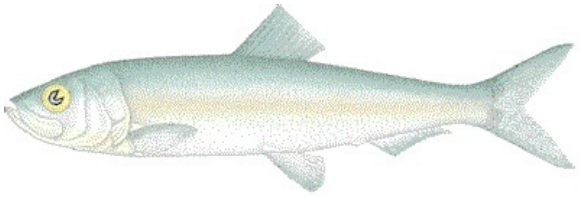
Pacific herring preliminary data summary for Area 2 West 2016

DFO Science*

June 16, 2017



Pacific herring (*Clupea pallasii*). Image credit: Fisheries and Oceans Canada (`www.pac.dfo-mpo.gc.ca`).

Disclaimer This report contains preliminary data. Therefore, the data may differ from data used and presented in the final Pacific herring stock assessment for Area 2 West 2016.

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1 Context

Pacific herring (*Clupea pallasii*) in British Columbia are assessed as 5 major and 2 minor stock assessment regions (SARs), and data are collected and summarized on this scale (Table 1, Figure 1). The Pacific herring data collection program includes fishery-dependent and -independent data from 1951 to 2016. 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 herring biomass to plan harvesting activities. In-season acoustic soundings are not used by stock assessment to inform the estimation of spawning biomass.

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The following is a description of data collected for Pacific herring in the Area 2 West minor SAR in 2016 (Figure 2). Data collected outside the SAR boundary are not included in this summary, and are not used for the purposes of stock assessment. Note that we refer to 'year' instead of 'herring season' in this report; therefore 2016 refers to the 2015/2016 herring season.

2 Data collection programs

In 2016, biological samples were collected by the "Queens Reach", a seine test charter vessel funded by the DFO. The Queens Reach operated a 6-day charter from March 20$^{\text{th}}$ to March 26$^{\text{th}}$, collecting biological samples from main bodies of herring, identified from soundings. The Progressor operated a 6-day snorkel surface survey in Port Louis, Area 2W, from March 29$^{\text{th}}$ to April 3$^{\text{rd}}$. Both vessels were funded by DFO, through a contract to the HCRS.

3 Catch and biological samples

There were no commercial seine or gillnet opportunities in 2016 in the Area 2 West minor stock area, and there was an opportunity for 1 commercial SOK licence to operate. The total landed commercial catch of Pacific herring from all fisheries in 2016 in the Area 2 West minor SAR was 0 t, which is the same as last year (Table 2 and Figure 3). The total harvested spawn on kelp (SOK) in 2016 in the Area 2 West minor SAR was 0 lb, which is associated with an estimated spawning biomass of 0 t (Table 3). We use the following equation to convert SOK harvest to spawning biomass [ref?]

$$SB = SOK \cdot 0.00832 \tag{1}$$

where SOK is SOK harvest in pounds, and SB is spawning biomass in tonnes.

In 2016, 5 Pacific herring biological samples were collected and processed for the Area 2 West minor SAR (Table 4, Table 5), and a total of 478 Pacific herring were aged in 2016. The locations in which the biological samples were collected are presented in Figure 4. Included herein are biological summaries of observed proportion-, number-, and weight-at-age (Figure 5, Table 6, and Figure 6, respectively). Biological summaries only include samples collected using seine nets (commercial and test) due to size-selectivity of other gear types such as gillnet.

4 Spawn survey data

Herring spawn surveys were conducted at 2 locations in 2016 in the Area 2 West minor SAR (Table 7, Figure 7). Spawn surveys are conducted to estimate the spawn length, width, number of layers, and substrate type, and these data are used to estimate the index of spawning biomass (i.e., the spawn index; Figure 8, Figure 9, Figure 10, Figure 11, and Table 8). 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 (1951–1987), and dive surveys (1988–2016).

Some herring Sections contribute more than others to the total spawn index, and the percentage contributed by Section varies yearly (Figure 11b, Figure 12). For example, in 2016, Section 002 contributed the most to the spawn index (100%). As with Sections, some Statistical Areas contribute more than others to the total spawn index (Figure 11c, Figure 13).

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:

- Surface spawn survey was well executed, implementing the snorkel survey methodology developed by HG Resource Managers.
- Survey efforts were focussed in Port Louis, with a brief visit to Port Chanal.
- Spawn was surveyed in Port Louis and Port Chanal by surface survey. Survey observations indicate very strong and above average spawning abundance in Port Louis.
- Spawn length, width, and coverage was larger/more extensive than average, and is reflected as an increase in the spawn index data.

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. Total landed commercial catch of Pacific herring in metric tonnes (t) by fishery in 2016 in the Area 2 West minor stock assessment region (SAR).

Fishery	Use	Catch (t)
NA	NA	0

Table 3. Total harvested Pacific herring spawn on kelp (SOK) in pounds (lb), and the associated estimate of spawning biomass in metric tonnes (t) from 2006 to 2016 in the Area 2 West minor stock assessment region (SAR).

Year	Harvest (lb)	Spawning biomass (t)
2006	0	0
2007	59,019	491
2008	42,054	350
2009	28,499	237
2010	46,705	389
2011	0	0
2012	29,644	247
2013	26,171	218
2014	26,523	221
2015	0	0
2016	0	0

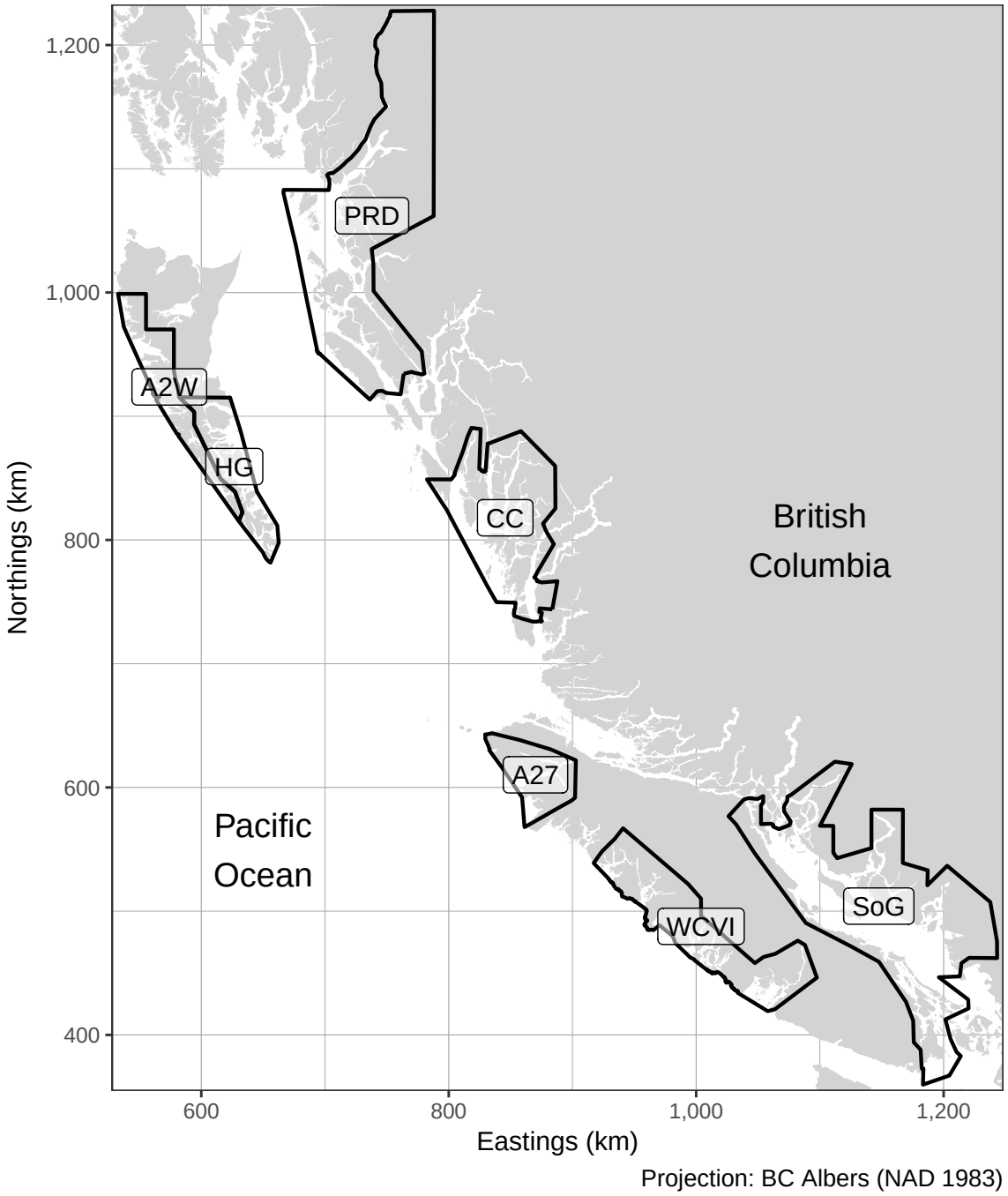

Figure 1. Boundaries for the Pacific herring stock assessment regions (SARs) in British Columbia: there are 5 major SARs (HG, PRD, CC, SoG, and WCVI), and 2 minor SARs (A27 and A2W). Units: kilometres (km). Also see Table 1.

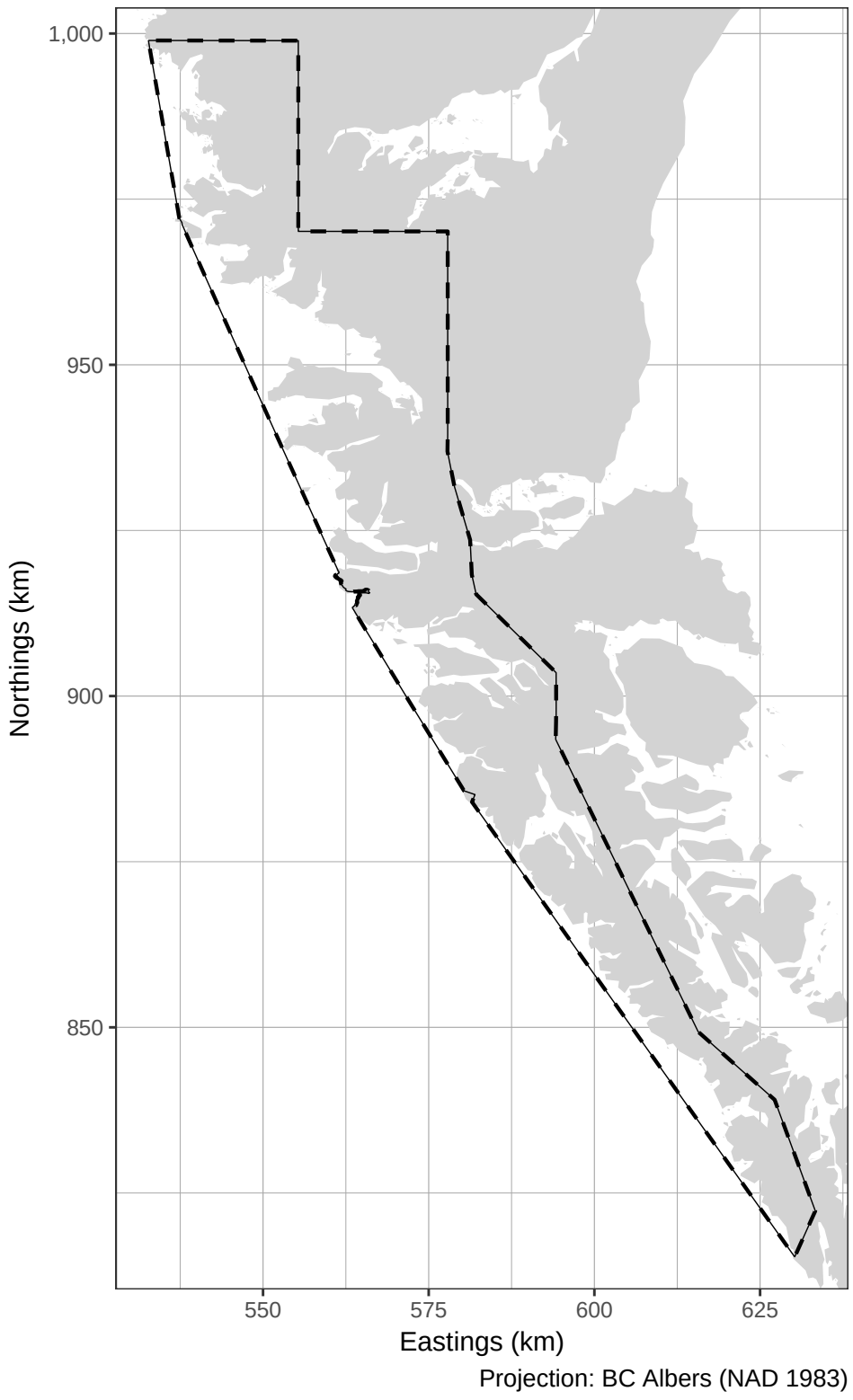

Figure 2. Boundaries for the Area 2 West minor stock assessment region (SAR; thick dashed lines), and associated Statistical Areas (SA; thin solid lines). Units: kilometres (km).

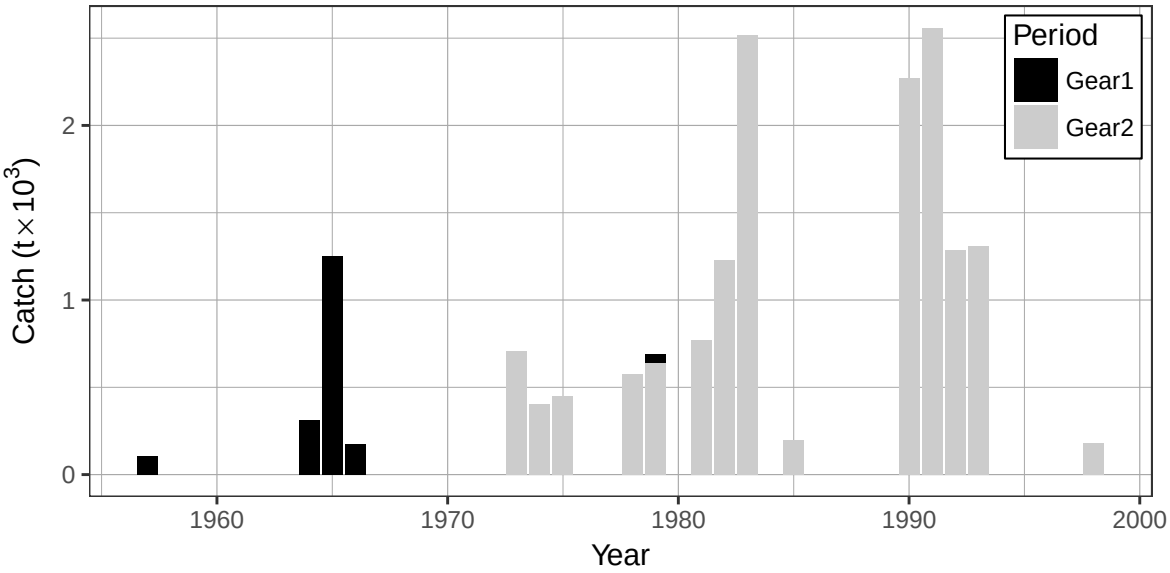

Figure 3. Time series of total landed catch in thousands of metric tonnes ($t \times 10^3$) of Pacific herring by gear type from 1951 to 2016 in the Area 2 West minor stock assessment region (SAR). Legend: 'Gear1' represents the reduction, the food and bait, as well as the special use fishery; 'Gear2' represents the roe seine fishery; and 'Gear3' represents the roe gillnet fishery.

Table 4. Number of Pacific herring biological samples processed from 2006 to 2016 in the Area 2 West minor stock assessment region (SAR). Each sample is approximately 100 fish.

	Number of samples		
Year	Commercial	Test	Total
2006	0	5	5
2007	1	6	7
2008	0	2	2
2009	4	5	9
2010	1	6	7
2011	0	10	10
2012	0	5	5
2013	1	6	7
2014	3	0	3
2015	0	4	4
2016	0	5	5

Table 5. Number and type of Pacific herring biological samples processed in 2016 in the Area 2 West minor stock assessment region (SAR). Each sample is approximately 100 fish.

Type	Gear	Use	Number of samples
Test	Seine	Test Fishery	5

Table 6. Observed proportion-at-age for Pacific herring from 2006 to 2016 in the Area 2 West minor 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
2006	0.108	0.140	0.176	0.069	0.449	0.034	0.017	0.006	0.000
2007	0.003	0.579	0.113	0.065	0.033	0.186	0.015	0.005	0.002
2008	0.341	0.017	0.419	0.084	0.028	0.022	0.084	0.000	0.006
2009	0.026	0.725	0.025	0.122	0.022	0.025	0.022	0.029	0.005
2010	0.083	0.316	0.361	0.027	0.095	0.021	0.054	0.026	0.018
2011	0.022	0.499	0.183	0.232	0.016	0.035	0.007	0.004	0.001
2012	0.072	0.192	0.372	0.148	0.159	0.015	0.030	0.004	0.008
2013	0.003	0.612	0.085	0.183	0.062	0.048	0.000	0.006	0.001
2014	0.053	0.004	0.438	0.068	0.208	0.106	0.094	0.011	0.019
2015	0.036	0.689	0.028	0.122	0.010	0.070	0.026	0.016	0.003
2016	0.036	0.096	0.715	0.027	0.105	0.017	0.004	0.000	0.000

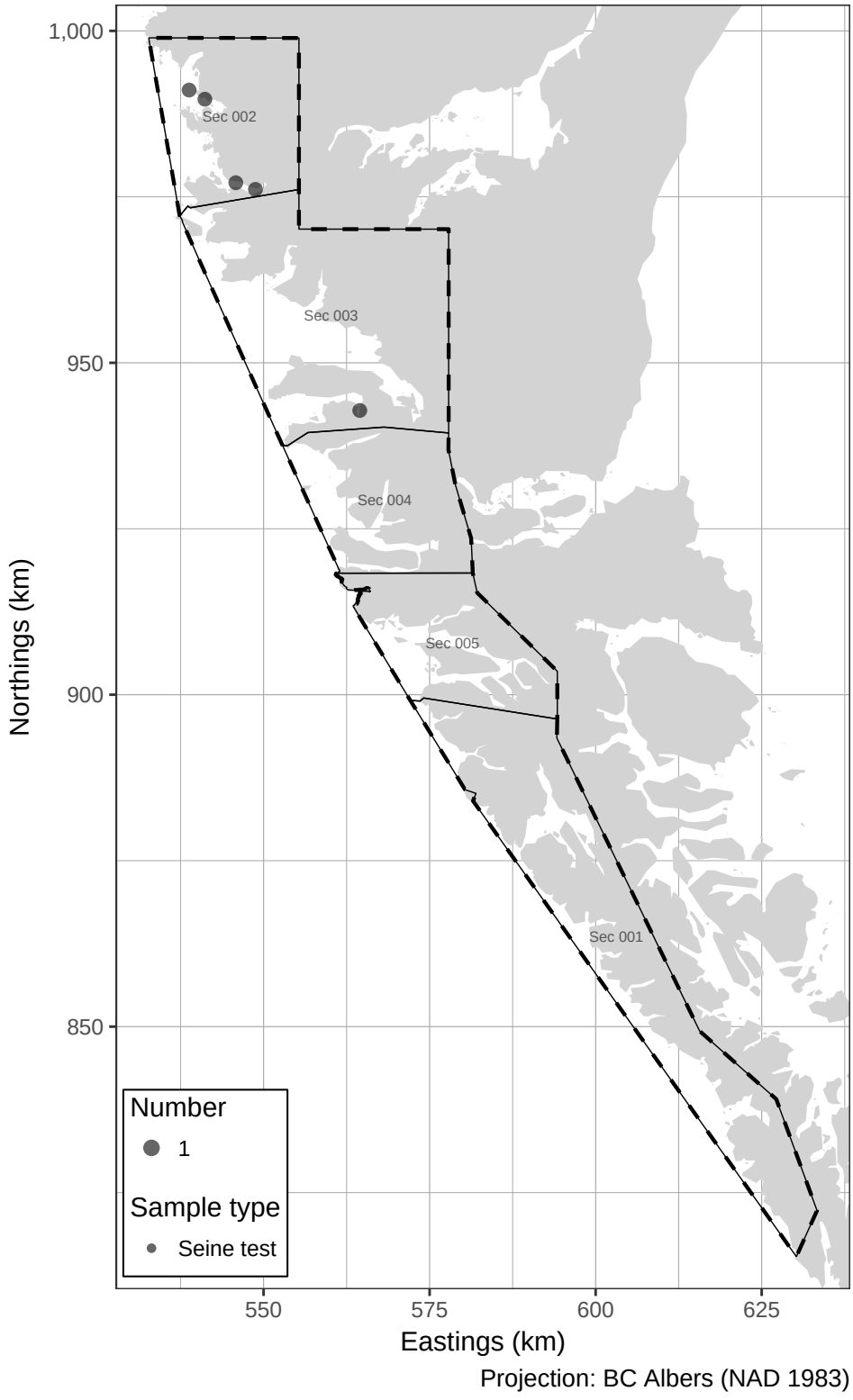

Figure 4. Location and type of Pacific herring biological samples collected in 2016 in the Area 2 West minor stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). Units: kilometres (km).

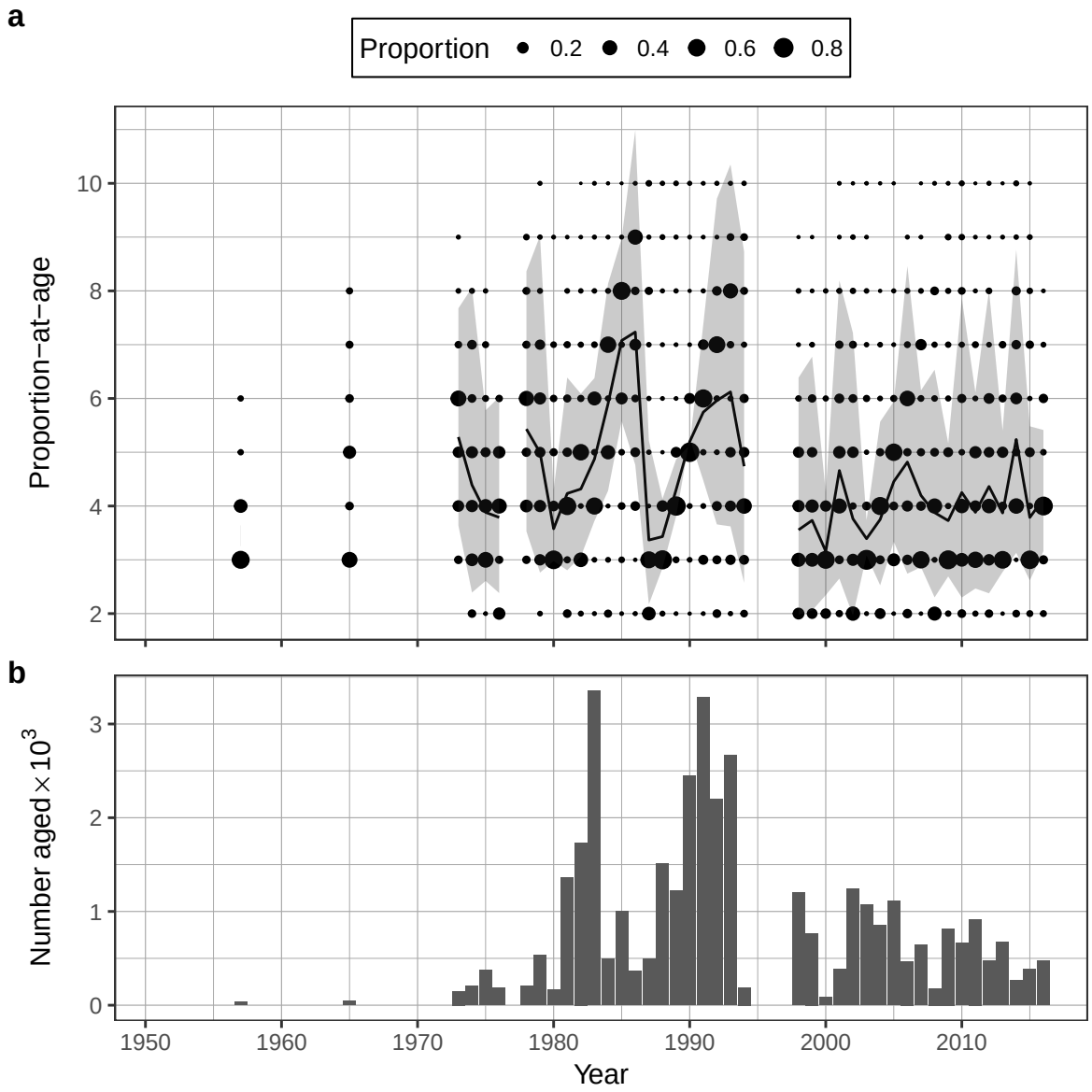

Figure 5. Time series of observed proportion-at-age (a) and number aged (b) of Pacific herring from 1951 to 2016 in the Area 2 West minor stock assessment region (SAR). The black line is the mean age, and the shaded area is the approximate 90% distribution. Biological summaries only include samples collected 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.

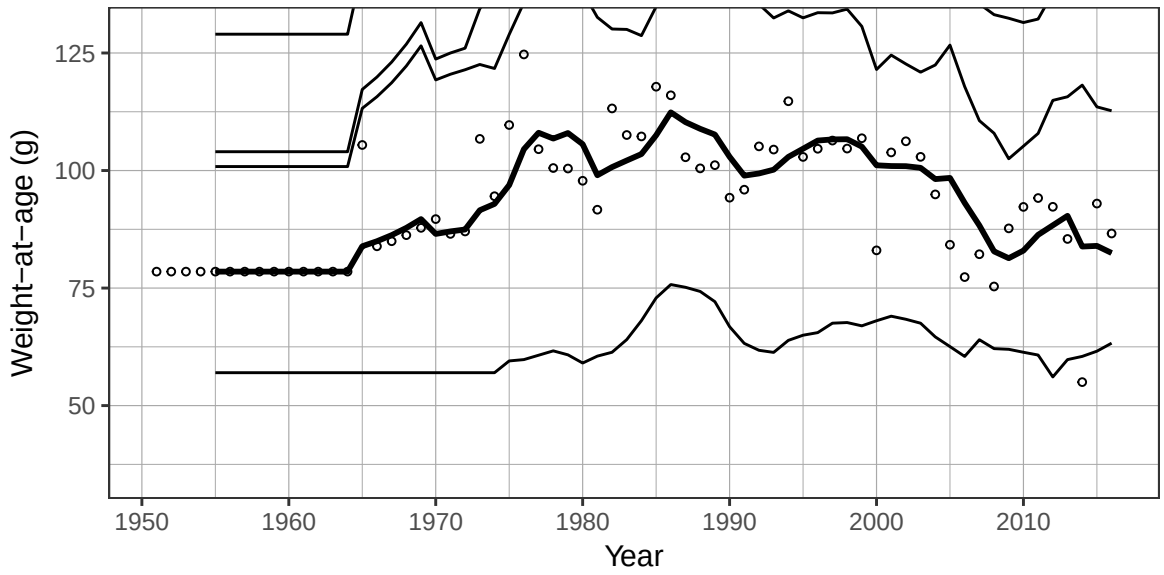

Figure 6. Time series of weight-at-age in grams (g) for age-3 (circles) and 5-year running mean weight-at-age (lines) for Pacific herring from 1951 to 2016 in the Area 2 West minor stock assessment region (SAR). Lines show 5-year running means for age-2 to age-10 herring (incrementing higher from the lowest line); the thick black line highlights age-3 herring. Missing weight-at-age values (i.e., years where there are 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.

Table 7. Pacific herring spawn survey locations and spawn index in metric tonnes (t) in 2016 in the Area 2 West minor 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 (i.e., NA) indicate incomplete spawn surveys.

Statistical Area	Section	Location code	Location name	Spawn index (t)
00	002	60	Port Louis	2,732
00	002	62	Port Chanal	269

Table 8. Summary of spawn survey data from 2006 to 2016 in the Area 2 West minor stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951–1987), and dive surveys (1988–2016). 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 layers	Spawn index (t)
2006	21,550	18	1.942	1,828
2007	12,612	10	2.191	1,469
2008	15,950	19	2.110	2,000
2009	26,945	16	0.597	2,871
2010	24,490	25	1.792	2,725
2011	14,130	30	2.083	2,641
2012	19,704	14	2.247	2,416
2013	14,965	11	1.636	2,076
2014	12,050	27	1.167	1,368
2015	NA	NA	NA	NA
2016	15,800	27	3.007	3,001

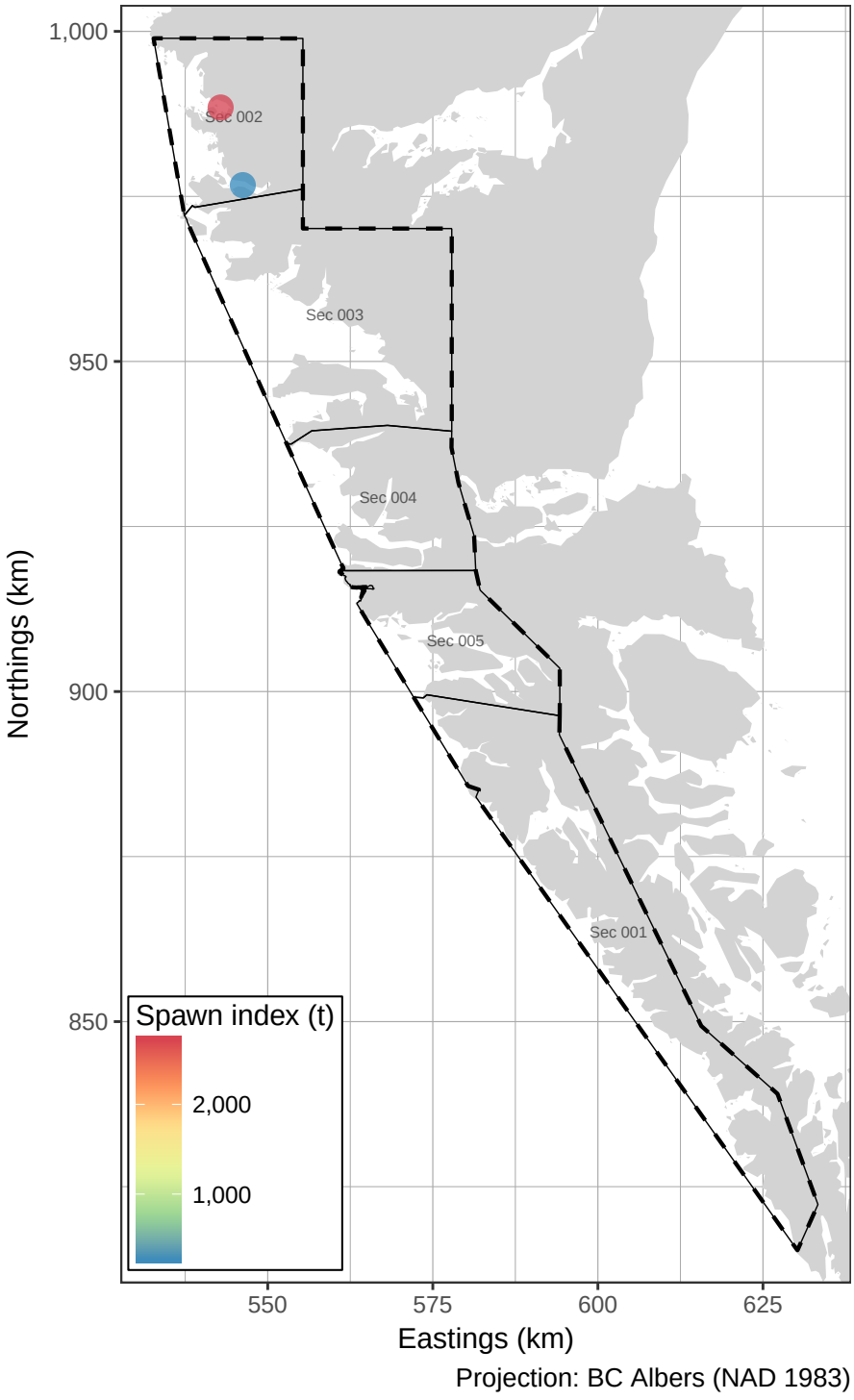

Figure 7. Location of Pacific herring spawning locations in 2016 in the Area 2 West minor stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The 'spawn index' represents the raw survey data only, and is not scaled by the spawn survey scaling parameter, q. Missing spawn index values (grey circles) indicate incomplete spawn surveys. Units: kilometres (km), and metric tonnes (t).

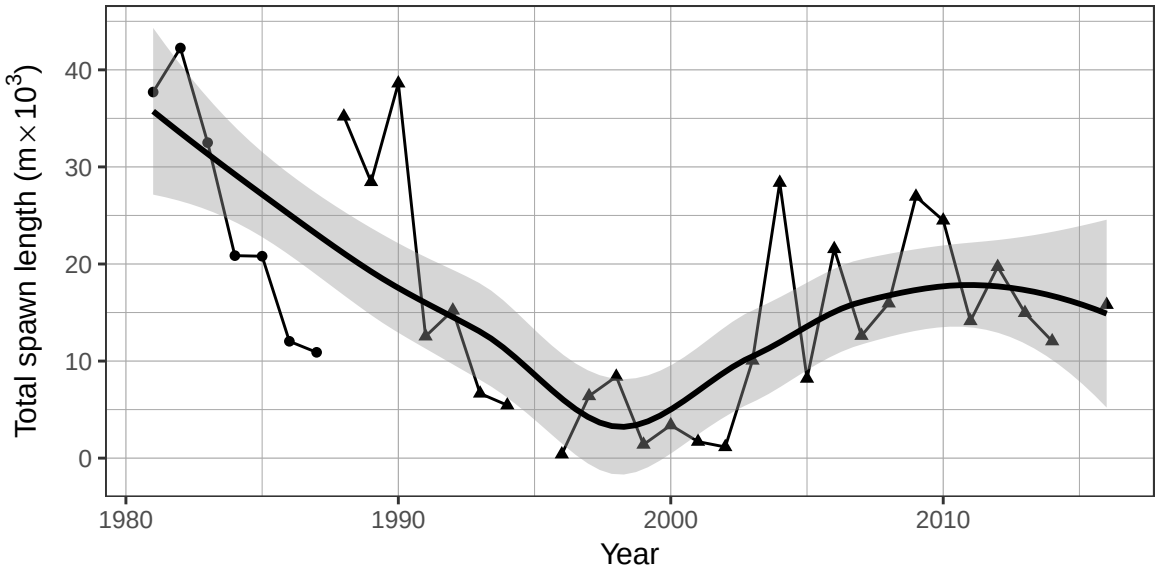

Figure 8. Time series of total spawn length in thousands of metres ($m \times 10^3$) for Pacific herring from 1981 to 2016 in the Area 2 West minor stock assessment region (SAR). The thick black line is a loess curve, and the shaded area is the 90% confidence interval. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951–1987), and dive surveys (1988–2016).

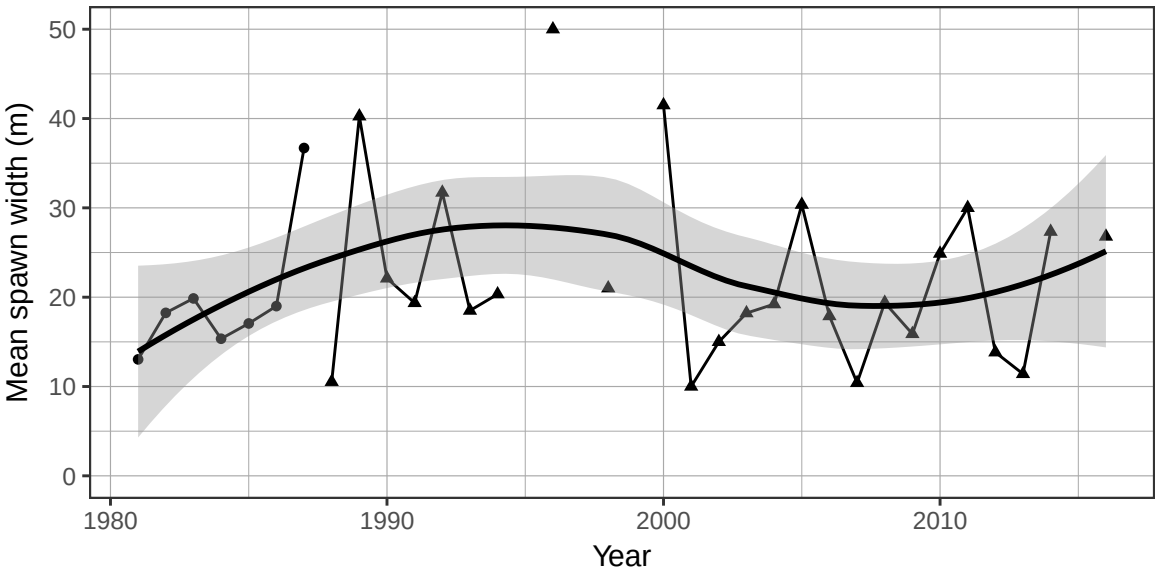

Figure 9. Time series of mean spawn width in metres (m) for Pacific herring from 1981 to 2016 in the Area 2 West minor stock assessment region (SAR). The thick black line is a loess curve, and the shaded area is the 90% confidence interval. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951–1987), and dive surveys (1988–2016).

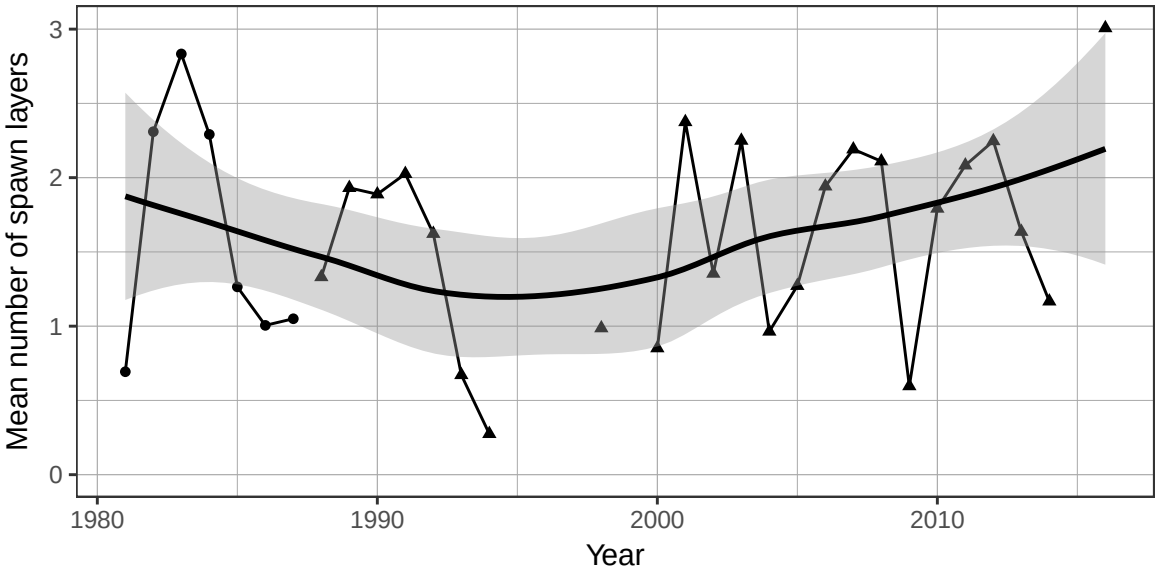

Figure 10. Time series of mean number of spawn layers for Pacific herring from 1981 to 2016 in the Area 2 West minor stock assessment region (SAR). The thick black line is a loess curve, and the shaded area is the 90% confidence interval. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951–1987), and dive surveys (1988–2016).

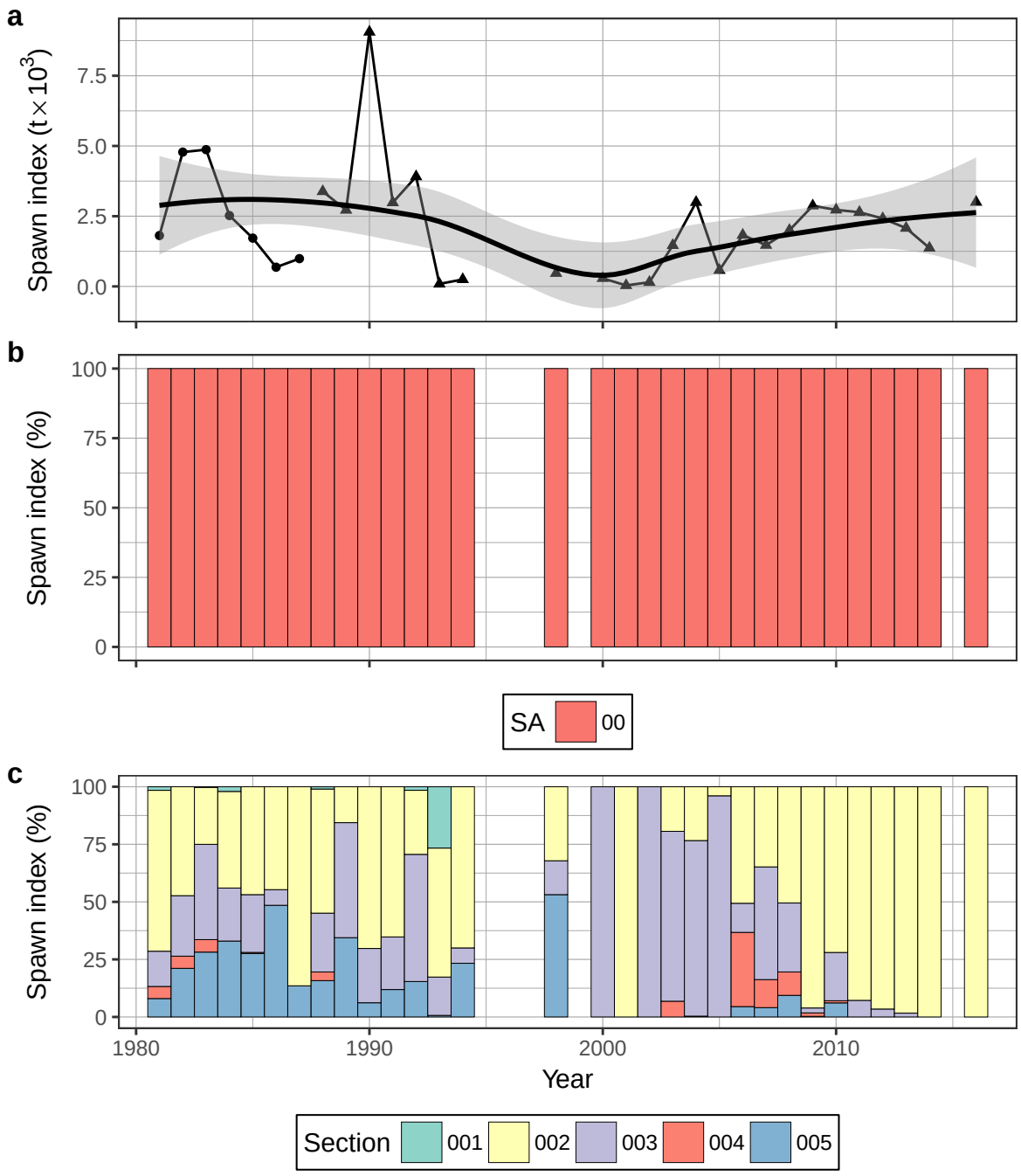

Figure 11. Time series of spawn index in thousands of metric tonnes (t $\times$ 10^3) for Pacific herring from 1981 to 2016 in the Area 2 West minor stock assessment region (SAR; a), as well as percent contributed by Statistical Area (SA), and Section (b, & c, respectively). The thick black line is a loess curve, and the shaded area is the 90% confidence interval. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951–1987), and dive surveys (1988–2016). The 'spawn index' represents the raw survey data only, and is not scaled by the spawn survey scaling parameter, q.

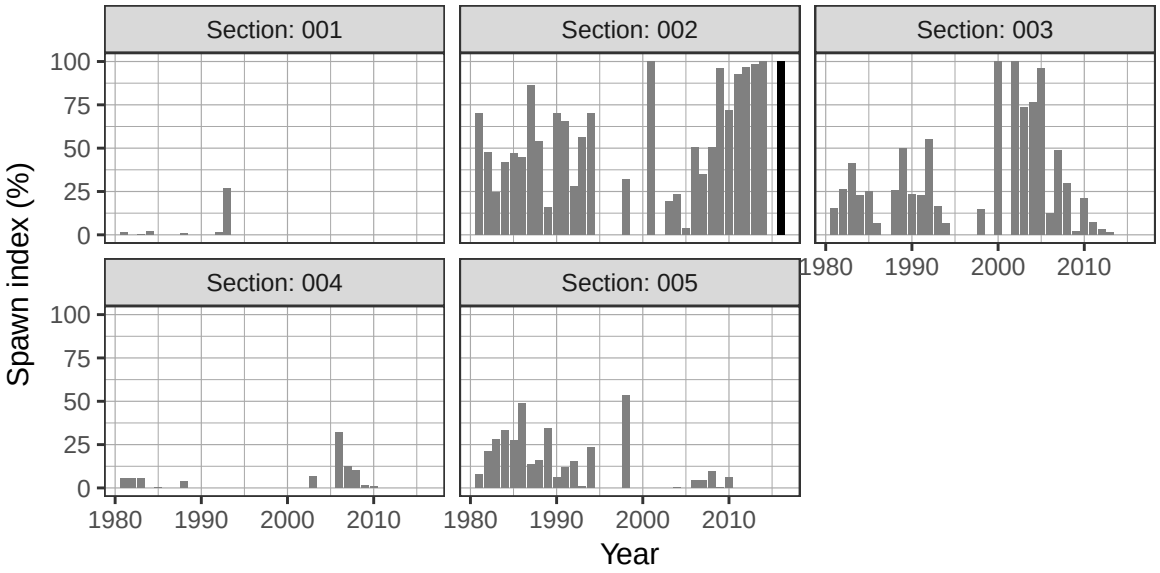

Figure 12. Time series of percent of spawn index by Section for Pacific herring from 1981 to 2016 in the Area 2 West minor stock assessment region (SAR). The year 2016 has a darker bar to facilitate interpretation. The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951–1987), and dive surveys (1988–2016). The 'spawn index' represents the raw survey data only, and is not scaled by the spawn survey scaling parameter, q.

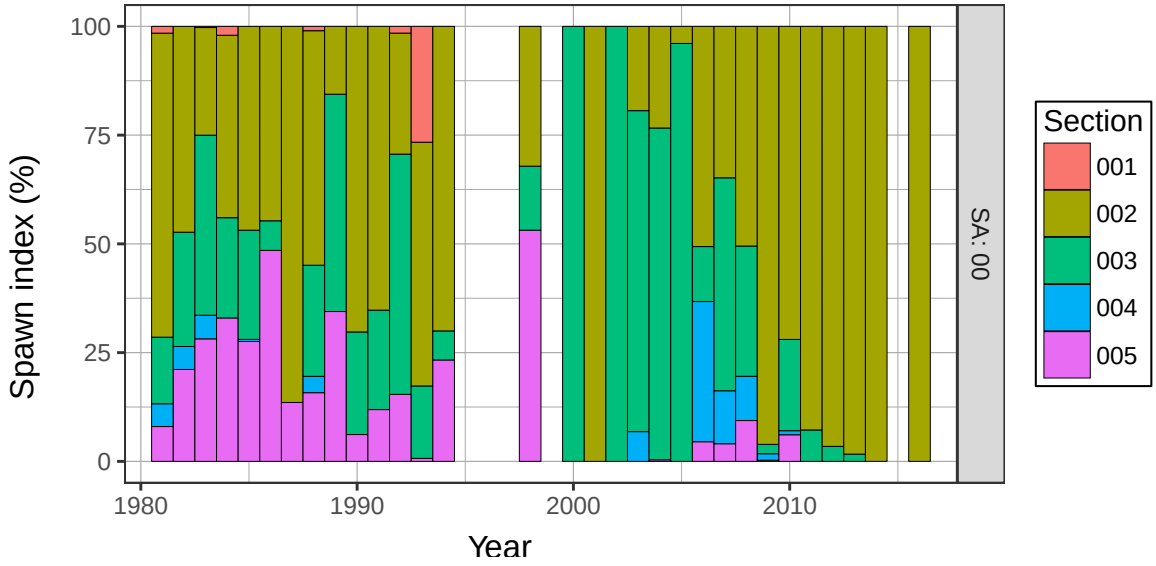

Figure 13. Time series of percent of spawn index by Statistical Area (SA) and Section for Pacific herring from 1981 to 2016 in the Area 2 West minor stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951–1987), and dive surveys (1988–2016). The 'spawn index' represents the raw survey data only, and is not scaled by the spawn survey scaling parameter, q.