Alaska plaice (*Pleuronectes quadrituberculatus*)*

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Biology

Alaska plaice (*Pleuronectes quadrituberculatus*) is a shallow-water flatfish generally found at depths less than 200 m. This species is easily identified by its yellow blind side, small mouth, and four prominent protuberances along the postocular ridge. In the eastern Pacific Ocean, Alaska plaice is found in the Chukchi Sea, Bering Sea, and northern Gulf of Alaska, predominantly on mixed sand and mud bottoms (Wolotira et al., 1993; McConnaughey and Smith, 2000).

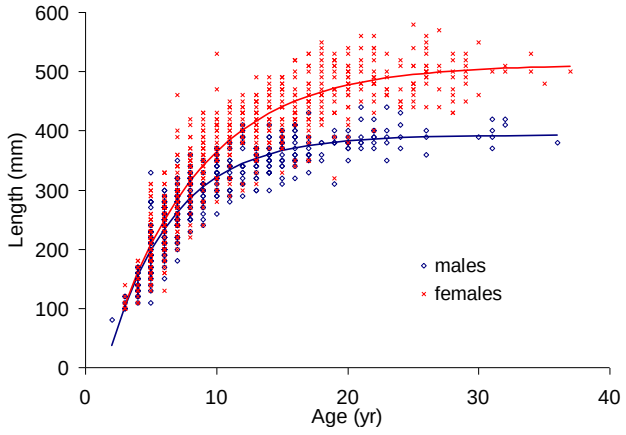

Figure 1
Length-at-age data fit with von Bertalanffy growth functions for male and female Alaska plaice collected from trawl surveys in the Bering Sea from 2005 through 2007.

This species is far more common in the eastern Bering Sea than the Gulf of Alaska, although its biomass appears to be increasing in the Gulf of Alaska (Turnock and Wilderbuer, 2007; Wilderbuer et al., 2007). Alaska plaice is not commercially targeted in Alaskan waters, and while it is caught incidentally in other groundfish fisheries it is seldom retained (Turnock and Wilderbuer, 2007; Wilderbuer et al., 2007).

Figure 2
Clear Alaska plaice otolith surface patterns. Age estimate is 5 years. Viewed with reflected light.

Alaska plaice produce pelagic eggs and larvae that are dependent upon oceanic currents for transport to suitable nursery habitat areas,

Table 1
Age and length estimates (minimum, maximum, and average), otolith preparation method (SU: surface; BB: break-and-burn), and precision estimates (Agree: percent agreement; CV: coefficient of variation; APE: average percent error) for Alaska plaice aged by the AFSC Age and Growth Program. Data shown by year collected.

		AGE (yr)			LENGTH (mm)			METHOD (%)		PRECISION (%)		
Year collected	*n*	Min	Max	Ave	Min	Max	Ave	SU	BB	Agree	CV	APE
2007	335	3	35	12	100	570	341	6	94	82	0.9	0.6
2006	446	3	33	12	100	870	334	9	91	63	3.7	2.6
2005	336	2	37	11	80	580	324	12	88	58	4.3	3.0
2002	537	4	36	14	120	610	357	4	96	72	2.3	1.6
2001	335	5	33	14	170	580	362	7	93	75	1.4	1.0
2000	518	4	34	15	170	580	355	3	97	62	2.4	1.7
1998	416	4	31	12	140	590	343	6	94	70	2.4	1.7
1995	285	5	28	14	200	520	365	0	100	44	4.4	3.1
1994	228	3	28	12	100	530	343	4	96	60	2.7	1.9
1993	183	5	33	13	190	520	340	0	100	47	4.4	3.1
1992	311	4	28	14	190	540	381	4	96	44	4.3	3.1

which are essential for recruitment success (Bailey et al., 2003). In the eastern Bering Sea, spawning occurs during the months of April through June over a wide area of the middle continental shelf (Zhang et al., 1998).

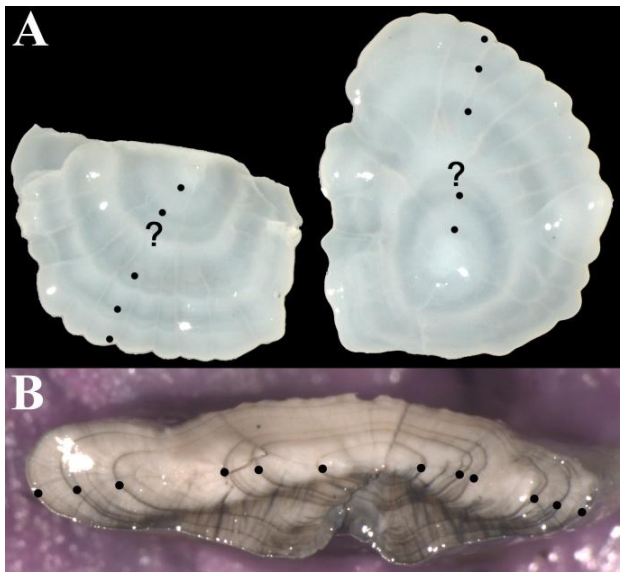

Figure 3
A) Otolith surface, and B) corresponding break-and-burn pattern from a 230 mm male Alaska plaice. Initial surface pattern age estimate is 5 years. However, the break-and-burn pattern is clearly 6 years. The third annual mark is close to the second annual mark and could be mistaken for a check in the surface pattern (indicated by question mark). Viewed with reflected light.

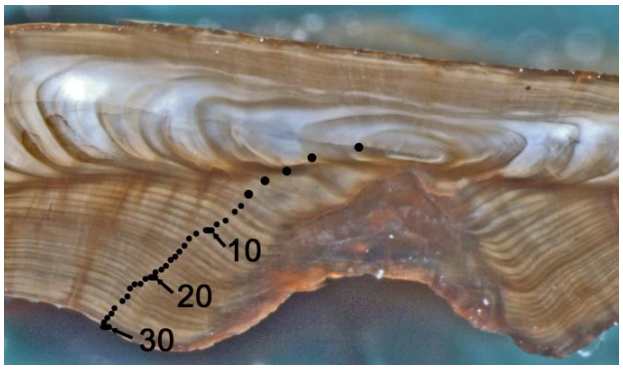

Figure 4
Clear Alaska plaice otolith break-and-burn pattern. Age estimate is 30 years. Viewed with reflected light.

In females, 50% maturity occurs at approximately 310 mm, corresponding roughly to 6 or 7 years of age (Zhang et al., 1998). According to Alaska Fisheries Science Center (AFSC) Age and Growth Program data, females grow slightly slower and to larger sizes than males (Fig. 1). Von Bertalanffy growth parameters were L_∞=392.05 mm, k=0.20/yr, and t_0=1.50 yr for males (*n*=440) and L_∞=503.49 mm, k=0.15/yr, and t_0=1.55 yr for females (*n*=677) collected from the Bering Sea from 2005 through 2007.

Age determination history

Over 4500 Alaska plaice otoliths have been aged by the AFSC Age and Growth Program since 1988.

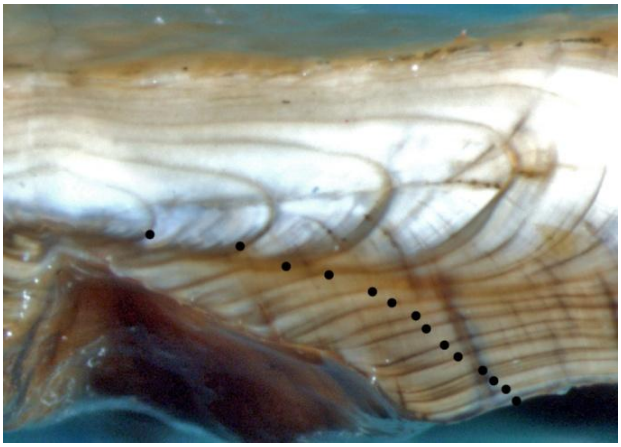

Figure 5
Alaska plaice otolith that was burned over an alcohol flame for a relatively long time, diminishing the appearance of pre-annular checks and producing high contrast between translucent and opaque growth zones. Age estimate is 14 years. Viewed with reflected light.

At the time of this writing, the oldest Alaska plaice aged at the AFSC was a 37-year-old female (Table 1). To date, nearly all specimens have been aged using the break-and-burn method, although a small percentage has been aged by examination of surface patterns (Table 1). Alaska plaice otoliths are relatively easy to interpret, and inter-reader agreement tends to be high (Table 1). Age estimates have not yet been validated for this species.

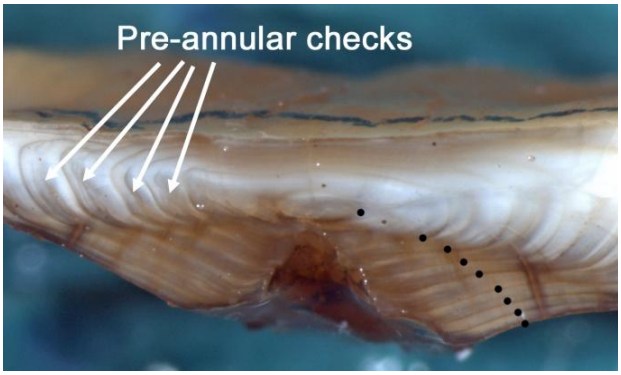

Figure 6
Alaska plaice otolith that was not sufficiently burned. Pre-annular checks are more difficult to distinguish from annual marks. Age estimate is 9 years. Viewed with reflected light.

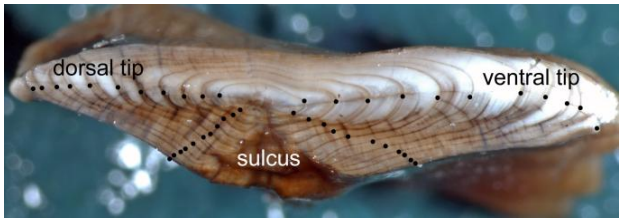

Figure 7
Clear Alaska plaice otolith break-and-burn pattern. Annual marks can be followed from dorsal and ventral tips to the sulcus. Age estimate is 11 years. Viewed with reflected light.

Current age determination methods

Alaska plaice is one of the easier species aged at the AFSC. In general, the otolith surface has a cloudy appearance; however, surface patterns may be used occasionally to determine age in young fish (Fig. 2). Even in young fish, seemingly clear surface patterns can sometimes be deceiving (Fig. 3). In these cases and for older fish, the break-and-burn method is more appropriate (Fig. 4). (Please see Goetz et al., 2012, for a more detailed description of standard AFSC otolith preparation methods.)

Figure 8
Alaska plaice otolith break-and-burn pattern in which the region adjacent to the sulcus is the clearest reading axis. Collected from a 400 mm female. Age estimate is 11 years. Viewed with reflected light.

Alaska plaice otoliths are relatively large and can shatter easily if not sectioned properly. If a scalpel is used for cross-sectioning, it is best to score the surface prior to cutting in order to obtain an even break. A low-speed saw may be used to section the otolith instead of a scalpel. While this method is more time-consuming, it produces a smooth surface ideal for identifying annual marks. Topography on the break-and-burn cross section can sometimes cause an age reader to mistake a "ridge" for an annual mark. On break-and-burn cross sections, translucent

growth zones are very thin and almost appear etched across the reading surface. Adjusting the angle of the fiber optic light source can make these zones stand out.

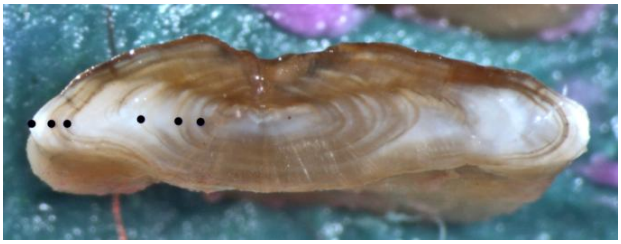

Figure 9
Alaska plaice otolith break-and-burn pattern with irregular spacing between annual marks. Collected from a 230 mm female. Age estimate is 6 years. Viewed with reflected light.

Adequate burning produces higher contrast between translucent and opaque growth zones (Fig. 5), although care should be taken to avoid over-burning otoliths. Pre-annular checks are very common and are especially prevalent in lightly burned otoliths (Fig. 6). Longer burn times can be used to distinguish between pre-annular checks and annual marks, as checks typically become very faint and annual marks extend all the way around the otolith (Fig. 7).

The first annual mark is usually the most difficult one to identify in Alaska plaice otoliths; therefore viewing the surface pattern together with the break-and-burn pattern can be helpful.

Figure 10
Fast-growing Alaska plaice otolith with relatively wide opaque growth zones. Collected from a 330 mm female. Age estimate is 6 years. Viewed with reflected light.

The preferred reading axes in break-and-burn cross sections are from the core to the dorsal and ventral tips. The areas adjacent to the sulcus may also be used as reading axes, although it is often more difficult to distinguish between checks and annual marks. However, in certain cases the areas around the sulcus are clearest (Fig. 8). This is especially true in older otoliths, in which the dorsal and ventral tip axes may be compressed and contain many checks.

Figure 11
Slow-growing Alaska plaice otolith with relatively narrow opaque growth zones. Collected from a 200 mm female. Age estimate is 7 years. Viewed with reflected light.

Irregular spacing of annual marks (Fig. 9) is encountered somewhat commonly in Alaska plaice otoliths, as are fast-growing (Fig. 10) and slow-growing (Fig. 11) growth patterns.

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