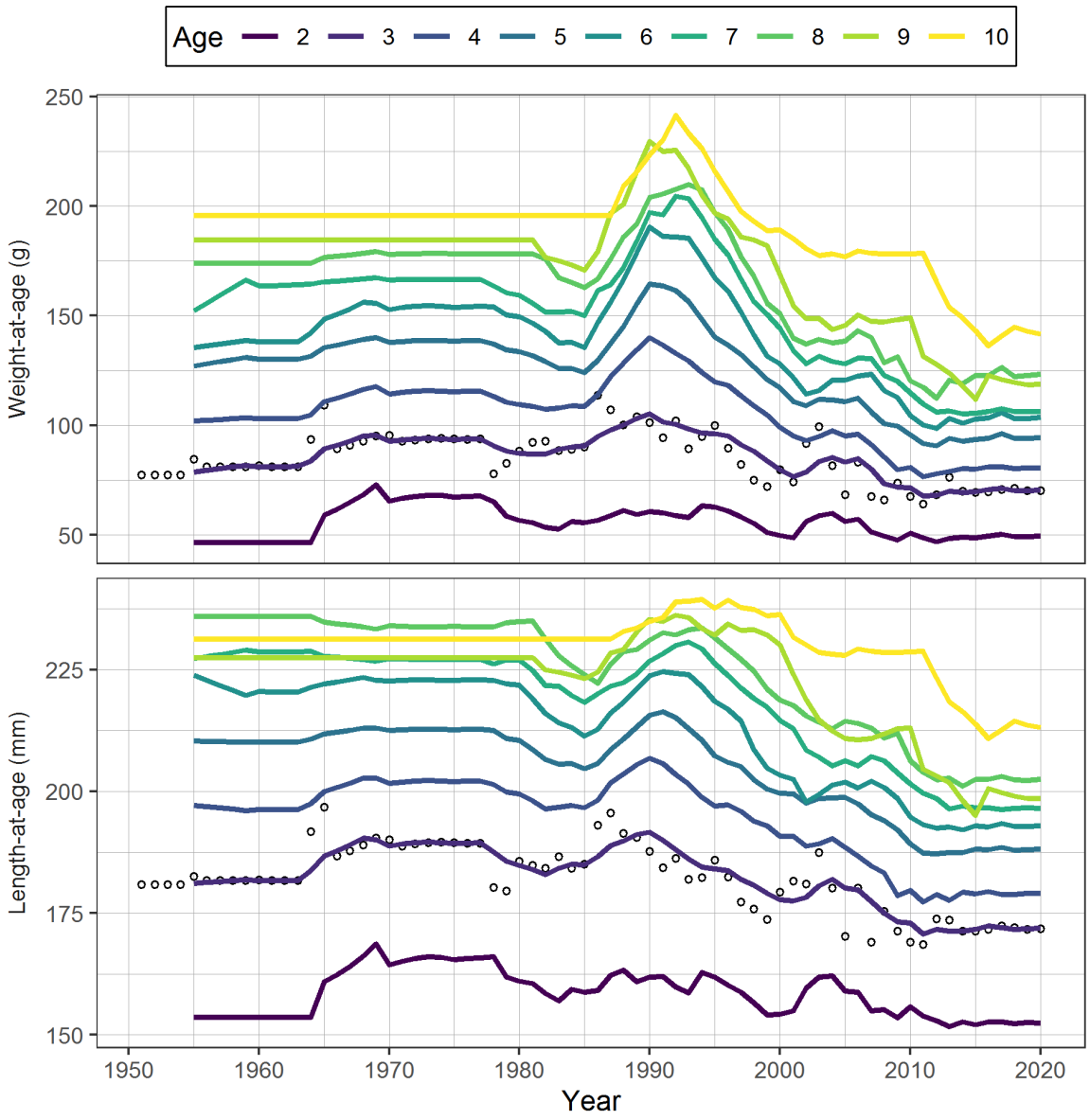

Figure 5. Time series of weight-at-age in grams (g) and length-at-age in milimetres (mm) for age-3 (circles) and 5-year running mean weight- and length-at-age (lines) for Pacific Herring from 1951 to 2020 in the Area 27 minor stock assessment region (SAR). Missing weight- and length-at-age values (i.e., 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.

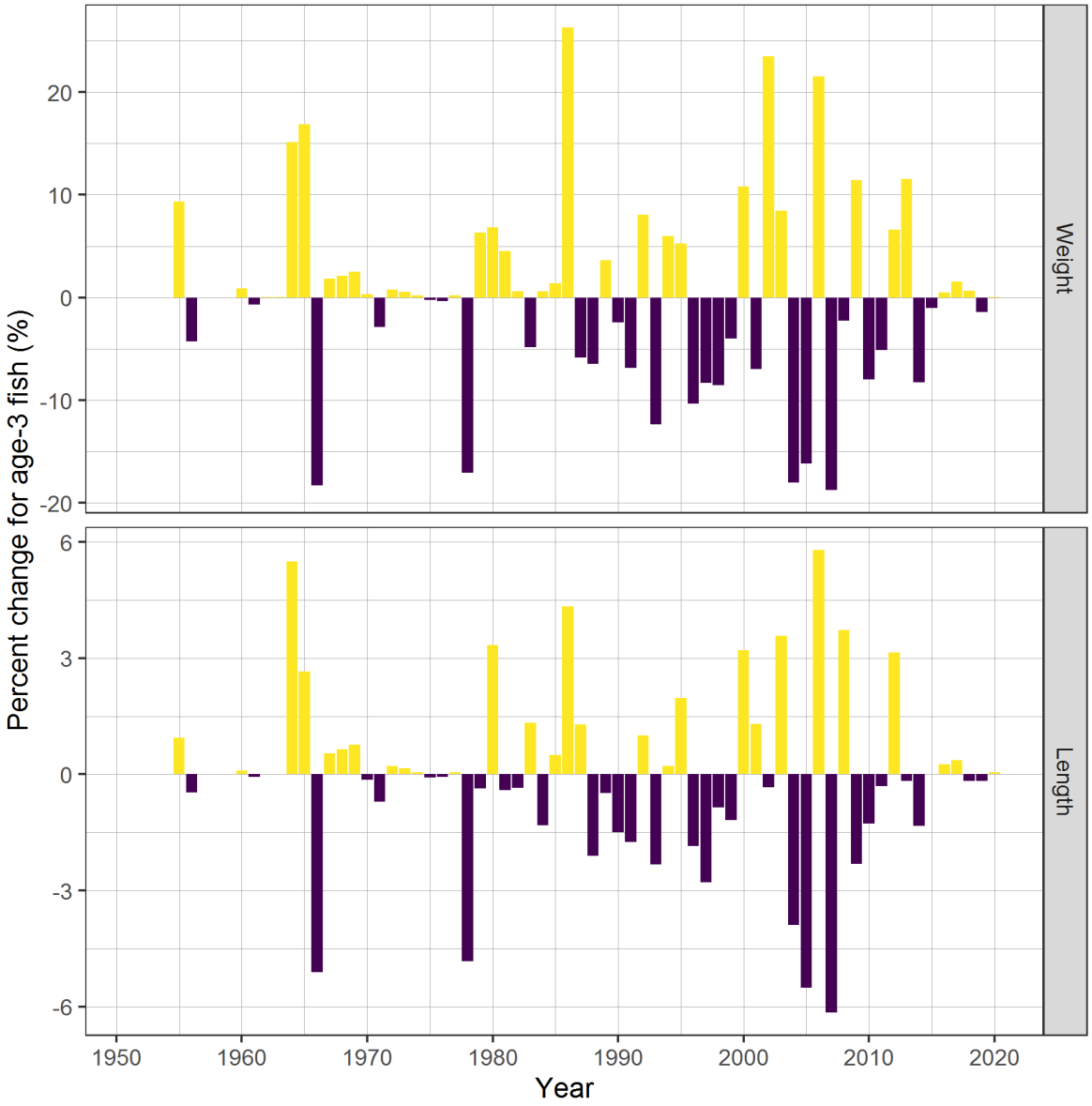

Figure 6. Time series of percent change (%) in weight and length for age-3 fish for Pacific Herring from 1951 to 2020 in the Area 27 minor stock assessment region (SAR). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the weight and length of age-3 fish, respectively, 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.

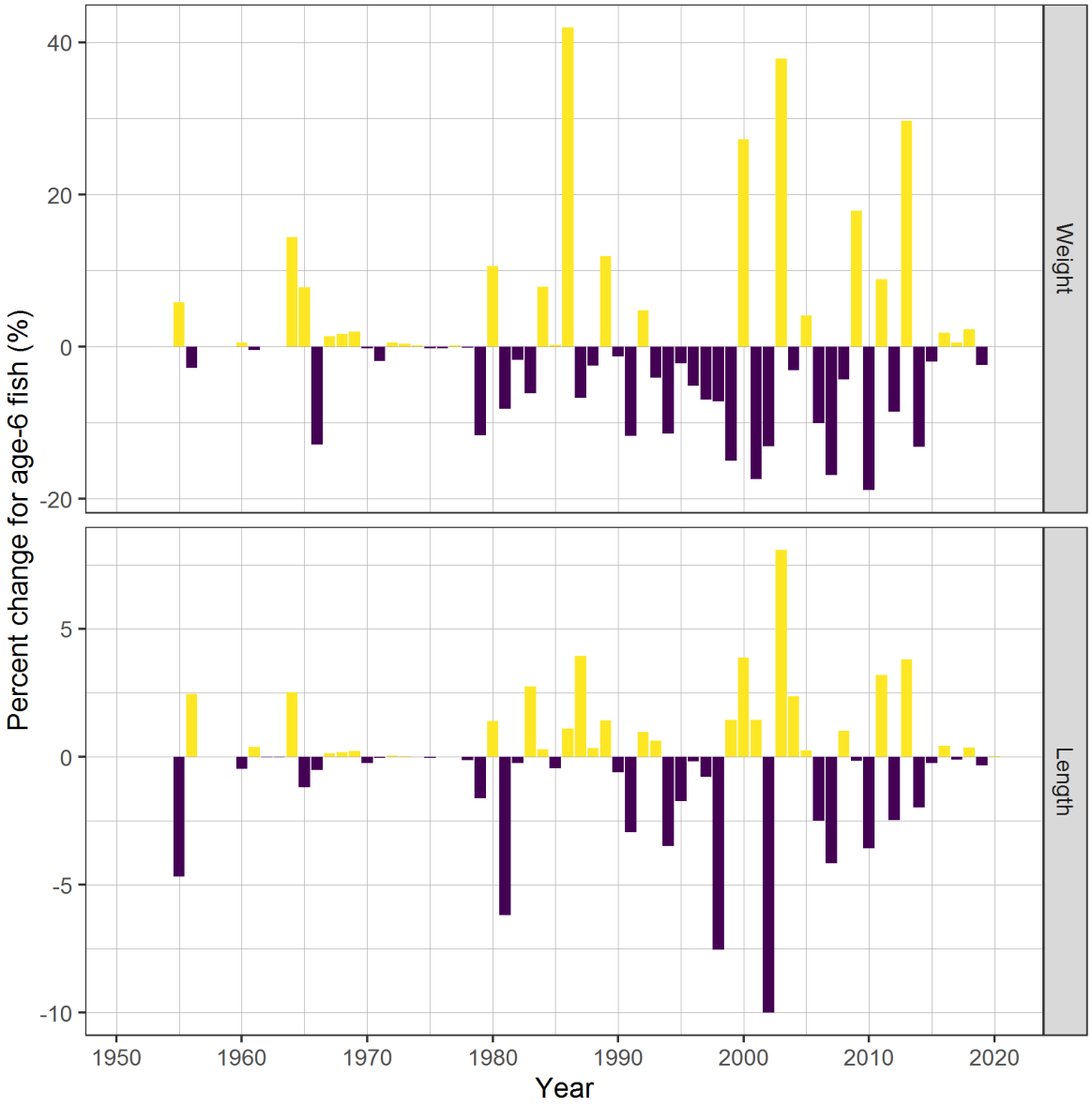

Figure 7. Time series of percent change (%) in weight and length for age-6 fish for Pacific Herring from 1951 to 2020 in the Area 27 minor stock assessment region (SAR). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the weight and length of age-6 fish, respectively, 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.

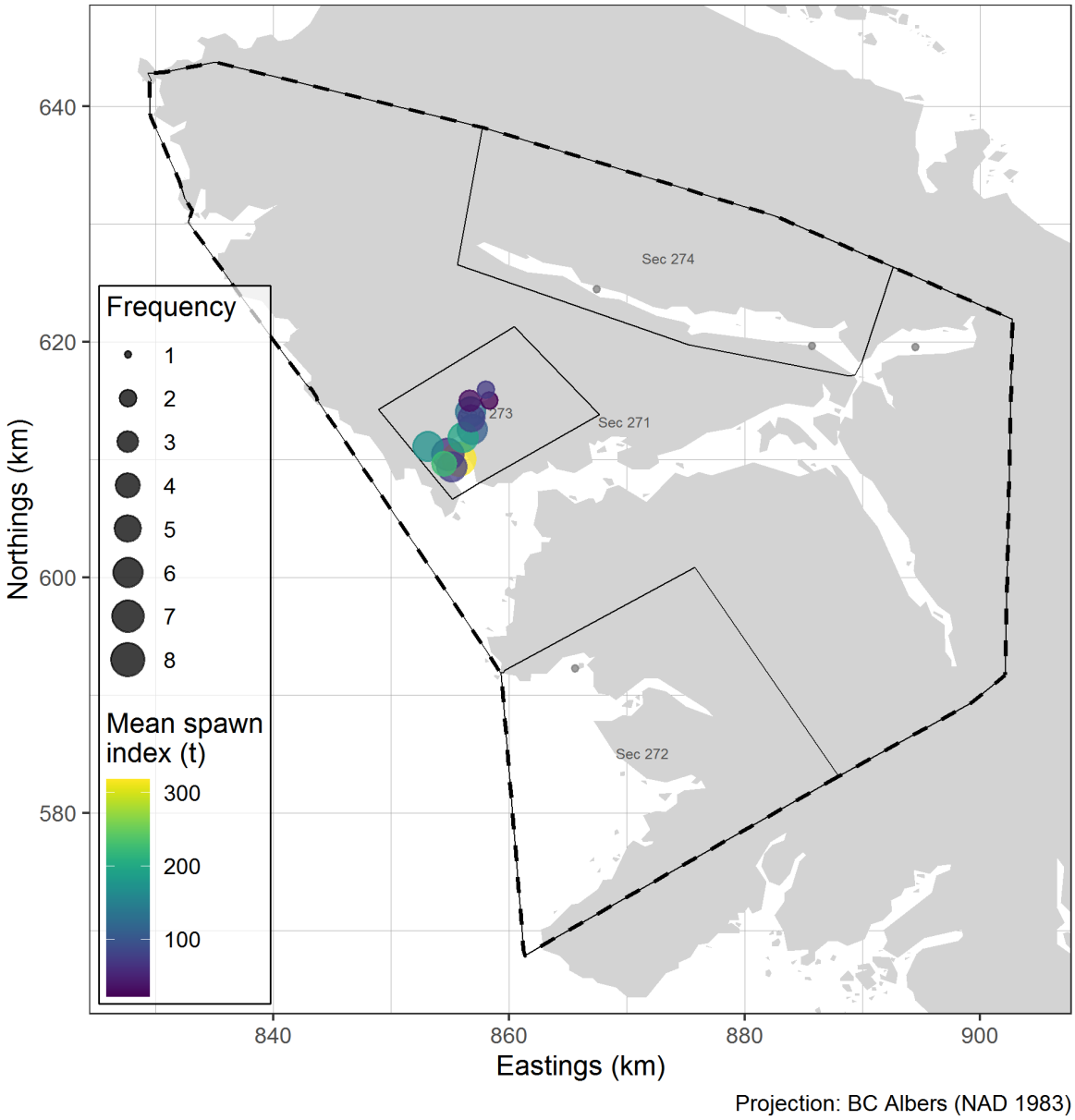

Figure 8. Pacific Herring spawn survey location, mean spawn index in metric tonnes (t), and spawn frequency from 2010 to 2019 in the Area 27 minor stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values (grey circles) indicate incomplete spawn surveys. Units: kilometres (km).

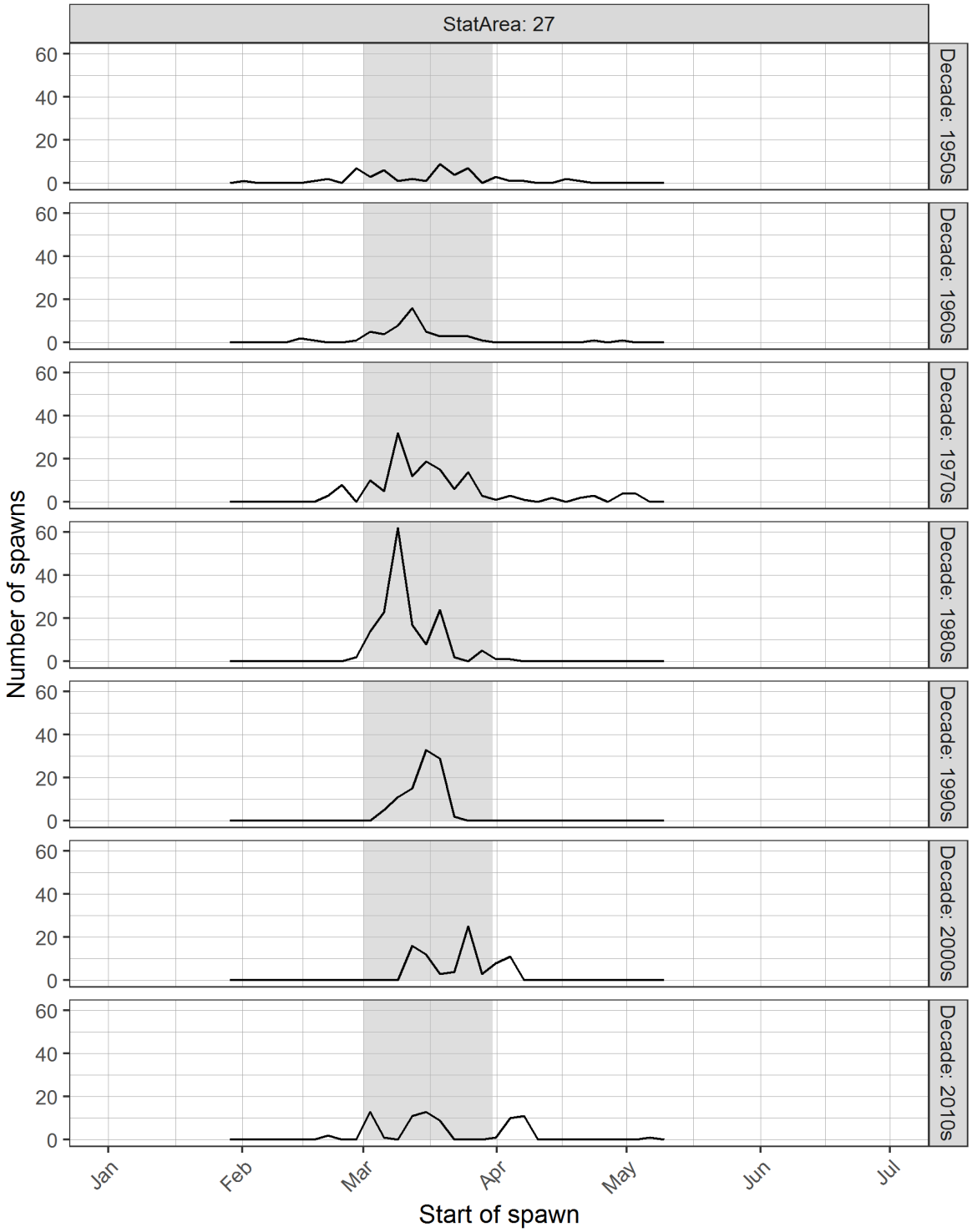

Figure 9. Pacific Herring spawn start date by decade and Statistical Area. Grey shaded regions indicate March 1st to 31st. Note that spawn size and intensity varies; therefore the number of spawns is not directly proportional to spawn extent or biomass.

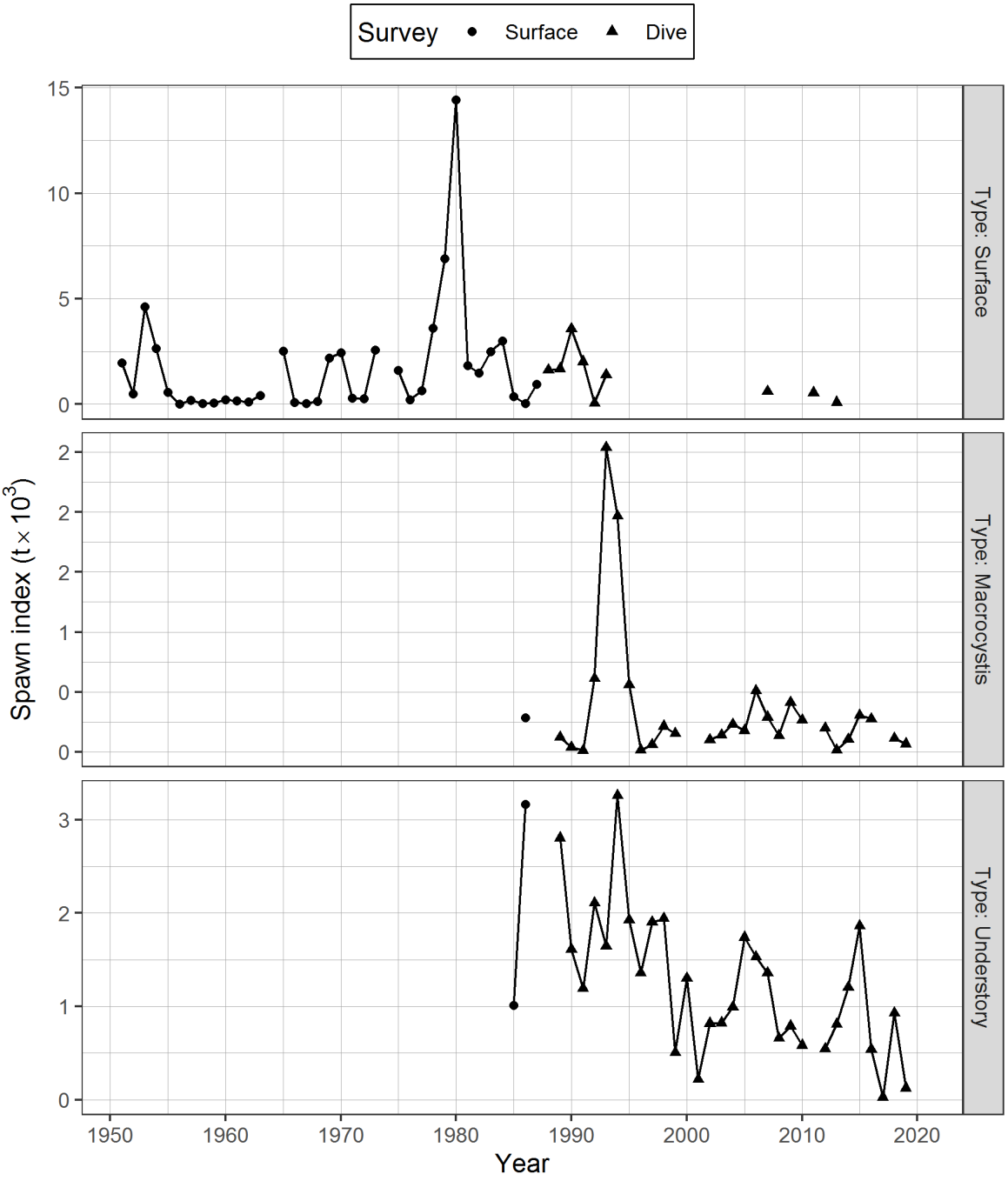

Figure 10. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) by type for Pacific Herring from 1951 to 2020 in the Area 27 minor stock assessment region (SAR). There are three types of spawn survey observations: observations of spawn taken from the surface usually at low tide, 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).

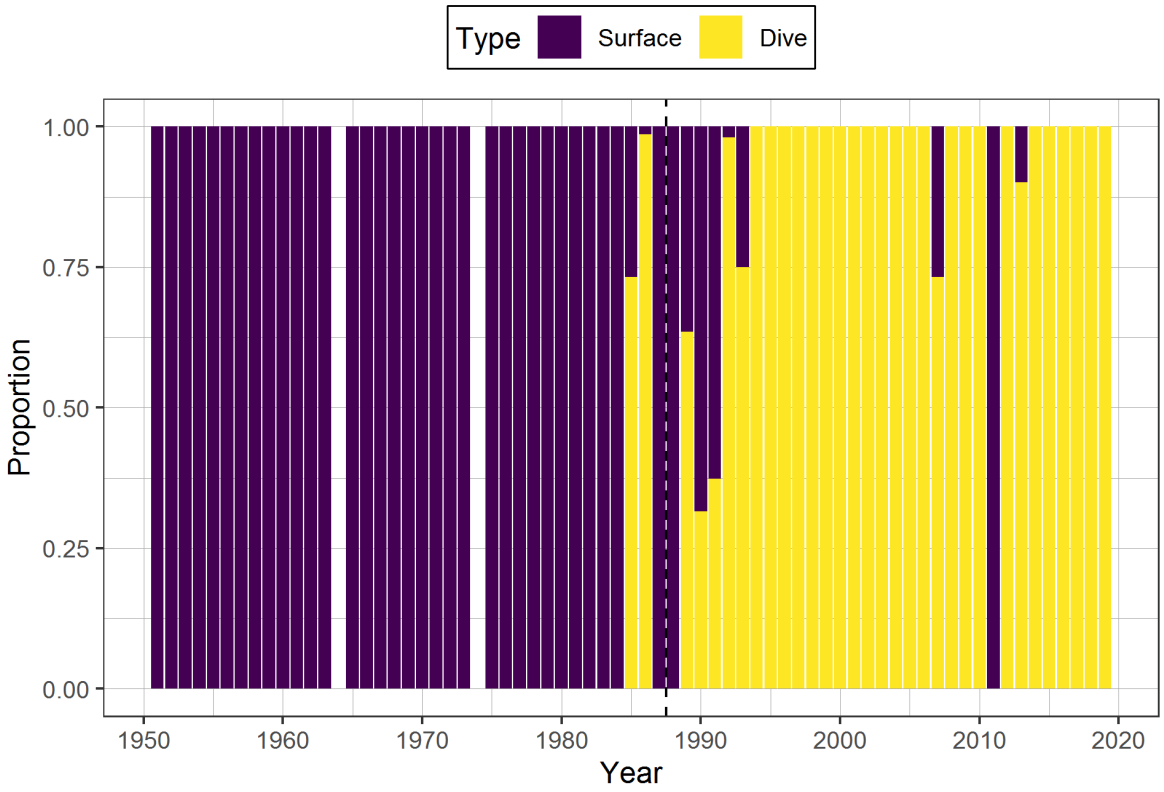

Figure 11. Time series of proportion of spawn index by surface and dive surveys for Pacific Herring from 1951 to 2020 in the Area 27 minor stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020).

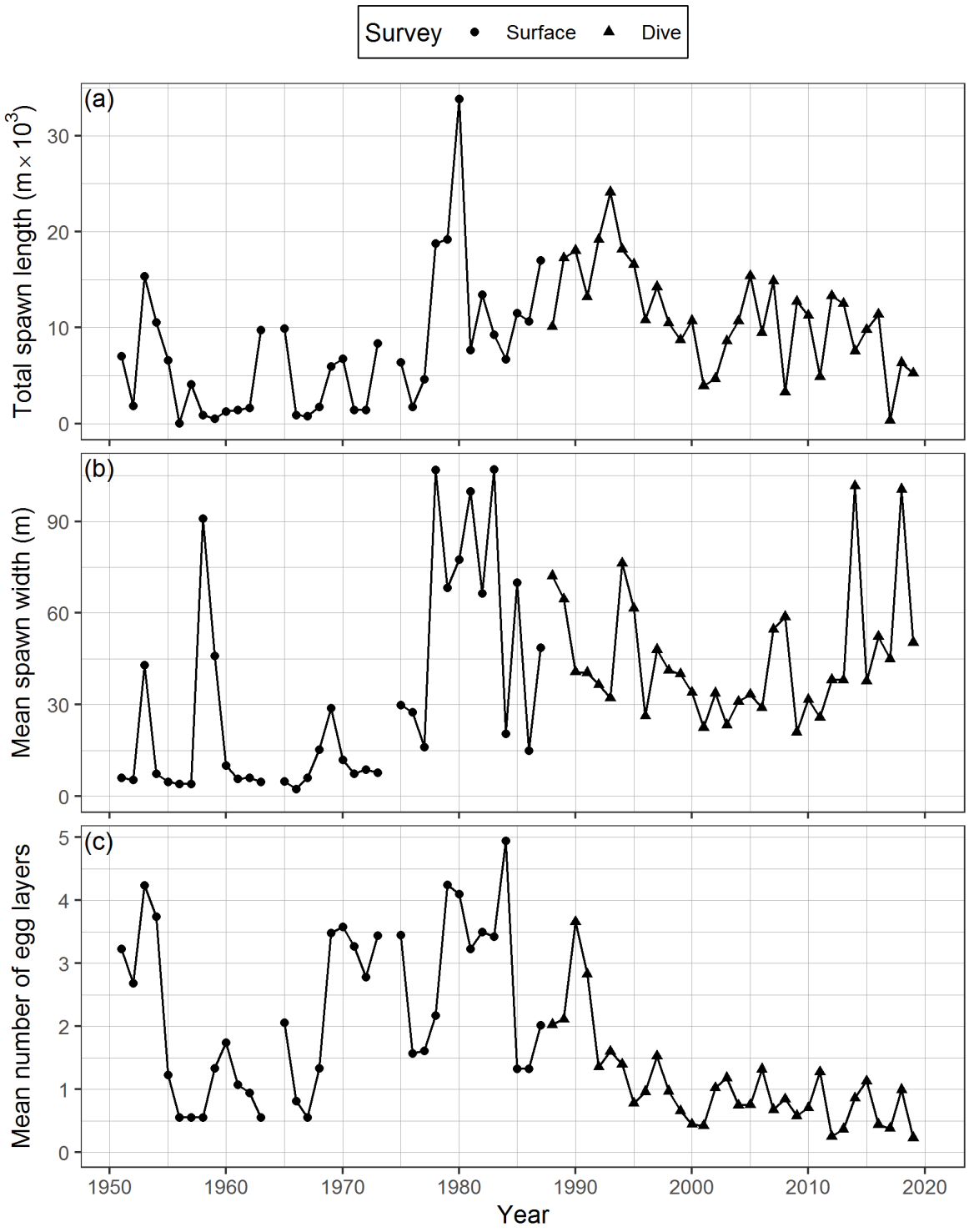

Figure 12. Time series of total spawn length in thousands of metres ($m \times 10^3$; panel a), mean spawn width in metres (b), and mean number of egg layers (c) for Pacific Herring from 1951 to 2020 in the Area 27 minor stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020).

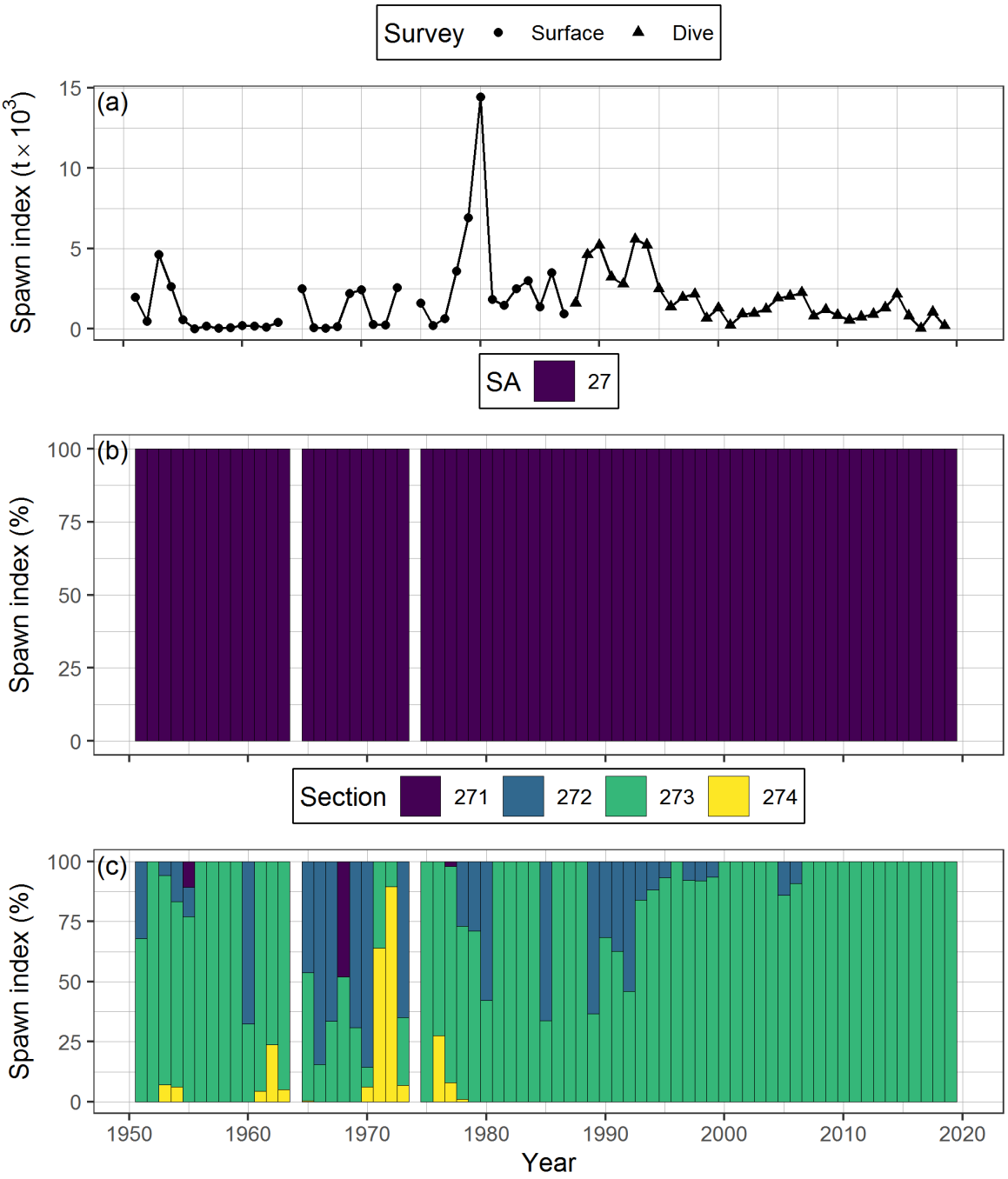

Figure 13. Time series of spawn index in thousands of metric tonnes (t $\times$ 10^3) for Pacific Herring from 1951 to 2020 in the Area 27 minor stock assessment region (SAR; panel a), as well as percent contributed by Statistical Area (SA), and Section (b, & c, respectively). The spawn index has two 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.

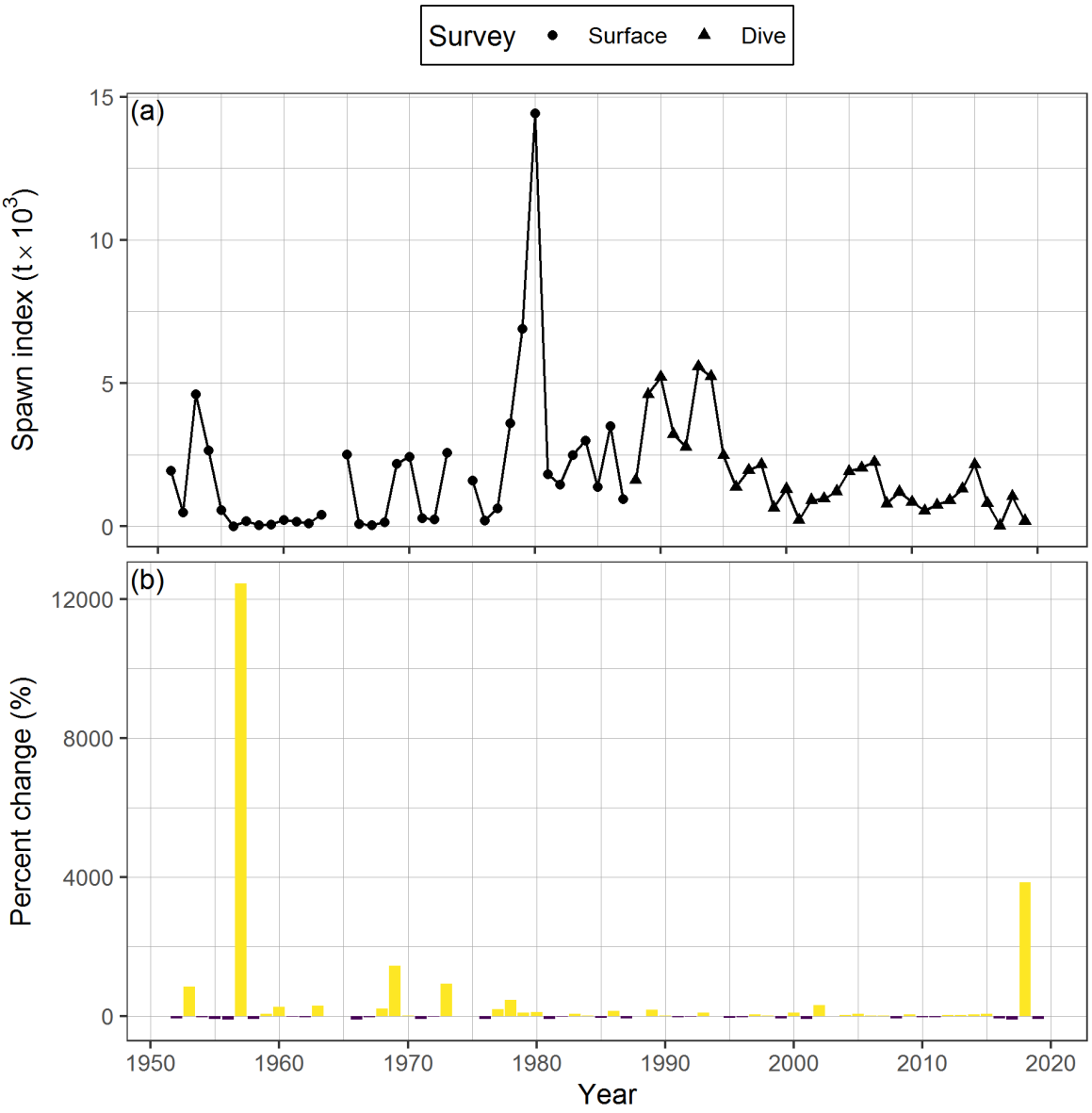

Figure 14. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) for Pacific Herring from1951 to 2020 in the Area 27 minor stock assessment region (SAR; panel a), and percent change (b). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the 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.

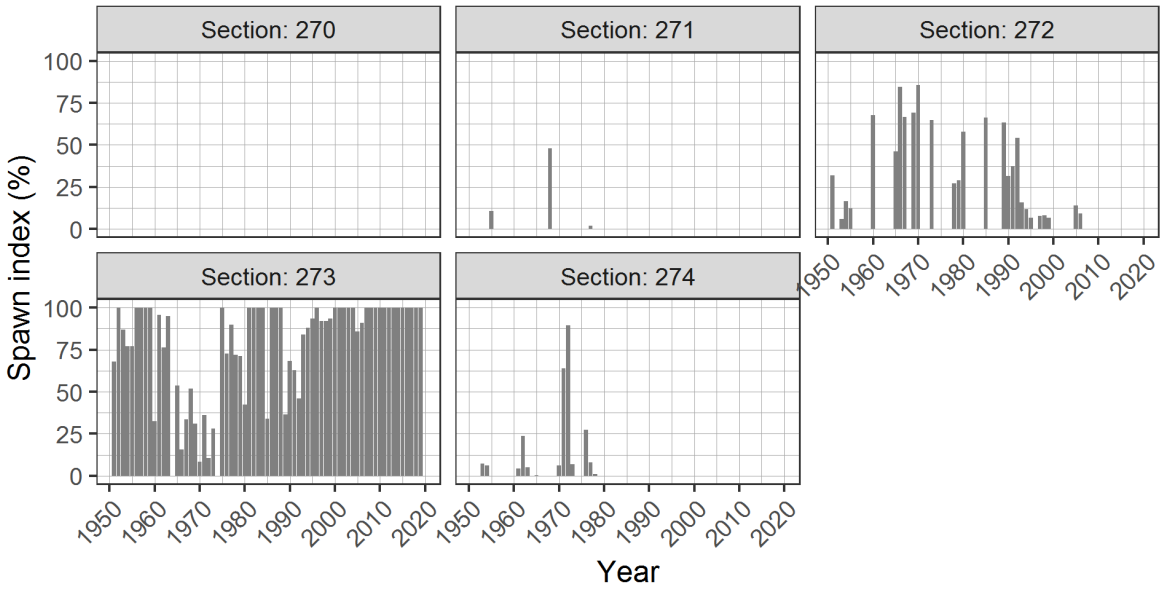

Figure 15. Time series of percent of spawn index by Section for Pacific Herring from 1951 to 2020 in the Area 27 minor stock assessment region (SAR). The year 2020 has a darker bar to facilitate interpretation. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

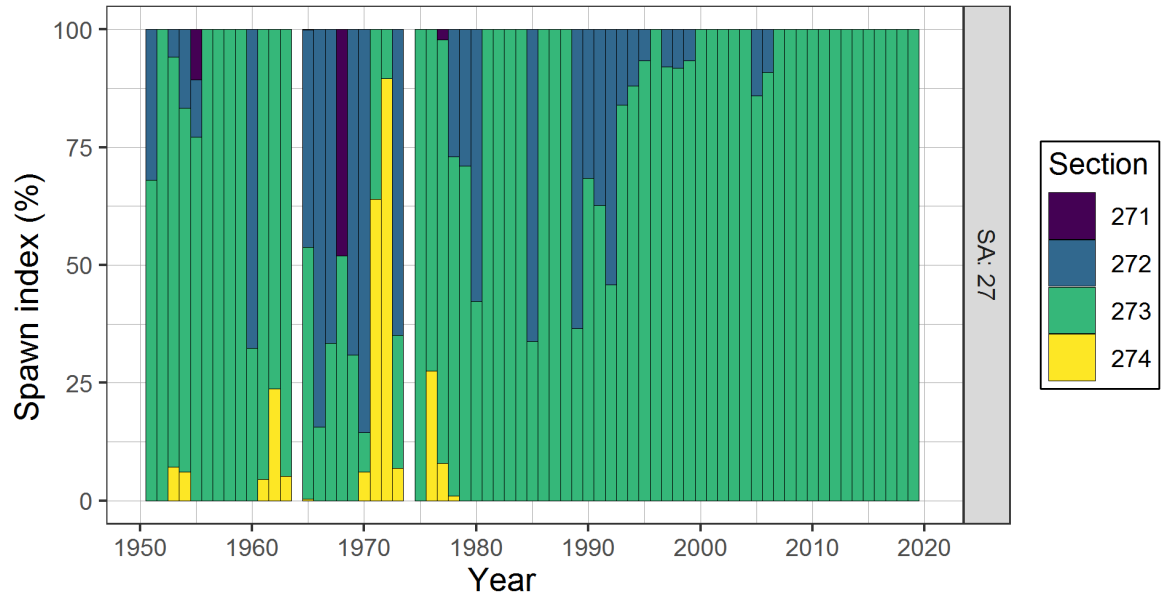

Figure 16. Time series of percent of spawn index by Statistical Area (SA) and Section for Pacific Herring from 1951 to 2020 in the Area 27 minor stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2020). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

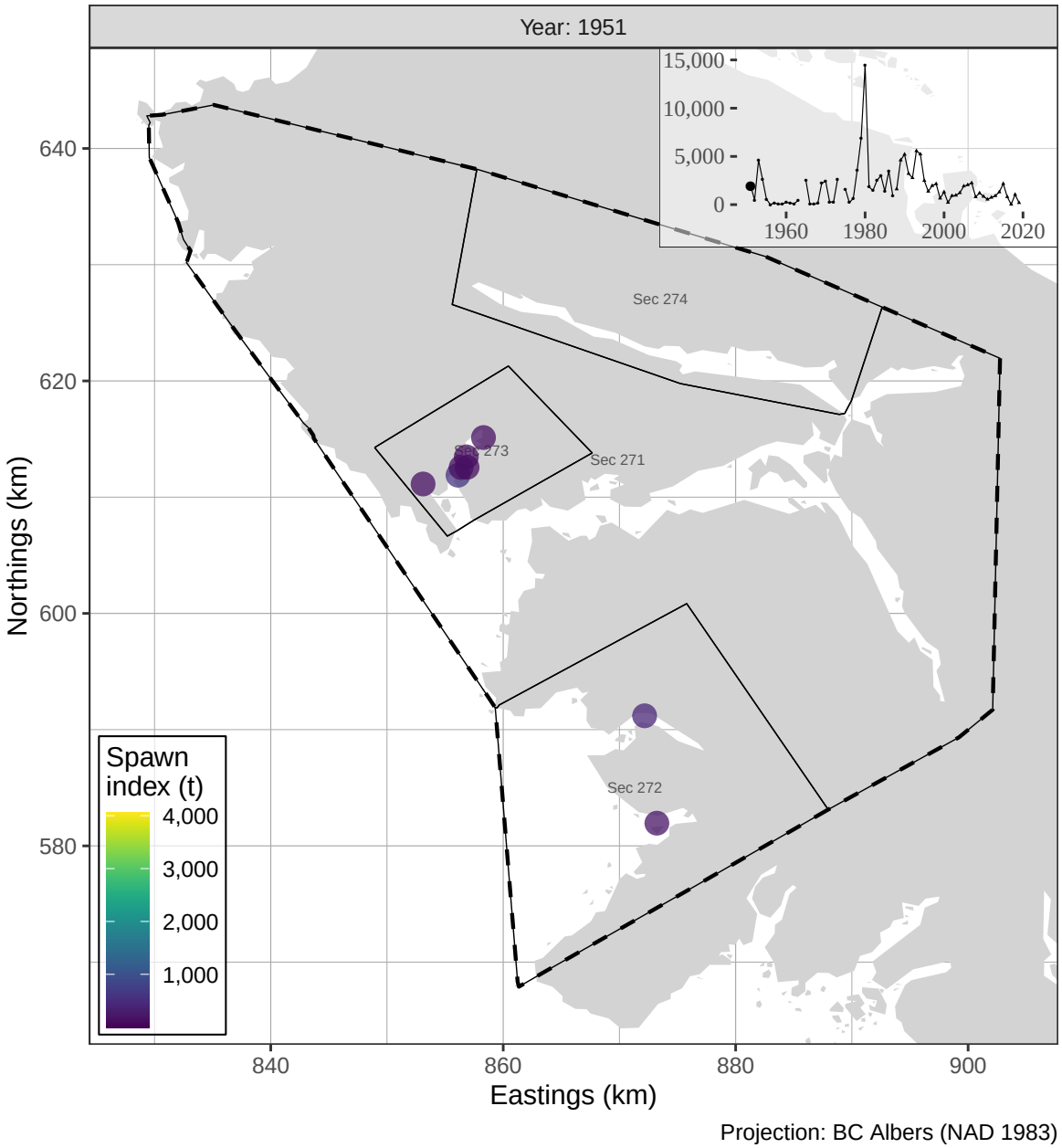

Figure 17. Animation of Pacific Herring spawn index in metric tonnes (t) by Location from 1951 to 2020 in the Area 27 minor stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The spawn index has two distinct periods defined by the dominant survey method: 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).