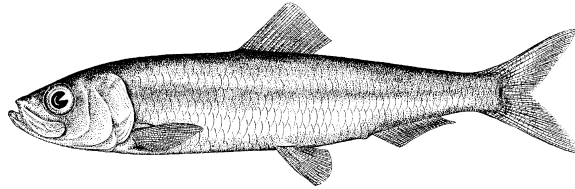


Pacific Herring preliminary data summary for Central Coast 2018

Jaclyn Cleary* Matthew Grinnell†

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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 2018 in the Central Coast major stock assessment area (SAR). These data may differ from data used and presented in the final stock assessment.

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 2018. 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.

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

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

The following is a description of data collected for Pacific Herring in 2018 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 2018 refers to the 2017/2018 Pacific Herring season.

2 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 “Windward Isle” for 21 days from March 15th to April 4th. 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.

Herring spawn locations were primarily identified with fixed-wing overflights conducted by DFO Resource Management Area staff. Seven flights were conducted this season, between February and April. Three dive charter vessels operated in the CC:

- The “Viking Spirit” surveyed 21 days from April 6th to April 25th,
- The “Ocean Cloud” surveyed 12 days from April 4th to April 15th, and
- The Kitasoo First Nations surveyed 5 days from April 1st to April 5th.

Three gillnet sounding vessels were operating by the Heiltsuk Nation this season: two primarily in Area 07 and one primarily in Area 08 to assist the location of fish for the spawn on kelp (SOK) operations.

2.1 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 $\sim 7\%$ 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., $\sim 7\%$). 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.

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. Total harvested spawn on kelp (SOK) in 2018 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 techincal report](#) for calculations to convert SOK harvest to spawning biomass.

In 2018, 34 Pacific Herring biological samples were collected and processed for the Central Coast major SAR (Table 5, Table 6), and a total of 1,307 Pacific Herring were aged in 2018. 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). Some Statistical Areas tend to have larger fish at a given age (Figure 7, 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.

4 Spawn survey data

Pacific Herring spawn surveys were conducted at 44 individual locations in 2018 in the Central Coast major SAR (Table 9, and Figure 8). A summary of spawn from the last decade (2008 to 2017) 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, and Table 10). We describe the calculations used to estimate the spawn index in the [draft spawn index techincal report](#). In addition, spawn surveys estimate spawn depth by Statistical Area, and Section (Figure 13). The ‘spawn index’ represents the raw survey data only, and 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 2018).

Some Pacific Herring Sections contribute more than others to the total spawn index, and the percentage contributed by Section varies yearly (Figure 12b, Figure 14). For example, in 2018, Section 072 contributed the most to the spawn index (43%). As with Sections, some Statistical Areas contribute more than others to the total spawn index (Figure 12c, Figure 15). An animation shows the spawn index by spawn survey location from 1951 to 2018 (Figure 16).

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:

- Schools of herring were elusive to soundings, and appeared to be less abundant.
- Compared to last year, spawning was more spotty, and over a longer time period.
- Spawn quality ranged from good in some areas to poor and thin in others. Many areas that normally have good quality spawn had thin or no coverage this year.
- Spawn was quite late in a few areas.

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, Sections, and Groups for Pacific Herring in the Central Coast major stock assessment region (SAR). Legend: ‘6&7’ is Statistical Areas 6 and 7; and ‘8’ is Statistical Area 8.

Region	Statistical Area	Section	Group
Central Coast	06	067	6&7
Central Coast	07	070	6&7
Central Coast	07	071	6&7
Central Coast	07	072	6&7
Central Coast	07	073	6&7
Central Coast	07	074	6&7
Central Coast	07	075	6&7
Central Coast	07	076	6&7
Central Coast	07	077	6&7
Central Coast	07	078	6&7
Central Coast	07	079	6&7
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 2018 in the Central Coast 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 2008 to 2018 in the Central Coast major stock assessment region (SAR). See the [draft spawn index techincal 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: ‘WP’ indicates that data are withheld due to privacy concerns.

Year	Harvest (lb)	Spawning biomass (t)
2008	0	0
2009	0	0
2010	0	0
2011	0	0
2012	0	0
2013	0	0
2014	239,861	356
2015	169,470	252
2016	351,953	522
2017	392,747	583
2018	286,109	425

Table 5. Number of Pacific Herring biological samples processed from 2008 to 2018 in the Central Coast major stock assessment region (SAR). Each sample is approximately 100 fish.

Year	Number of samples		
	Commercial	Test	Total
2008	0	17	17
2009	0	34	34
2010	0	26	26
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

Table 6. Number and type of Pacific Herring biological samples processed in 2018 in the Central Coast major stock assessment region (SAR). Each sample is approximately 100 fish.

Type	Gear	Use	Number of samples
Commercial	Seine	Other	4
Test	Other	Nearshore	18
Test	Seine	Test fishery	12

Table 7. Observed proportion-at-age for Pacific Herring from 2008 to 2018 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
2008	0.142	0.103	0.419	0.117	0.156	0.028	0.027	0.005	0.001
2009	0.044	0.718	0.105	0.081	0.023	0.022	0.003	0.003	0.001
2010	0.017	0.157	0.650	0.054	0.077	0.021	0.021	0.001	0.002
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

Table 8. Sample size for Pacific Herring weight-at-age analysis in 2018 in the Central Coast major stock assessment region (SAR) by Group from the most recent decade (2009 to 2018), and the previous decade (1999 to 2008), as displayed in Figure 7. 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: ‘6&7’ is Statistical Areas 6 and 7; and ‘8’ is Statistical Area 8.

Group	Age	Sample size	
		Previous decade	Recent decade
6&7	2	850	610
6&7	3	8,960	5,356
6&7	4	12,024	4,957
6&7	5	8,756	2,816
6&7	6	5,212	1,595
6&7	7	3,007	632
6&7	8	1,376	295
6&7	9	541	101
6&7	10	241	39
8	2	63	303
8	3	718	1,082
8	4	929	856
8	5	495	325
8	6	277	198
8	7	172	74
8	8	67	17
8	9	12	7
8	10	5	4

Table 9. Pacific Herring spawn survey locations, start date, and spawn index in metric tonnes (t) in 2018 in the Central Coast major stock assessment region (SAR). The ‘spawn index’ represents the raw survey data only, and 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	March 28	19
06	067	Clifford Bay	March 28	NA
06	067	Kwakwa Cr	March 28	995
06	067	Marvin Is	March 28	509
06	067	Osment Inlt	March 28	973
06	067	Parsons Anch	March 28	734
06	067	Weeteeam Bay	March 28	21
06	067	Wilby Pt	March 28	557
06	067	Wingate Pt	March 28	146
07	072	Boat Inlt	April 04	2
07	072	Bullen Rk	March 30	163
07	072	Bush Pt	April 04	220
07	072	Don Lgn +	March 31	586
07	072	Fisher Pt	April 04	69
07	072	Foote Islets	March 31	73
07	072	Lambard Inlt	April 04	68
07	072	Leighton Is	April 06	196
07	072	Mosquito Bay	March 31	1,360
07	072	Mouat Cv	April 04	15
07	072	Oliver Cv	April 04	114
07	072	Port Blackney	April 04	155
07	072	Reid Pass	April 04	5
07	072	Shingle Rk	March 31	324
07	072	Spiller Chnl	March 31	1,446
07	072	Tankeeah River	March 31	402
07	072	Watch Is	April 04	69
07	073	Newby Is	April 02	2
07	073	Troup Psg	April 04	536
07	074	Idol Pt	April 03	35
07	074	Norman Morrison Bay	April 03	64
07	074	Peter Bay	April 24	NA
07	077	E Higgins Pass	April 04	4
07	078	Briggs Inlt	March 30	6
07	078	Neekas Cv	March 30	529
07	078	Neekas Inlt	March 30	924
07	078	Roscoe Inlt	March 30	62
07	078	Spiller Chnl Hd	March 30	136

Table 9 continued					
Statistical Area	Section	Location name	Start date	Spawn index (t)	
	07	078	Spiller Inlt	March 30	107
	08	085	Illahie Inlt	April 26	100
	08	085	Koeye Pt	April 01	59
	08	085	Kwakume Inlt	April 01	175
	08	085	Kwakume Pt	March 29	15
	08	085	Whidbey Pt	April 01	9
	08	086	Mustang Bay	April 04	279

Table 10. Summary of Pacific Herring spawn survey data from 2008 to 2018 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 2018). The ‘spawn index’ represents the raw survey data only, and 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)
2008	30,390	35	0.9	4,255
2009	70,980	31	1.4	10,771
2010	86,490	43	0.6	8,671
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

7 Figures

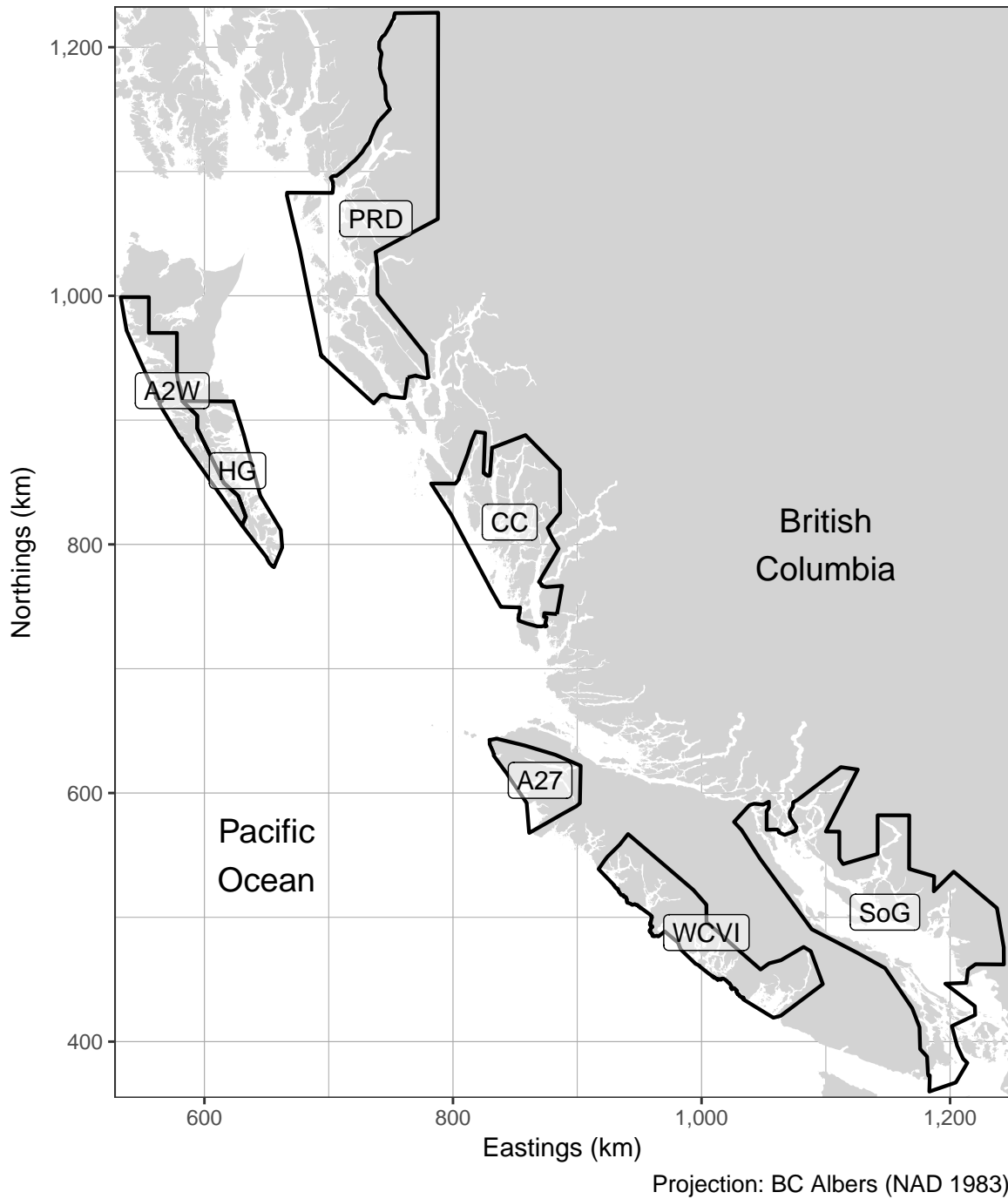


Figure 1. Boundaries for the Pacific Herring stock assessment regions (SARs) in British Columbia: there are 5 major SARs (HG, PRD, CC, SoG, and WCVI), and 2 minor SARs (A27 and A2W; Table 1). Units: kilometres (km).

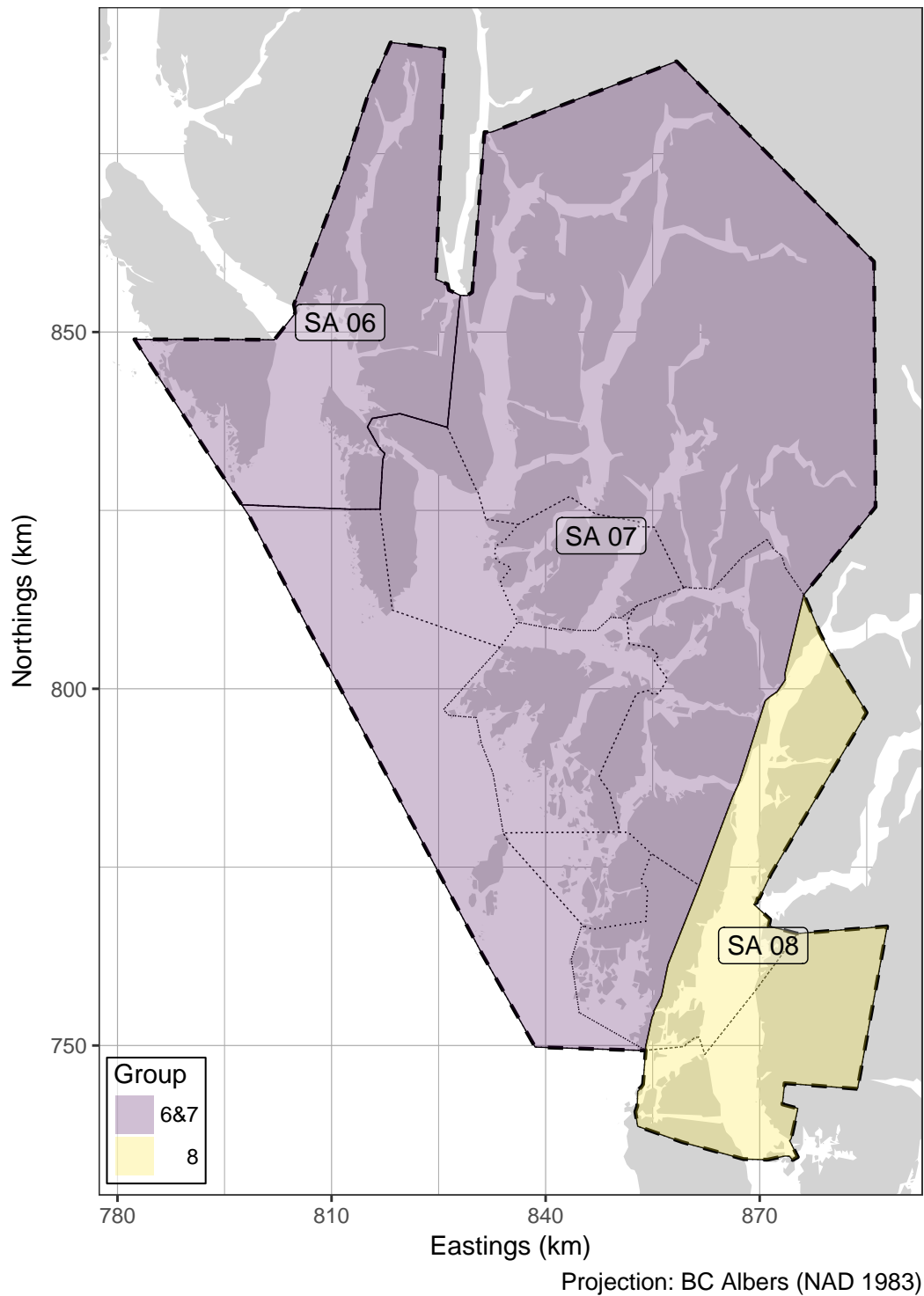


Figure 2. Boundaries for the Central Coast major stock assessment region (SAR; thick dashed lines), associated Statistical Areas (SA; thin solid lines), and associated Sections (thin dotted lines). Units: kilometres (km). Legend: '6&7' is Statistical Areas 6 and 7; and '8' is Statistical Area 8.

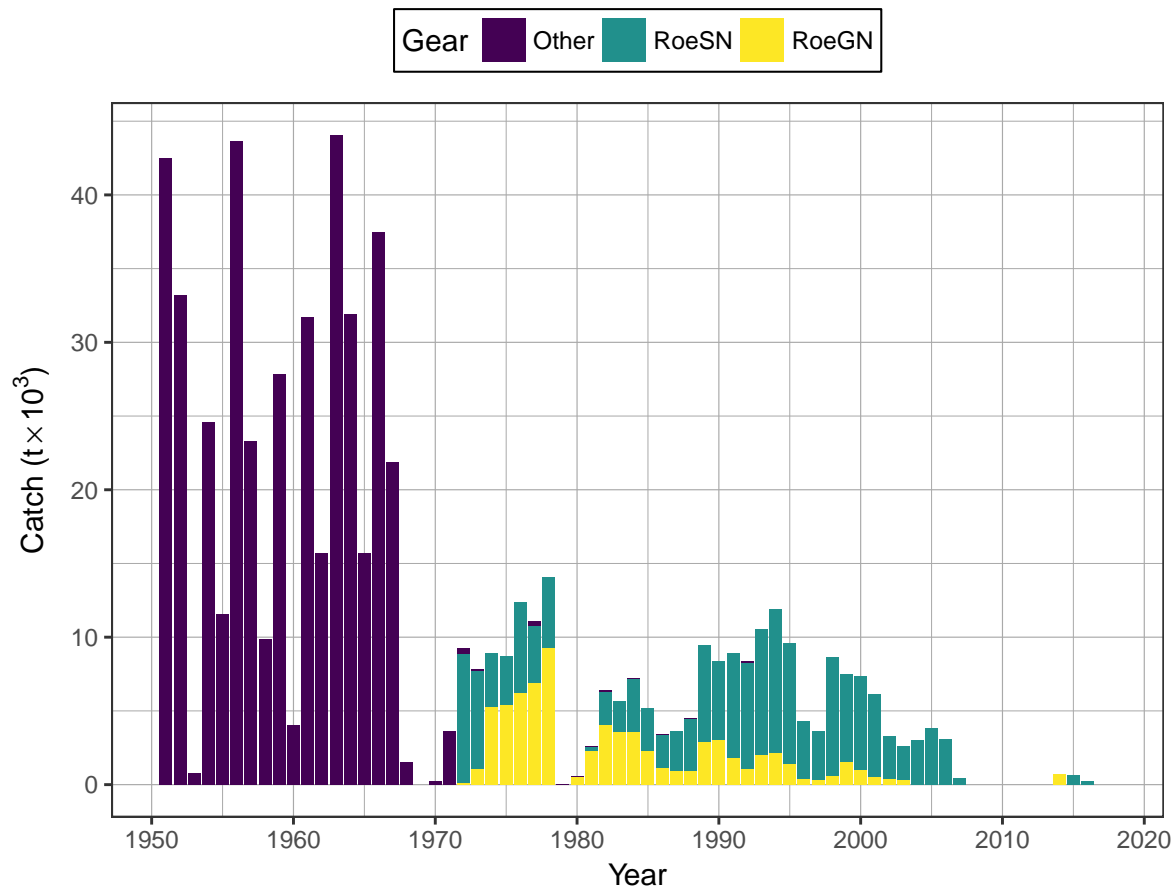


Figure 3. Time series of total landed catch in thousands of metric tonnes ($t \times 10^3$) of Pacific Herring by gear type from 1951 to 2018 in the Central Coast major stock assessment region (SAR). Legend: ‘Other’ represents the reduction, the food and bait, as well as the special use fishery; ‘RoeSN’ represents the roe seine fishery; and ‘RoeGN’ represents the roe gillnet fishery. Data from the spawn-on-kelp (SOK) fishery is not included.

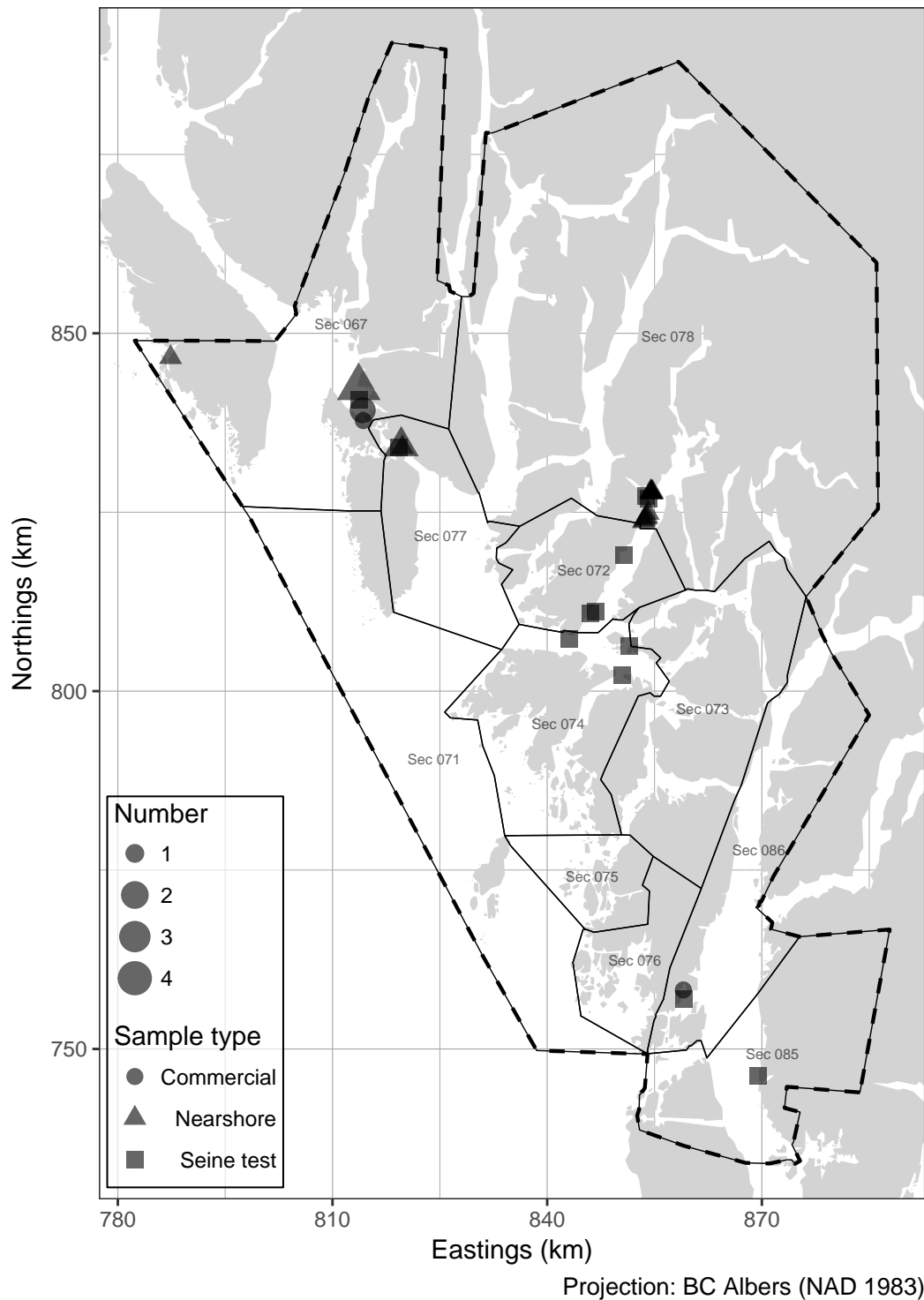


Figure 4. Location and type of Pacific Herring biological samples collected in 2018 in the Central Coast major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). Units: kilometres (km).

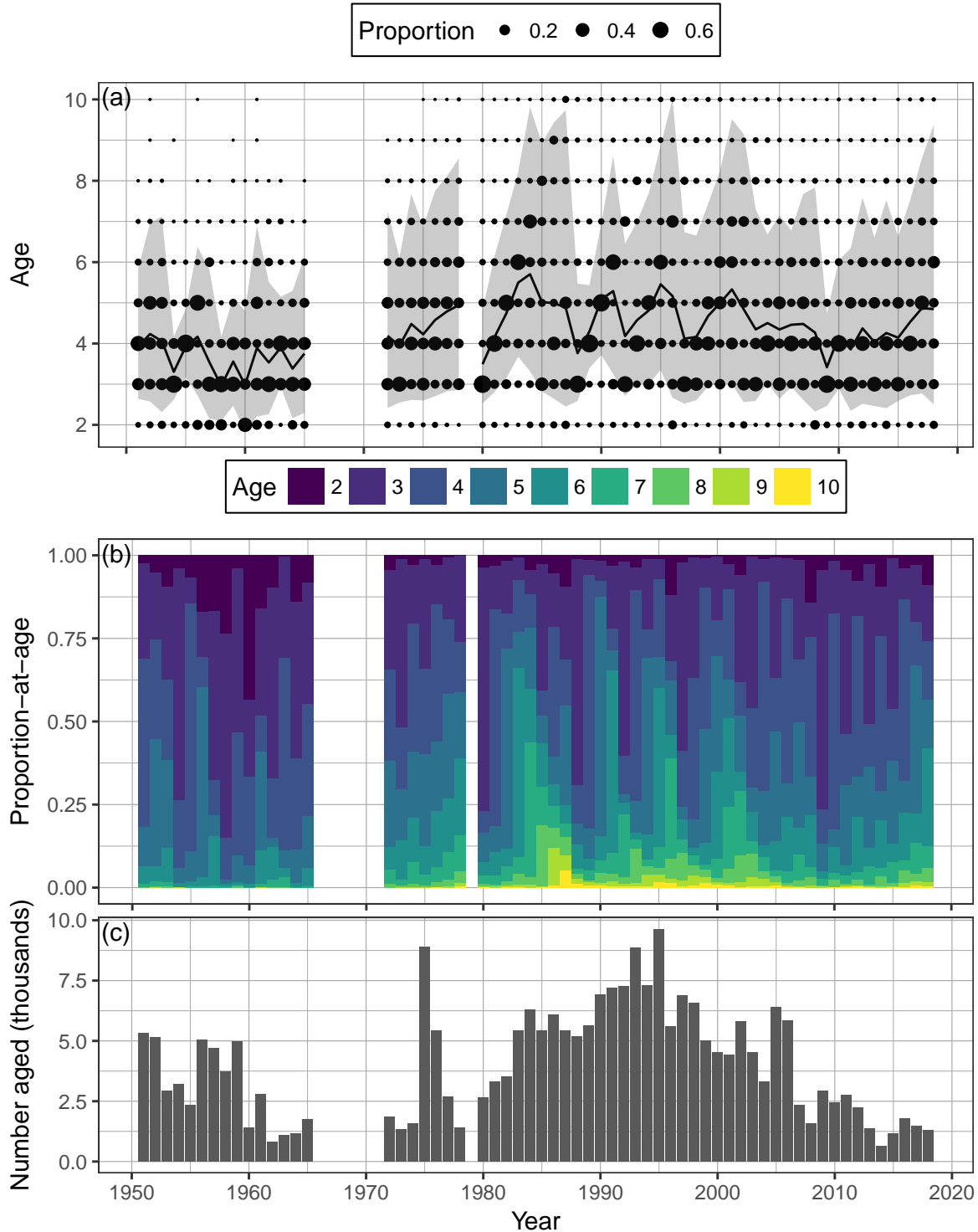


Figure 5. Time series of observed proportion-at-age (a, b) and number aged in thousands (c) of Pacific Herring from 1951 to 2018 in the Central Coast major stock assessment region (SAR). The black line is the mean age, and the shaded area is the approximate 90% distribution. Biological summaries only 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.

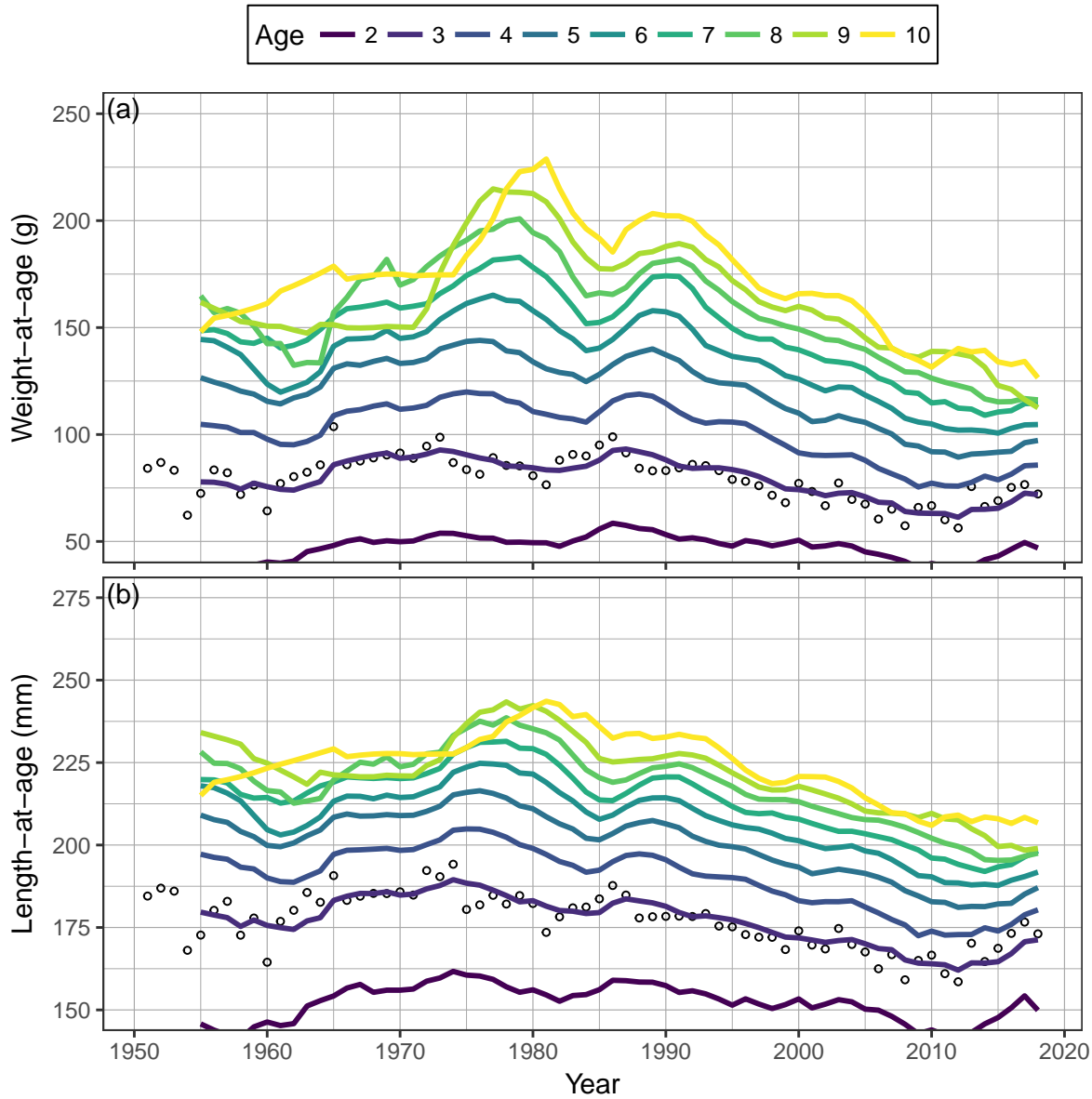


Figure 6. Time series of weight-at-age in grams (g; panel a) and length-at-age in millimetres (mm; panel b) for age-3 (circles) and 5-year running mean weight- and length-at-age (lines) for Pacific Herring from 1951 to 2018 in the Central Coast major stock assessment region (SAR). Missing weight- and 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.

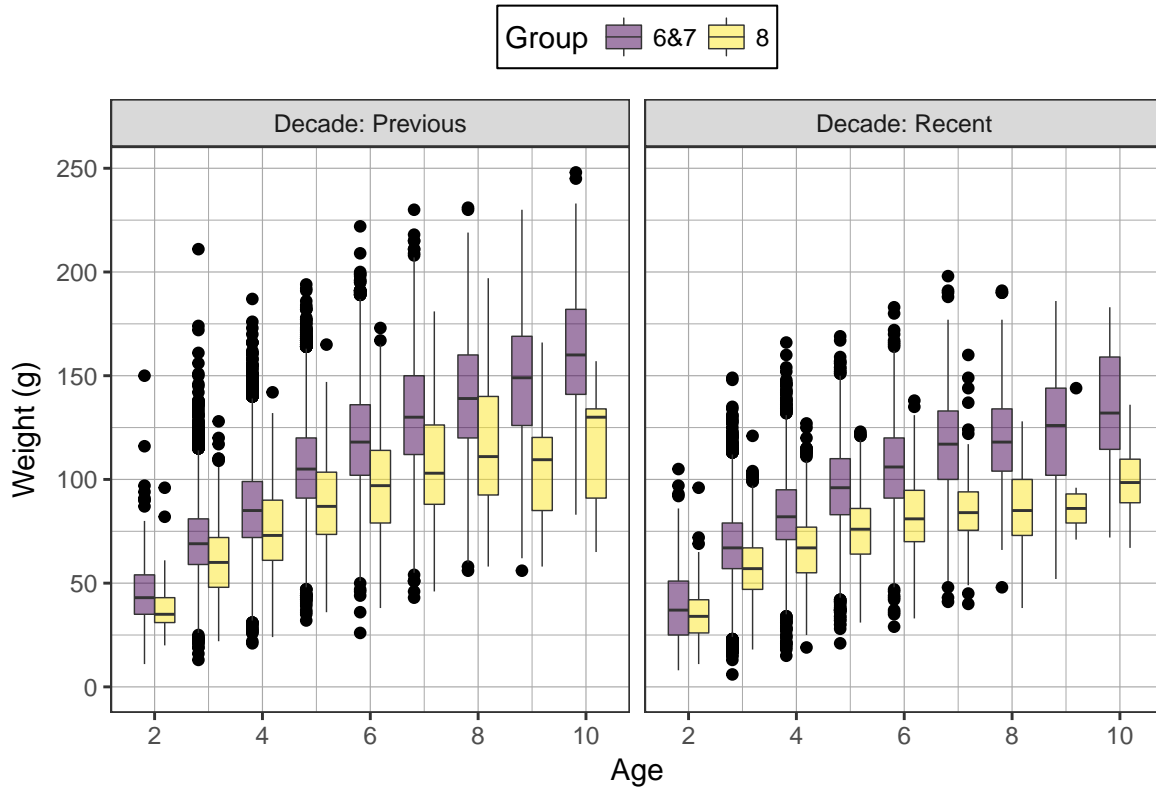


Figure 7. Weight-at-age in grams (g) of Pacific Herring in the Central Coast major stock assessment region (SAR) by Group from the most recent decade (2009 to 2018), and the previous decade (1999 to 2008). The outer edges of the boxes indicate the 25th and 75th percentiles, and the middle lines indicate the 50th percentiles (i.e., medians). The whiskers extend to $1.5 \times \text{IQR}$, 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: ‘6&7’ is Statistical Areas 6 and 7; and ‘8’ is Statistical Area 8.

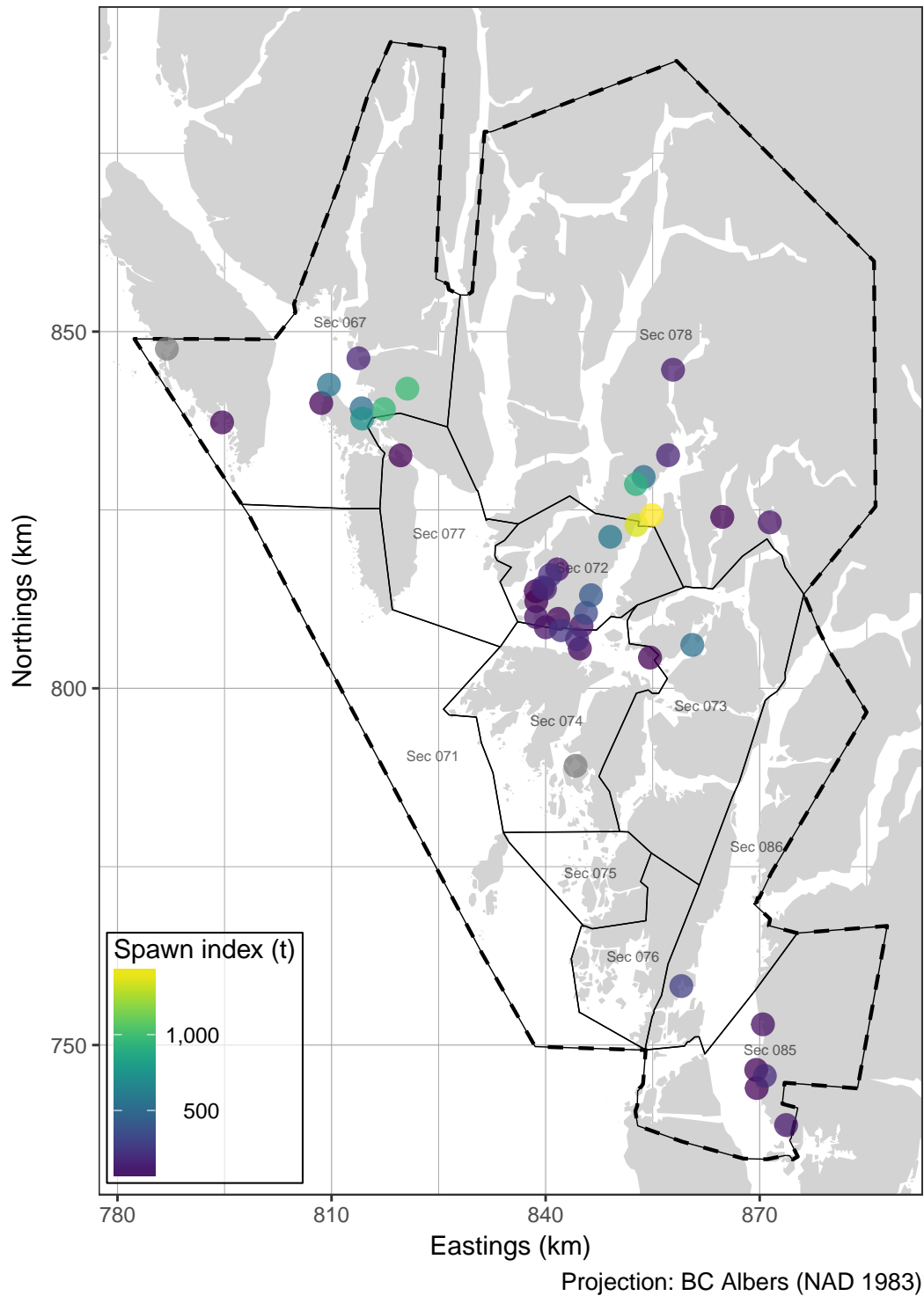


Figure 8. Pacific Herring spawn survey locations, and spawn index in metric tonnes (t) in 2018 in the Central Coast major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The ‘spawn index’ represents the raw survey data only, and is not scaled by the spawn survey scaling parameter, q . Missing spawn index values (grey circles) indicate incomplete spawn surveys. Units: kilometres (km).

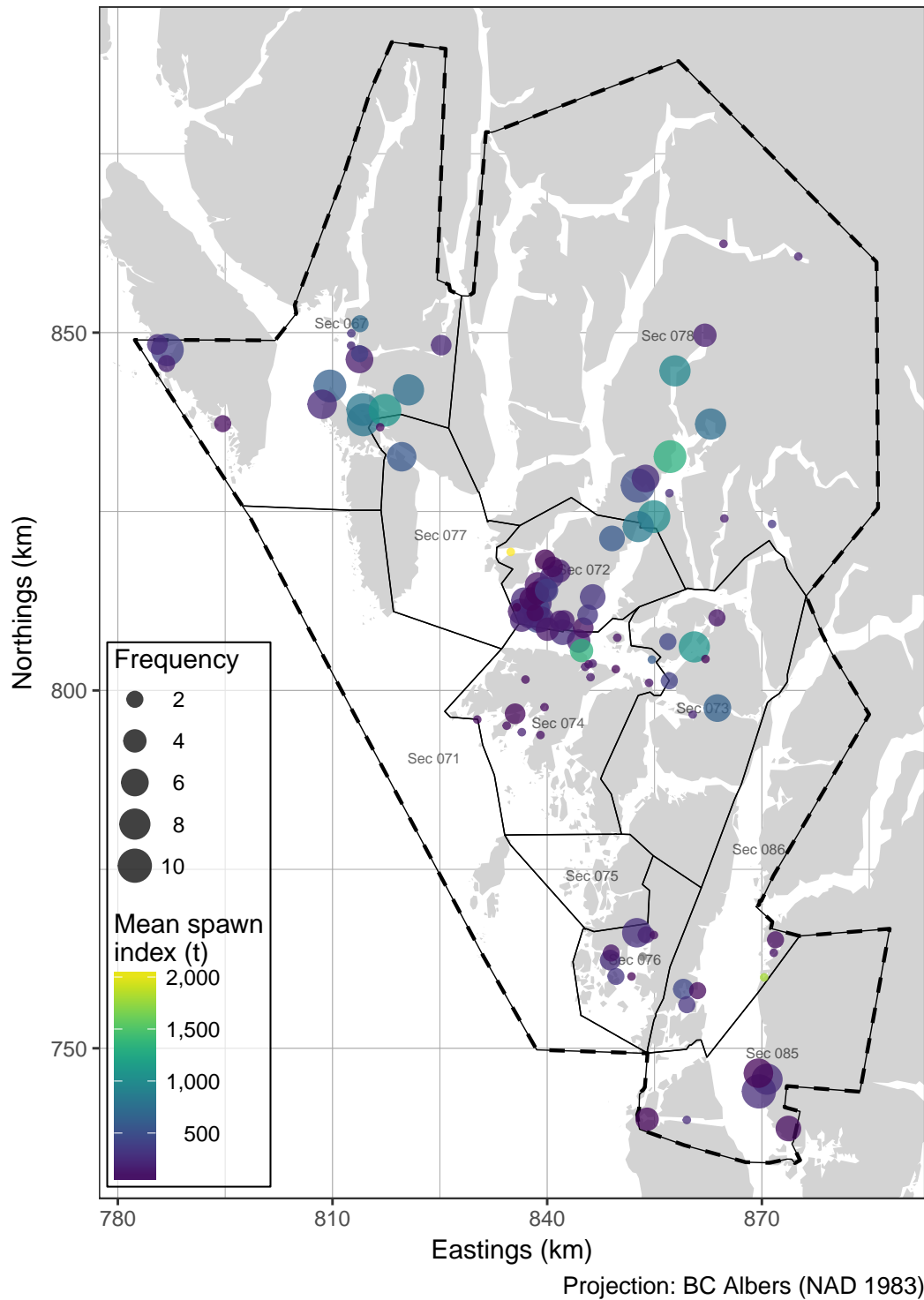


Figure 9. Pacific Herring spawn survey locations, mean spawn index in metric tonnes (t), and spawn frequency from 2008 to 2017 in the Central Coast major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The ‘spawn index’ represents the raw survey data only, and is not scaled by the spawn survey scaling parameter, q . Missing spawn index values (grey circles) indicate incomplete spawn surveys. Units: kilometres (km).

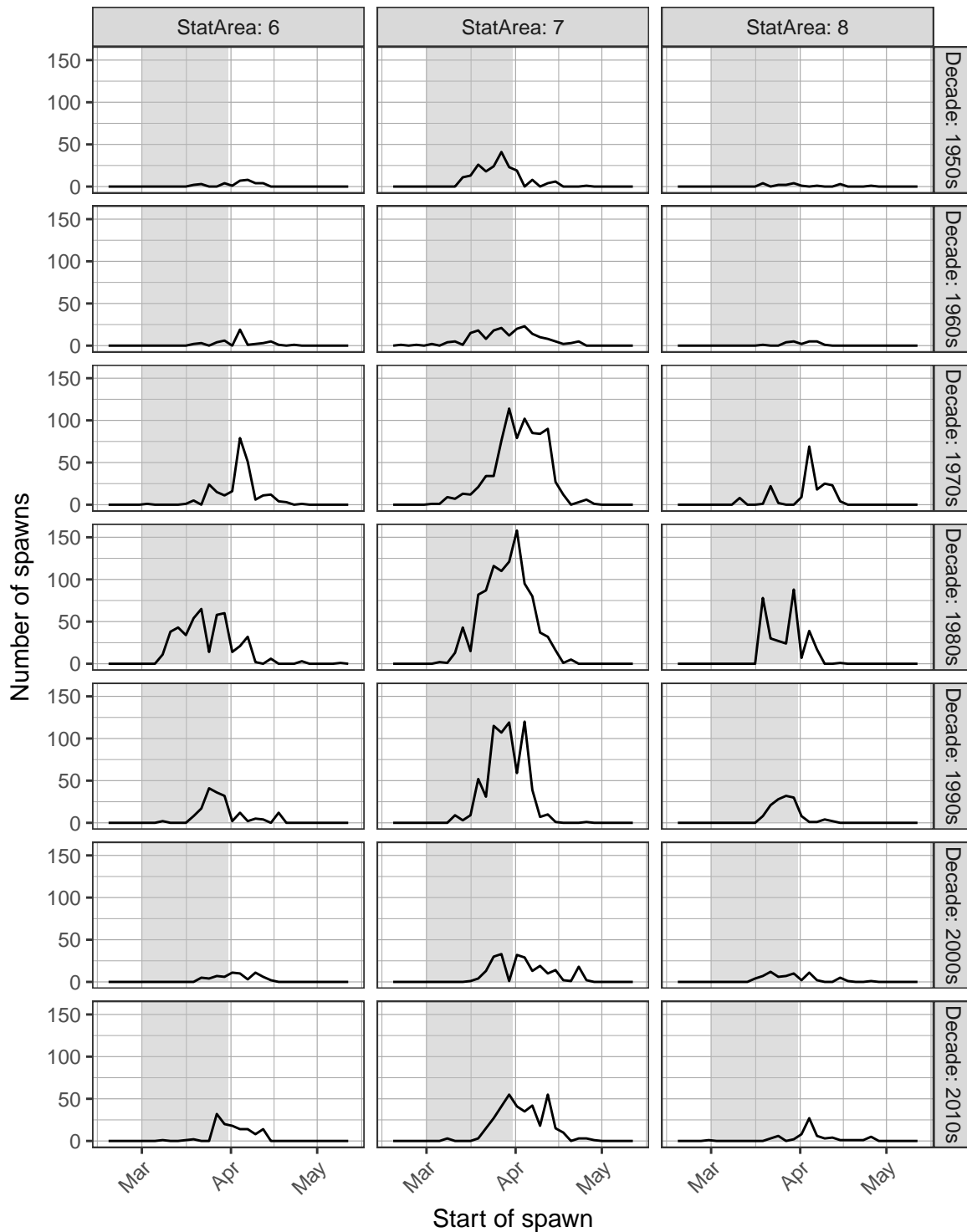


Figure 10. Pacific Herring spawn start date by decade and Statistical Area. Grey shaded regions indicate March 1st to 31st. Note that spawn size and intensity varies; therefore the number of spawns is not directly proportional to spawn extent or biomass.

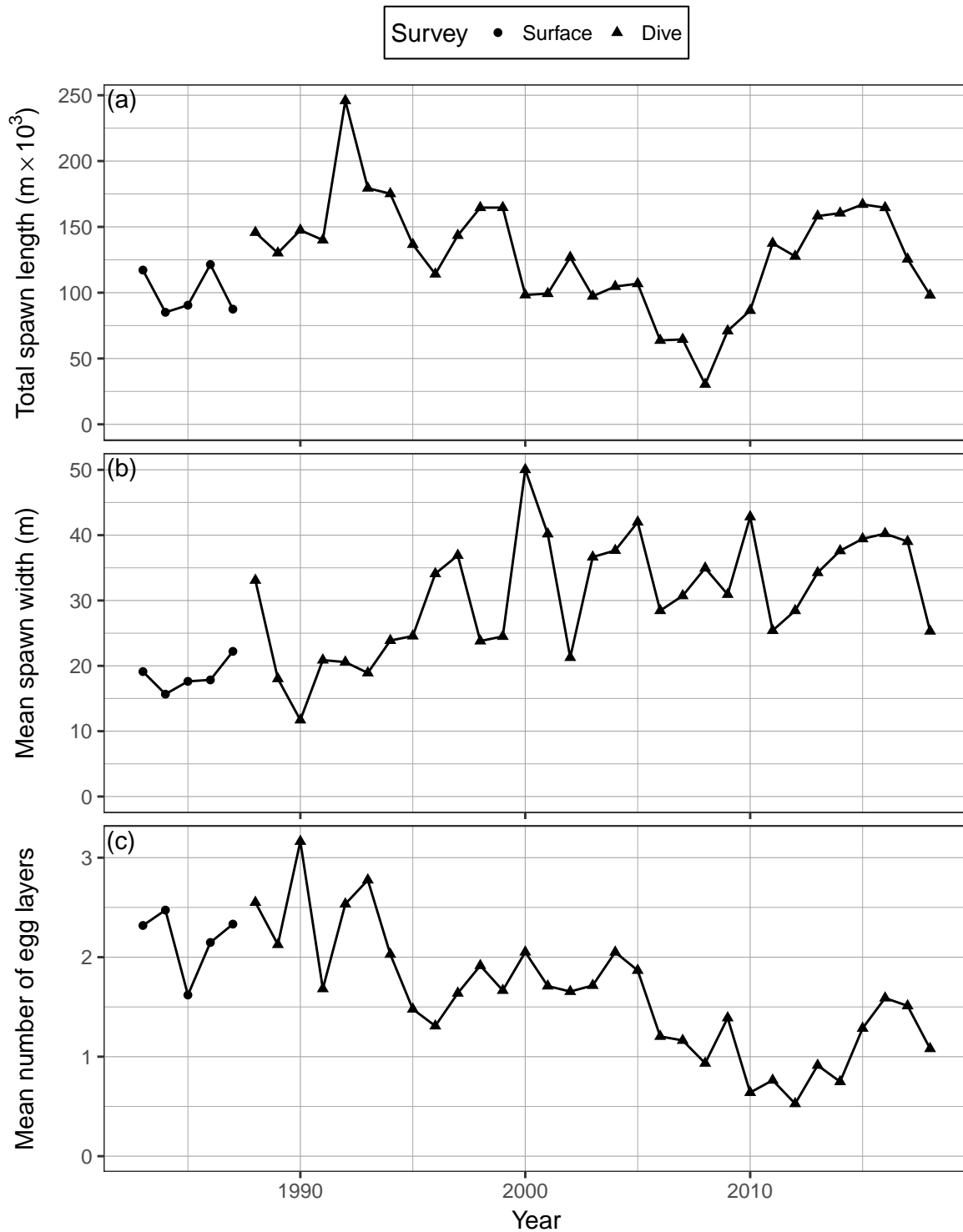


Figure 11. Time series of total spawn length in thousands of metres ($m \times 10^3$; panel a), mean spawn width in metres (b), and mean number of egg layers (c) for Pacific Herring from 1983 to 2018 in the Central Coast major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2018).

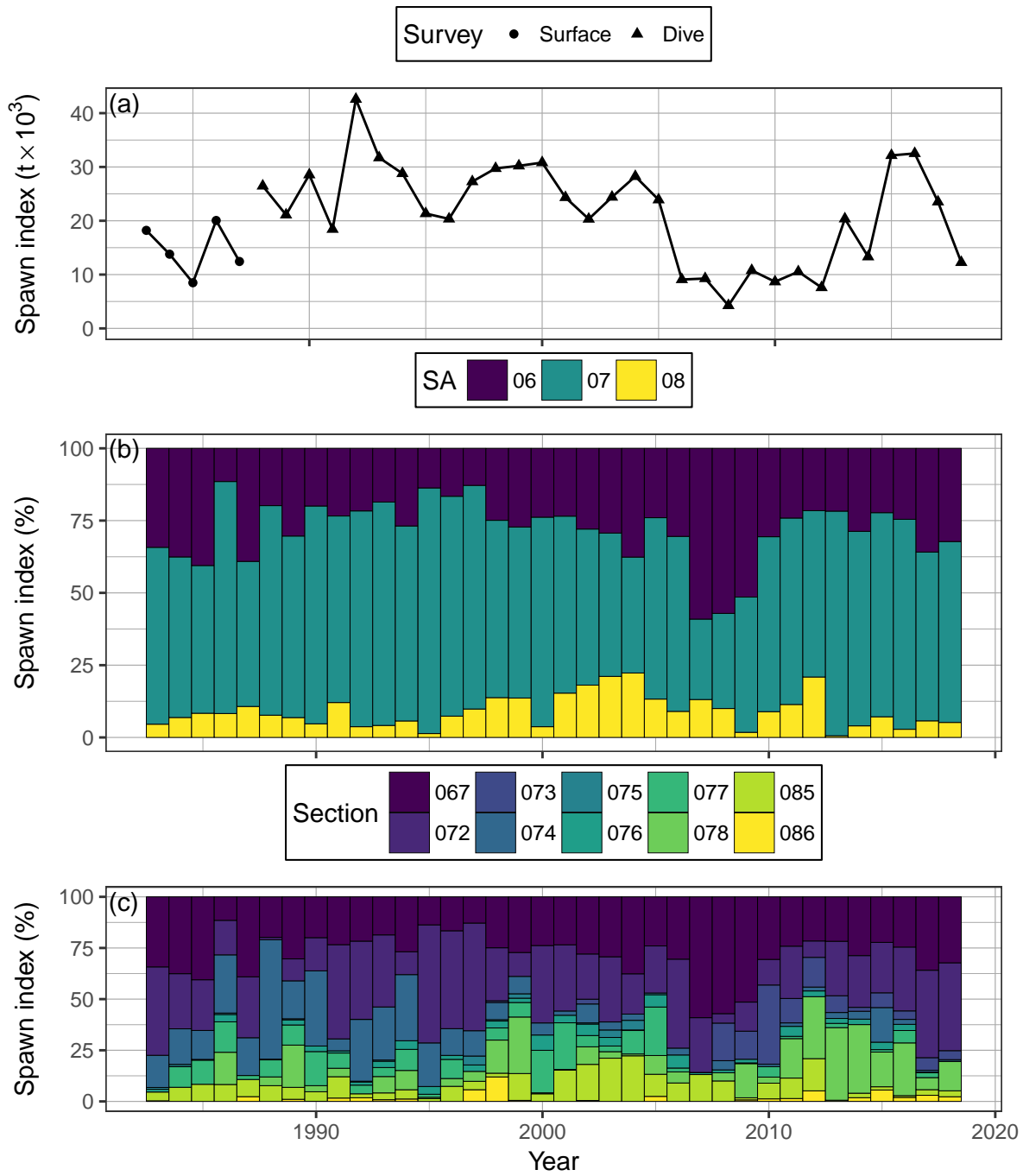


Figure 12. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) for Pacific Herring from 1983 to 2018 in the Central Coast major stock assessment region (SAR; panel a), as well as percent contributed by Statistical Area (SA), and Section (b, & c, respectively). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2018). The ‘spawn index’ represents the raw survey data only, and is not scaled by the spawn survey scaling parameter, q . Legend: ‘6&7’ is Statistical Areas 6 and 7; and ‘8’ is Statistical Area 8.

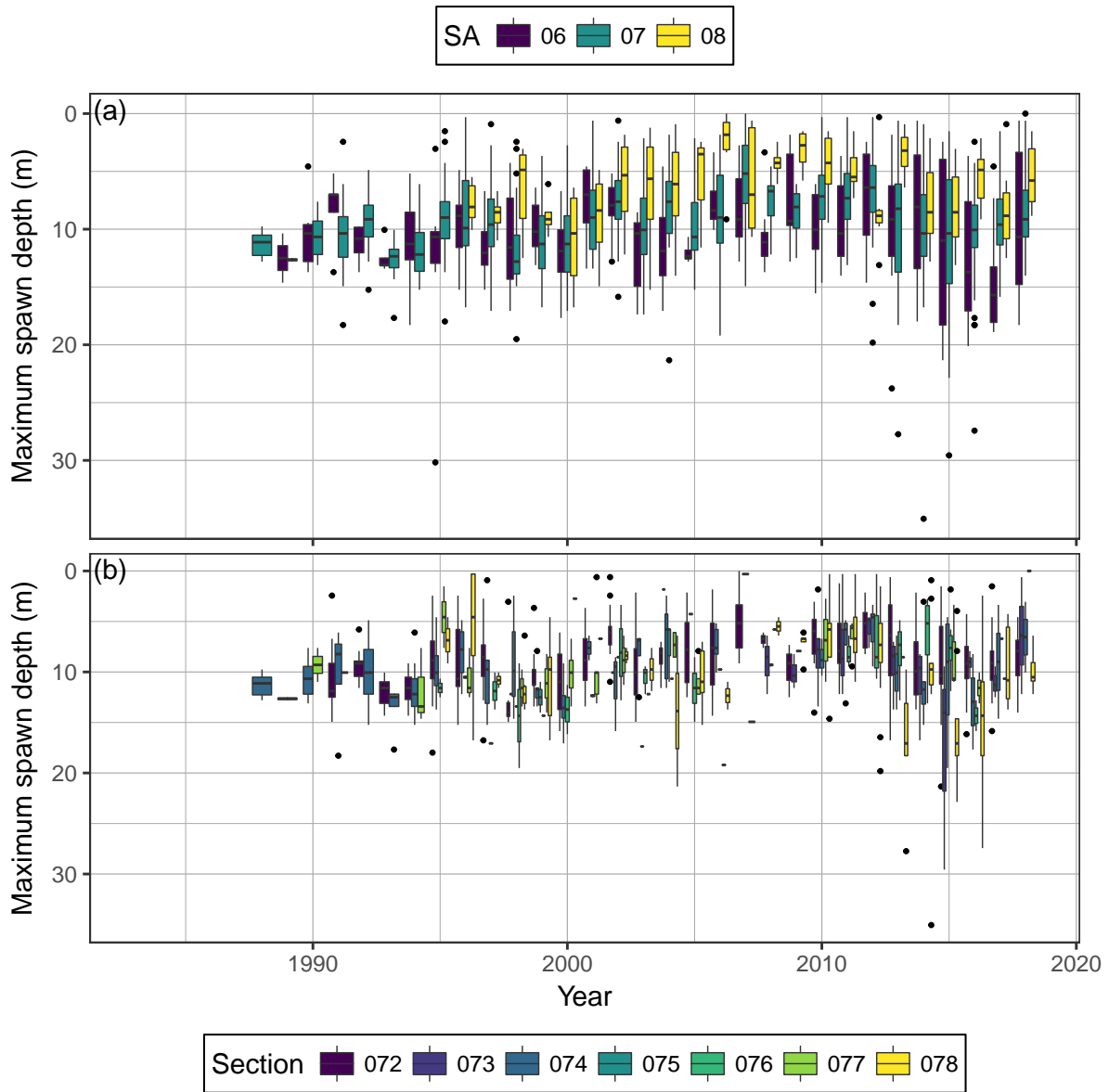


Figure 13. Time series of maximum spawn depth in metres (m) for Pacific Herring from 1983 to 2018 in the Central Coast major stock assessment region (SAR) by Statistical Area (SA; panel a), and Section (b). Note that depth is not corrected to the chart datum. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2018).

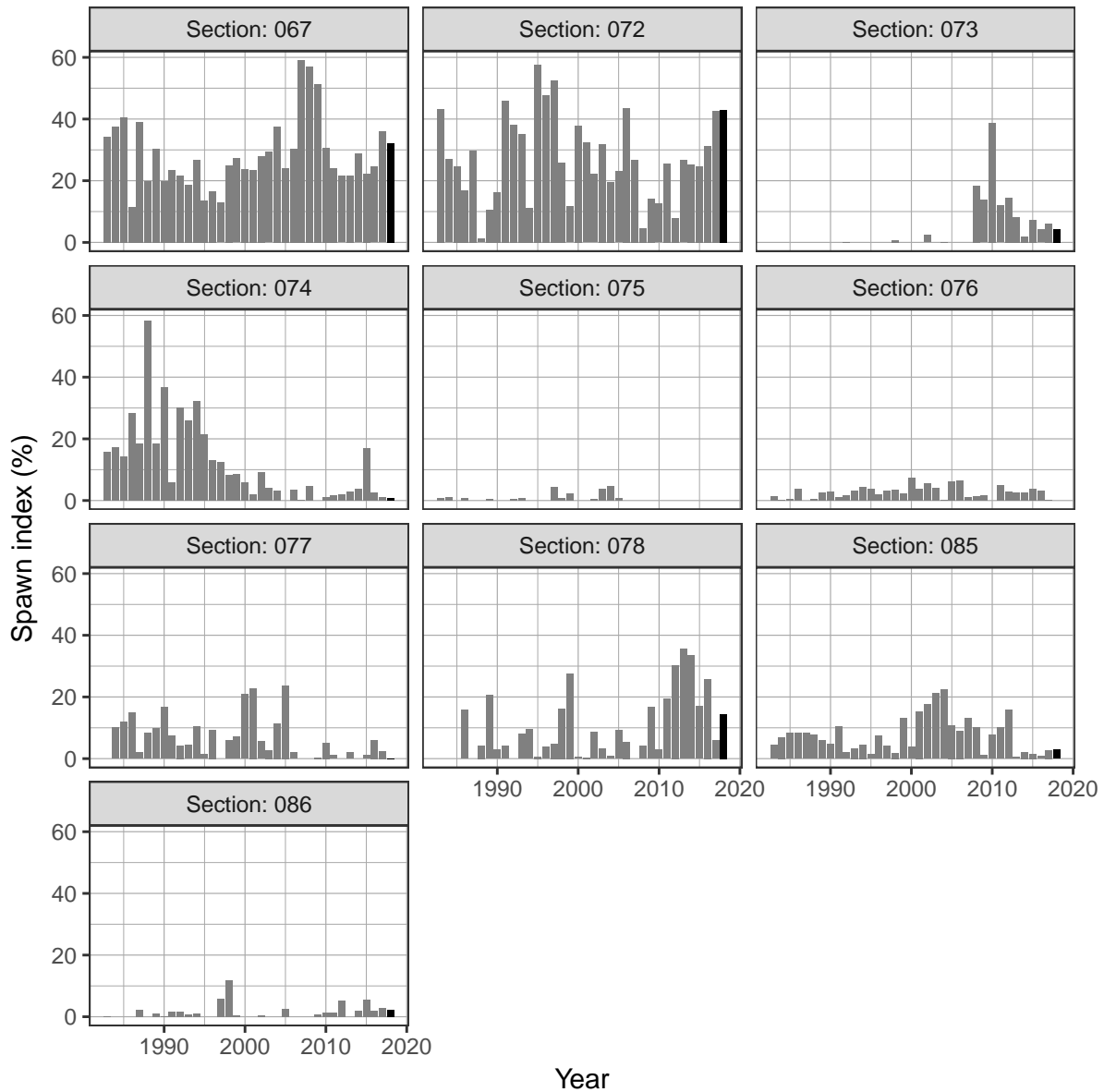


Figure 14. Time series of percent of spawn index by Section for Pacific Herring from 1983 to 2018 in the Central Coast major stock assessment region (SAR). The year 2018 has a darker bar to facilitate interpretation. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2018). The ‘spawn index’ represents the raw survey data only, and is not scaled by the spawn survey scaling parameter, q .

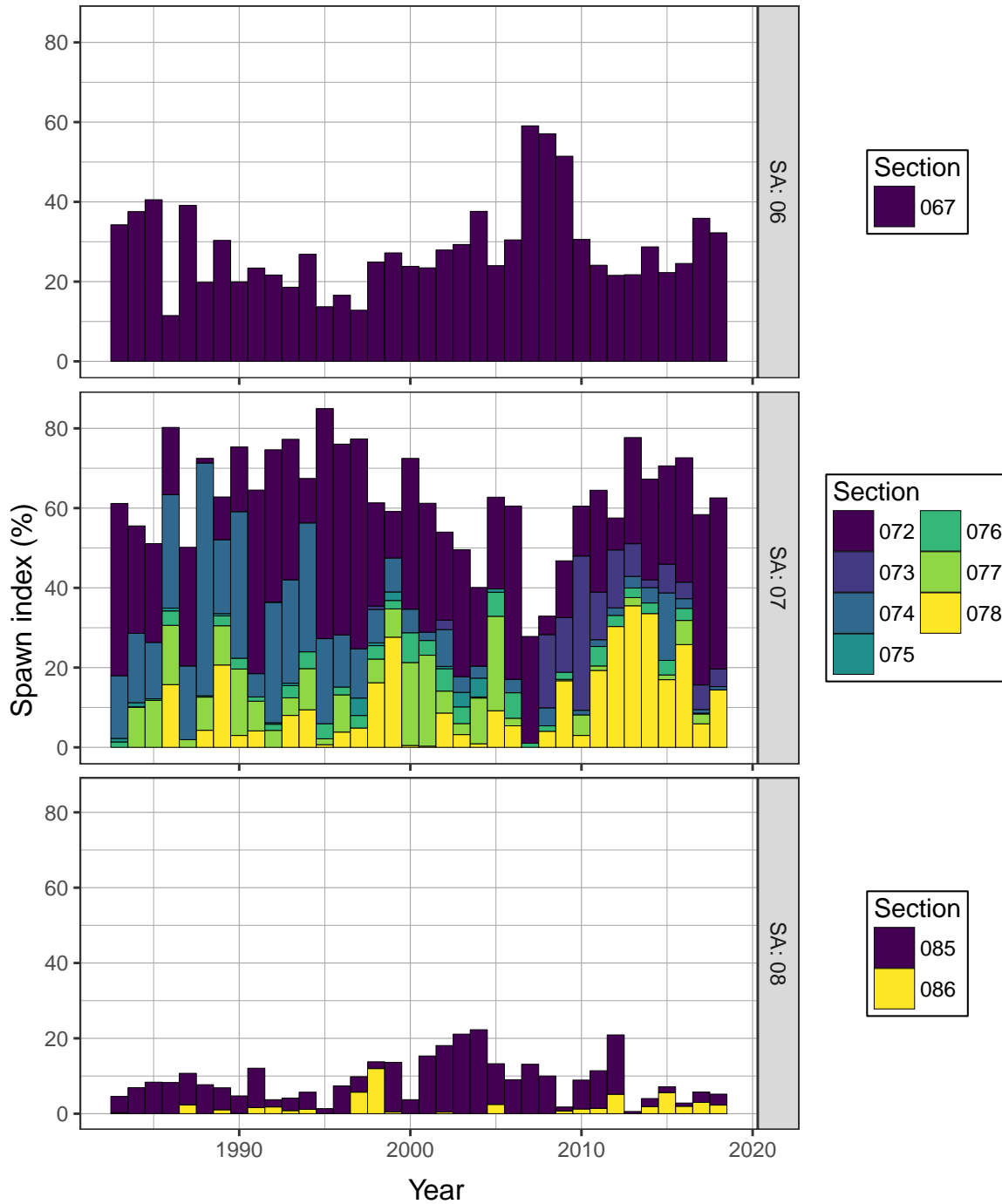


Figure 15. Time series of percent of spawn index by Statistical Area (SA) and Section for Pacific Herring from 1983 to 2018 in the Central Coast major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2018). The ‘spawn index’ represents the raw survey data only, and is not scaled by the spawn survey scaling parameter, q . Legend: ‘6&7’ is Statistical Areas 6 and 7; and ‘8’ is Statistical Area 8.

Figure 16. Animation of Pacific Herring spawn survey locations and spawn index in metric tonnes (t) from 1951 to 2018 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 2018). The ‘spawn index’ represents the raw survey data only, and 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).