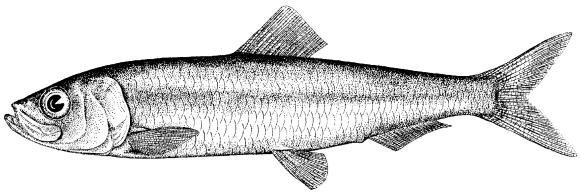
Pacific Herring preliminary data summary for Haida Gwaii 2022

Jaclyn Cleary* Matthew Grinnell†

July 21, 2022



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

Disclaimer This report contains preliminary data collected for Pacific Herring in 2022 in the Haida Gwaii major stock assessment region (SAR). These data may differ from data used and presented in the final stock assessment.

---

1 COVID-19 pandemic

Compared to 2020 and 2021, the COVID-19 pandemic had fewer impacts to Pacific Herring data collection and analysis in 2022. Spawn surveys proceeded as usual in most areas in 2022. The collection and analysis of biological data was not affected by the COVID-19 pandemic in 2022.

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

*DFO Science, Pacific Biological Station (email: Jaclyn.Cleary@dfo-mpo.gc.ca).
†DFO Science, Pacific Biological Station (email: Matthew.Grinnell@dfo-mpo.gc.ca).

this scale (Table 1, Figure 1). The Pacific Herring data collection program includes fishery-dependent and -independent data from 1951 to 2022. 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 2022 in the Haida Gwaii 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 2022 refers to the 2021/2022 Pacific Herring season.

3 Data collection programs

In 2022, biological samples were collected by the *Queens Reach*, a seine test charter vessel funded by DFO. The primary purpose of the test charter vessel was to collect biological samples from main bodies of herring from Haida Gwaii major (priority) and Area 2W minor stock areas, identified from soundings. The *Queens Reach* operated a 25 day charter from March 9th to April 2nd, collecting samples from HG and Area 2 West. The *Haida Spirit* operated an 18 day dive charter from April 8th to April 25th. The *Victoria Rose* operated a spawn reconnaissance charter for 19 days from April 1st to April 19th with some surface survey and drop-camera survey work.

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 2022 in the Haida Gwaii major

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 2022, 9 Pacific Herring biological samples were collected and processed for the Haida Gwaii major SAR (Table 5, Table 6), and a total of 818 Pacific Herring were aged in 2022. The locations in which the biological samples were collected are presented in Figure 4. 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 19 individual locations in 2022 in the Haida Gwaii major SAR (Table 8, and Figure 9). A summary of spawn from the last decade (2012 to 2021) 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 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 coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022).

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 2022, Section 025 contributed the most to the spawn index (57%). 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 2022 (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:

- Major stock assessment area sounding estimates were similar to 2021 but spawn abundance (area and number of layers) appeared to be considerably lower than

the previous two years.

- Water temperatures (test setting vessel) were similar to the previous two years.
- Spawn timing was several days earlier than in 2021 and closer to the historical average.
- Once again, the main spawning concentrations were in Skincuttle Inlet and around Burnaby Island with only one smaller spawn occurring in Juan Perez Sound (Sedgwick Bay).
- Observations suggested fewer whales (Humpback and Gray) and Sea Lions were present than in 2021.
- Although less Humpback whales were present than in 2021 they were very focused on the limited number of pre-spawning aggregations, which limited test setting opportunities.
- All observed spawns in the major area were assessed by dive. Independent surface assessments were performed in 87 duplicate transects by the reconnaisance vessel. Video assessments were performed on three transects. Both the surface and video assessment methodologies were compared to diver collected data to assess overlaps, similarities, and differences.

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 Haida Gwaii major stock assessment region (SAR).

Region	Statistical Area	Section
Haida Gwaii	00	006
Haida Gwaii	02	021
Haida Gwaii	02	023
Haida Gwaii	02	024
Haida Gwaii	02	025

Table 3. Total landed commercial catch of Pacific Herring in metric tonnes (t) by gear type in 2022 in the Haida Gwaii major stock assessment region (SAR). Legend: 'Other' represents the reduction (1951 to 1970 only), 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 2012 to 2022 in the Haida Gwaii major 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)
2012	0	0
2013	0	0
2014	0	0
2015	0	0
2016	0	0
2017	0	0
2018	0	0
2019	0	0
2020	0	0
2021	0	0
2022	0	0

Table 5. Number of Pacific Herring biological samples processed from 2012 to 2022 in the Haida Gwaii major stock assessment region (SAR). Each sample is approximately 100 fish. Note: Nearshore samples are not used in stock assessments.

	Number of samples			
Year	Commercial	Test	Nearshore	Total
2012	0	9	0	9
2013	0	12	0	12
2014	0	12	0	12
2015	0	11	0	11
2016	0	5	0	5
2017	0	8	0	8
2018	0	11	0	11
2019	0	10	0	10
2020	0	12	0	12
2021	0	11	0	11
2022	0	9	0	9

Table 6. Number and type of Pacific Herring biological samples processed in 2022 in the Haida Gwaii major stock assessment region (SAR). Each sample is approximately 100 fish.

Type	Gear	Use	Number of samples
Test	Seine	Test fishery	9

Table 7. Observed proportion-at-age for Pacific Herring from 2012 to 2022 in the Haida Gwaii 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
2012	0.174	0.148	0.380	0.040	0.203	0.018	0.030	0.002	0.004
2013	0.000	0.677	0.125	0.128	0.019	0.041	0.005	0.004	0.000
2014	0.014	0.037	0.684	0.115	0.094	0.014	0.034	0.005	0.003
2015	0.034	0.218	0.055	0.519	0.059	0.079	0.018	0.014	0.004
2016	0.166	0.162	0.170	0.058	0.376	0.044	0.020	0.002	0.002
2017	0.138	0.322	0.100	0.112	0.050	0.200	0.049	0.015	0.014
2018	0.045	0.404	0.242	0.098	0.063	0.072	0.070	0.004	0.002
2019	0.018	0.540	0.312	0.077	0.022	0.018	0.012	0.001	0.000
2020	0.006	0.020	0.751	0.159	0.043	0.013	0.006	0.002	0.001
2021	0.027	0.028	0.039	0.711	0.143	0.036	0.012	0.001	0.003
2022	0.021	0.281	0.031	0.065	0.527	0.072	0.001	0.002	0.000

Table 8. Pacific Herring spawn survey locations, start date, and spawn index in metric tonnes (t) in 2022 in the Haida Gwaii major stock assessment region (SAR). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values indicate incomplete surveys (NAs).

Statistical Area	Section	Location name	Start date	Spawn index (t)
02	021	Alder Is	April 01	3
02	021	Alder Is Cr	March 25	3
02	021	Kat Is	March 25	697
02	021	Nomad Islet	March 26	183
02	021	Scudder Pt	April 01	553
02	021	Sedgwick Bay	April 10	23
02	023	Kitson Pt	April 02	10
02	024	Little Goose	April 10	185
02	024	Powrivco Bay	March 30	120
02	024	Traynor Cr	April 10	480
02	025	Bolkus Is	March 28	39
02	025	Boulder Is	March 28	285
02	025	Huston Pt	March 28	292
02	025	Kingfisher Cv	March 28	32
02	025	Poole Inlt	March 30	200
02	025	Rebecca Pt	March 30	65
02	025	Slim Inlt	March 28	1,264
02	025	Swan Bay	March 28	363
02	025	Tangle Cv	March 29	484

Table 9. Summary of Pacific Herring spawn survey data from 2012 to 2022 in the Haida Gwaii major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022). 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)
2012	54,610	28	1.1	9,720
2013	70,300	33	1.7	16,025
2014	52,900	57	0.9	10,566
2015	57,150	55	1.4	13,102
2016	30,345	54	1.1	6,888
2017	31,350	62	0.9	3,016
2018	35,575	44	1.1	4,588
2019	77,965	40	1.4	11,624
2020	47,950	75	2.8	20,423
2021	48,300	79	2.0	18,234
2022	33,250	57	1.0	5,281

8 Figures

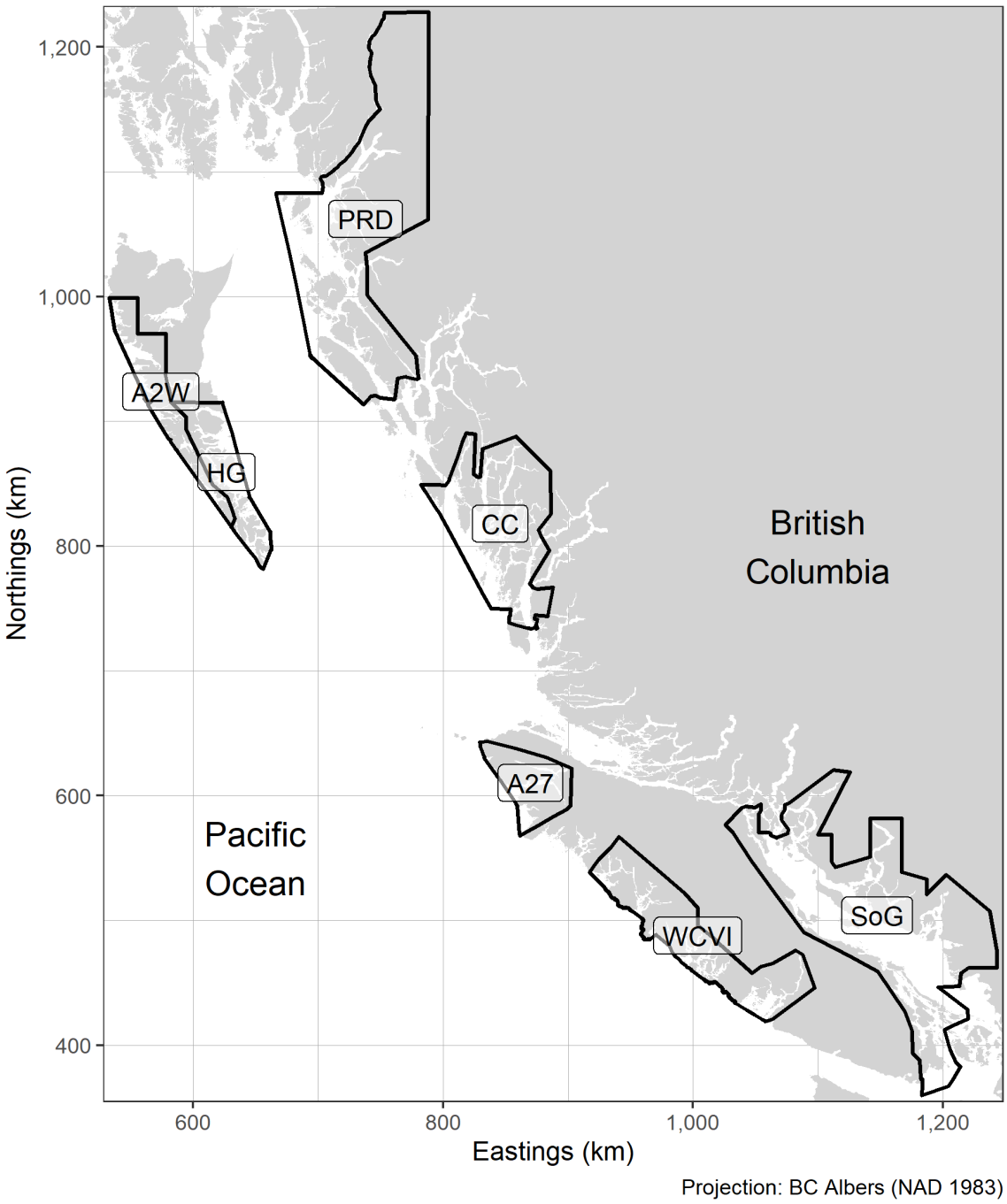


Figure 1. Boundaries for the Pacific Herring stock assessment regions (SARs) in British Columbia. There are 5 major SARs: Haida Gwaii (HG), Prince Rupert District (PRD), Central Coast (CC), Strait of Georgia (SoG), and West Coast of Vancouver Island (WCVI). There are 2 minor SARs: Area 27 (A27) and Area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

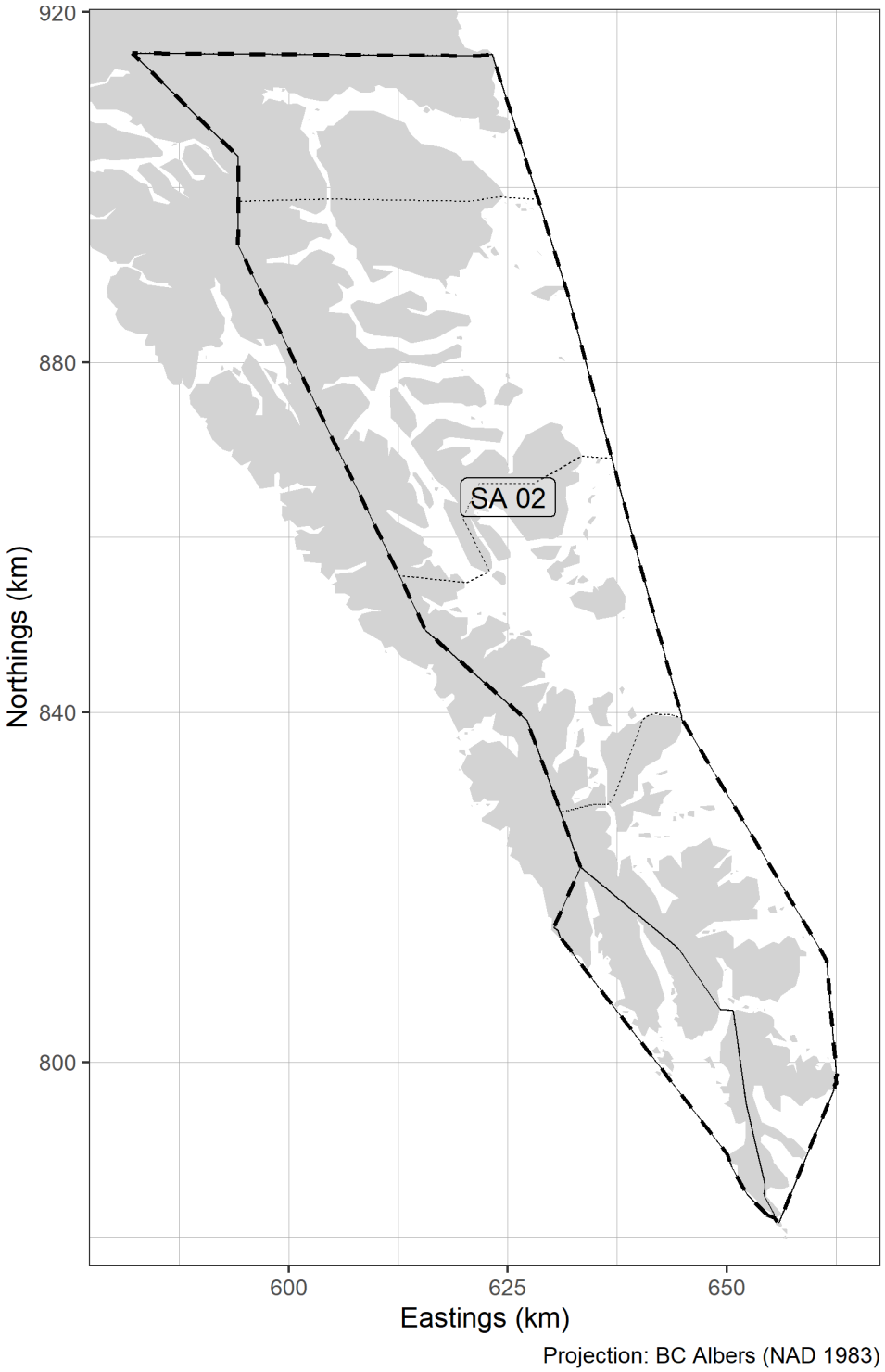


Figure 2. Boundaries for the Haida Gwaii major stock assessment region (SAR; thick dashed lines), associated Statistical Areas (SA; thin solid lines), and associated Sections (thin dotted lines). Units: kilometres (km).

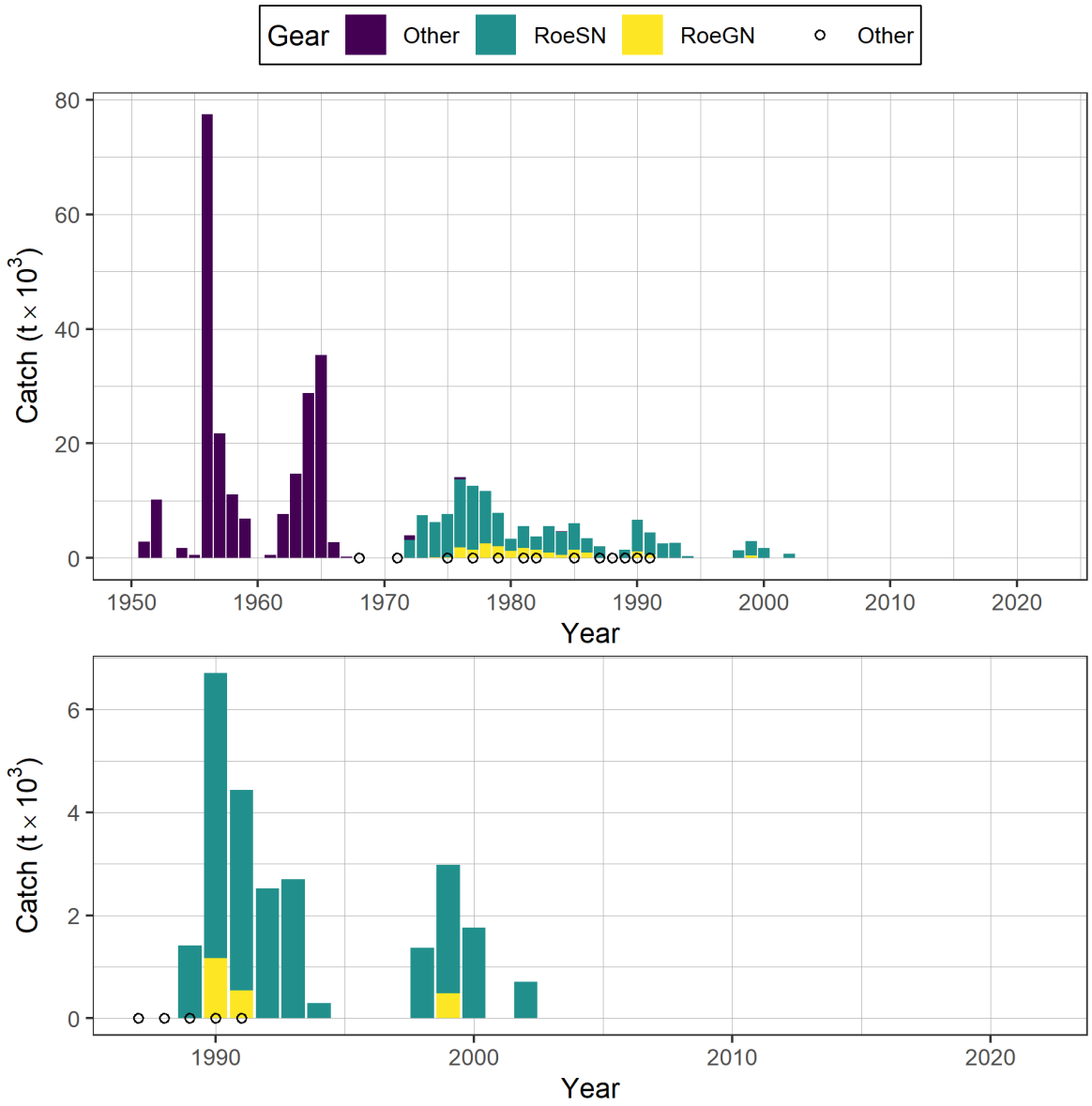


Figure 3. Time series of total landed catch in thousands of metric tonnes (t $\times$ 10^3) of Pacific Herring by gear type from 1951 to 2022 in the Haida Gwaii major stock assessment region (SAR). Legend: 'Other' represents the reduction (1951 to 1970 only), the food and bait, as well as the special 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. Bottom panel shows catch since 1987 in more detail. Note: symbols indicate years in which catch by gear type (i.e., Other, RoeSN, RoeGN) is withheld due to privacy concerns.

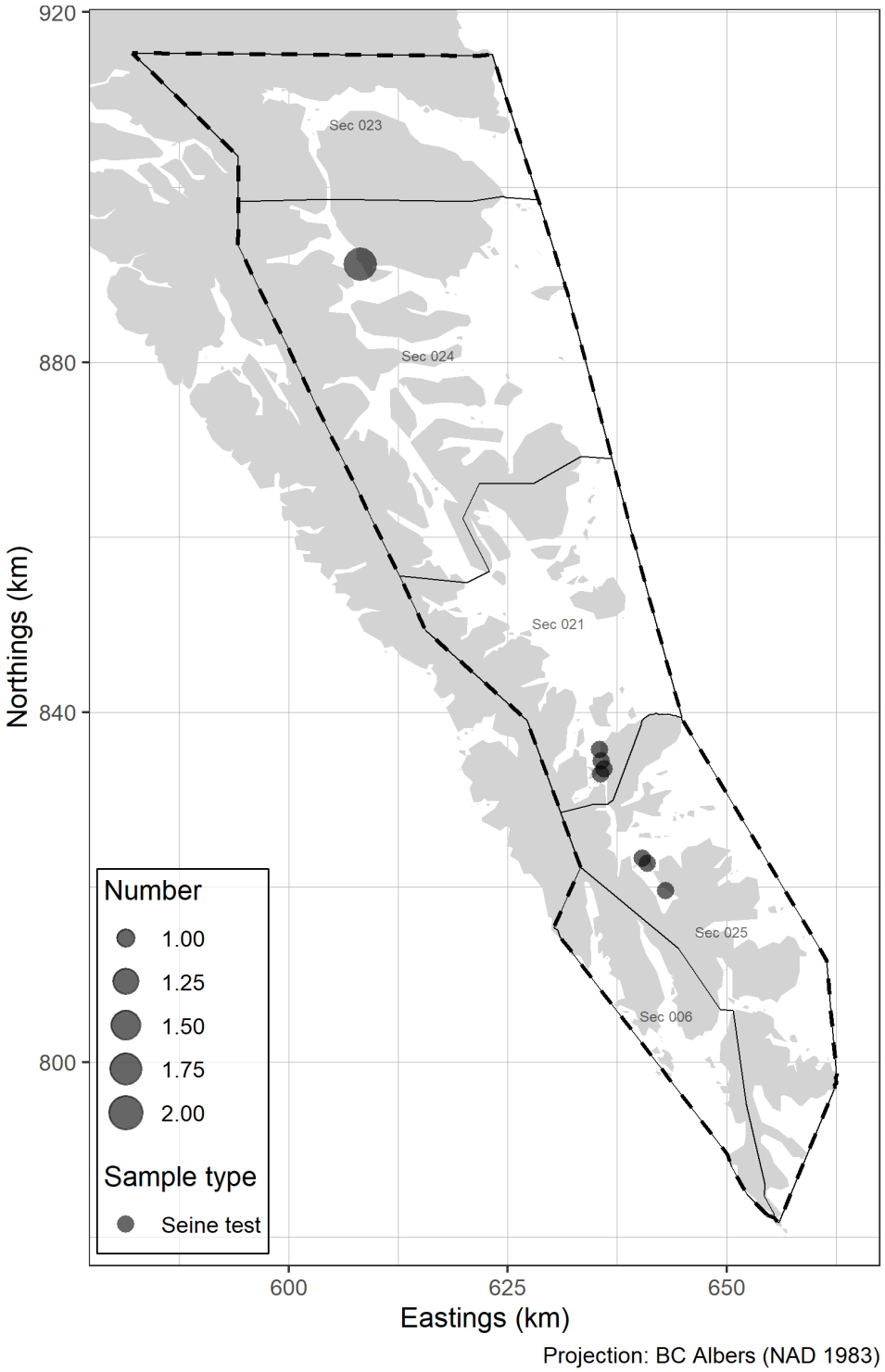


Figure 4. Location and type of Pacific Herring biological samples collected in 2022 in the Haida Gwaii major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). Units: kilometres (km).

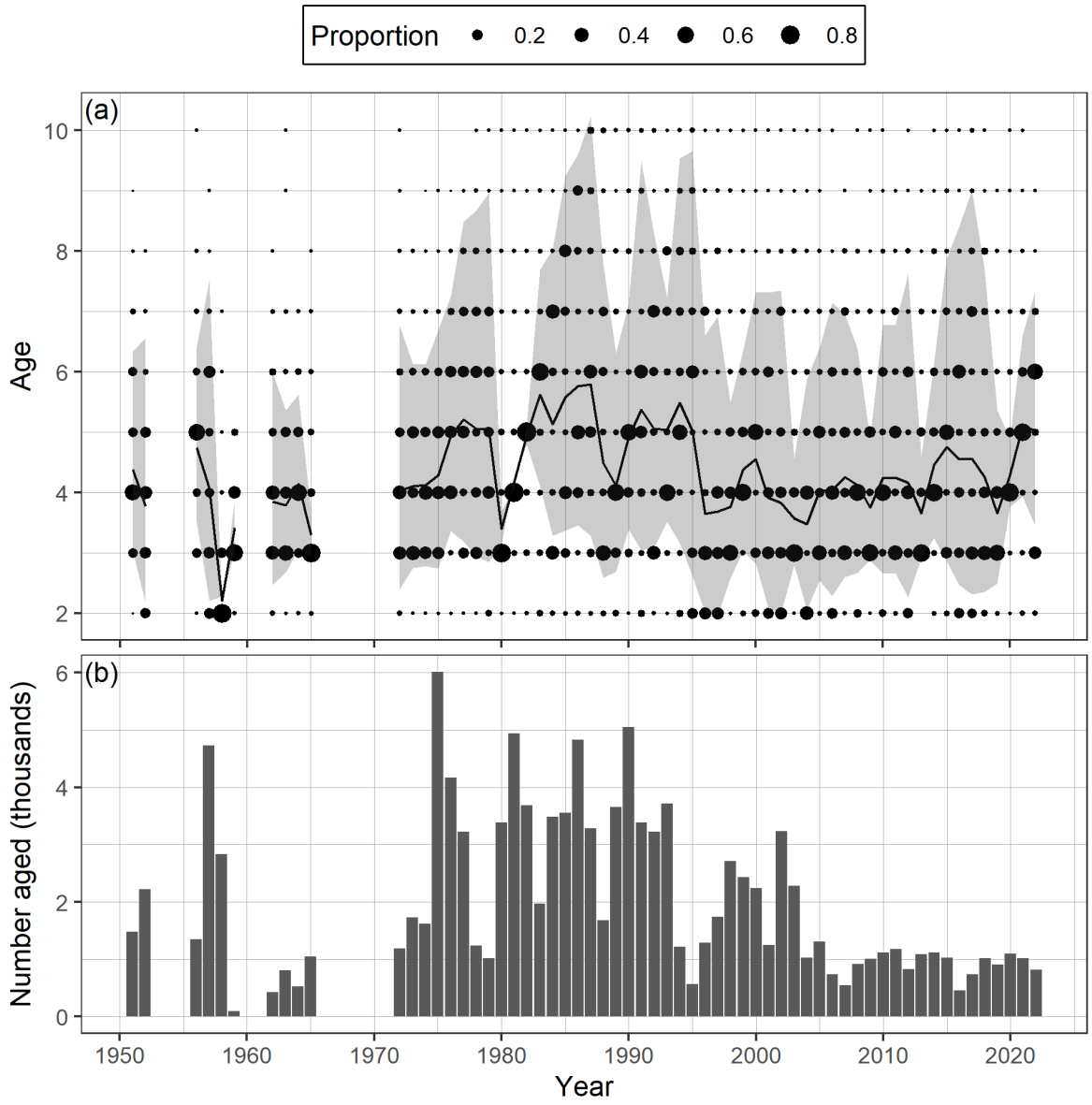


Figure 5. Time series of observed proportion-at-age (a) and number aged in thousands (b) of Pacific Herring from 1951 to 2022 in the Haida Gwaii major stock assessment region (SAR). The black line is the mean age, and the shaded area is the approximate 90% distribution. Biological summaries only include 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.

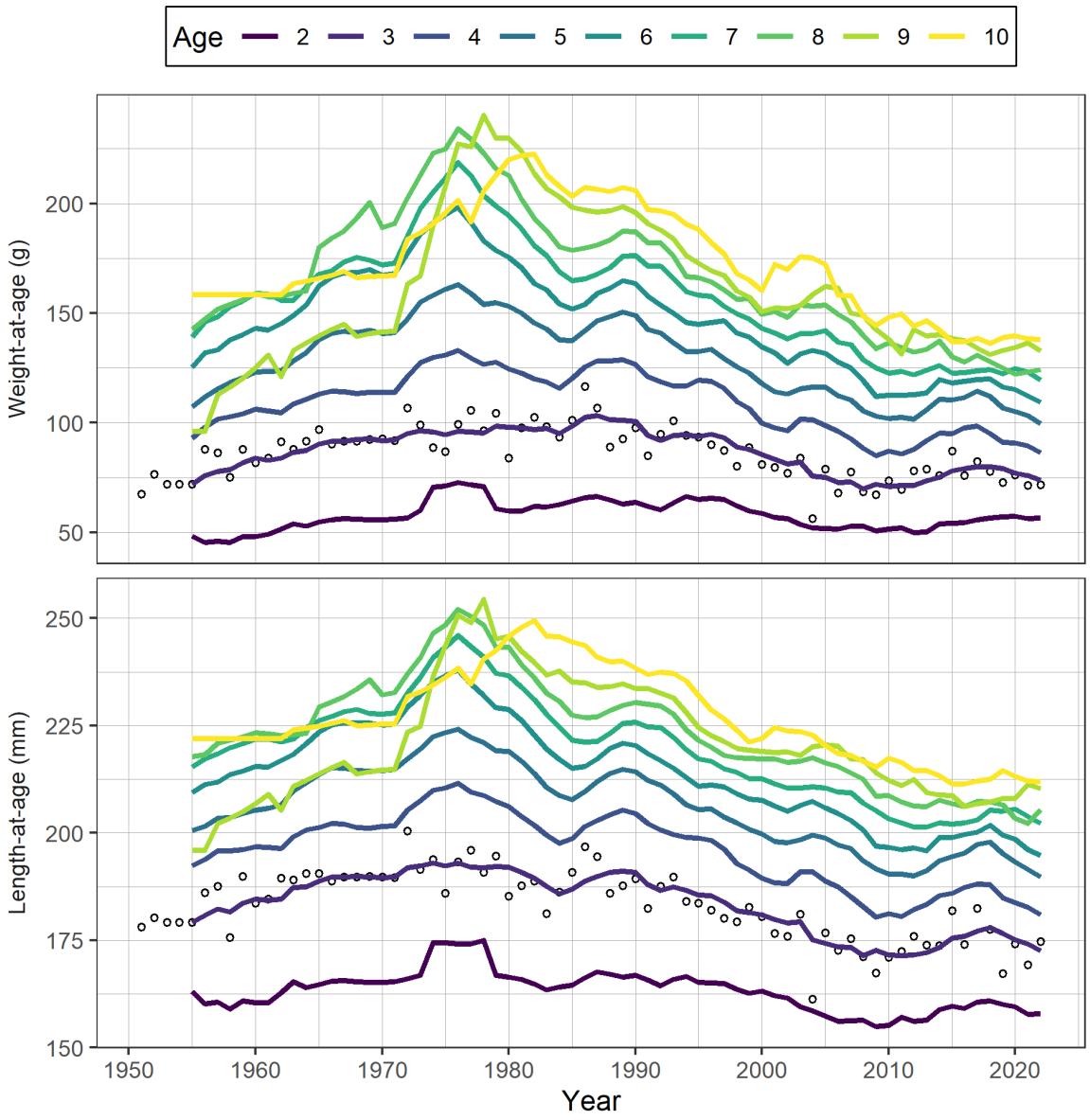


Figure 6. Time series of weight-at-age in grams (g) and length-at-age in milimetres (mm) for age-3 (circles) and 5-year running mean weight- and length-at-age (lines) for Pacific Herring from 1951 to 2022 in the Haida Gwaii major stock assessment region (SAR). Missing weight- and length-at-age values (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.

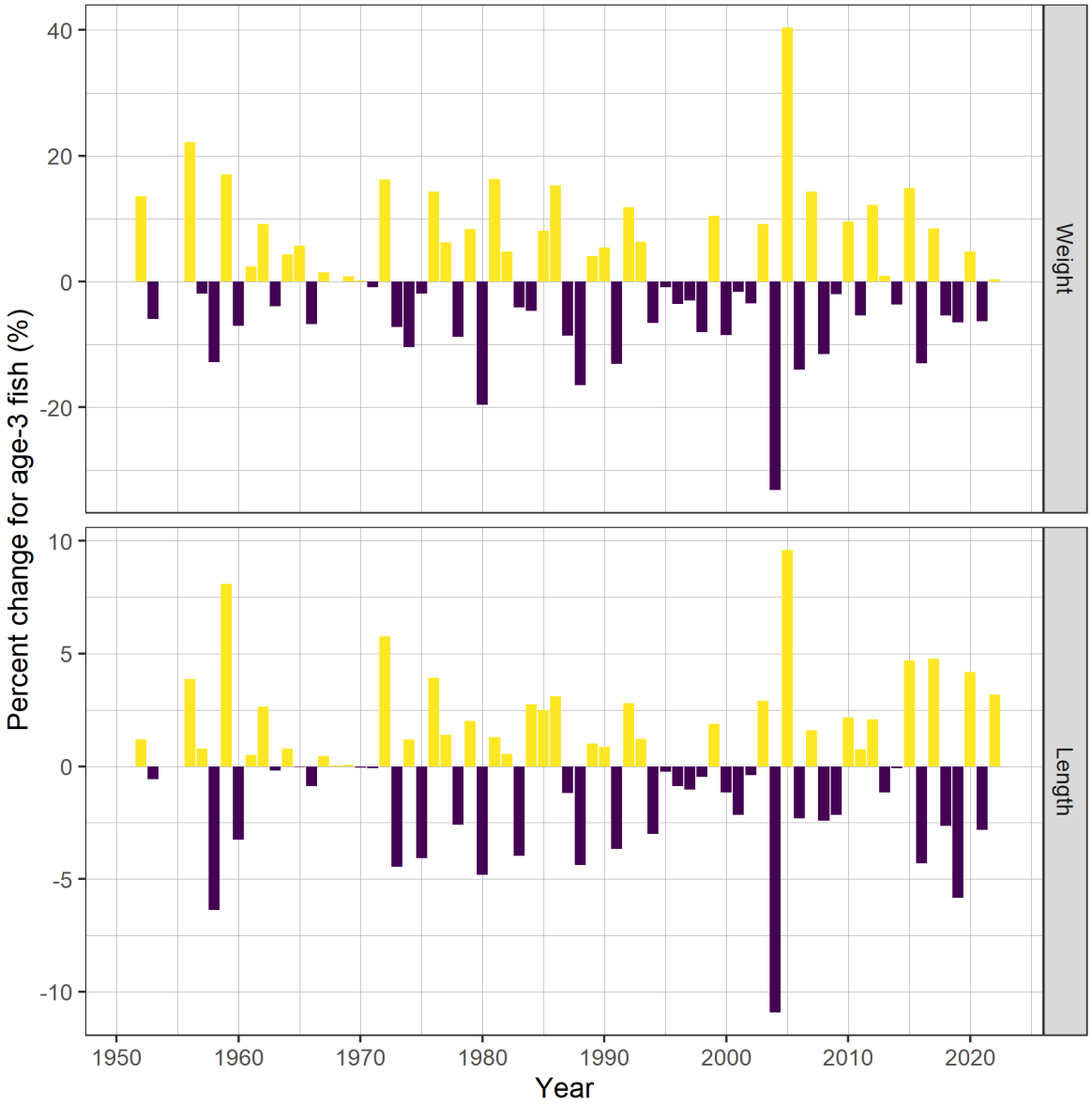


Figure 7. Time series of percent change (%) in weight and length for age-3 fish for Pacific Herring from 1951 to 2022 in the Haida Gwaii major stock assessment region (SAR). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the weight and length of age-3 fish, respectively, 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.

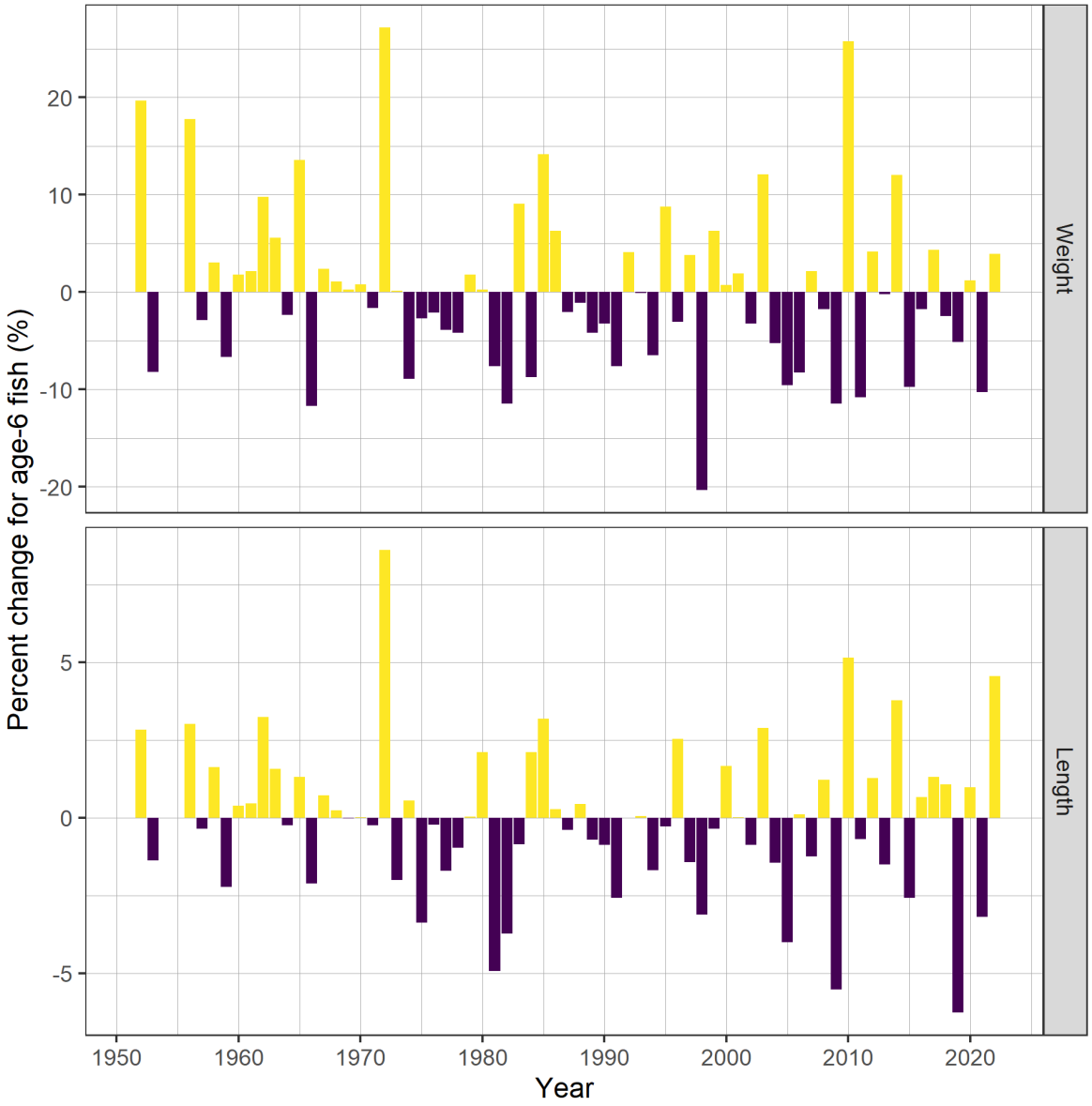


Figure 8. Time series of percent change (%) in weight and length for age-6 fish for Pacific Herring from 1951 to 2022 in the Haida Gwaii major stock assessment region (SAR). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the weight and length of age-6 fish, respectively, 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.

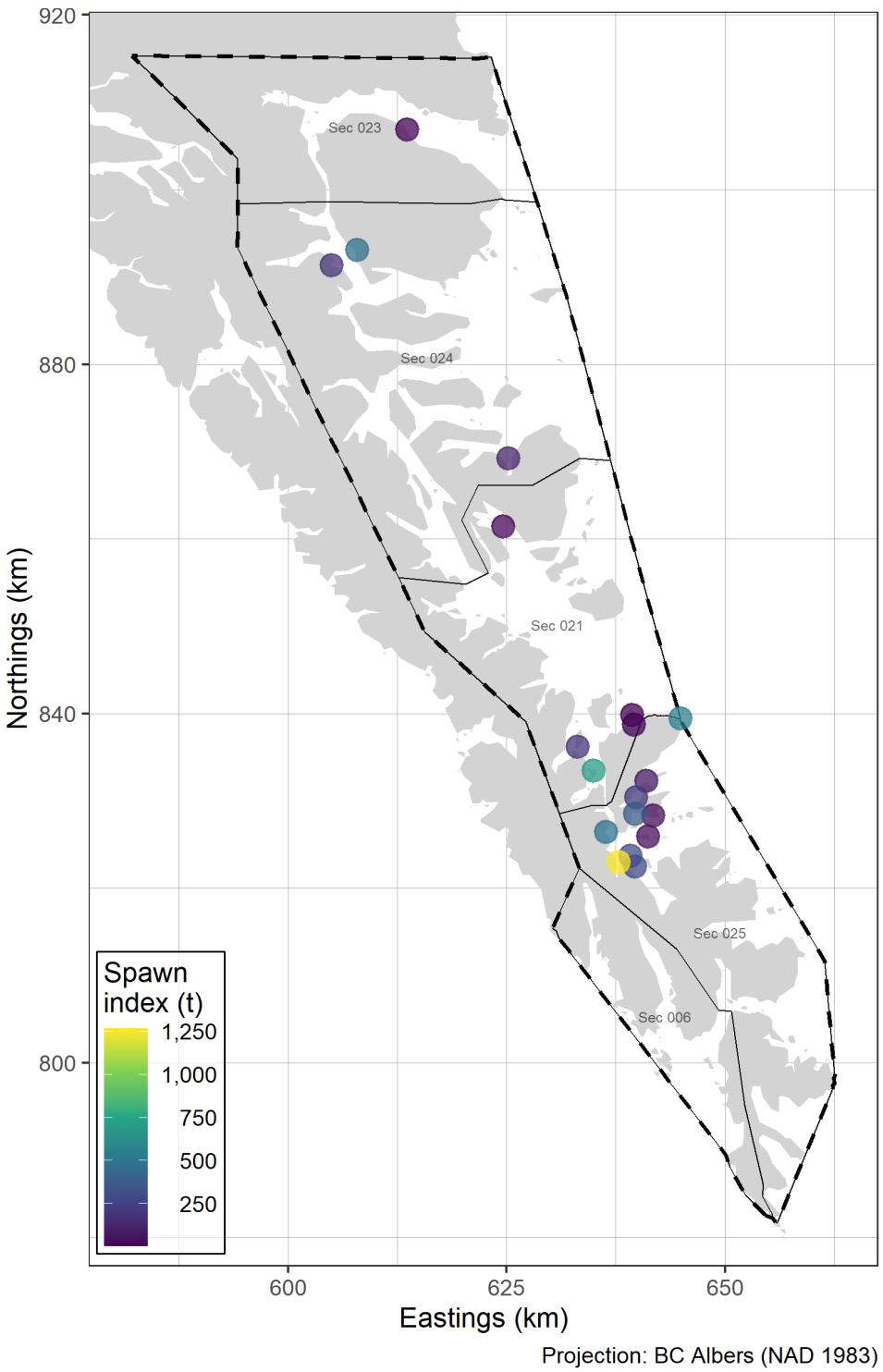


Figure 9. Pacific Herring spawn survey locations, and spawn index in metric tonnes (t) in 2022 in the Haida Gwaii major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values indicate incomplete surveys (grey circles). Units: kilometres (km).

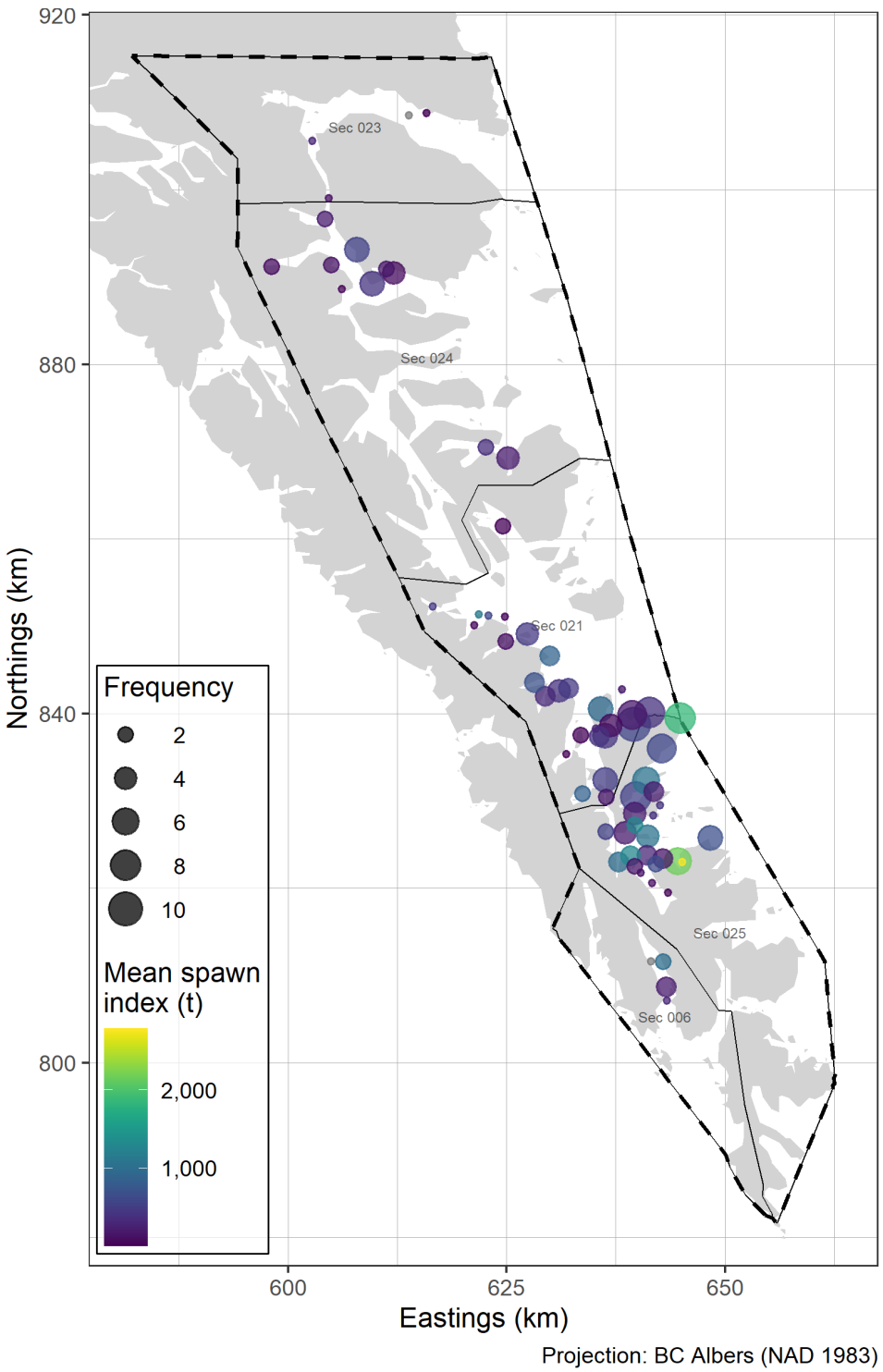


Figure 10. Pacific Herring spawn survey locations, mean spawn index in metric tonnes (t), and spawn frequency from 2012 to 2021 in the Haida Gwaii major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values indicate incomplete surveys (grey circles). Units: kilometres (km).

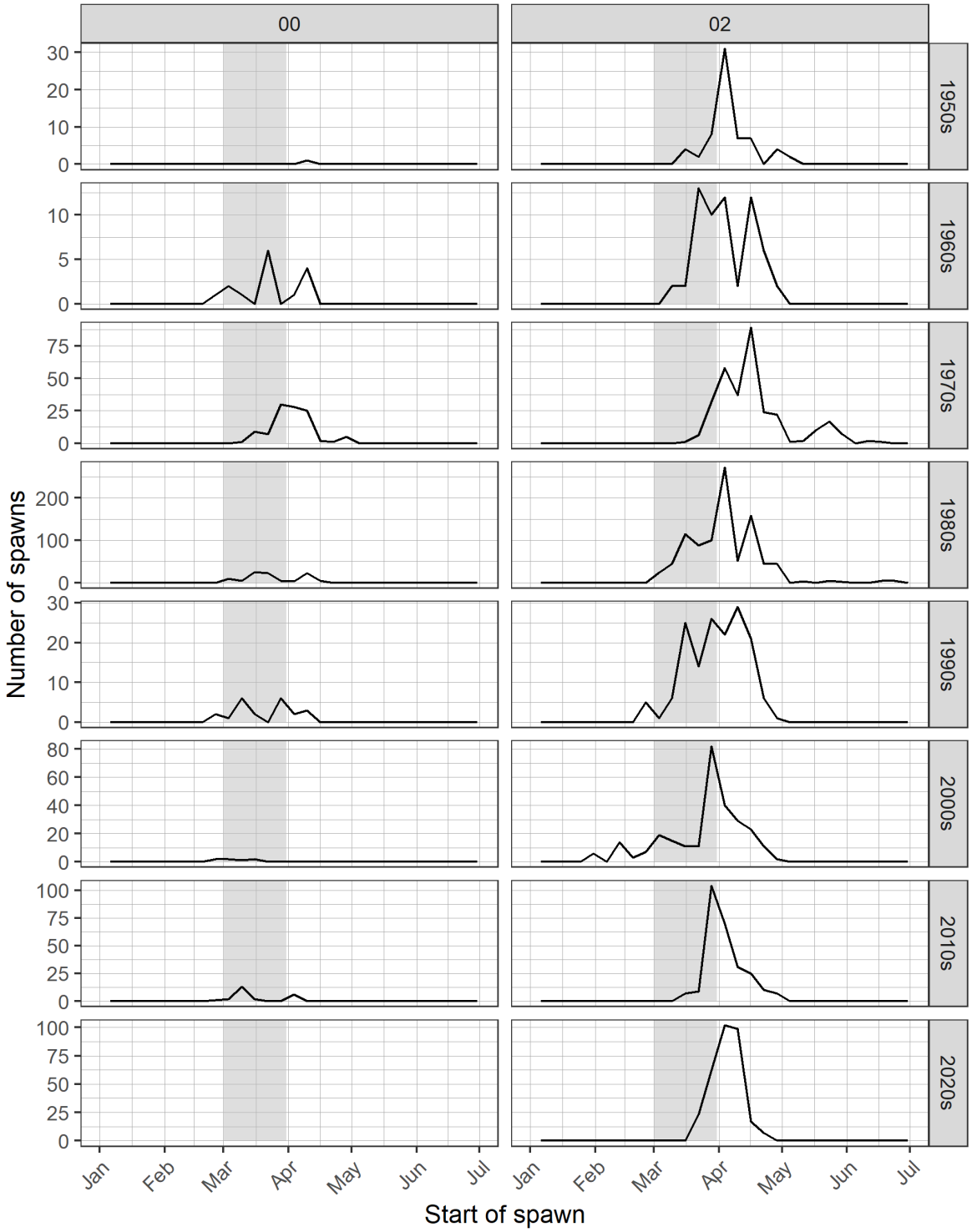


Figure 11. Pacific Herring spawn start date by decade and Statistical Area. Grey shaded regions indicate March 1st to 31st. Note that spawn size and intensity varies; therefore the number of spawns is not directly proportional to spawn extent or biomass.

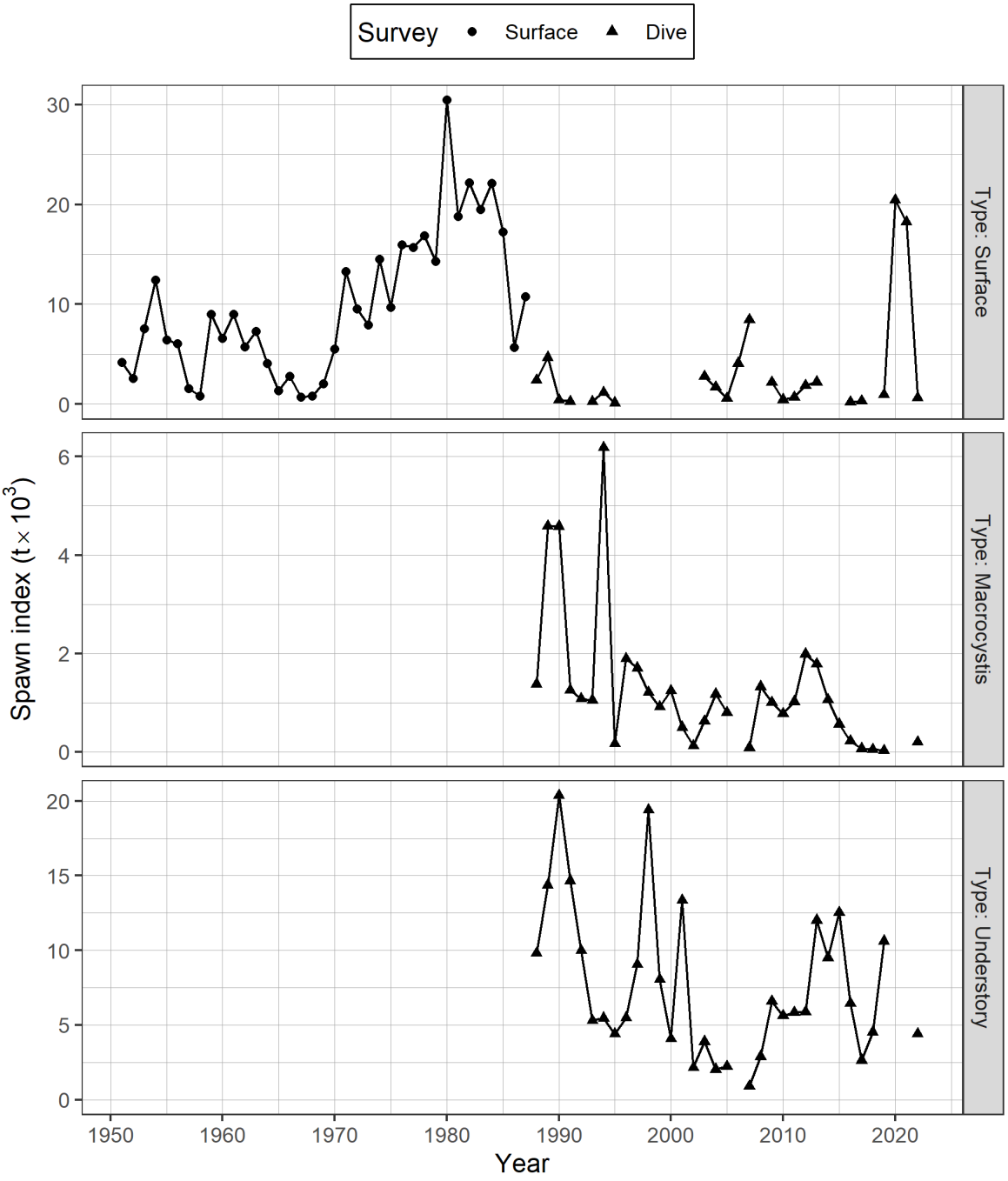


Figure 12. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) by type for Pacific Herring from 1951 to 2022 in the Haida Gwaii major stock assessment region (SAR). There are three types of spawn survey observations: observations of spawn taken from the surface usually at low tide, 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 coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022).

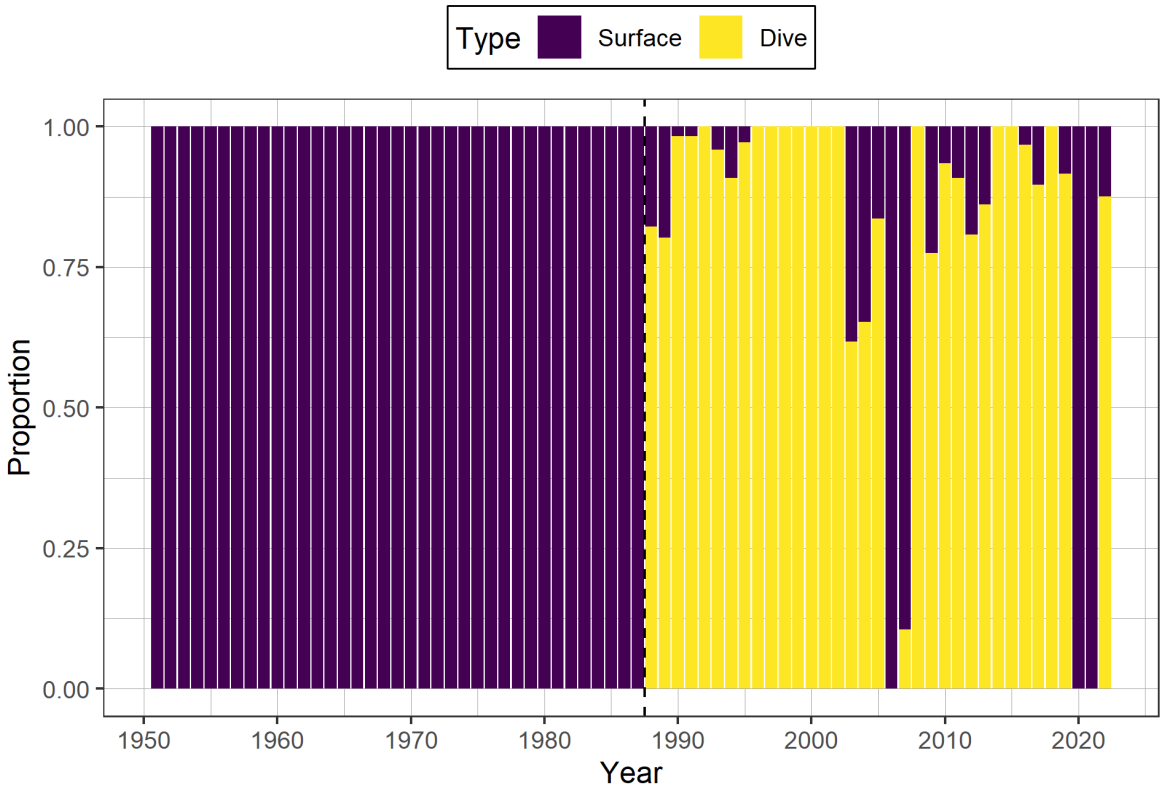


Figure 13. Time series of proportion of spawn index by surface and dive surveys for Pacific Herring from 1951 to 2022 in the Haida Gwaii major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022).

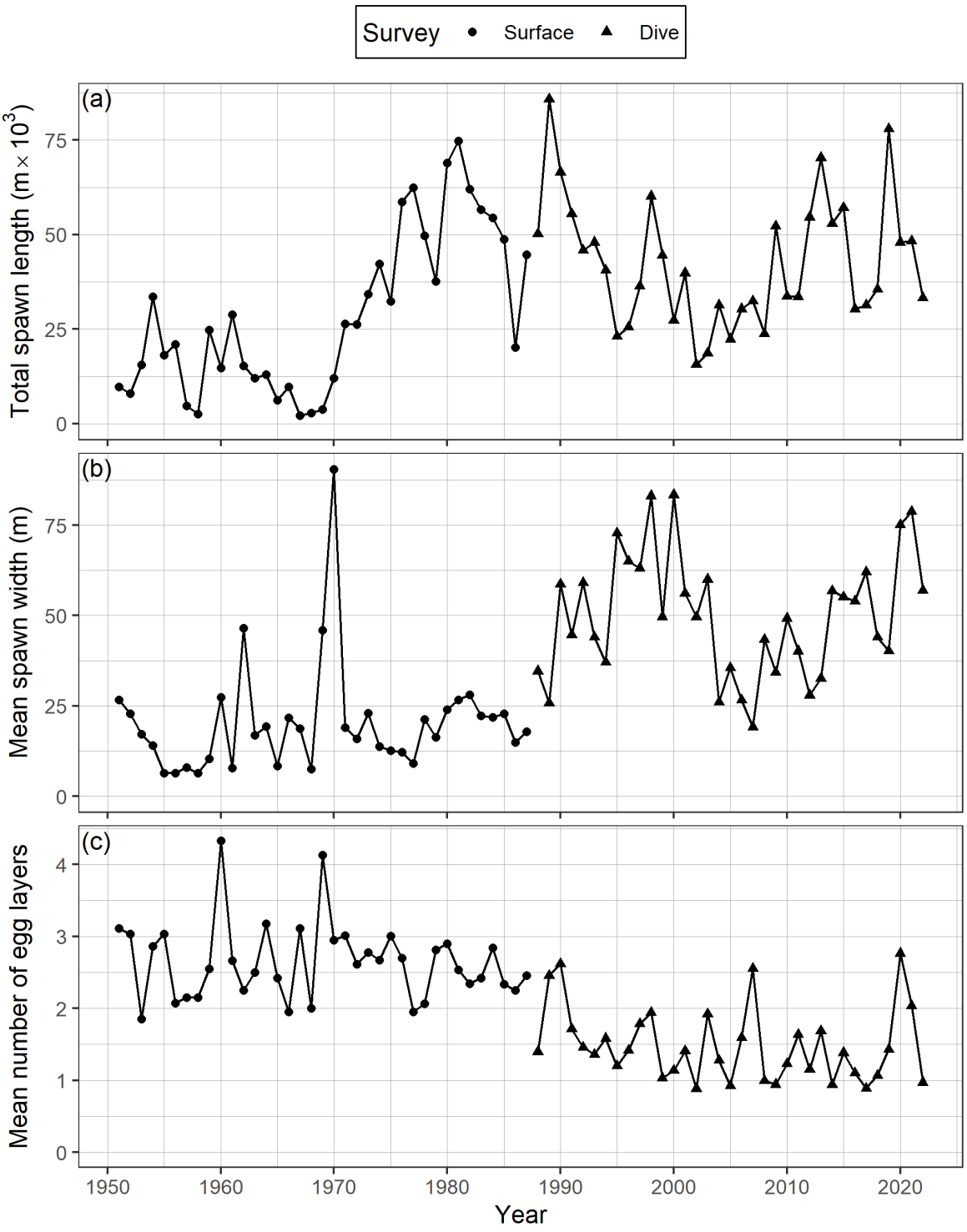


Figure 14. Time series of total spawn length in thousands of metres (m $\times$ 10^3; panel a), mean spawn width in metres (b), and mean number of egg layers (c) for Pacific Herring from 1951 to 2022 in the Haida Gwaii major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022).

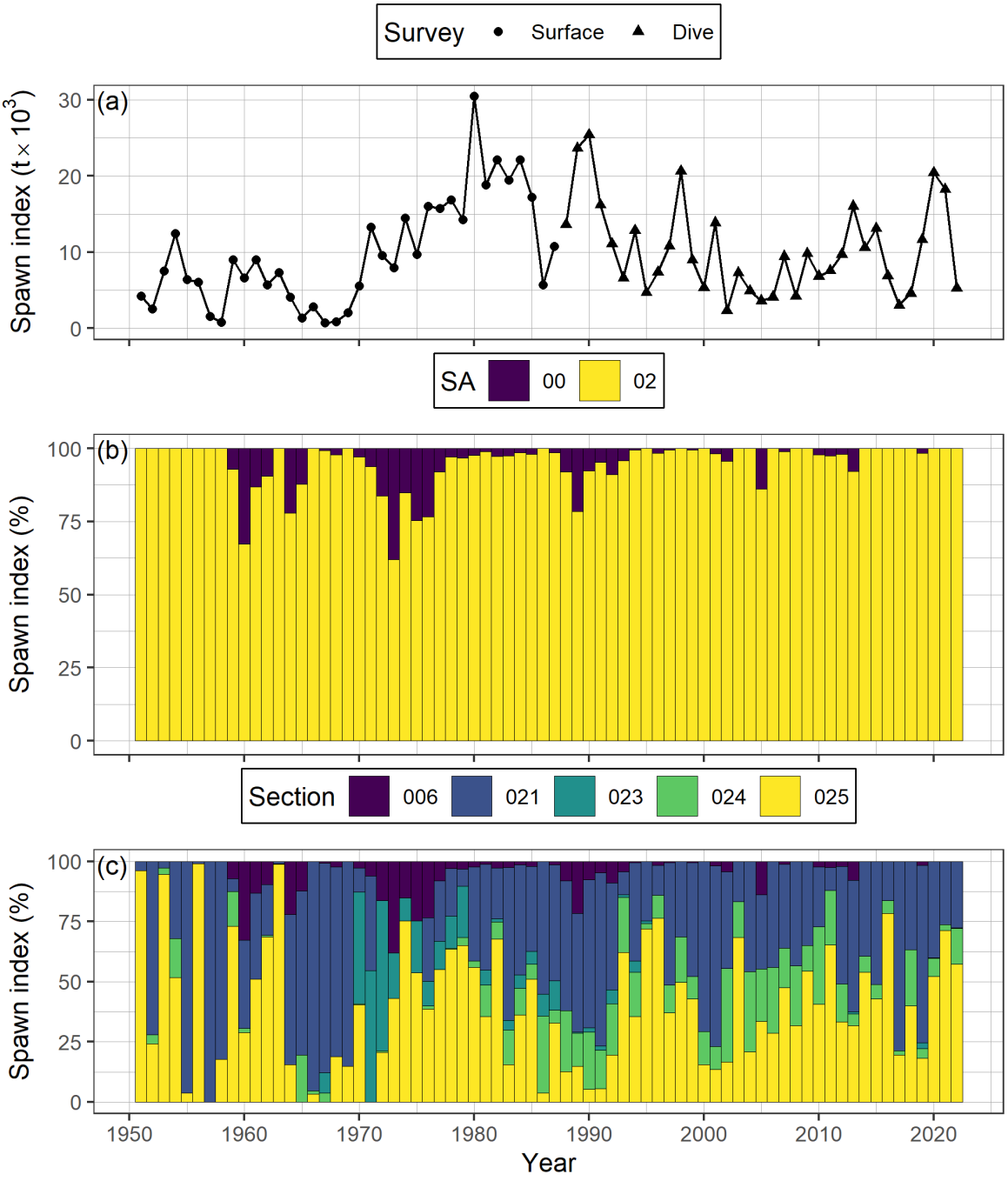


Figure 15. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) for Pacific Herring from 1951 to 2022 in the Haida Gwaii major stock assessment region (SAR; panel a), as well as percent contributed by Statistical Area (SA), and Section (b, & c, respectively). The spawn index has two distinct periods defined by the dominant coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022). Note that spawn surveys in the dive survey period (1988 to 2022) are a combination of surface and dive surveys (Figures 12 and 13). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

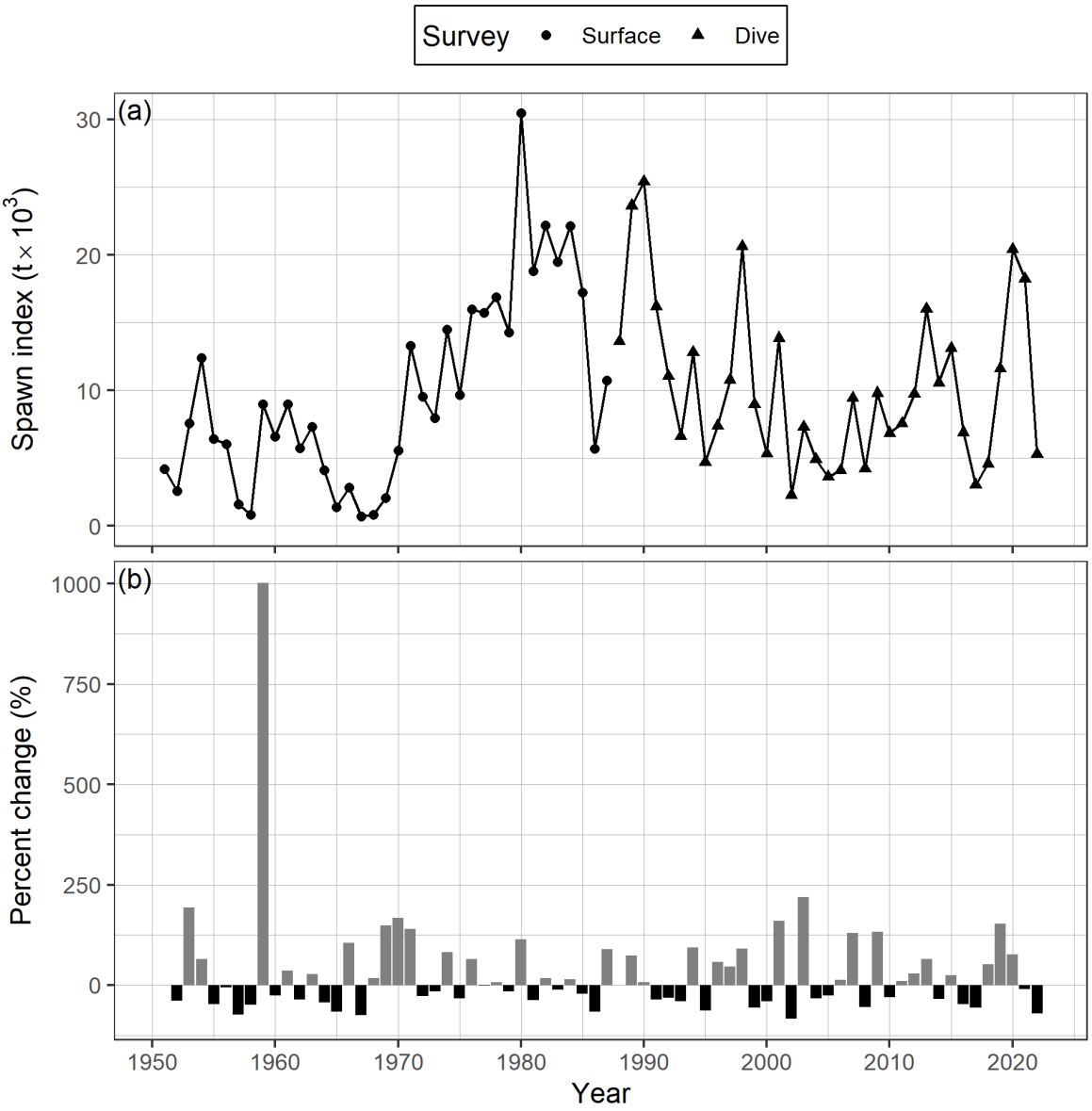


Figure 16. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) for Pacific Herring from 1951 to 2022 in the Haida Gwaii major stock assessment region (SAR; panel a), and percent change (b). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the spawn index in year t. The spawn index has two distinct periods defined by the dominant coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Note that spawn surveys in the dive survey period (1988 to 2022) are a combination of surface and dive surveys (Figures 12 and 13).

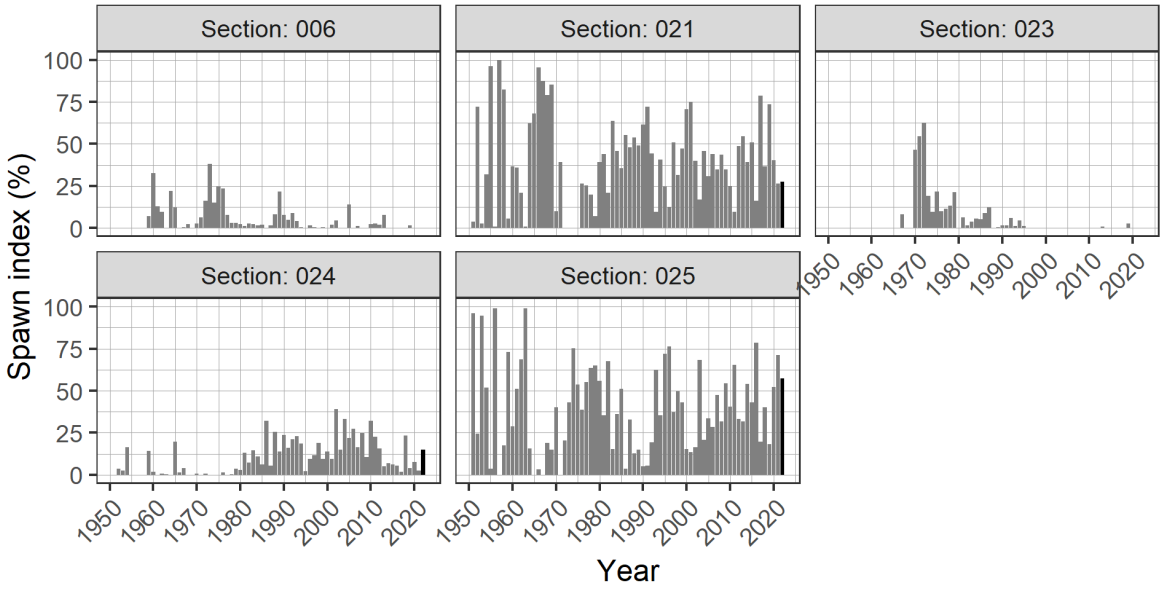


Figure 17. Time series of percent of spawn index by Section for Pacific Herring from 1951 to 2022 in the Haida Gwaii major stock assessment region (SAR). The year 2022 has a darker bar to facilitate interpretation. The spawn index has two distinct periods defined by the dominant coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

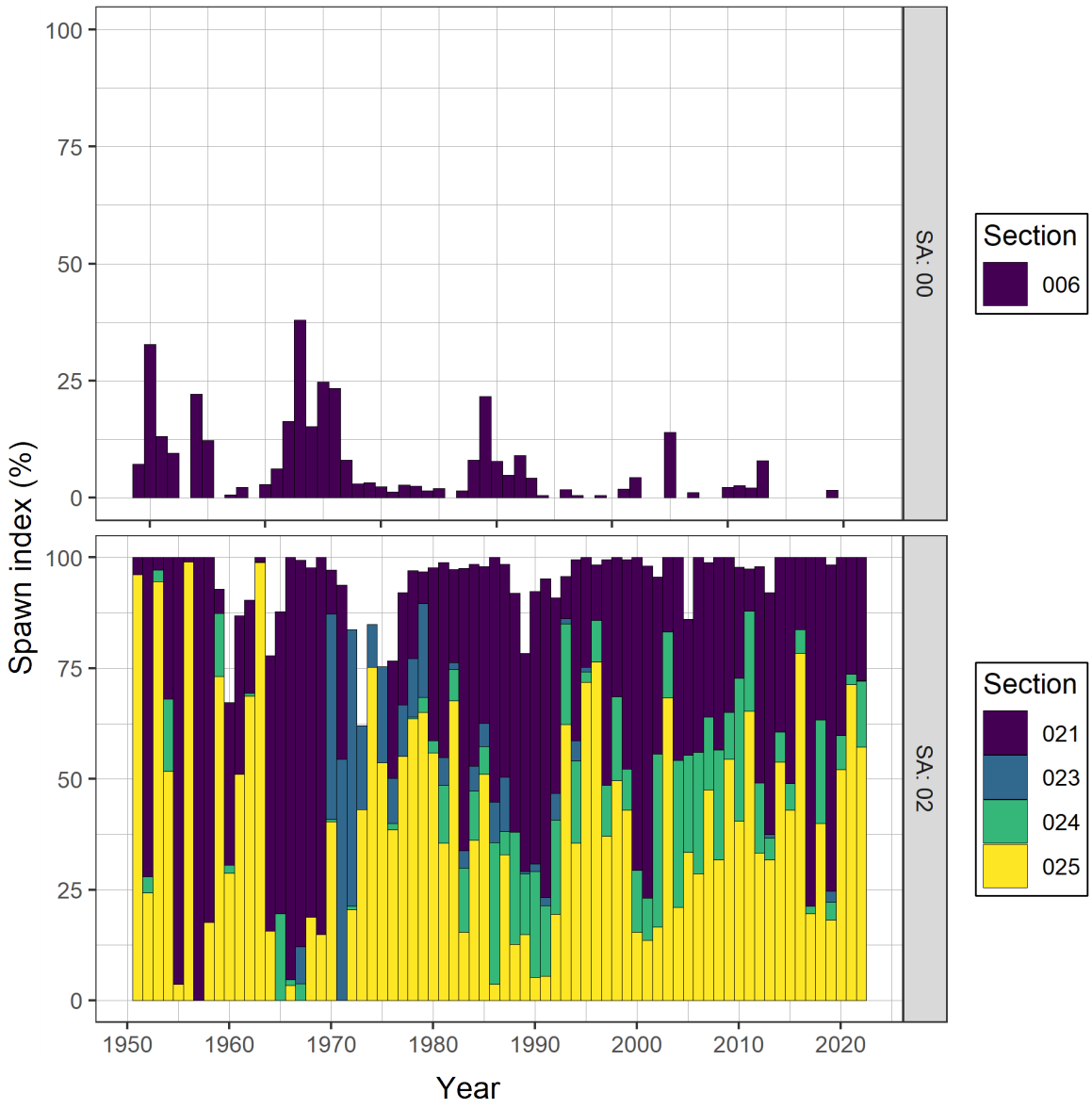


Figure 18. Time series of percent of spawn index by Statistical Area (SA) and Section for Pacific Herring from 1951 to 2022 in the Haida Gwaii major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

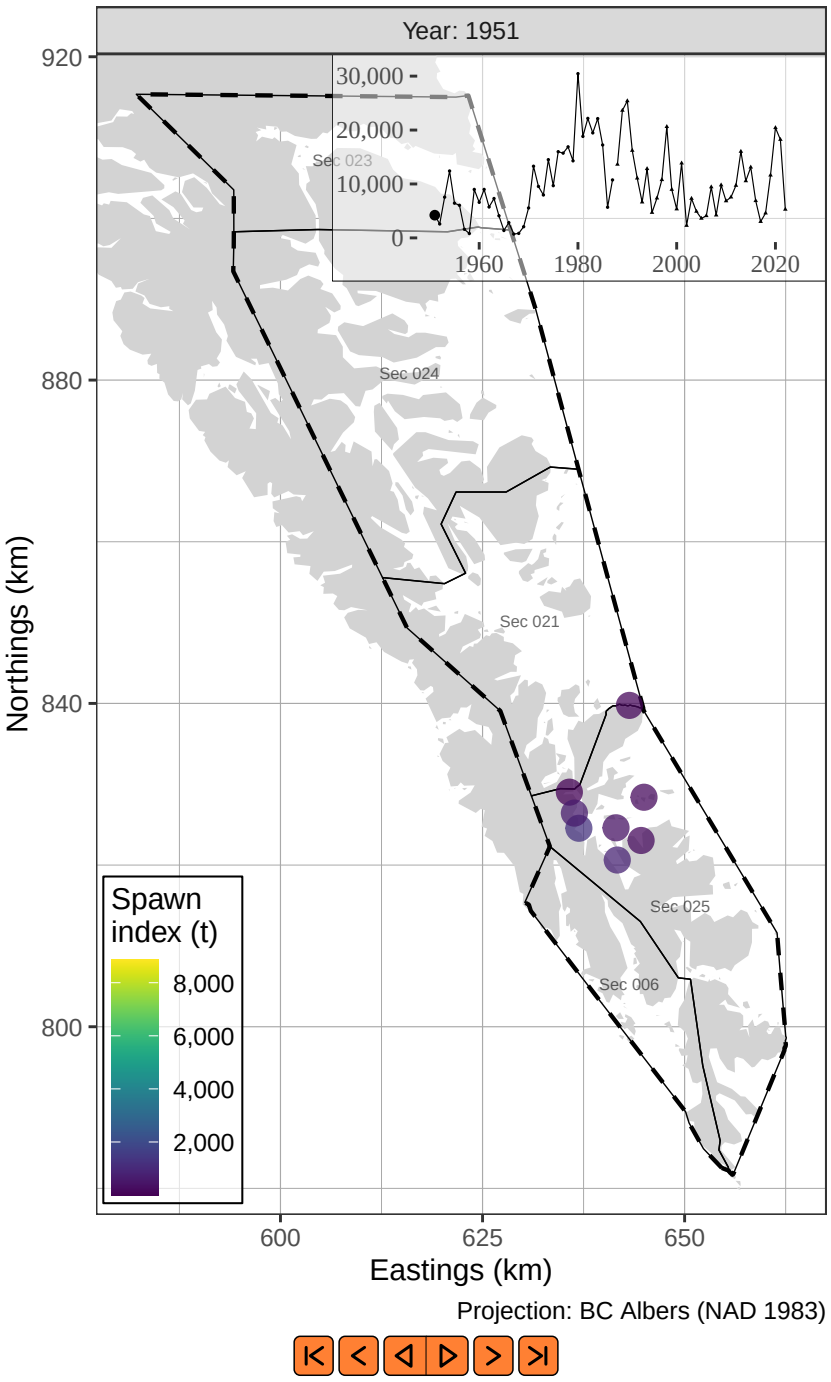


Figure 19. Animation of Pacific Herring spawn index in metric tonnes (t) by Location from 1951 to 2022 in the Haida Gwaii major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The spawn index has two distinct periods defined by the dominant coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values indicate incomplete surveys (grey circles). Inset tracks the total spawn index. Units: kilometres (km). View the animation: download the report, open with Adobe, enable Java, and click "play".