Pacific Herring preliminary data summary for Prince Rupert District 2019

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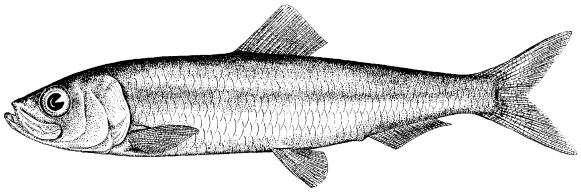

Pacific Herring (*Clupea pallasii*). Image credit: Fisheries and Oceans Canada.

Disclaimer This report contains preliminary data collected for Pacific Herring in 2019 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 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 2019. 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.

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The following is a description of data collected for Pacific Herring in 2019 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 2019 refers to the 2018/2019 Pacific Herring season.

2 Data collection programs

In 2019, biological samples were collected by two seine test vessels:

- The "Nita Maria" collected samples in Big Bay for 13 days from March 16th to March 28th, and
- The "Franciscan No.1" collected samples in Kitkatla for 13 days from March 15th to March 29th.

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. Both vessels were also used as management platforms: "Franciscan No.1" in Kitkatla, and "Nita Maria" in Big Bay. Herring spawn locations were primarily identified using a drone in Statistical Area 4 conducted by DFO Resource Management Area staff. Spawn in Statistical Area 5 was primarily identified by DFO Resource Management Area staff aboard the "Franciscan No.1." One overflight was conducted in early April. The dive charter vessel "Royal Pride" operated a 20-day charter from March 28th to April 16th, surveying spawn throughout the stock area. All three charter vessels were funded by DFO, through a contract to the Herring Conservation Research Society.

3 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 2019 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.

In 2019, 15 Pacific Herring biological samples were collected and processed for the Prince Rupert District major SAR (Table 5, Table 6), and a total of 1,308 Pacific Herring were aged in 2019. The locations in which the biological samples were collected are presented in Figure 5. Included herein are biological summaries of observed proportion-, number-, weight-, and length-at-age (Figure 6, Table 7, and 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.

4 Spawn survey data

Pacific Herring spawn surveys were conducted at 35 individual locations in 2019 in the Prince Rupert District major SAR (Table 8, and Figure 8). A summary of spawn from the last decade (2009 to 2018) is shown in Figure 9. Figure 10 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 11, Figure 12, Figure 13, Table 9, and Figure 14). We describe the calculations used to estimate the spawn index in the draft spawn index techincal report. 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 2019).

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 2019, Section 052 contributed the most to the spawn index (54%). 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 2019 (Figure 17).

5 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:

- Sea surface temperatures were $\sim 9°C$ at Kitkatla, and $\sim 6°C$ degrees in Big Bay. With the cooling temperatures, herring appear to be settling back to traditional

holding patterns and spawn timing.

- Soundings and observed spawns indicated more fish than usual in Kitkatla Inlet.
- Increase in overall length of spawn compared to previous years.
- Spawning occurred around the same time in Big Bay and Kitkatla.
- Compared to last year, spawning was generally more continuous rather than spot spawns. However, spawn intensity was still weak compared to past years.
- There were large extensive spawns around Dries Inlet in Kitkatla for over a week, with spawns out around Cape George and Oona River. Spawns were observed at the North end of Porcher Island, in Hudson's Bay Passage south of Dundas Island, and in Venn Passage outside of Metlakatla. A significant spawn occurred outside Kitkatla Inlet and Freeman Pass, from Cape George to Joachim Point. Moderate spawns reported at Banks Island and Willis Bay prior to the test fishery.
- No spawn observed in Butler's Cove.
- Generally, the egg hatch-out time was back to normal in Kitkatla (2 to 3 weeks), as opposed to 10 days seen with warmer sea surface temperatures. Hatch-out time around Big Bay and outside Tree Bluff was shorter (10 days).
- Test sets in Kitkatla indicated that two waves of fish were encountered. The first wave was present at the beginning of the test charter. The second wave appeared to move in at the end of the test charter, with a mix of juveniles and spawned out fish.
- Herring were observed to be generally smaller than previous years, and gradually increased in size in the Duncan bay/Tugwell Island area.
- The sea lion population appeared to be increased from recent years.

6 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 2019 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 is not included. Note: 'WP' indicates that data are withheld due to privacy concerns.

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 2009 to 2019 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: 'WP' indicates that data are withheld due to privacy concerns.

Year	Harvest (lb)	Spawning biomass (t)
2009	158,198	235
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	15,418	23

Table 5. Number of Pacific Herring biological samples processed from 2009 to 2019 in the Prince Rupert District major stock assessment region (SAR). Each sample is approximately 100 fish.

	Number of samples		
Year	Commercial	Test	Total
2009	32	23	55
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

Table 6. Number and type of Pacific Herring biological samples processed in 2019 in the Prince Rupert District major stock assessment region (SAR). Each sample is approximately 100 fish.

Type	Gear	Use	Number of samples
Commercial	Seine	SOK	2
Test	Seine	Test fishery	13

Table 7. Observed proportion-at-age for Pacific Herring from 2009 to 2019 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.

	Proportion-at-age								
Year	2	3	4	5	6	7	8	9	10
2009	0.003	0.219	0.181	0.445	0.074	0.051	0.012	0.015	0.001
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

Table 8. Pacific Herring spawn survey locations, start date, and spawn index in metric tonnes (t) in 2019 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 11	39
03	033	Grassy Pt	April 11	14
03	033	Port Simpson	April 11	51
03	033	Stumaun Bay	April 11	138
03	033	Village Is	April 11	37
04	041	Melville Is W	March 25	257
04	042	Belletti Pt	March 19	1,466
04	042	Big Bay	March 19	880
04	042	Burnt Cliff Is	March 20	2,084
04	042	Duncan Bay	April 01	1,471
04	042	Finlayson Is W	March 20	349
04	042	Metlakatla Village	April 08	262
04	042	Mist Is	March 20	77
04	042	Observation Pt	April 08	56
04	042	Pearl Hrbr	March 20	299
04	042	Pike Is	April 08	221
04	042	Reeks Pt	March 22	211
04	042	Swamp Is	March 23	2,338
04	042	Tree Bluff	March 23	1,623
04	042	Tugwell Is	March 27	103
04	043	Island Pt	March 31	169
04	043	Oona Rvr	March 29	412
05	052	Cape George	March 27	1,768
05	052	Dries Inlt	March 20	4,553
05	052	Freeman Pass	March 27	476
05	052	Goschen Is	March 28	40
05	052	Gurd Is	March 23	172
05	052	Gurd Pt	March 23	602
05	052	Joachim Spit	March 27	2,701
05	052	Kitkatla Cr	March 21	2,634
05	052	Nubble Pt	March 28	180
05	052	Porcher Pen	March 26	102
05	052	Serpentine Inlt	March 26	96
05	052	Snass Pt	March 21	375
05	052	Wilcox Grp	March 26	933

Table 9. Summary of Pacific Herring spawn survey data from 2009 to 2019 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 2019). 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)
2009	32,360	158	0.4	11,961
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

7 Figures

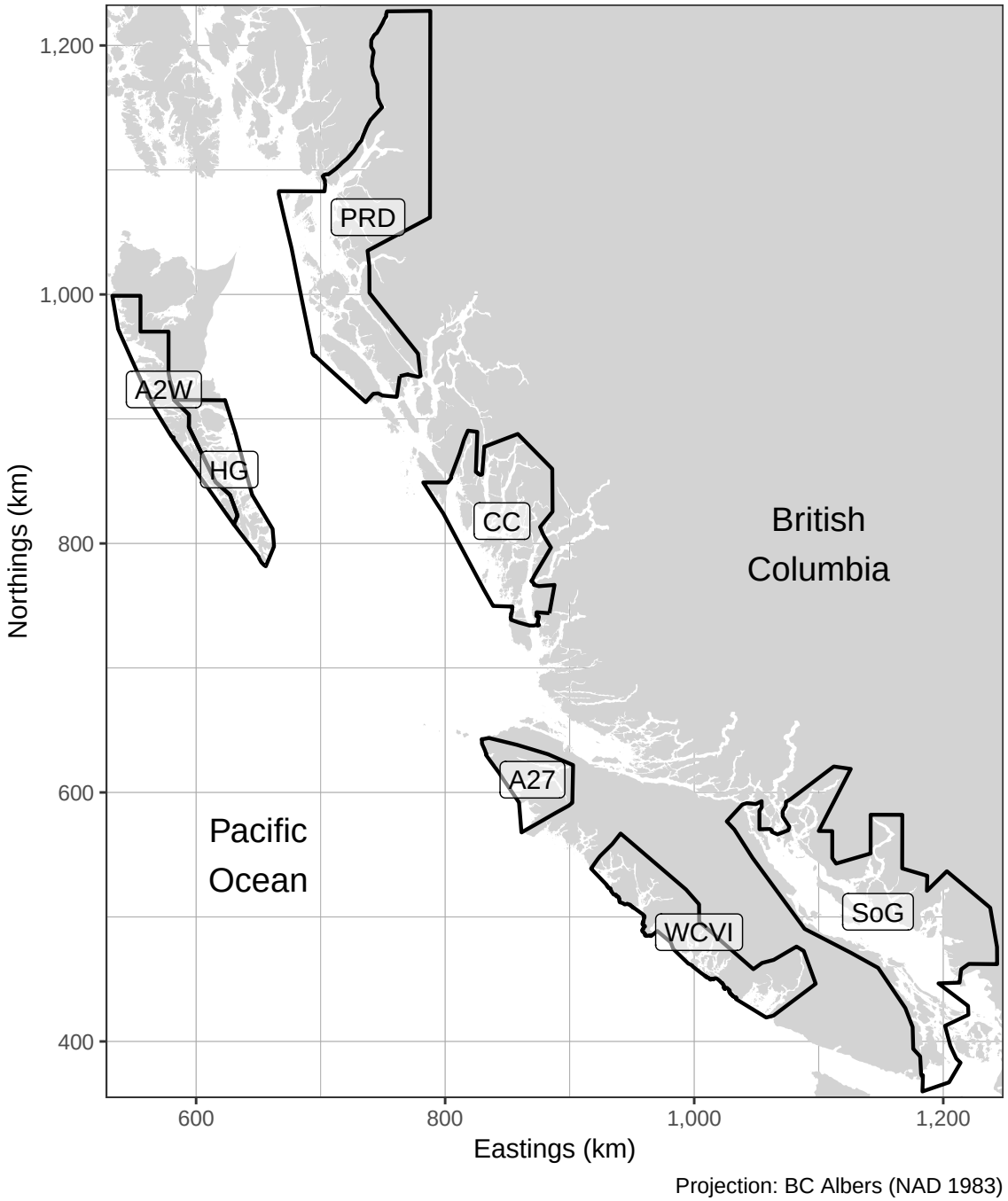

Figure 1. Boundaries for the Pacific Herring stock assessment regions (SARs) in British Columbia. There are 5 major SARs: Haida Gwaii (HG), Prince Rupert District (PRD), Central Coast (CC), Strait of Georgia (SoG), and West Coast of Vancouver Island (WCVI). There are 2 minor SARs: Area 27 (A27) and Area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

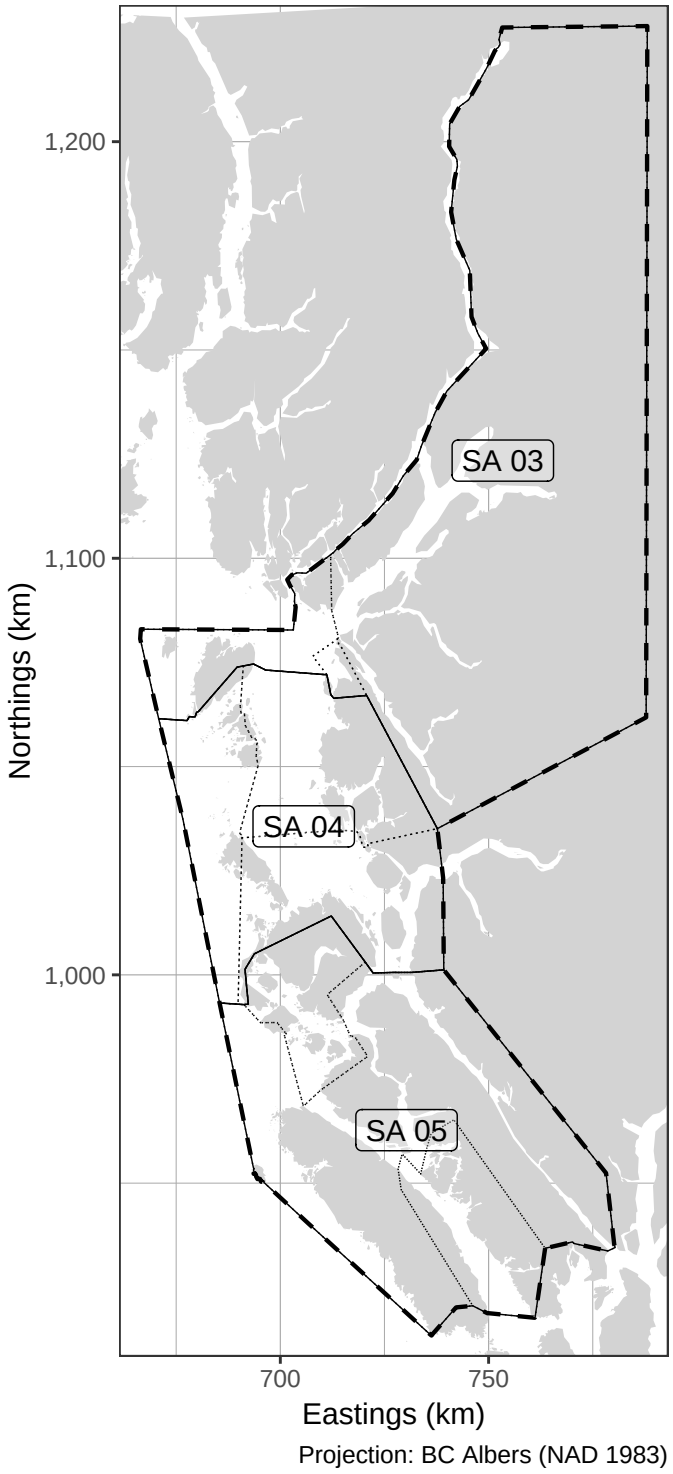

Figure 2. Boundaries for the Prince Rupert District major stock assessment region (SAR; thick dashed lines), associated Statistical Areas (SA; thin solid lines), and associated Sections (thin dotted lines). Units: kilometres (km).

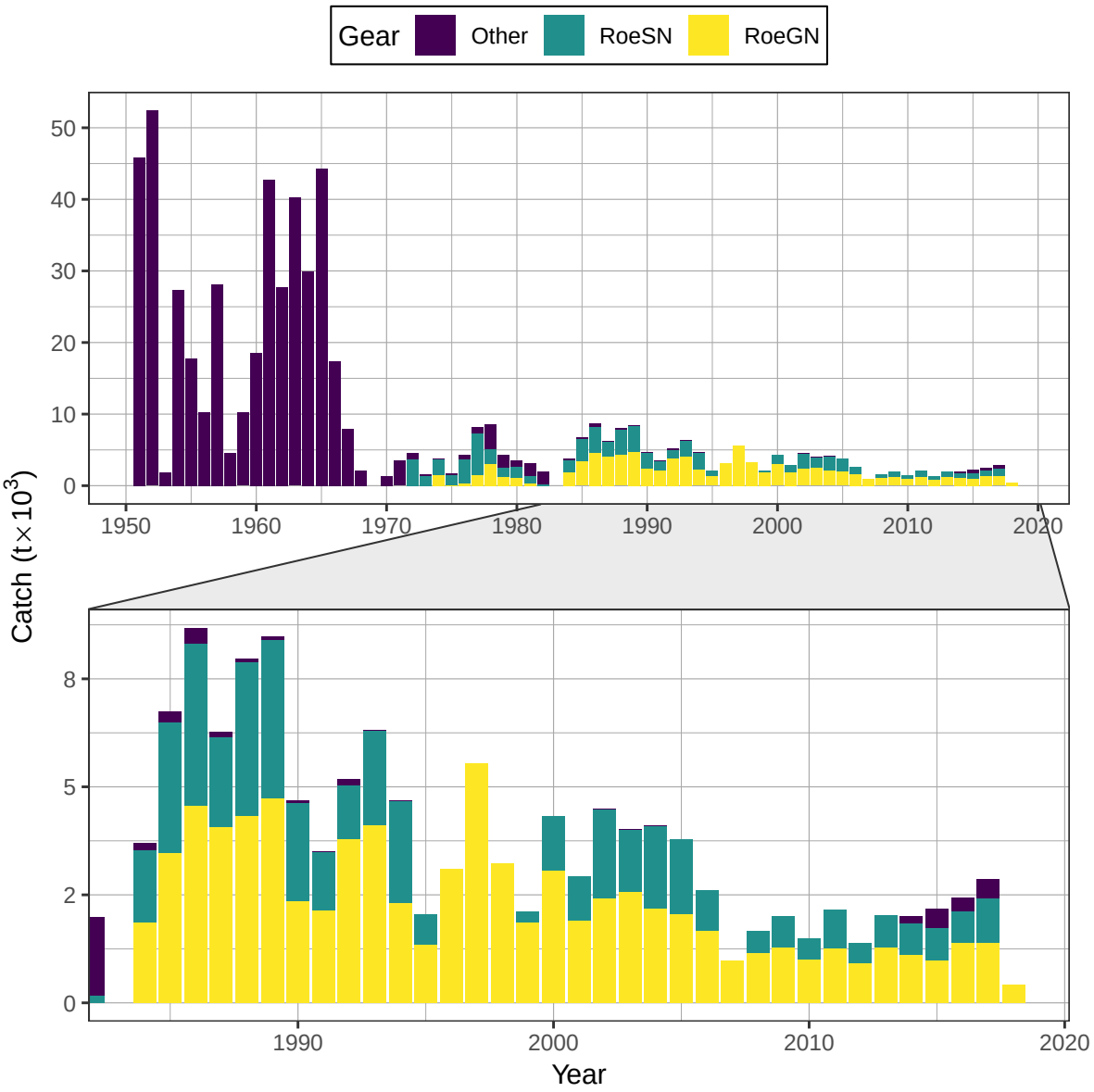

Figure 3. Time series of total landed catch in thousands of metric tonnes ($t \times 10^3$) of Pacific Herring by gear type from 1951 to 2019 in the Prince Rupert District major stock assessment region (SAR). Legend: 'Other' represents the reduction, the food and bait, as well as the special use fishery; 'RoeSN' represents the roe seine fishery; and 'RoeGN' represents the roe gillnet fishery. Data from the spawn-on-kelp (SOK) fishery is not included.

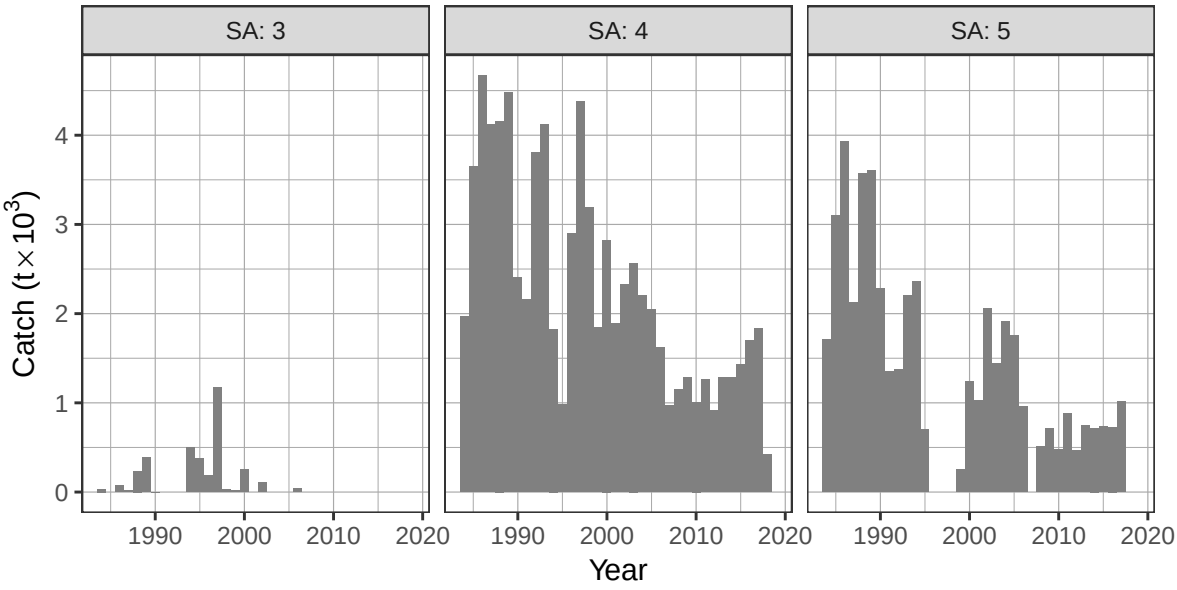

Figure 4. Time series of total landed catch in thousands of metric tonnes ($t \times 10^3$) of Pacific Herring by Statistical Area (SA) from 1984 to 2019 in the Prince Rupert District major stock assessment region (SAR). The year 2019 has a darker bar to facilitate interpretation.

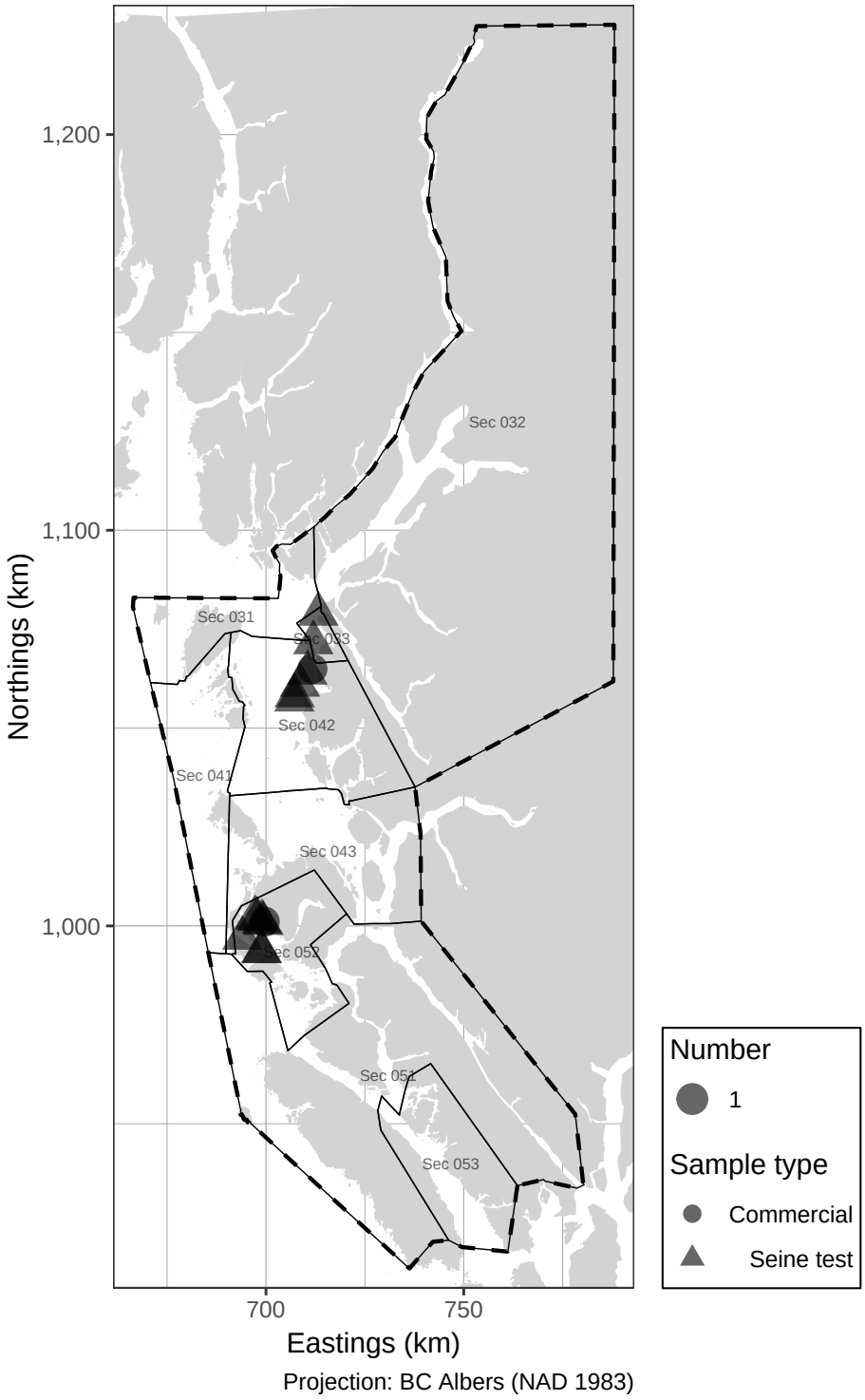

Figure 5. Location and type of Pacific Herring biological samples collected in 2019 in the Prince Rupert District major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). Units: kilometres (km).

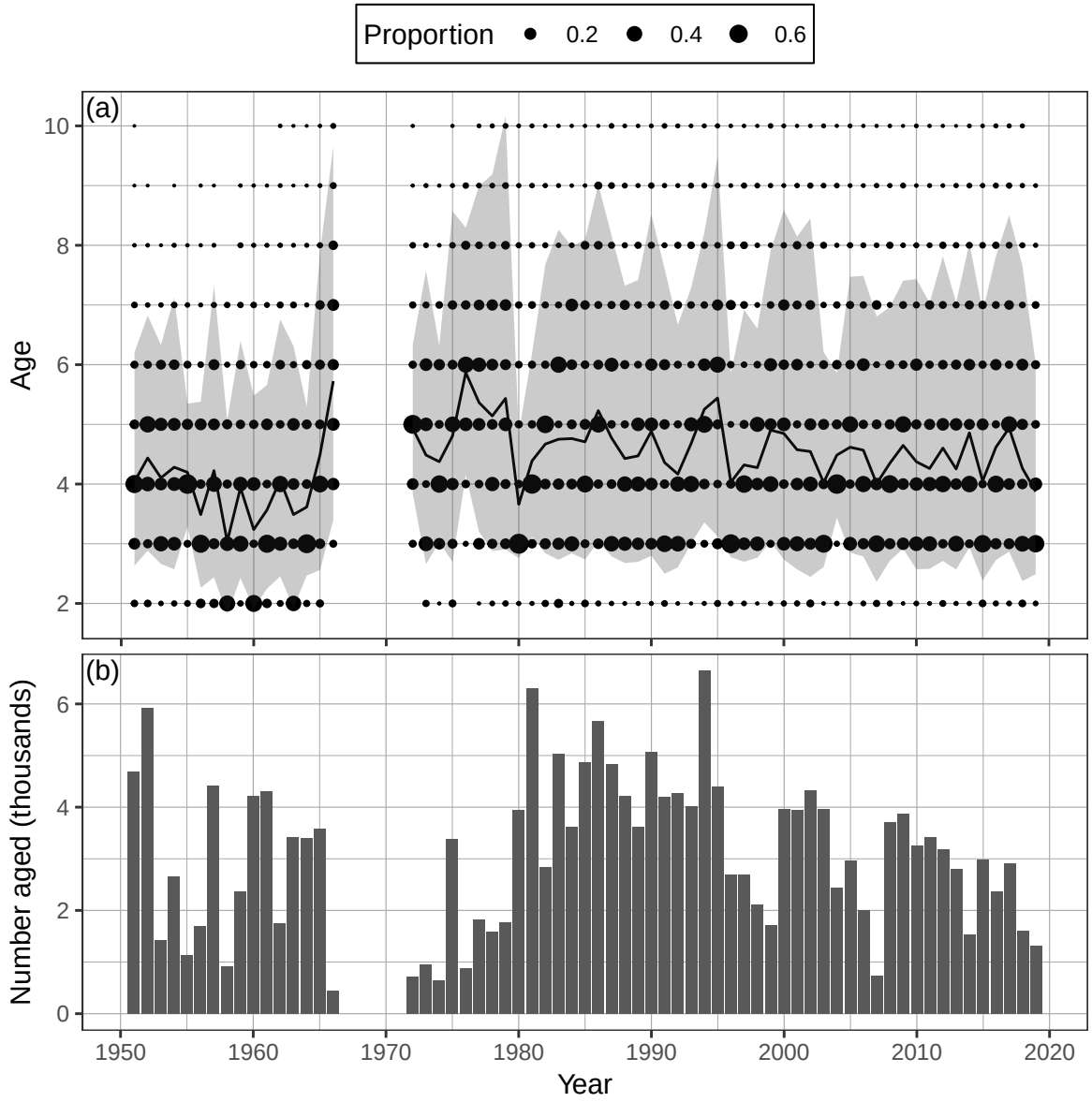

Figure 6. Time series of observed proportion-at-age (a) and number aged in thousands (c) of Pacific Herring from 1951 to 2019 in the Prince Rupert District major stock assessment region (SAR). The black line is the mean age, and the shaded area is the approximate 90% distribution. Biological summaries 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.

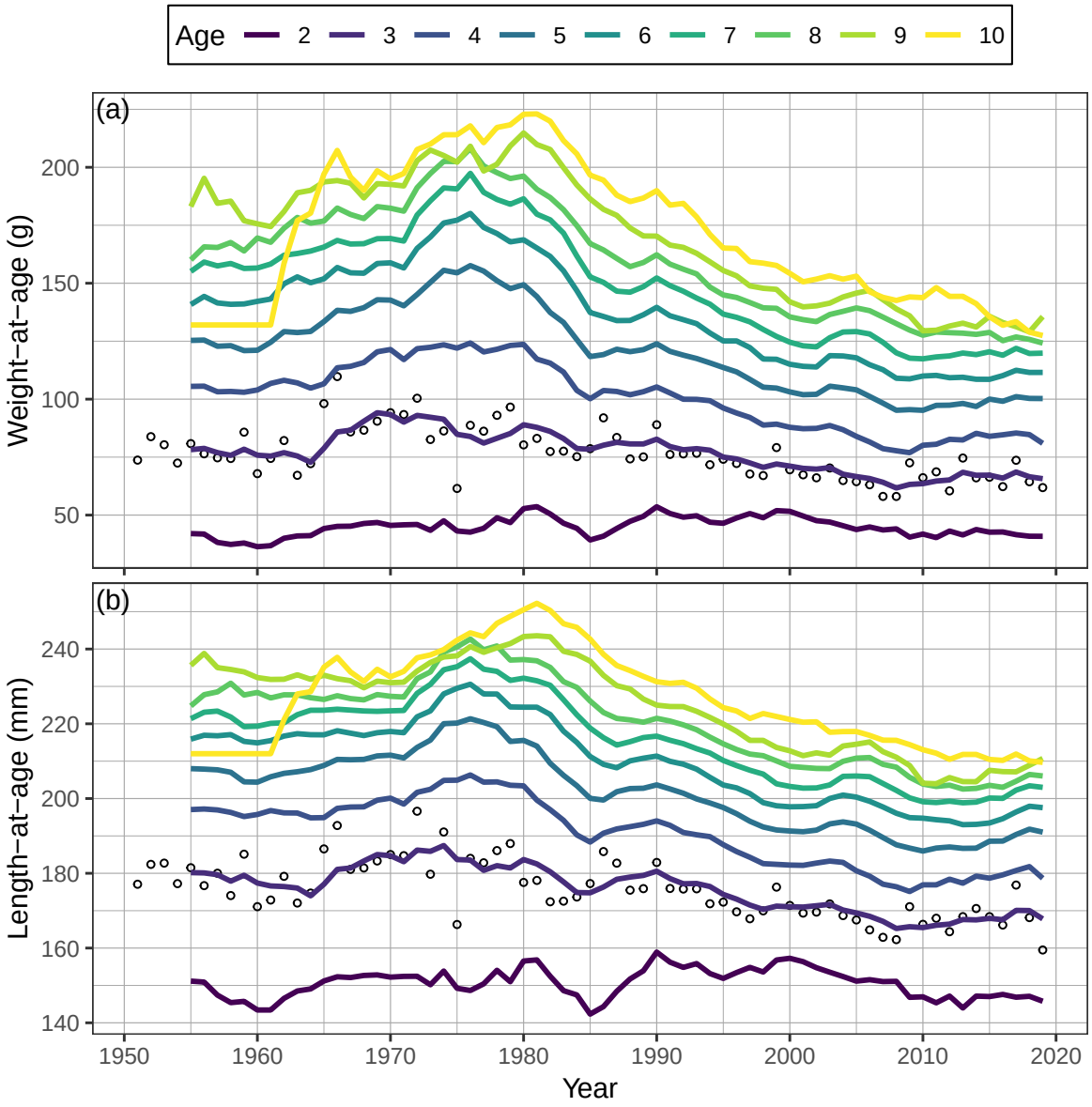

Figure 7. Time series of weight-at-age in grams (g; panel a) and length-at-age in milimetres (mm; panel b) for age-3 (circles) and 5-year running mean weight- and length-at-age (lines) for Pacific Herring from 1951 to 2019 in the Prince Rupert District major stock assessment region (SAR). Missing weight- 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.

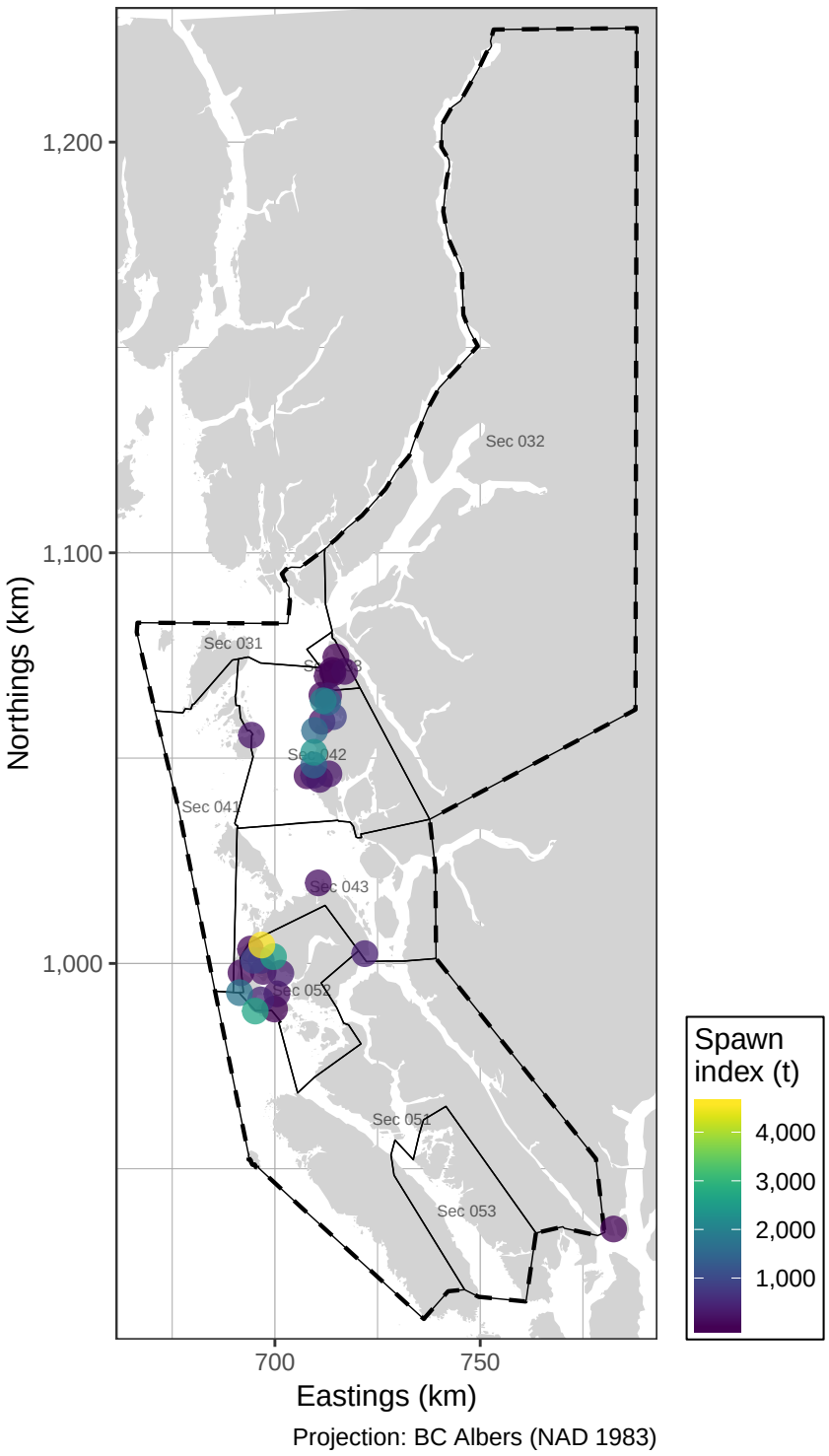

Figure 8. Pacific Herring spawn survey locations, and spawn index in metric tonnes (t) in 2019 in the Prince Rupert District major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values (grey circles) indicate incomplete spawn surveys. Units: kilometres (km).

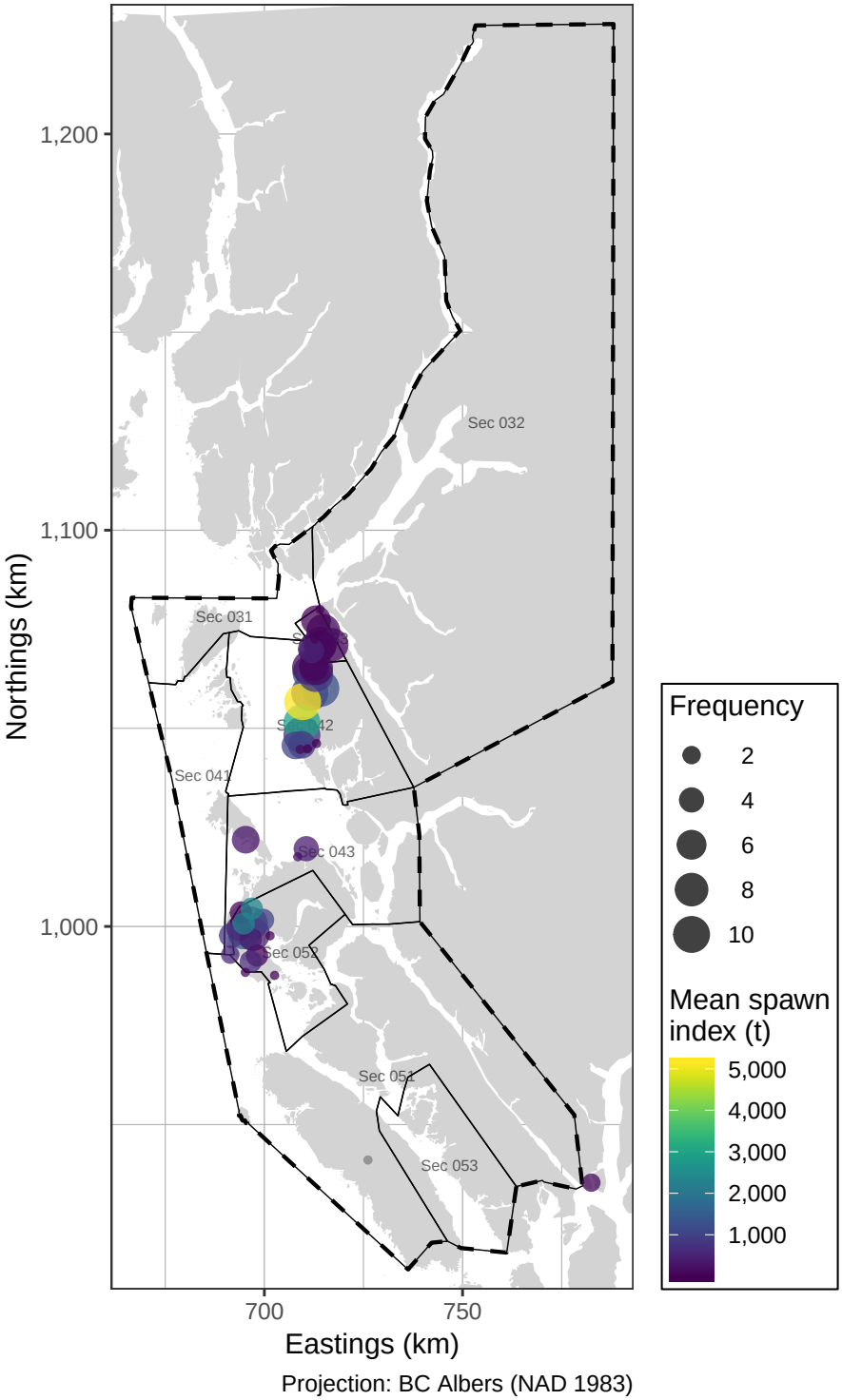

Figure 9. Pacific Herring spawn survey locations, mean spawn index in metric tonnes (t), and spawn frequency from 2009 to 2018 in the Prince Rupert District major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values (grey circles) indicate incomplete spawn surveys. Units: kilometres (km).

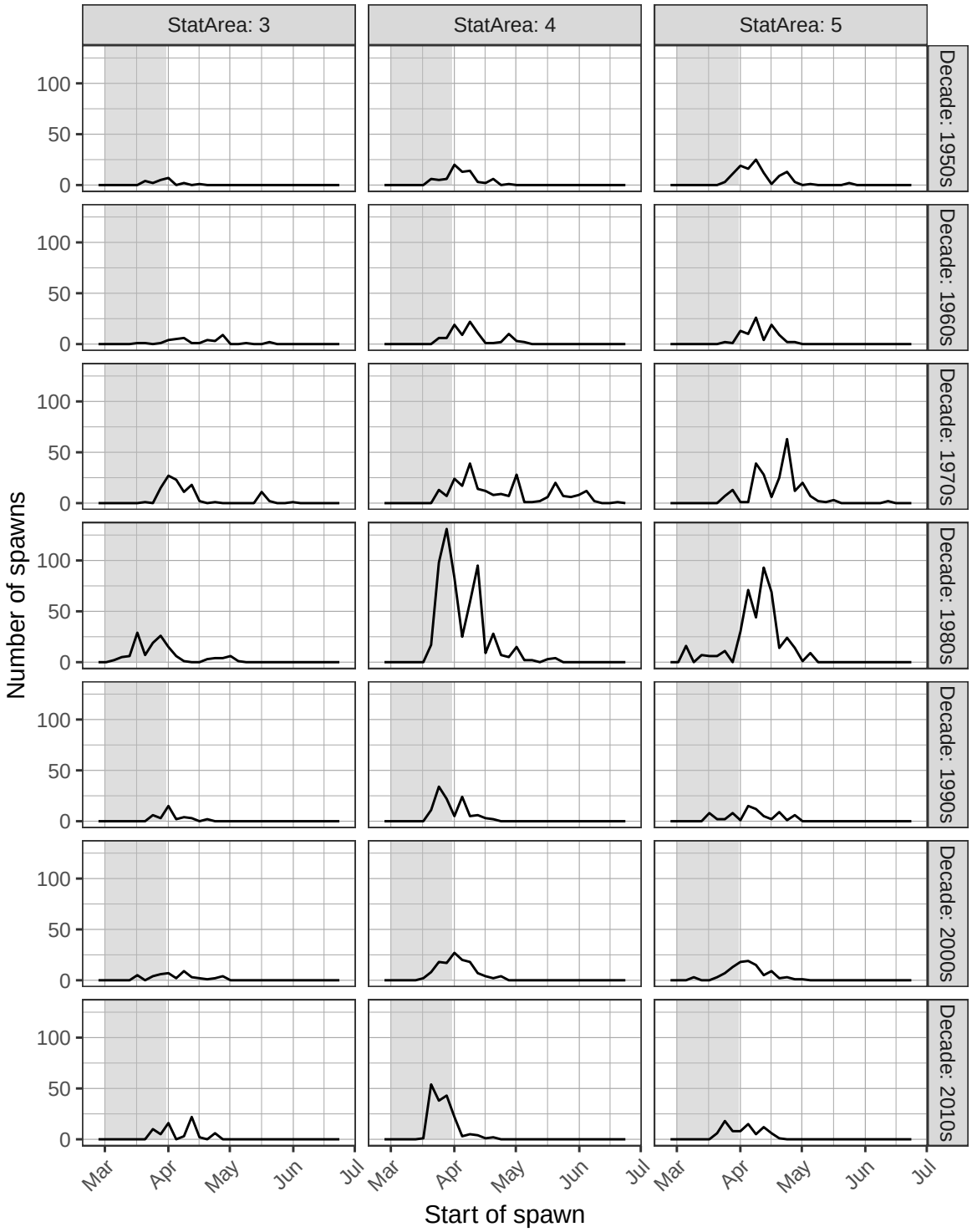

Figure 10. Pacific Herring spawn start date by decade and Statistical Area. Grey shaded regions indicate March 1st to 31st. Note that spawn size and intensity varies; therefore the number of spawns is not directly proportional to spawn extent or biomass.

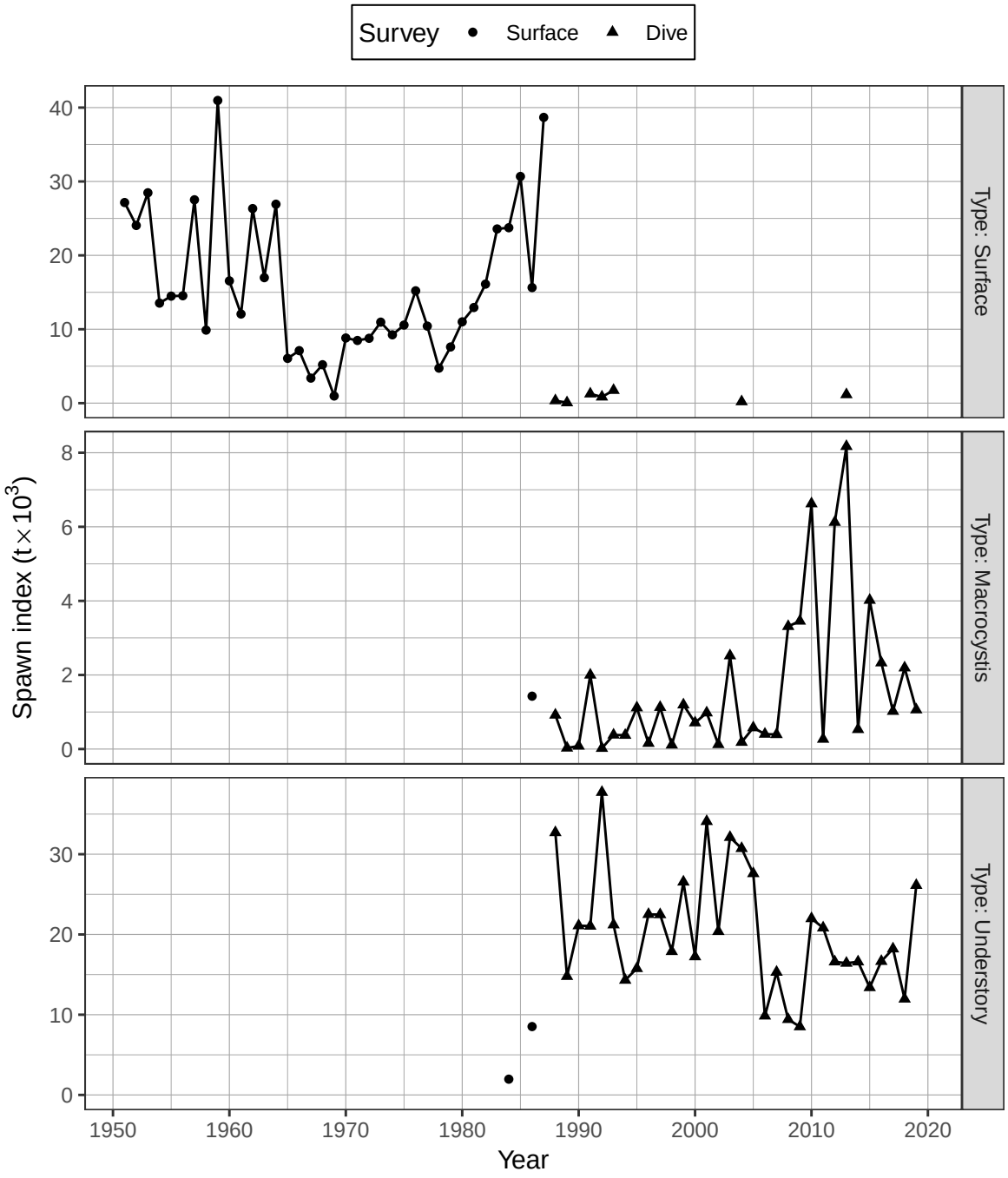

Figure 11. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) by type for Pacific Herring from 1951 to 2019 in the Prince Rupert District major stock assessment region (SAR). There are three types of spawn survey observations: observations of spawn taken from the surface usually 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 2019).

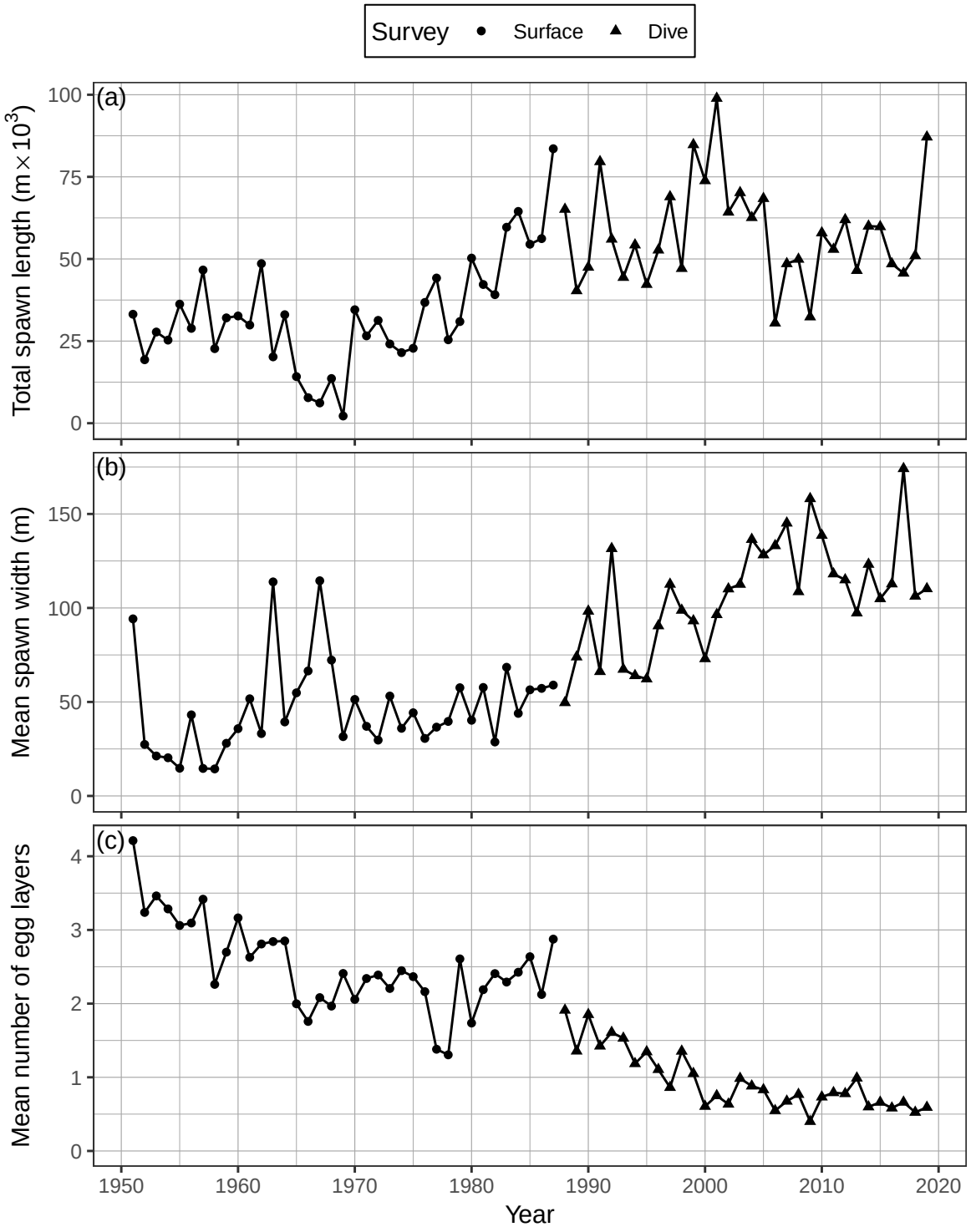

Figure 12. Time series of total spawn length in thousands of metres ($m \times 10^3$; panel a), mean spawn width in metres (b), and mean number of egg layers (c) for Pacific Herring from 1951 to 2019 in the Prince Rupert District major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2019).

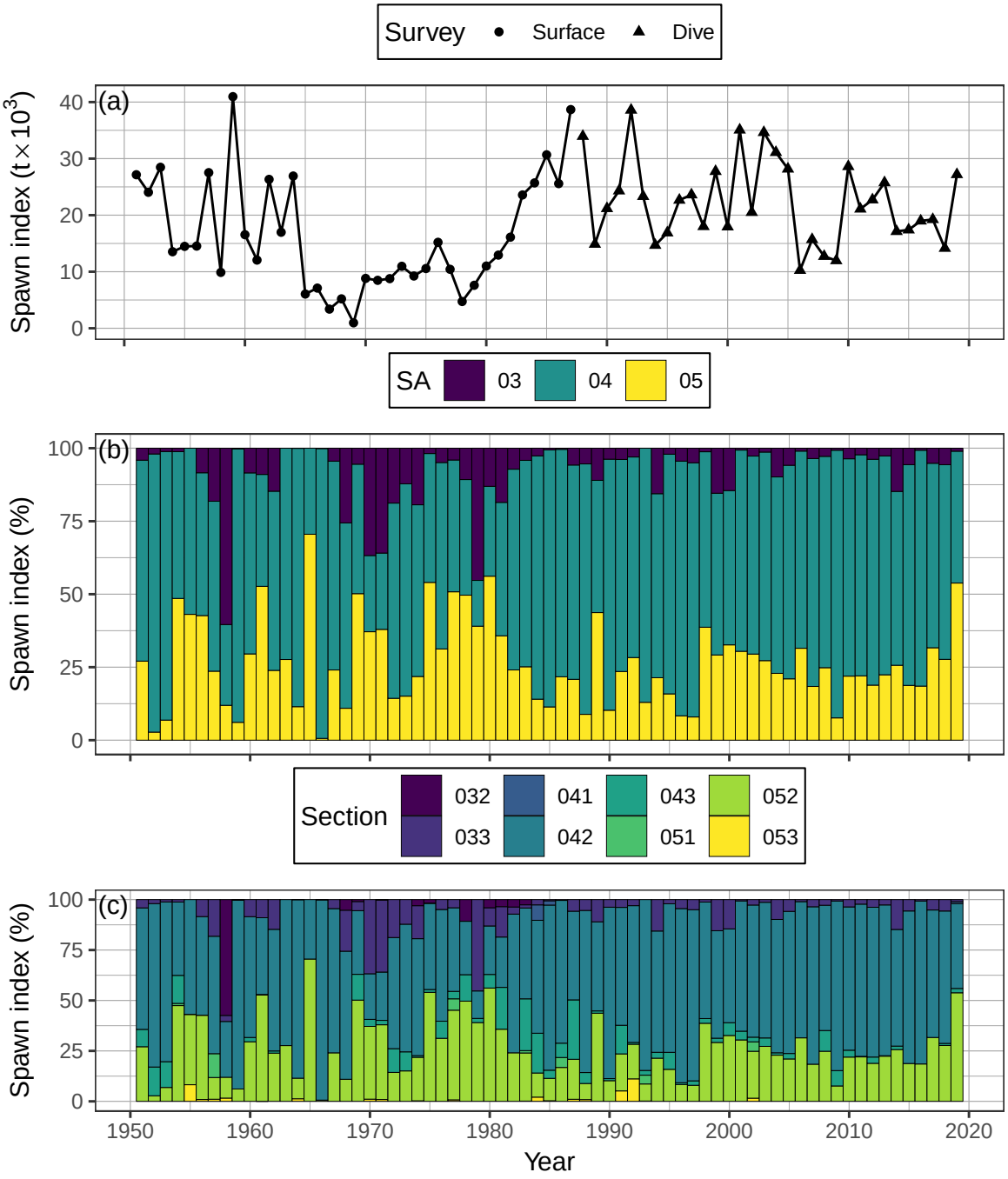

Figure 13. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) for Pacific Herring from 1951 to 2019 in the Prince Rupert District major stock assessment region (SAR; panel a), as well as percent contributed by Statistical Area (SA), and Section (b, & c, respectively). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2019). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

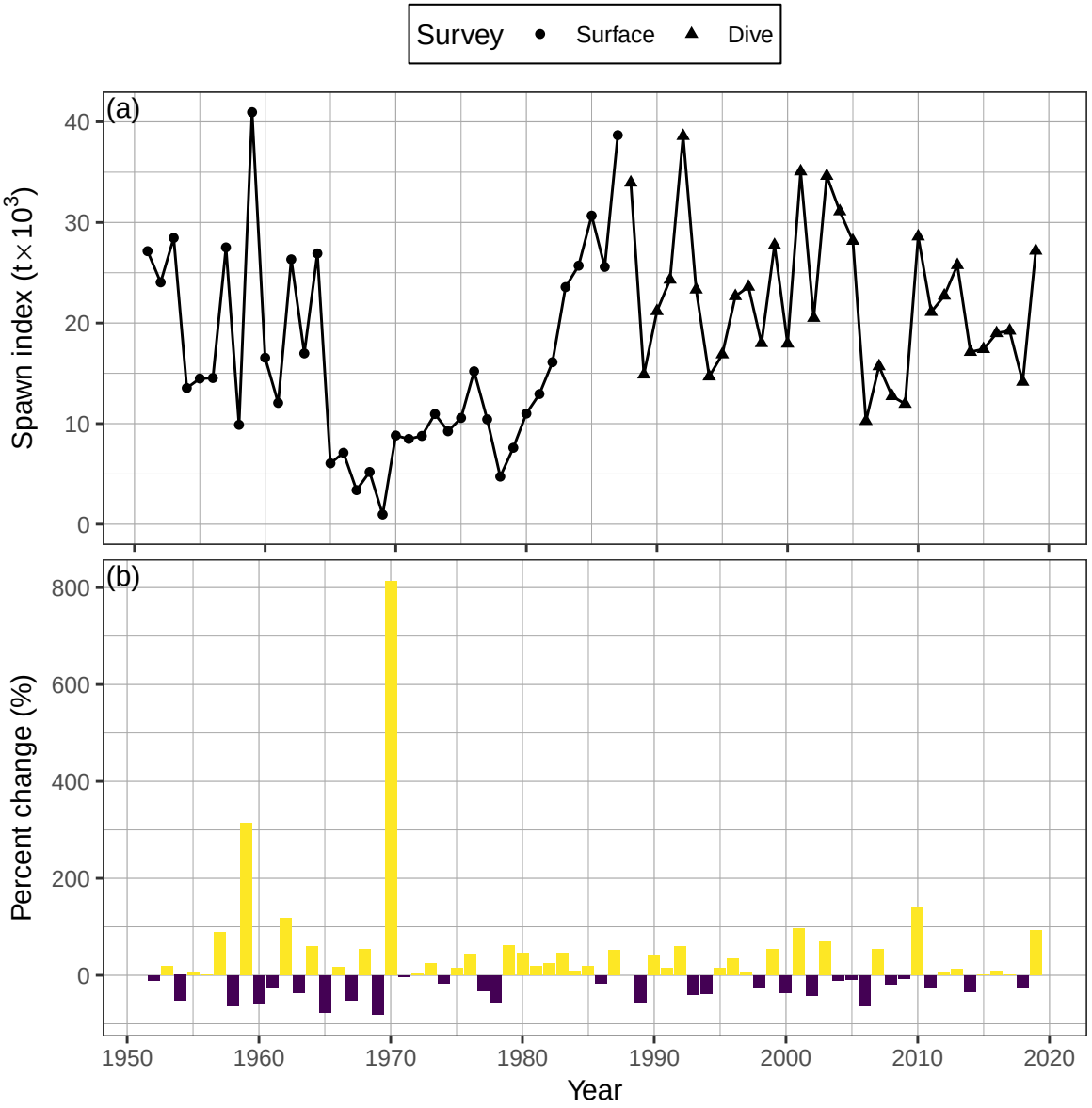

Figure 14. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) for Pacific Herring from1951 to 2019 in the Prince Rupert District major stock assessment region (SAR; panel a), and percent change (b). We calculate percent change as $\delta_t = \frac{I_t - I_{t-1}}{I_{t-1}}$ where I_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 2019). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

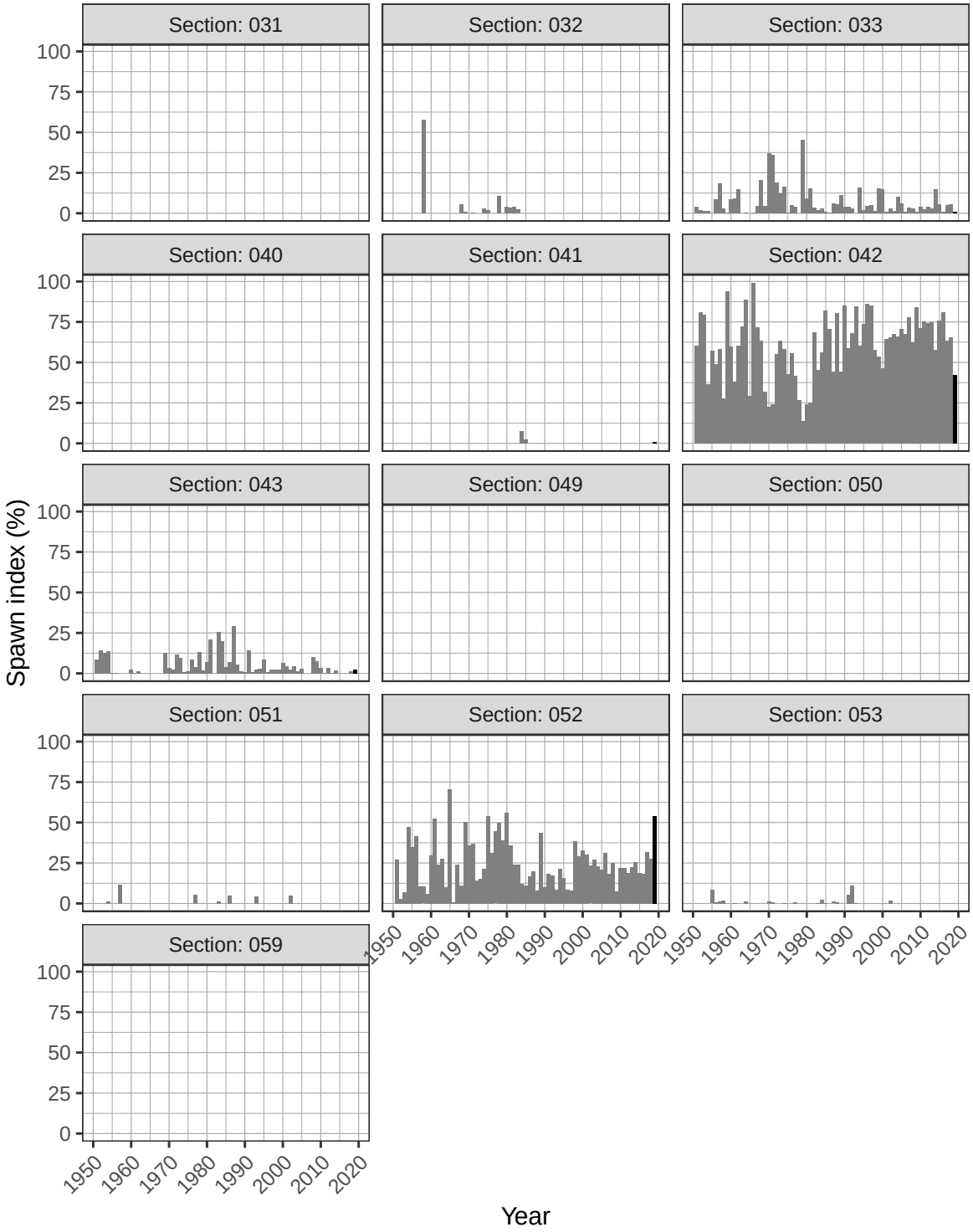

Figure 15. Time series of percent of spawn index by Section for Pacific Herring from 1951 to 2019 in the Prince Rupert District major stock assessment region (SAR). The year 2019 has a darker bar to facilitate interpretation. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2019). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

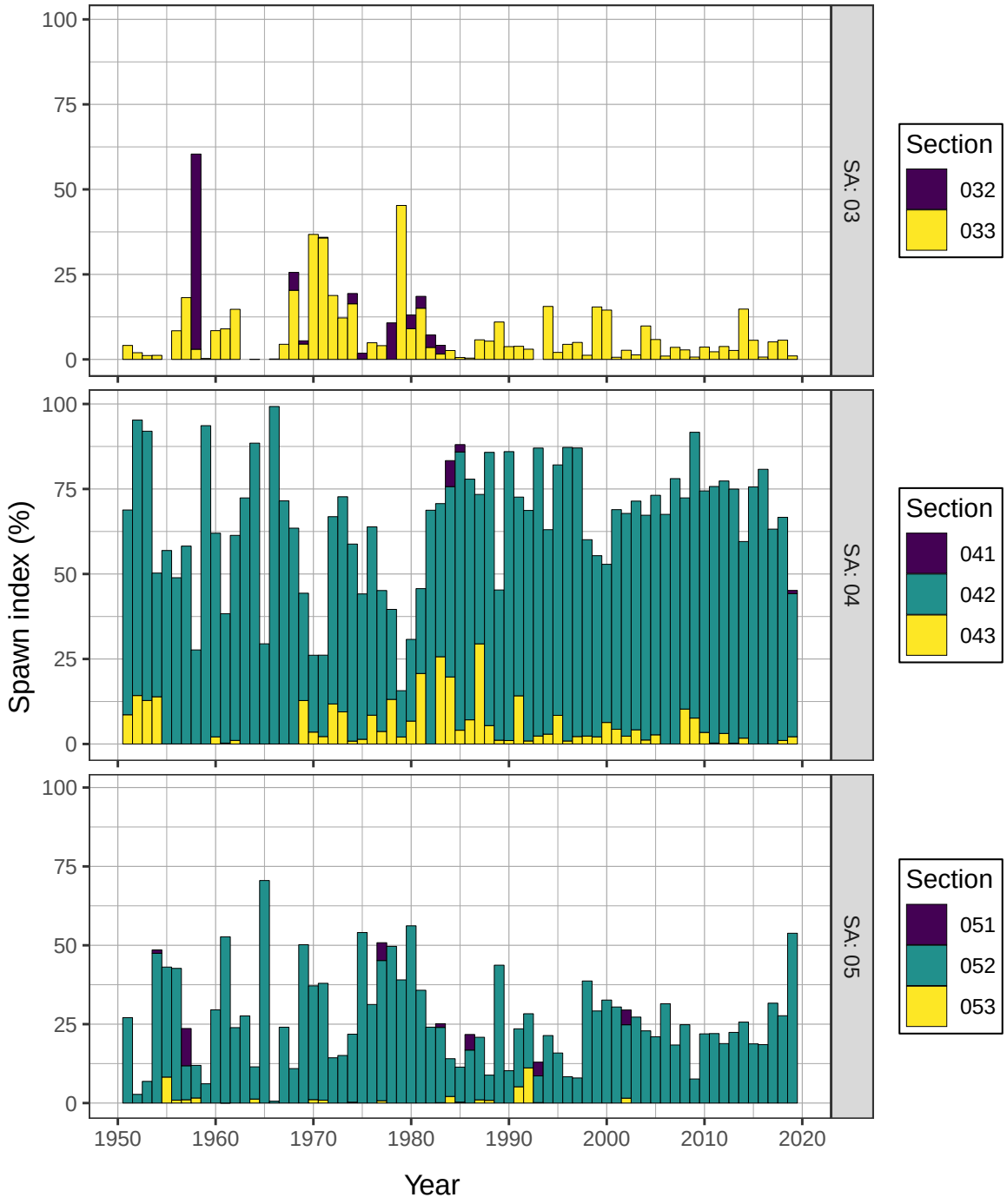

Figure 16. Time series of percent of spawn index by Statistical Area (SA) and Section for Pacific Herring from 1951 to 2019 in the Prince Rupert District major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2019). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

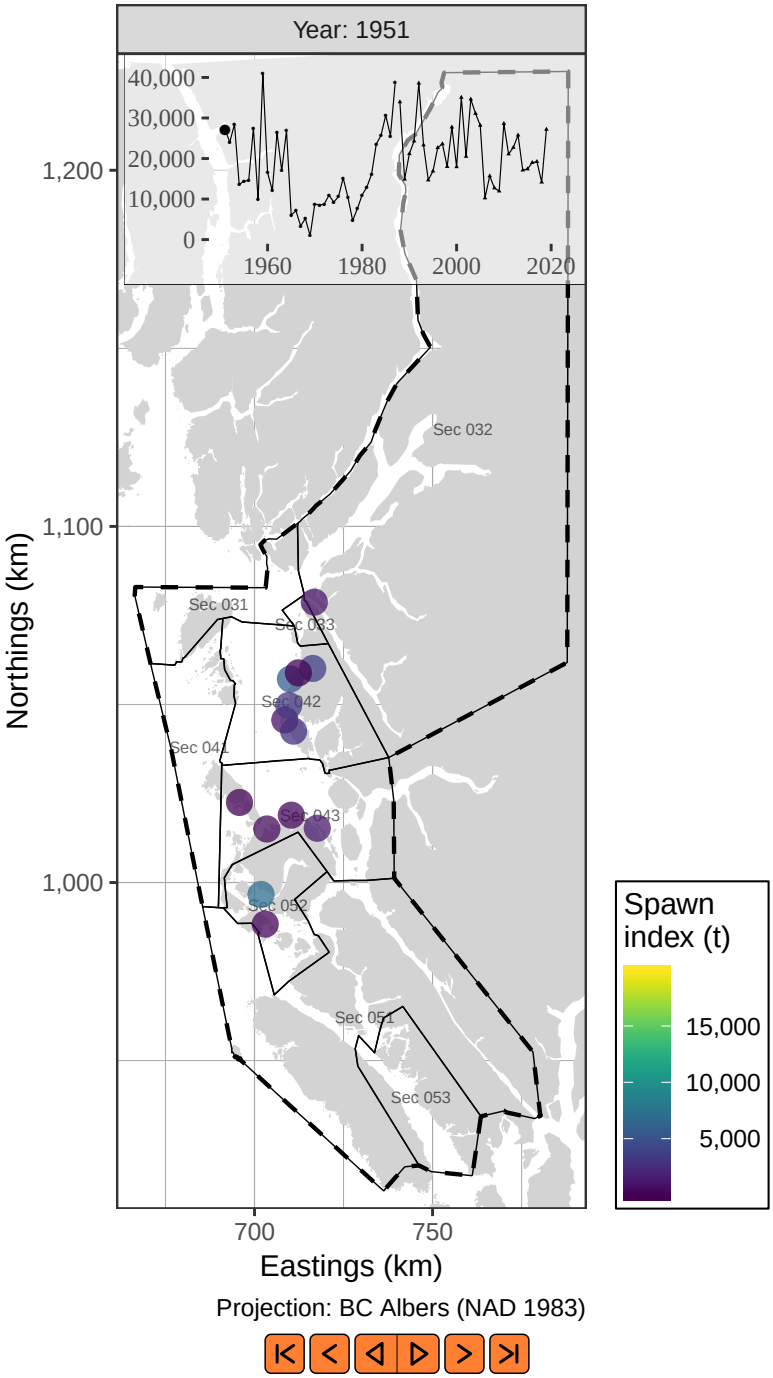

Figure 17. Animation of Pacific Herring spawn survey locations and spawn index in metric tonnes (t) from 1951 to 2019 in the Prince Rupert District major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2019). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values (grey circles) indicate incomplete spawn surveys. The inset shows the total spawn index by year. Units: kilometres (km).