Pacific Herring preliminary data summary for Central Coast 2022

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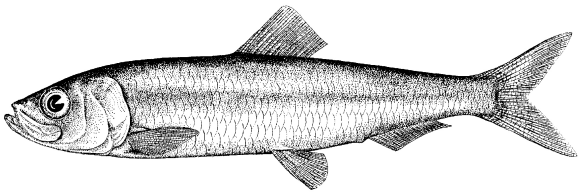

Pacific Herring (*Clupea pallasii*). Image credit: Fisheries and Oceans Canada.

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

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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

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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 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 2022 refers to the 2021/2022 Pacific Herring season.

3 Data collection programs

In 2022, 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 12$^{\text{th}}$ to April 6$^{\text{th}}$. 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 and Kitasoo Nations collected 15 nearshore cast net herring samples in 2022. Herring spawn locations were primarily identified with fixed-wing overflights. Seven spawn flights were conducted this season, in mid-March to mid-April.

Two dive charter vessels operated in the CC:

- The *Pachena No.1* surveyed 21 days from April 4$^{\text{th}}$ to April 24$^{\text{th}}$, and
- The *Ocean Cloud* surveyed 12 days from April 4$^{\text{th}}$ to April 15$^{\text{th}}$.

Heiltsuk and Kitasoo Nations collected 15 nearshore cast net herring samples in 2022. Additional spawn reconnaissance for Area 08 was conducted by the Wuikinuxv Fisheries Program.

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 $\sim 7\%$ 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.

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 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 2022, 29 Pacific Herring biological samples were collected and processed for the Central Coast major SAR (Table 5, Table 6), and a total of 1,229 Pacific Herring were aged in 2022. Differences between biological data collected from two sampling protocols regarding the number-, proportion-, weight-, and length-at-age for Pacific Herring in 2022 in the Central Coast major SAR are shown in Table 7, Table 8, Table 9, and Table 10, respectively. The nearshore sampling program is a multi-year pilot study (using cast nets), therefore only biological data from the seine samples were used for the purposes of stock assessment. Summaries of data collected by the nearshore sampling program are shown in Table 11, Table 12, Table 13, and Table 14. In addition, Figure 9 and Figure 10 show differences in length-at-age between the two sampling protocols, and differences by Statistical Area, respectively. 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 15, 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 11, Table 16). 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 57 individual locations in 2022 in the Central Coast major SAR (Table 17, and Figure 12). A summary of spawn from the last decade (2012 to 2021) is shown in Figure 13. Figure 14 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 15, Figure 16, Figure 17, Figure 18, Table 18, and Figure 19). 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 20). 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 18b, Figure 21). For example, in 2022, Section 074 contributed the most to the spawn index (40%). As with Sections, some Statistical Areas contribute more than others to the total spawn index (Figure 18c, Figure 22). An animation shows the spawn index by spawn survey location from 1951 to 2022 (Figure 23).

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:

- Compared to previous years, colder water temperatures were reported throughout CC.
- Consistently poor weather conditions affected overflight schedules and management platform logistics.
- In general, spawn duration was shorter and less consistent than in previous years.
- Spawn was less concentrated and began much later in southern areas of the CC.
- A lack of reliable communication tools between the management and test platforms made sending and receiving the most up-to-date information challenging.
- Due to continuing COVID precautions in Bella Bella, all overflights had to be based out of Port Hardy.

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 2022 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 2012 to 2022 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)
2012	0	0
2013	0	0
2014	239,861	355
2015	169,470	251
2016	351,953	521
2017	392,747	582
2018	289,358	429
2019	356,042	528
2020	44,857	66
2021	294,269	436
2022	0	0

Table 5. Number of Pacific Herring biological samples processed from 2012 to 2022 in the Central Coast 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	24	0	24
2013	0	15	0	15
2014	14	12	0	26
2015	6	14	0	20
2016	5	15	0	20
2017	4	13	27	44
2018	4	12	18	34
2019	2	10	28	40
2020	0	12	5	17
2021	2	13	14	29
2022	0	14	15	29

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

Type	Gear	Use	Number of samples
Test	Other	Nearshore	15
Test	Seine	Test fishery	14

Table 7. Observed number-at-age of Pacific Herring by sample type in 2022 in the Central Coast major stock assessment region (SAR). The age-10 class is a 'plus group' which includes fish ages 10 and older. Legend: 'Nearshore' refers to samples collected using cast nets as part of a pilot study with First Nations.

	Number-at-age								
Sample type	2	3	4	5	6	7	8	9	10
Nearshore	51	177	308	43	527	68	19	6	3
Seine test	129	200	462	55	299	58	16	7	3
Total	180	377	770	98	826	126	35	13	6

Table 8. Observed proportion-at-age of Pacific Herring by sample type in 2022 in the Central Coast major stock assessment region (SAR). The age-10 class is a 'plus group' which includes fish ages 10 and older. Legend: 'Nearshore' refers to samples collected using cast nets as part of a pilot study with First Nations.

	Proportion-at-age								
Sample type	2	3	4	5	6	7	8	9	10
Nearshore	0.042	0.147	0.256	0.036	0.438	0.057	0.016	0.005	0.002
Seine test	0.105	0.163	0.376	0.045	0.243	0.047	0.013	0.006	0.002
Total	0.074	0.155	0.317	0.040	0.340	0.052	0.014	0.005	0.002

Table 9. Observed mean weight-at-age in grams (g) of Pacific Herring by sample type in 2022 in the Central Coast major stock assessment region (SAR). The age-10 class is a 'plus group' which includes fish ages 10 and older. Legend: 'Nearshore' refers to samples collected using cast nets as part of a pilot study with First Nations.

	Mean weight-at-age (g)								
Sample type	2	3	4	5	6	7	8	9	10
Nearshore	46	60	72	92	94	103	108	121	108
Seine test	50	70	78	104	118	128	135	133	129
Total	49	65	76	99	103	114	120	127	119

Table 10. Observed mean length-at-age in millimetres (mm) of Pacific Herring by sample type in 2022 in the Central Coast major stock assessment region (SAR). The age-10 class is a 'plus group' which includes fish ages 10 and older. Legend: 'Nearshore' refers to samples collected using cast nets as part of a pilot study with First Nations.

	Mean length-at-age (mm)								
Sample type	2	3	4	5	6	7	8	9	10
Nearshore	150	164	176	190	193	198	201	210	203
Seine test	154	169	174	188	195	199	201	204	204
Total	153	166	175	189	193	199	201	207	204

Table 11. Observed number-at-age of Pacific Herring for nearshore samples from 2017 to 2022 in the Central Coast major stock assessment region (SAR). The age-10 class is a 'plus group' which includes fish ages 10 and older. Legend: 'Nearshore' refers to samples collected using cast nets as part of a pilot study with First Nations.

	Number-at-age								
Year	2	3	4	5	6	7	8	9	10
2017	97	279	208	1111	174	454	85	74	18
2018	24	328	252	231	521	135	87	33	10
2019	15	1543	605	133	129	100	26	7	3
2020	31	10	301	66	29	23	4	4	1
2021	9	226	51	833	134	28	20	8	1
2022	51	177	308	43	527	68	19	6	3

Table 12. Observed proportion-at-age of Pacific Herring for nearshore samples from 2017 to 2022 in the Central Coast major stock assessment region (SAR). The age-10 class is a 'plus group' which includes fish ages 10 and older. Legend: 'Nearshore' refers to samples collected using cast nets as part of a pilot study with First Nations.

	Proportion-at-age								
Year	2	3	4	5	6	7	8	9	10
2017	0.039	0.112	0.083	0.444	0.070	0.182	0.034	0.030	0.007
2018	0.015	0.202	0.155	0.143	0.321	0.083	0.054	0.020	0.006
2019	0.006	0.602	0.236	0.052	0.050	0.039	0.010	0.003	0.001
2020	0.066	0.021	0.642	0.141	0.062	0.049	0.009	0.009	0.002
2021	0.007	0.173	0.039	0.636	0.102	0.021	0.015	0.006	0.001
2022	0.042	0.147	0.256	0.036	0.438	0.057	0.016	0.005	0.002

Table 13. Observed mean weight-at-age in grams (g) of Pacific Herring for nearshore samples from 2017 to 2022 in the Central Coast major stock assessment region (SAR). The age-10 class is a 'plus group' which includes fish ages 10 and older. Legend: 'Nearshore' refers to samples collected using cast nets as part of a pilot study with First Nations.

	Mean weight-at-age (g)								
Year	2	3	4	5	6	7	8	9	10
2017	49	69	83	93	98	115	116	120	128
2018	48	68	78	94	96	104	107	107	109
2019	52	61	67	84	97	103	102	119	114
2020	34	59	73	78	89	88	102	89	93
2021	38	58	74	82	91	94	103	120	104
2022	46	60	72	92	94	103	108	121	108

Table 14. Observed mean length-at-age in millimetres (mm) of Pacific Herring for nearshore samples from 2017 to 2022 in the Central Coast major stock assessment region (SAR). The age-10 class is a 'plus group' which includes fish ages 10 and older. Legend: 'Nearshore' refers to samples collected using cast nets as part of a pilot study with First Nations.

	Mean length-at-age (mm)								
Year	2	3	4	5	6	7	8	9	10
2017	158	175	187	193	198	207	208	209	213
2018	154	172	178	191	193	199	201	204	200
2019	153	162	167	180	190	195	196	200	206
2020	136	162	173	178	186	184	193	187	194
2021	141	161	175	180	185	192	196	200	195
2022	150	164	176	190	193	198	201	210	203

Table 15. Observed proportion-at-age for Pacific Herring from 2012 to 2022 in the Central Coast 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	0.077	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
2022	0.105	0.163	0.376	0.045	0.243	0.047	0.013	0.006	0.002

Table 16. Sample size for Pacific Herring weight-at-age analysis in 2022 in the Central Coast major stock assessment region (SAR) by Group from the most recent decade (2013 to 2022), and the previous decade (2003 to 2012), as displayed in Figure 11. 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.

		Sample size	
Group	Age	Previous decade	Recent decade
06&07	2	727	423
06&07	3	9,320	2,684
06&07	4	10,969	3,152
06&07	5	5,475	2,517
06&07	6	3,023	1,404
06&07	7	1,052	585
06&07	8	716	251
06&07	9	329	85
06&07	10	111	30
8	2	147	211
8	3	923	821
8	4	991	704
8	5	317	240
8	6	160	185
8	7	58	75
8	8	25	27
8	9	9	10
8	10	4	3

Table 17. Pacific Herring spawn survey locations, start date, and spawn index in metric tonnes (t) in 2022 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 indicate incomplete surveys (NAs).

Statistical Area	Section	Location name	Start date	Spawn index (t)
06	067	Abrams Is	March 24	377
06	067	Hartnell Pt	March 27	2
06	067	Hastings Is Lgn	March 27	27
06	067	Kwakwa Cr	March 28	476
06	067	Marvin Is	March 26	385
06	067	Meyers Nrws	March 27	342
06	067	Meyers Psg	March 27	273
06	067	Milne Is	March 27	10
06	067	Osment Inlt	March 26	1,372
06	067	Parsons Anch	March 28	1,261
06	067	Swindle Is	March 30	661
06	067	Thistle Psg	March 27	34
06	067	Wilby Pt	March 25	644
06	067	Wingate Pt	March 26	14
07	072	Balagny Pass	March 28	66
07	072	Berry Inlt	March 28	230
07	072	Bird Pt	March 27	3
07	072	Bullen Rk	March 25	475
07	072	Bush Pt	March 28	520
07	072	Don Lgn +	April 10	102
07	072	Fisher Pt	March 28	401
07	072	Foote Islets	March 25	346
07	072	Mosquito Bay	April 10	57
07	072	Mouat Cv	March 28	693
07	072	Shingle Rk	March 25	323
07	072	Spiller Chnl	March 26	499
07	072	Tankeeah River	March 25	733
07	072	Watch Is	March 28	274
07	073	Morehouse Bay	March 25	142
07	073	Troup Psg	March 25	416
07	074	Ardmillan Bay	March 28	428
07	074	Dundivan Inlt	March 27	183
07	074	Hose Pt	March 28	1,230
07	074	Idol Pt	March 28	850
07	074	Kimlock Pt	March 27	13
07	074	Kynumpt Hrbr	March 28	1,029
07	074	Little Thompson Bay	March 23	9
07	074	Newby Is	March 25	802

Table 17 continued

Statistical Area	Section	Location name	Start date	Spawn index (t)
07	074	Norman Morrison Bay	March 31	1,204
07	074	Odin Cv	March 28	164
07	074	Ormidale Hrbr	March 28	1,670
07	074	Princess Alice Is	March 25	0
07	074	Rait Nrws	March 27	49
07	074	Raymond Pass	April 09	120
07	074	Stryker Is	March 23	1,361
07	074	Waskesiu Pass	March 25	67
07	076	Brydon Chnl	March 31	713
07	076	Leckie Bay	April 10	643
07	076	Manley Is	March 31	35
07	077	E Higgins Pass	April 09	107
07	078	Spiller Inlt	April 16	13
08	085	Kwakume Inlt	April 01	296
08	085	Whidbey Pt	April 06	87
08	086	Hergest Pt	April 13	254
08	086	Mustang Bay	April 13	112
08	086	Target Bay	April 13	100
08	086	Warrior Cv	April 21	17

Table 18. Summary of Pacific Herring spawn survey data from 2012 to 2022 in the Central Coast 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	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
2022	153,675	43	1.3	22,711

8 Figures

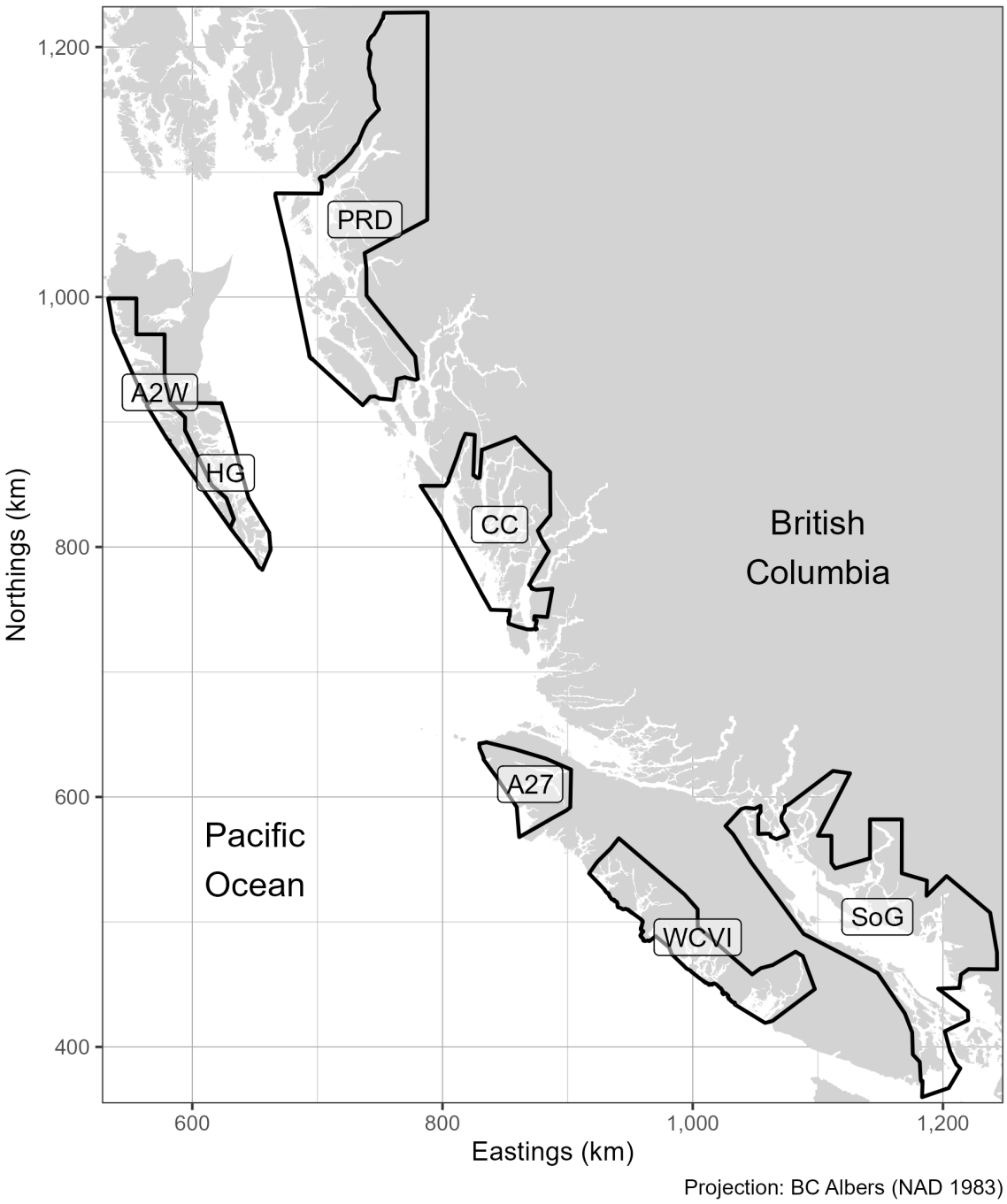

Figure 1. Boundaries for the Pacific Herring stock assessment regions (SARs) in British Columbia. There are 5 major SARs: Haida Gwaii (HG), Prince Rupert District (PRD), Central Coast (CC), Strait of Georgia (SoG), and West Coast of Vancouver Island (WCVI). There are 2 minor SARs: Area 27 (A27) and Area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

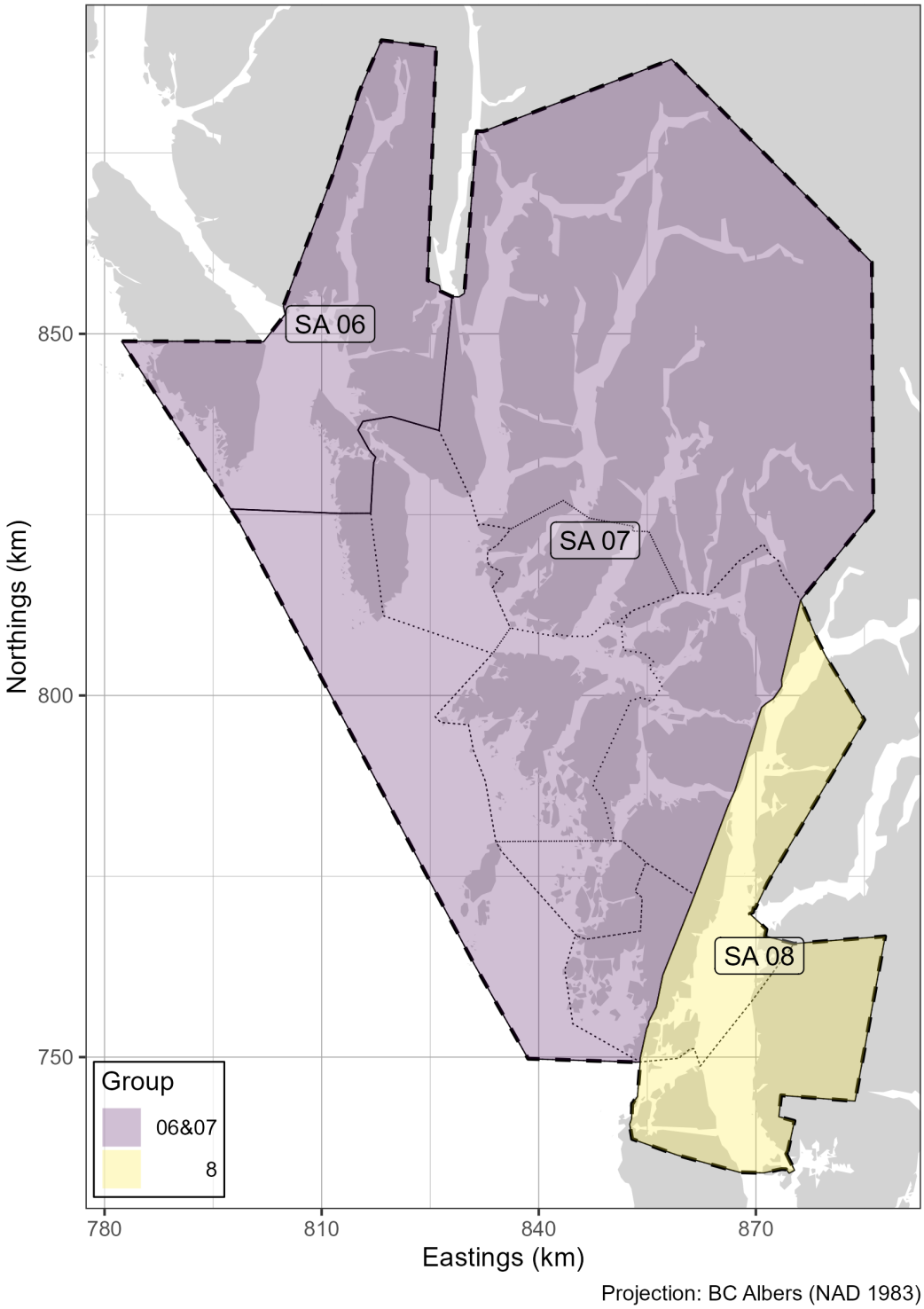

Figure 2. Boundaries for the Central Coast major stock assessment region (SAR; thick dashed lines), associated Statistical Areas (SA; thin solid lines), and associated Sections (thin dotted lines). Units: kilometres (km). Legend: '06&07' is Statistical Areas 06 and 07; and '08' is Statistical Area 08.

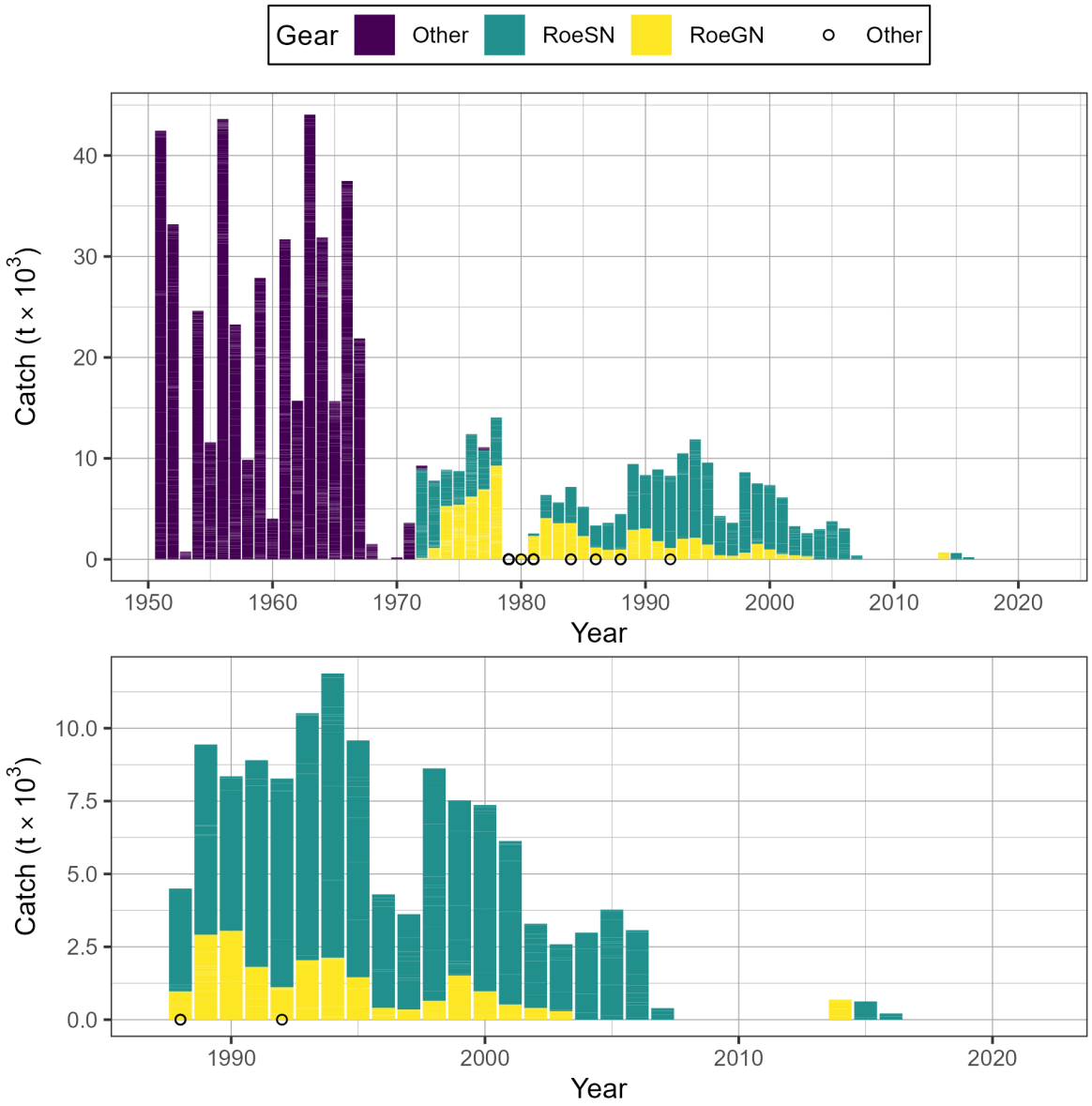

Figure 3. Time series of total landed catch in thousands of metric tonnes ($t \times 10^3$) of Pacific Herring by gear type from 1951 to 2022 in the Central Coast major stock assessment region (SAR). Legend: 'Other' represents the reduction (1951 to 1970 only), the food and bait, as well as the special 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. 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.

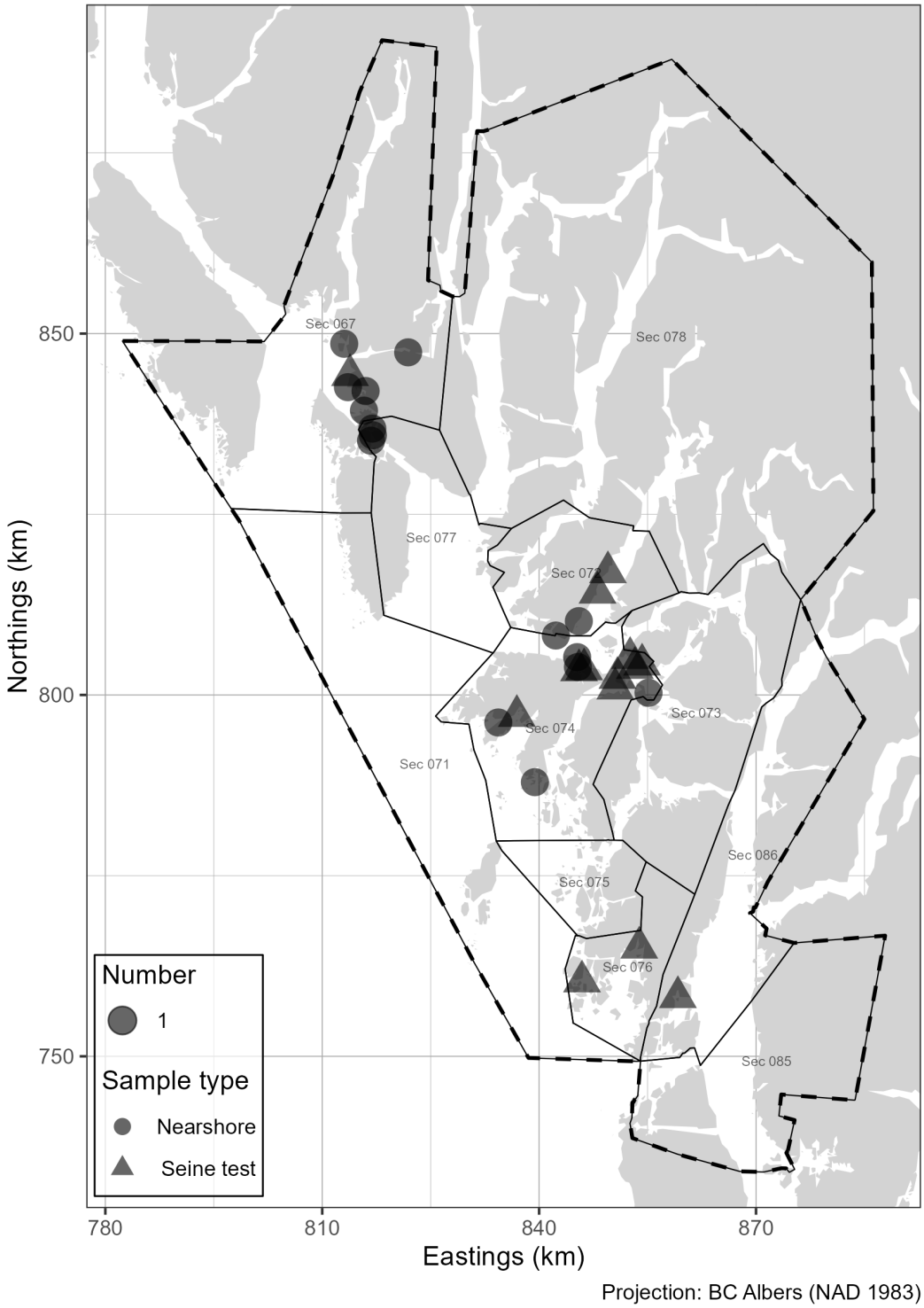

Figure 4. Location and type of Pacific Herring biological samples collected in 2022 in the Central Coast major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). Units: kilometres (km).

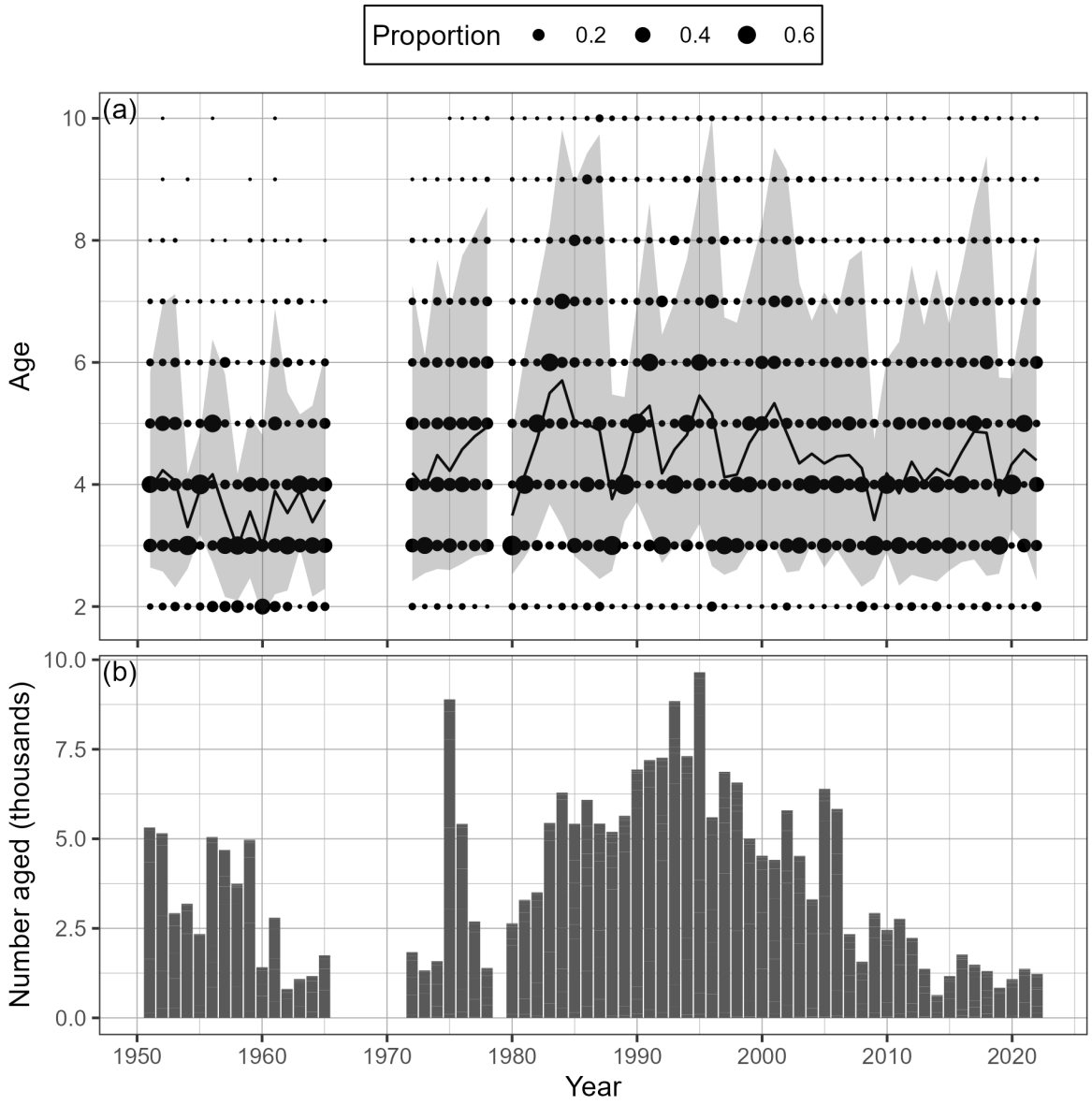

Figure 5. Time series of observed proportion-at-age (a) and number aged in thousands (b) of Pacific Herring from 1951 to 2022 in the Central Coast major stock assessment region (SAR). The black line is the mean age, and the shaded area is the approximate 90% distribution. Biological summaries only include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

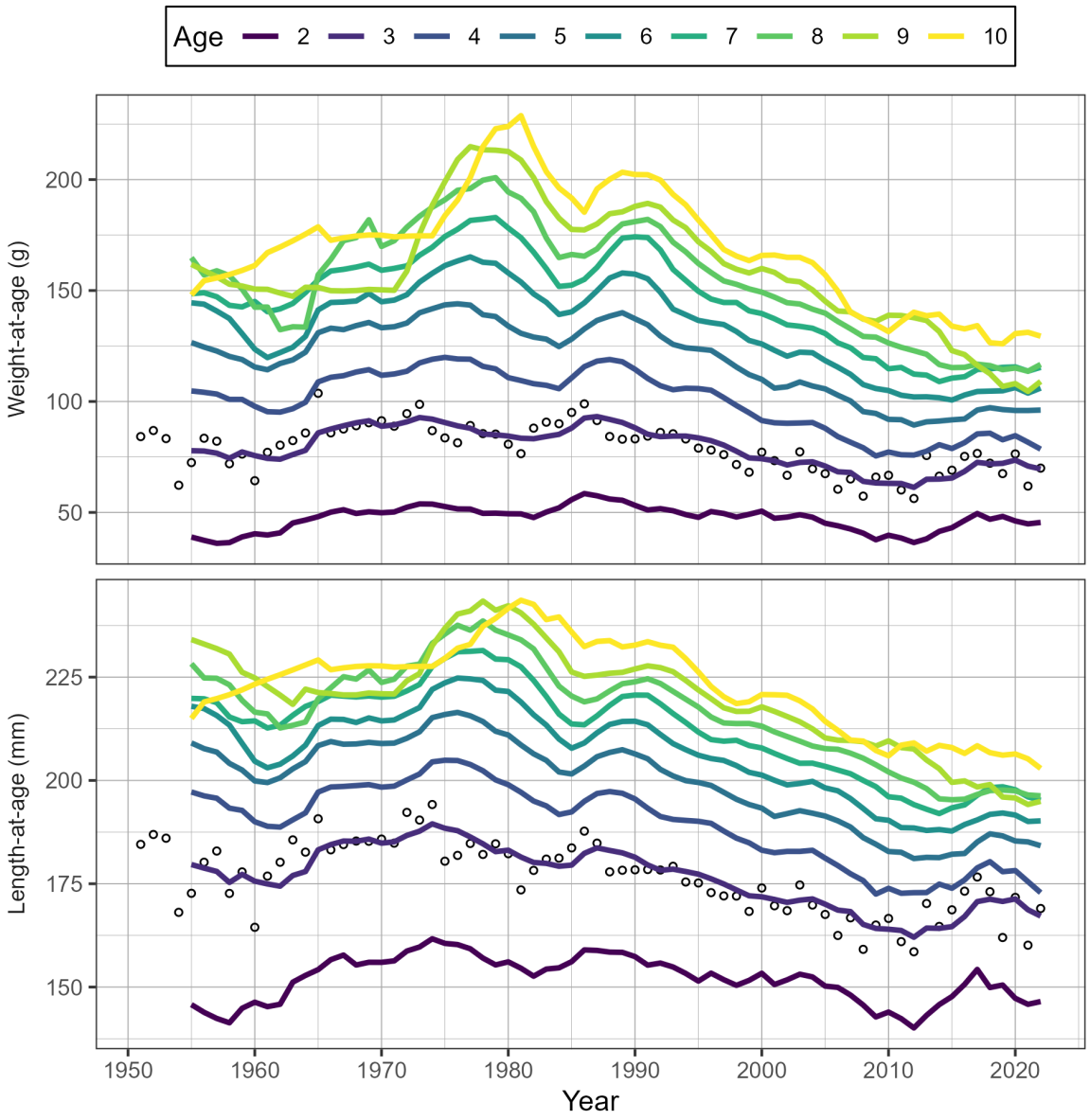

Figure 6. Time series of weight-at-age in grams (g) and length-at-age in milimetres (mm) for age-3 (circles) and 5-year running mean weight- and length-at-age (lines) for Pacific Herring from 1951 to 2022 in the Central Coast major stock assessment region (SAR). Missing weight- and length-at-age values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

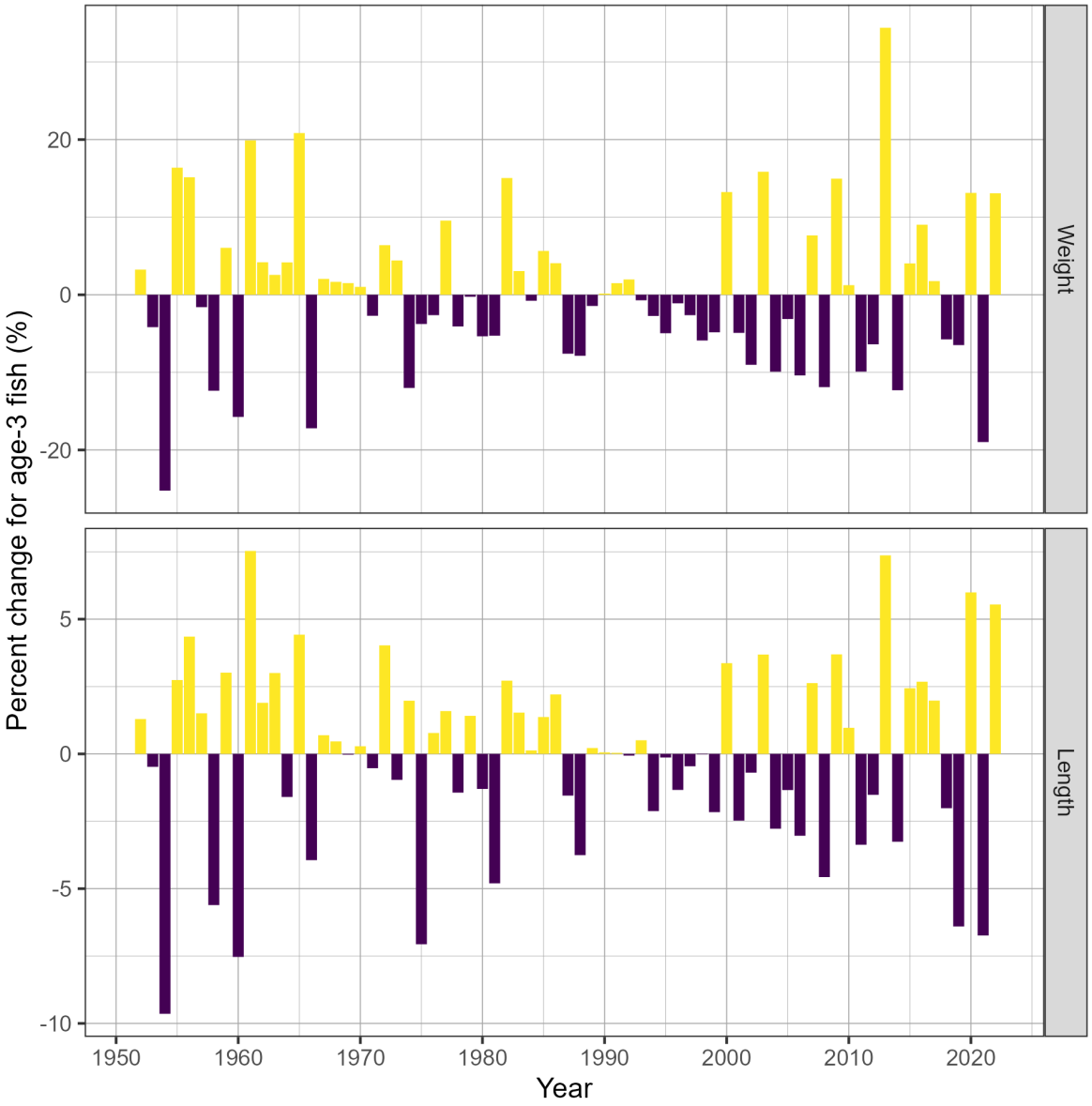

Figure 7. Time series of percent change (%) in weight and length for age-3 fish for Pacific Herring from 1951 to 2022 in the Central Coast major stock assessment region (SAR). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the weight and length of age-3 fish,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

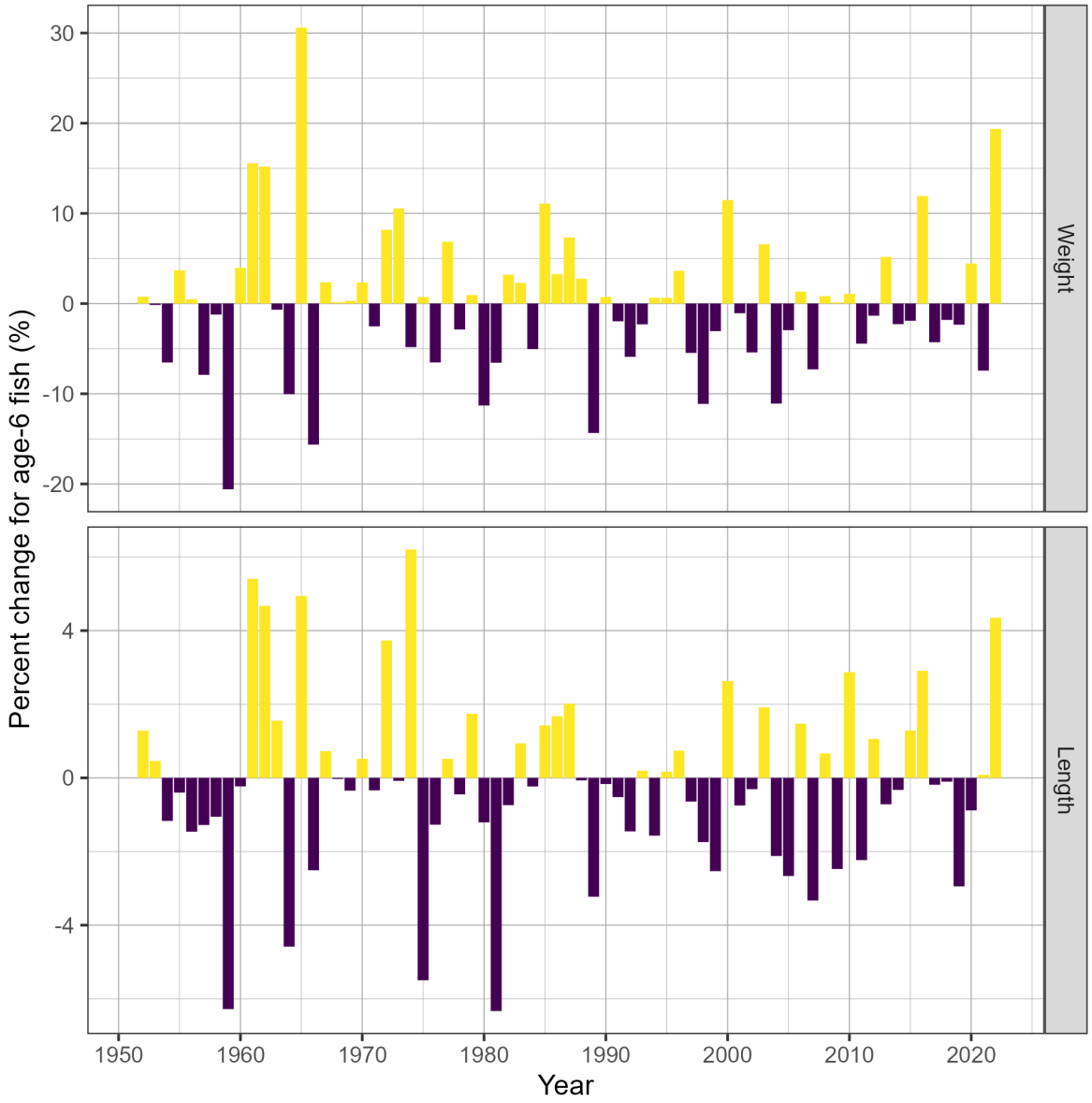

Figure 8. Time series of percent change (%) in weight and length for age-6 fish for Pacific Herring from 1951 to 2022 in the Central Coast major stock assessment region (SAR). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the weight and length of age-6 fish,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

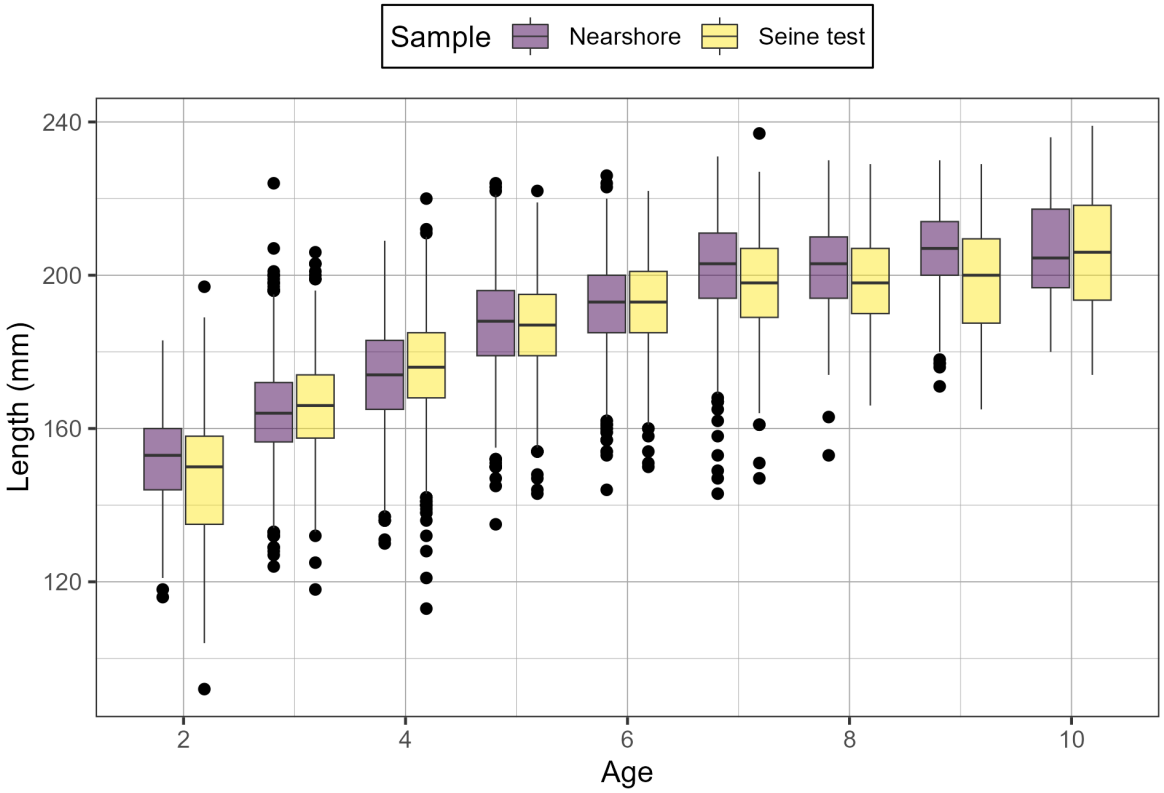

Figure 9. Length-at-age in millimetres (mm) of Pacific Herring from 2017 to 2022 in the Central Coast major stock assessment region (SAR) by sample type. The outer edges of the boxes indicate the 25th and 75th percentiles, and the middle lines indicate the 50th percentiles (i.e., medians). The whiskers extend to 1.5 × IQR, where IQR is the distance between the 25th and 75th percentiles, and dots indicate outliers. Biological summaries only include samples collected using seine nets (commercial and test) due to size-selectivity of other gear types such as gillnet. Legend: 'Nearshore' refers to samples collected using cast nets as part of a pilot study with First Nations. The age-10 class is a 'plus group' which includes fish ages 10 and older.

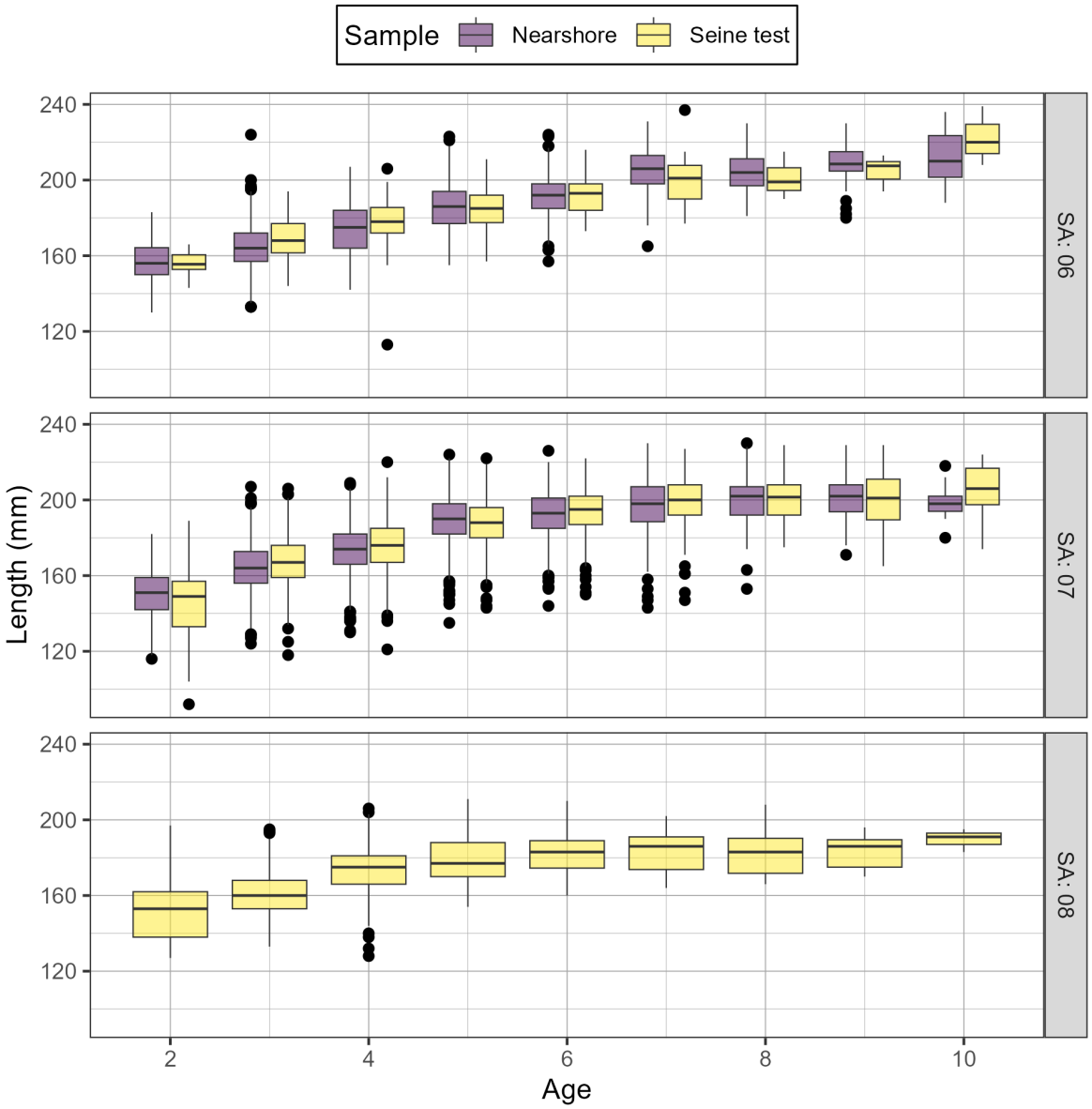

Figure 10. Length-at-age in millimetres (mm) of Pacific Herring from 2017 to 2022 in the Central Coast major stock assessment region (SAR) by sample type and statistical area (SA). The outer edges of the boxes indicate the 25th and 75th percentiles, and the middle lines indicate the 50th percentiles (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. Biological summaries only include samples collected using seine nets (commercial and test) due to size-selectivity of other gear types such as gillnet. Legend: 'Nearshore' refers to samples collected using cast nets as part of a pilot study with First Nations. The age-10 class is a 'plus group' which includes fish ages 10 and older.

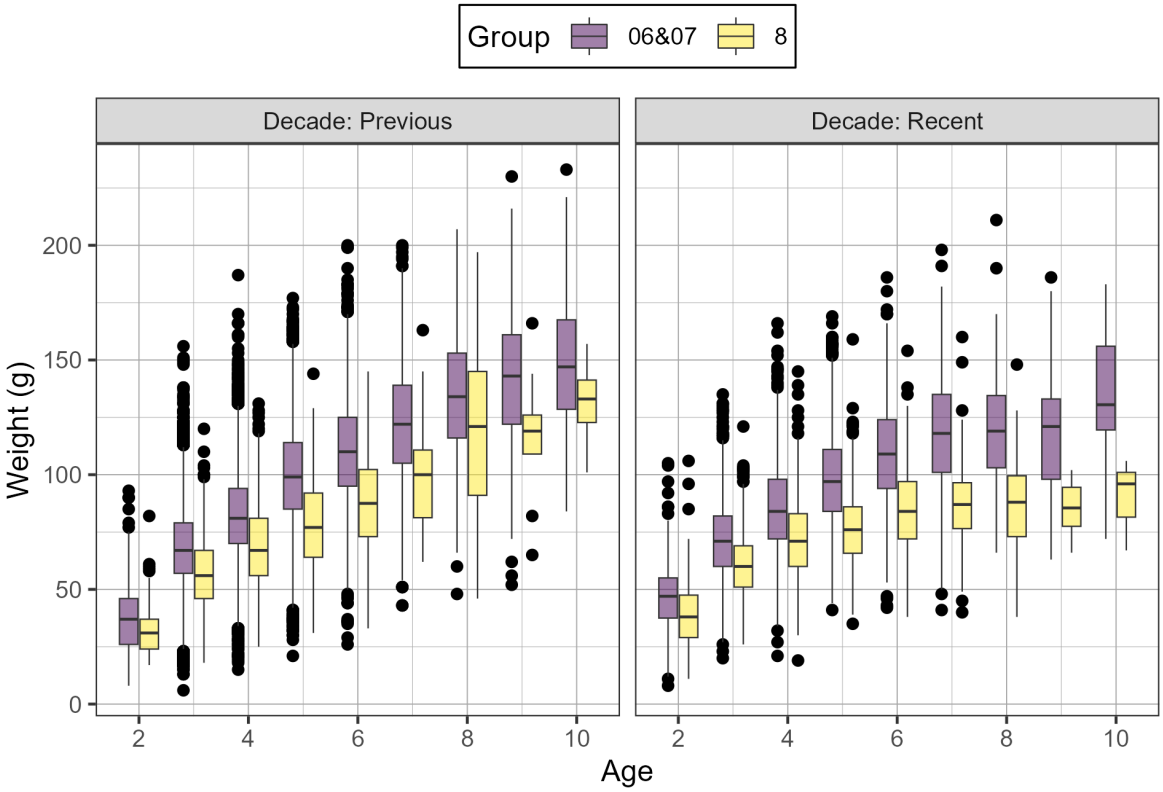

Figure 11. Weight-at-age in grams (g) of Pacific Herring in the Central Coast major stock assessment region (SAR) by Group from the most recent decade (2013 to 2022), and the previous decade (2003 to 2012). The outer edges of the boxes indicate the 25th and 75th percentiles, and the middle lines indicate the 50th percentiles (i.e., medians). The whiskers extend to 1.5 $\times$ IQR, where IQR is the distance between the 25th and 75th percentiles, and dots indicate outliers. Sample sizes are given in Table 16. 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.

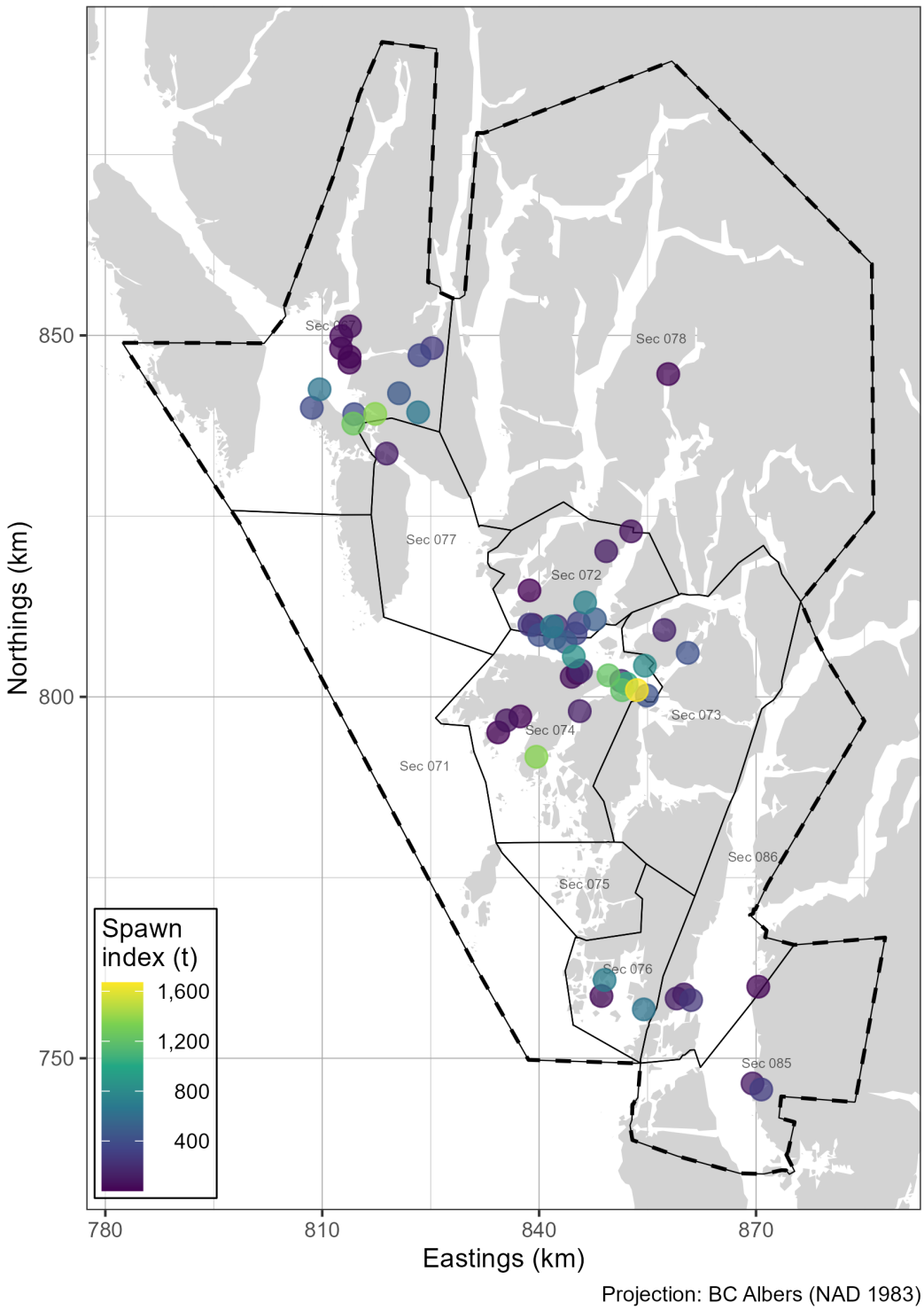

Figure 12. Pacific Herring spawn survey locations, and spawn index in metric tonnes (t) in 2022 in the Central Coast major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values indicate incomplete surveys (grey circles). Units: kilometres (km).

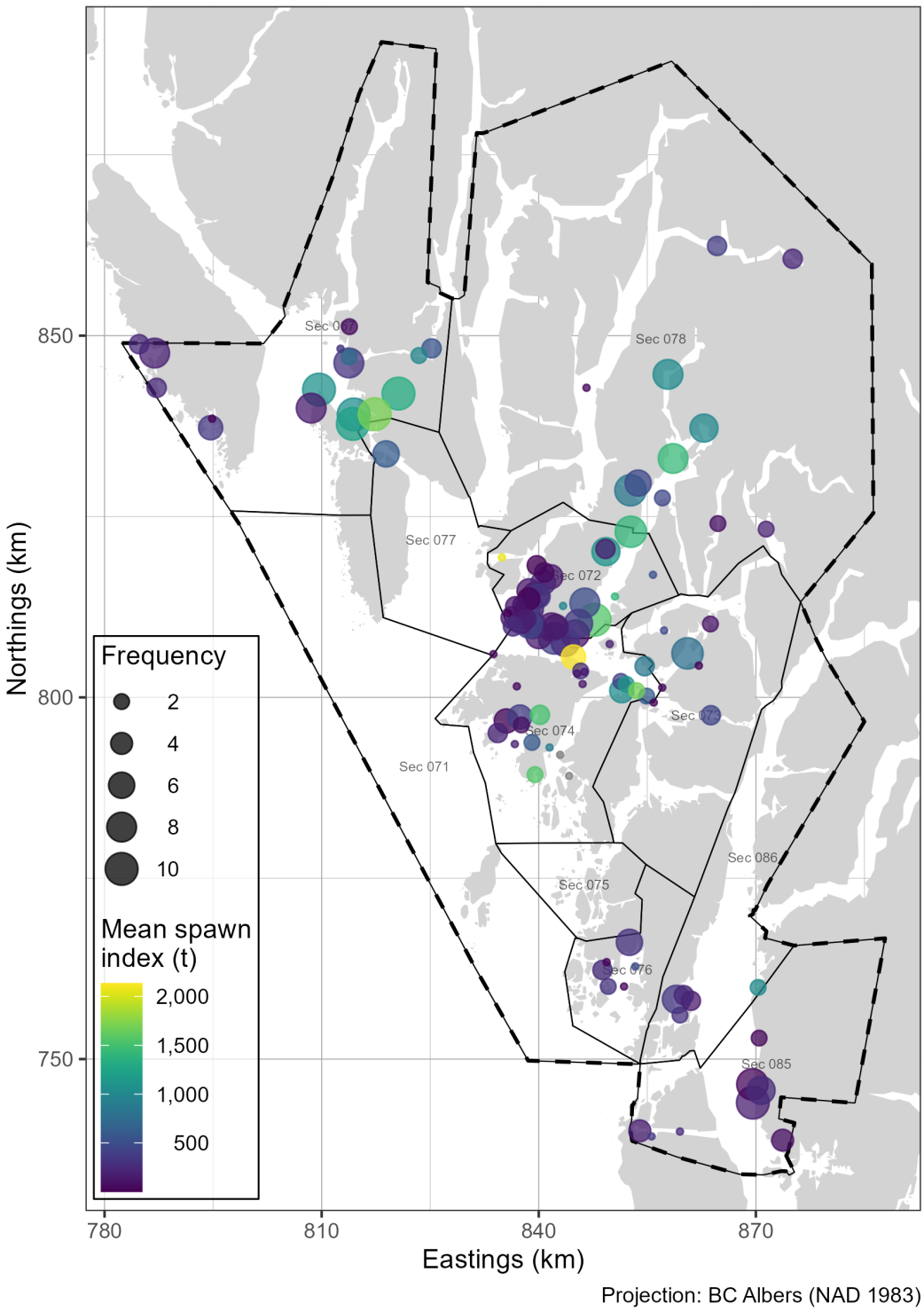

Figure 13. Pacific Herring spawn survey locations, mean spawn index in metric tonnes (t), and spawn frequency from 2012 to 2021 in the Central Coast major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Missing spawn index values indicate incomplete surveys (grey circles). Units: kilometres (km).

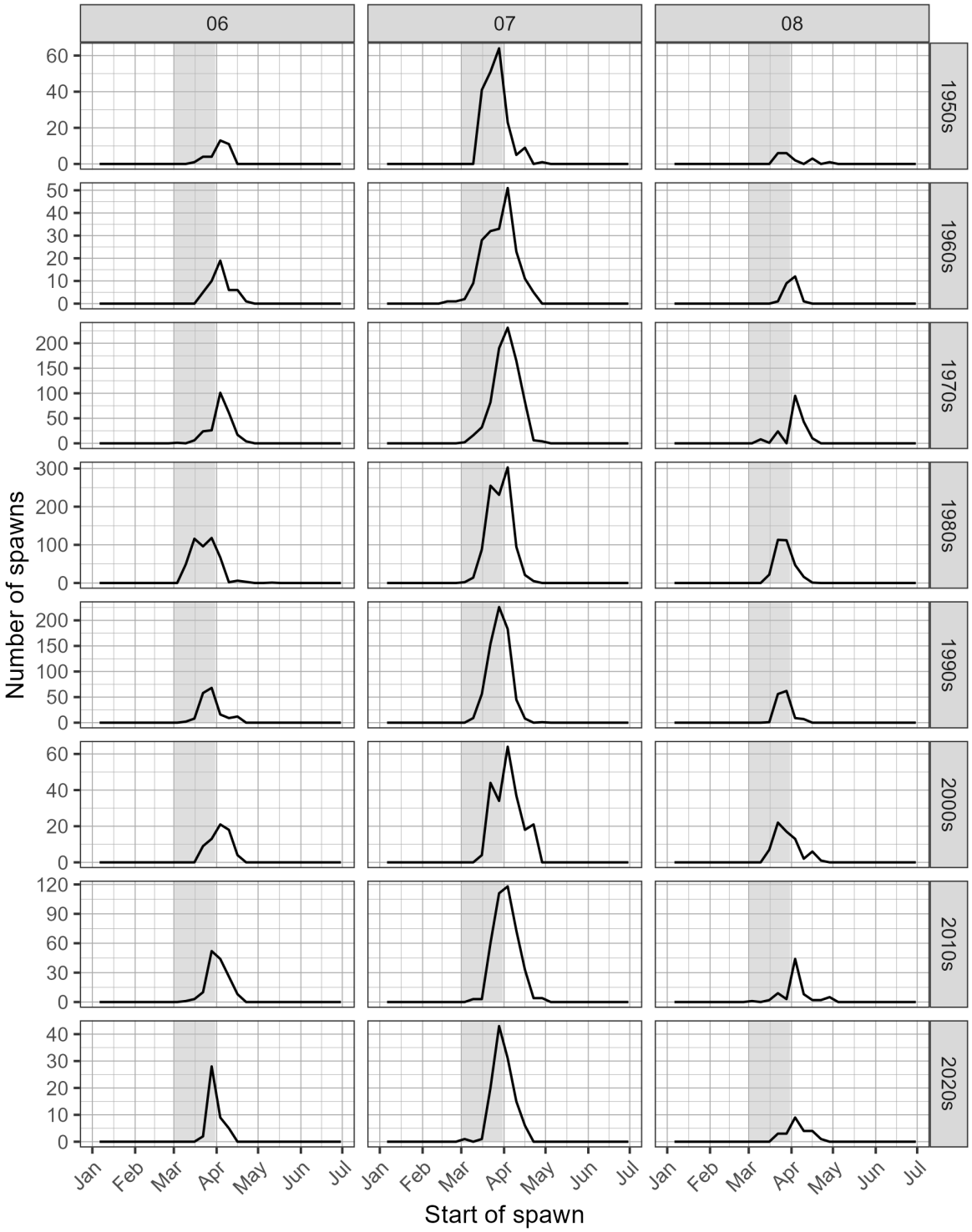

Figure 14. Pacific Herring spawn start date by decade and Statistical Area. Grey shaded regions indicate March 1st to 31st. Note that spawn size and intensity varies; therefore the number of spawns is not directly proportional to spawn extent or biomass.

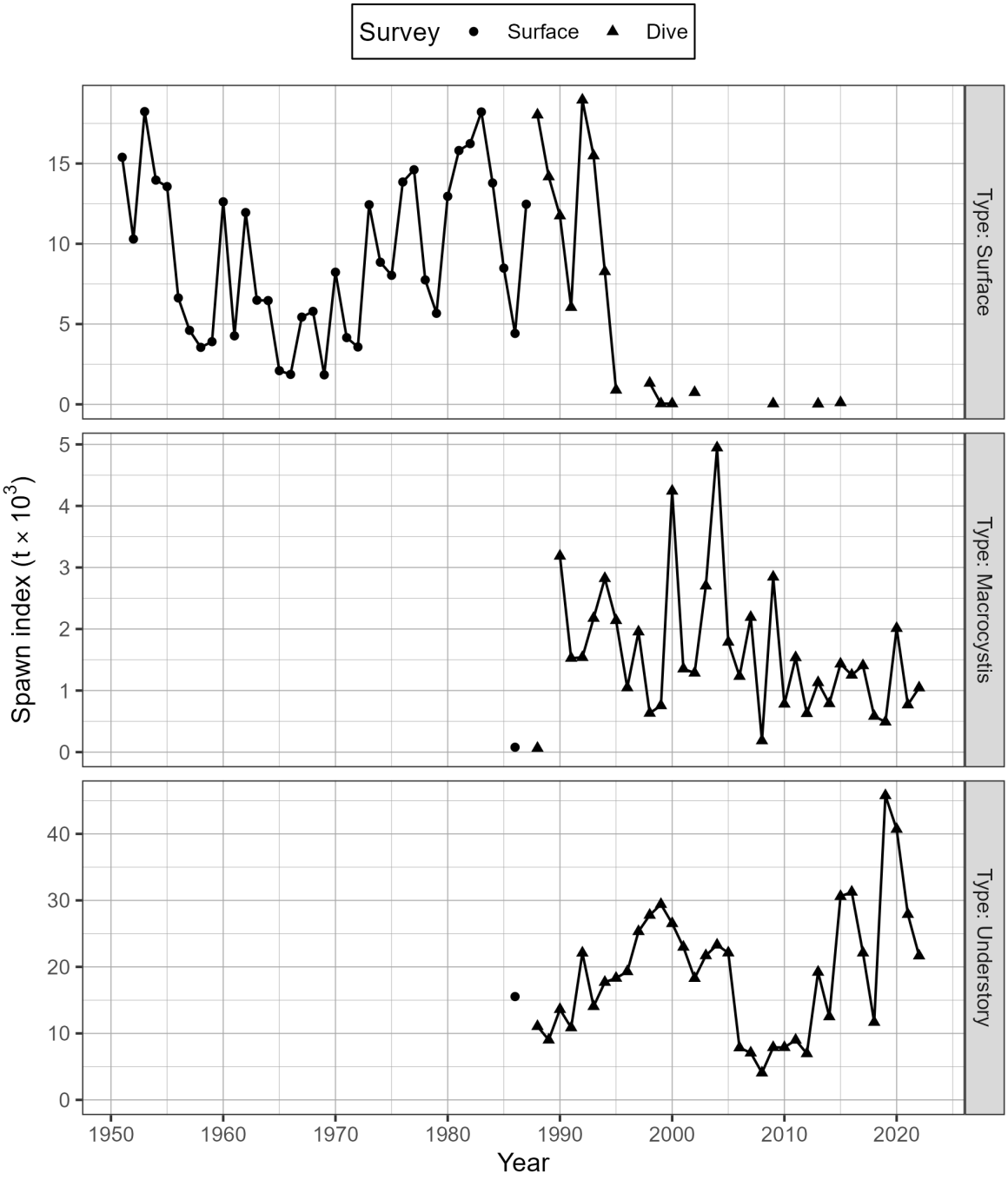

Figure 15. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) by type for Pacific Herring from 1951 to 2022 in the Central Coast major stock assessment region (SAR). There are three types of spawn survey observations: observations of spawn taken from the surface usually at low 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 coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022).

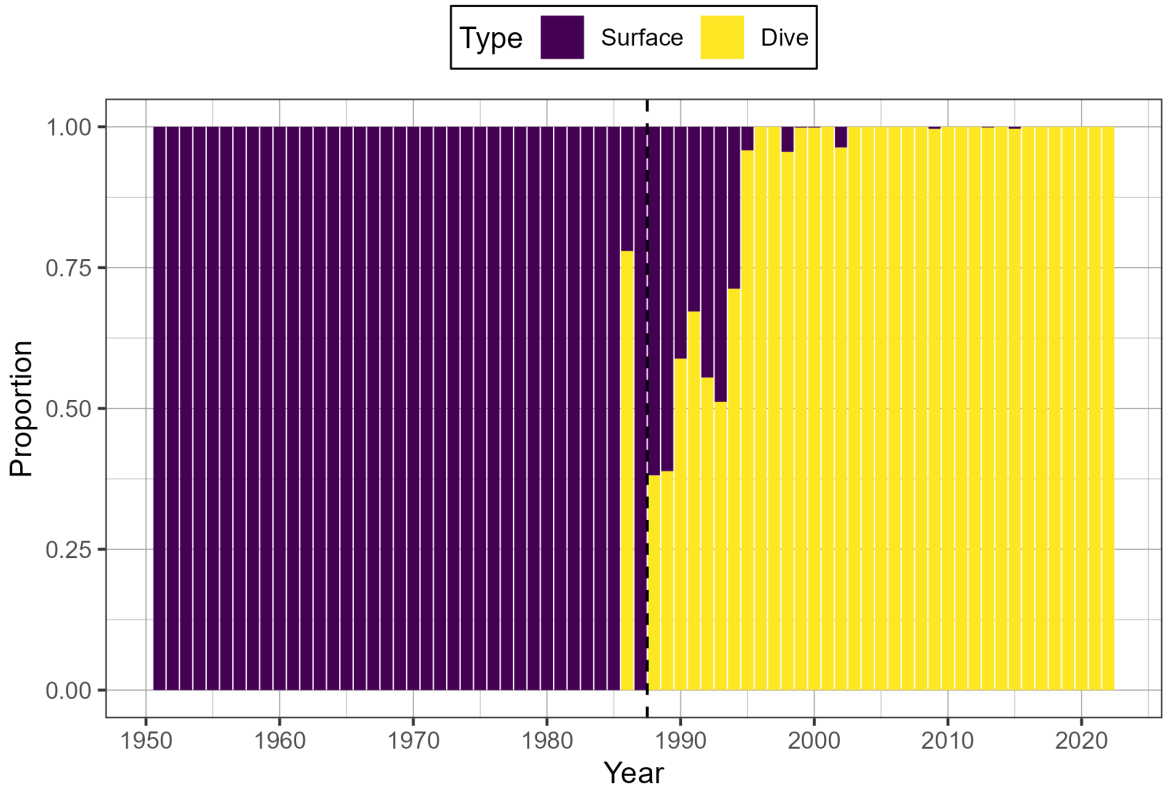

Figure 16. Time series of proportion of spawn index by surface and dive surveys for Pacific Herring from 1951 to 2022 in the Central Coast major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022).

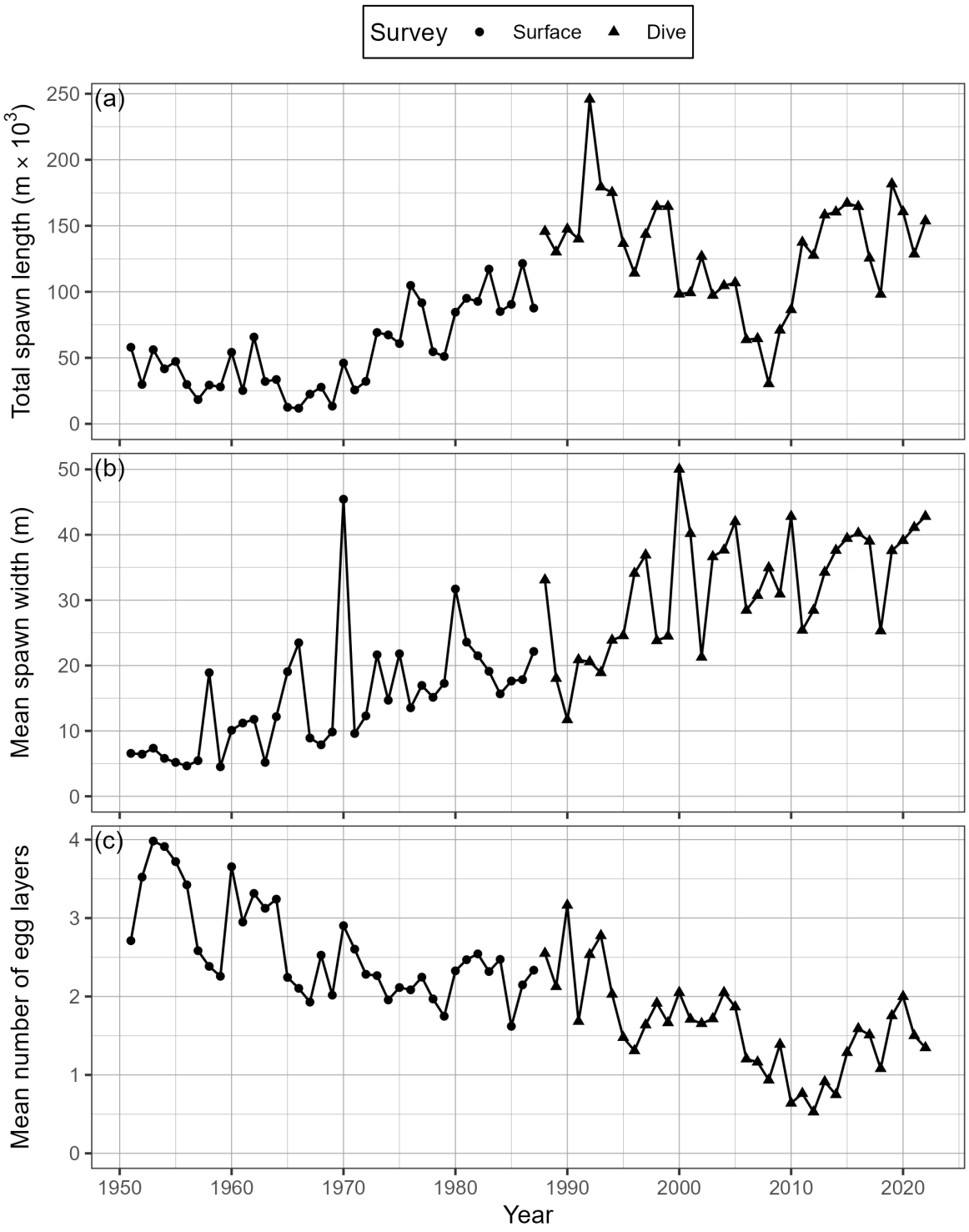

Figure 17. Time series of total spawn length in thousands of metres (m $\times$ 10^3; panel a), mean spawn width in metres (b), and mean number of egg layers (c) for Pacific Herring from 1951 to 2022 in the Central Coast major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022).

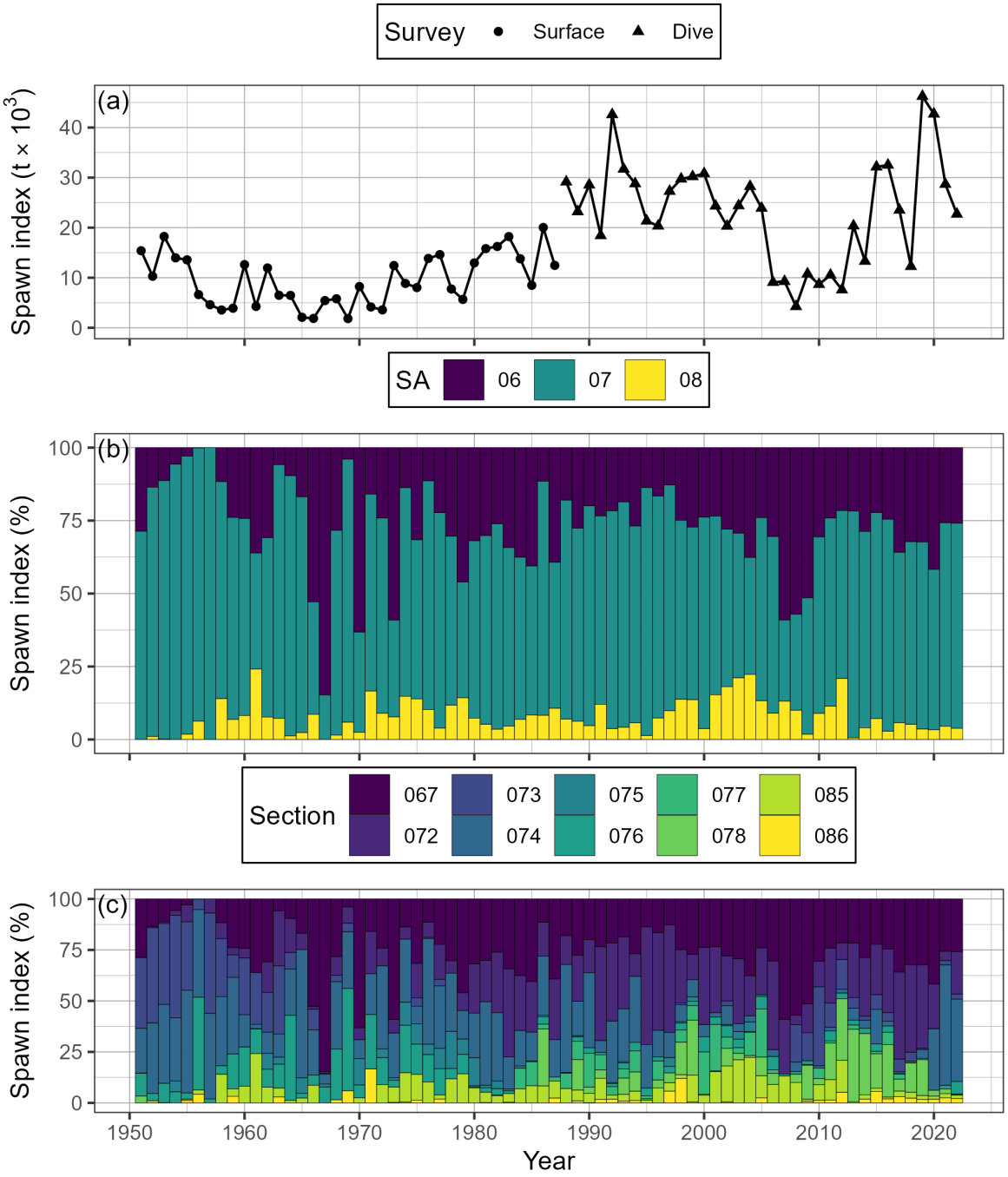

Figure 18. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) for Pacific Herring from 1951 to 2022 in the Central Coast major stock assessment region (SAR; panel a), as well as percent contributed by Statistical Area (SA), and Section (b, & c, respectively). The spawn index has two distinct periods defined by the dominant 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 15 and 16). 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.

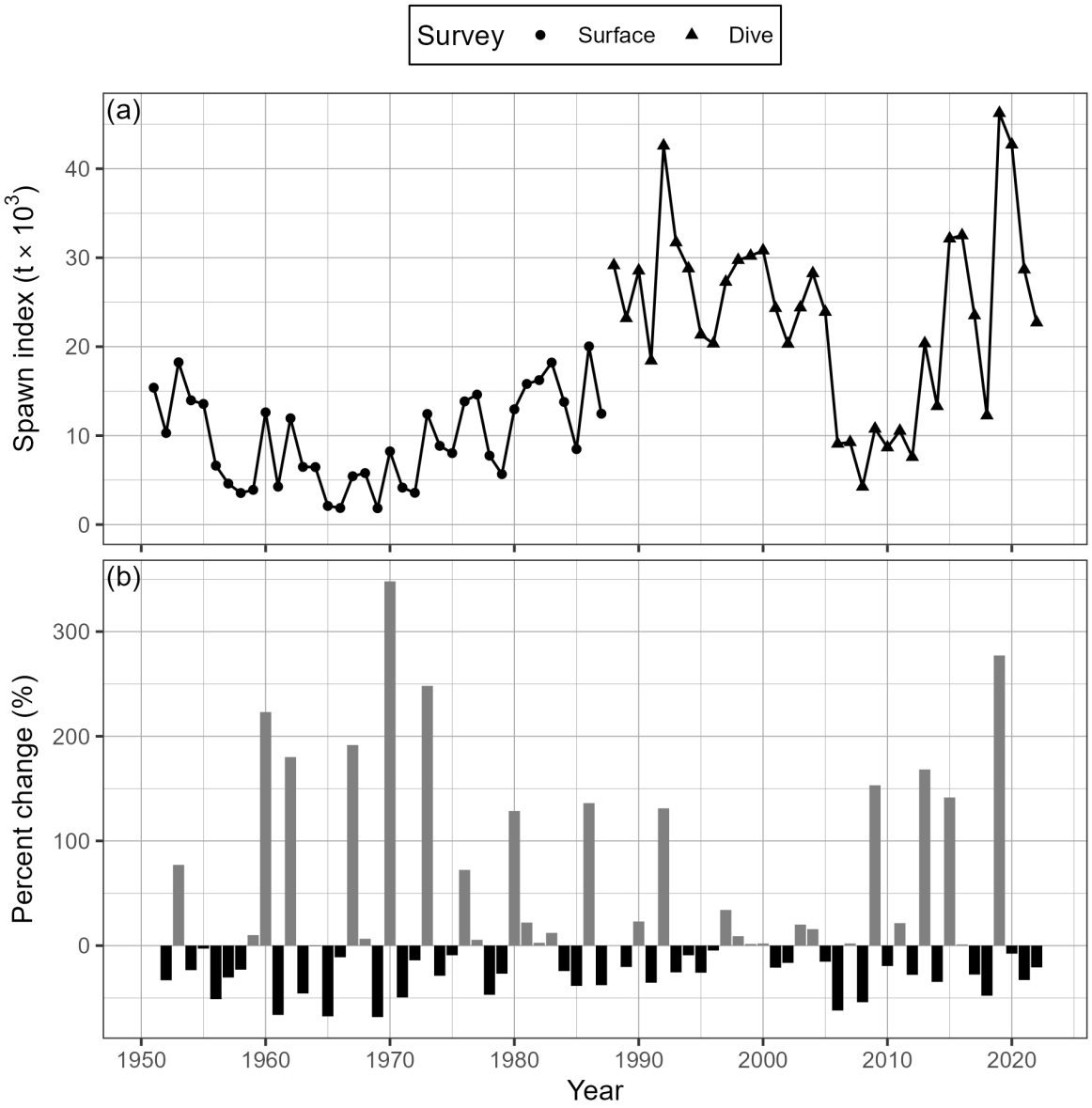

Figure 19. Time series of spawn index in thousands of metric tonnes ($t \times 10^3$) for Pacific Herring from 1951 to 2022 in the Central Coast major stock assessment region (SAR; panel a), and percent change (b). Percent change is $\delta_t = \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$ where α_t is the spawn index in year t. The spawn index has two distinct periods defined by the dominant 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 15 and 16).

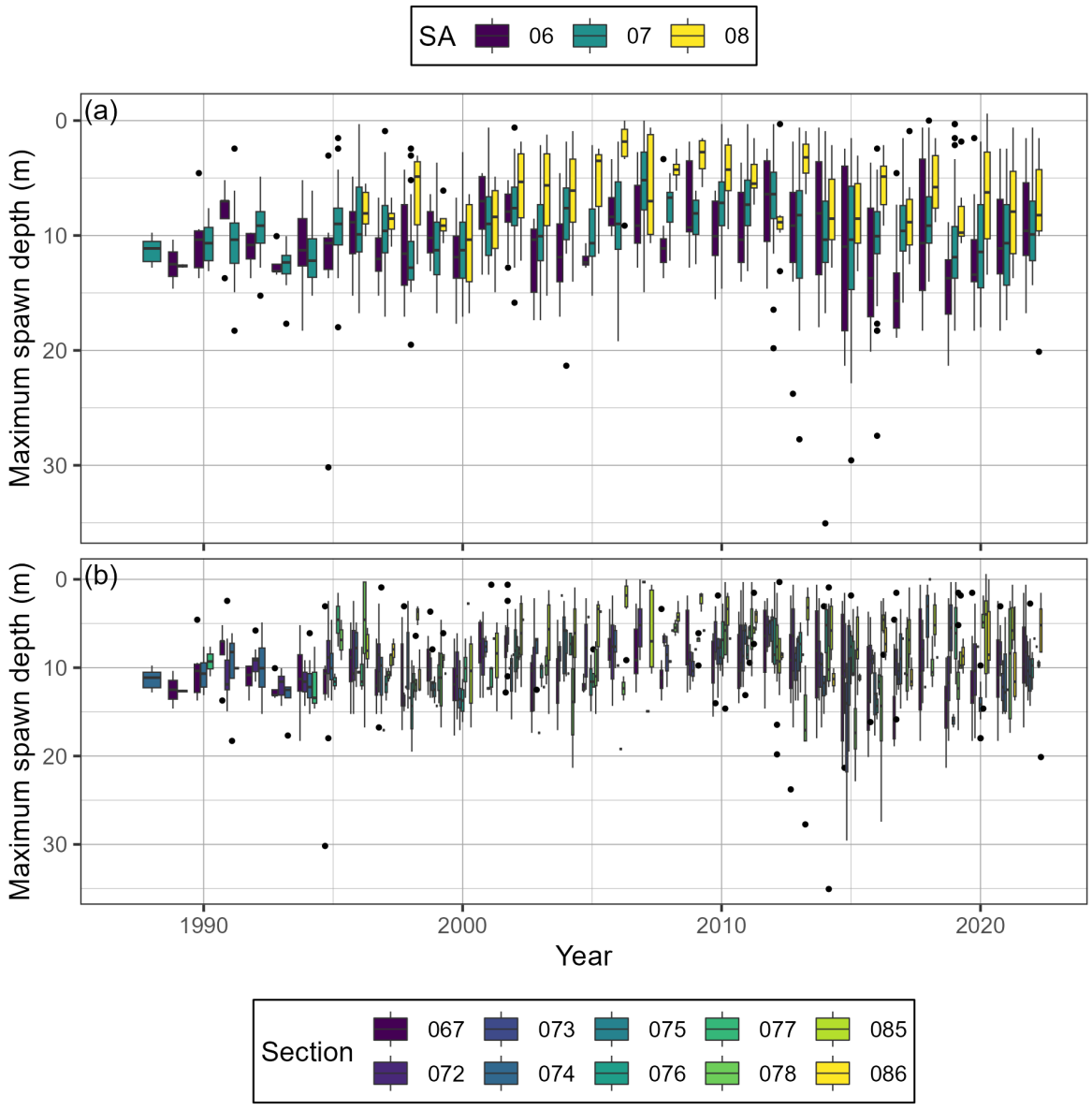

Figure 20. Time series of maximum spawn depth in metres (m) for Pacific Herring from 1987 to 2022 in the Central Coast major stock assessment region (SAR) by Statistical Area (SA; panel a), and Section (b). Note that depth is not corrected to chart datum. The spawn index has two distinct periods defined by the dominant coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022).

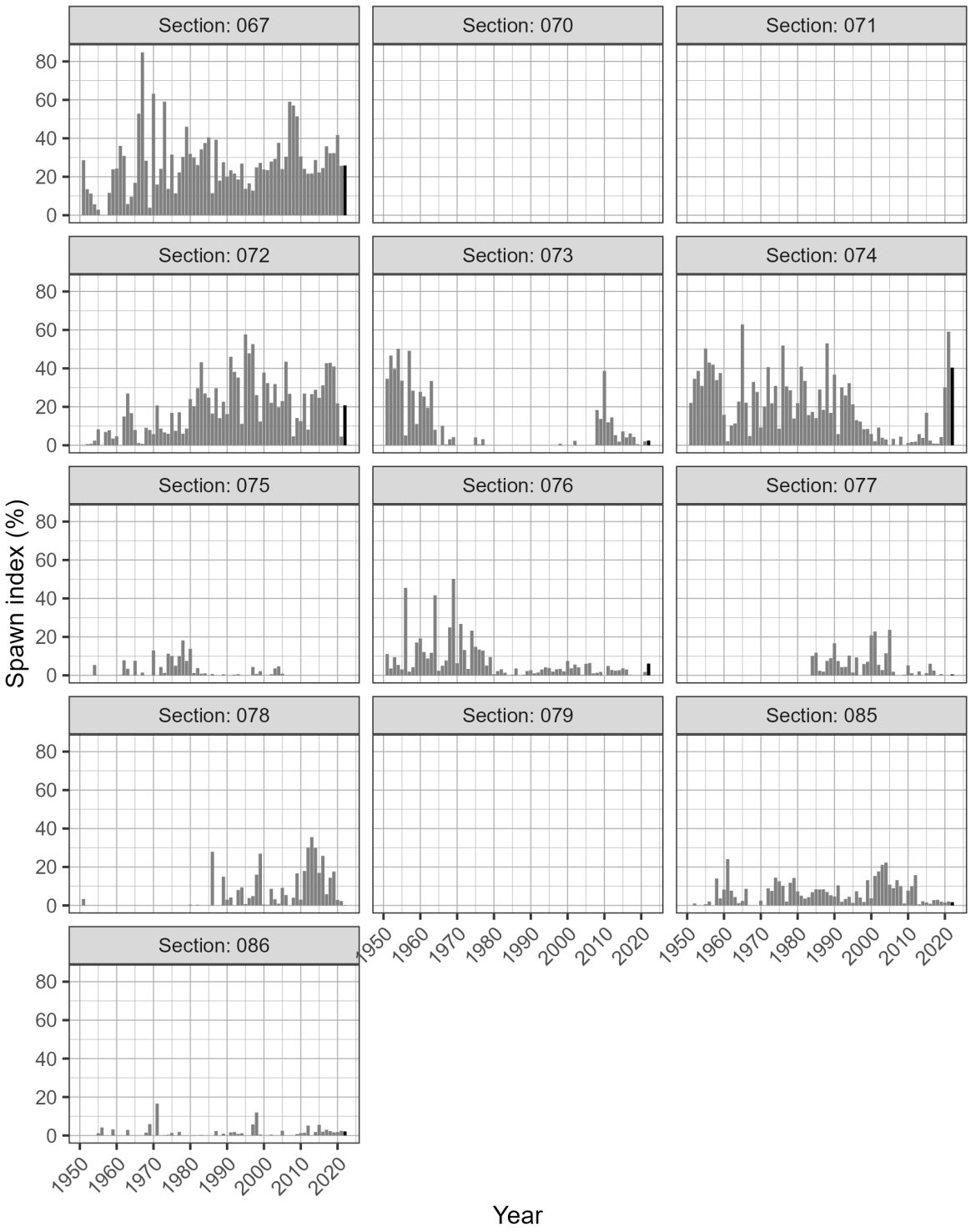

Figure 21. Time series of percent of spawn index by Section for Pacific Herring from 1951 to 2022 in the Central Coast major stock assessment region (SAR). The year 2022 has a darker bar to facilitate interpretation. The spawn index has two distinct periods defined by the dominant coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022). The 'spawn index' is not scaled by the spawn survey scaling parameter, q.

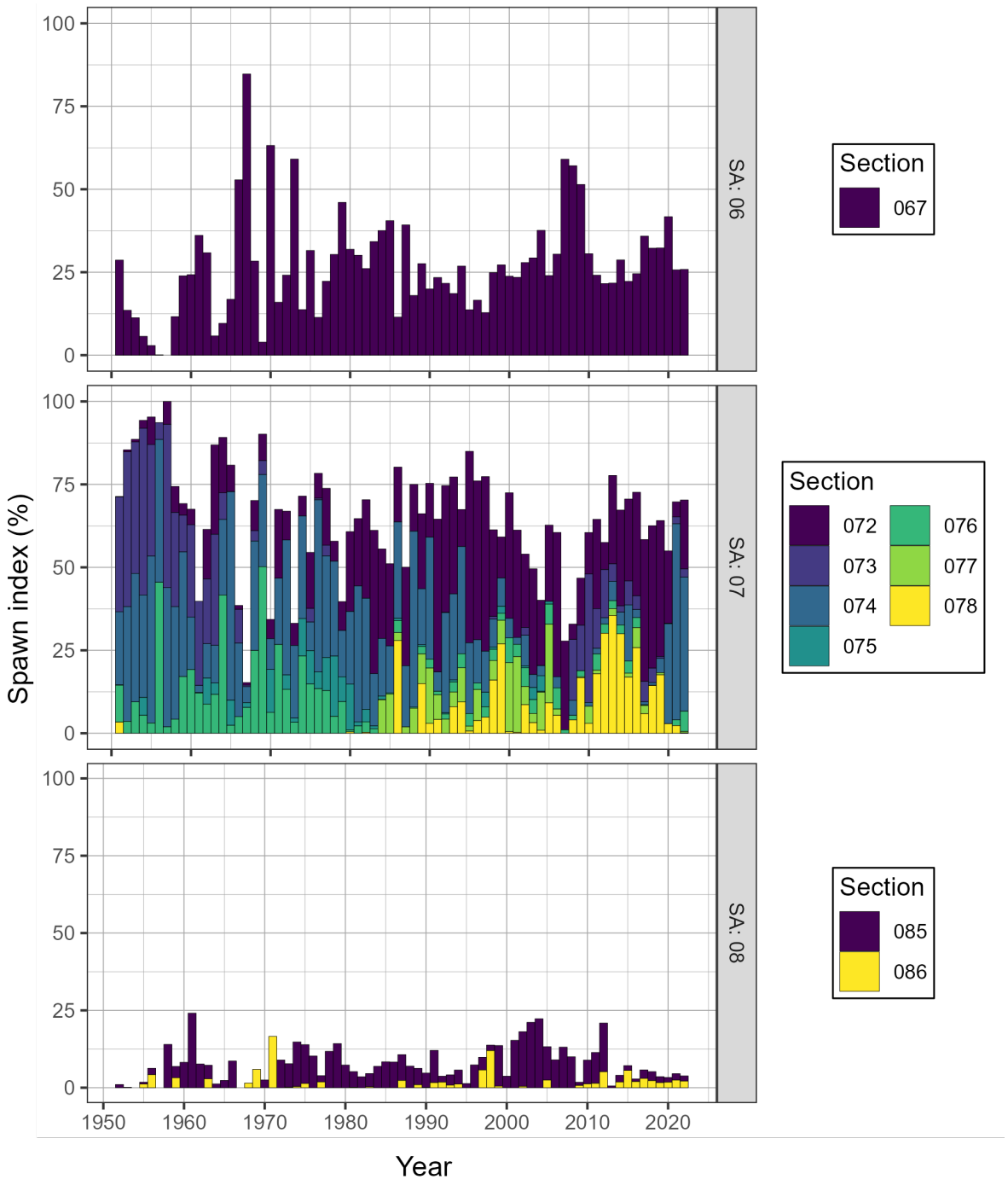

Figure 22. Time series of percent of spawn index by Statistical Area (SA) and Section for Pacific Herring from 1951 to 2022 in the Central Coast major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant coastwide survey method: surface surveys (1951 to 1987), and dive surveys (1988 to 2022). The 'spawn index' is not scaled by the spawn survey scaling parameter, q. Legend: '06&07' is Statistical Areas 06 and 07; and '08' is Statistical Area 08.

Figure 23. Animation of Pacific Herring spawn index in metric tonnes (t) by Location from 1951 to 2022 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 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".