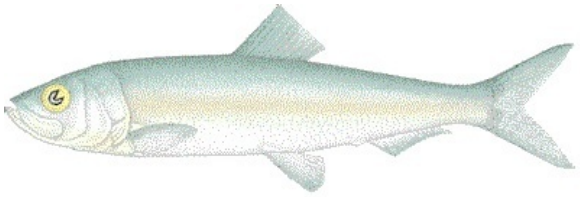
Pacific herring preliminary data summary for Haida Gwaii 2016

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 Haida Gwaii 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 Haida Gwaii major 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 primary purpose of the test charter vessel was to collect biological samples from main bodies of herring from Haida Gwaii major (priority) and minor stock areas, identified from soundings. The "Queens Reach" operated a 25-day charter from March 10$^{\text{th}}$ to April 3$^{\text{rd}}$, collecting samples from HG and Area 2W. The spawn reconnaissance vessel, Victoria Rose, operated a 19-day charter from March 31$^{\text{th}}$ to April 18$^{\text{th}}$, and the dive charter vessel, Haida Spirit operated a 20-day charter from April 3$^{\text{rd}}$ to April 22$^{\text{nd}}$. These vessels were funded by DFO, through a contract to the HCRS, with 6 days of the reconnaissace survey funded by the Haida Nation (via AFS). The dive survey contract was awarded to and operated by the Haida Nation.

3 Catch and biological samples

There were no commercial opportunities in 2016 in the Haida Gwaii major stock area. The total landed commercial catch of Pacific herring from all fisheries in 2016 in the Haida Gwaii major 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 Haida Gwaii major 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 Haida Gwaii major SAR (Table 4, Table 5), and a total of 452 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 17 locations in 2016 in the Haida Gwaii major 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 025 contributed the most to the spawn index (78%). 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:

- Observations that spawn has moved off HG proper and more into the outer islands.
- Observations of spawning season concentrated in time (occurring over a shorter number of days), as opposed to in the past when spawning season was more spread out.
- Warmer water termperatures were observed again in 2016, and resulted in early spawns, with the majority of spawns occurring within a 10-week period.
- We received fewer reports of fungal eggs (when compared with 2015) – to be confirmed.
- Area with significant egg mortality and fungal growth was observed by dive teams in areas of very thick spawn along the Burnaby Island shore in Pool Inlet.
- Dive charter needed to skip transects in some areas so ensure sampling in all areas before eggs hatched out. The dive team then returned to areas and surveyed missed transects once the area was completed. After spawn was all measured, no new reports of spawn were reported.
- Observed decline in herring spawn in 2016. This is also reflected in the data: decline in total length, average width, with total length declining by almost half.
- Spawns in Louscoone Inlet and Carpenter Bay were reported but were not surveyed. General sense is the majority ($> 90\%$) of the HG spawn was surveyed.
- FSC harvest hast not been reported however anecdotal reports indicated that kelp quality was poor this year and FSC harvests were negligible.

- Spawns from Skidegate Inlet are monitored by HFP and have not been reported to HG Resource Manager.

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 Haida Gwaii major 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 Haida Gwaii major stock assessment region (SAR).

Year	Harvest (lb)	Spawning biomass (t)
2006	0	0
2007	0	0
2008	0	0
2009	0	0
2010	0	0
2011	0	0
2012	0	0
2013	0	0
2014	0	0
2015	0	0
2016	0	0

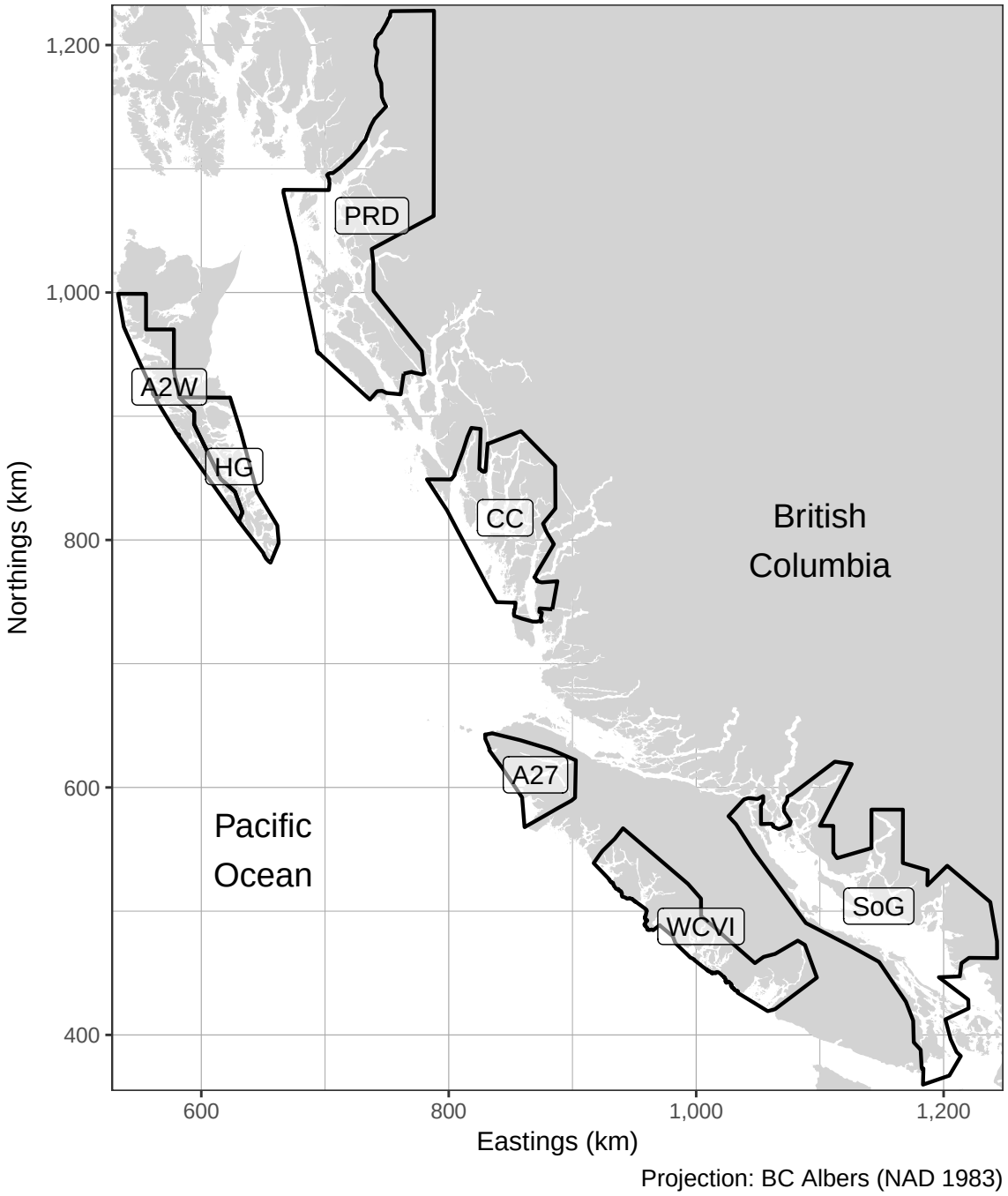

Figure 1. Boundaries for the Pacific herring stock assessment regions (SARs) in British Columbia: there are 5 major SARs (HG, PRD, CC, SoG, and WCVI), and 2 minor SARs (A27 and A2W). Units: kilometres (km). Also see Table 1.

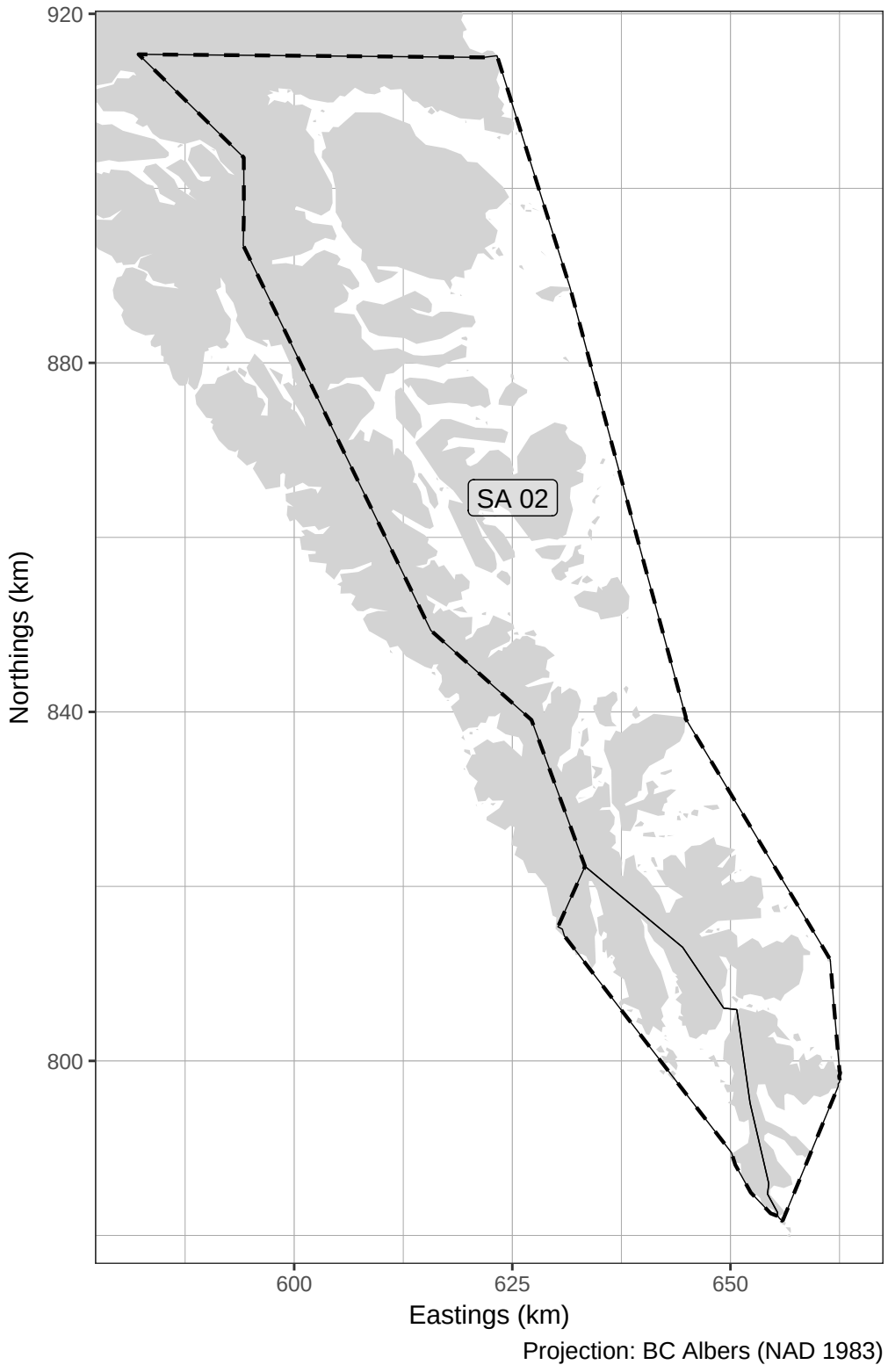

Figure 2. Boundaries for the Haida Gwaii major stock assessment region (SAR; thick dashed lines), and associated Statistical Areas (SA; thin solid lines). Units: kilometres (km).

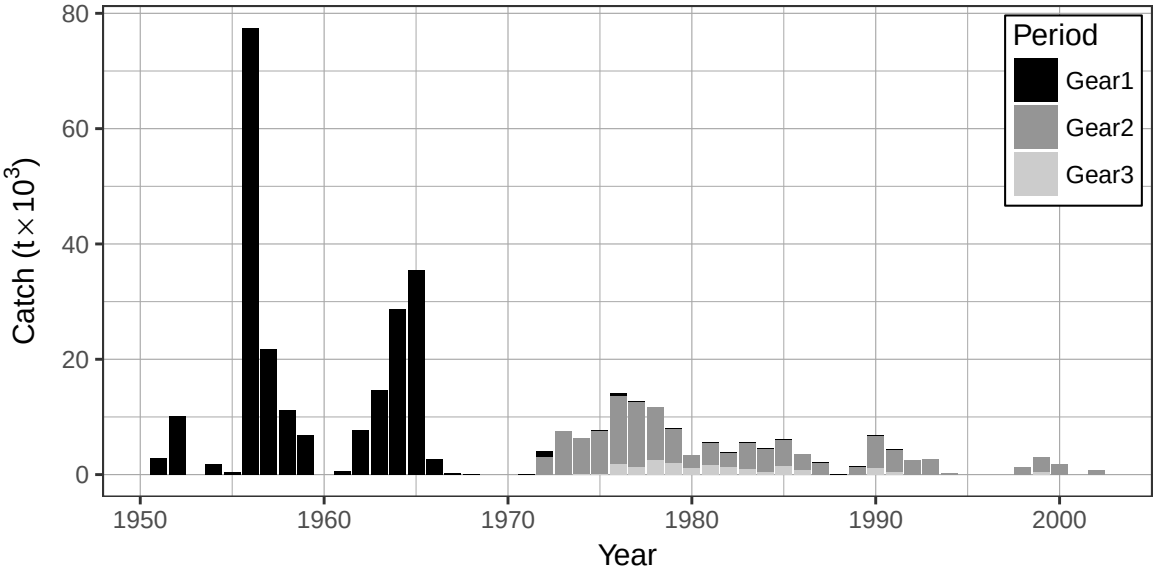

Figure 3. Time series of total landed catch in thousands of metric tonnes ($t \times 10^3$) of Pacific herring by gear type from 1951 to 2016 in the Haida Gwaii major stock assessment region (SAR). Legend: 'Gear1' represents the reduction, the food and bait, as well as the special use fishery; 'Gear2' 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 Haida Gwaii major stock assessment region (SAR). Each sample is approximately 100 fish.

	Number of samples		
Year	Commercial	Test	Total
2006	0	9	9
2007	0	6	6
2008	1	9	10
2009	0	12	12
2010	0	12	12
2011	0	13	13
2012	0	9	9
2013	0	12	12
2014	0	12	12
2015	0	11	11
2016	0	5	5

Table 5. Number and type of Pacific herring biological samples processed in 2016 in the Haida Gwaii major stock assessment region (SAR). Each sample is approximately 100 fish.

Type	Gear	Use	Number of samples
Test	Seine	Test Fishery	5

Table 6. Observed proportion-at-age for Pacific herring from 2006 to 2016 in the Haida Gwaii major stock assessment region (SAR). The age-10 class is a 'plus group' which includes fish ages 10 and older.

	Proportion-at-age								
Year	2	3	4	5	6	7	8	9	10
2006	0.189	0.098	0.432	0.095	0.151	0.029	0.004	0.000	0.003
2007	0.011	0.452	0.143	0.209	0.059	0.103	0.022	0.002	0.000
2008	0.093	0.074	0.634	0.076	0.086	0.018	0.016	0.000	0.002
2009	0.001	0.643	0.076	0.221	0.020	0.029	0.004	0.005	0.001
2010	0.082	0.085	0.589	0.056	0.153	0.017	0.013	0.003	0.002
2011	0.018	0.442	0.076	0.314	0.055	0.085	0.008	0.003	0.000
2012	0.174	0.148	0.380	0.040	0.203	0.018	0.030	0.002	0.004
2013	0.000	0.677	0.125	0.128	0.019	0.041	0.005	0.004	0.000
2014	0.014	0.037	0.684	0.115	0.094	0.014	0.034	0.005	0.003
2015	0.034	0.218	0.055	0.519	0.059	0.079	0.018	0.014	0.004
2016	0.166	0.162	0.170	0.058	0.376	0.044	0.020	0.002	0.002

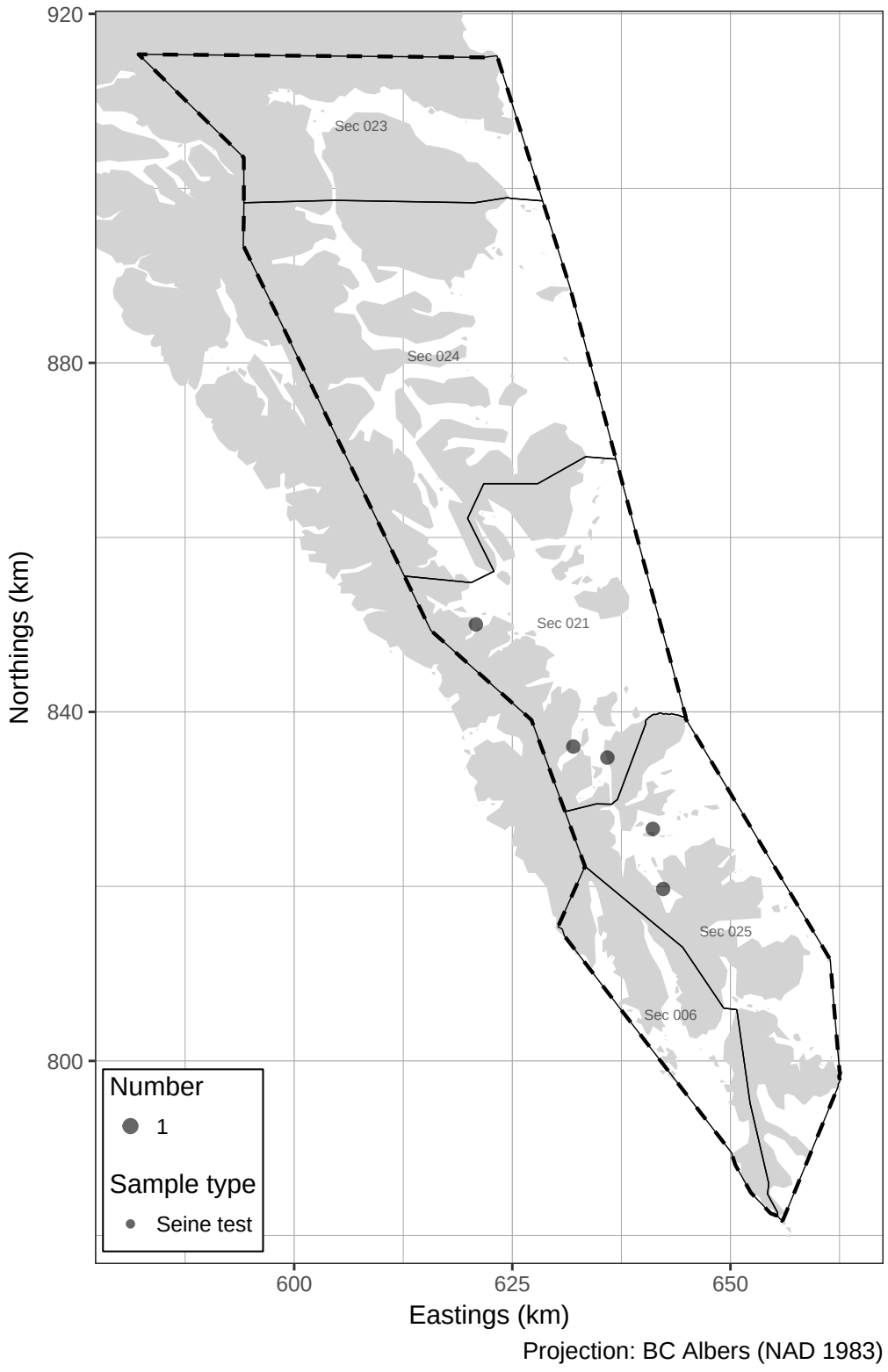

Figure 4. Location and type of Pacific herring biological samples collected in 2016 in the Haida Gwaii major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). Units: kilometres (km).

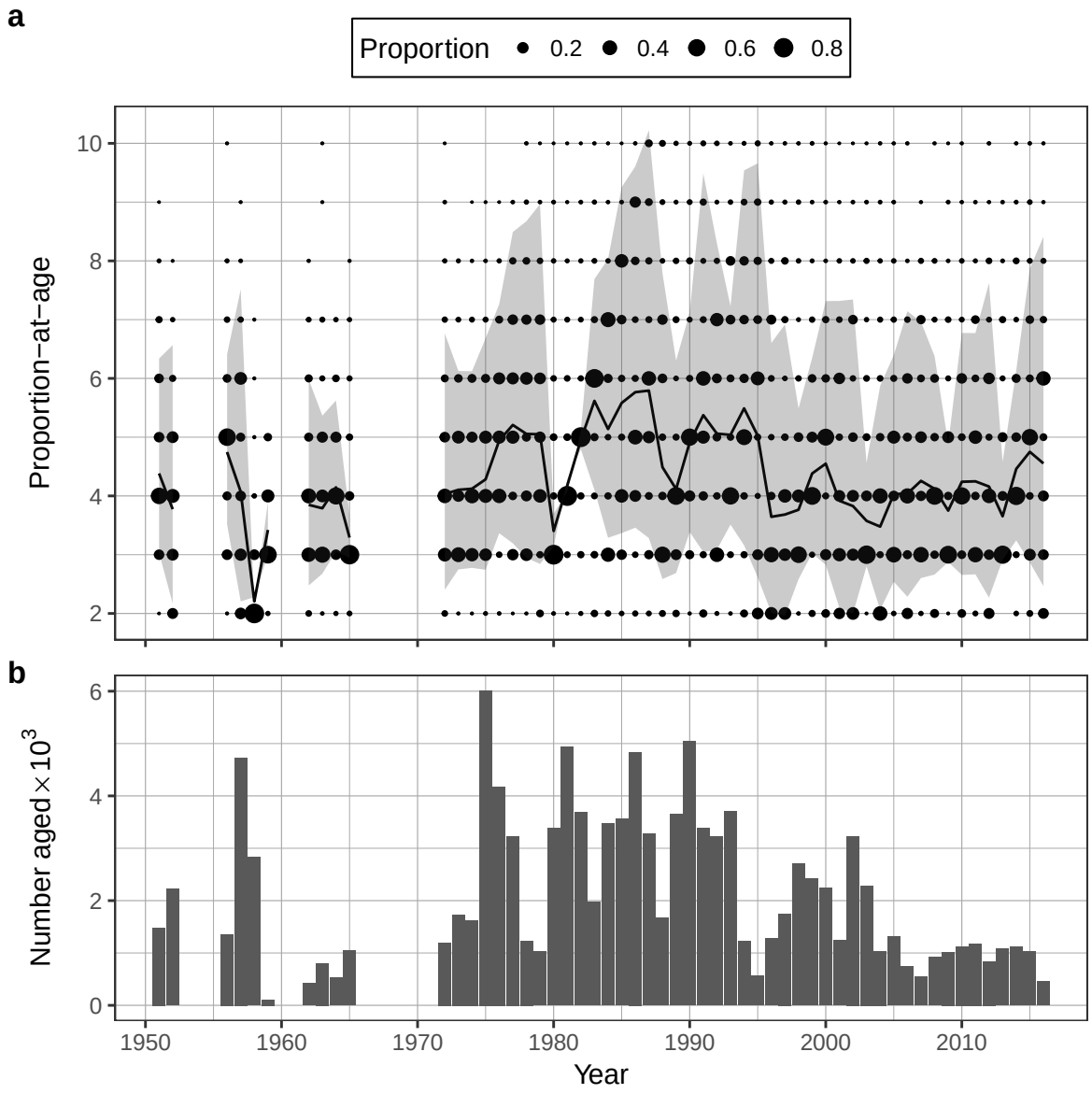

Figure 5. Time series of observed proportion-at-age (a) and number aged (b) of Pacific herring from 1951 to 2016 in the Haida Gwaii major stock assessment region (SAR). The black line is the mean age, and the shaded area is the approximate 90% distribution. Biological summaries only include samples collected using seine nets (commercial and test) due to size-selectivity of other gear types such as gillnet. The age-10 class is a 'plus group' which includes fish ages 10 and older.

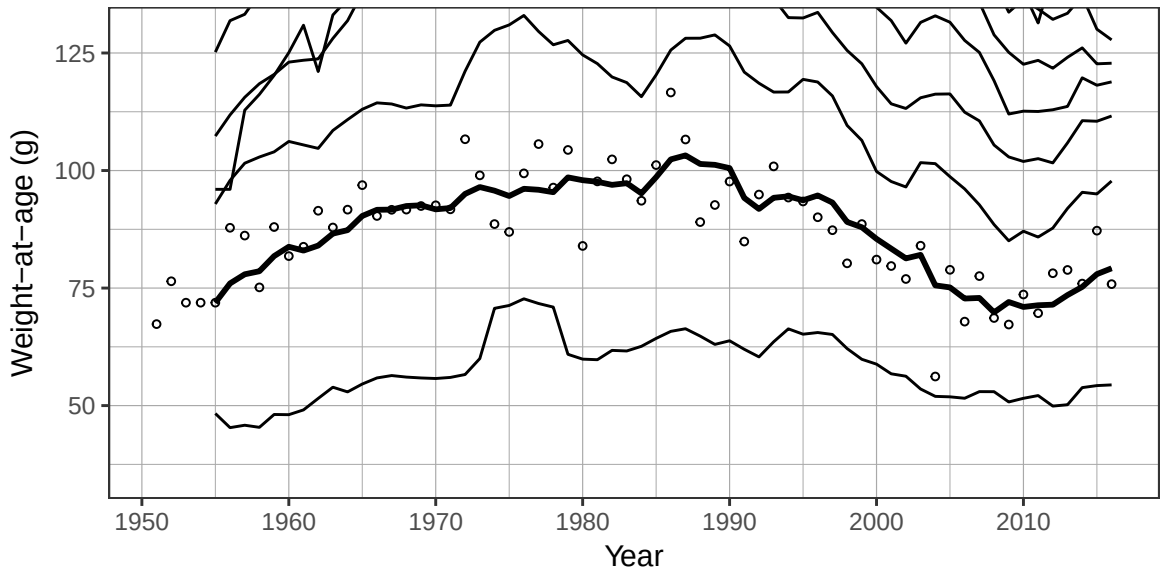

Figure 6. Time series of weight-at-age in grams (g) for age-3 (circles) and 5-year running mean weight-at-age (lines) for Pacific herring from 1951 to 2016 in the Haida Gwaii major stock assessment region (SAR). Lines show 5-year running means for age-2 to age-10 herring (incrementing higher from the 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 Haida Gwaii 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 (i.e., NA) indicate incomplete spawn surveys.

Statistical Area	Section	Location code	Location name	Spawn index (t)
02	021	143	Sedgwick Bay	0
02	021	184	Skaat Hrbr	2
02	021	1425	Wanderer Is	76
02	021	1552	Scudder Pt	869
02	021	1553	Alder Is	11
02	021	1738	Alder Is Cr	131
02	021	1958	Newberry Cv	34
02	024	1739	Kilmington Pt	266
02	024	1897	Alfred Pt	97
02	025	185	Harriet Hrbr	945
02	025	1538	Swan Bay	12
02	025	1606	Poole Inlt	718
02	025	1648	Francis Bay	633
02	025	1714	Rebecca Pt	2,524
02	025	1859	Scudder Cr	372
02	025	1899	Deluge Pt	20
02	025	2025	Unknown Sec 025	175

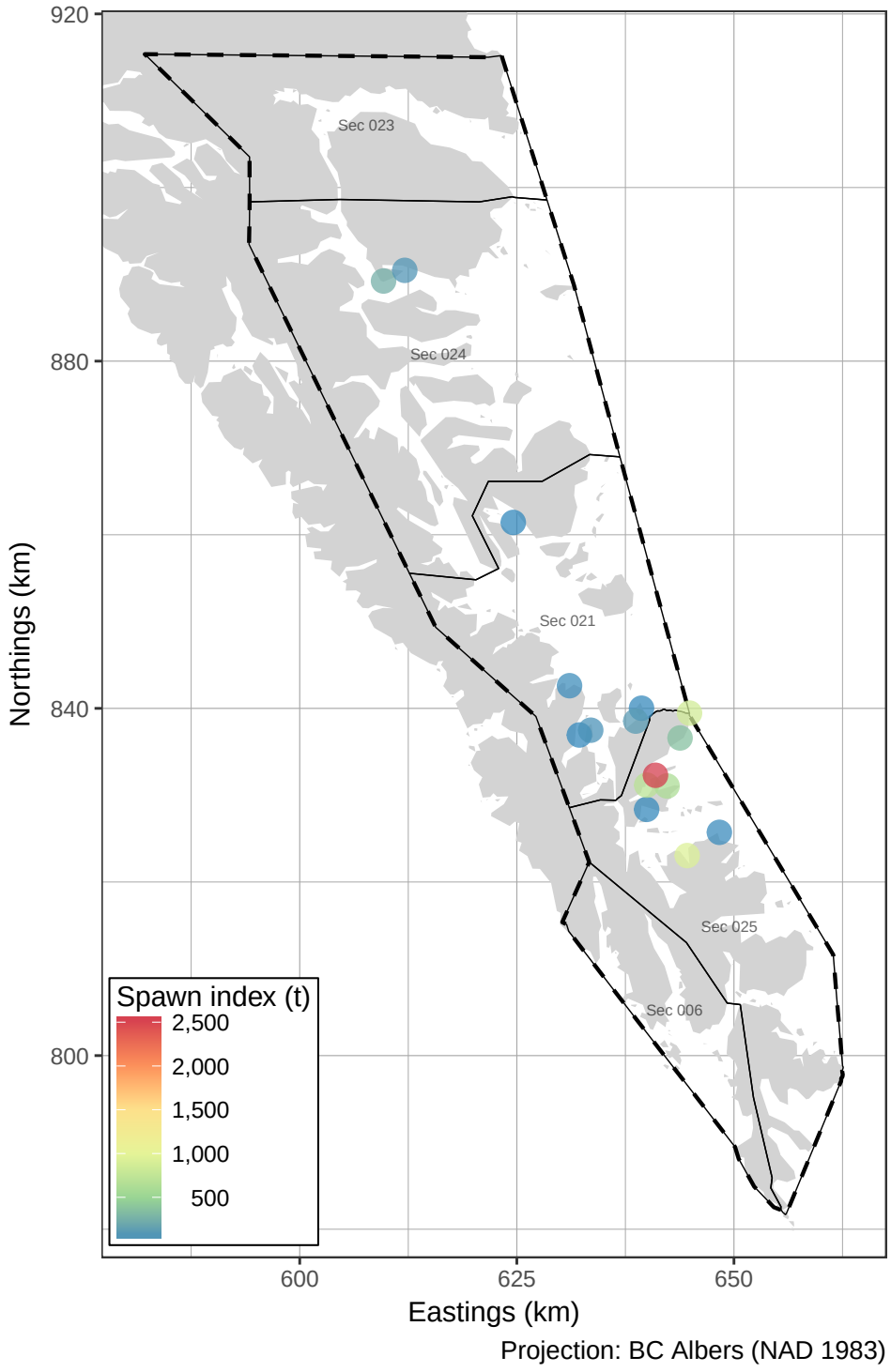

Figure 7. Location of Pacific herring spawning locations in 2016 in the Haida Gwaii major stock assessment region (SAR; thick dashed lines), and associated Sections (Sec; thin solid lines). The 'spawn index' represents the raw survey data only, and is not scaled by the spawn survey scaling parameter,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

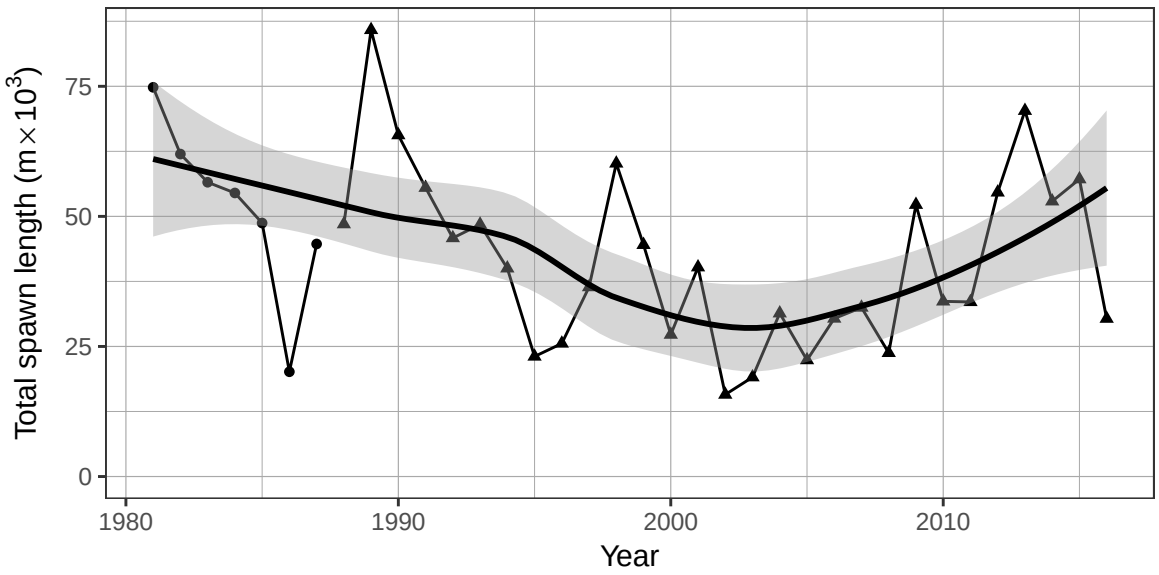

Figure 8. Time series of total spawn length in thousands of metres ($m \times 10^3$) for Pacific herring from 1981 to 2016 in the Haida Gwaii major stock assessment region (SAR). The thick black line is a loess curve, and the shaded area is the 90% confidence interval. The spawn index has two distinct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

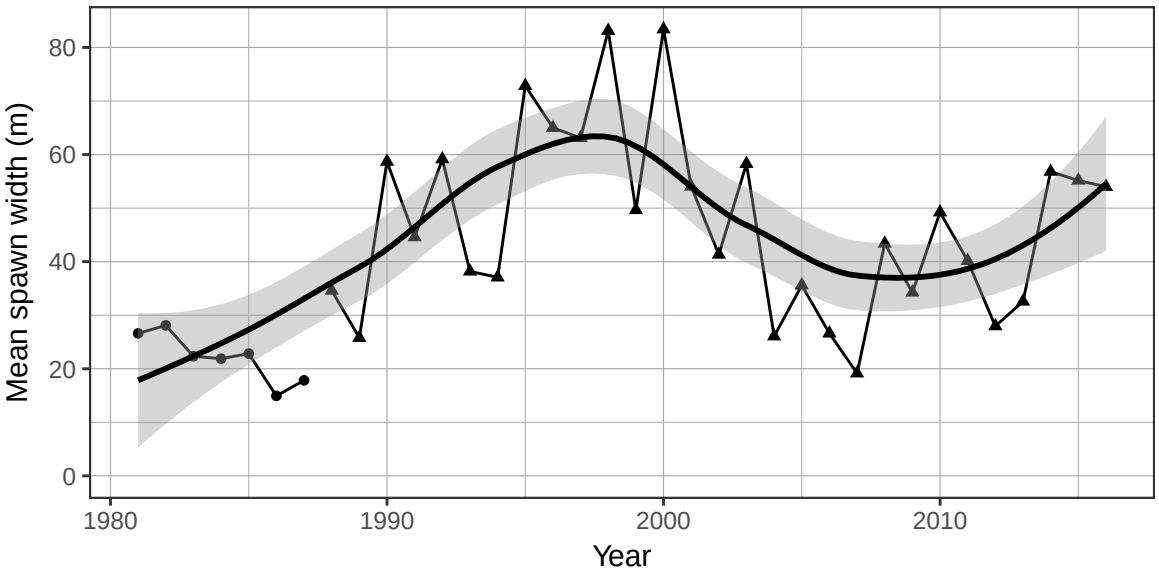

Figure 9. Time series of mean spawn width in metres (m) for Pacific herring from 1981 to 2016 in the Haida Gwaii major stock assessment region (SAR). The thick black line is a loess curve, and the shaded area is the 90% confidence interval. The spawn index has two distinct periods defined by the dominant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

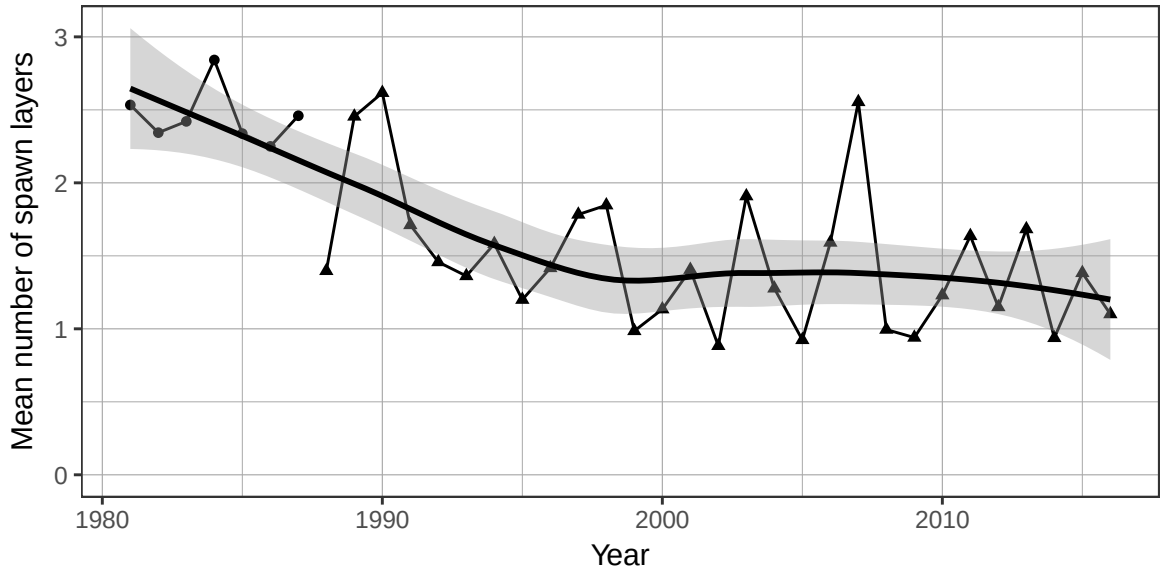

Figure 10. Time series of mean number of spawn layers for Pacific herring from 1981 to 2016 in the Haida Gwaii major stock assessment region (SAR). The thick black line is a loess curve, and the shaded area is the 90% confidence interval. The spawn index has two distinct periods defined by the dominant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

Table 8. Summary of spawn survey data from 2006 to 2016 in the Haida Gwaii major 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	30,370	27	1.591	4,097
2007	32,483	19	2.554	9,436
2008	23,770	43	0.995	4,213
2009	52,239	34	0.940	9,794
2010	33,670	49	1.230	6,845
2011	33,560	40	1.636	7,554
2012	54,610	28	1.149	9,720
2013	70,300	33	1.683	16,025
2014	52,900	57	0.938	10,566
2015	57,150	55	1.383	13,102
2016	30,345	54	1.101	6,888

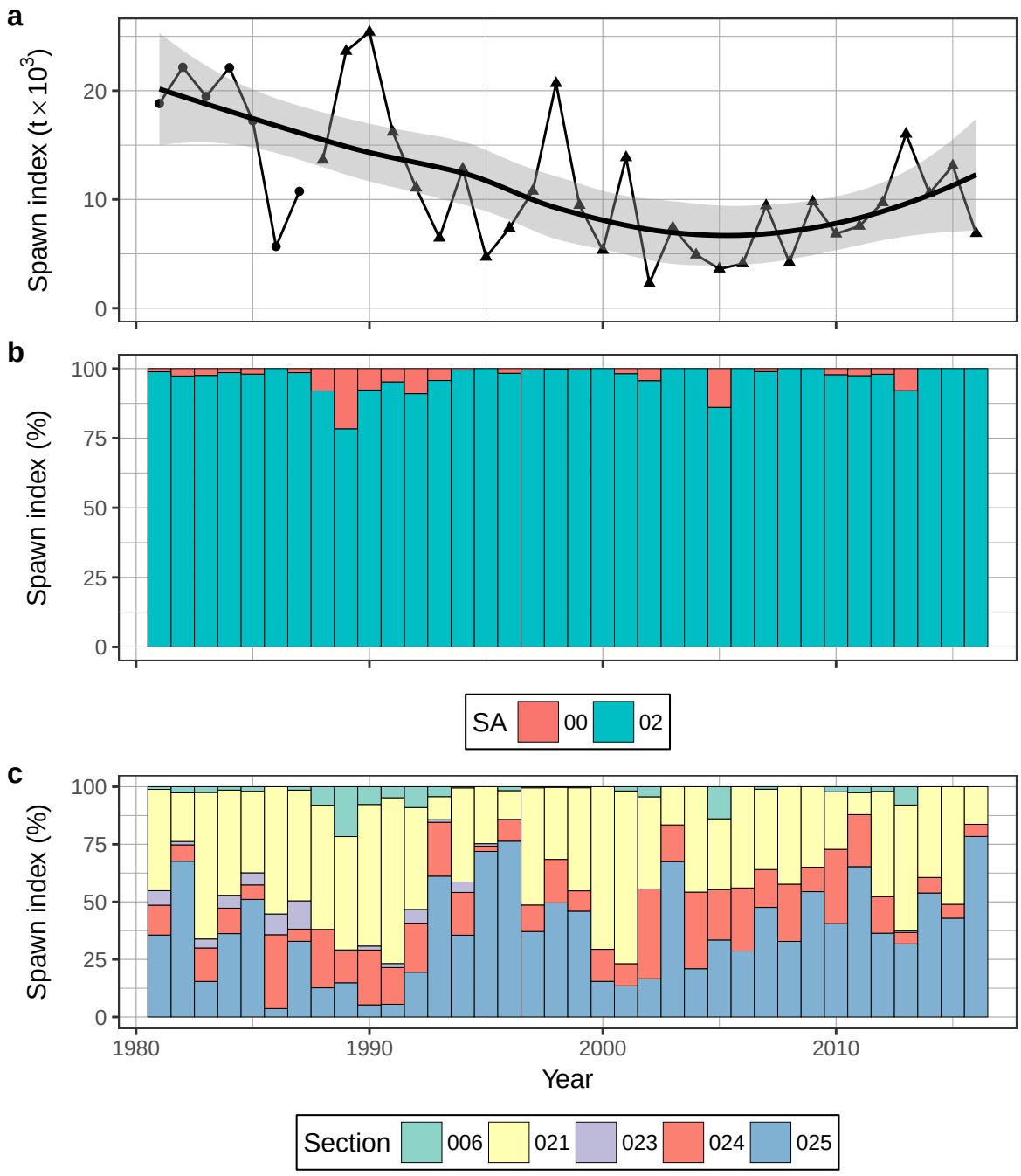

Figure 11. Time series of spawn index in thousands of metric tonnes (t $\times$ 10^3) for Pacific herring from 1981 to 2016 in the Haida Gwaii major stock assessment region (SAR; a), as well as percent contributed by Statistical Area (SA), and Section (b, & c, respectively). The thick black line is a 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.

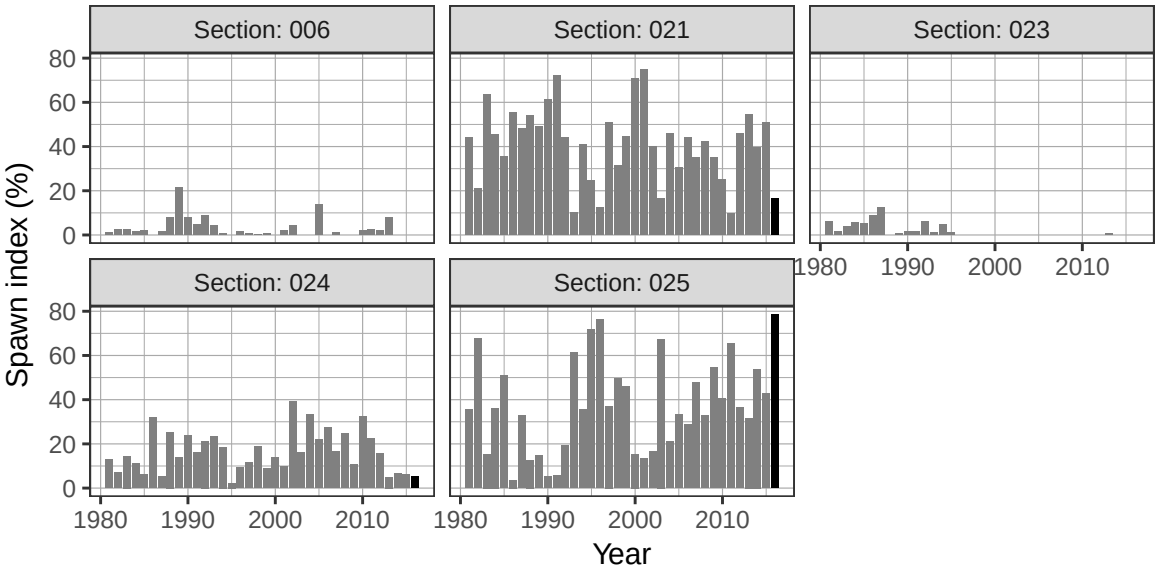

Figure 12. Time series of percent of spawn index by Section for Pacific herring from 1981 to 2016 in the Haida Gwaii major stock assessment region (SAR). The year 2016 has a darker bar to facilitate interpretation. The spawn index has two distinct periods defined by the dominant survey method: surface 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.

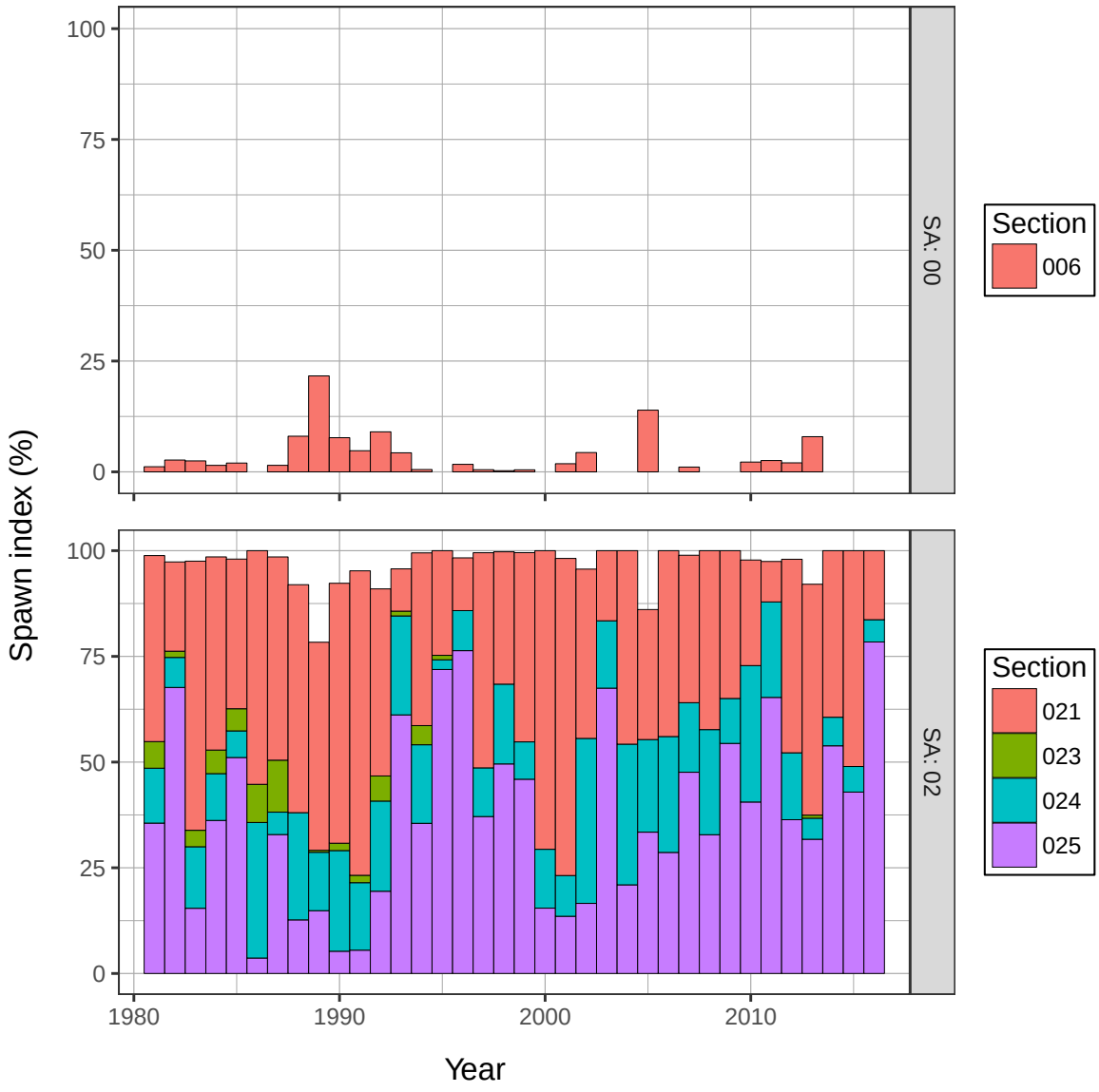

Figure 13. Time series of percent of spawn index by Statistical Area (SA) and Section for Pacific herring from 1981 to 2016 in the Haida Gwaii major stock assessment region (SAR). The spawn index has two distinct periods defined by the dominant survey method: surface surveys (1951–1987), and dive surveys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