Great sculpin (*Myoxocephalus polyacanthocephalus*)

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Biology

The great sculpin (*Myoxocephalus polyacanthocephalus*), a member of the Cottidae family, is found over sand and mud bottoms in the North Pacific Ocean from the Washington coast to the Bering Sea at depths up to 240 m (Eschmeyer et al., 1983). There are currently no targeted fisheries for sculpins in Alaskan waters; however, they are often caught incidentally in trawl and longline fisheries, with *Myoxocephalus* species making up a large proportion of the total sculpin catch (Reuter et al., 2006; Reuter and TenBrink, 2007).

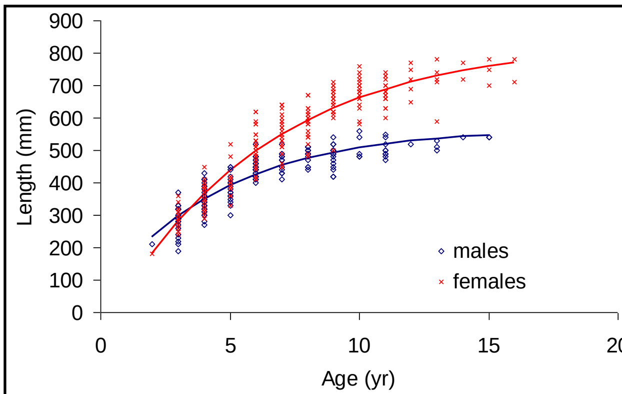

Figure 1
Length-at-age data fit with von Bertalanffy growth functions for male (n=169) and female (n=228) great sculpin collected from a Bering Sea trawl survey in 2005.

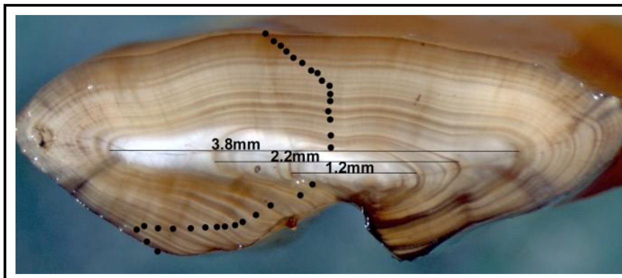

Figure 2
The oldest great sculpin otolith aged at the AFSC to date, collected from a 710 mm female. Age estimate is 16 years. Relatively clear growth pattern. Bars represent expected diameters of first, second, and third annual marks. Viewed with reflected light.

In the waters around Kamchatka, great sculpin spawning takes place in January and February on sandy and silty-sandy bottoms at depths of 120-210 m and water temperatures of 0.8-1.9°C (Tokranov, 1984). Absolute fecundity averages 185,000 (± 11,000) eggs in eastern Kamchatka waters and 225,000 (± 11,000) eggs in western Kamchatka waters; absolute fecundity depends primarily on weight and to a lesser extent on length and age (Tokranov, 1984). Kamchatka males begin to mature in their fifth year at lengths of 330-340 mm, with mass maturation taking place in the sixth year at lengths of 380-400 mm, while females begin to mature in their seventh year at lengths of 490-500 mm, with mass maturation taking place at

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 great sculpin aged by the AFSC Age and Growth Program.

		AGE (yr)			LENGTH (mm)			METHOD (%)		PRECISION (%)		
Year collected	*n*	Min	Max	Ave	Min	Max	Ave	SU	BB	Agree	CV	APE
2005	397	2	16	7	180	780	481	8	92	61	6.6	4.7

the age of 8 years, or lengths of 540-580 mm (Tokranov, 1984).

According to Alaska Fisheries Science Center (AFSC) Age and Growth Program data, male and female great sculpins exhibit significant growth differences, with females reaching much larger sizes than males (Fig. 1). Von Bertalanffy growth parameters for great sculpin collected during a Bering Sea trawl survey in 2005 were L_∞=567.79 mm, k=0.21/yr, and t_0=-0.46 yr (*n*=169) for males and L_∞=836.51 mm, k=0.16/yr, and t_0=0.51 yr (*n*=228) for females (Fig. 1).

Age determination history

The AFSC Age and Growth Program does not currently age great sculpins on a production basis. However, we have made a recent attempt to establish aging criteria and generate age estimates as part of a broader life history study of several large sculpin species. For this study, otoliths from 403 great sculpins were examined. An overall percent agreement of 61% (Table 1) and minimal bias between age readers indicates well-defined aging criteria for this species. At the time of this writing, the oldest specimen aged at the AFSC was a 16-year-old female (Fig. 2).

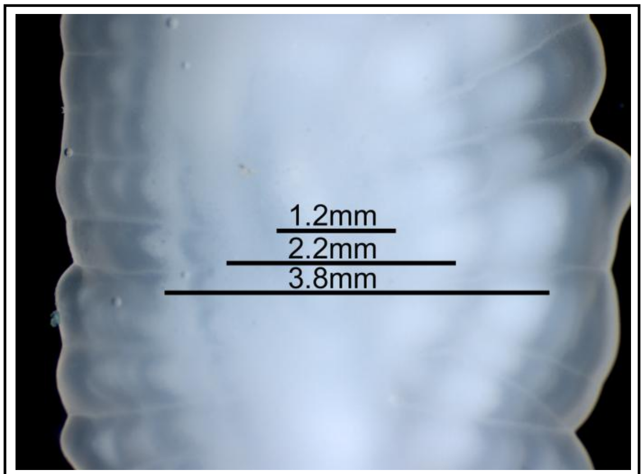

Figure 3
Measurements of the first three annual marks on the distal surface of a great sculpin otolith. Viewed with reflected light.

Current age determination methods

Surface examination

The first step in great sculpin age determination is to examine the whole otolith under 6× magnification using a dissecting microscope with reflected light from a fiber-optic light source. Typically, the distal surface is the preferred reading surface because the sulcus, located on the proximal surface, can obscure annual marks. On clear otoliths, age estimates of up to 4 years can be confidently assigned solely from examining the surface pattern.

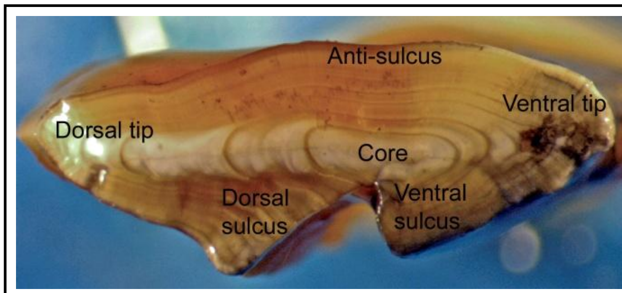

Figure 4
Reading axes of a burned great sculpin otolith cross section. Viewed with reflected light.

On otoliths with faint growth patterns, measurements help identify the first three annual marks. The average anterior-posterior length of an otolith from a 3-year-old fish is 7 mm. The dorsal-ventral width of the first annual mark is typically around 1.2 mm, and widths of the second and third annual marks are approximately 2.2 mm and 3.8 mm, respectively (Fig. 3). While some great sculpin otoliths can be aged solely from the surface pattern, most specimens must be aged using the break-and-burn method. (Please see Goetz et al., 2012 for a more detailed description of standard AFSC otolith preparation methods).

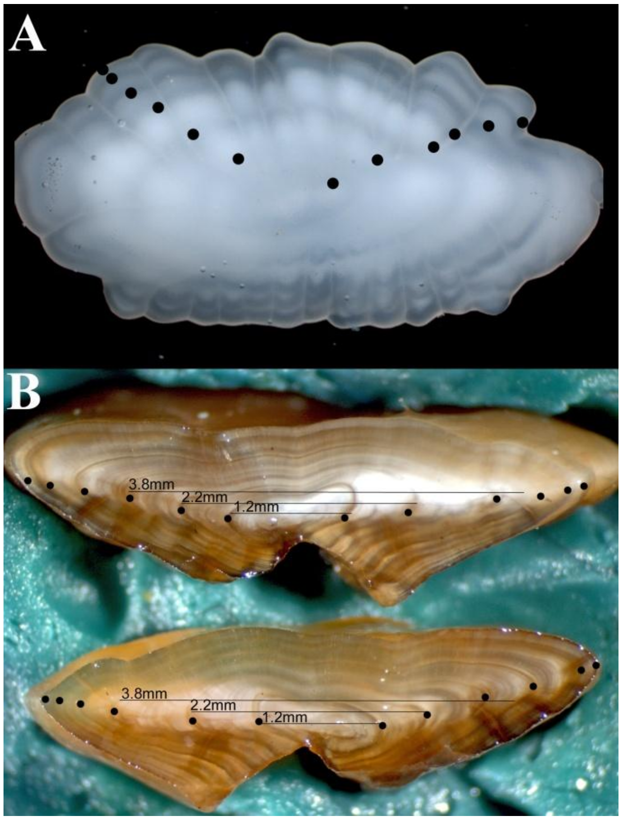

Figure 5
A) Clear great sculpin otolith surface pattern, and B) corresponding break-and-burn pattern. Pre-annular checks are evident along the dorsal sulcus of the break-and-burn pattern. Bars represent expected diameters of first, second, and third annual marks. Estimated age is 6 years. Viewed with reflected light.

Break-and-burn examination

Surfaces can indicate the approximate age of the fish, but the break-and-burn method generally results in greater contrast between translucent and opaque growth zones and in many cases reveals annual marks near the otolith margin that would not otherwise be visible.

The left sagittal otolith is usually selected for the break-and-burn method. The otolith is sectioned transversely through the core using a scalpel. Great sculpin otolith cross sections may be sanded to yield a smoother surface prior to burning. The otoliths of this species can crumble if burned too long. The otolith is examined with a dissecting microscope at magnifications ranging from 6–25×. The clearest patterns on great sculpin otolith cross sections are usually found from the core to the dorsal sulcus and from the ventral tip around the anti-sulcus to the dorsal tip (Fig. 4). Translucent growth zones that are complete concentric rings around the core are counted as annual marks.

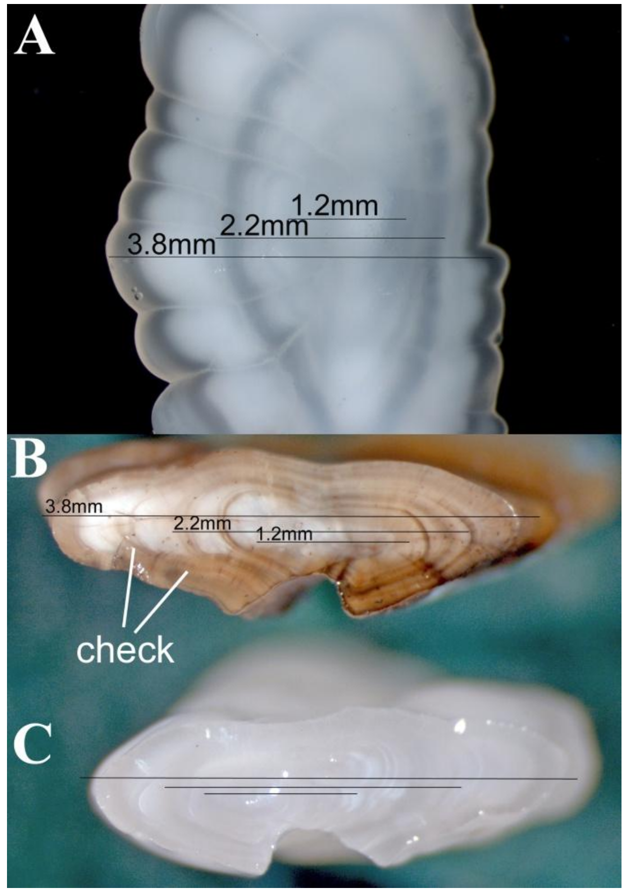

Figure 6
A) Great sculpin otolith surface pattern, and corresponding B) burned and C) unburned cross-section patterns. Surface pattern is clearly 3 years, while many checks are evident on the break-and-burn cross section. Measurements (bars) confirm age estimate of 3 years. Viewed with reflected light.

Great sculpin otoliths can be difficult to age because of checks, splitting, and pre-annular checks. For example, Figure 5 shows the surface and break-and-burn patterns of a 6-year-old specimen. The surface pattern is fairly clear but somewhat obscure along the otolith edge. The break-and-burn cross section has a check between the second and third annual marks, confirmed by measurements. Furthermore, pre-annular checks are present along the dorsal sulcus of the burn pattern. These checks are strong near the sulcus but cannot be followed throughout the otolith. Because of the confusion caused by pre-annular checks, the best way to estimate age for this specimen is using the dorsal and ventral tips or the anti-sulcus as reading axes and locating the early annual marks with measurements.

Figure 6 is another good example of how checks can complicate age determination. The surface pattern clearly is 3 years, but the break-and-burn pattern has checks that resemble annual marks. Measured distances on the break-and-burn cross section confirm that the otolith is indeed 3 years.

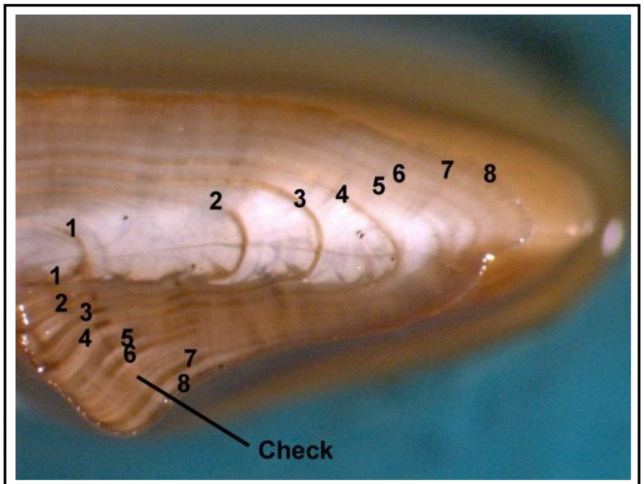

Figure 7
Great sculpin otolith break-and-burn pattern with a check between the sixth and seventh annual marks and some opaque growth on the margin. Age estimate is 8 years. Viewed with reflected light.

Figure 7 shows an otolith with a check near the sulcus between the sixth and seventh annual marks. Based on the growth pattern viewed along the tip, the otolith is clearly 8 years, but it appears to be 9 years reading down the sulcus. After careful examination, the translucent growth zone between the sixth and seventh annual marks is revealed to be a check because it cannot be followed throughout the otolith and it has a broader, weaker appearance.

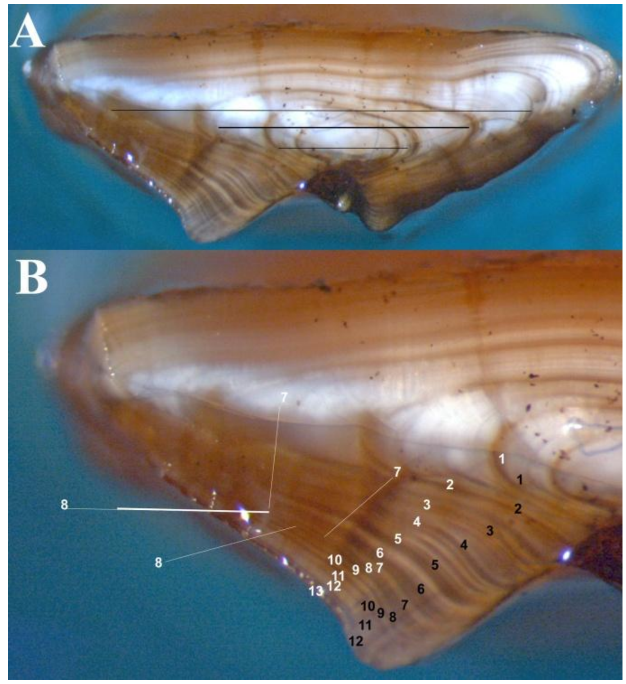

Figure 8
Difficult great sculpin otolith growth pattern with many checks. A) Measurements indicate the first three annual marks, represented by black bars. B) Two possible ways to estimate age. White numbering represents the final age estimate of 13 years, with the seventh and eighth annual marks counted separately because they could each be followed from the sulcus to the dorsal tip. Viewed with reflected light.

Figure 2 shows an old specimen with a fairly clear pattern that still can be difficult to age. There are some checks and shadows within the first few annual marks. Measurements help identify the first three annual marks. There is a pre-annular check inside the third annual mark which is not considered a separate annual mark because of the spacing of the first 3 years. Additional pre-annular checks are present within the fourth and fifth annual marks. There appears to be a transition zone at the fifth annual mark, after which every translucent growth zone is counted as an annual mark. The estimated age for this otolith was 16 years.

Some great sculpin otolith patterns can have many checks, as observed in Figure 8. Measurements confirm the first three annual marks, indicating splitting has occurred within the first year. Numerous checks are found between the third and fifth annual marks along the dorsal sulcus and are not considered annual marks because of the relative intensity of the true annual marks, especially at the sulcus edge. The seventh and eighth translucent growth zones could be considered a single annual mark with doubling. However, both of these growth zones can be traced from the dorsal tip to the sulcus and therefore are separate annual marks.

Otolith edge interpretation

To properly characterize edge type, edge growth needs to be examined from samples collected at various intervals throughout the year. To date, great sculpin otolith collections have been limited to early June through early July. Most otoliths collected in early to mid-June had either a fully formed opaque growth zone or a new translucent growth zone starting to form on the margin. Most specimens collected in late June or early July had a narrow opaque growth zone present on the margin. Therefore, we assume that translucent growth zone formation takes place in mid-to-late June.

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