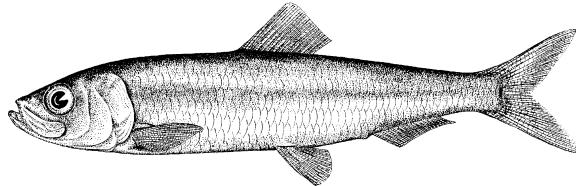


Pacific Herring preliminary data summary for Central Coast 2021

Jaclyn Cleary* Matthew Grinnell†

July 8, 2021



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

Disclaimer This report contains preliminary data collected for Pacific Herring in 2021 in the Central Coast major stock assessment region (SAR). These data may differ from data used and presented in the final stock assessment.

1 COVID-19 pandemic

1.1 Data collection and analysis in 2020

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

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

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

surveyed by surface surveys instead of underwater dive surveys in Prince Rupert District and Haida Gwaii.

Although Pacific Herring biological samples were collected as usual, the pandemic delayed the analysis of biological data for all SARs. This delay was 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 provision of age data for Pacific Herring and many other species. Despite these delays, biological data was available for use in the 2020 stock assessment.

1.2 Data collection and analysis in 2021

Compared to 2020, the COVID-19 pandemic had fewer impacts to Pacific Herring data collection and analysis in 2021. Spawn surveys proceeded as usual in most areas, with dive surveys in all major areas except Haida Gwaii. Haida Gwaii would normally have a dive survey, but had surface surveys in 2021 due to COVID-19. The collection and analysis of biological data was not affected by the COVID-19 pandemic in 2021.

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 2021. 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 2021 in the Central Coast 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). For the Central Coast major SAR, we use another level of spatial aggregation which we refer to as a ‘Group’. Note that we refer to ‘year’ instead of ‘herring season’ in this report; therefore 2021 refers to the 2020/2021 Pacific Herring season.

3 Data collection programs

The data collection program in the Central Coast reflected a number of collaborations between DFO, the Heiltsuk Nation, and the Herring Industry. Biological samples were

collected by the seine test charter vessel "Ocean Venture" for 22 days from March 16th to April 6th. The primary purpose of the test charter vessel was to collect biological samples from main bodies of herring in Statistical Areas 06, 07, and 08, identified from soundings. Heiltsuk or Kitasoo collected 12 nearshore cast net herring samples in 2021. Herring spawn locations were primarily identified with fixed-wing overflights. Eight spawn flights were conducted this season, in late March and early April. Two dive charter vessels operated in the CC:

- The "Pachena No.1" surveyed 21 days from April 6nd to April 26th, and
- The "Ocean Cloud" surveyed 12 days from April 3rd to April 14th.

Five gillnet sounding vessels were operated by the Heiltsuk Nation this season; most effort was focused in Statistical Area 07, as well as effort in Statistical Area 08 to assist in locating fish for spawn on kelp (SOK) operations.

3.1 Biological samples in Statistical Area 08

In the Central Coast major SAR, Pacific Herring in Statistical Area (SA) 08 tend to be smaller than fish in other areas. In addition, fewer biological samples are typically collected from SA 08 compared to the other areas. For example, between 1994 and 2013, on average $\sim numeric(0)\%$ of biological samples came from SA 08. In 2014 and 2015, additional resources were available to collect biological samples in SA 08, which consequently received more sampling effort than previous years, compared to the other areas. In order to avoid using non-representative biological data in the Central Coast stock assessment model, biological samples from SA 08 in 2014 and 2015 are weighted by the average historic proportion of samples in that area (i.e., $\sim numeric(0)\%$). Biological data presented in this report (e.g., proportion-at-age, weight-at-age) reflect these weights, and are considered to be representative of the Central Coast major SAR.

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 2021 in the Central Coast 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 2021, 27 Pacific Herring biological samples were collected and processed for the Central Coast major SAR (Table 5, Table 6), and a total of 1,371 Pacific Herring were aged in 2021. 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). Some Statistical Areas tend to have larger fish at a given age (Figure 9, Table 8). 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 47 individual locations in 2021 in the Central Coast major SAR (Table 9, and Figure 10). A summary of spawn from the last decade (2011 to 2020) is shown in Figure 11. Figure 12 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 13, Figure 14, Figure 15, Figure 16, Table 10, and Figure 17). See the [draft spawn index technical report](#) for calculations to convert SOK harvest to spawning biomass. In addition, spawn surveys estimate spawn depth by Statistical Area, and Section (Figure 18). 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 2021).

Some Pacific Herring Sections contribute more than others to the total spawn index, and the percentage contributed by Section varies yearly (Figure 16b, Figure 19). For example, in 2021, Section 074 contributed the most to the spawn index (52%). As with Sections, some Statistical Areas contribute more than others to the total spawn index (Figure 16c, Figure 20). An animation shows the spawn index by spawn survey location from 1951 to 2021 (Figure 21).

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:

- Herring behaviour different than previous seasons; spawn in different areas and apparent lower amount of spawn in Spiller Channel. However, the dive survey indicated only slightly less than observed.
- Cold weather, colder surface water temperatures noted.
- It is extremely difficult to run a herring program without sufficient presence of staff in the field.
- It is next to impossible to run an effective herring program in Central Coast without reliable communications.
- Use of DFO radio network was severely restricted just as herring season started, resulting in no communication between gillnet vessels and DFO, and very limited communications with the herring test boat.
- Satellite phone service is not consistent to rely upon at all times.
- The overall quality of the program suffered due to these two issues.
- Challenges for 2022:
 - Establish new communications methods prior to 2022 season.
 - Re-establish DFO field presence on management platform, and Heiltsuk/DFO presence on spawn flights.

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, Sections, and Groups for Pacific Herring in the Central Coast major stock assessment region (SAR). Legend: ‘06&07’ is Statistical Areas 06 and 07; and ‘08’ is Statistical Area 08.

Region	Statistical Area	Section	Group
Central Coast	06	067	06&07
Central Coast	07	070	06&07
Central Coast	07	071	06&07
Central Coast	07	072	06&07
Central Coast	07	073	06&07
Central Coast	07	074	06&07
Central Coast	07	075	06&07
Central Coast	07	076	06&07
Central Coast	07	077	06&07
Central Coast	07	078	06&07
Central Coast	07	079	NA
Central Coast	08	085	8
Central Coast	08	086	8

Table 3. Total landed commercial catch of Pacific Herring in metric tonnes (t) by gear type in 2021 in the Central Coast 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 2011 to 2021 in the Central Coast major stock assessment region (SAR). See the [draft spawn index technical report](#) for calculations to convert SOK harvest to spawning biomass. Harvest does not include the 2,411 lbs of spawn on egregia in 2018. Note: data may be withheld due to privacy concerns (WP).

Year	Harvest (lb)	Spawning biomass (t)
2011	0	0
2012	0	0
2013	0	0
2014	239,861	355
2015	169,470	251
2016	351,953	521
2017	392,747	582
2018	286,109	424
2019	356,042	528
2020	44,857	66
2021	294,269	436

Table 5. Number of Pacific Herring biological samples processed from 2011 to 2021 in the Central Coast major stock assessment region (SAR). Each sample is approximately 100 fish.

Year	Number of samples		
	Commercial	Test	Total
2011	0	30	30
2012	0	24	24
2013	0	15	15
2014	14	12	26
2015	6	14	20
2016	5	15	20
2017	4	40	44
2018	4	30	34
2019	2	38	40
2020	0	17	17
2021	2	25	27

Table 6. Number and type of Pacific Herring biological samples processed in 2021 in the Central Coast major stock assessment region (SAR). Each sample is approximately 100 fish.

Type	Gear	Use	Number of samples
Commercial	Seine	SOK	2
Test	Other	Nearshore	12
Test	Seine	Test fishery	13

Table 7. Observed proportion-at-age for Pacific Herring from 2011 to 2021 in the Central Coast major stock assessment region (SAR). The age-10 class is a ‘plus group’ which includes fish ages 10 and older.

Year	Proportion-at-age									
	2	3	4	5	6	7	8	9	10	
2011	0.045	0.491	0.154	0.243	0.031	0.023	0.007	0.006	0.001	
2012	0.077	0.106	0.484	0.119	0.167	0.024	0.016	0.005	0.003	
2013	0.026	0.480	0.129	0.243	0.056	0.057	0.004	0.003	0.001	
2014	0.095	0.146	0.467	0.089	0.141	0.028	0.029	0.004	0.000	
2015	0.008	0.454	0.156	0.249	0.055	0.064	0.009	0.004	0.001	
2016	0.040	0.091	0.549	0.094	0.146	0.028	0.039	0.011	0.003	
2017	0.029	0.170	0.132	0.446	0.089	0.092	0.024	0.012	0.007	
2018	0.090	0.168	0.174	0.147	0.295	0.066	0.041	0.014	0.005	
2019	0.012	0.616	0.178	0.053	0.053	0.059	0.024	0.002	0.002	
2020	0.028	0.028	0.739	0.101	0.045	0.029	0.021	0.007	0.002	
2021	0.012	0.295	0.031	0.521	0.085	0.033	0.015	0.007	0.001	

Table 8. Sample size for Pacific Herring weight-at-age analysis in 2021 in the Central Coast major stock assessment region (SAR) by Group from the most recent decade (2012 to 2021), and the previous decade (2002 to 2011), as displayed in Figure 9. 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. Legend: ‘06&07’ is Statistical Areas 06 and 07; and ‘08’ is Statistical Area 08.

Group	Age	Sample size	
		Previous decade	Recent decade
06&07	2	932	409
06&07	3	10,840	2,696
06&07	4	10,569	3,682
06&07	5	6,135	2,704
06&07	6	2,987	1,475
06&07	7	2,084	581
06&07	8	1,129	269
06&07	9	395	89
06&07	10	117	34
8	2	108	267
8	3	1,042	845
8	4	890	794
8	5	361	265
8	6	161	188
8	7	97	74
8	8	52	28
8	9	10	10
8	10	6	3

Table 9. Pacific Herring spawn survey locations, start date, and spawn index in metric tonnes (t) in 2021 in the Central Coast 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)
	06	067 Abrams Is	April 02	27
	06	067 Clifford Bay	April 08	2
	06	067 Kwakwa Cr	April 07	565
	06	067 Marvin Is	April 02	1,265
	06	067 Normansell Is	April 08	341
	06	067 Osment Inlt	April 02	1,738
	06	067 Parsons Anch	April 02	1,445
	06	067 Weeteeam Bay	April 07	82
	06	067 Wilby Pt	April 02	1,914
	07	072 Berry Inlt	April 04	85
	07	072 Bird Pt	April 04	75
	07	072 Bullen Rk	April 04	314
	07	072 Bush Pt	April 04	234
	07	072 Foote Islets	April 04	96
	07	072 Mouat Cv	April 04	75
	07	072 Shingle Rk	April 04	10
	07	072 Spiller Chnl	March 28	165
	07	072 Tankeeah River	April 04	247
	07	073 Morehouse Bay	April 01	464
	07	073 Newby Is	April 01	1,934
	07	073 Troup Psg	April 01	134
	07	074 Ardmillan Bay	April 01	957
	07	074 Cree Pt	April 06	22
	07	074 Dearth Is	April 02	189
	07	074 Dryad Pt	April 02	11
	07	074 Dundivan Inlt	April 04	604
	07	074 Idol Pt	April 02	5,215
	07	074 Kynumpt Hrbr	April 01	871
	07	074 Little Thompson Bay	April 07	0
	07	074 Matilda Is	March 01	NA
	07	074 Norman Morrison Bay	April 01	2,994
	07	074 Odin Cv	April 01	700
	07	074 Ormidale Hrbr	April 01	2,352
	07	074 Potts Is	April 06	252
	07	074 Princess Alice Is	April 06	98
	07	074 Quinoot Pt	April 07	717
	07	074 Waskesiu Pass	April 06	24
	07	076 Seafire Is	April 12	499

Table 9 continued

Statistical Area	Section	Location name	Start date	Spawn index (t)
07	078	Culpepper Lgn	April 16	317
07	078	Kynoch Inlt	April 16	303
07	078	Mathieson Chnl	April 16	38
08	085	Kwakume Inlt	April 06	398
08	085	Kwakume Pt	April 06	193
08	085	Whidbey Pt	April 06	7
08	086	Hergest Pt	April 12	232
08	086	Mustang Bay	April 12	30
08	086	Target Bay	April 12	441

Table 10. Summary of Pacific Herring spawn survey data from 2011 to 2021 in the Central Coast 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 2021). 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)
2011	137,530	25	0.8	10,534
2012	127,632	28	0.5	7,592
2013	158,205	34	0.9	20,369
2014	160,450	38	0.7	13,309
2015	167,060	39	1.3	32,146
2016	164,575	40	1.6	32,508
2017	125,525	39	1.5	23,517
2018	98,149	25	1.1	12,264
2019	181,750	38	1.8	46,255
2020	160,625	39	2.0	42,713
2021	128,625	41	1.5	28,674

8 Figures

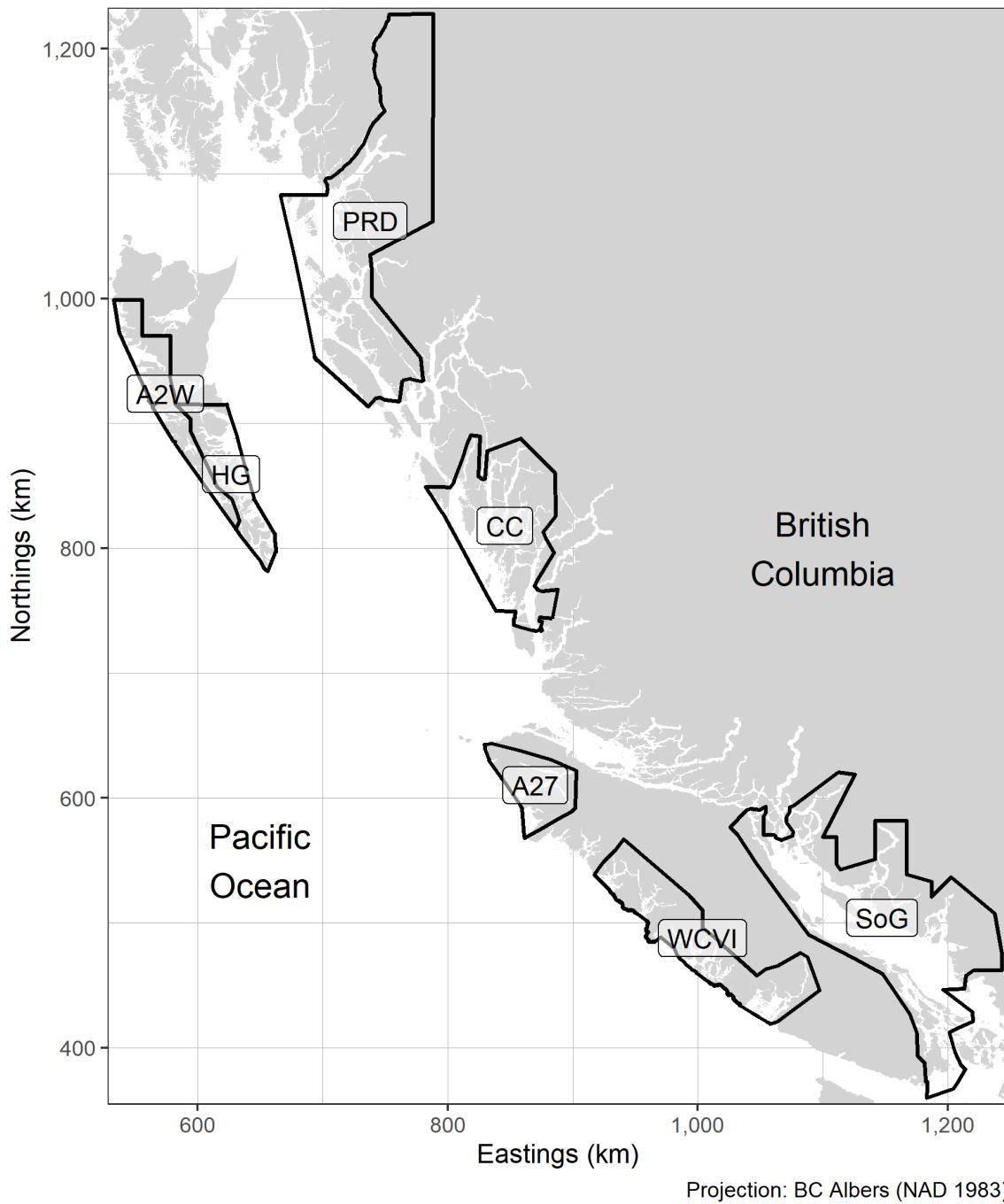


Figure 1. Boundaries for the Pacific Herring stock assessment regions (SARs) in British Columbia. There are 5 major SARs: Haida Gwaii (HG), Prince Rupert District (PRD), Central Coast (CC), Strait of Georgia (SoG), and West Coast of Vancouver Island (WCVI). There are 2 minor SARs: Area 27 (A27) and Area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

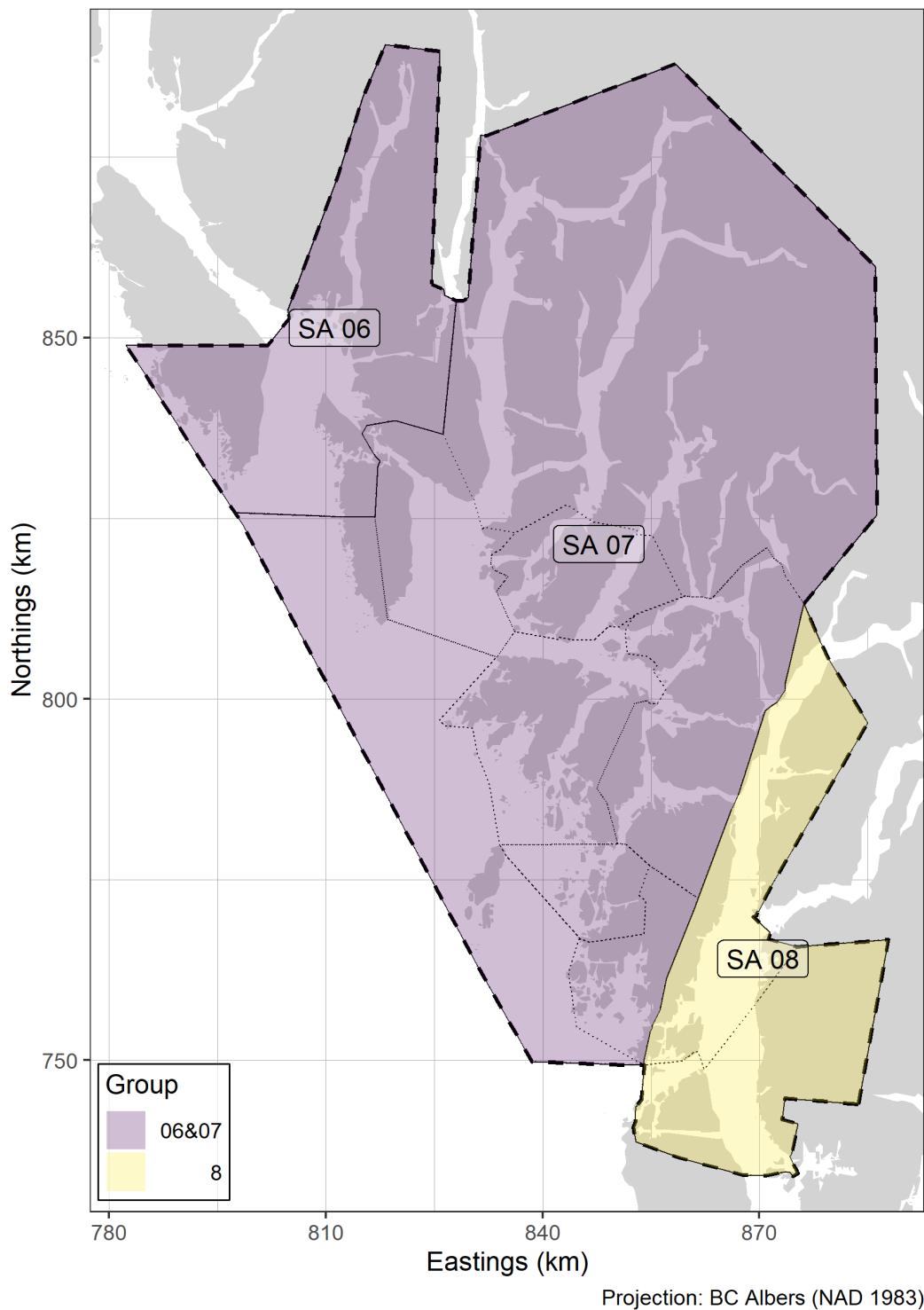


Figure 2. Boundaries for the Central Coast major stock assessment region (SAR; thick dashed lines), associated Statistical Areas (SA; thin solid lines), and associated Sections (thin dotted lines). Units: kilometres (km). Legend: '06&07' is Statistical Areas 06 and 07; and '08' is Statistical Area 08.

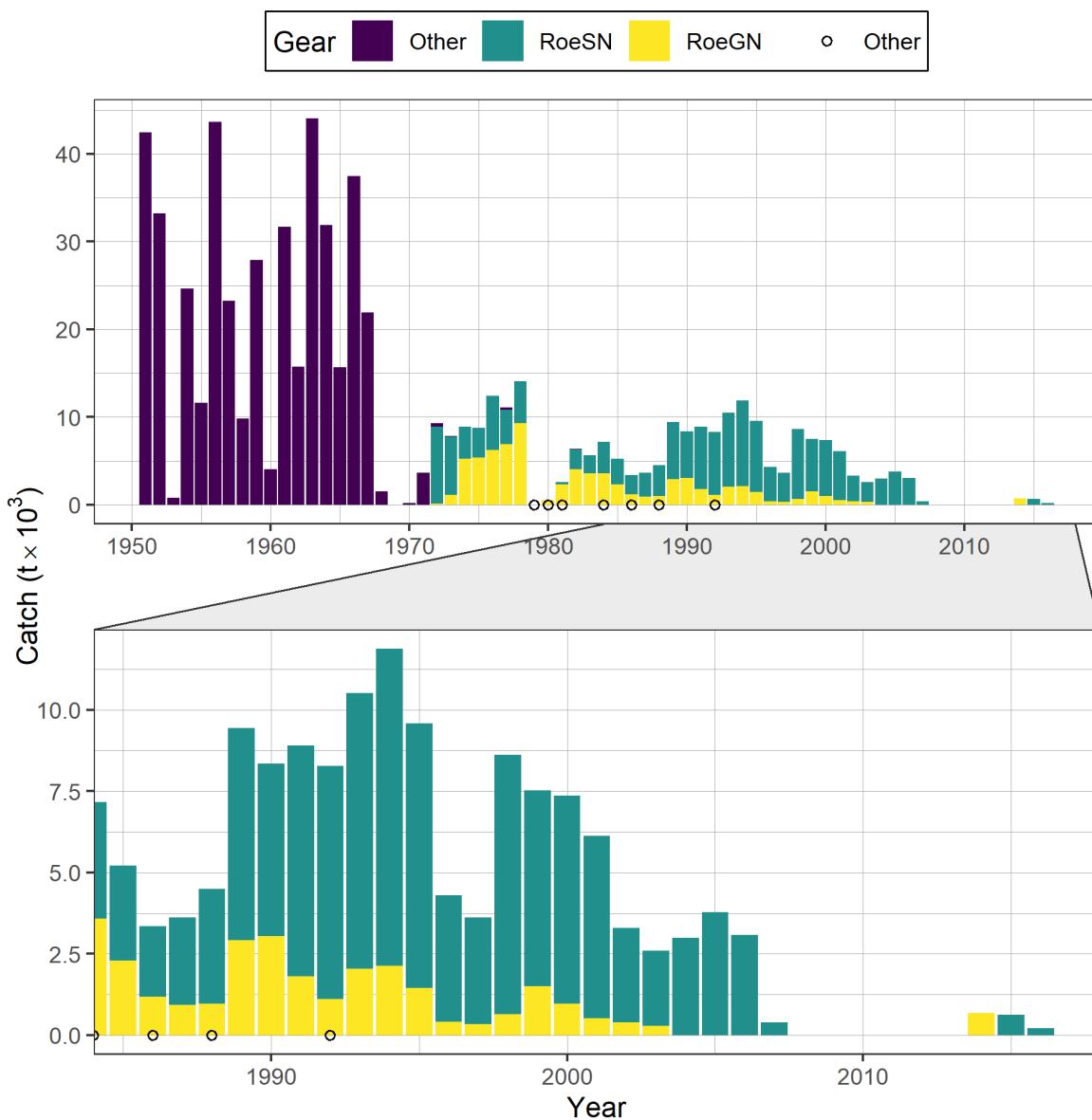


Figure 3. Time series of total landed catch in thousands of metric tonnes ($t \times 10^3$) of Pacific Herring by gear type from 1951 to 2021 in the Central Coast major stock assessment region (SAR). Legend: ‘Other’ represents the reduction (1951 to 1970 only), the food and bait, as well as the special 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: symbols indicate years in which catch by gear type (i.e., Other, RoeSN, RoeGN) is withheld due to privacy concerns.

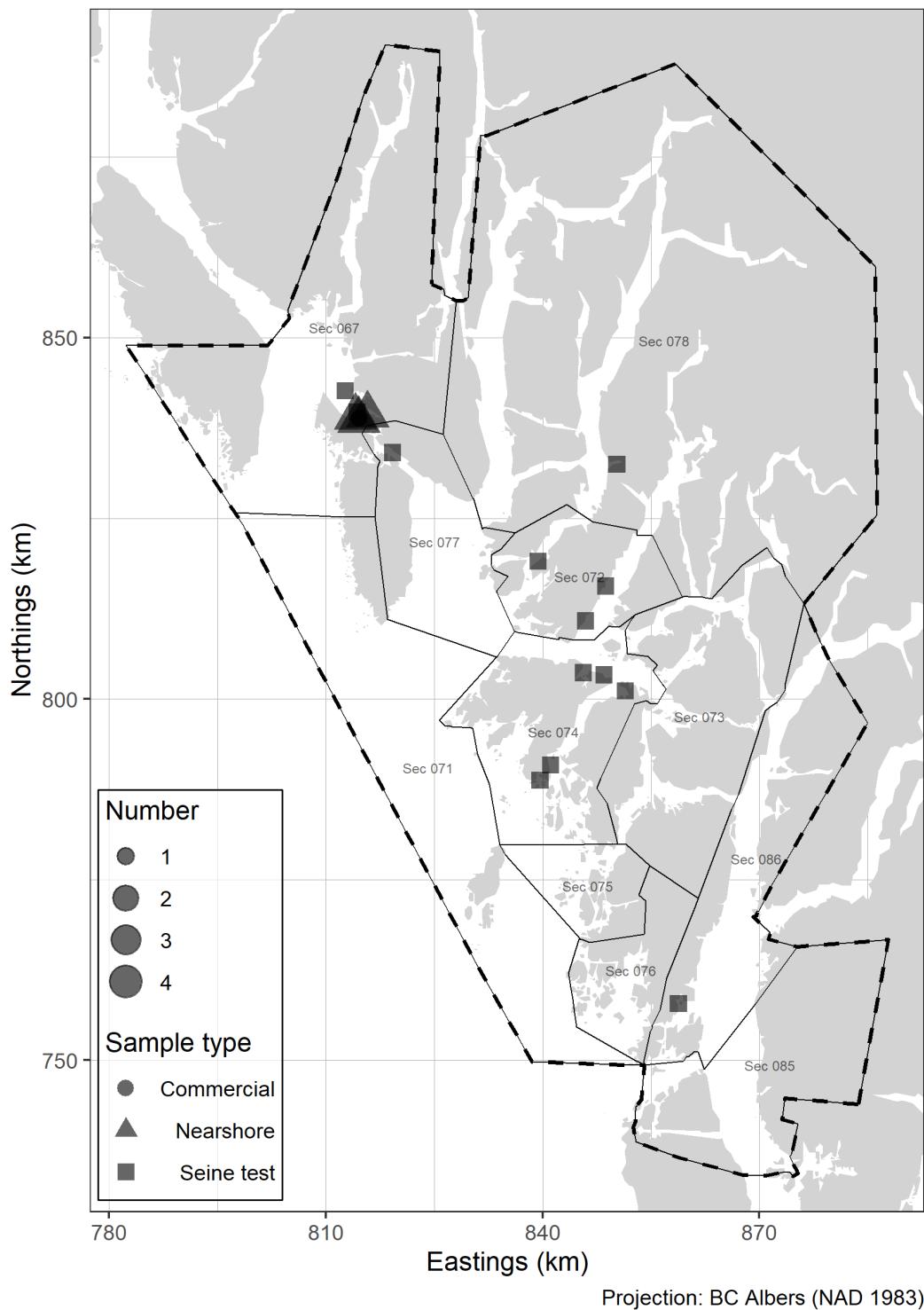


Figure 4. Location and type of Pacific Herring biological samples collected in 2021 in the Central Coast major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). Units: kilometres (km).

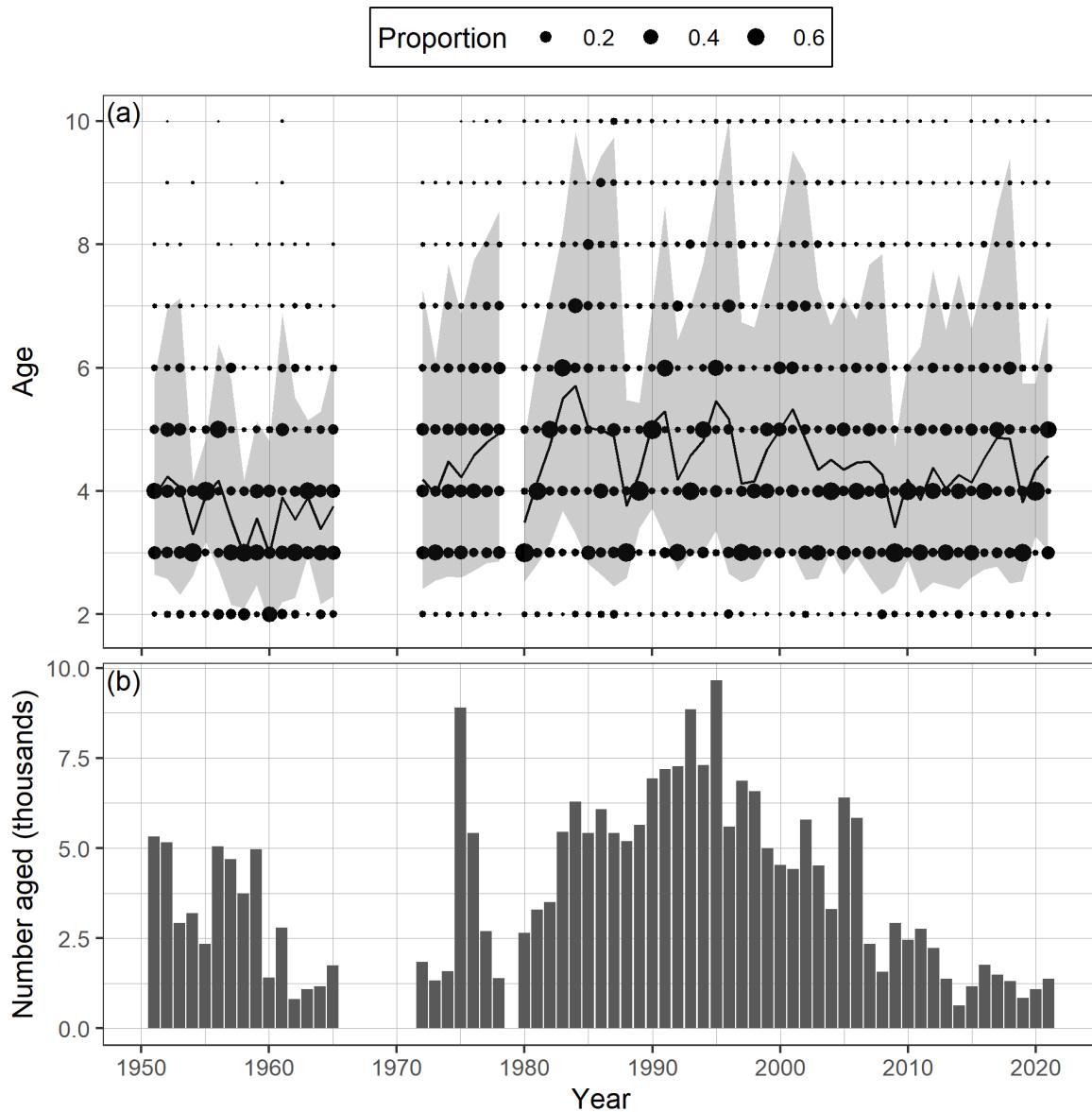


Figure 5. Time series of observed proportion-at-age (a) and number aged in thousands (c) of Pacific Herring from 1951 to 2021 in the Central Coast major stock assessment region (SAR). The black line is the mean age, and the shaded area is the approximate 90% distribution. Biological summaries only include 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.

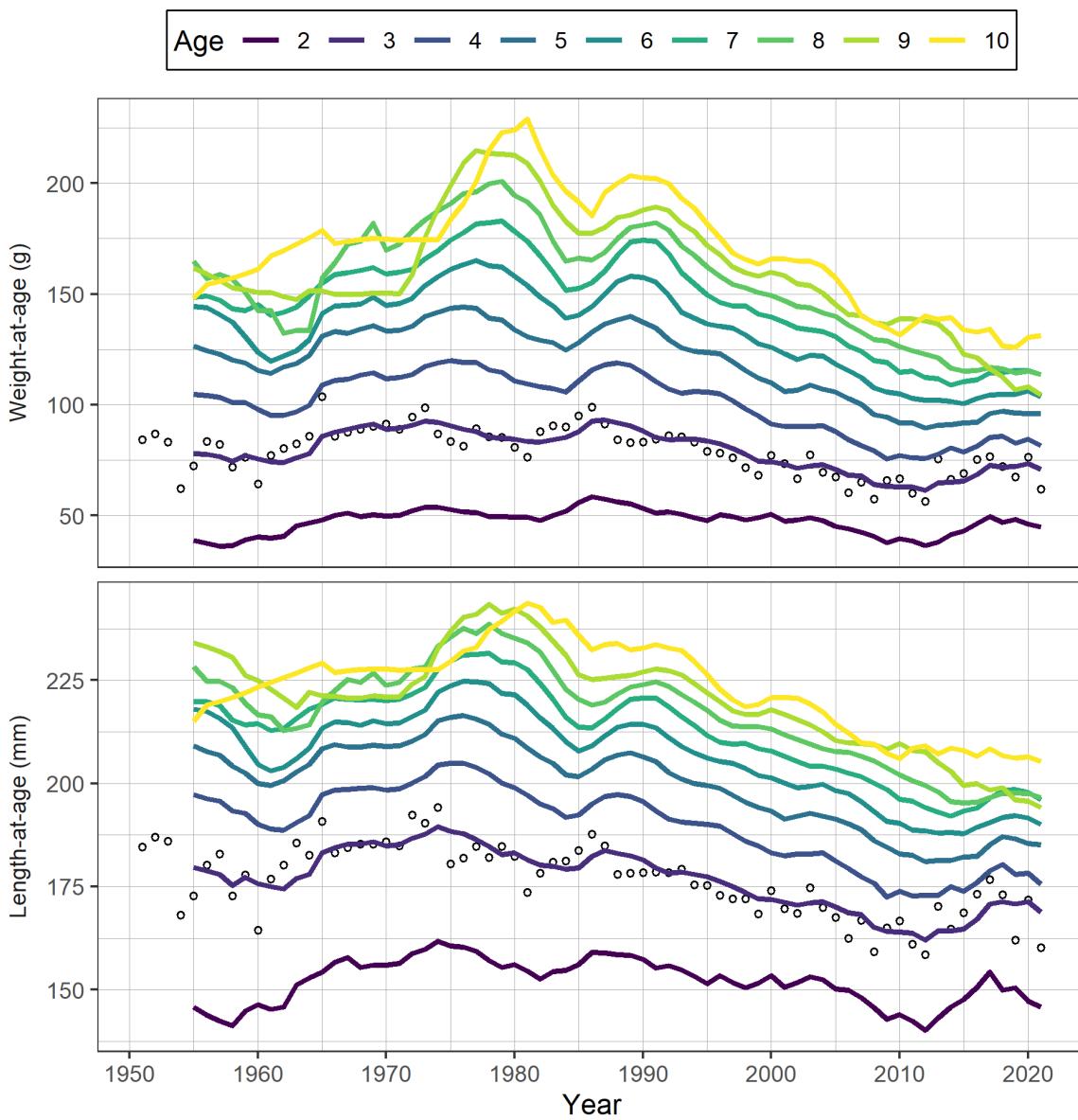


Figure 6. Time series of weight-at-age in grams (g) and length-at-age in milimetres (mm) for age-3 (circles) and 5-year running mean weight- and length-at-age (lines) for Pacific Herring from 1951 to 2021 in the Central Coast major stock assessment region (SAR). Missing weight- and length-at-age values (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.

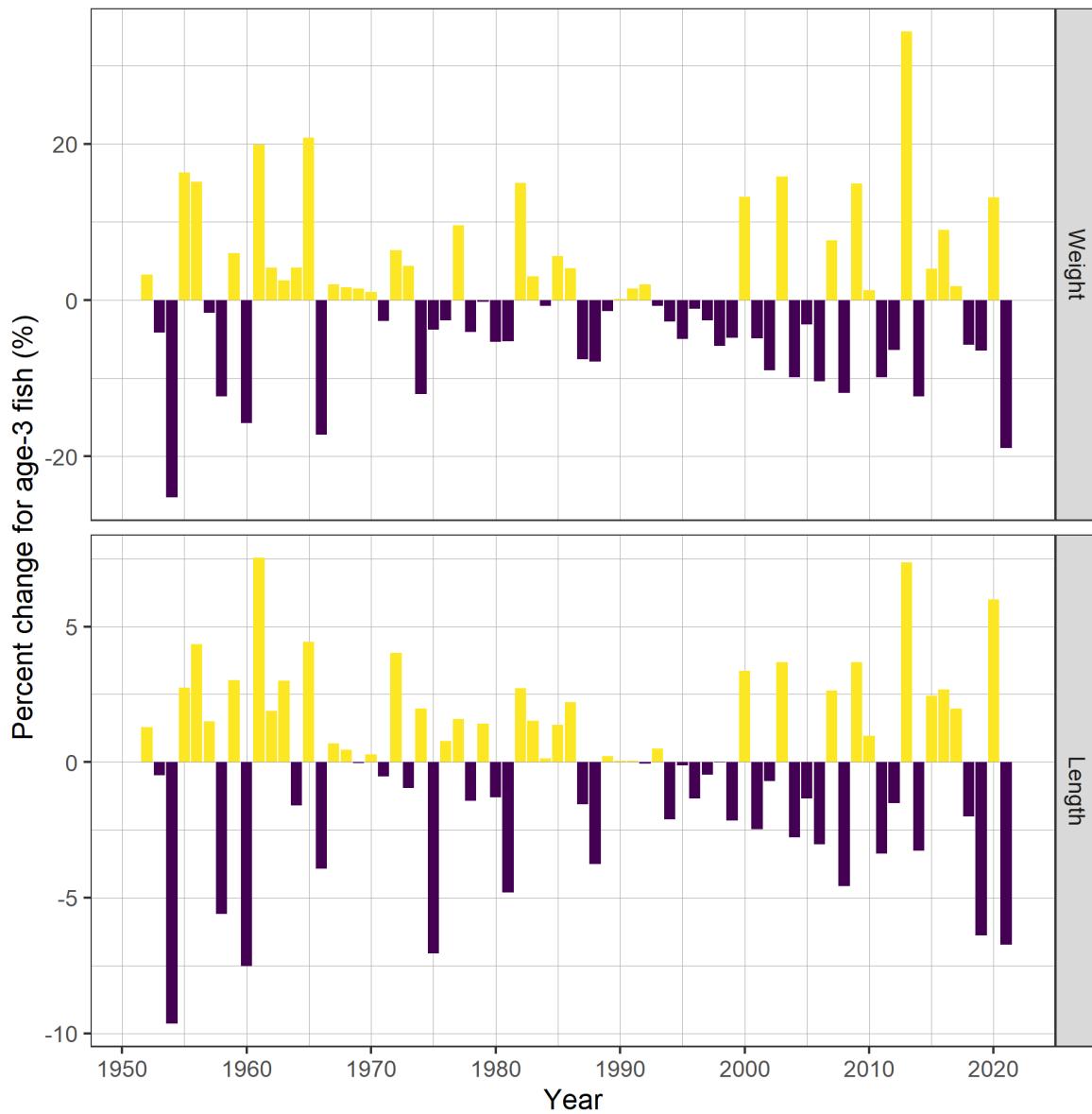


Figure 7. Time series of percent change (%) in weight and length for age-3 fish for Pacific Herring from 1951 to 2021 in the Central Coast major stock assessment region (SAR). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the weight and length of age-3 fish, 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.

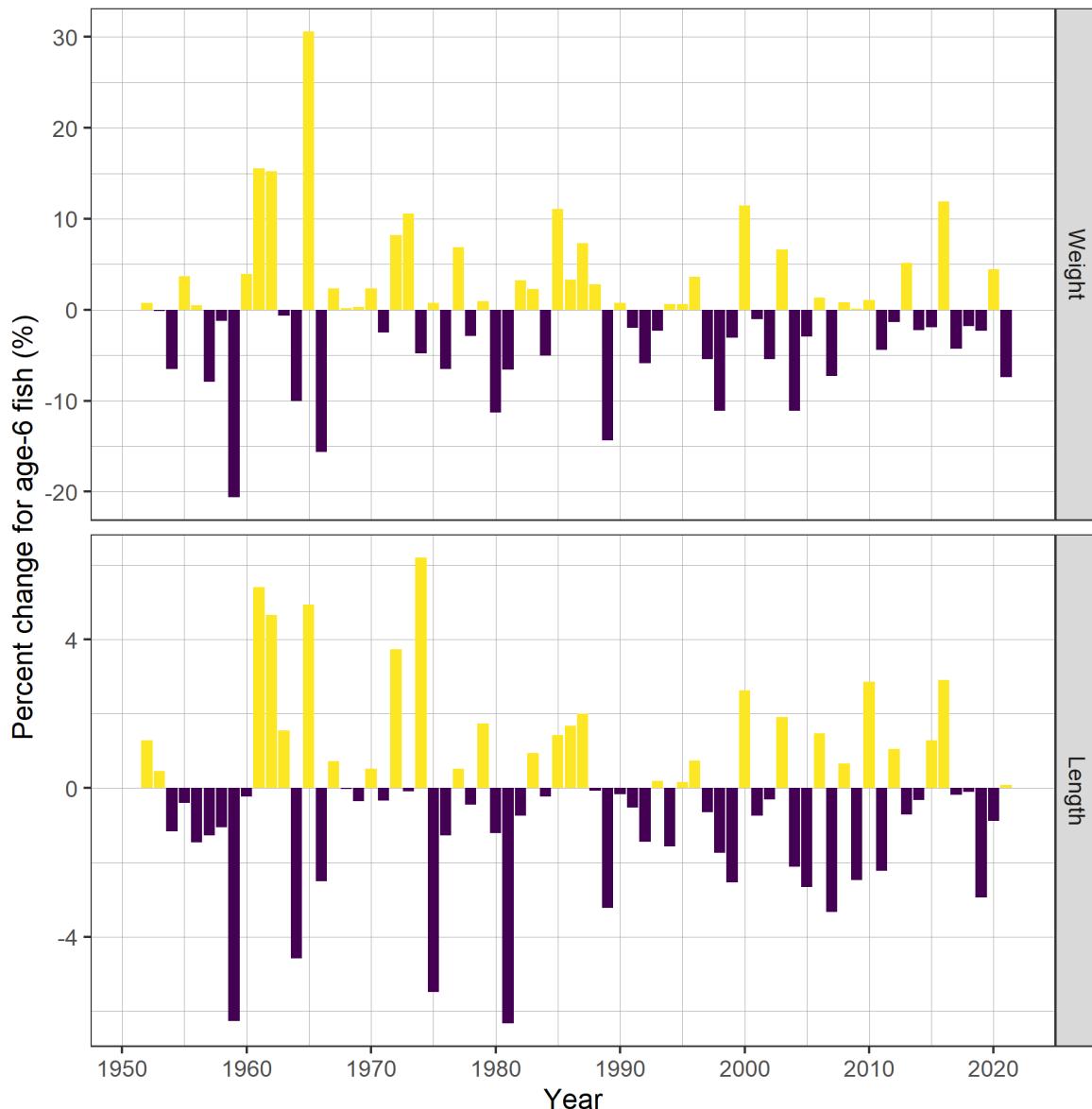


Figure 8. Time series of percent change (%) in weight and length for age-6 fish for Pacific Herring from 1951 to 2021 in the Central Coast major stock assessment region (SAR). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the weight and length of age-6 fish, 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.

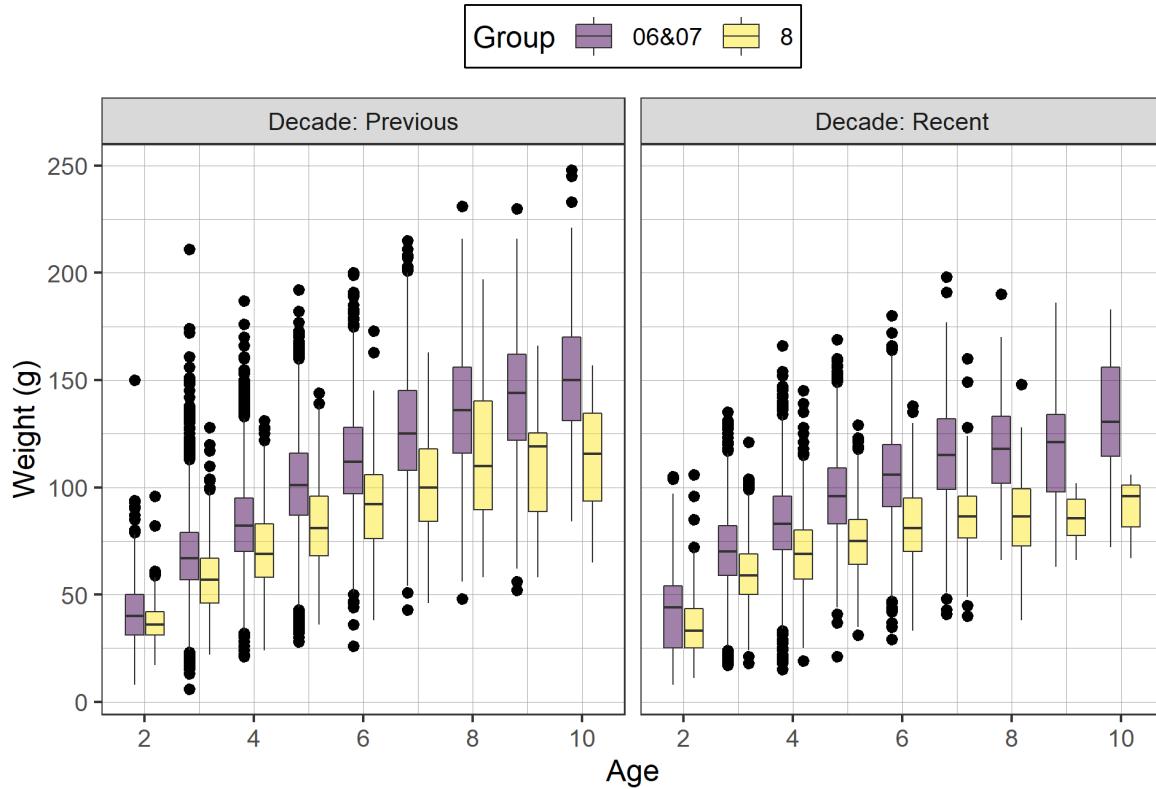


Figure 9. Weight-at-age in grams (g) of Pacific Herring in the Central Coast major stock assessment region (SAR) by Group from the most recent decade (2012 to 2021), and the previous decade (2002 to 2011). The outer edges of the boxes indicate the 25th and 75th percentiles, and the middle lines indicate the 50th percentiles (i.e., medians). The whiskers extend to 1.5 × IQR, where IQR is the distance between the 25th and 75th percentiles, and dots indicate outliers. Sample sizes are given in Table 8. 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. Legend: ‘06&07’ is Statistical Areas 06 and 07; and ‘08’ is Statistical Area 08.

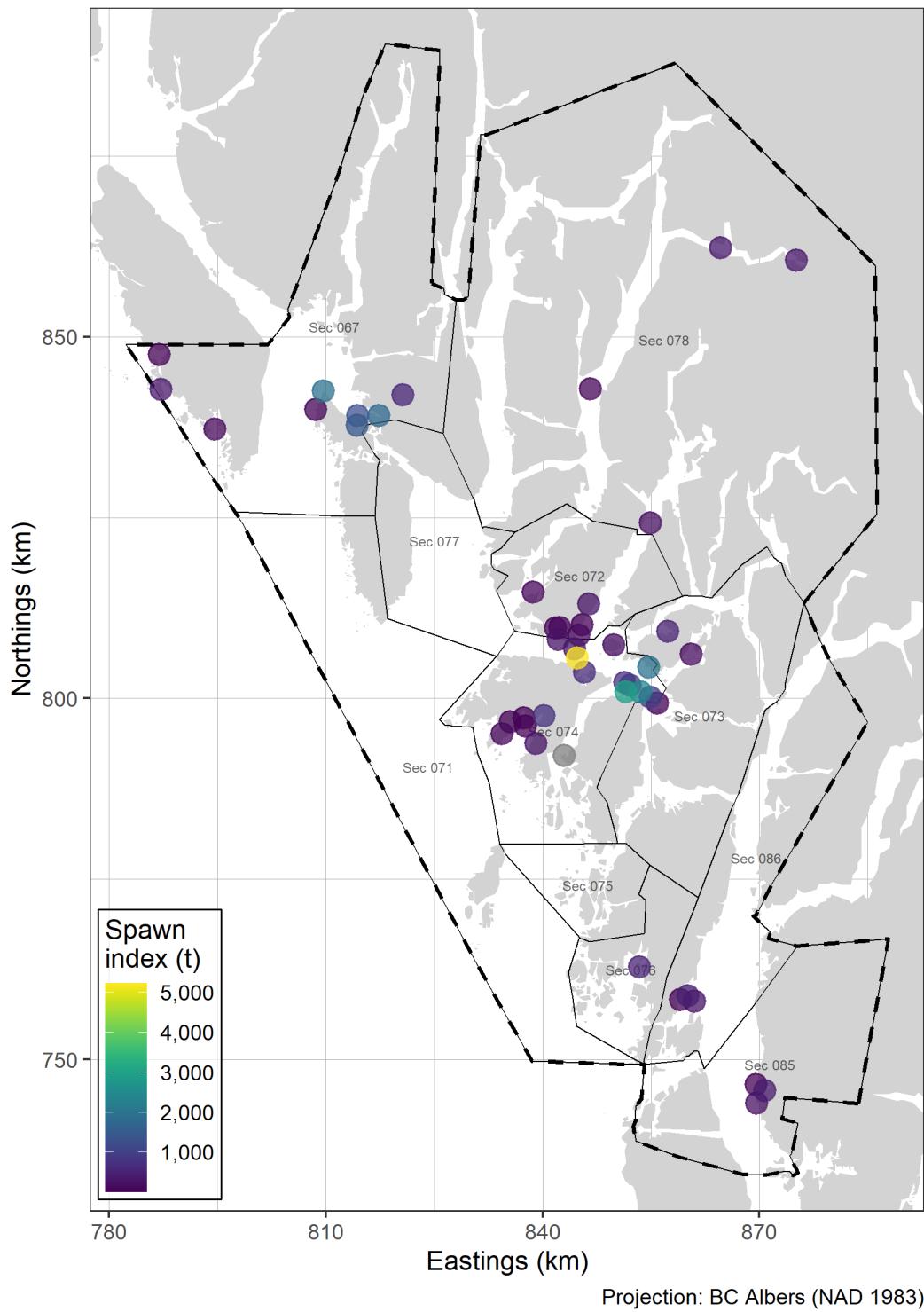


Figure 10. Pacific Herring spawn survey locations, and spawn index in metric tonnes (t) in 2021 in the Central Coast major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The ‘spawn index’ is not scaled by the spawn survey scaling parameter, q . Missing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

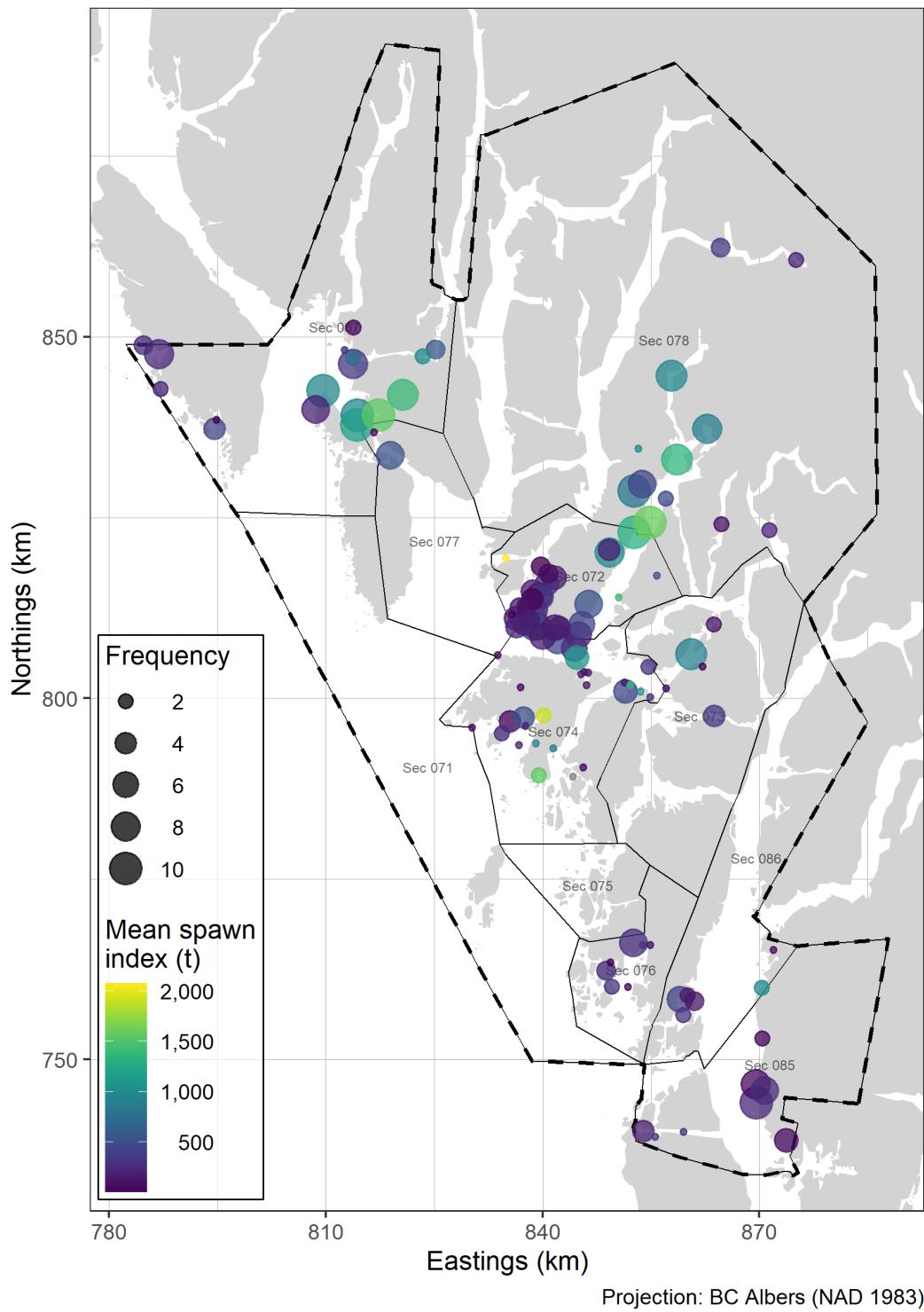


Figure 11. Pacific Herring spawn survey locations, mean spawn index in metric tonnes (t), and spawn frequency from 2011 to 2020 in the Central Coast major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The ‘spawn index’ is not scaled by the spawn survey scaling parameter, q . Missing spawn index values (grey circles) indicate incomplete spawn surveys. Units: kilometres (km).

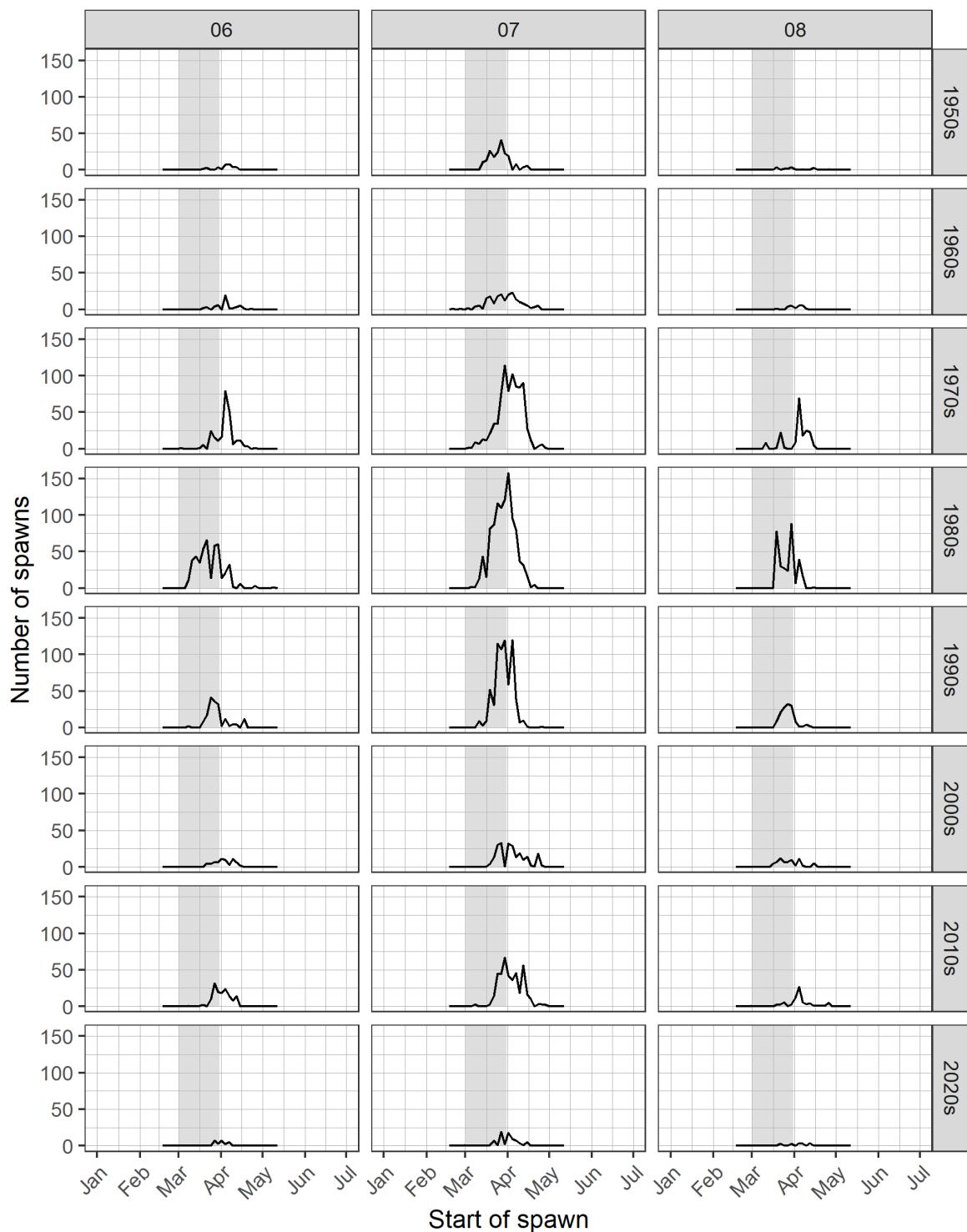


Figure 12. Pacific Herring spawn start date by decade and Statistical Area. Grey shaded regions indicate March 1st to 31st. Note that spawn size and intensity varies; therefore the number of spawns is not directly proportional to spawn extent or biomass.

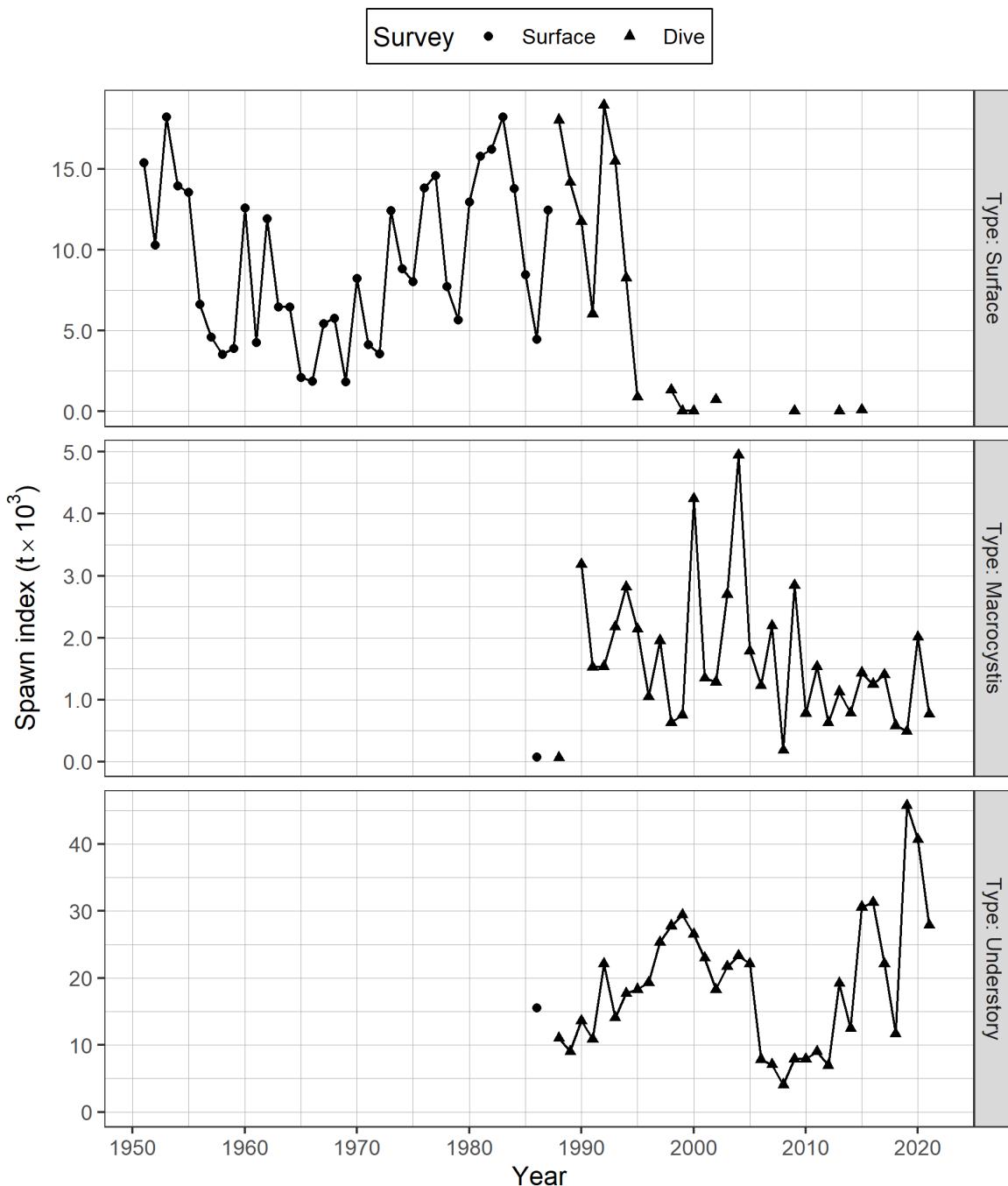


Figure 13. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) by type for Pacific Herring from 1951 to 2021 in the Central Coast major stock assessment region (SAR). There are three types of spawn survey observations: observations of spawn taken from the surface usually at low 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 2021).

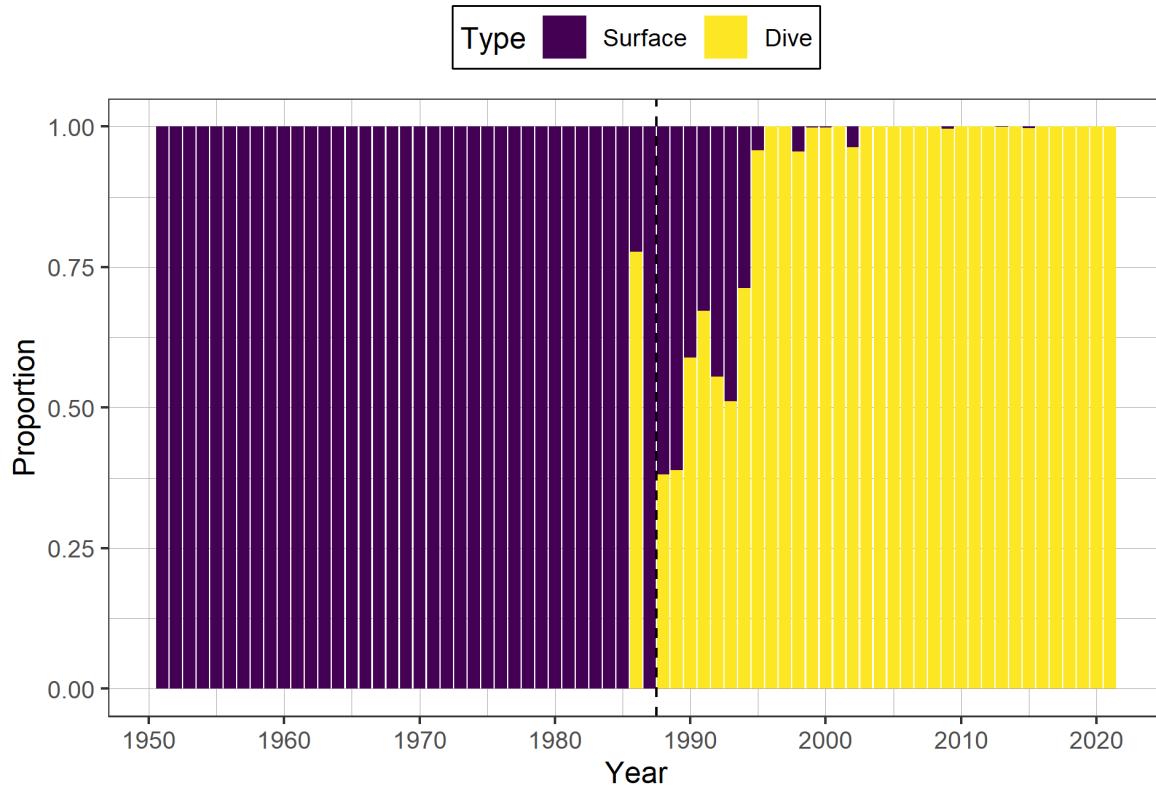


Figure 14. Time series of proportion of spawn index by surface and dive surveys for Pacific Herring from 1951 to 2021 in the Central Coast major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2021).

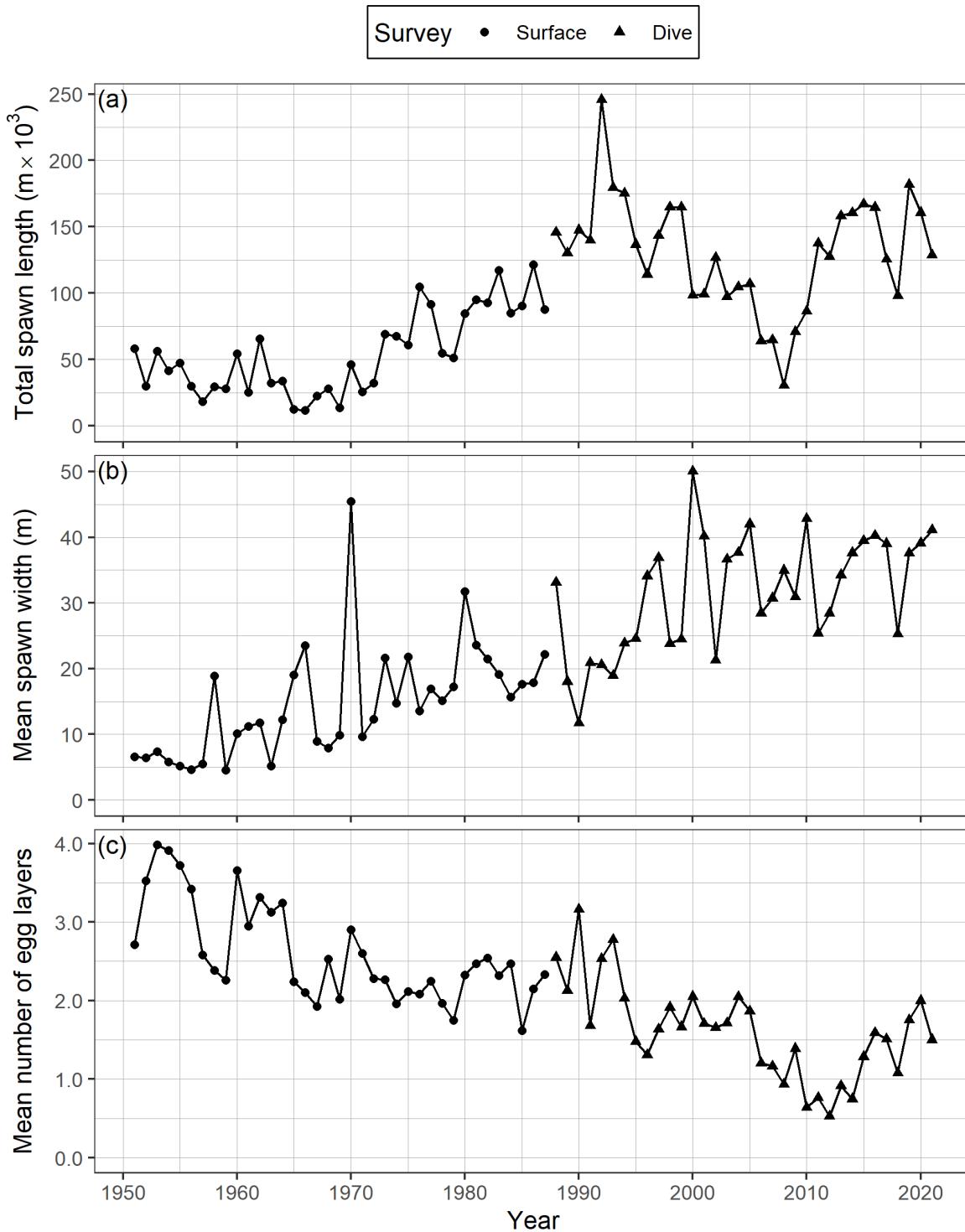


Figure 15. Time series of total spawn length in thousands of metres ($m \times 10^3$; panel a), mean spawn width in metres (b), and mean number of egg layers (c) for Pacific Herring from 1951 to 2021 in the Central Coast major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2021).

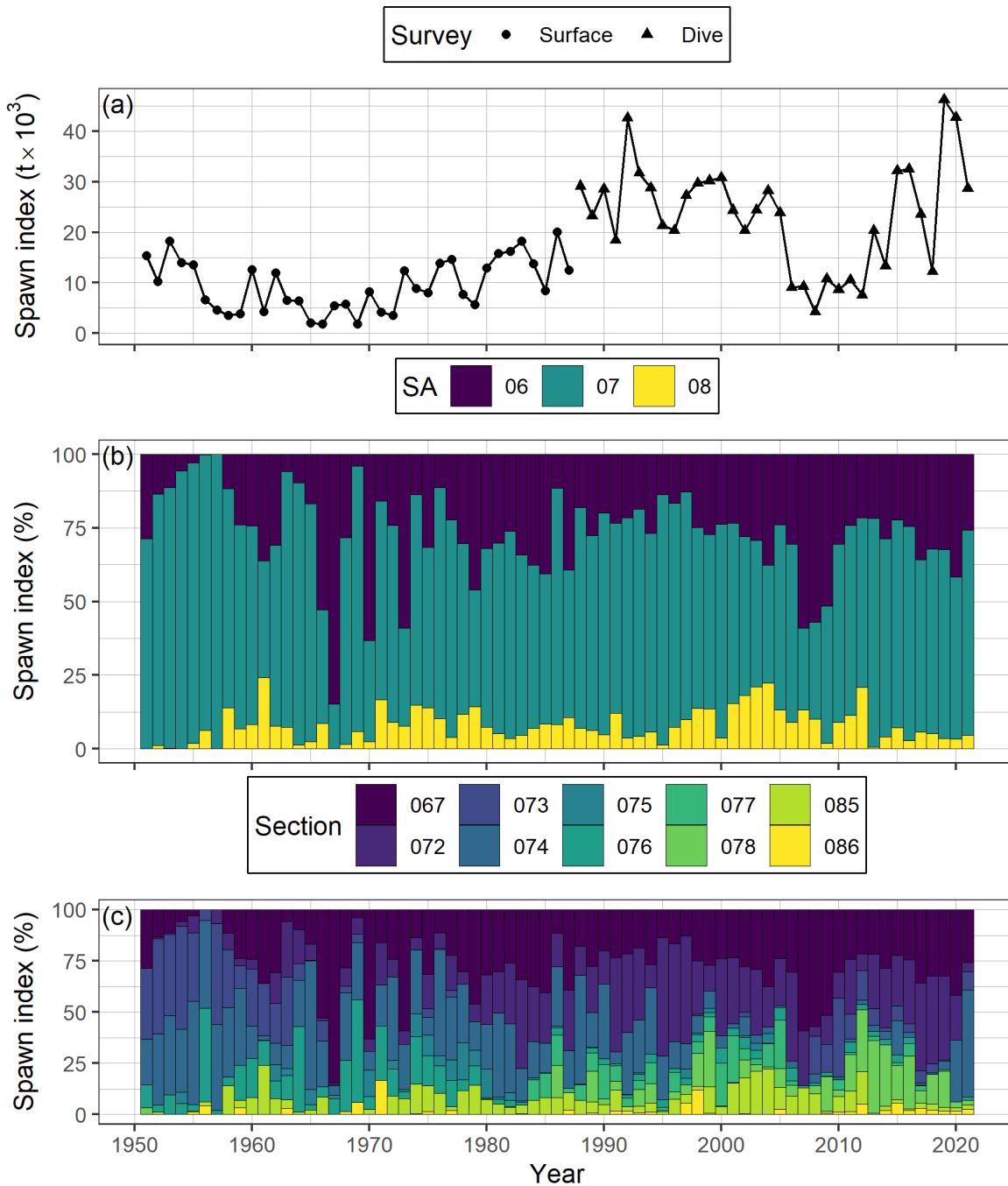


Figure 16. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) for Pacific Herring from 1951 to 2021 in the Central Coast major stock assessment region (SAR; panel a), as well as percent contributed by Statistical Area (SA), and Section (b, & c, respectively). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2021). Note that spawn surveys in the dive survey period (1988 to 2021) are a combination of surface and dive surveys (Figures 13 and 14). The ‘spawn index’ is not scaled by the spawn survey scaling parameter, q . Legend: ‘06&07’ is Statistical Areas 06 and 07; and ‘08’ is Statistical Area 08.

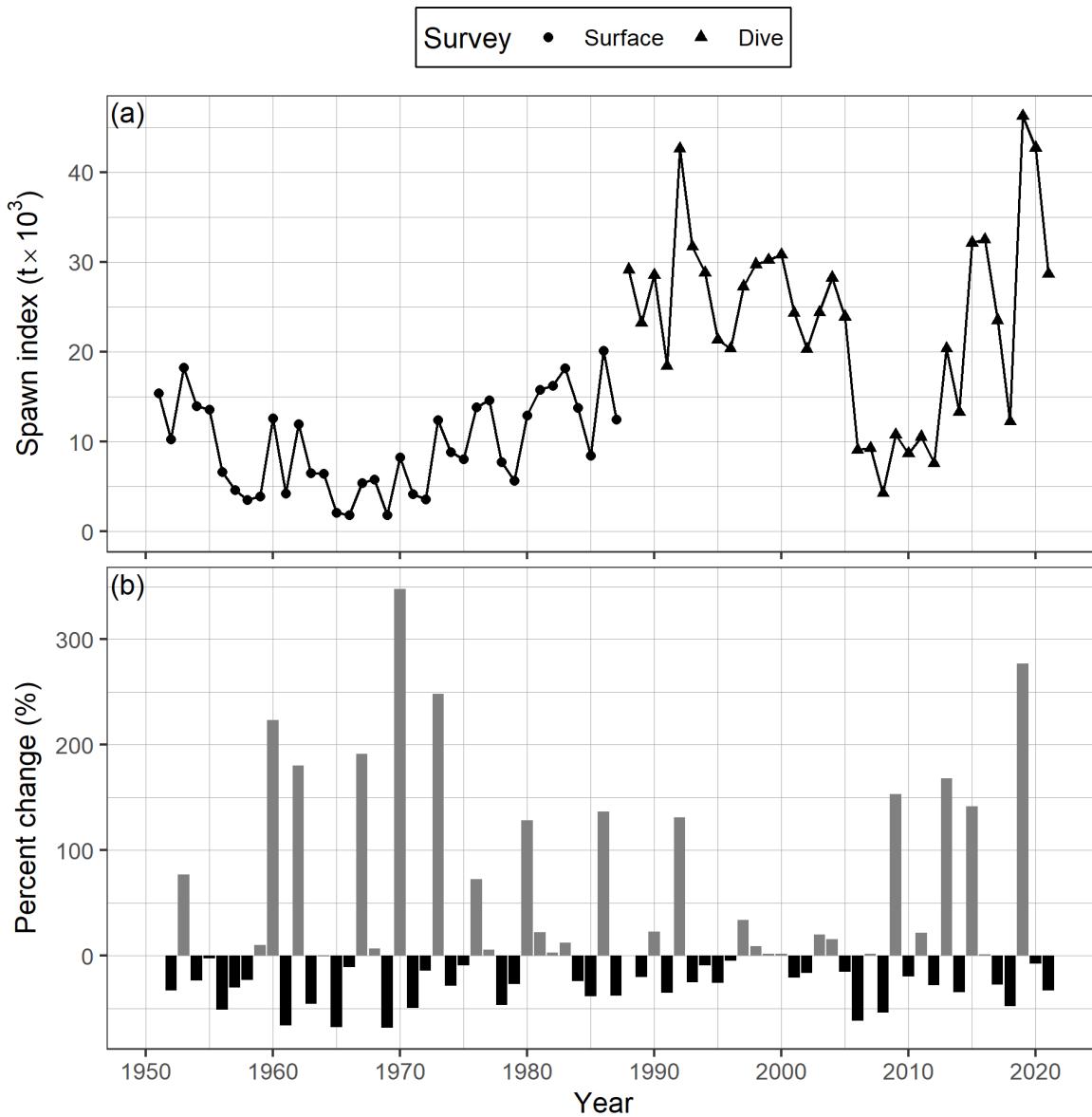


Figure 17. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) for Pacific Herring from 1951 to 2021 in the Central Coast major stock assessment region (SAR; panel a), and percent change (b). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t 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 2021). The ‘spawn index’ is not scaled by the spawn survey scaling parameter, q . Note that spawn surveys in the dive survey period (1988 to 2021) are a combination of surface and dive surveys (Figures 13 and 14).

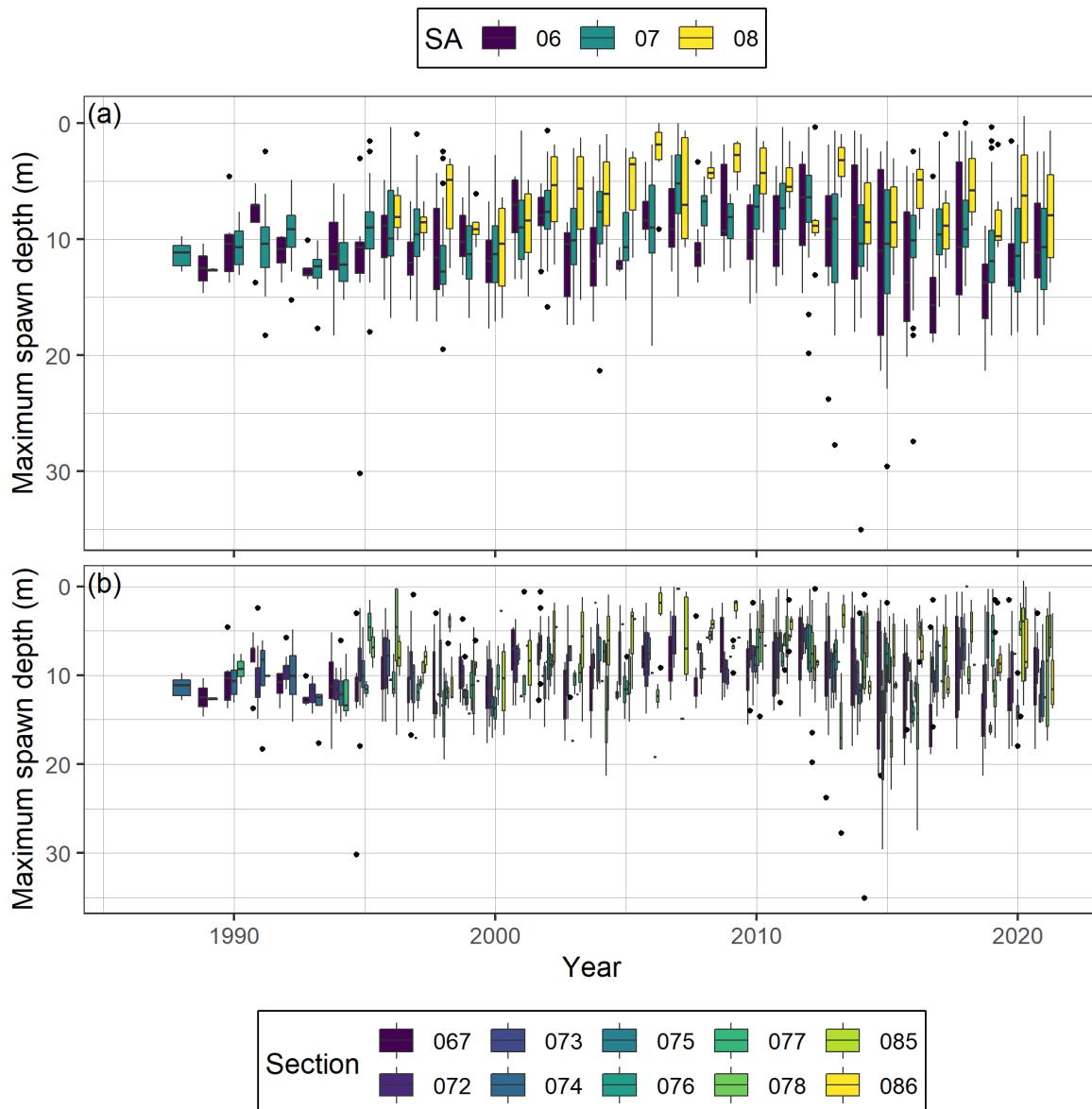


Figure 18. Time series of maximum spawn depth in metres (m) for Pacific Herring from 1986 to 2021 in the Central Coast major stock assessment region (SAR) by Statistical Area (SA; panel a), and Section (b). Note that depth is not corrected to chart datum. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2021).

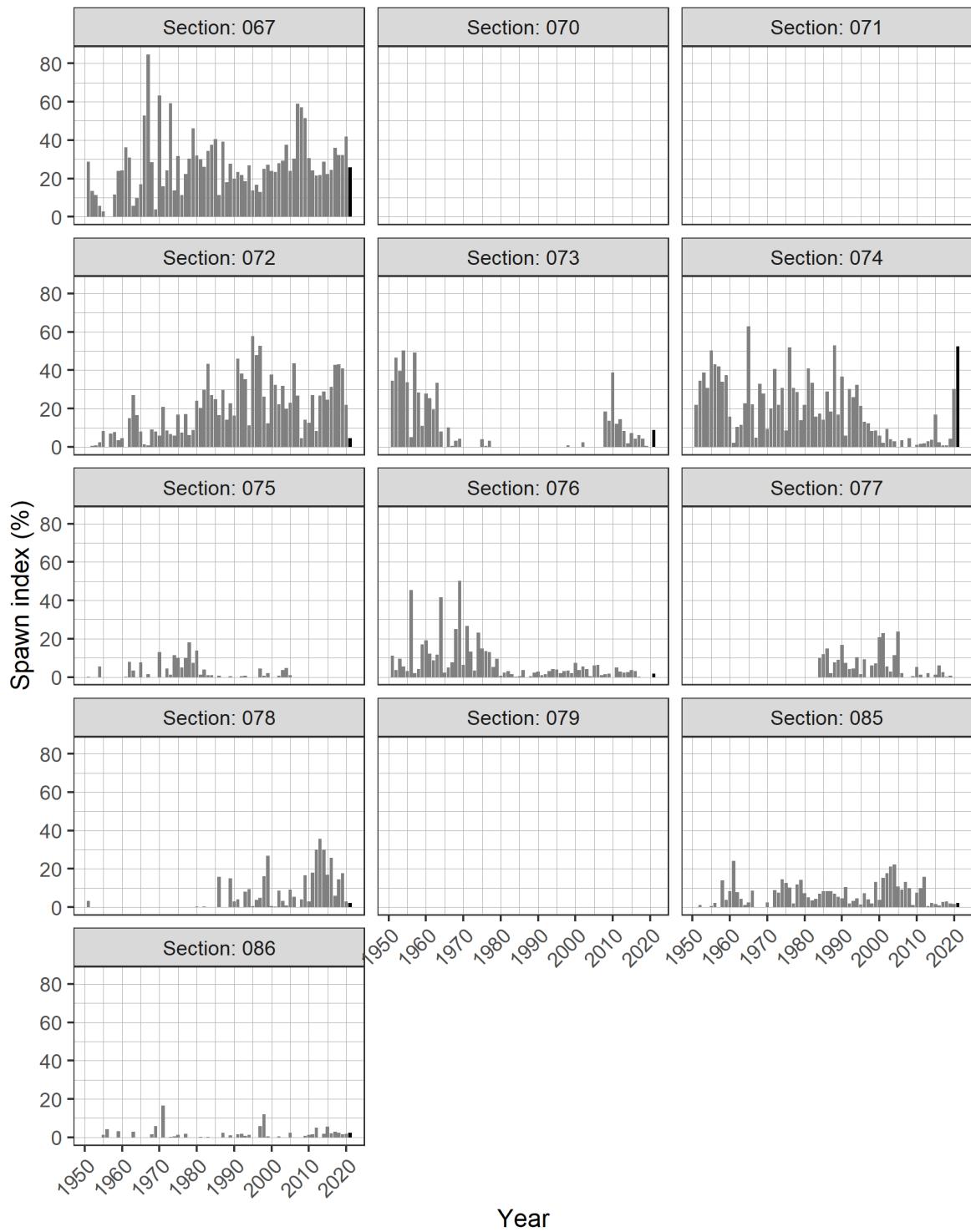


Figure 19. Time series of percent of spawn index by Section for Pacific Herring from 1951 to 2021 in the Central Coast major stock assessment region (SAR). The year 2021 has a darker bar to facilitate interpretation. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2021). The ‘spawn index’ is not scaled by the spawn survey scaling parameter, q .

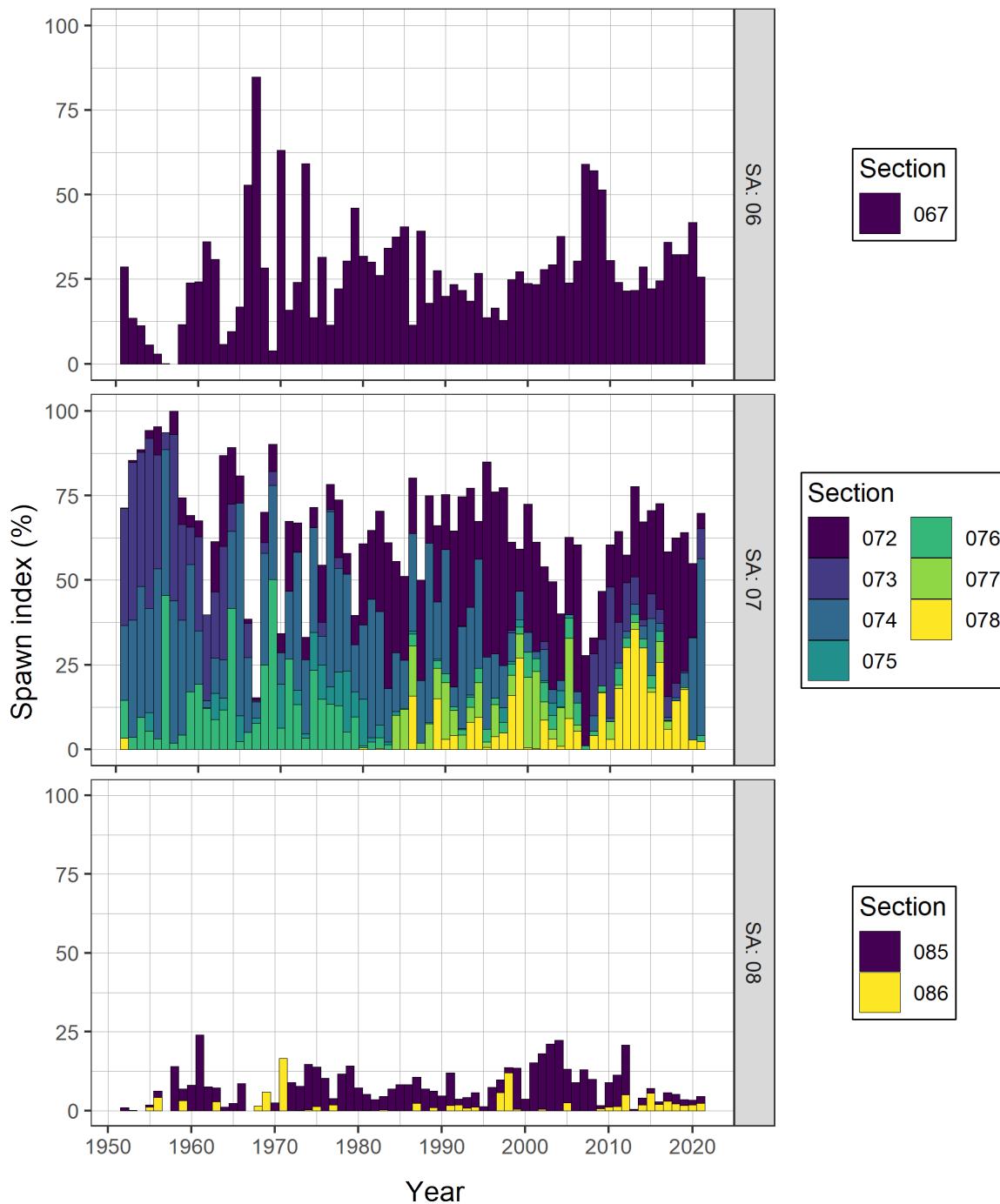


Figure 20. Time series of percent of spawn index by Statistical Area (SA) and Section for Pacific Herring from 1951 to 2021 in the Central Coast major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2021). The ‘spawn index’ is not scaled by the spawn survey scaling parameter, q . Legend: ‘06&07’ is Statistical Areas 06 and 07; and ‘08’ is Statistical Area 08.

Figure 21. Animation of Pacific Herring spawn index in metric tonnes (t) by Location from 1951 to 2021 in the Central Coast 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 2021). 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).