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Maximum age of New Zealand sole (*Peltorhamphus novaezeelandiae*) from the west coast South Island

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Final Research Report

Report title:	Maximum age of New Zealand sole (*Peltorhamphus novaezeelandiae*) from the west coast South Island.
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7. Executive summary:

Large New Zealand sole collected from the west coast of South Island were aged by counting opaque growth zones in whole and sectioned otoliths.

Zones counts from whole otoliths were poor indicators of age compared with counts from thin otolith sections. Agreement between thin section zone counts made by the same reader was good, but agreement was lower between readers. This is thought to be at least partially due to the difficulties associated with ageing this sample and the relative inexperience of one reader.

The maximum observed age was 7 years. However, the largest fish measured in the sample was 50 cm total length (TL) and they are reported to grow to 55 cm TL. The sample size was small, increment resolution was poor, zone interpretation difficult, and true longevity may be greater than we observed. Using a maximum observed age of 7 years, a natural mortality rate of 0.60 was estimated. For a maximum age of 10 years, the estimated value of M would be 0.42.

8 Objectives:

To determine the maximum age of New Zealand sole.

9. Introduction:

New Zealand sole (*Peltorhamphus novaezeelandiae*) are managed in the New Zealand Quota Management System in a species complex that includes six other flatfish species: yellow-belly flounder, *Rhombosolea leporina;* sand flounder, *R. plebeia;* black flounder, *R. retiaria;* greenback flounder, *R. tapirina;* lemon sole, *Pelotretis flavilatus;* brill, *C. guntheri;* and turbot, *C. nudipinnis*.

Historically, most flatfish ageing in New Zealand has focused on two species: the sand flounder, and the yellow-belly flounder, which are fast growing and generally only live for 3–4 years (Colman 1974; Kirk 1988). These studies led to the widely held belief that all New Zealand's commercial flatfish species were fast growing and short lived. However, recent work on New Zealand brill and turbot under project FLA2000/01 observed maximum ages of 21 and 16 years respectively (Stevens et al. 2001). The next species to be selected for study is the New Zealand sole.

Previous studies of age and growth in New Zealand sole have reported fast growth rates and relatively low maximum ages (James, 1969). Finlay (in James 1969) aged a small number of New Zealand soles in the 1920's. He found that while the scales were difficult, if not impossible to read, the otoliths proved more satisfactory; 16 fish from 25 to 48 cm total length (TL) were aged as 2½ to 4 years old. These results agree well with those of James (1969), who estimated the age of 290 New Zealand soles (greater than 18 cm TL) from whole otoliths and observed a maximum age of 6+. He also attempted to age a further 372 otoliths from smaller (6 to 21 cm) fish but the first opaque zone was extremely variable and the ageing technique was unsuccessful. This is likely to have been at least partially due to the presence of two cryptic, dwarf *Peltorhamphus* species in the sample (the slender sole, *P. tenuis*, and the speckled sole, *P. latus*) (G. James, pers. comm.). James also achieved increment validation by recording the state of the otolith margin (i.e. opaque or translucent) over a 12–month period. However, the otoliths of large New Zealand sole are thick, dense, and opaque, making whole otolith readings difficult. James found that 7.6% of otoliths were unreadable and there is some doubt as to whether whole otolith readings are a suitable indicator of age in large fish, particularly given the discrepancy between whole and sectioned turbot and brill otoliths (Stevens et al. 2001).

The purpose of this study was to estimate the maximum age of New Zealand sole from the west coast of the South Island, and determine whether whole otolith readings are an accurate indicator of age.

10. Methods:

Otoliths were removed from 50 large NZ sole (49 females and 1 male) collected from Talley's Ltd fish processing sheds in Greymouth on the 15th of October 2003. Females measured 44 – 50 cm TL and the single male was 45 cm TL.

Otoliths were examined whole and as thin transverse sections. Whole otoliths were immersed in water in a petri dish and read with transmitted light under a binocular microscope (x20). Polarised light filters were used to enhance zone clarity. A pattern of wide, white translucent and thin, dark opaque zones was visible in some otoliths.

Thin otolith transverse sections were obtained following the methodology of Stevens & Kalish (1998). They were read with transmitted white light under a compound microscope (x40). A pattern of clear (translucent) and dark (opaque) zones was visible.

Each otolith count was given a readability score from 1 to 5, where 1 was considered to be 100% reliable and 5 was considered to be unreadable. All grade 5 readings were omitted from further consideration.

To assess the level of within-reader variability, each thin section was read twice by an experienced reader (Reader 1), two months apart. To assess the level of between-reader variation, each section was also read by a less-experienced reader (Reader 2).

The final age assigned to each fish was an agreed age developed by Reader 1, by checking any discrepancies between his first and second readings. No adjustment was made for period of time elapsed since the hypothetical birthday (1 October; James, 1969) as the capture date (15 October) was very close to the hypothetical birthday.

An estimate of the natural mortality coefficient, *M*, was obtained using Hoenig's (1983) regression equation describing the relationship between mortality rate and life span:

$$\log_e M = 1.46 - 1.01[\log_e(t_{max})]$$

where t_{max} is the maximum age reached by the species in an unexploited population.

11. Results:

Whole New Zealand sole otoliths are very thick, opaque, and dense compared with those from other flounders (e.g. *Rhombosolea* spp.), which are usually read whole (e.g. Mundy 1968, Colman 1974). The sulcus is shallow, and barely penetrates the proximal surface reducing light penetration. Even with high levels of transmitted light, opaque zones were difficult to resolve in this study (Figure 1).

Thin otolith sections were a noticeable improvement on whole otolith readings, although age estimation was still difficult. The dark (opaque) zones were narrow, often split or poorly defined, and the contrast with the light (translucent) zones was poor.

Of the 43 otoliths that were read whole and as thin sections by Reader 1 (first reading), 46.5% of readings were identical, 79.1% were within one year, and 90.7% were within two years (Figure 2). Whole otolith readings were often substantially lower than thin section readings.

Of the 30 thin sections that were read by both readers, 26.7% of readings were identical, 73.3% were within one year, and 86.7% were within two years of each other (Figure 3a). There was poor within-reader agreement. Reader 1 often aged New Zealand sole older than did Reader 2 (Figure 3a).

Of the 45 thin sections that were read twice by Reader 1, 73.3% of readings were identical, 97.8% were within one year, and all readings were within two years of each other (Figure 3b). Within-reader agreement was high, with no apparent bias (Figure 3b).

The single male New Zealand sole was aged by Reader 1 as 8 and 9 years old on the first two readings (Figure 4). When this specimen was re-examined an age of 7 years was thought to be a more accurate estimate. However given the difficulty in ageing this specimen the true age may be older.

The oldest female was also aged as 7 years old. However zone resolution was poor and interpretation difficult, and longevity may be higher. Using a maximum observed age of 7 years, a natural mortality rate of 0.60 was estimated. For a maximum age of 10 years, the estimated value of *M* would be 0.42.

12. Conclusions:

Whole New Zealand sole otolith readings were lower compared with counts obtained from thin section readings, but ageing precision for both methods was poor. The correlation between the two readings of thin sections by Reader 1 was high with no apparent ageing bias. The correlation between readers was relatively poor. This is likely to be at least partly due to the difficulties with zone interpretation in this species and the relative inexperience of Reader 2 with thin sections.

New Zealand sole are a relatively short lived New Zealand flatfish species, with a maximum observed age of 7 years. However, the largest fish measured in the sample was 50 cm TL and they are reported to grow to 55 cm TL (Paul 2000). The sample size was small, increment resolution was poor, zone interpretation difficult, and true longevity may be greater than we observed. For maximum ages of 7 and 10 years, the estimated values of *M* would be 0.60 and 0.42 respectively.

Interestingly a small sample of New Zealand sole otoliths from the east coast South Island was thin sectioned prior to this study and they were significantly easier to age than west coast fish (Figures 4 & 5). The contrast between zones and increment resolution were much higher in east coast fish and they could be aged with confidence. Increment resolution has been shown to vary between areas in other species, e.g. Cook Strait ling (*Genypterus blacodes*) otoliths are significantly harder to age than those from other New Zealand areas (P. Horn, pers. comm.). For a true estimate of longevity in New Zealand sole, we recommend a similar study should be conducted on east coast South Island fish.

13. Acknowledgements

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14. Publications:

Nil.

15. Data storage:

The age and growth data have been stored on the Ministry of Fisheries database *age* (maintained by NIWA).

16. References

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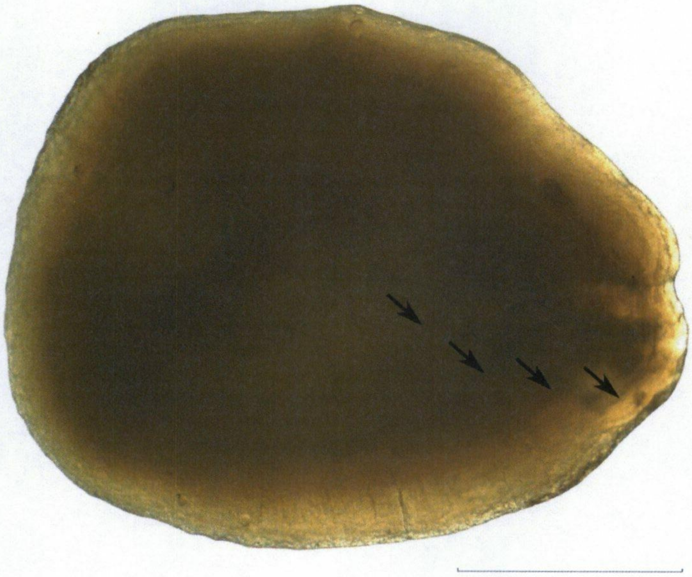

Figure 1: **Whole otolith from a 40 cm TL female West coast South Island New Zealand sole viewed under transmitted polarised light. Arrows indicate possible growth zones. Scale bar represents 1 mm.**

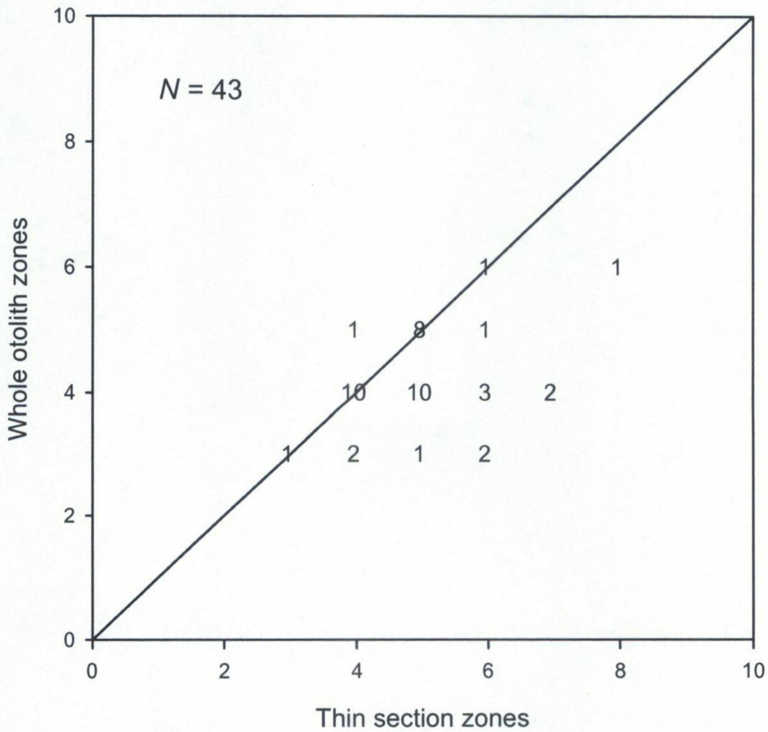

Figure 2: Comparison of whole otolith and thin section readings made by Reader 1. Numbers represent actual numbers of fish counted. Diagonal line indicates the expected relationship. *N*, total sample size.

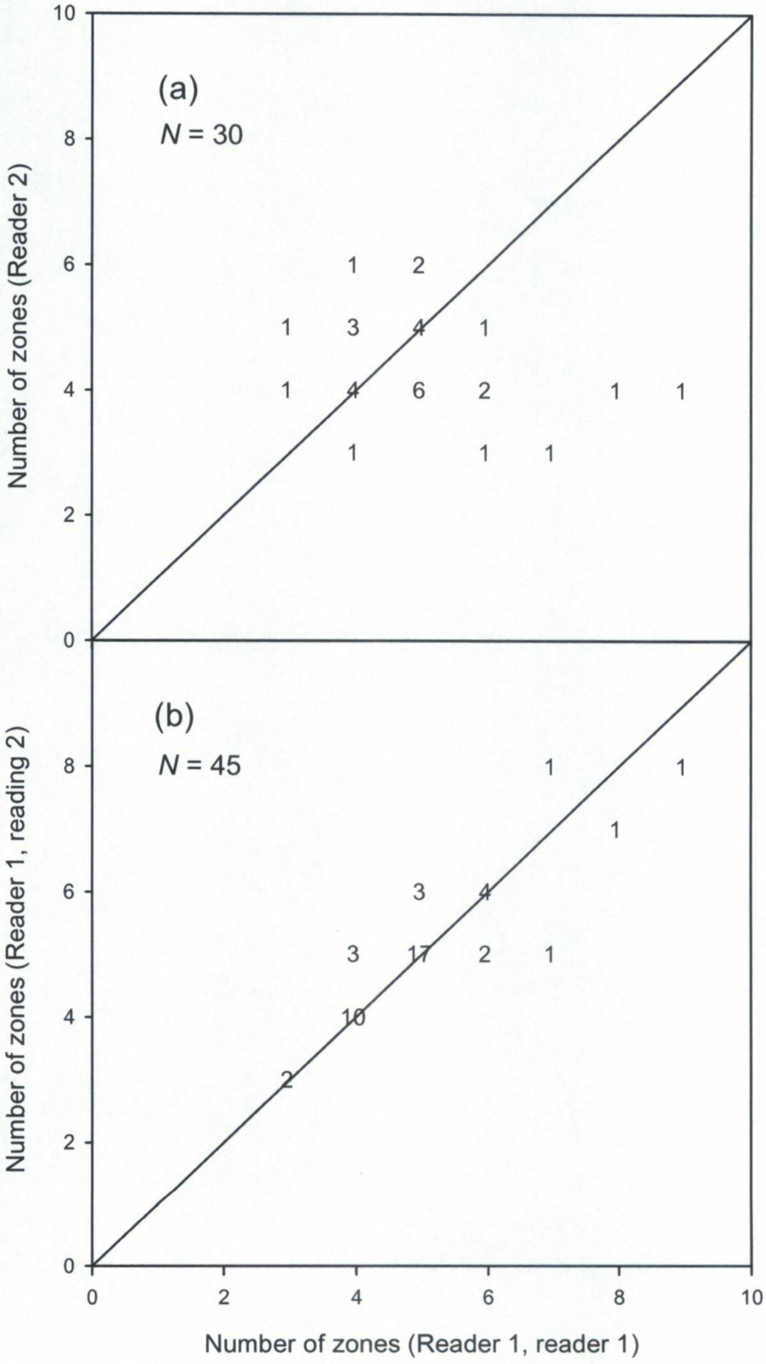

Figure 3: Comparison of otolith thin section readings between (a) Reader 1 and Reader 2, and (b) the two readings made by Reader 1. Numbers represent actual numbers of fish counted. Diagonal lines indicate the expected relationship. *N*, total sample size.

Figure 4: Otolith thin sections from (top) a 451 mm TL female west coast South Island New Zealand sole aged as 4 years old, and (bottom) a 446 mm TL male west coast South Island New Zealand sole aged 7 years old. Arrows indicate the growth zones counted in this study. Scale bar represents 1 mm.

Figure 5: Otolith thin section from a 352 mm TL female east coast South Island New Zealand sole aged as 3 years old. Arrows indicate growth zones. Scale bar represents 1 mm.