Age determination of oreo dory species by radiometric analysis

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1. Non-technical Summary

Black Allocyttus niger, smooth Pseudocyttus maculatus ,and spiky oreo Neocyttus rhomboidalis, are caught commercially in southern Australian waters. Given the increase in catch rates in recent years biological information is needed to ensure appropriate management of the fishery. Estimates of the age and growth of these species are therefore required.

Fish age is usually determined by counting rings present on their scales or otoliths. However, it is necessary to independently check the accuracy of ages based on ring counts since the frequency of ring formation is not usually known and therefore needs to be determined.

Radiometric ageing is an ideal method to check fish age since it is based on physical laws of radioactive decay. Probably the most familiar radioactive dating method is carbon-dating, using ^{14}C. Radioactive isotopes decay at known rates and therefore set a time scale. The isotopes used here are ^{210}Pb and ^{226}Ra since they have the biologically useful time scale for ageing from 0 to greater than 100 years.

Age for all three oreo species have been estimated radiometrically with the oldest black oreos analysed about 100 years old, the oldest smooth oreos around 40-45 years, and the oldest spiky oreos over 100 years. Age at maturity has also been estimated at above 60 years for black oreos and approximately 30 years for smooth and 20 years for spiky oreos. The radiometric age estimates are similar to those estimated from rings seen in otolith sections by Smith and Stewart (1994).

Therefore age estimates for all the oreo species are now available for management of the resource.

2. Background To Research Project

Four species of oreos (Family Oreosomatidae) are caught commercially in Australian waters black Allocyttus niger, smooth Pseudocyttus maculatus, spiky Neocyttus rhomboidalis and warty Allocyttus verrucosus. Fishing for oreos commenced as a by-catch of the orange roughy fishery but in recent years they have become an important part of the deepwater trawl fishery in south eastern Australia. Commercial fishing of oreo dory species has rapidly increased with landings of less than 100 tonnes prior to 1989 to in excess of 1000 tonnes in 1990 and 1500 t in 1991 (Lyle et. al. 1992). The catch in 1992 was in excess of 3000 t and over 1000 t were retained in 1993 and 1994 (Yearsley, 1996). To date commercial fishing of oreo species has predominantly taken place in the South East Fishery (SEF) and to a lesser degree in the Great Australian Bight Fishery and Western Deep Water Fishery. A combination of factors including restrictions on the orange roughy catch, followed by direct targeting of oreos together with greater market acceptability of oreos has resulted in increasing catches of oreos in Australia. Commercial fishing for smooth and black oreos is also important in New Zealand with approximately 19000 t caught each year (Yearsley, 1996).

Age determination is critical for the proper management of the developing oreo dory fishery. In particular an estimate of longevity, growth rates and the age at maturity are required. The most widely used methods of ageing fish include the modal analysis of size-frequency data and counting the growth rings present on structures such as scales, otoliths, vertebrae and shells. However oreo dory species have proven difficult to age by conventional methods. Davies *et al.* (1988), in a study of smooth and black dory otoliths, found that the growth rings present on, and inside their otoliths were not suitable for estimating age. Mel'nikov (1981) estimated age for the warty dory Allocyttus verrucosus using growth rings present on the scales (since these zones were more clearly defined than on the otoliths). The maximum age claimed was 15 years for females and 14 years for males although the bulk of the catch was composed of fish 6-9 years old but these ages were not validated. These age estimates of warty oreos have since been shown to be gross underestimates by Stewart et al., (1995) in a comparison between radiometric ages and otolith section ages.

The problem of ageing oreo has been simultaneously studied by Dr. David Smith (Central Ageing Facility, Victorian Fisheries Research Institute, Marine Science Laboratories, Queenscliff) as part of a research project funded by FRDC. The project conducted here using radionuclides to age the oreo species, was developed with direct consultation with Dr. David Smith.

The success of previous projects (FIRTA/FIRDC 87/94 and ARC SGS91-92) to develop and assess the potential of the radionuclide ageing technique for ageing fish prompted this oreo project. The radionuclide method has been successfully applied to orange roughy (Fenton *et al.*, 1991, Smith *et al.*, 1995), warty oreo (Stewart *et al.* 1995) and blue grenadier (Fenton and Short, 1995). Radiometric analysis of warty dory otoliths suggest this species is very long-lived >150 years (Stewart *et al.* 1995) similar to although possibly older than orange roughy (Fenton *et al.*, 1991; Smith et al., 1995). Our success with the radiometric method for ageing orange roughy and warty dory indicate the suitability of this approach to determine the oreo dory ages. Importantly our results offer a method of validating the section ages determined by Dr. David Smith's group at the Central Ageing Facility, Victoria. No other method is currently viable for validation of age for these deep-sea species. The aim of this project is to apply the radionuclide method developed in previous grants to estimate ages for smooth, spiky and black dory.

3. Objectives

To determine the age of spiky dory Neocyttus rhomboidalis, smooth dory Pseudocyttus maculatus and black dory Allocyttus sp. by radionuclide analysis using the naturally occurring radionuclides $^{210}Pb/^{226}Ra$.

4. Introductory Technical Information

1. Oreo Species Studied

Three species from the family Oreosomatidae have been studied in this project:
Black oreo Allocyttus niger ,

Smooth oreo Pseudocyttus maculatus and
Spiky oreo Neocyttus rhomboidalis.
Detailed taxonomic descriptions of these species are given in James *et al.* (1988) and a simplified version presented as part of an identification key in Yearsley, (1996).

Adult oreos live in deep water generally deeper than 600 m frequently below 1000 m where they are found close to the sea bed forming large shoals over rough ground near pinnacles and canyons. Immature fish tend to be dispersed over smooth ground (Stewart, 1993). Oreo eggs float near the sea surface and the larvae inhabit surface waters. Virtually nothing is known about their early life history. Although the juveniles of all species are very different in appearance to the adults and there is a quite dramatic metamorphosis into the adult form but prior to maturation (Yearsley pers. comm.). A brief synopsis of the biology of each species studied is given below.

a) Black Oreo *Allocyttus niger*

Australian Fish Species Code: 266005
Diagnostic features:
Body rhomboidal with up to five soft protuberances visible on each side of the abdomen. Scales strongly attached (cannot be removed by hand).
Biological Information:

Black oreos grow up to 47 cm TL and 1.5 kg in weight. Most of the commercial catch range between 33 and 45 cm and weighs around 1 kg.

Black oreos are found in New Zealand and southern Australian waters south of Lat 43°S. Catches have only been confirmed from southern Tasmania and the South Tasman Rise. Black oreo are found in the depth range 560-1180m (James *et al.*, 1988) and are usually found aggregating on rough ground near seamounts and canyons (Lyle *et al.* 1992).

Black oreos spawn slightly later than smooth oreo in late November to early January. The spawning season is similar in both New Zealand and Australian waters. Lyle *et al.* (1991) reported black oreos release up to 62000 eggs. Male black oreos mature at about 33 cm total length and 36 cm for females. Females attain a larger size than males by 1-2 cm.

Salps dominate the diet of black oreo (Clarke *et al.*, 1989) particularly for fish 20-24 cm and 40-44 cm, however fish between 30-40 cm were found

to eat more crustaceans (hyperiid amphipods and natant decapod crustaceans) than salps. Therefore reducing dietary overlap between smooth and black oreos for the mid-size range.

Davies *et al.* (1988) attempted to age smooth and black oreos using sagittal otoliths but concluded that the otoliths were not suitable for age determination. However recent studies at MSL and in New Zealand (Annala, 1992) have had more success with otoliths and estimate that both are very slow growing species and may live for over 100 years. Annala (1992) also reported that black oreos appear to have a slightly faster growth rate than either smooth oreo or orange roughy, perhaps due to a longer juvenile pelagic phase.

b) Smooth (or spotted) Oreo *Pseudocyttus maculatus*

Australian Fish Species Code: 266003
Diagnostic features: Body oval with first dorsal spine longer than second. Scales on sides deciduous, belly without enlarged bony scutes. Dark blotches present on sides of body.
Biological Information:

Smooth oreos have been recorded to a size of 61 cm total length and a weight of about 5 kg, but there are reports of larger fish in commercial catches (Stewart, 1993).

Smooth oreo have a wide distribution in the southern hemisphere. They are found off South America, southern Africa and are common in the waters of New Zealand and southern Australia (Last *et al.*, 1983). The distribution of smooth oreo in Australia extends from the central NSW around Tasmania to southern Western Australia including the Cascade Plateau and the South Tasman Rise (Lyle *et al.* 1992).

Adult smooth oreo inhabit the 400-1200m depth zone (James *et al.* 1988) while the juveniles are pelagic and quite different in appearance to the adults. The adults tend to aggregate on areas of rough ground near pinnacles or canyons and there in some indication that there are localised "hot spots" for the different oreo species. Smooth oreos are thought to prefer deeper water than the other oreo species.

Smooth oreo is the preferred commercial oreo species because of their larger size, growing to at least 60 cm total length, with the bulk of the commercial catch 35-55 cm in length. Fish less than 35 cm (or 0.75 kg) are generally considered too small for processing. The average weight of smooth oreos retained is 1.5 kg although some individuals up to 5 kg have been

recorded (Stewart, 1993). Smooth oreos constitute the main oreo species caught (approximately 95%) and are many are exported since the fillets have a high water content and are suitable for the food service and restaurant industry. They are the most common oreo species landed in Tasmanian waters.

In Tasmanian waters most of the males are mature when they reach 32 cm total length and most of the females are mature at 41 cm (Lyle *et al.*, 1992). Spawning in Tasmania runs from early November to December. Spawning fish have been found at several sites off southern Tasmania including the Cascade Plateau. There does not seem to be a single major spawning site as there is for orange roughy. Spawning occurs at a similar times of year in New Zealand (Pankhurst *et al.* 1987, Conroy and Pankhurst, 1989). Smooth oreos produce up to 84000 eggs which indicates a quite low fecundity. Interestingly, almost all of the smooth oreo juveniles recorded had been collected in mid-water trawls near the Antarctic Circle, always associated with Antarctic krill (James *et al.* 1988).

Feeding studies of smooth oreo in New Zealand have reported that they feed benthopelagically mainly (up to 90%) on salps at all ages (Thailiacea) the most common species in the diet was *Salpa thompsoni* . However, the relative importance of salps in the diet declined with increasing fish length with large smooth oreo also eating some planktonic crustacean (hyperiid amphipods) and fish.

c) Spiky Oreo *Neocyttus rhomboidalis*

Australian Fish Species Code: 266001
Diagnostic features: Body extremely rhomboidal with second dorsal fin spine thick and strong, longer than longest fin ray. Body surface rough, covered with ctenoid scales, with no bony plates or protuberances on belly.
Biological Information: Spiky oreo are widely distributed in the southern hemisphere including southern Australia, South Africa, New Zealand and the Louisville Ridge in the South Pacific (James *et al.* 1988). In Australian waters spiky oreo has been recorded from NSW to southern WA (Last *et al.* 1983). Adults are commonly found at depths between 500-1000m although they have been recorded over the range 200-1240m (Stewart, 1993). Trawl catch rates for oreos show no evidence of vertical migration during day or night (Clarke *et al.* 1989). Interestingly, recent genetic work conducted by CSIRO Fisheries funded by FR&DC has identified two depth separated

races of spiky oreo (Yearsley pers. comm.) with one race predominantly between 450-630 m and the other greater than 750 m.

Catches of spiky oreo are usually small (Lyle *et al.* 1992). And yet spiky oreos are reported to be the most common oreo in southern Australian waters. A recent survey of the GAB (Newton and Klaer, 1991) reported that spiky oreo made up approximately 55% of the total oreo/dory catch. Spiky are good eating but are generally of a small size and thus only small quantities are taken commercially (Lyle *et al.* 1991).

Spiky oreos reach a maximum length of 42 cm and 2 kg in weight. Spawning is synchronous in spiky oreo with evidence of spawning in September-October (Lyle *et al.* 1992), commencing in August and being completed by November. Lyle *et al.* (1991) found that greater than 50% of the males were sexually mature at 29 cm and that greater than 50% of the females were sexually mature at 34 cm. The size of first maturity for males was 28 cm and 29 cm for females. Only one juvenile spiky oreo has been recorded (James *et al.*, 1988), from this it appears that the juveniles are pelagic like the other oreos and different in appearance to the adults.

No studies to determine the age of spiky oreos have been published. The recent work by Smith and Stewart (1994) suggest they live for over 100 years.

2. Radiometric analysis

Radionuclide analysis is an alternative independent ageing method that is ideal to apply to spiky, smooth and black dory. This method has been applied to range of fish including the splitnose rockfish Sebastes diploproa (Bennett *et al.*, 1982), Atlantic redfish Sebastes mentella (Campana *et al.*, 1990), orange roughy Hoplostethus atlanticus (Fenton *et al.*, 1991;Smith *et al.*, 1995),blue grenadier (Fenton *et al.*, 1990; Fenton and Short, 1995), flying fish Hirundichthys affinis and silver hake Merluccius bilinearis (Smith *et al.*, 1991; Campana *et al.* 1993), sablefish Anoplopoma fimbria (Kastelle *et al.*, 1994), three species of tropical snapper (Milton *et al.*, 1995) and warty oreo (Stewart *et al.*, 1995). The radiometric technique is based on the fact that radioisotopes decay at known rates and therefore provide natural "clocks" by which age can be determined. Natural levels of the radioisotopes ^{210}Pb (22.3 year half-life) and ^{226}Ra (1602 year half-life) can be used for ageing fish. These isotopes occur naturally in seawater and are

incorporated unequally (i.e. in disequilibrium) into the otoliths of fish. ^{226}Ra is taken up as a chemical analogue of calcium and thereafter decays via a series of intermediate isotopes into ^{210}Pb (Fig. 1). It is the increasing level of ^{210}Pb relative to ^{226}Ra that provides a measure of time elapsed since incorporation and hence fish age.

5. Research Methodology

1. Methods and techniques

a) Collection of fish otoliths

Otolith collections of spiky, smooth and black oreos from the Division of Marine Resources Tasmanian Department of Primary Industry, Victorian Fisheries Research Institute and CSIRO Fisheries. Additional collections of spiky, smooth and black oreo were purchased from local fisherman.

To minimise variables, otoliths were used from fish of similar length, otolith weight, capture location, date and sex. Wherever possible otoliths analysed were from the same fish analysed by the Central Fish Ageing Facility, Victoria.

Lists of all black, smooth and spiky oreo otoliths used in this study are provided in Appendices 1, 2 and 3 respectively.

b) Trace element Analysis

Ion coupled plasma atomic absorption spectrometry (ICP-AES) of calcium and strontium ,and ion coupled plasma mass spectrometry (ICP-MS) of lead and barium analysis of otoliths was conducted for oreos from a range of size classes. These elements were analysed to establish the pattern of incorporation of Pb & Ba (analogous to Ra) throughout life i.e. whether the uptake is linear or not. The analysis was conducted at CSIRO Centre for Advanced Analytical Chemistry , Lucas Heights NSW.

c) Radionuclide Analysis

Otoliths from a range of oreo size classes were analysed. Juvenile samples were composed of immature males and females, while most adult samples were composed of female fish unless otherwise indicated.

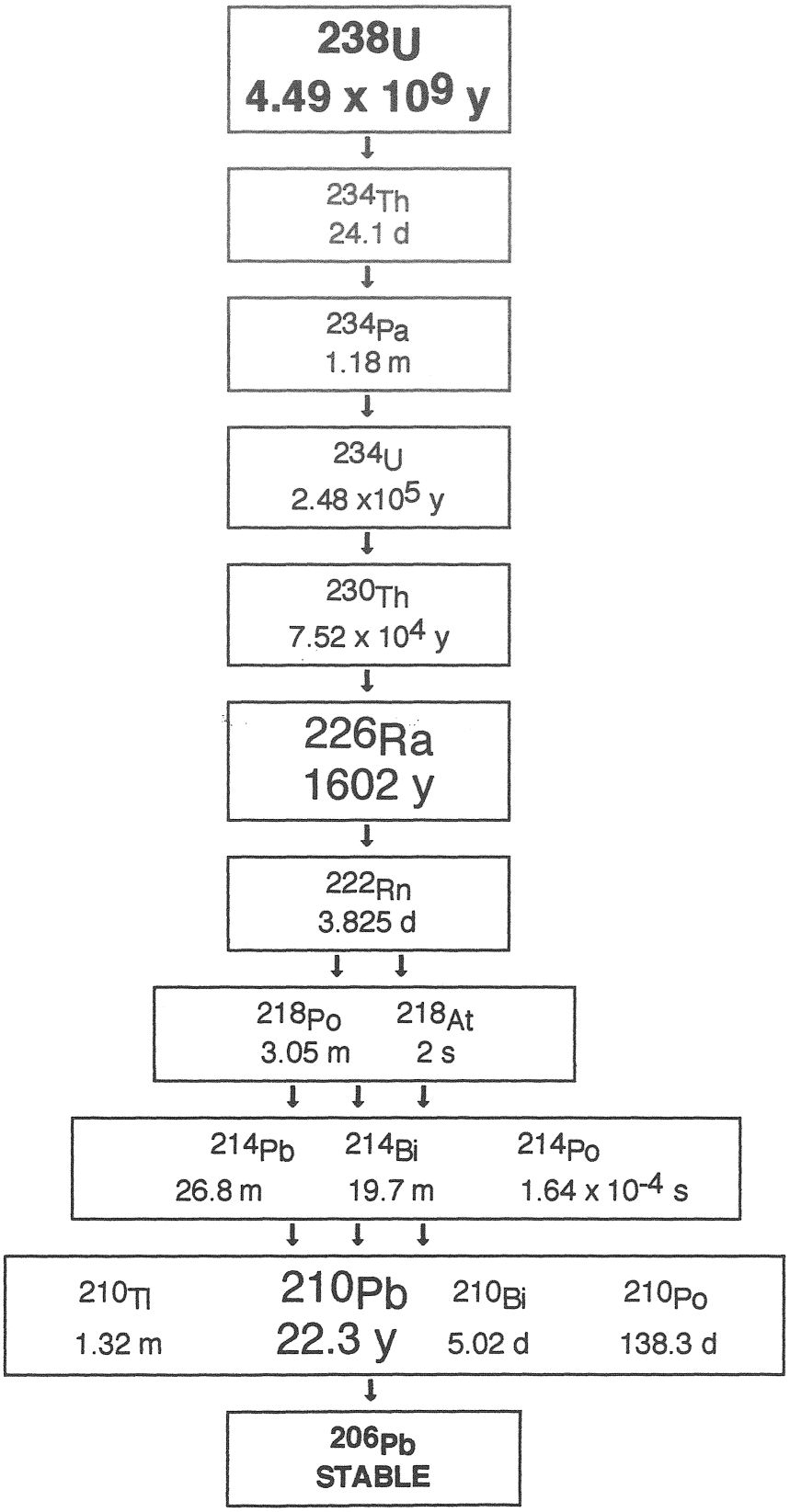


Fig 1. Uranium Decay Series.

Radiometric analysis was conducted on otolith samples that were 1-year post-collection, to allow for ^{210}Pb and ^{210}Po to reach radioactive equilibrium. Whole otoliths were be analysed and ages estimated using a models of mass growth of the otolith. It was hoped that analysis of otolith cores might be possible for the oreo species. However, coring was unsuccessful due to a combination of the small size and propeller shape of their otoliths.

The analysis of ^{210}Pb via its alpha-emitting, short-lived daughter proxy ^{210}Po, followed the method described in Fenton *et al.* (1991) employing high resolution alpha-spectrometry. Polonium-210 (half-life 138 days) was assumed to be in equilibrium with ^{210}Pb in all samples, since all samples were collected more than 1 year before analysis. Recovery of ^{210}Po was invariably > 90%. Instrumental background counts (for ^{208}Po and ^{210}Po) were less than 1 count per day. Analysis of ^{226}Ra was made using a direct alpha spectrometry technique (Fenton *et al.* 1991).

6. Results

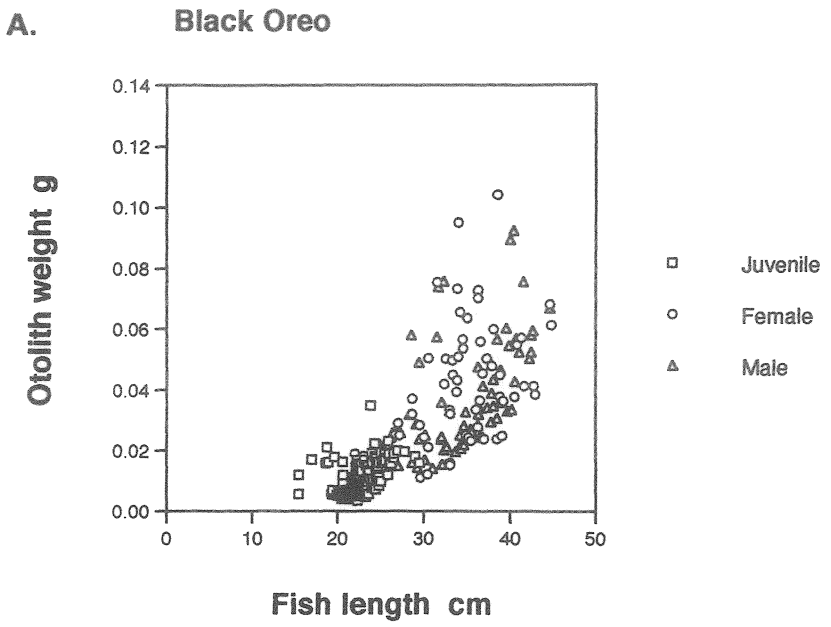
1. Otolith Weight

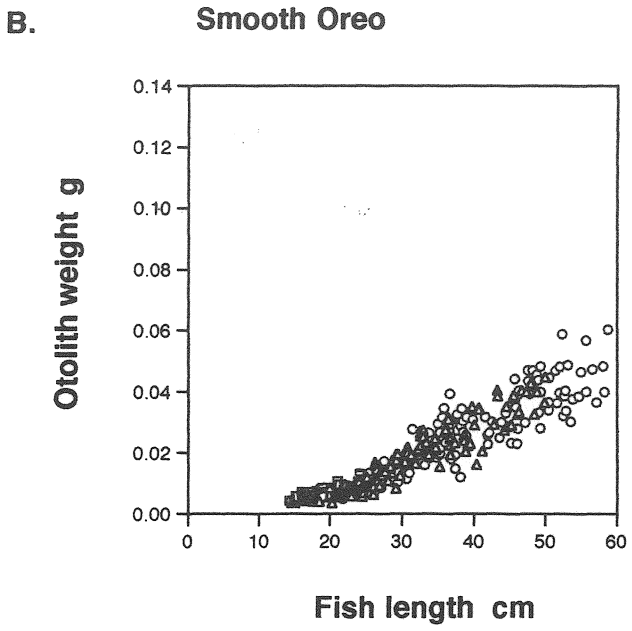
a) Black Oreo

Otoliths were collected from fish ranging in size from 15.5 cm to 44.8 cm. The weight of all the otoliths was recorded and ranged from 0.0041 to a maximum of 0.1084 g. The relationship between otolith weight and fish length is plotted in Fig. 2A. The otolith weight was quite variable in this species, with variation among juveniles greater than that seen for smooth and spiky oreos (Figs. 2B & 2C). Linear relationships between otolith length, width, depth and fish length for black oreo were reported by Smith and Stewart (1994) and have not been repeated here.

b) Smooth Oreo

Otoliths were collected from fish ranging in size from 14.0 cm to 58.7 cm. Smooth oreo otoliths are smaller and lighter than those found in the other oreo species. The weight of all the otoliths was recorded and ranged from 0.0029 to a maximum of 0.0605 g. The relationship between otolith weight and fish length is plotted in Fig. 2B. This graph shows a tight linear relationship between otolith weight and fish length. For females the relationship can be described by the equation $y = 0.001x-0.018$ $r^2= 0.836$





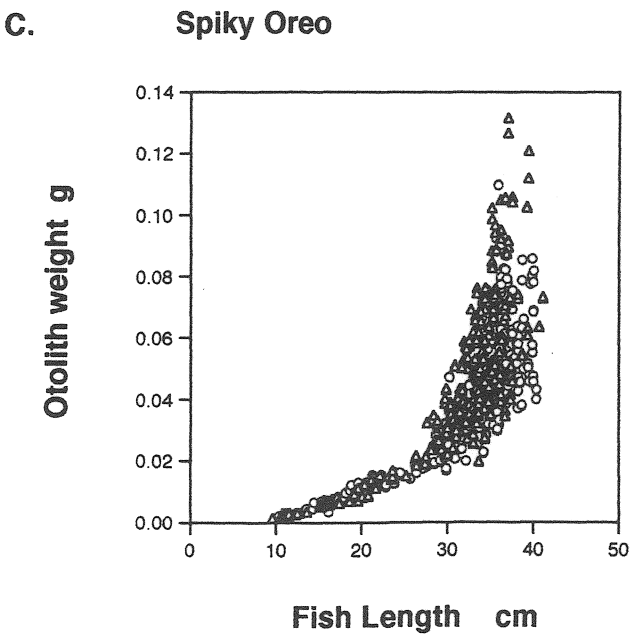


Fig. 2 Otolith weight versus fish length for A) Black Oreo, B) Smooth Oreo and C) Spiky Oreo.

and for males by the equation y = 0.001x-0.020 r^2=0.900. Linear relationships between otolith length, width, depth and fish length for smooth oreo were reported by Smith and Stewart (1994) and have not been repeated here.

c) Spiky Oreo

Otoliths were collected from fish ranging in size from 9.6 cm to 40.4 cm. The weight of all the otoliths was recorded and ranged from 0.0014 to a maximum of 0.1097 g. The relationship between otolith weight and fish length is plotted in Fig. 2C. The graph shows a large variation in otolith weight for mature fish. Linear relationships between otolith length, width, depth and fish length for spiky oreo were reported by Smith and Stewart (1994) and have not been repeated here.

2. Stable element analysis

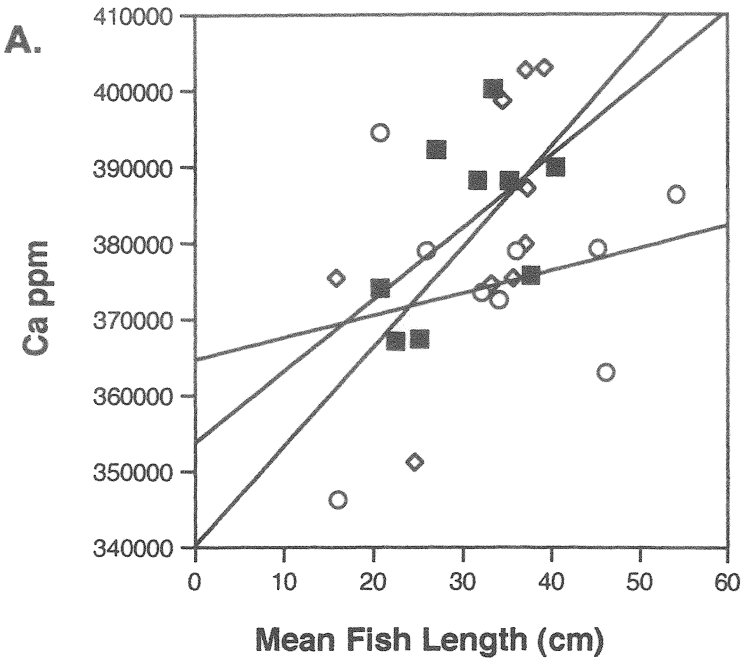
Calcium and strontium levels were measured by ICP-AES and the lead and barium levels by ICP-MS from an aliquot of the solution subsequently analysed radiometrically. All data is presented in parts per million ppm (mg/kg) and is provided in Appendix 4.

The reagent blanks for calcium were always <10 ppm and usually less than 1 ppm, while the samples ranged from 346472 to 402999 ppm. For strontium the blank values were always <1 ppm and usually less than 0.1 ppm, compared to the samples values of 2669 to 4237 ppm.

On the other hand the levels of lead and barium in the reagent blanks represented a much higher proportion of the solution analysed and the results were disappointing (see Appendix 4). In many cases the reagent blank values were above the levels found in the samples and therefore of little use. However the results do tell us that the Pb and Ba values for the otolith samples are clearly very low but no further interpretation of the results is possible.

a) Calcium levels

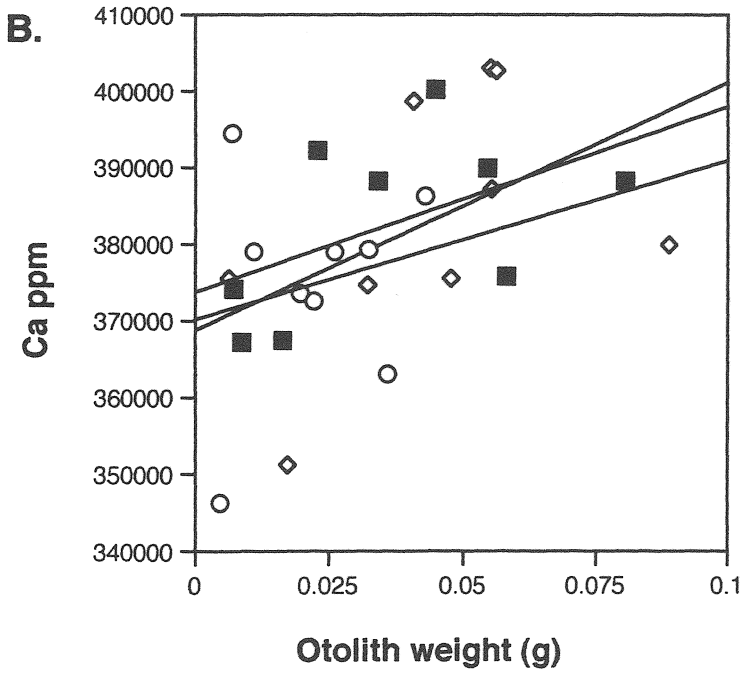
The levels of calcium were similar in all three species and showed a slight increase with increasing fish length and with increasing otolith weight (Fig. 3A & 3B respectively), although there was considerable variability in the data. As a consequence the linear equations had very low r^2 values, particularly for smooth oreo where no real relationship was evident. The average calcium levels ± 1 standard deviation are given in Table 1.



■ Black Oreo $y = 947.852x + 353791.420$ $r^2 = 0.310$

○ Smooth $y = 293.299x + 364736.204$ $r^2 = 0.070$

◇ Spiky $y = 1316.208x + 340149.098$ $r^2 = 0.354$



■ Black $y = 242373.730x + 373789.675$ $r^2 = 0.267$

○ Smooth $y = 208107.673x + 370180.652$ $r^2 = 0.040$

◇ Spiky $y = 324041.583x + 368759.353$ $r^2 = 0.219$

Fig 3. Calcium levels in whole otoliths versus A) fish length and B) otolith weight.

b) Strontium levels

The level of strontium in each species was reasonably distinctive, with smooth oreo having the highest levels followed by black oreo, with the lowest values found in spiky oreo. A positive linear relationship is evident between strontium levels and fish length for black (r^2= 0.333) and spiky oreo (r^2= 0.398) Fig. 4A., while a negative linear relationship is evident for smooth oreo (r^2= 0.390). A similar pattern between strontium levels and otolith mass was found for black (r^2= 0.312) and spiky oreo (r^2=0.313), while a negative relationship was present for smooth oreo (r^2= 0.363) Fig. 4B.

Table 1: Oreo dory otolith average calcium and strontium levels ± 1 standard deviation.

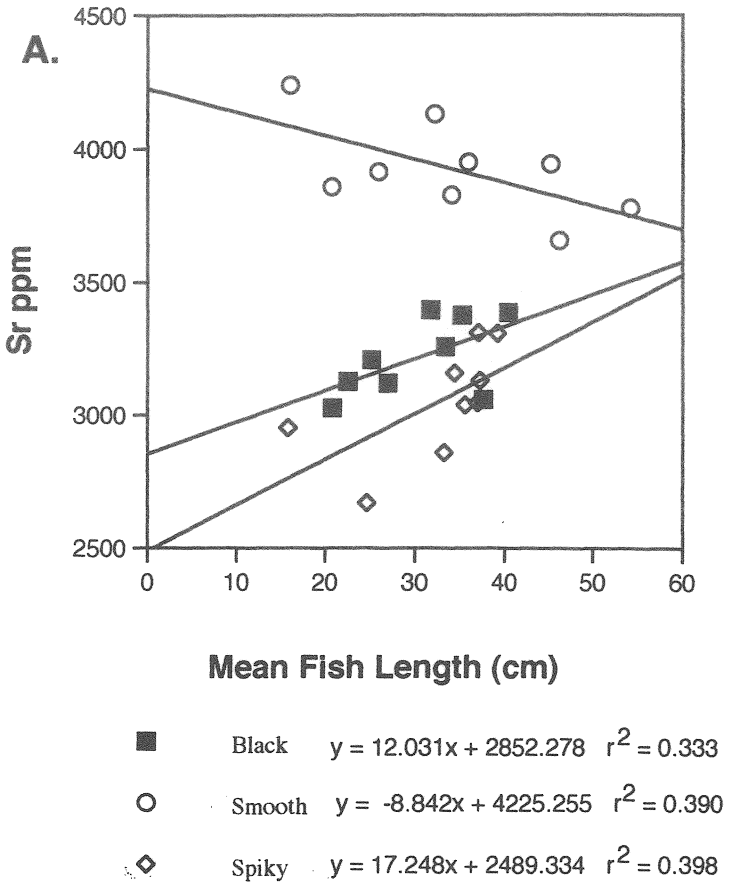
Species	Mean Calcium Level ppm	Mean Strontium Level ppm
Black oreo	382604± 11765	3218± 144
Smooth oreo	374847± 13847	3920 ± 177
Spiky oreo	383154± 16776	3053 ± 207

The relationship for Sr/ Ca for all three species is given in Fig. 5 relative to fish length and otolith weight. The patterns are similar for both fish length and otolith weight with a negative relationship between Sr/Ca and fish length (r^2 = 0.308) and otolith weight (r^2= 0.257) for smooth oreo. However, for black (r^2= 0.048) and spiky oreo (r^2=0.374) a positive relationship between Sr/Ca levels fish length is only slight (Fig. 5A) and is even weaker when compared to otolith weight (Fig. 5B) with black oreo (r^2=0.053) and spiky oreo (r^2= 0.285).

3. Radioactive Isotopes

a) ^{210}Pb levels

The levels of ^{210}Pb measured in the otoliths of all three species show a strong positive linear relationship with increasing fish length (Fig. 6). The increase in ^{210}Pb levels for fish of increasing size is consistent with the fact that the ^{210}Pb is formed from the decay of ^{226}Ra inside the otolith since no evidence of stable lead levels rapidly increasing in larger fish was detected from the ICP-MS data.



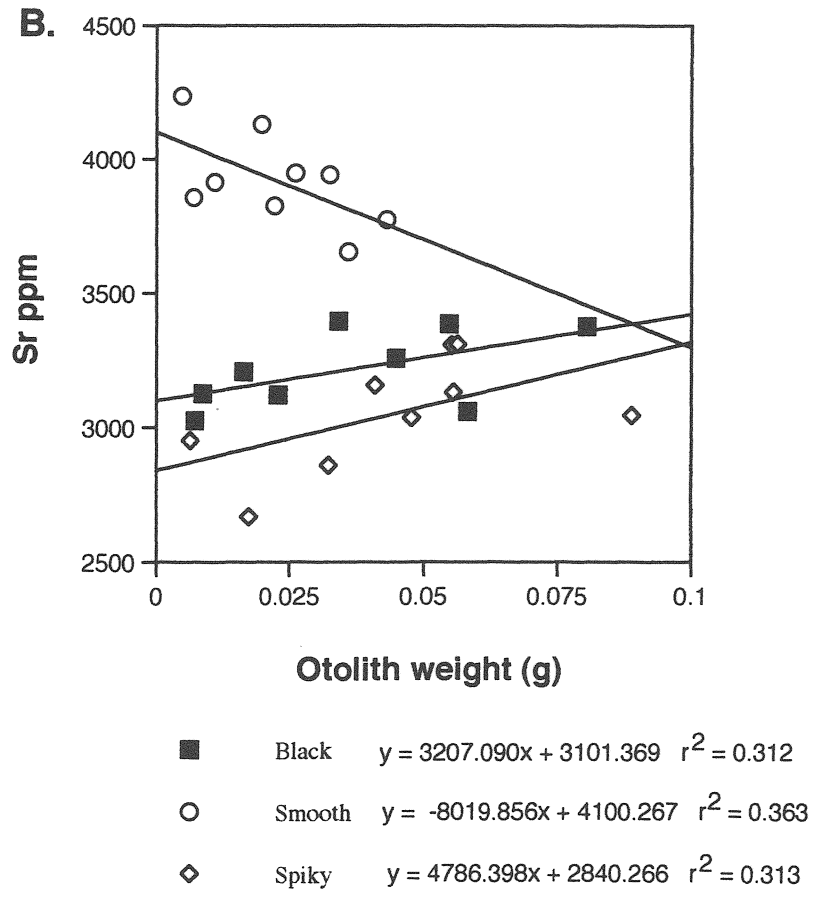
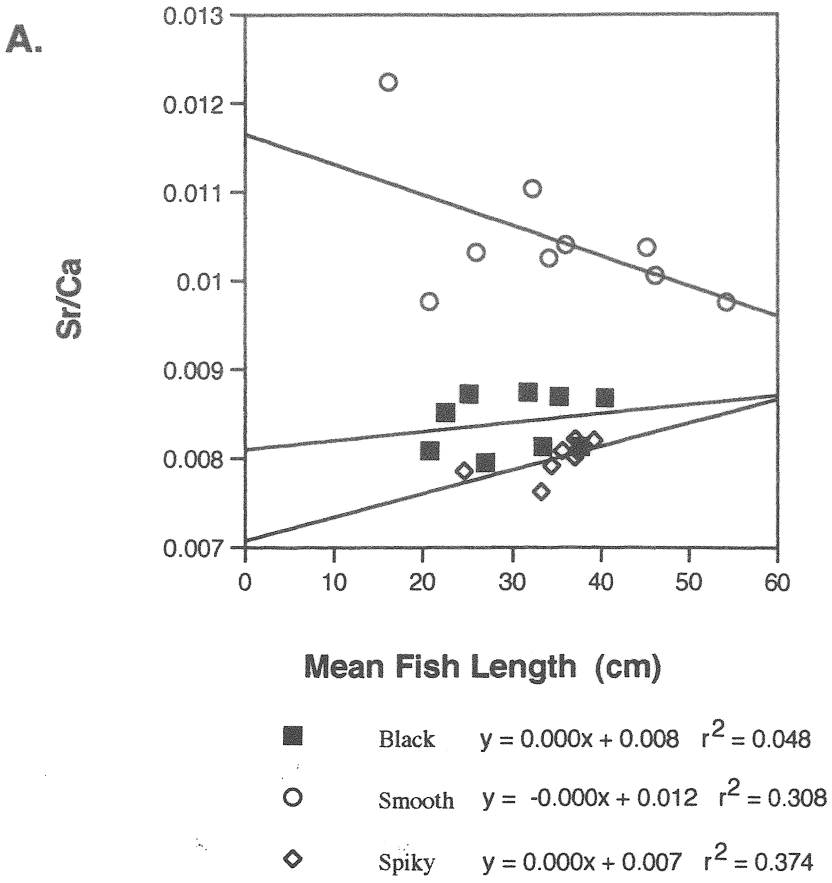


Fig 4. Strontium levels in whole otoliths versus A) fish length and B) otolith weight for black, smooth and spiky oreos.s



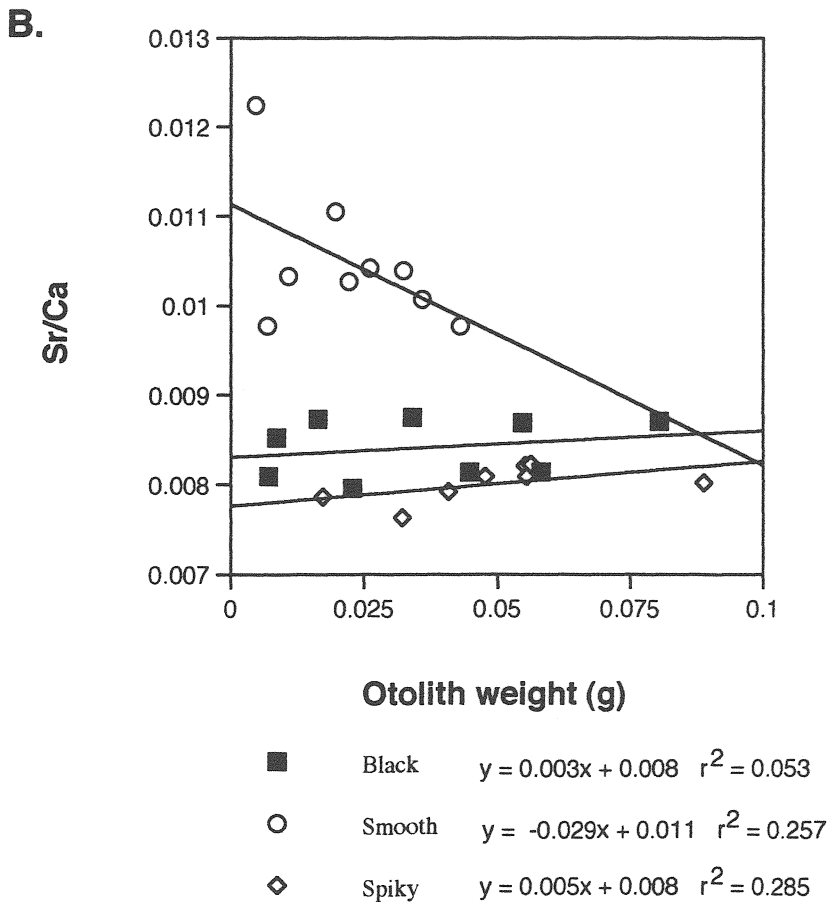


Fig.5 Strontium / calcium ratios from Black, Smooth and Spiky oreo otoliths versus A) fish length and B) otolith mass.

The ^{210}Pb levels in black oreo otolith are given in Table 2. They range from 0.0230 ± 0.0064 dpm.g^{-1} for 20.73 ± 1.28 cm fish up to 0.1088 ± 0.0109 dpm.g^{-1} for 40.43 ± 1.77 cm fish. A tight linear relationship between fish length and ^{210}Pb is evident (see Fig. 6A) with r^2= 0.971.

Smooth oreo ^{210}Pb levels ranged from 0.0136±0.0114 dpm.g^{-1} for 16.05 ± 1.0 cm fish to 0.4839 ± 0.0295 dpm.g^{-1} for female fish 54.13 ± 2.72 cm and up to 0.5675 ± 0.0335 dpm.g^{-1} for males 45.16 ± 3.65 cm (Table 3). A linear relationship between fish length and ^{210}Pb is also evident (see Fig. 6B) with r^2= 0.870 for the combined data set.

The ^{210}Pb levels in spiky oreo ranged form a negative value of -0.0651 ± 0.0069 for fish 15.86 ± 3.19 cm up to 0.2924 ± 0.0137 for a sample of female fish 36.98 ± 1.58 cm in length (Table 4). The latter sample interestingly was composed of the heaviest otoliths of all the spiky oreo samples analysed. Although the spiky oreo data included one negative reading of ^{210}Pb a linear relationship is still evident (Fig 6C) an r^2=0.730.

^{210}Pb background levels ranged from 0.001126 ± 0.000193 dpm.g^{-1} up to 0.02826 ± 0.00372 dpm.g^{-1} (for spiky LH 4186 , LH 4187 , LH 4188 , LH 4189). The latter background was much higher than usual and indicated a minor contaminant in one of the chemicals. It is this increased background that resulted in the negative value for the spiky juveniles LH 4188 . All subsequent samples were analysed with new chemicals eliminating this problem.

b) ^{226}Ra levels

The ^{226}Ra levels were quite different in each of three species. The values for black oreo ranged from 0.0809 ± 0.0183 to 0.1782 ± 0.0394 dpm. g^{-1} (Table 2) for smooth from 0.2236 ± 0.0130 to 1.3409 ± 0.0609 dpm. g^{-1} (Table 3) and for spiky 0.2590 ± 0.0070 to 0.8966 ±0.0394 dpm. g^{-1} (Table 4).

The relationship between ^{226}Ra levels and fish length are plotted in Fig 7 for each species. There is a positive linear relationship for black oreo r^2= 0.689 and for smooth r^2= 0.543 but a negative relationship for spiky r^2= 0.211. Because of these relationships all age calculations have been presented using both individual ^{226}Ra levels and mean ^{226}Ra levels.

The chemical recovery of ^{226}Ra was monitored using the tracer ^{133}Ba in all analyses. Examining the relationship between the ^{133}Ba tracer levels and the ^{226}Ra levels revealed that the actual ^{226}Ra value recorded was related to the ^{133}Ba recovery. For example for smooth oreo samples LH 4505, LH 4498, and LH 4501 had lower ^{133}Ba recoveries.

Table 2 : Black oreo age calculation using linear otolith mass growth model.

Sample Number	Mean Fish Length TL (cm)	Mean Otolith Mass (g)	n	Collection Date	210Pb dpm	226Ra dpm	Mean 226Ra dpm	210Pb/ 226Ra Activity ratio	210Pb/ 226Ra Activity ratio (using mean Ra)	AGE :Linear otolith growth model using individual 226Ra, R=0	AGE: Linear otolith growth model using mean 226Ra, R=0
LH 4497 B1	20.73 ±1.28	0.0072 ±0.0035	147	11-Sep-93	0.0230 ±0.0064	0.0913 ±0.0058	0.0913 ±0.0019	0.2519 ±0.0706	0.2519 ±0.0706	19.6 (+7.2, -6.3)	19.6 (+7.2, -6.3)
LH 4496 B2	22.47 ±0.28	0.0087 ±0.0036	119	11-Sep-93	0.0230 ±0.0065	0.0811 ±0.0072	0.0913 ±0.0019	0.2836 ±0.0843	0.2519 ±0.0717	22.8 (+9.4, -7.9)	19.6 (+7.4, -6.4)
LH 4494 B4	25.14 ±0.44	0.0164 ±0.0033	64	12-Sep-93	0.0263 ±0.0070	0.0809 ±0.0183	0.0913 ±0.0019	0.3252 ±0.1138	0.2882 ±0.0771	27.2 (+14.4, -11.3)	23.2 (+8.6, -7.4)
LH 4495 B5	26.98 ±0.86	0.0229 ±0.0066	49	13-Sep-93	0.0422 ±0.0077	0.112 ±0.0080	0.0913 ±0.0019	0.3767 ±0.0737	0.4621 ±0.0847	33.2 (+10, -8.4)	45 (+14.9, -11.7)
LH 4492 B9	31.65 ±1.74	0.0341 ±0.0186	32	21-Mar-93	0.0677 ±0.0099	0.1782 ±0.0256	0.1623 ±0.0049	0.3799 ±0.0777	0.4171 ±0.0621	33.6 (+10.7, -8.9)	38.5 (+9.2, -7.9)
LH4489 B6	33.36 ±1.43	0.0448 ±0.0069	24	30-Aug-93	0.0744 ±0.0094	0.1623 ±0.0130	0.1623 ±0.0049	0.4584 ±0.0686	0.4584 ±0.0594	44.4 (+11.6, -9.6)	44.4 (+9.9, -8.4)
LH4491 B8	35.19 ±2.19	0.0805 ±0.0143	14	26-Aug-93	0.0823 ±0.0095	0.1753 ±0.0099	0.1623 ±0.0049	0.4697 ±0.0606	0.5073 ±0.0608	46.2 (+10.5, -8.8)	52.5 (+11.9, -9.8)
LH 4490 B7	37.63 ±3.3	0.0581 ±0.065	18	21-Mar-93	0.1062 ±0.0097	0.1391 ±0.0081	0.1623 ±0.0049	0.7638 ±0.0829	0.6546 ±0.0631	133.9 (+75.3, -38.3)	86.7 (+23.3, -17.1)
LH 4493 B10	40.43 ±1.77	0.0546 ±0.171	20	9-Feb-92	0.1088 ±0.0109	0.1567 ±0.0088	0.1623 ±0.0049	0.6940 ±0.0796	0.6701 ±0.0699	100.3 (+39.7, -25)	91.8 (+28.9, -20)

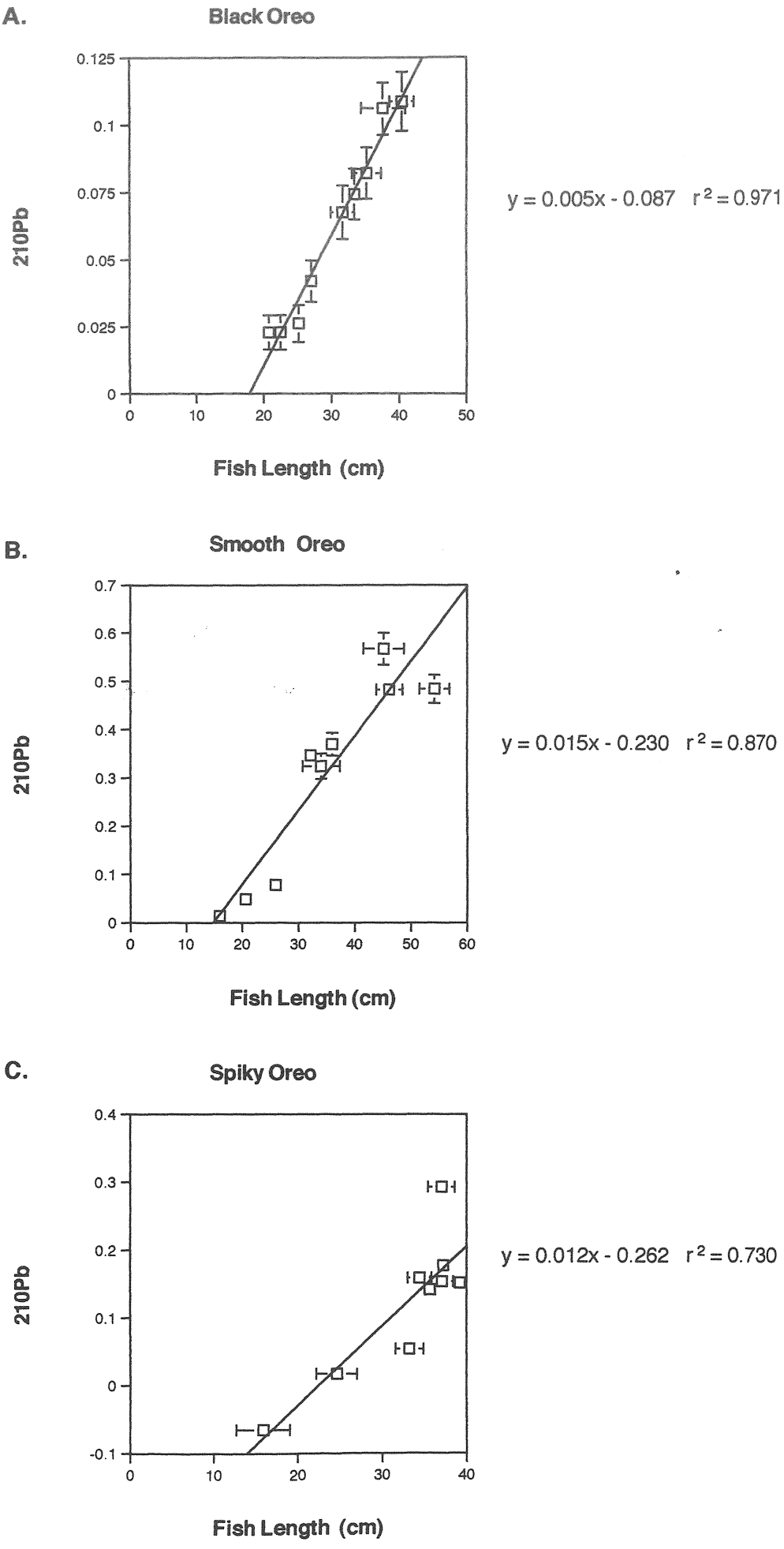


Fig. 6 ^{210}Pb (dpm.g-1) levels measured in the otoliths versus fish length for A) Black Oreo, B) Smooth Oreo and C) Spiky Oreo

Table 3 : Smooth oreo age calculation using linear otolith mass growth model.

Sample Number	Mean Fish Length TL (cm)	Mean Otolith Mass (g)	n	Collection Date	210Pb dpm	226Ra dpm	Mean 226Ra dpm	210Pb/ 226Ra Activity ratio	210Pb/ 226Ra Activity ratio (using mean Ra)	AGE :Linear otolith growth model using individual 226Ra, R=0	AGE: Linear otolith growth model using mean 226Ra, R=0
LH 4506 SM1	16.05 ±1.0	0.0047 ±0.0009	222	15-Feb-94	0.0136 ±0.0114	0.2236 ±0.0130	0.4785 ±0.0176	0.0609 ±0.0512	0.0284 ±0.0239	4.1 (+3.7, -3.5)	1.9 (±1.6)
LH 4505 SM2	20.7 ±1.78	0.0069 ±0.0013	146	20-Mar-93	0.0487 ±0.0148	0.4785 ±0.0172	0.4785 ±0.0176	0.1017 ±0.0311	0.1017 ±0.0311	7 (+2.4, -2.3)	7 (+2.4,-2.3)
LH 4504 SM3	25.94 ±1.45	0.0109 ±0.0026	98	26-Feb-93	0.0784 ±0.0151	0.7333 ±0.0343	0.4785 ±0.0176	0.1069 ±0.0212	0.1638 ±0.0321	7.4 (±1.6)	11.9 (+2.7, -2.6)
LH 4503 SM4	32.13 ±1.39	0.0197 ±0.0036	49	17-May-93	0.3472 ±0.0178	0.9959 ±0.0507	1.2102 ±0.1378	0.3486 ±0.0252	0.2869 ±0.0358	29.8 (+3.0, -2.9)	23.1 (+3.8, -3.5)
LH 4498 SM 5	35.96 ±1.1	0.0261 ±0.0053	39	17-May-93	0.3694 ±0.0236	1.2102 ±0.0162	1.2102 ±0.1378	0.3053 ±0.0399	0.3053 ±0.0399	25 (+4.4, -4.1)	25.0 (+4.4, -4.1)
LH 4499 SM6	46.15 ±2.38	0.0359 ±0.0088	29	16-Sep-91	0.4827 ±0.0146	1.2504 ±0.0581	1.2102 ±0.1378	0.3860 ±0.0214	0.3989 ±0.0470	34.4 (+2.8, -2.7)	36 (+6.5, -5.8)
LH 4500 SM7	54.13 ±2.72	0.043 ±0.0078	29	18-Dec-90	0.4839 ±0.0295	1.2535 ±0.0575	1.2102 ±0.1378	0.3861 ± 0.0294	0.3999 ±0.0516	34.4 (+3.9, -3.6)	36.2 (+7.2, -6.4)
LH 4501 SM8 MALE	34.03 ±3.26	0.0222 ±0.0051	46	25-Jan-93	0.3243 ±0.0264	1.2102 ±0.1150	1.2102 ±0.1378	0.2680 ±0.0375	0.2680 ±0.0375	21.2 (+3.8, -3.6)	21.2 (+3.8, -3.6)
LH 4502 SM9 MALE	45.16 ±3.65	0.0324 ±0.0081	30	16-Jun-91	0.5675 ±0.0335	1.3409 ±0.0609	1.2102 ±0.1378	0.4232 ±0.0315	0.4690 ±0.0600	39.3 (+4.6, -4.2)	46.1 (+10.4, -8.7)

Table4 :Spiky oreo age calculation using linear otolith mass growth model.

Sample Number	Mean Fish Length TL (cm)	Mean Otolith Mass (g)	n	Collection Date	210Pb dpm	226Ra dpm	Mean 226Ra dpm	210Pb/ 226Ra Activity ratio	210Pb/ 226Ra Activity ratio (using mean Ra)	AGE :Linear otolith growth model using individual 226Ra, R=0	AGE: Linear otolith growth model using mean 226Ra, R=0
LH 4188 SP8	15.86 ±3.19	0.0063 ±0.0032	158	3-Oct-88	(-)0.0651 ±0.0069	0.6072 ±0.0293	0.4135 ±0.0038	(-)0.1071 ±0.0124	(-)0.1573 ±0.0167	na	na
LH4189 SP9	24.6 ±2.4	0.0173 ±0.0055	58	4-Nov-88	0.0166 ±0.0087	0.8966 ±0.0394	0.4135 ±0.0038	0.0185 ±0.0097	0.0402 ±0.0210	2.7 (+1.4, -1.3)	1.2 (±0.6)
LH 4186 SP6	33.19 ±1.68	0.0322 ±0.0013	31	8-Dec-88	0.0535 ±0.0095	0.2948 ±0.0147	0.4135 ±0.0038	0.1815 ±0.0335	0.1294 ±0.0231	9.1 (±1.8)	13.3 (+2.9, -2.7)
LH 3546 SP5	34.4 ±1.4	0.0408 ±0.002	25	3-Dec-88	0.1583 ±0.0086	0.259 ±0.0070	0.4135 ±0.0038	0.6110 ±0.0370	0.3827 ±0.0211	34 (+2.7, -2.6)	74.4 (+10.3, -8.8)
LH 2829 SP1	35.6 ±0.4	0.0477 ±0.0146	24	16-Feb-89	0.1410 ±0.0085	0.4379 ±0.0060	0.4135 ±0.0038	0.3220 ±0.0482	0.3410 ±0.0208	28.9 (+2.4, -2.3)	28.8 (+5.6, -5)
LH 4187 SP7	36.98 ±1.58	0.0888 ±0.0104	12	20-Jan-89	0.2924 ±0.0137	0.3912 ±0.0162	0.4135 ±0.0038	0.7474 ±0.0467	0.7071 ±0.0337	105.5 (+15.5, -12.7)	124.5 (+30.2, -21.6)
LH 3545 SP4	37.03 ±1.35	0.0562 ±0.0024	20	27-Oct-88	0.1528 ±0.0083	0.378 ±0.006	0.4135 ±0.0038	0.4042 ±0.0228	0.3695 ±0.0203	32.3 (+2.5, -2.4)	36.7 (+3.1, -2.9)
LH 2830 SP2	37.2 ±0.47	0.0554 ±0.0099	20	17-Feb-89	0.1769 ±0.0098	0.444 ±0.0300	0.4135 ±0.0038	0.3983 ±0.0348	0.4277 ±0.0240	39.9 (+3.5, -3.3)	36 (+4.8, -4.4)
LH 2831 SP3	39.2 ±0.79	0.0551 ±0.0139	18	17-Feb-89	0.1507 ±0.0093	0.6895 ±0.0645	0.4135 ±0.0038	0.2186 ±0.0245	0.3646 ±0.0227	31.7 (+2.8, -2.7)	16.6 (+2.3,-2.2)

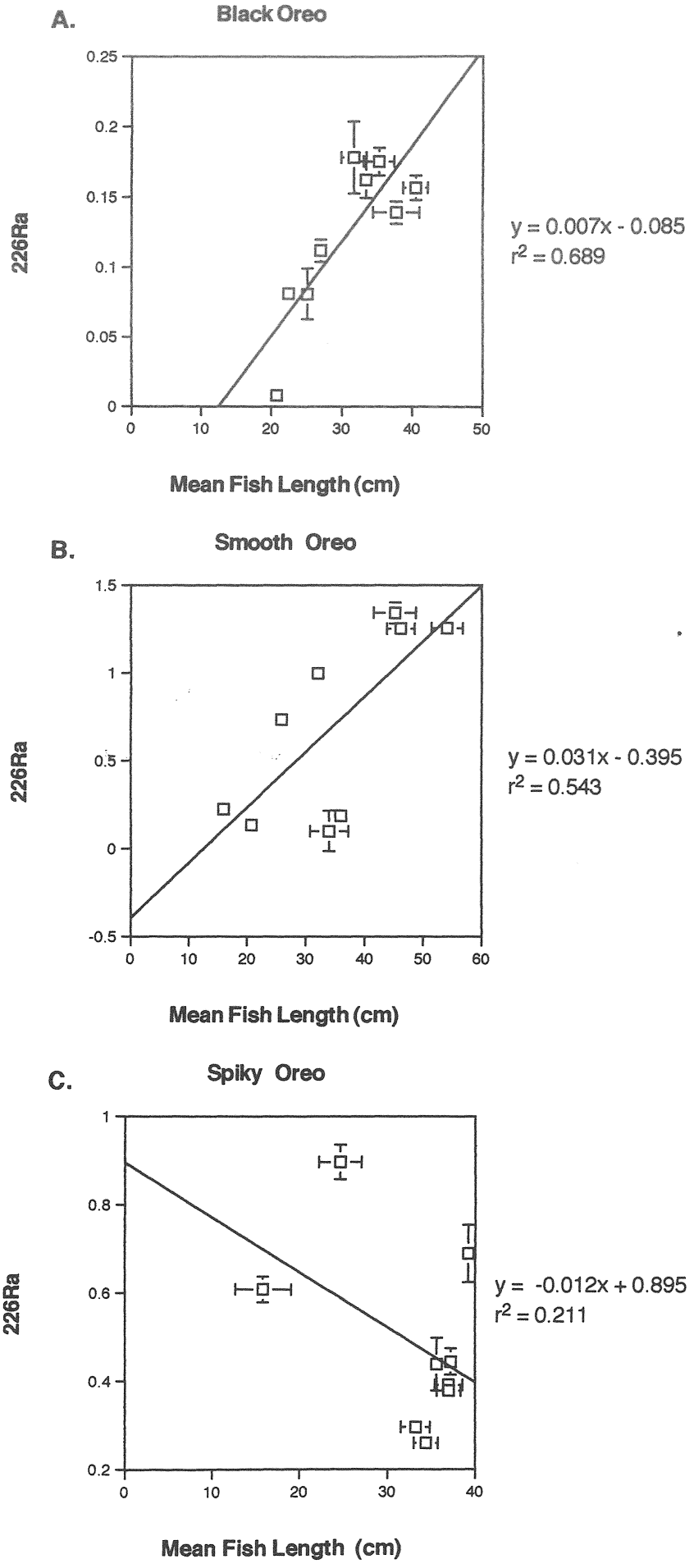


Fig. 7: 226Ra (dpm.g-1) levels versus fish length for A) Black oreo, B) Smooth oreo and C) Spiky oreo

Therefore mean ^{226}Ra values were used where there was clearly a problem with ^{133}Ba recovery. The mean ^{226}Ra values calculated were based on the recovery of ^{133}Ba and similarity of ^{226}Ra levels for similar sized fish (Table 5).

The individual ^{226}Ra values (where accurate) and mean ^{226}Ra values have both been used in the calculation of ages. For black and smooth oreos the mean ^{226}Ra values were lower for prematurity fish than post-maturity fish. The pattern was different for spiky oreo with initially higher levels of ^{226}Ra followed by a lower more even level for most of the samples, although an elevated value was found in the otoliths of the largest fish sample 39.2 ± 0.79 cm. .

The ^{226}Ra background readings were very constant for all samples around 0.024±0.002 dpm. g^{-1} to except for spiky samples LH 4186, LH 4187, LH 4188 and LH 4189 where the value was slightly higher 0.0317±0.0032 dpm. g^{-1} (for the reasons already discussed).

c) $^{210}Pb/^{226}Ra$ Activity ratios

The $^{210}Pb/^{226}Ra$ activity ratio for each species is given in Tables 2, 3 and 4, and has been plotted against fish length in Fig. 8 using individual ^{226}Ra values in the calculation and using mean ^{226}Ra values in Fig. 9 . Strong linear relationships are present with increasing activity ratio with increased fish length for black (r^2= 0.824) and smooth oreo (r^2= 0.828) but with a weaker relationship for spiky oreo (r^2= 0.299) using individual ^{226}Ra values in the activity ratio (Fig. 8) . Similar relationships are present for black (r^2= 0.895) and smooth oreo (r^2= 0.895), with a slightly stronger relationship for spiky oreo (r^2= 0.524) using mean ^{226}Ra values in the activity ratio (Fig. 9) than was present using the individual ^{226}Ra values.

The $^{210}Pb/^{226}Ra$ activity ratio for each species has also been plotted against otolith weight in Fig. 10 using individual ^{226}Ra values in the calculation and using mean ^{226}Ra values in Fig 11. Interestingly the relationship using individual ^{226}Ra values for black oreo (r^2= 0.545) was lower , while the relationship was similar for smooth oreo (r^2= 0.837) and much higher for spiky oreo (r^2= 0.611) compared to the values seen for fish length. A similar pattern was seen using mean ^{226}Ra values (Fig 11) with black oreo (r^2= 0.649), smooth oreo (r^2= 0.874) and higher for spiky oreo (r^2= 0.927).

Table 5: Oreo otolith levels of 226Ra and 133Ba recovery.

Sample Number	Mean Fish Length TL (cm)	226Ra	226Ra error	133Ba yield
Black Oreo				
LH 4497 B1	20.73	0.0078	0.0058	30.32
LH 4496 B2	22.47	0.0811	0.0072	94.15
LH 4494 B4	25.14	0.0809	0.0183	9.16
LH 4495 B5	26.98	0.1120	0.0080	92.64
LH4489 B6	33.36	0.1623	0.0131	6.56
LH 4490 B7	37.63	0.1391	0.0081	65.57
LH4491 B8	35.19	0.1753	0.0099	78.73
LH 4492 B9	31.65	0.1782	0.0256	11.96
LH 4493 B10	40.43	0.1567	0.0088	73.02
Smooth Oreo				
LH 4506 SM1	16.05	0.2236	0.0130	92.07
LH 4505 SM2	20.61	0.1328	0.0172	21.17
LH 4504 SM3	25.97	0.7333	0.0343	91.44
LH 4503 SM4	32.12	0.9959	0.0507	66.26
LH 4498 SM 5	35.98	0.1874	0.0162	29.43
LH 4499 SM6	46.15	1.2504	0.0581	91.44
LH 4500 SM7	54.10	1.2535	0.0575	93.45
LH 4501 SM8	33.82	0.0996	0.1150	22.72
LH 4502 SM9	45.02	1.3409	0.0609	97.52
Spiky Oreo				
LH 2829 SP1	35.60	0.4379	0.0600	79.00
LH 2830 SP2	37.20	0.4440	0.0300	74.50
LH 2831 SP3	39.20	0.6895	0.0645	75.00
LH 3545 SP4	37.03	0.3780	0.0060	57.51
LH 3546 SP5	34.40	0.2590	0.0070	82.86
LH 4186 SP6	33.19	0.2948	0.0147	76.03
LH 4187 SP7	36.98	0.3912	0.0162	81.99
LH 4188 SP8	15.86	0.6072	0.0293	80.33
LH4189 SP9	24.60	0.8966	0.0394	85.88

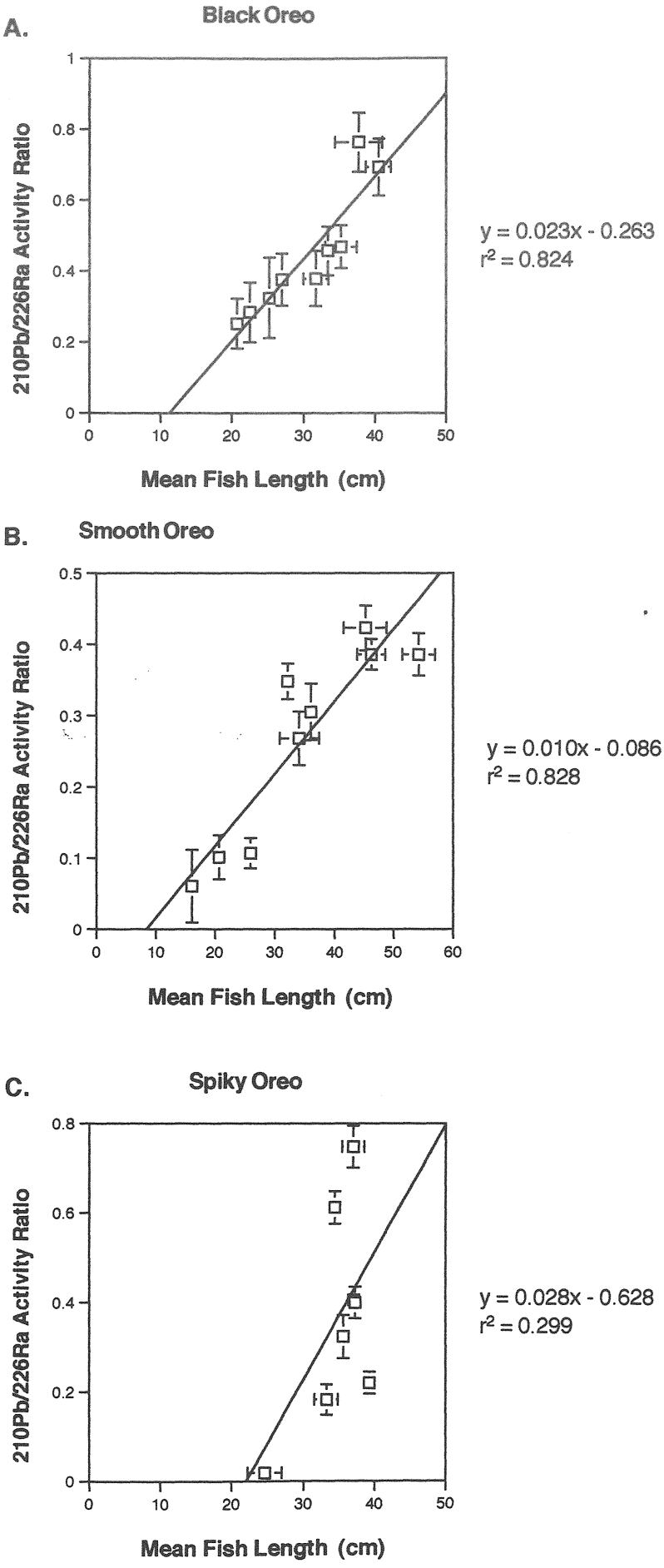


Fig. 8: 210Pb/226Ra activity ratio versus fish length for A) Black Oreo, B) Smooth Oreo and C) Spiky Oreo.

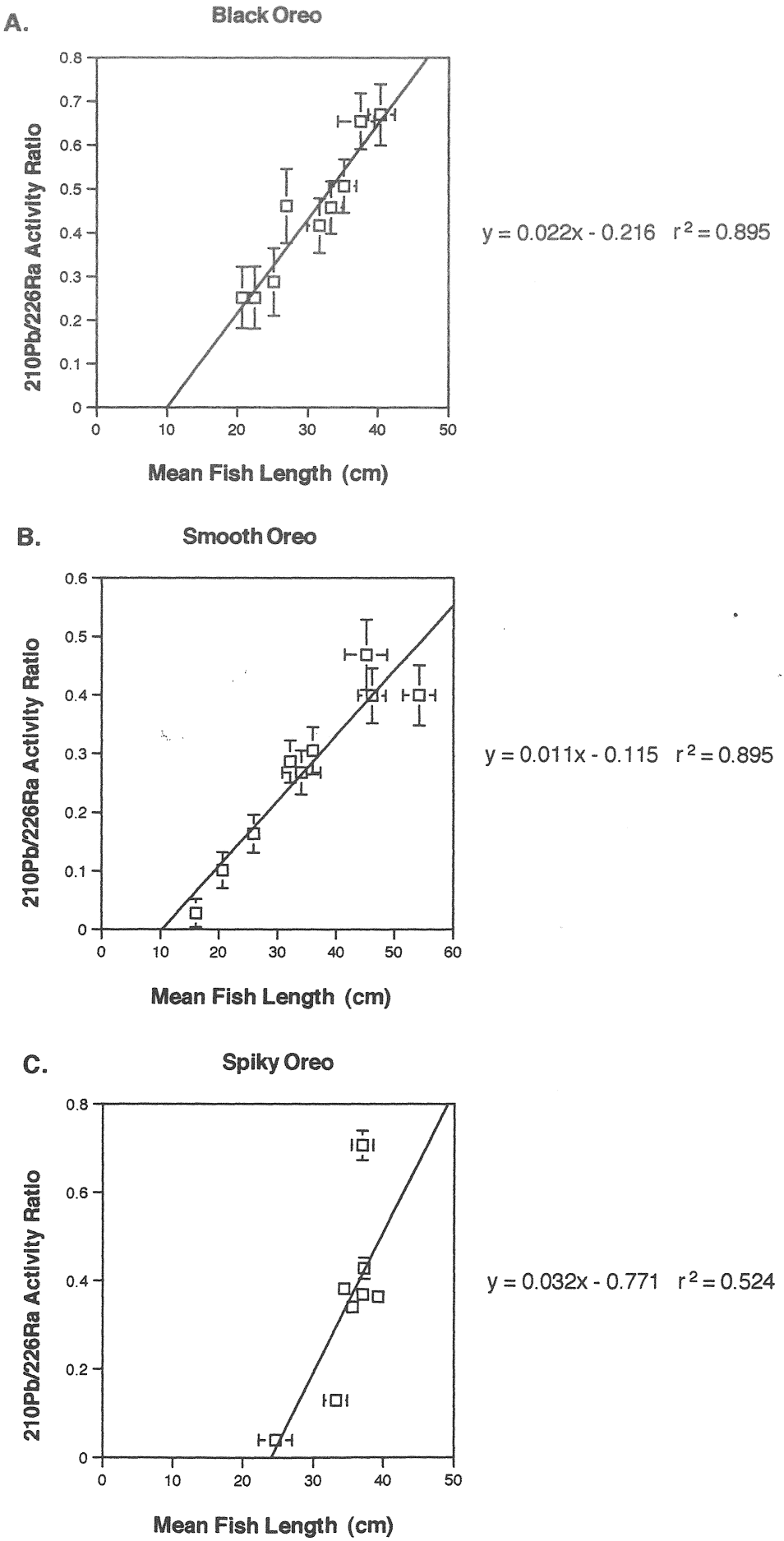


Fig.9: 210Pb/226Ra activity ratio using mean 226Ra versus fish length for A) Black Oreo, B) Smooth Oreo and C) Spiky Oreo.

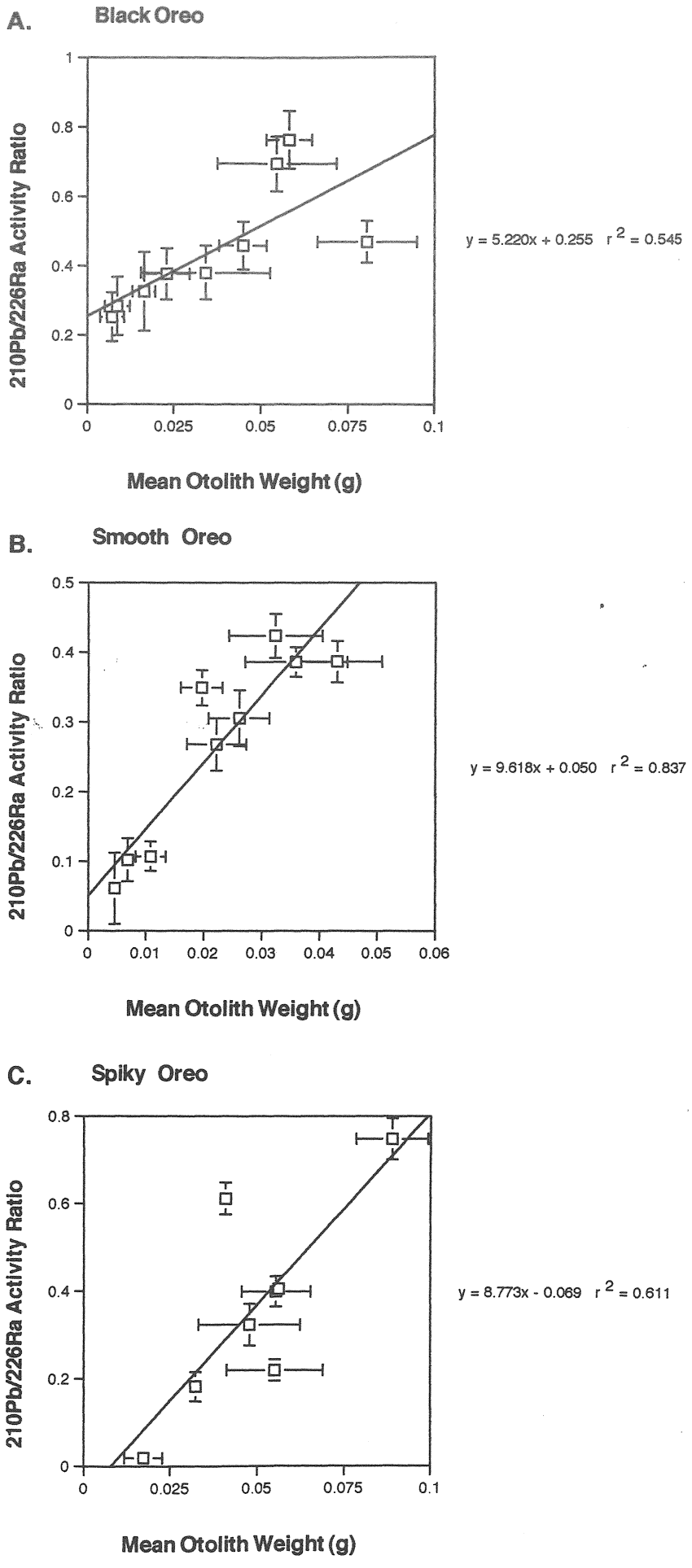


Fig.10: 210Pb/226Ra activity ratio versus otolith weight for A) Black Oreo, B) Smooth Oreo and C) Spiky Oreo.

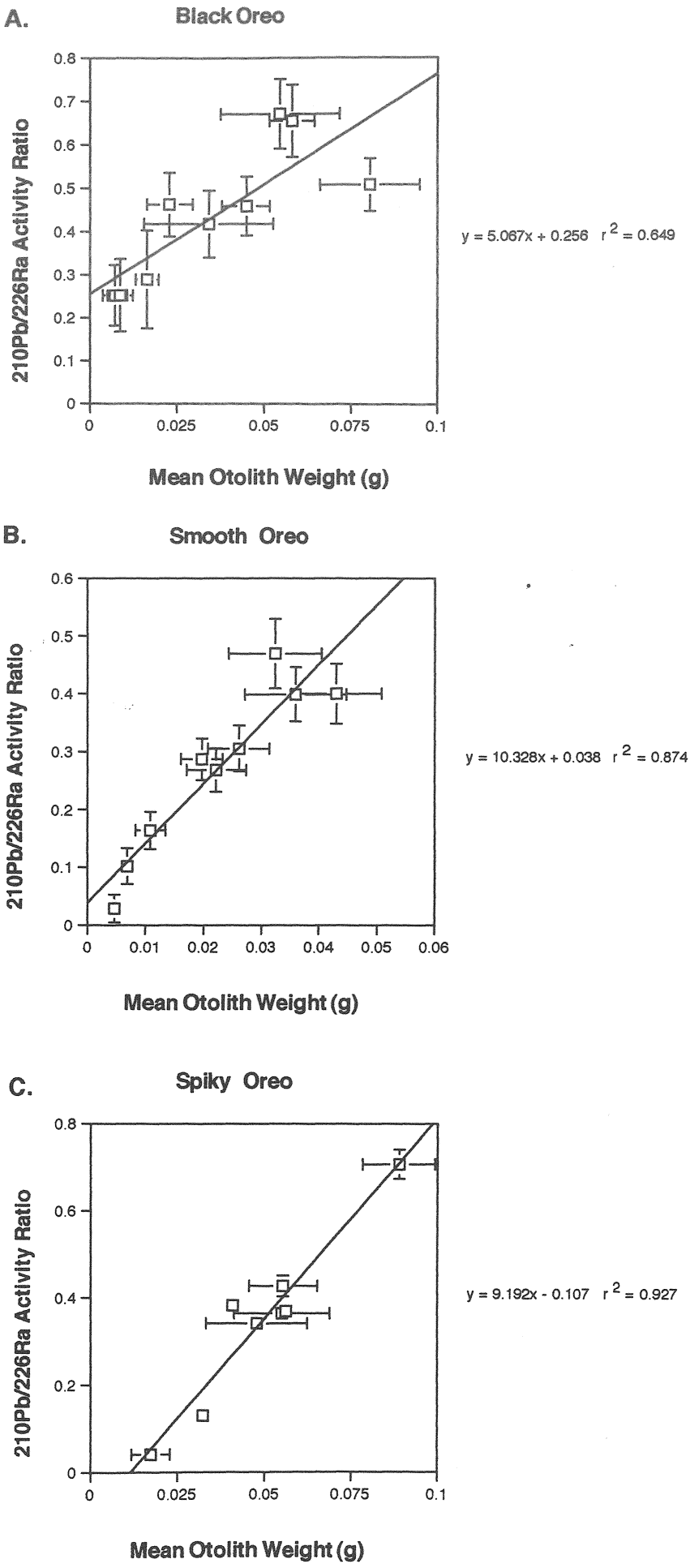


Fig.11: 210Pb/226Ra activity ratio using mean 226Ra versus otolith weight for A) Black oreo, B) Smooth oreo and C) Spiky oreo.

4. Calculation of fish age

a) Mean otolith age.

The mean otolith age has been calculated from the degree of ^{210}Pb ingrowth (assuming an initial activity ratio of 0) using the equation:

$$t = \frac{1}{\lambda_p}\left[\frac{\ln(1\ A)}{1\ R}\right]$$

where t = age (years)

λ_p = decay constant for ^{210}Pb (0.03114 years^{-1})

$A = (^{210}Pb/^{226}Ra)_t$ = activity at time t

$R = (^{210}Pb/^{226}Ra)_0$ = initial activity ratio at time of deposition

The mean otolith age for each sample of the three oreo species is given in Table 6. This calculation takes no account of otolith mass growth, however it is useful to demonstrate that fish age will be significantly greater than, (approximately twice), the mean age of the otolith. However in order to calculate fish age radiometrically the mass-growth regime of the otolith has to be taken into account, since the otolith adds mass gradually throughout life.

b) Linear growth model.

The simplest model of otolith mass growth assumes a constant mass growth (linear) model. Ages have therefore been calculated using the linear growth model equation derived by Bennett *et al.* (1982):

$$A = 1\ \ (1\ \ R)\frac{1\ \ e^{\ \lambda_p t}}{\lambda_p t}$$

where $A = (^{210}Pb/^{226}Ra)_t$ = activity at time t

$R = (^{210}Pb/^{226}Ra)_0$ = initial activity ratio at time of deposition

λ_p= decay constant for ^{210}Pb (0.03114 year^{-1})

Table 6: Mean otolith age calculated from the radiometric data for black, smooth and spiky oreo.

Sample Code	Fish length (cm)	Otolith weight (g)	n	Mean otolith age (yr) using individual 226Ra	Mean otolith age (yr) using mean 226Ra
Black Oreo					
LH 4497 B1	20.73 ± 1.28	0.0072 ± 0.0035	147	7.67 ±5.49	7.67 ±5.49
LH 4496 B2	22.47 ± 0.28	0.0087 ±0.0036	119	9.06 ±6.45	7.67 ±5.54
LH 4494 B4	25.14 ± 0.44	0.0164 ±0.0033	64	10.99 ±8.55	9.27 ±6.1
LH 4495 B5	26.98 ± 0.86	0.0229 ±0.0066	49	13.53 ±6.7	18.26± 8.49
LH 4492 B9	31.65 ± 1.74	0.0341 ±0.0186	32	13.7 ±6.98	15.68 ±6.37
LH4489 B6	33.36 ±1.43	0.0448 ±0.0069	24	18.04 ±7.26	18.04 ±6.61
LH4491 B8	35.19 ±2.19	0.0805 ±0.0143	14	18.72 ±6.82	21.08 ±7.29
LH 4490 B7	37.63 ± 3.3	0.0581 ±0.065	18	44.7 ±18.7	32.5 ± 10.26
LH 4493 B10	40.43 ±1.77	0.0546 ±0.171	20	36.39 ±13.83	33.97 ±11.57
Smooth Oreo					
LH 4506 SM1	16.05 ±1.0	0.0047 ±0.0009	222	0.37 ±3.65	(-)0.72 ±2.54
LH 4505 SM2	20.7 ±1.78	0.0069 ±0.0013	146	1.8 ±3.02	1.8±3.02
LH 4504 SM3	25.94 ±1.45	0.0109 ±0.0026	98	1.98 ±2.65	4.1±3.27
LH 4503 SM4	32.13±1.39	0.0197 ±0.0036	49	12.12 ±3.71	9.21±3.96
LH 4501 SM8 MALE	34.03 ± 3.26	0.0222 ±0.0051	46	8.37 ±3.95	8.37 ± 3.95
LH 4498 SM 5	35.96 ±1.1	0.0261 ±0.0053	39	10.05±4.26	10.05 ±4.26
LH 4502 SM9 MALE	45.16 ± 3.65	0.0324 ±0.0081	30	16.03 ±4.48	18.68 ±6.78
LH 4499 SM6	46.15 ± 2.38	0.0359 ±0.0088	29	14.02 ±3.67	14.7 ±5.26
LH 4500 SM7	54.13 ± 2.72	0.043 ±0.0078	29	14.02 ±4.13	14.75 ±5.55
Spiky Oreo					
LH 4188 SP8	15.86 ± 3.19	0.0063 ±0.0032	158	(-)4.92 ±1.86	(-)6.34 ±1.89
LH4189 SP9	24.6 ± 2.4	0.0173 ±0.0055	58	(-)1.05±2.02	(-)0.33± 2.47
LH 4186 SP6	33.19± 1.68	0.0322 ±0.0013	31	4.78 ±3.4	2.8 ±2.79
LH 3546 SP5	34.4 ± 1.4	0.0408 ±0.002	25	28.68 ±6.63	13.85 ± 3.64
LH 2829 SP1	35.6 ± 0.4	0.0477 ±0.0146	24	10.83 ±4.8	11.74±3.44
LH 4187 SP7	36.98 ±1.58	0.0888 ±0.0104	12	42.54 ±10.88	37.78 ±7.86
LH 3545 SP4	37.03 ± 1.35	0.0562 ±0.0024	20	14.98 ±3.84	13.16 ±3.53
LH 2830 SP2	37.2 ± 0.47	0.0554 ±0.0099	20	14.67 ±4.52	16.28±4.04
LH 2831 SP3	39.2 ± 0.79	0.0551 ±0.0139	18	6.28 ±3.14	12.92 ±3.64

In all cases the juvenile fish activity ratio values were very low therefore the initial activity ratio used in the calculations was R =0. Ages calculated using this model are given in Tables 2, 3 and 4 for black, smooth and spiky oreo respectively. Given the errors associated with the ages there is little difference between using ages calculated with individual ^{226}Ra or mean ^{226}Ra values.

The maximum age estimated for black oreo using individual ^{226}Ra values in the calculation was approximately 134 years and using mean ^{226}Ra values was approximately 92 years.

The ages for smooth oreo were much lower with the maximum age using individual ^{226}Ra values in the calculation approximately 39 years and 46 years using mean ^{226}Ra values. The oldest smooth oreos analysed were males. The oldest female smooth oreos were approximately 34 or 36 years using individual ^{226}Ra values and mean ^{226}Ra values respectively.

The maximum age for spiky oreos using individual ^{226}Ra values in the calculation was approximately 106 years and approximately 125 years using mean ^{226}Ra values.

The relationship between otolith weight and fish age calculated using individual ^{226}Ra and mean ^{226}Ra values are plotted in Figs. 12 and 13, not surprisingly the relationship is strongly linear given that constant mass growth is assumed in the age calculation. The relationship between fish length and fish age calculated using individual ^{226}Ra and mean ^{226}Ra values are plotted in Fig. 14. In this case linear relationships have been fitted to the data and it is clear from the r^2 values that a linear relationship is not appropriate for spiky oreo with . The data is plotted using power curves in Fig 15 and clearly the r^2 values are better in all cases.

5. Von Bertalanffy Growth Curves

Von Bertalanffy growth curves are fitted to the age estimates for each species and plotted together with the radiometric data points and the curves given by Smith and Stewart (1994) in Fig. 16. A summary of the Von Bertalanffy parameters for all the species are given in Table 7.

6. Age at maturity

The age at maturity was estimated using the length of female maturation (Lyle *et al.* 1991) from the relationship of linear mass growth

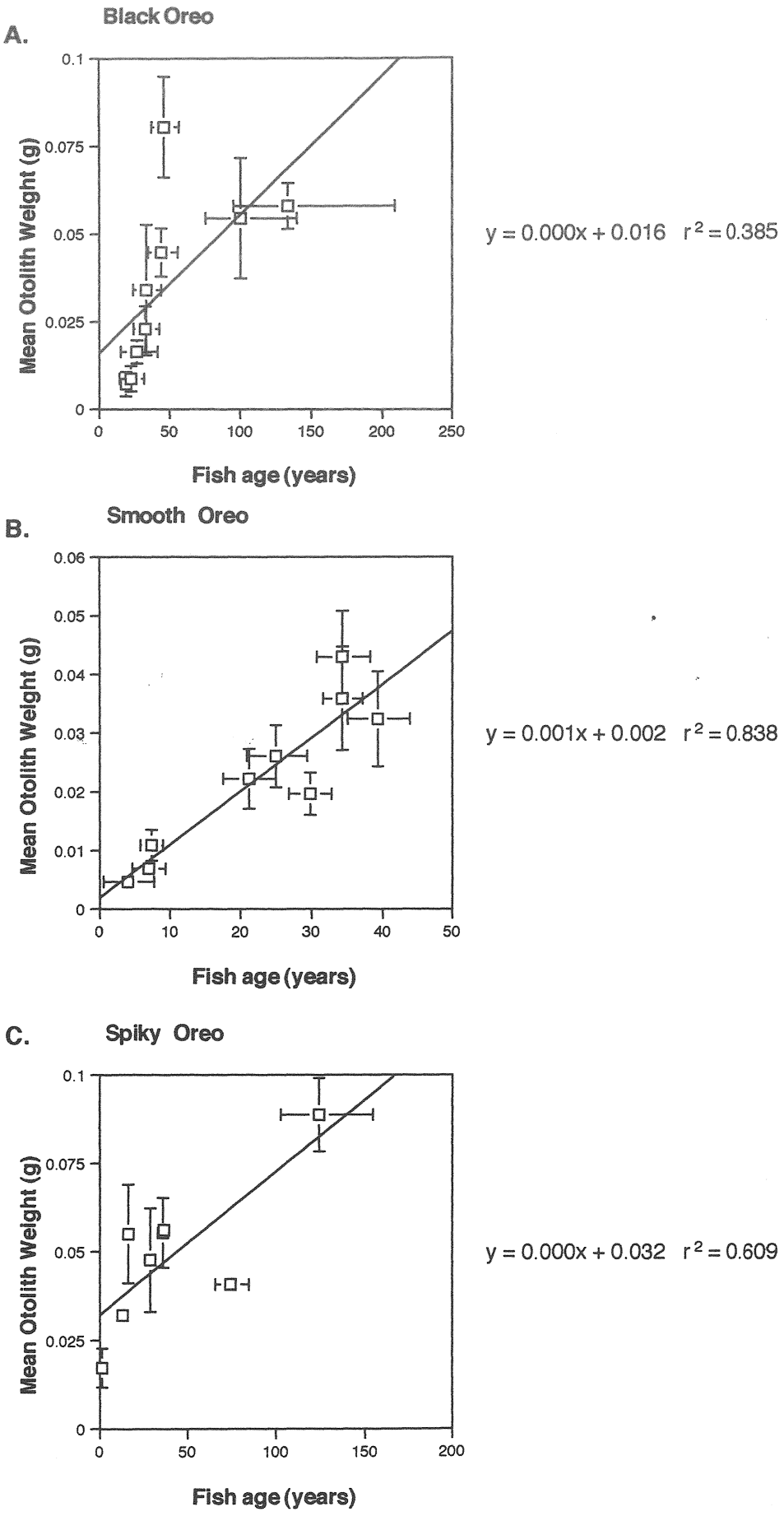
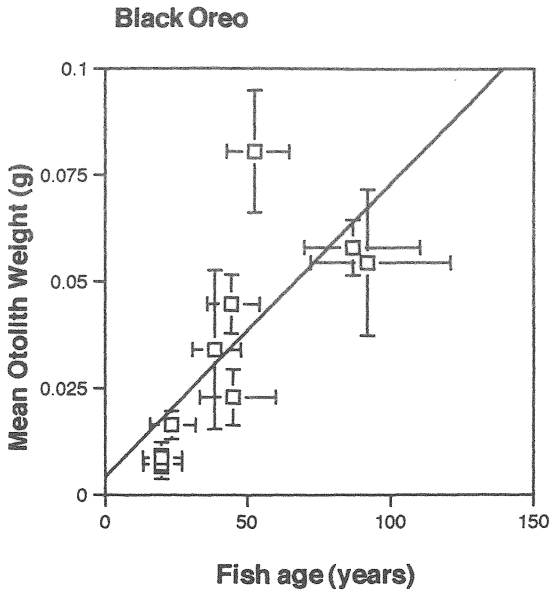


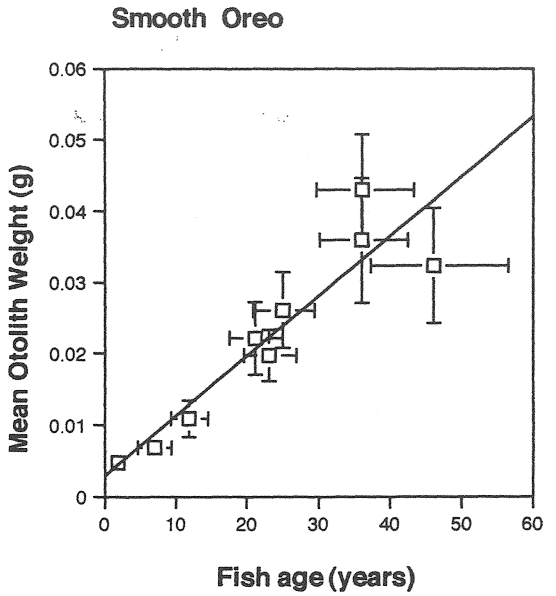
Fig.12: Relationship between otolith weight and fish age calculated using individual ^{226}Ra values for A) Black Oreo, B) Smooth Oreo and C) Spiky Oreo.

A.



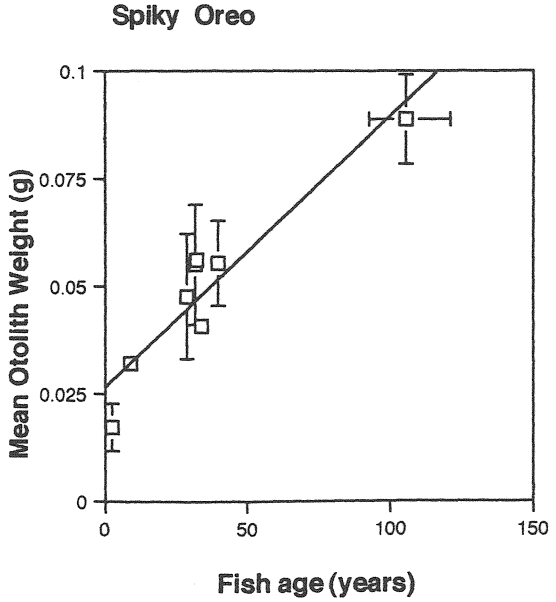
$y = 0.001x + 0.004$ $r^2 = 0.547$

B.



$y = 0.001x + 0.003$ $r^2 = 0.853$

C.



$y = 0.001x + 0.027$ $r^2 = 0.879$

Fig. 13 Relationship between otolith weight and radiometric age calculated using mean 226Ra values for A) Black Oreo, B) Smooth Oreo and C) Spiky Oreo.

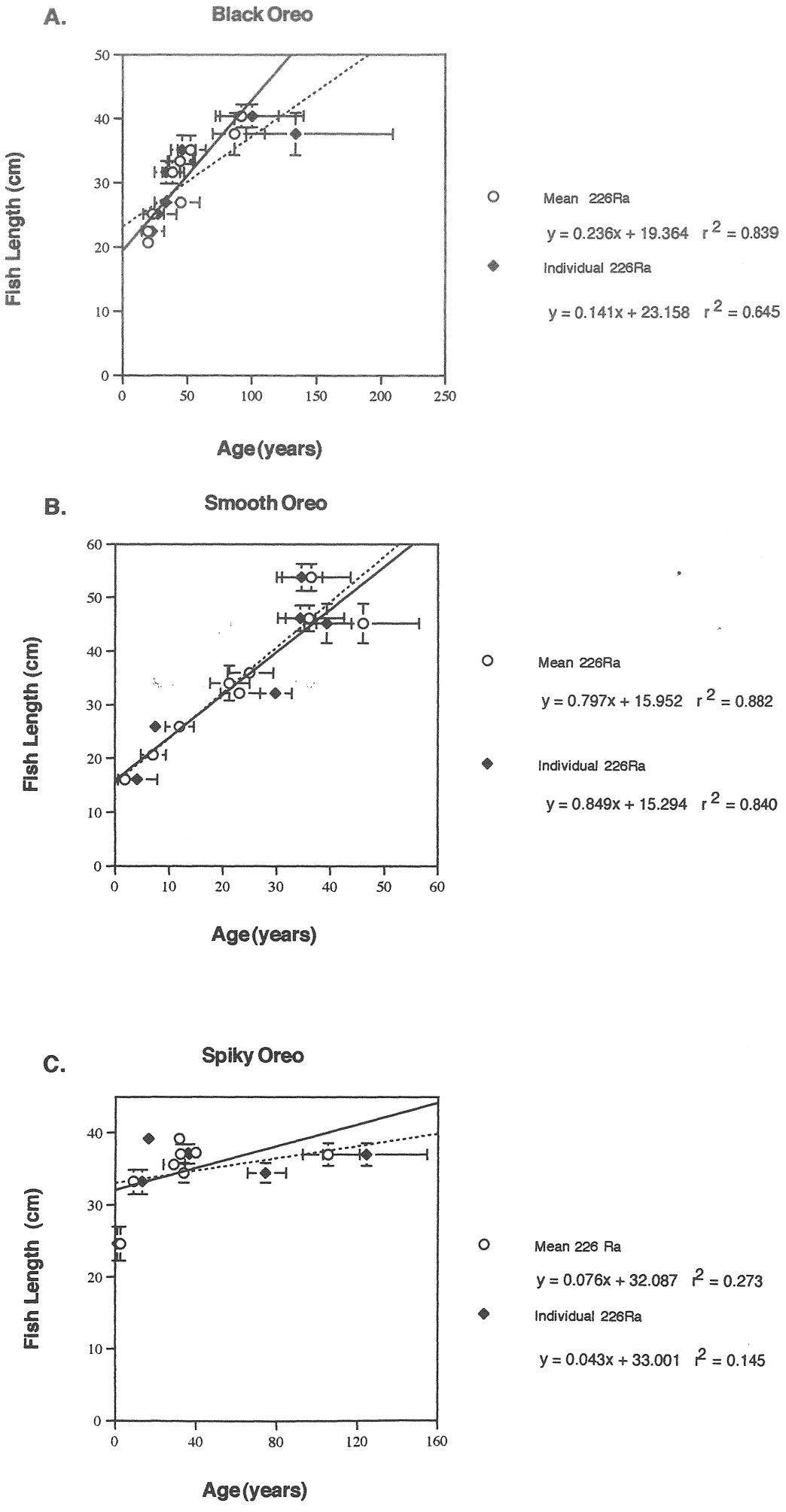


Fig 14. Relationship between radiometric age and fish length for A) Black Oreo, B) Smooth Oreo and C) Spiky Oreo calculated using the linear otolith mass-growth model.

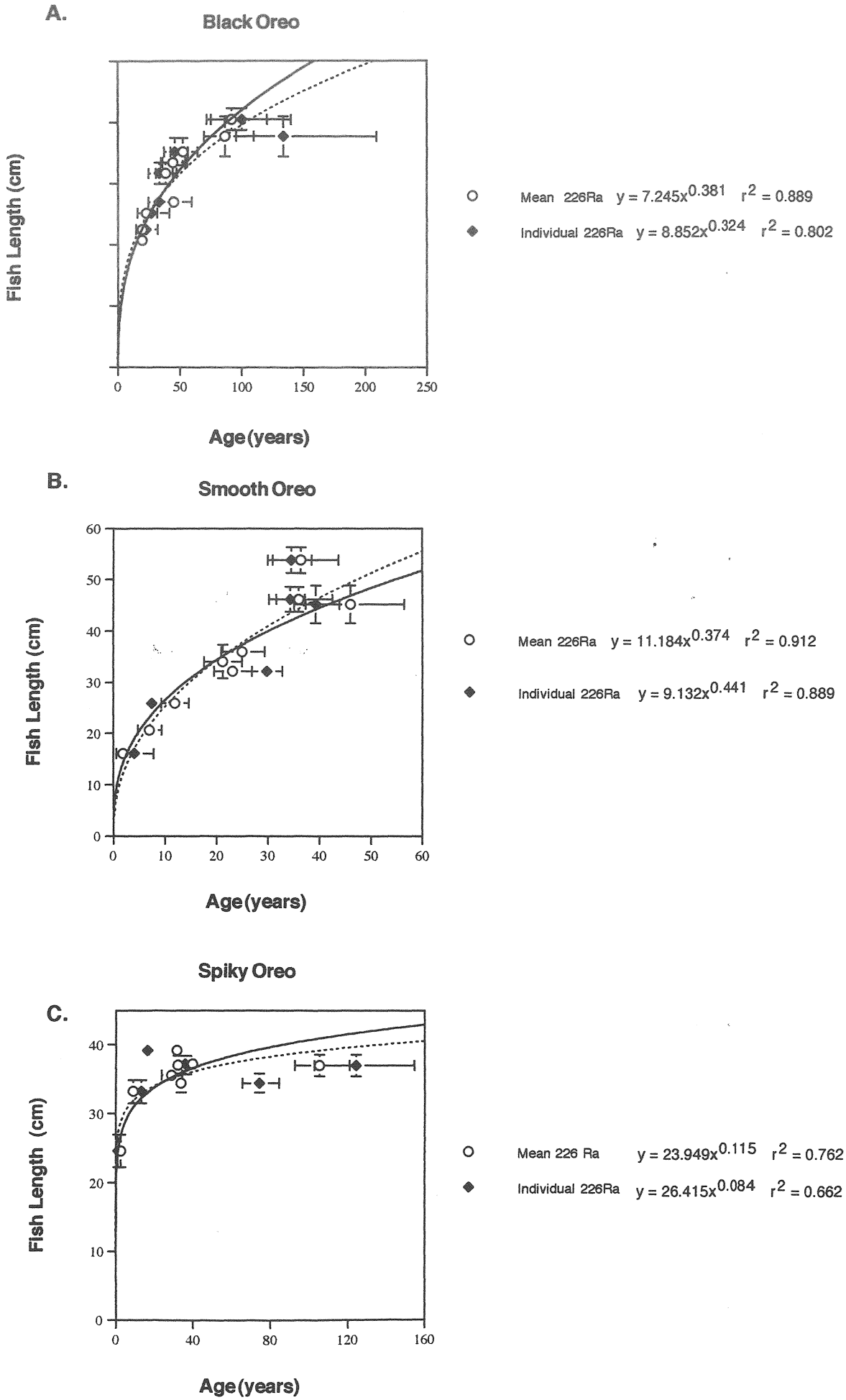


Fig.15: Relationship between radiometric age and fish length for A) Black Oreo, B) Smooth Oreo and C) Spiky Oreo calculated using the linear otolith mass-growth model. Power curves have been fitted to the data.

Table 7: Comparison of Von Bertalanffy parameter estimates for black, smooth and spiky oreo derived from radiometric and section age data.

Method and Species	k	L inf	to	Author
Radiometric Age				
Black	0.026	42.53	-9.20	Present study
Smooth	0.021	73.56	-9.00	Present study
Spiky	0.194	36.50	-4.56	Present study
Section Age				
Australia				
Black	0.052	41.10	-10.30	Smith and Stewart 1994
Smooth	0.051	50.94	1.05	Smith and Stewart 1994
Spiky	0.051	36.16	-1.69	Smith and Stewart 1994
New Zealand				
Black female *	0.019	44.40	-35.10	Annala 1995
Black male*	0.017	43.00	-42.50	Annala 1995
Smooth female	0.046	52.00	-2.90	Annala 1995
Smooth male	0.080	14.00	-1.00	Annala 1995
* Post settlement fish >21cm TL used in calculation				

radiometric age and fish length from the equations given in Figs 14 & 15 and the von Bertalanffy growth curves . The results are presented in Table 8 together with the estimates provided by Smith and Stewart (1994). The radiometric results suggest that the age of maturity in black oreo is high, in all cases above 60 years, while the age of maturity for smooth oreo seems consistent around 30 years and for spiky about 20 years although the von Bertalanffy growth curve suggests it may be lower, between 10-15 years.

7. Discussion

1. Trace element analysis

The Sr/Ca results for smooth oreo suggest a change in the water mass/ temperature they inhabit as they grow, with higher Sr/Ca values suggesting cooler water (Radtke *et al.* 1993). Therefore there is some evidence to suggest that smooth oreo may inhabit colder waters while small with their otolith Sr/Ca values gradually approaching (but not reaching) the lower values seen in the otoliths of black and smooth oreos. Interestingly the only records of small juvenile smooth oreo to date have been from the Antarctic Circumpolar current (James et al., 1988). The idea that the young smooth oreos are further south is also supported by dietary stable isotope data ^{13}C for oreos collected from the Pedra Branca region south of Tasmania (Fenton unpubl. data) where there is a dramatic change in ^{13}C values from juveniles to adults suggesting a diet based on an Antarctic food source.

The Pb and Ba data were of no real use due to the relatively high reagent blank values. However the data does indicate that stable lead is not changing as fish grow. There has been some discussion in the literature about the source of the ^{210}Pb seen in otoliths (West and Gauldie, 1994) however for there to be a significant increase in ^{210}Pb from external sources we would expect an increase in the far more abundant stable form of lead. Our results for all species analysed have not demonstrated a significant level, or an increase in the level of stable lead in the otoliths as fish grow. Therefore any suggestion that the ^{210}Pb seen in the otoliths is from sources other than in situ radioactive decay of ^{226}Ra are not supported. Discussed in detail for other species by Milton *et al* ., (1995), Kastelle *et al.*, (1994) Smith *et al.*, (1995).

Table 8 : Estimation of age at maturity based on radiometric and section age methods.

Method and Species	Length at Maturity (Female)	Section Age Estimate	Power Model Mean 226Ra	Power Model individual 226Ra	Linear with mean 226Ra	Linear with individual 226Ra	Mean Maturity	Von Bertalanffy	Author
Radiometric Age									
Black Oreo	36		67	76	70	91	76	60-65	Present study
Smooth Oreo	41		32	30	31	30	31	30	Present study
Spiky Oreo	34		21	20	25	23	22	10-15	Present study
Section Age									
Australia									
Black Oreo	36	20						30	Smith and Stewart 1994
Smooth Oreo	41	20-25						30-35	Smith and Stewart 1994
Spiky Oreo	34	30-35						55	Smith and Stewart 1994
New Zealand									
Black Oreo	34							42	Annala 1995
Smooth Oreo	40							30	Annala 1995

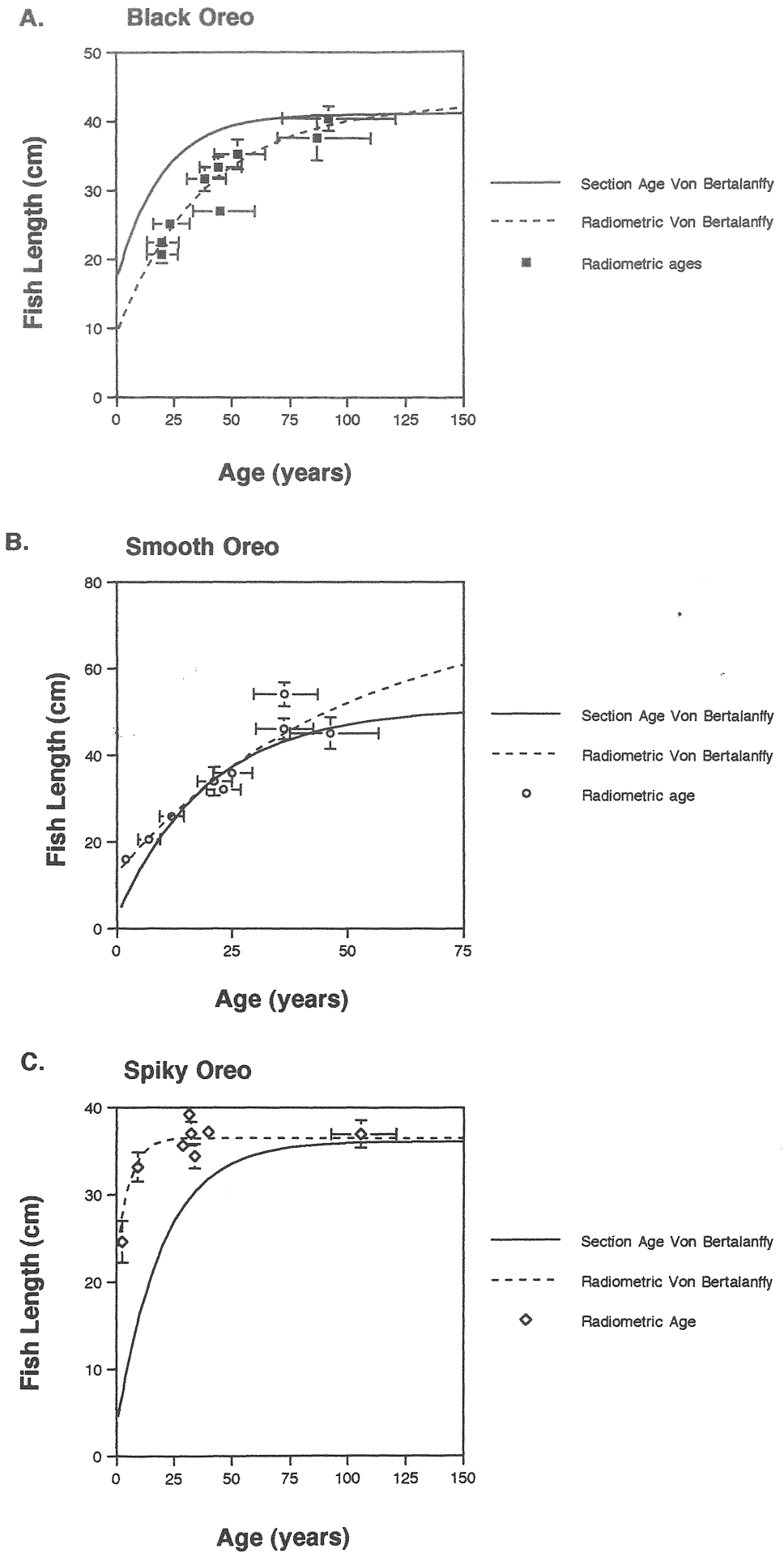


Fig.16: Comparison of section age (Stewart and Smith 1994) and radiometric age Von Bertalanffy curves together with radiometric ages using mean ^{226}Ra for A) Black Oreo, B) Smooth Oreo and C) Spiky Oreo

2. ^{226}Ra

The levels of ^{226}Ra found in a range of fish species from throughout the world are summarised in Table 9. It is worth noting that levels found in the black, smooth and spiky oreos analysed here are higher than for most other species and the levels for smooth oreo are the highest yet reported. The physiology/genetics of each species are implicated as important in controlling the uptake of ^{226}Ra, since of the species listed four oreo species and orange roughy were all collected from southern Australia and at least as adults are presumably exposed to similar water masses. Edmonds *et al.* (1991) reported that different species clearly incorporate trace elements at different rates. As more species are analysed radiometrically the interpretation of the ^{226}Ra levels should become clearer.

3. Age estimates

This study has successfully produced age estimates for black, smooth and spiky oreo and provided estimates of their age at maturity. The results have also been compared to the results of Smith and Stewart (1994). Both studies have shown that black and spiky oreo are very long-lived, but that smooth oreo probably are not quite so long-lived.

Smith and Stewart (1994) tried several approaches to determine the age of oreo otoliths. They found that age estimates were only possible from whole otoliths for fish less than 25 cm in length but their confidence in the ages was low. Breaking and burning the otoliths was also of limited value. However they found that it was possible to provide age estimates from sectioned otoliths using sections ranging from 100-200 μm.

Smith and Stewart (1994) found that the first 4 to 5 increments in the otoliths of black oreos were very broad and distinct. There was then a rapid transition into narrower increments. Of a total of 174 otoliths prepared it they were able to provide ages for 127. Their ages ranged from 8 years for a 28.1 cm female to 100 years for a 43.5 cm female fish. Age at maturity was estimated at 20 years.

Smooth oreo otoliths also showed a distinct difference between the first few increments and the remainder, with the first 5 to 6 increments much broader Smith and Stewart (1994) . They sectioned 276 otoliths, but it was only possible to provide age estimates for 131, due mainly to unsuccessful

Table 9: Comparison of ^{226}Ra values measured in fish otoliths from a range of species. (* reflects a mean value)

Species	Location	Depth m	226Ra lowest dpm.g-1	226Ra highest dpm.g-1	Author
Sebastes diploproa	West coast USA and Canada	Outer continental shelf and upper slope	0.033 ±0.007	0.054 ±0.0090	Bennett et al. (1982)
Sebastes mentella	Nova Scotia	200-900	0.033* ±0.0020		Campana et al. (1990)
Hoplostethus atlanticus	S.TAS	750-1000	0.0522* ±0036	0.0625* ±0.0030	Fenton et al. (1991)
Anoplopoma fimbria	California	135-1426	0.288 ±0.0120	0.517 ±0.0210	Kastelle et al. (1994)
Lutjanus erythropterus	NTH Aust Gulf of Carpentaria	< 55	0.1331 ±0.0087	0.2277 ±0.0132	Milton et al. (1994)
L.malabaricus	NTH Aust Gulf of Carpentaria	< 55	0.0582 ±0.0049	0.2942 ±0.0141	Milton et al. (1994)
L.sebae	NTH Aust Gulf of Carpentaria	< 55	0.046 ±0.0042	0.2143 ±0.0114	Milton et al. (1994)
Macruronus novaezelandiae	S.TAS	500-850	0.0179 ±0.0026	0.029 ±0.0036	Fenton and Short (1995)
Allocyttus verrucosus	S.TAS	800-1200	0.0391 ±0.0031	0.0694 ±0.0042	Stewart et al. (1995)
Neocyttus rhomboidalis	S.TAS	1000	0.259 ±0.0070	0.8966 ±0.0394	Present study
Pseudocyttus maculatus	S.TAS	1000	0.733 ±0.0343	1.3409 ±0.0609	Present study
Allocyttus niger	S.TAS	1000	0.0811 ±0.0072	0.1782 ±0.0256	Present study

preparations of these small otoliths. Ages ranged from 7 years for a male 18.1 cm in length up to 78 years for a female fish 54.0 cm in length. They estimated the age of maturity at about 20-25 years.

Smith and Stewart (1994) found spiky oreo otoliths were clearer to read than the other species and provided ages for 106 of the 154 otoliths prepared. Their age estimates ranged from 4 years for and immature fish 9.9 cm in length up to 128 years for a female fish of 40.1 cm. They estimated the age of maturity at about 30-35 years.

Previous attempts in New Zealand to age smooth and black oreos by Davies et al (1988) from very thin sections of otoliths (20 μm) and acetate peels were unsuccessful. However recently in New Zealand Annala (1995) using the same methods as Smith and Stewart (1994) have provided age estimates from sectioned otoliths. They reported that both black and smooth oreo appear to have a pelagic juvenile phase but little is known about this stage since only six smooth oreos <16 cm TL and 12 blacks < 21 cm have been caught. Unvalidated ages estimates suggest this pelagic phase last 5-6 years for smooth oreos equivalent to fish lengths 16-19 cm TL and 4-5 years for black oreo equivalent to fish lengths 21-26 cm TL. Unvalidated age estimates from Chatham Rise smooth and black oreos based on thin otolith sections indicate slow growth with a maximum age of 86 years for a smooth oreo 51.3 cm TL and 153 years for a black oreo 45.5 cm TL. The New Zealand data indicates that the age at maturity for smooth oreo is 30 years and 42 years for female black oreos.

The radiometric results have proven themselves valuable as a comparison/validation of the section ages estimated by Smith and Stewart (1994) and are similar to the estimates from New Zealand for black and smooth oreo. The results presented here have used the linear growth model to estimate age. In most of the other radiometric fish studies a double growth model has also been applied, however the data here suggest that was not required and not using the double growth model avoids the circularity of using otolith weight as discussed in Francis (1995).

The radiometric technique has now proven itself for several important commercial fish species in Australia (e.g. orange roughy, blue grenadiear and warty oreo) and should be considered a practical method for checking age estimates in the future.

The combination of low fecundity (Conroy and Pankhurst, 1989) and high of maturity and longevity of the oreo species means they would be susceptible to over-exploitation and therefore require careful management.

8. Implications and recommendation-include costs and benefits to the Australian industry or future research needs

The Australian fishing industry requires accurate age estimates for development of appropriate management plans for both existing and developing fisheries. Therefore given the importance of validating age estimates independently, the radiometric method appears well suited to fulfil this role. The technique using $^{210}Pb/^{226}Ra$ is ideal for mid- to long lived species and in particular where tagging or other alternate methods are not feasible or are too expensive. The radiometric method provides a very easy and quick way of checking the approximate age of a species. For example, with the knowledge and experience we now have with the technique, it is practical to consider analysing 2-3 samples to give an approximate age for that species. This would tell us whether the species is old or not. Clearly this is an appealing option since for a relatively modest cost < $4 000 an age estimate could be provided. (A more detailed validation would of course require analysis of more samples similar to the study conducted here). Radiometric age determination is particularly important for ageing species where only adults are found or where traditional techniques prove impractical. It is also important to mention that otolith coring is recommended whenever possible (e.g. Fenton and Short, 1995).

At present the radiometric ageing research has concentrated on bony fish (mostly deep-sea species). Research is underway at present using this technique on sharks FR&DC grant 94/21, but there are obvious applications in other areas of fisheries research:

- for commercially important mollusc species
- development of the $^{228}Ra/^{228}Th$ isotope pair for short lived species e.g. under 20 years of age.
- for determining the age of moults in large crustaceans e.g. crabs and crayfish

9. Intellectual property arising

The results of the project are scientific and of no direct commercial value. The results of the study will be published in the scientific literature

and was presented at the World Fisheries Congress in Brisbane July 1996 jointly with Dr. David Smith..

10. Technical summary of all information developed as a part of the research

This project applied methodology developed in earlier FR&DC projects. However this project has increased the experience with the radiometric technique using ^{210}Pb and ^{226}Ra together with stable Pb, Ba, Sr and Ca analysis. The radiometric technique has again proven its value for determining fish age. The radiometric technique could now be regarded as a pratical alternative for age determination and a valuable tool for age validation of fish species.

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APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
2	1	70	R	31-Aug-93	44.1576/147.1555	720-1000		3	15.5	0.0056	
3		70	R	31-Aug-93	44.1576/147.1555	720-1000		3	15.5	0.0057	
4		286	R	2-Oct-93	41.4402/148.4236	700-900	6	3	15.5	0.0121	
5		286	R	2-Oct-93	41.4402/148.4236	700-900	6	3	15.5	0.0122	
6		283	R	2-Oct-93	41.4402/148.4236	700-900	6	3	17	0.0171	
7		283	R	2-Oct-93	41.4402/148.4236	700-900	6	3	17	0.0169	
8		282	R	2-Oct-93	41.4402/148.4236	700-900	6	3	18.6	0.0158	
9		282	R	2-Oct-93	41.4402/148.4236	700-900	6	3	18.6	0.0143	
10		284	R	2-Oct-93	41.4402/148.4236	700-900	6	3	18.7	0.021	
11		284	R	2-Oct-93	41.4402/148.4236	700-900	6	3	18.7	0.0212	
12		285	R	2-Oct-93	41.4402/148.4236	700-900	6	3	18.9	0.0163	
13		285	R	2-Oct-93	41.4402/148.4236	700-900	6	3	18.9	0.0158	
14		92	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	19.3	0.0055	
15		83	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	19.4	0.0066	
16		83	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	19.4	0.0066	
17		158	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	19.4	0.006	
18		158	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	19.4	0.006	
19		277	R	25-Sep-93	44.16/147.15	984		3	19.4	0.0069	
20		277	R	25-Sep-93	44.16/147.15	984		3	19.4	0.0067	
21		281	R	2-Oct-93	41.4402/148.4236	700-900	6	3	19.6	0.0179	
22		281	R	2-Oct-93	41.4402/148.4236	700-900	6	3	19.6	0.0176	
23		198	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	3	19.9	0.0053	
24		198	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	3	19.9	0.0052	
25		52	R	31-Aug-93	44.1576/147.1555	720-1000		3	20.1	0.0052	
26		52	R	31-Aug-93	44.1576/147.1555	720-1000		3	20.1	0.0051	
27		217	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	3	20.1	0.0063	
28		68	R	31-Aug-93	44.1576/147.1555	720-1000		3	20.2	0.0057	
29		68	R	31-Aug-93	44.1576/147.1555	720-1000		3	20.2	0.0054	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
30		272	R	25-Sep-93	44.16/147.15	984		3	20.2	0.0057	
31		272	R	25-Sep-93	44.16/147.15	984		3	20.2	0.0056	
32		202	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	2	20.3	0.0045	
33		202	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	2	20.3	0.0043	
34		93	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	20.3	0.006	
35		40	R	31-Aug-93	44.1576/147.1555	720-1000		3	20.4	0.0041	
36		40	R	31-Aug-93	44.1576/147.1555	720-1000		3	20.4	0.0042	
37		55	R	31-Aug-93	44.1576/147.1555	720-1000		3	20.4	0.005	
38		55	R	31-Aug-93	44.1576/147.1555	720-1000		3	20.4	0.0052	
39		51	R	31-Aug-93	44.1576/147.1555	720-1000		3	20.5	0.0058	
40		51	R	31-Aug-93	44.1576/147.1555	720-1000		3	20.5	0.0056	
41		150	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	20.5	0.0066	
42		150	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	20.5	0.0066	
43		210	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	3	20.5	0.0053	
44		210	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	3	20.5	0.0052	
45		76	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	20.6	0.0058	
46		95	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	20.6	0.0067	
47		95	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	20.6	0.0065	
48		127	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	20.6	0.0093	
49		127	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	20.6	0.0089	
50		131	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	20.6	0.0055	
51		154	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	20.6	0.0064	
52		154	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	20.6	0.0059	
53		235	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	3	20.6	0.0164	
54		235	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	3	20.6	0.0152	
55		261	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	3	20.6	0.012	
56		261	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	3	20.6	0.0123	
57		270	R	25-Sep-93	44.16/147.15	984		3	20.6	0.0056	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
58		270	R	25-Sep-93	44.16/147 .15	984		3	20.6	0.0058	
59		207	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	20.7	0.0059	
60		207	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	20.7	0.0057	
61		157	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	20.7	0.0046	
62		157	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	20.7	0.0046	
63		44	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	20.8	0.0053	
64		234	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	20.8	0.0049	
65		234	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	20.8	0.0048	
66		53	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	20.9	0.005	
67		53	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	20.9	0.0054	
68		110	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	20.9	0.0061	
69		110	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	20.9	0.0062	
70		164	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	20.9	0.0068	
71		164	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	20.9	0.0071	
72		186	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	20.9	0.0061	
73		50	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21	0.0058	
74		50	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21	0.0056	
75		250	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	21	0.0056	
76		250	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	21	0.0059	
77		62	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.1	0.0055	
78		62	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.1	0.0054	
79		211	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.1	0.0052	
80		211	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.1	0.0053	
81		253	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	21.1	0.0053	
82		41	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.2	0.0054	
83		41	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.2	0.0053	
84		147	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.2	0.0071	
85		147	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.2	0.0067	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
86		183	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.2	0.0061	
87		183	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.2	0.0059	
88		35	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.3	0.0053	
89		35	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.3	0.0052	
90		116	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	21.3	0.0058	
91		196	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	1	21.4	0.0101	
92		196	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	1	21.4	0.0101	
93		57	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.4	0.0062	
94		57	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.4	0.0056	
95		128	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	21.4	0.0063	
96		128	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	21.4	0.0066	
97		148	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.4	0.0062	
98		148	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.4	0.006	
99		199	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.4	0.0053	
100		199	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.4	0.0056	
101		48	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.5	0.0041	
102		48	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.5	0.0056	
103		91	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.5	0.0056	
104		91	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.5	0.0057	
105		213	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	21.6	0.0059	
106		213	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	21.6	0.0054	
107		45	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.6	0.0053	
108		45	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.6	0.005	
109		71	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.6	0.0058	
110		71	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.6	0.0059	
111		108	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	21.6	0.0095	
112		120	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	21.6	0.0058	
113		120	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	21.6	0.0058	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
114		192	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.6	0.0091	
115		192	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.6	0.0091	
116		276	R	25-Sep-93	44.16/147 .15	984		3	21.6	0.0057	
117		276	R	25-Sep-93	44.16/147 .15	984		3	21.6	0.0056	
118		39	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.7	0.0055	
119		39	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.7	0.0051	
120		109	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	21.7	0.0045	
121		109	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	21.7	0.0044	
122		170	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.7	0.0075	
123		170	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.7	0.0072	
124		143	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	21.8	0.0064	
125		143	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	21.8	0.0061	
126		159	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.8	0.0113	
127		159	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.8	0.0111	
128		220	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.8	0.0054	
129		232	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.8	0.0064	
130		232	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.8	0.0064	
131		42	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.9	0.0054	
132		42	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.9	0.0055	
133		60	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.9	0.0092	
134		60	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.9	0.0091	
135		67	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.9	0.0053	
136		67	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	21.9	0.0051	
137		86	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.9	0.0064	
138		86	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.9	0.0063	
139		103	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	21.9	0.0055	
140		103	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	21.9	0.0052	
141		166	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.9	0.0059	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
142		166	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	21.9	0.0057	
143		218	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.9	0.0055	
144		218	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.9	0.006	
145		222	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.9	0.0113	
146		222	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	21.9	0.0114	
147		279	R	25-Sep-93	44.16/147 .15	984		3	21.9	0.0073	
148		279	R	25-Sep-93	44.16/147 .15	984		3	21.9	0.0073	
149										1.0585	
150				11-Sep-93					20.73	0.0072	
151									1.283	0.00347	
152									147		
153											
154	2	265	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	22	0.0189	
155		265	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	22	0.018	
156		152	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22	0.0067	
157		152	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22	0.0064	
158		190	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22	0.0068	
159		190	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22	0.0066	
160		245	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	22	0.0052	
161		245	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	22	0.0055	
162		49	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	22.1	0.006	
163		49	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	22.1	0.0061	
164		56	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	22.1	0.0055	
165		56	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	22.1	0.0054	
166		105	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.1	0.0062	
167		105	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.1	0.0057	
168		139	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.1	0.0144	
169		139	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.1	0.0147	
170		163	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.1	0.0072	
171		163	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.1	0.0067	
172		175	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.1	0.0103	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
173		175	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.1	0.0102	
174		206	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.1	0.0061	
175		206	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.1	0.0065	
176		118	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.2	0.0052	
177		118	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.2	0.0056	
178		122	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.2	0.017	
179		122	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.2	0.0171	
180		254	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	22.2	0.0084	
181		254	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	22.2	0.0081	
182		238	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	22.3	0.0106	
183		238	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	22.3	0.0096	
184		77	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.3	0.0089	
185		77	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.3	0.0087	
186		81	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.3	0.0121	
187		81	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.3	0.0119	
188		100	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.3	0.0061	
189		100	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.3	0.0058	
190		101	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.3	0.0124	
191		101	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.3	0.0118	
192		117	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.3	0.0119	
193		117	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.3	0.0114	
194		137	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.3	0.015	
195		137	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.3	0.0154	
196		184	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.3	0.0036	
197		184	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.3	0.0088	
198		212	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.3	0.0083	
199		212	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.3	0.0088	
200		72	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	22.4	0.0053	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
201		72	R	31-Aug-93	44.1576/147.1555	720-1000		3	22.4	0.0052	
202		112	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	22.4	0.0062	
203		112	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	22.4	0.0062	
204		142	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	22.4	0.0157	
205		142	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	22.4	0.0155	
206		165	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	22.4	0.0054	
207		165	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	22.4	0.0056	
208		230	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	3	22.4	0.0056	
209		230	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	3	22.4	0.0055	
210		69	R	31-Aug-93	44.1576/147.1555	720-1000		3	22.5	0.0055	
211		69	R	31-Aug-93	44.1576/147.1555	720-1000		3	22.5	0.0054	
212		114	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	22.5	0.0084	
213		114	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	22.5	0.0082	
214		133	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	22.5	0.0077	
215		133	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	22.5	0.0078	
216		138	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	22.5	0.0084	
217		138	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	22.5	0.0082	
218		181	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	22.5	0.0059	
219		209	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	3	22.5	0.0061	
220		209	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	3	22.5	0.0058	
221		251	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	3	22.5	0.0076	
222		251	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	3	22.5	0.0077	
223		194	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	2	22.6	0.0062	
224		194	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	2	22.6	0.0064	
225		63	R	31-Aug-93	44.1576/147.1555	720-1000		3	22.6	0.0063	
226		63	R	31-Aug-93	44.1576/147.1555	720-1000		3	22.6	0.006	
227		88	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	22.6	0.0051	
228		88	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	22.6	0.0051	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
229		104	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.6	0.0085	
230		104	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.6	0.0084	
231		111	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.6	0.0073	
232		111	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.6	0.0075	
233		121	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.6	0.0058	
234		121	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.6	0.0059	
235		123	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.6	0.0119	
236		123	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.6	.0.0119	
237		215	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.6	0.0071	
238		215	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.6	0.0069	
239		201	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	22.7	0.0119	
240		201	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	22.7	0.012	
241		113	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.7	0.0072	
242		113	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.7	0.0072	
243		187	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.7	0.0156	
244		187	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.7	0.0149	
245		200	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.7	0.0056	
246		200	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.7	0.0052	
247		229	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.7	0.007	
248		229	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.7	0.0069	
249		273	R	25-Sep-93	44.16/147 .15	984		3	22.7	0.0078	
250		273	R	25-Sep-93	44.16/147 .15	984		3	22.7	0.0078	
251		191	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	22.8	0.0115	
252		191	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	22.8	0.0113	
253		125	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.8	0.0069	
254		125	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	22.8	0.0067	
255		145	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.8	0.0131	
256		145	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.8	0.0133	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
257		155	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.8	0.0091	
258		155	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.8	0.0091	
259		278	R	25-Sep-93	44.16/147 .15	720-1000		3	22.8	0.0069	
260		278	R	25-Sep-93	44.16/147 .15	720-1000		3	22.8	0.0068	
261		54	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	22.9	0.0063	
262		54	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	22.9	0.0063	
263		74	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.9	0.0063	
264		74	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	22.9	0.0064	
265		189	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.9	0.0084	
266		189	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	22.9	0.0089	
267		161	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	23	0.0181	
268		161	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	23	0.0195	
269		144	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	23	0.0097	
270		144	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	23	0.0096	
271		243	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	23	0.007	
272		243	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	23	0.0066	
273										1.0297	
274				11-Sep-93					22.47	0.00865	
275									0.284	0.00356	
276									119		
277											
278	3	188	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	23.1	0.017	
279		188	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	23.1	0.0166	
280		193	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	1	23.2	0.0125	
281		193	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	1	23.2	0.0124	
282		38	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.2	0.0094	
283		47	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.2	0.0059	
284		47	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.2	0.0058	
285		61	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.2	0.0054	
286		61	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.2	0.0054	
287		98	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	23.2	0.0047	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
288		214	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	23.2	0.0084	
289		214	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	23.2	0.0081	
290		224	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	23.2	0.0067	
291		224	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	23.2	0.0068	
292		153	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	23.3	0.0164	
293		87	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	23.3	0.0064	
294		87	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	23.3	0.0064	
295		58	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.3	0.0062	
296		58	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.3	0.0061	
297		66	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.3	0.007	
298		66	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.3	0.0071	
299		73	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	23.3	0.0062	
300		73	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	23.3	0.0064	
301		79	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	23.3	0.0151	
302		79	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	23.3	0.0149	
303		203	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	23.3	0.0059	
304		203	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	23.3	0.006	
305		34	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.4	0.0087	
306		34	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.4	0.0086	
307		46	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.4	0.0068	
308		46	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.4	0.0066	
309		126	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	23.4	0.0109	
310		126	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	23.4	0.0106	
311		208	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	23.5	0.0121	
312		208	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	23.5	0.0124	
313		90	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	23.5	0.0139	
314		90	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	23.5	0.0144	
315		65	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	23.5	0.0057	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
316		65	R	31-Aug-93	44.1576/147.1555	720-1000		3	23.5	0.0059	
317		135	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	23.5	0.0147	
318		135	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	23.5	0.0146	
319		259	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	3	23.5	0.0129	
320		259	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	3	23.5	0.0131	
321		247	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	2	23.6	0.0066	
322		247	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	2	23.6	0.007	
323		36	R	31-Aug-93	44.1576/147.1555	720-1000		3	23.6	0.0056	
324		36	R	31-Aug-93	44.1576/147.1555	720-1000		3	23.6	0.0056	
325		168	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	23.6	0.0133	
326		168	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	23.6	0.0154	
327		239	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	3	23.6	0.0126	
328		239	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	3	23.6	0.012	
329		271	R	25-Sep-93	44.16/147.15	984		3	23.6	0.0108	
330		271	R	25-Sep-93	44.16/147.15	984		3	23.6	0.0105	
331		64	R	31-Aug-93	44.1576/147.1555	720-1000		3	23.8	0.0108	
332		64	R	31-Aug-93	44.1576/147.1555	720-1000		3	23.8	0.0108	
333		178	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	23.9	0.0183	
334		178	R	12-Sep-93	44.72.11/146.11.19	720-1000	2	3	23.9	0.0181	
335		221	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	3	23.9	0.0192	
336		221	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	3	23.9	0.0192	
337		1	R	31-Aug-93	44.1576/147.1555	720-1000		3	24	0.0077	
338		1	R	31-Aug-93	44.1576/147.1555	720-1000		3	24	0.0074	
339		37	R	31-Aug-93	44.1576/147.1555	720-1000		3	24	0.0077	
340		37	R	31-Aug-93	44.1576/147.1555	720-1000		3	24	0.0077	
341		219	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	3	24	0.0159	
342		219	R	13-Sep-93	44.72.11/146.11.19	720-1000	5	3	24	0.0154	
343		115	R	13-Sep-93	44.72.11/146.11.19	720-1000	7	3	24.1	0.0105	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
344		115	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	24.1	0.0108	
345		172	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	24.2	0.0197	
346		172	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	24.2	0.0192	
347		173	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	24.2	0.0193	
348		173	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	24.2	0.0178	
349		227	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	1	24.2	0.0135	
350		227	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	1	24.2	0.0132	
351		33	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	24.2	0.0079	
352		33	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	24.2	0.0076	
353		141	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	24.3	0.018	
354		141	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	24.3	0.0167	
355		225	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	24.4	0.0201	
356		225	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	24.4	0.0202	
357		59	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	24.4	0.0073	
358		132	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	24.4	0.0179	
359		132	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	24.4	0.0171	
360		149	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	24.4	0.0123	
361		149	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	24.4	0.0123	
362		258	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	24.4	0.0173	
363		258	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	24.4	0.0173	
364										0.9807	
365				9-Sep-93					23.68	0.0114	
366									0.42	0.0047	
367									86		
368											
369	4	119	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	24.5	0.0104	
370		119	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	24.5	0.0112	
371		156	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	24.5	0.015	
372		156	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	24.5	0.0144	
373		96	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	24.6	0.0117	
374		96	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	24.6	0.0117	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
375		216	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	24.6	0.0147	
376		216	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	24.6	0.0149	
377		75	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	24.7	0.0192	
378		75	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	24.7	0.0176	
379		85	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	24.7	0.0171	
380		85	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	24.7	0.0176	
381		248	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	24.7	0.0181	
382		248	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	24.7	0.0172	
383		231	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	1	24.7	0.0223	
384		231	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	1	24.7	0.0209	
385		129	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	24.7	0.0159	
386		129	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	24.7	0.0159	
387		140	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	24.7	0.0112	
388		249	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	24.8	0.0208	
389		249	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	24.8	0.0208	
390		185	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	24.8	0.0086	
391		255	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	24.9	0.0181	
392		255	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	24.9	0.0177	
393		97	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	25	0.0195	
394		97	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	25	0.0198	
395		205	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	25	0.0098	
396		205	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	25	0.0099	
397		233	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	25.1	0.0179	
398		233	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	25.1	0.0184	
399		82	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	25.1	0.0123	
400		82	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	25.1	0.0125	
401		167	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	25.1	0.0163	
402		167	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	25.1	0.0167	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
403		246	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	25.1	0.0158	
404		246	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	25.1	0.0153	
405		78	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	25.2	0.0165	
406		78	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	25.2	0.0177	
407		89	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	25.2	0.0148	
408		89	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	25.2	0.0135	
409		171	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	25.2	0.0191	
410		171	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	25.2	0.0186	
411		174	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	25.3	0.0165	
412		174	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	25.3	0.0172	
413		226	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	25.4	0.0191	
414		226	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	3	25.4	0.0191	
415		102	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	25.5	0.0175	
416		102	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	25.5	0.0169	
417		106	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	25.5	0.0166	
418		106	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	25.5	0.0168	
419		195	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	1	25.6	0.0193	
420		195	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	1	25.6	0.0194	
421		241	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	25.7	0.0143	
422		241	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	25.7	0.0138	
423		32	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	25.8	0.012	
424		32	R	31-Aug-93	44.1576/1 47.1555	720-1000		3	25.8	0.012	
425		80	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	25.8	0.0232	
426		80	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	25.8	0.0224	
427		237	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	25.9	0.0174	
428		237	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	25.9	0.0168	
429		176	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	25.9	0.0175	
430		176	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	25.9	0.0163	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
431		136	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	25.9	0.019	
432		136	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	25.9	0.0189	
433										1.0494	
434				12-Sep-93					25.14	0.0164	
435									0.445	0.00327	
436									64		
437											
438	5	260	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	26	0.0159	
439		260	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	3	26	0.0165	
440		204	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	26.1	0.0188	
441		169	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	26.1	0.0243	
442		169	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	26.1	0.0236	
443		99	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	26.1	0.0157	
444		99	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	26.1	0.0155	
445		197	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	26.2	0.0198	
446		197	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	5	2	26.2	0.0199	
447		267	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	26.3	0.0242	
448		267	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	26.3	0.0243	
449		151	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	26.4	0.0173	
450		151	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	26.4	0.0156	
451		236	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	26.4	0.0152	
452		236	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	26.4	0.0163	
453		182	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	26.5	0.0254	
454		182	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	26.5	0.0263	
455		264	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	26.5	0.0165	
456		264	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	26.5	0.0155	
457		107	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	26.5	0.0175	
458		107	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	26.5	0.0188	
459		275	R	25-Sep-93	44.16/147 .15	984		3	26.5	0.019	
460		275	R	25-Sep-93	44.16/147 .15	984		3	26.5	0.0191	
461		84	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	26.6	0.0262	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
462		84	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	26.6	0.0249	
463		162	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	26.6	0.0254	
464		162	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	26.6	0.0242	
465		179	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	26.9	0.02	
466		179	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	26.9	0.0193	
467		263	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	27	0.0291	
468		263	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	2	27	0.0302	
469		257	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	27	0.015	
470		257	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	27	0.0156	
471		274	R	25-Sep-93	44.16/147 .15	984		2	27.1	0.0251	
472		274	R	25-Sep-93	44.16/147 .15	984		2	27.1	0.0262	
473		180	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	27.2	0.0261	
474		180	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	1	27.2	0.0277	
475		130	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	27.7	0.0196	
476		130	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	3	27.7	0.0201	
477		256	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	28.3	0.0319	
478		256	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	28.3	0.033	
479		160	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	28.3	0.035	
480		160	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	3	28.3	0.0348	
481		124	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	2	28.6	0.0321	
482		124	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	7	2	28.6	0.035	
483		146	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	28.6	0.0372	
484		146	R	12-Sep-93	44.72.11/ 146.11.19	720-1000	2	2	28.6	0.0364	
485		242	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	28.6	0.016	
486		242	R	13-Sep-93	44.72.11/ 146.11.19	720-1000	6	1	28.6	0.0166	
487										1.1237	
488				13-Sep-93					26.98	0.02293	
489									0.861	0.00663	
490									49		
491											
492	6	014	R	26-Aug-93	44.1559/1 47.0682	720-1000		2	30.5	0.0506	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
493		014	R	26-Aug-93	44.1559/147.0682	720-1000		2	30.5	0.0514	
494		028	R	26-Aug-93	44.1559/147.0682	720-1000		2	32.3	0.0422	
495		028	R	26-Aug-93	44.1559/147.0682	720-1000		2	32.3	0.0424	
496		020	R	26-Aug-93	44.1559/147.0682	720-1000		2	32.5	0.0503	
497		020	R	26-Aug-93	44.1559/147.0682	720-1000		2	32.5	0.0483	
498		031	R	26-Aug-93	44.1559/147.0682	720-1000		2	32.9	0.0335	
499		031	R	26-Aug-93	44.1559/147.0682	720-1000		2	32.9	0.0330	
500		003	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.0	0.0322	
501		003	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.0	0.0334	
502		016	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.2	0.0499	
503		016	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.2	0.0506	
504		009	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.3	0.0451	
505		009	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.3	0.0457	
506		012	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.7	0.0395	
507		012	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.7	0.0387	
508		268	R	25-Sep-93	44.16/147.15	984		2	34.5	0.0538	
509		268	R	25-Sep-93	44.16/147.15	984		2	34.5	0.0539	
510		244	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	2	33.8	0.0433	
511		244	R	13-Sep-93	44.72.11/146.11.19	720-1000	6	2	33.8	0.0447	
512		019	R	26-Aug-93	44.1559/147.0682	720-1000		2	36.7	0.0455	
513		019	R	26-Aug-93	44.1559/147.0682	720-1000		2	36.7	0.0434	
514		011	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.9	0.0509	
515		011	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.9	0.0532	
516										1.0755	
517				30-Aug-93					33.4	0.0448	
518									1.4	0.0069	
519									24.0		
520											
521	7	008	R	26-Aug-93	44.1559/147.0682	720-1000		2	37.8	0.0480	
522		008	R	26-Aug-93	44.1559/147.0682	720-1000		2	37.8	0.0456	
523		18	R	26-Aug-93	44.1559/147.0682	720-1000		2	37.2	0.0506	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
524		18	R	26-Aug-93	44.1559/147.0682	720-1000		2	37.2	0.0513	
525		15	R	26-Aug-93	44.1559/147.0682	720-1000		2	36.5	0.0549	
526		80		16-Sep-91	44.10/147.31			2	40.7	0.055	78
527		15	R	26-Aug-93	44.1559/147.0682	720-1000		2	36.5	0.0562	
528		13	R	26-Aug-93	44.1559/147.0682	720-1000		2	34.4	0.0568	
529		34		16-Sep-91	44.10/147.31	940-1080		2	41.2	0.0573	70
530		13	R	26-Aug-93	44.1559/147.0682	720-1000		2	34.4	0.059	
531		23	R	26-Aug-93	44.1559/147.0682	720-1000		2	38	0.0601	
532		69		16-Sep-91	44.10/147.31			2	44.8	0.0614	
533		23	R	26-Aug-93	44.1559/147.0682	720-1000		2	38	0.062	
534		30	R	26-Aug-93	44.1559/147.0682	720-1000		2	35	0.0629	
535		30	R	26-Aug-93	44.1559/147.0682	720-1000		2	35	0.0639	
536		27	R	26-Aug-93	44.1559/147.0682	720-1000		2	34.1	0.0656	
537		27	R	26-Aug-93	44.1559/147.0682	720-1000		2	34.1	0.0674	
538		47		16-Sep-91	44.10/147.31	940-1080		2	44.6	0.0683	75
539										1.0463	
540				21-Mar-93					37.6	0.0581	74.33
541									3.3	0.0065	4.04
542									18		
543											
544	8	26	R	26-Aug-93	44.1559/147.0682	720-1000		2	36.2	0.0694	
545		26	R	26-Aug-93	44.1559/147.0682	720-1000		2	36.2	0.0704	
546		4	R	26-Aug-93	44.1559/147.0682	720-1000		2	36.2	0.0712	
547		6	R	26-Aug-93	44.1559/147.0682	720-1000		2	36.2	0.0716	
548		4	R	26-Aug-93	44.1559/147.0682	720-1000		2	36.2	0.0725	
549		6	R	26-Aug-93	44.1559/147.0682	720-1000		2	36.2	0.0731	
550		005	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.8	0.0691	
551		5	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.8	0.0733	
552		25	R	26-Aug-93	44.1559/147.0682	720-1000		2	31.5	0.0743	
553		25	R	26-Aug-93	44.1559/147.0682	720-1000		2	31.5	0.0755	
554		17	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.9	0.0951	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
555		17	R	26-Aug-93	44.1559/147.0682	720-1000		2	33.9	0.0988	
556		2	R	26-Aug-93	44.1559/147.0682	720-1000		2	38.5	0.1042	
557		2	R	26-Aug-93	44.1559/147.0682	720-1000		2	38.5	0.1084	
558										1.1269	
559				26-Aug-93					35.19	0.08049	
560									2.192	0.01426	
561									14		
562											
563	9	74		16-Sep-91	44.10/147.31			1	33.6	0.0198	23
564		21		23-Apr-93	PEDRA			1	34.1	0.025	
565		49		23-Apr-93	PEDRA			1	34.2	0.0221	
566		3	63	16-Sep-91	44.10/147.31	940-1080		1	34.6	0.0283	35
567		56		16-Sep-91	44.10/147.31	940-1080		1	34.6	0.022	28
568		45		16-Sep-91	44.10/147.31	940-1080		1	34.8	0.0327	
569		228	R	13-Sep-93	44.72.11/146.11.19		5	1	29.1	0.0289	
570		228	R	13-Sep-93	44.72.11/146.11.19		5	1	29.1	0.0279	
571		27		22-Apr-93	PEDRA			1	29.2	0.0144	
572		7	R	26-Aug-93	44.1559/147.0682			1	29.4	0.0492	
573		7	R	26-Aug-93	44.1559/147.0682			1	29.4	0.0498	
574		223	R	13-Sep-93	44.72.11/146.11.19		5	1	29.5	0.0237	
575		223	R	13-Sep-93	44.72.11/146.11.19		5	1	29.5	0.0248	
576		2	62	16-Sep-91	44.10/147.31	940-1080		1	30.1	0.0169	15
577		240	R	13-Sep-93	44.72.11/146.11.19		6	1	30.1	0.025	
578		240	R	13-Sep-93	44.72.11/146.11.19		6	1	30.1	0.026	
579		46		22-Apr-93	PEDRA			1	31	0.0141	
580		269	R	25-Sep-93	44.16/147.15			1	31.4	0.0574	
581		269	R	25-Sep-93	44.16/147.15			1	31.4	0.057	
582		29	R	26-Aug-93	44.1559/147.0682			1	31.6	0.0739	
583		29	R	26-Aug-93	44.1559/147.0682			1	31.6	0.0694	
584		45		22-Apr-93	PEDRA			1	32	0.0247	
585		10	R	26-Aug-93	44.1559/147.0682	720-1000		1	32	0.0237	
586		10	R	26-Aug-93	44.1559/147.0682	720-1000		1	32	0.0231	
587		21	R	26-Aug-93	44.1559/147.0682	720-1000		1	32	0.036	

APPENDIX 1 BLACK OREO SAMPLES

	A	B	C	D	E	F	G	H	I	J	K
1	Sample	No.	Ser.	Date Coll.	Lat/Long	Depth m	Shot	Sex	Length SL (cm)	Otolith Wt (g)	Section Age
588		21	R	26-Aug-93	44.1559/147.0682	720-1000		1	32	0.0362	
589		75		16-Sep-91	44.10/147.31	940-1080		1	32.1	0.0156	20
590		280	R	25-Sep-93	44.16/147.15			1	32.2	0.0759	
591		280	R	25-Sep-93	44.16/147.15			1	32.2	0.0722	
592		9		22-Apr-93	PEDRA			1	32.3	0.0202	
593		38		22-Apr-93	PEDRA			1	32.6	0.0213	
594		25		22-Apr-93	PEDRA			1	32.9	0.0333	
595										1.0905	
596				21-Mar-93					31.65	0.03408	24.2
597									1.742	0.01858	7.66
598									32		
599											
600	10	14	74	16-Sep-91	44.10/147.31	940-1080		1	38	0.0347	44
601		47		23-Apr-93	PEDRA			1	38	0.0435	
602		17	77	16-Sep-91	44.10/147.31	940-1080		1	38.4	0.0569	50
603		28		16-Sep-91	44.10/147.31	940-1080		1	38.4	0.0307	46
604		48		16-Sep-91	44.10/147.31	940-1080		1	38.8	0.0466	45
605		27	87	16-Sep-91	44.10/147.31	940-1080		1	39.5	0.0605	80
606		23	83	16-Sep-91	44.10/147.31	940-1080		1	39.6	0.0332	45
607		66		16-Sep-91	44.10/147.31	940-1080		1	39.8	0.0548	65
608		1		23-Apr-93	PEDRA			1	39.9	0.0895	
609		50		23-Apr-93	PEDRA			1	40.1	0.0336	
610		59		16-Sep-91	44.10/147.31	940-1080		1	40.3	0.0925	100
611		33		16-Sep-91	44.10/147.31	940-1080		1	40.5	0.0428	56
612		7		23-Apr-93	PEDRA			1	40.6	0.0571	
613		68		16-Sep-91	44.10/147.31	940-1080		1	41	0.0525	65
614		18	78	16-Sep-91	44.10/147.31	940-1080		1	41.5	0.0758	100
615		87		16-Sep-91	44.10/147.31	940-1080		1	42.2	0.0504	68
616		73		16-Sep-91	44.10/147.31	940-1080		1	42.4	0.0581	70
617		29		23-Apr-93	PEDRA			1	42.4	0.0526	
618		44		16-Sep-91	44.10/147.31	940-1080		1	42.6	0.0595	90
619		29		16-Sep-91	44.10/147.31	940-1080		1	44.6	0.0671	90
620										1.0924	
621				9-Feb-92					40.43	0.05462	67.6
622									1.771	0.01711	20.29
623									20		

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
2	1	27	7-May-94	Barrameda/Pedra	880	3	14.00	0.0034	
3		27	7-May-94	Barrameda/Pedra	880	3	14.00	0.0035	
4		41	7-May-94	Barrameda/Pedra	880	3	14.00	0.0038	
5		41	7-May-94	Barrameda/Pedra	880	3	14.00	0.0037	
6		67	7-May-94	Barrameda/Pedra	880	3	14.20	0.0043	
7		67	7-May-94	Barrameda/Pedra	880	3	14.20	0.0044	
8		015	12-Sep-93	44.72.11/146.11.19		J	14.30	0.0044	
9		015	12-Sep-93	44.72.11/146.11.19		J	14.30	0.0043	
10		50	7-May-94	Barrameda/Pedra	880	3	14.30	0.0050	
11		50	7-May-94	Barrameda/Pedra	880	3	14.30	0.0050	
12		045	13-Sep-93	44.72.11/146.11.19		J	14.50	0.0040	
13		045	13-Sep-93	44.72.11/146.11.19		J	14.50	0.0036	
14		14	7-May-94	Barrameda/Pedra	880	3	14.50	0.0033	
15		14	7-May-94	Barrameda/Pedra	880	3	14.50	0.0033	
16		42	7-May-94	Barrameda/Pedra	880	3	14.50	0.0036	
17		42	7-May-94	Barrameda/Pedra	880	3	14.50	0.0039	
18		61	7-May-94	Barrameda/Pedra	880	3	14.50	0.0043	
19		61	7-May-94	Barrameda/Pedra	880	3	14.50	0.0042	
20		66	7-May-94	Barrameda/Pedra	880	3	14.50	0.0040	
21		66	7-May-94	Barrameda/Pedra	880	3	14.50	0.0040	
22		73	7-May-94	Barrameda/Pedra	880	3	14.50	0.0037	
23		73	7-May-94	Barrameda/Pedra	880	3	14.50	0.0036	
24		38	7-May-94	Barrameda/Pedra	880	3	14.60	0.0043	
25		38	7-May-94	Barrameda/Pedra	880	3	14.60	0.0043	
26		57	7-May-94	Barrameda/Pedra	880	3	14.60	0.0039	
27		57	7-May-94	Barrameda/Pedra	880	3	14.60	0.0040	
28		77	7-May-94	Barrameda/Pedra	880	3	14.70	0.0048	
29		20	7-May-94	Barrameda/Pedra	880	3	14.80	0.0036	
30		20	7-May-94	Barrameda/Pedra	880	3	14.80	0.0039	
31		55	7-May-94	Barrameda/Pedra	880	3	14.80	0.0040	
32		063	25-Sep-93	44.16/147.15		J	14.90	0.0040	
33		063	25-Sep-93	44.16/147.15		J	14.90	0.0041	
34		060	25-Sep-93	44.16/147.15		J	15.00	0.0036	
35		060	25-Sep-93	44.16/147.15		J	15.00	0.0037	
36		75	7-May-94	Barrameda/Pedra	880	3	15.00	0.0038	
37		75	7-May-94	Barrameda/Pedra	880	3	15.00	0.0038	
38		014	12-Sep-93	44.72.11/146.11.19		J	15.20	0.0056	
39		014	12-Sep-93	44.72.11/146.11.19		J	15.20	0.0054	
40		6	7-May-94	Barrameda/Pedra	880	3	15.20	0.0040	
41		6	7-May-94	Barrameda/Pedra	880	3	15.20	0.0041	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
42		8	7-May-94	Barrameda/Pedra	880	3	15.20	0.0040	
43		8	7-May-94	Barrameda/Pedra	880	3	15.20	0.0041	
44		19	7-May-94	Barrameda/Pedra	880	3	15.20	0.0041	
45		19	7-May-94	Barrameda/Pedra	880	3	15.20	0.0043	
46		29	7-May-94	Barrameda/Pedra	880	3	15.20	0.0039	
47		29	7-May-94	Barrameda/Pedra	880	3	15.20	0.0036	
48		45	7-May-94	Barrameda/Pedra	880	3	15.20	0.0038	
49		45	7-May-94	Barrameda/Pedra	880	3	15.20	0.0038	
50		34	7-May-94	Barrameda/Pedra	880	3	15.30	0.0047	
51		34	7-May-94	Barrameda/Pedra	880	3	15.30	0.0051	
52		76	7-May-94	Barrameda/Pedra	880	3	15.30	0.0050	
53		76	7-May-94	Barrameda/Pedra	880	3	15.30	0.0048	
54		79	7-May-94	Barrameda/Pedra	880	3	15.30	0.0040	
55		79	7-May-94	Barrameda/Pedra	880	3	15.30	0.0042	
56		104	25-Sep-93	44.16/147.15		J	15.40	0.0043	
57		15	7-May-94	Barrameda/Pedra	880	3	15.40	0.0042	
58		15	7-May-94	Barrameda/Pedra	880	3	15.40	0.0042	
59		21	7-May-94	Barrameda/Pedra	880	3	15.40	0.0055	
60		21	7-May-94	Barrameda/Pedra	880	3	15.40	0.0054	
61		041	13-Sep-93	44.72.11/146.11.19		J	15.50	0.0046	
62		041	13-Sep-93	44.72.11/146.11.19		J	15.50	0.0046	
63		062	25-Sep-93	44.16/147.15		J	15.50	0.0055	
64		062	25-Sep-93	44.16/147.15		J	15.50	0.0053	
65		35	7-May-94	Barrameda/Pedra	880	3	15.50	0.0049	
66		35	7-May-94	Barrameda/Pedra	880	3	15.50	0.0049	
67		39	7-May-94	Barrameda/Pedra	880	3	15.50	0.0033	
68		39	7-May-94	Barrameda/Pedra	880	3	15.50	0.0032	
69		44	7-May-94	Barrameda/Pedra	880	3	15.50	0.0036	
70		44	7-May-94	Barrameda/Pedra	880	3	15.50	0.0036	
71		64	7-May-94	Barrameda/Pedra	880	3	15.50	0.0046	
72		64	7-May-94	Barrameda/Pedra	880	3	15.50	0.0046	
73		78	7-May-94	Barrameda/Pedra	880	3	15.50	0.0043	
74		78	7-May-94	Barrameda/Pedra	880	3	15.50	0.0042	
75		80	7-May-94	Barrameda/Pedra	880	3	15.50	0.0043	
76		80	7-May-94	Barrameda/Pedra	880	3	15.50	0.0043	
77		5	7-May-94	Barrameda/Pedra	880	3	15.60	0.0044	
78		5	7-May-94	Barrameda/Pedra	880	3	15.60	0.0044	
79		28	7-May-94	Barrameda/Pedra	880	3	15.60	0.0043	
80		28	7-May-94	Barrameda/Pedra	880	3	15.60	0.0046	
81		51	7-May-94	Barrameda/Pedra	880	3	15.60	0.0049	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
82		51	7-May-94	Barrameda/Pedra	880	3	15.60	0.0046	
83		60	7-May-94	Barrameda/Pedra	880	3	15.60	0.0044	
84		60	7-May-94	Barrameda/Pedra	880	3	15.60	0.0044	
85		65	7-May-94	Barrameda/Pedra	880	3	15.60	0.0050	
86		65	7-May-94	Barrameda/Pedra	880	3	15.60	0.0052	
87		4	7-May-94	Barrameda/Pedra	880	3	15.70	0.0039	
88		4	7-May-94	Barrameda/Pedra	880	3	15.70	0.0039	
89		26	7-May-94	Barrameda/Pedra	880	3	15.70	0.0035	
90		26	7-May-94	Barrameda/Pedra	880	3	15.70	0.0037	
91		33	7-May-94	Barrameda/Pedra	880	3	15.70	0.0054	
92		33	7-May-94	Barrameda/Pedra	880	3	15.70	0.0053	
93		43	7-May-94	Barrameda/Pedra	880	3	15.70	0.0035	
94		43	7-May-94	Barrameda/Pedra	880	3	15.70	0.0036	
95		52	7-May-94	Barrameda/Pedra	880	3	15.70	0.0038	
96		52	7-May-94	Barrameda/Pedra	880	3	15.70	0.0038	
97		72	7-May-94	Barrameda/Pedra	880	3	15.70	0.0029	
98		17	7-May-94	Barrameda/Pedra	880	3	15.80	0.0043	
99		17	7-May-94	Barrameda/Pedra	880	3	15.80	0.0041	
100		24	7-May-94	Barrameda/Pedra	880	3	15.80	0.0036	
101		24	7-May-94	Barrameda/Pedra	880	3	15.80	0.0035	
102		71	7-May-94	Barrameda/Pedra	880	3	15.80	0.0052	
103		71	7-May-94	Barrameda/Pedra	880	3	15.80	0.0051	
104		027	12-Sep-93	44.72.11/146.11.19		J	16.00	0.0049	
105		027	12-Sep-93	44.72.11/146.11.19		J	16.00	0.0047	
106		074	25-Sep-93	44.16/ 147.15		J	16.00	0.0071	
107		7	7-May-94	Barrameda/Pedra	880	3	16.00	0.0050	
108		7	7-May-94	Barrameda/Pedra	880	3	16.00	0.0052	
109		40	7-May-94	Barrameda/Pedra	880	3	16.00	0.0057	
110		40	7-May-94	Barrameda/Pedra	880	3	16.00	0.0058	
111		48	7-May-94	Barrameda/Pedra	880	3	16.00	0.0049	
112		48	7-May-94	Barrameda/Pedra	880	3	16.00	0.0048	
113		63	7-May-94	Barrameda/Pedra	880	3	16.00	0.0047	
114		63	7-May-94	Barrameda/Pedra	880	3	16.00	0.0049	
115		68	7-May-94	Barrameda/Pedra	880	3	16.00	0.0048	
116		68	7-May-94	Barrameda/Pedra	880	3	16.00	0.0051	
117		81	7-May-94	Barrameda/Pedra	880	3	16.00	0.0046	
118		81	7-May-94	Barrameda/Pedra	880	3	16.00	0.0047	
119		020	13-Sep-93	44.72.11/146.11.19		J	16.10	0.0047	
120		020	13-Sep-93	44.72.11/146.11.19		J	16.10	0.0043	
121		11	7-May-94	Barrameda/Pedra	880	3	16.10	0.0042	

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
122		11	7-May-94	Barrameda/Pedra	880	3	16.10	0.0041	
123		13	7-May-94	Barrameda/Pedra	880	3	16.20	0.0038	
124		13	7-May-94	Barrameda/Pedra	880	3	16.20	0.0040	
125		23	7-May-94	Barrameda/Pedra	880	3	16.20	0.0058	
126		23	7-May-94	Barrameda/Pedra	880	3	16.20	0.0056	
127		47	7-May-94	Barrameda/Pedra	880	3	16.20	0.0033	
128		47	7-May-94	Barrameda/Pedra	880	3	16.20	0.0038	
129		56	7-May-94	Barrameda/Pedra	880	3	16.20	0.0040	
130		56	7-May-94	Barrameda/Pedra	880	3	16.20	0.0040	
131		016	12-Sep-93	44.72.11/146.11.19		J	16.30	0.0057	
132		016	12-Sep-93	44.72.11/146.11.19		J	16.30	0.0058	
133		3	7-May-94	Barrameda/Pedra	880	3	16.30	0.0046	
134		3	7-May-94	Barrameda/Pedra	880	3	16.30	0.0045	
135		18	7-May-94	Barrameda/Pedra	880	3	16.30	0.0045	
136		18	7-May-94	Barrameda/Pedra	880	3	16.30	0.0042	
137		62	7-May-94	Barrameda/Pedra	880	3	16.30	0.0044	
138		043	13-Sep-93	44.72.11/146.11.19		J	16.40	0.0061	
139		043	13-Sep-93	44.72.11/146.11.19		J	16.40	0.0059	
140		22	7-May-94	Barrameda/Pedra	880	3	16.40	0.0037	
141		22	7-May-94	Barrameda/Pedra	880	3	16.40	0.0039	
142		31	7-May-94	Barrameda/Pedra	880	3	16.40	0.0042	
143		31	7-May-94	Barrameda/Pedra	880	3	16.40	0.0044	
144		32	7-May-94	Barrameda/Pedra	880	3	16.40	0.0043	
145		32	7-May-94	Barrameda/Pedra	880	3	16.40	0.0041	
146		018	13-Sep-93	44.72.11/146.11.19		J	16.50	0.0059	
147		018	13-Sep-93	44.72.11/146.11.19		J	16.50	0.0059	
148		077	25-Sep-93	44.16/147.15		J	16.50	0.0045	
149		077	25-Sep-93	44.16/147.15		J	16.50	0.0042	
150		105	25-Sep-93	44.16/147.15		J	16.50	0.0043	
151		105	25-Sep-93	44.16/147.15		J	16.50	0.0044	
152		30	7-May-94	Barrameda/Pedra	880	3	16.50	0.0049	
153		30	7-May-94	Barrameda/Pedra	880	3	16.50	0.0046	
154		36	7-May-94	Barrameda/Pedra	880	3	16.50	0.0045	
155		36	7-May-94	Barrameda/Pedra	880	3	16.50	0.0044	
156		46	7-May-94	Barrameda/Pedra	880	3	16.50	0.0063	
157		46	7-May-94	Barrameda/Pedra	880	3	16.50	0.0065	
158		066	25-Sep-93	44.16/147.15		J	16.60	0.0053	
159		066	25-Sep-93	44.16/147.15		J	16.60	0.0049	
160		046	13-Sep-93	44.72.11/146.11.19		J	16.70	0.0050	
161		046	13-Sep-93	44.72.11/146.11.19		J	16.70	0.0048	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
162		061	25-Sep-93	44.16/147.15		J	16.70	0.0064	
163		061	25-Sep-93	44.16/147.15		J	16.70	0.0063	
164		083	25-Sep-93	44.16/147.15		J	16.70	0.0049	
165		083	25-Sep-93	44.16/147.15		J	16.70	0.0048	
166		099	25-Sep-93	44.16/147.15		J	16.80	0.0049	
167		099	25-Sep-93	44.16/147.15		J	16.80	0.0051	
168		102	25-Sep-93	44.16/147.15		J	16.90	0.0059	
169		102	25-Sep-93	44.16/147.15		J	16.90	0.0057	
170		125	25-Sep-93	44.16/147.15		J	16.90	0.0055	
171		125	25-Sep-93	44.16/147.15		J	16.90	0.0051	
172		103	25-Sep-93	44.16/147.15		J	17.00	0.0053	
173		103	25-Sep-93	44.16/147.15		J	17.00	0.0053	
174		10	7-May-94	Barrameda/Pedra	880	3	17.00	0.0043	
175		10	7-May-94	Barrameda/Pedra	880	3	17.00	0.0043	
176		072	25-Sep-93	44.16/147.15		J	17.10	0.0070	
177		072	25-Sep-93	44.16/147.15		J	17.10	0.0070	
178		079	25-Sep-93	44.16/147.15		J	17.10	0.0059	
179		079	25-Sep-93	44.16/147.15		J	17.10	0.0061	
180		095	25-Sep-93	44.16/147.15		J	17.10	0.0054	
181		095	25-Sep-93	44.16/147.15		J	17.10	0.0053	
182		53	7-May-94	Barrameda/Pedra	880	3	17.10	0.0052	
183		53	7-May-94	Barrameda/Pedra	880	3	17.10	0.0053	
184		106	25-Sep-93	44.16/147.15		J	17.20	0.0051	
185		106	25-Sep-93	44.16/147.15		J	17.20	0.0053	
186		2	7-May-94	Barrameda/Pedra	880	3	17.20	0.0040	
187		9	7-May-94	Barrameda/Pedra	880	3	17.20	0.0058	
188		9	7-May-94	Barrameda/Pedra	880	3	17.20	0.0054	
189		065	25-Sep-93	44.16/147.15		J	17.30	0.0052	
190		065	25-Sep-93	44.16/147.15		J	17.30	0.0051	
191		110	25-Sep-93	44.16/147.15		J	17.30	0.0043	
192		110	25-Sep-93	44.16/147.15		J	17.30	0.0057	
193		82	7-May-94	Barrameda/Pedra	880	3	17.30	0.0063	
194		82	7-May-94	Barrameda/Pedra	880	3	17.30	0.0060	
195		057	25-Sep-93	44.16/147.15		J	17.40	0.0047	
196		057	25-Sep-93	44.16/147.15		J	17.40	0.0047	
197		59	7-May-94	Barrameda/Pedra	880	3	17.40	0.0050	
198		038	13-Sep-93	44.72.11/146.11.19		J	17.50	0.0053	
199		038	13-Sep-93	44.72.11/146.11.19		J	17.50	0.0055	
200		051	25-Sep-93	44.16/147.15		J	17.50	0.0061	
201		051	25-Sep-93	44.16/147.15		J	17.50	0.0060	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
202		37	7-May-94	Barrameda/Pedra	880	3	17.50	0.0046	
203		37	7-May-94	Barrameda/Pedra	880	3	17.50	0.0044	
204		74	7-May-94	Barrameda/Pedra	880	3	17.50	0.0067	
205		74	7-May-94	Barrameda/Pedra	880	3	17.50	0.0074	
206		013	12-Sep-93	44.72.11/146.11.19		J	17.60	0.0055	
207		013	12-Sep-93	44.72.11/146.11.19		J	17.60	0.0053	
208		025	12-Sep-93	44.72.11/146.11.19		J	17.60	0.0071	
209		025	12-Sep-93	44.72.11/146.11.19		J	17.60	0.0068	
210		040	13-Sep-93	44.72.11/146.11.19		J	17.60	0.0060	
211		040	13-Sep-93	44.72.11/146.11.19		J	17.60	0.0063	
212		107	25-Sep-93	44.16/147.15		J	17.60	0.0040	
213		107	25-Sep-93	44.16/147.15		J	17.60	0.0042	
214		58	7-May-94	Barrameda/Pedra	880	3	17.60	0.0041	
215		58	7-May-94	Barrameda/Pedra	880	3	17.60	0.0042	
216		100	25-Sep-93	44.16/147.15		J	17.70	0.0050	
217		100	25-Sep-93	44.16/147.15		J	17.70	0.0051	
218		068	25-Sep-93	44.16/147.15		J	17.90	0.0056	
219		068	25-Sep-93	44.16/147.15		J	17.90	0.0057	
220		126	25-Sep-93	44.16/147.15		J	18.00	0.0050	
221		126	25-Sep-93	44.16/147.15		J	18.00	0.0051	
222		49	7-May-94	Barrameda/Pedra	880	3	18.00	0.0051	
223		49	7-May-94	Barrameda/Pedra	880	3	18.00	0.0052	
224							16.05	0.0047	
225	SM1		15-Feb-94				1.00	0.0009	
226						N=	222.00		
227									
228									
229									
230	2	017	13-Sep-93	44.72.11/146.11.19		J	18.10	0.0074	
231		017	13-Sep-93	44.72.11/146.11.19		J	18.10	0.0067	
232		058	25-Sep-93	44.16/147.15		J	18.10	0.0067	
233		058	25-Sep-93	44.16/147.15		J	18.10	0.0064	
234		094	25-Sep-93	44.16/147.15		J	18.10	0.0060	
235		094	25-Sep-93	44.16/147.15		J	18.10	0.0056	
236		073	25-Sep-93	44.16/147.15		J	18.20	0.0053	
237		073	25-Sep-93	44.16/147.15		J	18.20	0.0053	
238		25	7-May-94	Barrameda/Pedra	880	3	18.20	0.0051	
239		25	7-May-94	Barrameda/Pedra	880	3	18.20	0.0049	
240		70	7-May-94	Barrameda/Pedra	880	3	18.20	0.0075	
241		70	7-May-94	Barrameda/Pedra	880	3	18.20	0.0073	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
242		16	7-May-94	Barrameda/Pedra	880	3	18.30	0.0055	
243		16	7-May-94	Barrameda/Pedra	880	3	18.30	0.0055	
244		070	25-Sep-93	44.16/147.15		J	18.40	0.0051	
245		070	25-Sep-93	44.16/147.15		J	18.40	0.0051	
246		54	7-May-94	Barrameda/Pedra	880	3	18.40	0.0053	
247		54	7-May-94	Barrameda/Pedra	880	3	18.40	0.0053	
248		111	16-Sep-91	44.10/147.31	940-1080	1	18.50	0.004	
249		010	12-Sep-93	44.72.11/146.11.19		J	18.50	0.0064	
250		010	12-Sep-93	44.72.11/146.11.19		J	18.50	0.0066	
251		082	25-Sep-93	44.16/147.15		J	18.50	0.0060	
252		082	25-Sep-93	44.16/147.15		J	18.50	0.0055	
253		096	25-Sep-93	44.16/147.15		J	18.50	0.0057	
254		096	25-Sep-93	44.16/147.15		J	18.50	0.0057	
255		054	25-Sep-93	44.16/147.15		J	18.70	0.0061	
256		054	25-Sep-93	44.16/147.15		J	18.70	0.0057	
257		071	25-Sep-93	44.16/147.15		J	18.70	0.0081	
258		071	25-Sep-93	44.16/147.15		J	18.70	0.0079	
259		69	7-May-94	Barrameda/Pedra	880	3	18.80	0.0069	
260		69	7-May-94	Barrameda/Pedra	880	3	18.80	0.0064	
261		033	13-Sep-93	44.72.11/146.11.19		J	18.90	0.0083	
262		033	13-Sep-93	44.72.11/146.11.19		J	18.90	0.0085	
263		039	13-Sep-93	44.72.11/146.11.19		J	18.90	0.0072	
264		039	13-Sep-93	44.72.11/146.11.19		J	18.90	0.0070	
265		081	25-Sep-93	44.16/147.15		J	18.90	0.0054	
266		081	25-Sep-93	44.16/147.15		J	18.90	0.0054	
267		093	25-Sep-93	44.16/147.15		J	18.90	0.0057	
268		093	25-Sep-93	44.16/147.15		J	18.90	0.0061	
269		153	16-Sep-91	44.10/147.31	940-1080	2	19.00	0.0058	14.0
270		12	7-May-94	Barrameda/Pedra	880	3	19.00	0.0053	
271		12	7-May-94	Barrameda/Pedra	880	3	19.00	0.0056	
272		019	13-Sep-93	44.72.11/146.11.19		J	19.20	0.0067	
273		019	13-Sep-93	44.72.11/146.11.19		J	19.20	0.0065	
274		031	13-Sep-93	44.72.11/146.11.19		J	19.40	0.0065	
275		031	13-Sep-93	44.72.11/146.11.19		J	19.40	0.0064	
276		032	13-Sep-93	44.72.11/146.11.19		J	19.50	0.0062	
277		032	13-Sep-93	44.72.11/146.11.19		J	19.50	0.0058	
278		042	13-Sep-93	44.72.11/146.11.19		J	19.50	0.0061	
279		042	13-Sep-93	44.72.11/146.11.19		J	19.50	0.0062	
280		121	25-Sep-93	44.16/147.15		J	19.50	0.0070	
281		124	25-Sep-93	44.16/147.15		J	19.60	0.0060	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
282		124	25-Sep-93	44.16/147.15		J	19.60	0.0060	
283		111	25-Sep-93	44.16/147.15		J	19.70	0.0060	
284		111	25-Sep-93	44.16/147.15		J	19.70	0.0058	
285		93	16-Sep-91	44.10/147.31	940-1080	2	20.00	0.0053	
286		097	25-Sep-93	44.16/147.15		J(M)	20.00	0.0085	
287		101	25-Sep-93	44.16/147.15		J(F)	20.00	0.0074	
288		004	12-Sep-93	44.72.11/146.11.19		J	20.10	0.0072	
289		004	12-Sep-93	44.72.11/146.11.19		J	20.10	0.0074	
290		119	16-Sep-91	44.10/147.31	940-1080	2	20.20	0.0059	12.0
291		064	25-Sep-93	44.16/147.15		J	20.20	0.0065	
292		075	25-Sep-93	44.16/147.15		J	20.20	0.0054	
293		075	25-Sep-93	44.16/147.15		J	20.20	0.0054	
294		117	16-Sep-91	44.10/147.31	940-1080	1	20.30	0.0036	10.0
295		055	25-Sep-93	44.16/147.15		J	20.50	0.0079	
296		055	25-Sep-93	44.16/147.15		J	20.50	0.0082	
297		95	16-Sep-91	44.10/147.31	940-1080	1	20.60	0.0058	12.0
298		114	16-Sep-91	44.10/147.31	940-1080	1	20.60	0.0055	12.0
299		142	16-Sep-91	44.10/147.31	940-1080	2	20.70	0.0065	13.0
300		154	16-Sep-91	44.10/147.31	940-1080	1	20.70	0.0054	
301		164	16-Sep-91	44.10/147.31	940-1080	1	20.90	0.0063	14.0
302		030	13-Sep-93	44.72.11/146.11.19		J	21.00	0.0105	
303		030	13-Sep-93	44.72.11/146.11.19		J	21.00	0.0100	
304		122	25-Sep-93	44.16/147.15		J	21.00	0.0069	
305		97	16-Sep-91	44.10/147.31	940-1080	1	21.10	0.0062	
306		028	13-Sep-93	44.72.11/146.11.19		J	21.10	0.0078	
307		036	13-Sep-93	44.72.11/146.11.19		J	21.10	0.0068	
308		036	13-Sep-93	44.72.11/146.11.19		J	21.10	0.0067	
309		044	13-Sep-93	44.72.11/146.11.19		J	21.20	0.0070	
310		044	13-Sep-93	44.72.11/146.11.19		J	21.20	0.0073	
311		115	25-Sep-93	44.16/147.15		J	21.20	0.0071	
312		115	25-Sep-93	44.16/147.15		J	21.20	0.0071	
313		96	16-Sep-91	44.10/147.31	940-1080	1	21.30	0.0069	
314		136	16-Sep-91	44.10/147.31	940-1080	2	21.30	0.006	12.0
315		145	16-Sep-91	44.10/147.31	940-1080	2	21.30	0.0063	
316		152	16-Sep-91	44.10/147.31	940-1080	1	21.30	0.0066	13.0
317		022	12-Sep-93	44.72.11/146.11.19		J	21.30	0.0093	
318		022	12-Sep-93	44.72.11/146.11.19		J	21.30	0.0093	
319		140	16-Sep-91	44.10/147.31	940-1080	2	21.40	0.006	15.0
320		035	13-Sep-93	44.72.11/146.11.19		J	21.40	0.0095	
321		035	13-Sep-93	44.72.11/146.11.19		J	21.40	0.0084	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
322		056	25-Sep-93	44.16/147.15		J	21.60	0.0069	
323		056	25-Sep-93	44.16/147.15		J	21.60	0.0069	
324		076	25-Sep-93	44.16/147.15		J	21.70	0.0059	
325		076	25-Sep-93	44.16/147.15		J	21.70	0.0059	
326		101	16-Sep-91	44.10/147.31	940-1080	1	21.80	0.0067	13.0
327		113	16-Sep-91	44.10/147.31	940-1080	2	21.80	0.0074	15.0
328		134	16-Sep-91	44.10/147.31	940-1080	2	21.80	0.0049	
329		012	12-Sep-93	44.72.11/146.11.19		J	21.90	0.0080	
330		012	12-Sep-93	44.72.11/146.11.19		J	21.90	0.0077	
331		133	16-Sep-91	44.10/147.31	940-1080	1	22.00	0.0071	12.0
332		120	25-Sep-93	44.16/147.15		J	22.00	0.0092	
333		120	25-Sep-93	44.16/147.15		J	22.00	0.0087	
334		122	16-Sep-91	44.10/147.31	940-1080	2	22.10	0.006	
335		163	16-Sep-91	44.10/147.31	940-1080	1	22.10	0.0095	
336		167	16-Sep-91	44.10/147.31	940-1080	2	22.10	0.0058	
337		94	16-Sep-91	44.10/147.31	940-1080	2	22.40	0.0065	14.0
338		120	16-Sep-91	44.10/147.31	940-1080	1	22.40	0.0067	12.0
339		108	25-Sep-93	44.16/147.15		J(M)	22.40	0.0081	
340		108	25-Sep-93	44.16/147.15		J(M)	22.40	0.0083	
341		143	16-Sep-91	44.10/147.31	940-1080	2	22.50	0.0077	13.0
342		151	16-Sep-91	44.10/147.31	940-1080	1	22.50	0.0077	14.0
343		161	16-Sep-91	44.10/147.31	940-1080	1	22.50	0.0079	
344		011	12-Sep-93	44.72.11/146.11.19		J	22.50	0.0082	
345		011	12-Sep-93	44.72.11/146.11.19		J	22.50	0.0085	
346		102	16-Sep-91	44.10/147.31	940-1080	1	22.60	0.0069	13.0
347		103	16-Sep-91	44.10/147.31	940-1080	1	22.60	0.006	
348		107	16-Sep-91	44.10/147.31	940-1080	1	22.60	0.0076	
349		148	16-Sep-91	44.10/147.31	940-1080	1	22.60	0.0061	14.0
350		098	25-Sep-93	44.16/147.15		J(M)	22.60	0.0083	
351		098	25-Sep-93	44.16/147.15		J(M)	22.60	0.0081	
352		001	12-Sep-93	44.72.11/146.11.19		J	22.70	0.0071	
353		001	12-Sep-93	44.72.11/146.11.19		J	22.70	0.0069	
354		116	16-Sep-91	44.10/147.31	940-1080	1	22.80	0.0067	
355		050	25-Sep-93	44.16/147.15		J	22.80	0.0086	
356		050	25-Sep-93	44.16/147.15		J	22.80	0.0080	
357		008	12-Sep-93	44.72.11/146.11.19		F	22.90	0.0075	
358		008	12-Sep-93	44.72.11/146.11.19		F	22.90	0.0079	
359		131	16-Sep-91	44.10/147.31	940-1080	1	23.00	0.0059	
360		160	16-Sep-91	44.10/147.31	940-1080	2	23.00	0.0066	15.0
361		037	13-Sep-93	44.72.11/146.11.19		J	23.00	0.0077	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
362		037	13-Sep-93	44.72.11/146.11.19		J	23.00	0.0076	
363		005	12-Sep-93	44.72.11/146.11.19		J	23.10	0.0089	
364		005	12-Sep-93	44.72.11/146.11.19		J	23.10	0.0090	
365		112	16-Sep-91	44.10/147.31	940-1080	2	23.30	0.0059	12.0
366		021	12-Sep-93	44.72.11/146.11.19		J	23.30	0.0083	
367		021	12-Sep-93	44.72.11/146.11.19		J	23.30	0.0083	
368		009	12-Sep-93	44.72.11/146.11.19		F	23.50	0.0080	
369		009	12-Sep-93	44.72.11/146.11.19		F	23.50	0.0079	
370		98	16-Sep-91	44.10/147.31	940-1080	1	23.60	0.0094	
371		100	16-Sep-91	44.10/147.31	940-1080	1	23.80	0.0077	
372		137	16-Sep-91	44.10/147.31	940-1080	1	23.80	0.007	
373		168	16-Sep-91	44.10/147.31	940-1080	2	23.80	0.0065	
374		029	25-Sep-93	44.16/147.15		J(M)	23.90	0.0087	
375		029	25-Sep-93	44.16/147.15		J(M)	23.90	0.0082	
376									
377	SM2		20-Mar-93				20.72	0.0069	
378							1.78	0.0013	
379						N=	146.00		
380		116	25-Sep-93	44.16/147.15		J(M)	24.00	0.0103	
381		116	25-Sep-93	44.16/147.15		J(M)	24.00	0.0103	
382		99	16-Sep-91	44.10/147.31	940-1080	1	24.10	0.0074	14.0
383		118	16-Sep-91	44.10/147.31	940-1080	1	24.10	0.0071	12.0
384		128	16-Sep-91	44.10/147.31	940-1080	1	24.10	0.0077	
385		138	16-Sep-91	44.10/147.31	940-1080	1	24.10	0.0065	
386		162	16-Sep-91	44.10/147.31	940-1080	2	24.10	0.0061	
387		085	25-Sep-93	44.16/147.15		J	24.10	0.0124	
388		085	25-Sep-93	44.16/147.15		J	24.10	0.0130	
389		105	16-Sep-91	44.10/147.31	940-1080	1	24.20	0.0068	14.0
390		023	12-Sep-93	44.72.11/146.11.19		J	24.20	0.0110	
391		023	12-Sep-93	44.72.11/146.11.19		J	24.20	0.0105	
392		053	25-Sep-93	44.16/147.15		J	24.20	0.0106	
393		053	25-Sep-93	44.16/147.15		J	24.20	0.0107	
394		109	16-Sep-91	44.10/147.31	940-1080	1	24.30	0.0077	15.0
395		126	16-Sep-91	44.10/147.31	940-1080	2	24.30	0.0085	
396		165	16-Sep-91	44.10/147.31	940-1080	2	24.30	0.0079	
397		166	16-Sep-91	44.10/147.31	940-1080	2	24.30	0.0066	
398		106	16-Sep-91	44.10/147.31	940-1080	1	24.40	0.0057	
399		003	12-Sep-93	44.72.11/146.11.19		J	24.50	0.0082	
400		003	12-Sep-93	44.72.11/146.11.19		J	24.50	0.0081	
401		091	25-Sep-93	44.16/147.15		J	24.50	0.0101	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
402		091	25-Sep-93	44.16/147.15		J	24.50	0.0095	
403		135	16-Sep-91	44.10/147.31	940-1080	1	24.60	0.0068	15.0
404		007	12-Sep-93	44.72.11/146.11.19		J	24.80	0.0101	
405		007	12-Sep-93	44.72.11/146.11.19		J	24.80	0.0101	
406		078	25-Sep-93	44.16/147.15		M	24.80	0.0105	
407		078	25-Sep-93	44.16/147.15		M	24.80	0.0101	
408		PM 124	17-May-93	44°14' S 147°08' E		2	24.90	0.0117	
409		PM 124	17-May-93	44°14' S 147°08' E		2	24.90	0.0113	
410		109	25-Sep-93	44.16/147.15		J	25.00	0.0110	
411		109	25-Sep-93	44.16/147.15		J	25.00	0.0101	
412		115	16-Sep-91	44.10/147.31	940-1080	1	25.10	0.0084	
413		067	25-Sep-93	44.16/147.15		J(M)	25.10	0.0096	
414		067	25-Sep-93	44.16/147.15		J(M)	25.10	0.0096	
415		090	25-Sep-93	44.16/147.15		M	25.10	0.0121	
416		090	25-Sep-93	44.16/147.15		M	25.10	0.0117	
417		002	12-Sep-93	44.72.11/146.11.19		J	25.30	0.0102	
418		002	12-Sep-93	44.72.11/146.11.19		J	25.30	0.0099	
419		088	25-Sep-93	44.16/147.15		F	25.30	0.0114	
420		088	25-Sep-93	44.16/147.15		F	25.30	0.0108	
421		PM 185	17-May-93	44°14' S 147°08' E		2	25.40	0.0106	
422		PM 185	17-May-93	44°14' S 147°08' E		2	25.40	0.0109	
423		PM 133	17-May-93	44°14' S 147°08' E		2	25.40	0.0134	
424		PM 133	17-May-93	44°14' S 147°08' E		2	25.40	0.0130	
425		132	16-Sep-91	44.10/147.31	940-1080	1	25.40	0.0071	15.0
426		PM 176	17-May-93	44°14' S 147°08' E		1	25.50	0.0099	
427		PM 176	17-May-93	44°14' S 147°08' E		1	25.50	0.0097	
428		129	16-Sep-91	44.10/147.31	940-1080	1	25.50	0.0071	
429		144	16-Sep-91	44.10/147.31	940-1080	1	25.50	0.0088	16.0
430		113	25-Sep-93	44.16/147.15	984	J(F)	25.60	0.0112	
431		113	25-Sep-93	44.16/147.15	984	J(F)	25.60	0.0105	
432		024	12-Sep-93	44.72.11/146.11.19		J	25.70	0.0091	
433		024	12-Sep-93	44.72.11/146.11.19		J	25.70	0.0100	
434		121	16-Sep-91	44.10/147.31	940-1080	1	26.00	0.009	13.0
435		141	16-Sep-91	44.10/147.31	940-1080	1	26.00	0.0063	16.0
436		069	25-Sep-93	44.16/147.15	984	M	26.00	0.0102	
437		069	25-Sep-93	44.16/147.15	984	M	26.00	0.0106	
438		110	16-Sep-91	44.10/147.31	940-1080	2	26.10	0.0072	
439		112	25-Sep-93	44.16/147.15	984	J(M)	26.20	0.0159	
440		112	25-Sep-93	44.16/147.15	984	J(M)	26.20	0.0168	
441		086	25-Sep-93	44.16/147.15	984	M	26.40	0.0145	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
442		086	25-Sep-93	44.16/147.15	984	M	26.40	0.0150	
443		123	16-Sep-91	44.10/147.31	940-1080	1	26.60	0.0111	16.0
444		147	16-Sep-91	44.10/147.31	940-1080	2	26.70	0.0106	
445		080	25-Sep-93	44.16/147.15	984	M	26.80	0.0129	
446		080	25-Sep-93	44.16/147.15	984	M	26.80	0.0123	
447		034	13-Sep-93	44.72.11/146.11.19		M	26.90	0.0094	
448		034	13-Sep-93	44.72.11/146.11.19		M	26.90	0.0090	
449		114	25-Sep-93	44.16/147.15	984	J(F)	26.90	0.0133	
450		114	25-Sep-93	44.16/147.15	984	J(F)	26.90	0.0131	
451		157	16-Sep-91	44.10/147.31	940-1080	2	27.10	0.0087	
452		084	25-Sep-93	44.16/147.15	984	J	27.10	0.0140	
453		084	25-Sep-93	44.16/147.15	984	J	27.10	0.0141	
454		127	25-Sep-93	44.16/147.15	984	F	27.10	0.0134	
455		127	25-Sep-93	44.16/147.15	984	F	27.10	0.0138	
456		006	12-Sep-93	44.72.11/146.11.19		M	27.20	0.0127	
457		006	12-Sep-93	44.72.11/146.11.19		M	27.20	0.0113	
458		119	25-Sep-93	44.16/147.15	984	J(F)	27.50	0.0172	
459		119	25-Sep-93	44.16/147.15	984	J(F)	27.50	0.0136	
460		170	16-Sep-91	44.10/147.31	940-1080	1	27.60	0.0139	18.0
461		117	25-Sep-93	44.16/147.15	984	J(?)	27.80	0.0130	
462		117	25-Sep-93	44.16/147.15	984	J(?)	27.80	0.0131	
463		PM 154	17-May-93	44°14' S 147°08' E		2	27.90	0.0132	
464		PM 154	17-May-93	44°14' S 147°08' E		2	27.90	0.0137	
465		026	12-Sep-93	44.72.11/146.11.19		J	28.00	0.0124	
466		026	12-Sep-93	44.72.11/146.11.19		J	28.00	0.0123	
467		118	25-Sep-93	44.16/147.15	984	J(?)	28.00	0.0125	
468		118	25-Sep-93	44.16/147.15	984	J(?)	28.00	0.0121	
469		108	16-Sep-91	44.10/147.31	940-1080	1	28.10	0.0109	
470		PM 180	17-May-93	44°14' S 147°08' E		1	28.40	0.0155	
471		PM 180	17-May-93	44°14' S 147°08' E		1	28.40	0.0148	
472		128	25-Sep-93	44.16/147.15	984	J(F)	28.50	0.0112	
473		128	25-Sep-93	44.16/147.15	984	J(F)	28.50	0.0113	
474		PM 127	17-May-93	44°14' S 147°08' E		1	28.70	0.0175	
475		PM 127	17-May-93	44°14' S 147°08' E		1	28.70	0.0163	
476		PM 158	17-May-93	44°14' S 147°08' E		2	28.70	0.0103	
477		156	16-Sep-91	44.10/147.31	940-1080	2	28.80	0.0135	20.0
478									
479	SM3		26-Feb-93				25.94	0.0109	
480							1.45	0.0026	
481						N=	98.00		

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
482									
483									
484									
485		PM 145	17-May-93	44°14' S 147°08' E		2	29.40	0.0137	
486		PM 145	17-May-93	44°14' S 147°08' E		2	29.40	0.0136	
487		PM 149	17-May-93	44°14' S 147°08' E		2	30.20	0.0159	
488		PM 149	17-May-93	44°14' S 147°08' E		2	30.20	0.0158	
489		PM 155	17-May-93	44°14' S 147°08' E		2	30.50	0.0171	
490		PM 155	17-May-93	44°14' S 147°08' E		2	30.50	0.0175	
491		PM 125	17-May-93	44°14' S 147°08' E		2	30.60	0.02	
492		PM 125	17-May-93	44°14' S 147°08' E		2	30.60	0.0193	
493		PM 175	17-May-93	44°14' S 147°08' E		2	30.70	0.0185	
494		PM 175	17-May-93	44°14' S 147°08' E		2	30.70	0.0177	
495		PM 153	17-May-93	44°14' S 147°08' E		2	30.80	0.0184	
496		PM 153	17-May-93	44°14' S 147°08' E		2	30.80	0.0189	
497		PM 136	17-May-93	44°14' S 147°08' E		2	30.80	0.0186	
498		PM 136	17-May-93	44°14' S 147°08' E		2	30.80	0.0173	
499		PM 108	17-May-93	44°14' S 147°08' E		2	31.00	0.0158	
500		PM 139	17-May-93	44°14' S 147°08' E		2	31.30	0.0161	
501		PM 139	17-May-93	44°14' S 147°08' E		2	31.30	0.0171	
502		PM 143	17-May-93	44°14' S 147°08' E		2	31.30	0.0192	
503		PM 143	17-May-93	44°14' S 147°08' E		2	31.30	0.0202	
504		PM 128	17-May-93	44°14' S 147°08' E		2	31.40	0.0277	
505		PM 128	17-May-93	44°14' S 147°08' E		2	31.40	0.0264	
506		PM 171	17-May-93	44°14' S 147°08' E		2	31.70	0.0176	
507		PM 171	17-May-93	44°14' S 147°08' E		2	31.70	0.0174	
508		PM 144	17-May-93	44°14' S 147°08' E		2	32.40	0.0193	
509		PM 144	17-May-93	44°14' S 147°08' E		2	32.40	0.0204	
510		PM 126	17-May-93	44°14' S 147°08' E		2	32.40	0.0206	
511		PM 126	17-May-93	44°14' S 147°08' E		2	32.40	0.0206	
512		PM 130	17-May-93	44°14' S 147°08' E		2	32.60	0.0271	
513		PM 130	17-May-93	44°14' S 147°08' E		2	32.60	0.0268	
514		PM 111	17-May-93	44°14' S 147°08' E		2	32.80	0.0259	
515		PM 122	17-May-93	44°14' S 147°08' E		2	33.10	0.016	
516		PM 122	17-May-93	44°14' S 147°08' E		2	33.10	0.0154	
517		PM 161	17-May-93	44°14' S 147°08' E		2	33.40	0.0186	
518		PM 161	17-May-93	44°14' S 147°08' E		2	33.40	0.0196	
519		PM 156	17-May-93	44°14' S 147°08' E		2	33.40	0.0188	
520		PM 156	17-May-93	44°14' S 147°08' E		2	33.40	0.0170	
521		PM 163	17-May-93	44°14' S 147°08' E		2	33.60	0.0183	

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
522		PM 163	17-May-93	44°14' S 147°08' E		2	33.60	0.0196	
523		PM 179	17-May-93	44°14' S 147°08' E		2	33.60	0.0236	
524		PM 179	17-May-93	44°14' S 147°08' E		2	33.60	0.0212	
525		PM 132	17-May-93	44°14' S 147°08' E		2	33.70	0.0264	
526		PM 132	17-May-93	44°14' S 147°08' E		2	33.70	0.0275	
527		PM 192	17-May-93	44°14' S 147°08' E		2	33.80	0.0183	
528		PM 192	17-May-93	44°14' S 147°08' E		2	33.80	0.0175	
529		PM 138	17-May-93	44°14' S 147°08' E		2	33.80	0.0186	
530		PM 138	17-May-93	44°14' S 147°08' E		2	33.80	0.0225	
531		PM 110	17-May-93	44°14' S 147°08' E		2	33.80	0.0212	
532		PM 110	17-May-93	44°14' S 147°08' E		2	33.80	0.0212	
533		PM 147	17-May-93	44°14' S 147°08' E		2	34.00	0.0239	
534	SM4		17-May-93				32.13	0.0197	
535							1.39	0.0036	
536						N=	49.00		
537		PM 117	17-May-93	44°14' S 147°08' E		2	34.10	0.0199	
538		PM 120	17-May-93	44°14' S 147°08' E		2	34.10	0.0204	
539		PM 120	17-May-93	44°14' S 147°08' E		2	34.10	0.0205	
540		PM 186	17-May-93	44°14' S 147°08' E		2	34.70	0.0185	
541		PM 186	17-May-93	44°14' S 147°08' E		2	34.70	0.0192	
542		PM 168	17-May-93	44°14' S 147°08' E		2	34.80	0.0223	
543		PM 168	17-May-93	44°14' S 147°08' E		2	34.80	0.0217	
544		PM 115	17-May-93	44°14' S 147°08' E		2	35.00	0.0294	
545		PM 115	17-May-93	44°14' S 147°08' E		2	35.00	0.0295	
546		PM 123	17-May-93	44°14' S 147°08' E		2	35.20	0.0193	
547		PM 123	17-May-93	44°14' S 147°08' E		2	35.20	0.0195	
548		PM 160	17-May-93	44°14' S 147°08' E		2	35.20	0.0268	
549		PM 160	17-May-93	44°14' S 147°08' E		2	35.20	0.0270	
550		PM 172	17-May-93	44°14' S 147°08' E		2	35.30	0.0199	
551		PM 172	17-May-93	44°14' S 147°08' E		2	35.30	0.0199	
552		PM 181	17-May-93	44°14' S 147°08' E		2	35.30	0.0216	
553		PM 181	17-May-93	44°14' S 147°08' E		2	35.30	0.0194	
554		PM 150	17-May-93	44°14' S 147°08' E		2	35.60	0.0317	
555		PM 140	17-May-93	44°14' S 147°08' E		2	35.70	0.0248	
556		PM 140	17-May-93	44°14' S 147°08' E		2	35.70	0.0246	
557		PM 118	17-May-93	44°14' S 147°08' E		2	35.80	0.0346	
558		PM 106	17-May-93	44°14' S 147°08' E		2	36.50	0.0275	
559		PM 106	17-May-93	44°14' S 147°08' E		2	36.50	0.0292	
560		PM 114	17-May-93	44°14' S 147°08' E		2	36.60	0.0394	
561		PM 114	17-May-93	44°14' S 147°08' E		2	36.60	0.0406	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
562		PM 190	17-May-93	44°14' S 147°08' E		2	36.70	0.0271	
563		PM 190	17-May-93	44°14' S 147°08' E		2	36.70	0.0285	
564		PM 137	17-May-93	44°14' S 147°08' E		2	36.80	0.0263	
565		PM 137	17-May-93	44°14' S 147°08' E		2	36.80	0.0257	
566		PM 148	17-May-93	44°14' S 147°08' E		2	36.80	0.0276	
567		PM 148	17-May-93	44°14' S 147°08' E		2	36.80	0.0276	
568		PM 134	17-May-93	44°14' S 147°08' E		2	36.90	0.0293	
569		PM 134	17-May-93	44°14' S 147°08' E		2	36.90	0.0286	
570		PM 152	17-May-93	44°14' S 147°08' E		2	37.60	0.0285	
571		PM 152	17-May-93	44°14' S 147°08' E		2	37.60	0.0275	
572		PM 121	17-May-93	44°14' S 147°08' E		2	37.60	0.0325	
573		PM 121	17-May-93	44°14' S 147°08' E		2	37.60	0.0275	
574		PM 167	17-May-93	44°14' S 147°08' E		2	37.70	0.0272	
575		PM 167	17-May-93	44°14' S 147°08' E		2	37.70	0.0274	
576									
577	SM5		17-May-93				35.96	0.0261	
578							1.10	0.0053	
579						N=	39.00		
580		89	16-Sep-91	44.10/147.31	940-1080	2	41.50	0.0318	
581		69	16-Sep-91	44.10/147.31	940-1080	2	41.80	0.0258	
582		38	16-Sep-91	44.10/147.31	940-1080	2	41.90	0.0228	36.0
583		11	16-Sep-91	44.10/147.31	940-1080	2	42.00	0.0264	35.0
584		37	16-Sep-91	44.10/147.31	940-1080	2	43.50	0.0249	
585		67	16-Sep-91	44.10/147.31	940-1080	2	43.80	0.0299	42.0
586		62	16-Sep-91	44.10/147.31	940-1080	2	44.40	0.0329	45.0
587		27	16-Sep-91	44.10/147.31	940-1080	2	45.20	0.0231	
588		52	16-Sep-91	44.10/147.31	940-1080	2	45.60	0.0442	
589		88	16-Sep-91	44.10/147.31	940-1080	2	45.60	0.0374	52.0
590		6	16-Sep-91	44.10/147.31	940-1080	2	45.80	0.035	
591		72	16-Sep-91	44.10/147.31	940-1080	2	45.80	0.0348	
592		79	16-Sep-91	44.10/147.31	940-1080	2	46.00	0.0229	36.0
593		8	16-Sep-91	44.10/147.31	940-1080	2	46.10	0.0279	38.0
594		51	16-Sep-91	44.10/147.31	940-1080	2	46.10	0.039	48.0
595		7	16-Sep-91	44.10/147.31	940-1080	2	46.20	0.0403	
596		13	16-Sep-91	44.10/147.31	940-1080	2	46.70	0.054	
597		84	16-Sep-91	44.10/147.31	940-1080	2	47.10	0.0298	48.0
598		30	16-Sep-91	44.10/147.31	940-1080	2	47.40	0.0471	56.0
599		61	16-Sep-91	44.10/147.31	940-1080	2	47.50	0.0435	56.0
600		82	16-Sep-91	44.10/147.31	940-1080	2	47.70	0.0393	
601		48	16-Sep-91	44.10/147.31	940-1080	2	48.10	0.0471	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
602		24	16-Sep-91	44.10/147.31	940-1080	2	48.20	0.042	
603		60	16-Sep-91	44.10/147.31	940-1080	2	48.70	0.0456	
604		55	16-Sep-91	44.10/147.31	940-1080	2	48.90	0.0438	
605		56	16-Sep-91	44.10/147.31	940-1080	2	49.00	0.0332	54.0
606		25	16-Sep-91	44.10/147.31	940-1080	2	49.20	0.0484	
607		70	16-Sep-91	44.10/147.31	940-1080	2	49.20	0.028	45.0
608		76	16-Sep-91	44.10/147.31	940-1080	2	49.30	0.0399	
609	SM6		16-Sep-91					0.0359	45.5
610							46.15	0.0088	7.7
611							2.38	29	
612		20	16-Sep-91	44.10/147.31	940-1080	2	50.40	0.034	
613		86	16-Sep-91	44.10/147.31	940-1080	2	50.40	0.0367	53.0
614		40	16-Sep-91	44.10/147.31	940-1080	2	50.50	0.0447	55.0
615		29	16-Sep-91	44.10/147.31	940-1080	2	51.40	0.0469	
616		78	16-Sep-91	44.10/147.31	940-1080	2	51.60	0.0363	
617		17	16-Sep-91	44.10/147.31	940-1080	2	52.00	0.0482	68.0
618		59	16-Sep-91	44.10/147.31	940-1080	2	52.00	0.0396	
619		64	16-Sep-91	44.10/147.31	940-1080	2	52.30	0.059	
620		34	16-Sep-91	44.10/147.31	940-1080	2	52.50	0.0321	
621		50	16-Sep-91	44.10/147.31	940-1080	2	52.70	0.0386	
622		74	16-Sep-91	44.10/147.31	940-1080	2	52.80	0.0403	
623		39	16-Sep-91	44.10/147.31	940-1080	2	52.90	0.0337	
624		83	16-Sep-91	44.10/147.31	940-1080	2	53.10	0.0487	
625		80	16-Sep-91	44.10/147.31	940-1080	2	53.60	0.0303	53.0
626		9	16-Sep-91	44.10/147.31	940-1080	2	53.80	0.0375	
627		10	16-Sep-91	44.10/147.31	940-1080	2	54.60	0.0383	
628		33	16-Sep-91	44.10/147.31	940-1080	2	54.90	0.0465	
629		35	16-Sep-91	44.10/147.31	940-1080	2	55.60	0.0567	75.0
630		250	8-Oct-89	43.57/ 150.23	871-875	2	55.70	0.04	
631		247	8-Oct-89	43.57/ 150.23	871-875	2	56.50	0.0473	
632		247	8-Oct-89	43.57/ 150.23	871-875	2	56.50	0.0496	
633		249	8-Oct-89	43.57/ 150.23	871-875	2	52.10	0.0364	
634		249	8-Oct-89	43.57/ 150.23	871-875	2	52.10	0.0382	
635		246	8-Oct-89	43.57/ 150.23	871-875	2	58.00	0.0483	
636		246	8-Oct-89	43.57/ 150.23	871-875	2	58.00	0.0462	
637		230	30-Aug-89	41.19/ 144.07	840-909	2	58.20	0.0401	
638		230	30-Aug-89	41.19/ 144.07	840-909	2	58.20	0.0407	
639		248	8-Oct-89	43.57/ 150.23	871-875	2	58.70	0.0605	
640		248	8-Oct-89	43.57/ 150.23	871-875	2	58.70	0.0505	
641						N=	29.00		

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
642	SM7		18-Dec-90				54.13	0.043	60.8
643							2.72	0.0078	10.1
644						N=	29.00		
645		169	16-Sep-91	0		1	29.20	0.0082	
646		87	25-Sep-93	44.16/147.15	984	1	29.20	0.0177	
647		87	25-Sep-93	44.16/147.15	984	1	29.20	0.0195	
648		92	25-Sep-93	44.16/147.15	984	1	29.40	0.0194	
649		92	25-Sep-93	44.16/147.15	984	1	29.40	0.0188	
650		124	16-Sep-91	44.10/147.31	940-1080	1	29.70	0.0124	16.0
651		PM 107	17-May-93	44°14' S 147°08' E		1	30.40	0.0171	
652		PM 107	17-May-93	44°14' S 147°08' E		1	30.40	0.0166	
653		PM 157	17-May-93	44°14' S 147°08' E		1	30.70	0.02	
654		PM 157	17-May-93	44°14' S 147°08' E		1	30.70	0.0217	
655		PM 113	17-May-93	44°14' S 147°08' E		1	31.20	0.0193	
656		PM 113	17-May-93	44°14' S 147°08' E		1	31.20	0.0186	
657		PM 178	17-May-93	44°14' S 147°08' E		1	31.80	0.0165	
658		49	25-Sep-93	44.16/147.15	984	1	32.20	0.0213	
659		49	25-Sep-93	44.16/147.15	984	1	32.20	0.0204	
660		47	25-Sep-93	44.16/147.15	984	1	32.50	0.0255	
661		47	25-Sep-93	44.16/147.15	984	1	32.50	0.0265	
662		PM 166	17-May-93	44°14' S 147°08' E		1	32.60	0.0226	
663		PM 166	17-May-93	44°14' S 147°08' E		1	32.60	0.0217	
664		PM 189	17-May-93	44°14' S 147°08' E		1	32.90	0.0252	
665		PM 189	17-May-93	44°14' S 147°08' E		1	32.90	0.0273	
666		PM 146	17-May-93	44°14' S 147°08' E		1	33.30	0.0234	
667		PM 146	17-May-93	44°14' S 147°08' E		1	33.30	0.0232	
668		PM 188	17-May-93	44°14' S 147°08' E		1	33.70	0.0193	
669		PM 188	17-May-93	44°14' S 147°08' E		1	33.70	0.0196	
670		PM 129	17-May-93	44°14' S 147°08' E		1	34.50	0.0246	
671		PM 129	17-May-93	44°14' S 147°08' E		1	34.50	0.0243	
672		89	25-Sep-93	44.16/147.15	984	1	34.70	0.0217	
673		89	25-Sep-93	44.16/147.15	984	1	34.70	0.0212	
674		68	16-Sep-91	44.10/147.31	940-1080	1	35.20	0.0156	
675		48	25-Sep-93	44.16/147.15	984	1	36.00	0.0276	
676		48	25-Sep-93	44.16/147.15	984	1	36.00	0.0267	
677		PM 141	17-May-93	44°14' S 147°08' E		1	36.40	0.031	
678		PM 141	17-May-93	44°14' S 147°08' E		1	36.40	0.0314	
679		PM 184	17-May-93	44°14' S 147°08' E		1	36.60	0.0226	
680		PM 184	17-May-93	44°14' S 147°08' E		1	36.60	0.0246	
681		2	16-Sep-91	44.10/147.31	940-1080	1	36.70	0.0193	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
682		41	16-Sep-91	44.10/147.31	940-1080	1	37.30	0.0232	
683		14	16-Sep-91	44.10/147.31	940-1080	1	38.60	0.0256	
684		23	16-Sep-91	44.10/147.31	940-1080	1	38.60	0.024	30.0
685		5	16-Sep-91	44.10/147.31	940-1080	1	38.80	0.0205	30.0
686		PM 151	17-May-93	44°14' S 147°08' E		1	39.10	0.0225	
687		PM 151	17-May-93	44°14' S 147°08' E		1	39.10	0.0222	
688		46	16-Sep-91	44.10/147.31	940-1080	1	39.40	0.023	37.0
689		87	16-Sep-91	44.10/147.31	940-1080	1	39.50	0.0343	
690		44	16-Sep-91	44.10/147.31	940-1080	1	39.60	0.035	40.0
691									
692	SM8		25-Jan-93				34.03	0.0222	30.6
693							3.26	0.0051	9.3
694						N=	46.00		
695		3	16-Sep-91	44.10/147.31	940-1080	1	40.00	0.0291	
696		15	16-Sep-91	44.10/147.31	940-1080	1	40.00	0.0291	
697		4	16-Sep-91	44.10/147.31	940-1080	1	40.30	0.0162	
698		4	16-Sep-91	44.10/147.31	940-1080	1	40.30	0.0161	
699		PM 174	17-May-93	44°14' S 147°08' E		1	40.60	0.0341	
700		PM 174	17-May-93	44°14' S 147°08' E		1	40.60	0.0347	
701		22	16-Sep-91	44.10/147.31	940-1080	1	41.10	0.0206	
702		26	16-Sep-91	44.10/147.31	940-1080	1	42.80	0.0293	46.0
703		65	16-Sep-91	44.10/147.31	940-1080	1	43.20	0.0405	45.0
704		54	16-Sep-91	44.10/147.31	940-1080	1	43.30	0.0386	
705		132	16-Nov-88	43.32/145.36	1028-1052	1	43.70	0.0287	
706		132	16-Nov-88	43.32/145.36	1028-1052	1	43.70	0.0278	
707		53	16-Sep-91	44.10/147.31	940-1080	1	44.20	0.0274	
708		18	16-Sep-91	44.10/147.31	940-1080	1	44.50	0.035	52.0
709		71	16-Sep-91	44.10/147.31	940-1080	1	44.60	0.0285	
710		66	16-Sep-91	44.10/147.31	940-1080	1	45.20	0.0291	
711		19	16-Sep-91	44.10/147.31	940-1080	1	45.50	0.038	50.0
712		92	16-Sep-91	44.10/147.31	940-1080	1	45.50	0.0388	50.0
713		81	16-Sep-91	44.10/147.31	940-1080	1	46.10	0.0326	
714		49	16-Sep-91	44.10/147.31	940-1080	1	46.20	0.0335	
715		31	16-Sep-91	44.10/147.31	940-1080	1	46.60	0.0403	
716		32	16-Sep-91	44.10/147.31	940-1080	1	47.30	0.04	50.0
717		91	16-Sep-91	44.10/147.31	940-1080	1	47.90	0.0429	
718		85	16-Sep-91	44.10/147.31	940-1080	1	48.40	0.0326	
719		28	16-Sep-91	44.10/147.31	940-1080	1	48.80	0.0399	
720		36	16-Sep-91	44.10/147.31	940-1080	1	49.80	0.0364	
721		75	16-Sep-91	44.10/147.31	940-1080	1	49.90	0.0448	

APPENDIX 2 SMOOTH OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Fish No.	Date	Lat/Long	Depth (m)	Sex	Lgth (cm)	Otolith weight g	Section Age
722		189	14-Feb-89	43.32/ 145.38	961-992	1	51.20	0.0132	
723		189	14-Feb-89	43.32/ 145.38	961-992	1	51.20	0.0320	
724		16	16-Sep-91	44.10/147.31	940-1080	1	52.30	0.0436	63.0
725									
726	SM9		16-Jun-91				45.16	0.0324	50.9
727							3.65	0.0082	5.9
728						N=	30.00		
729									

APPENDIX 3 SPIKY OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Otolith Code	Date	Cruise	Depth (m)	Sex	Fish Length (cm)	Otolith Weight (g)	Section age
2	SP1								
3		1434	19-Feb-89	PE 104/24	866-930	2	35.0	0.0343	
4		1307	15-Feb-89	PE 104/04	942-983	2	35.0	0.0351	
5		1417	19-Feb-89	PE 104/23	860-911	2	35.1	0.0388	
6		1476	15-Feb-89	PE 104/07	924-963	2	35.1	0.0460	
7		1381	16-Feb-89	PE 104/08	860-911	2	35.1	0.0476	
8		1419	19-Feb-89	PE 104/23	860-911	2	35.2	0.0343	
9		1293	19-Feb-89	PE 104/21	920-1012	2	35.3	0.0505	
10		1309	15-Feb-89	PE 104/04	942-983	2	35.4	0.0508	
11		1471	15-Feb-89	PE 104/07	924-963	2	35.5	0.0412	
12		1378	16-Feb-89	PE 104/08	844-895	2	35.5	0.0446	
13		1397	16-Feb-89	PE 104/09	911-982	2	35.5	0.0508	
14		1387	16-Feb-89	PE 104/08	844-895	2	35.6	0.0349	
15		1418	19-Feb-89	PE 104/23	860-911	2	35.6	0.0517	
16		1384	16-Feb-89	PE 104/08	844-895	2	35.7	0.0436	
17		1437	19-Feb-89	PE 104/24	866-930	2	35.7	0.0625	
18		1312	15-Feb-89	PE 104/04	942-983	2	35.8	0.0302	
19		1402	16-Feb-89	PE 104/09	911-982	2	35.8	0.0357	
20		1320	15-Feb-89	PE 104/04	942-983	2	35.8	0.0680	
21		1416	19-Feb-89	PE 104/23	860-911	2	35.9	0.0394	
22		1477	15-Feb-89	PE 104/07	924-963	2	36.0	0.0331	
23		1426	19-Feb-89	PE 104/23	860-911	2	36.0	0.0415	
24		1461	15-Feb-89	PE 104/07	924-963	2	36.1	0.0744	
25		1464	15-Feb-89	PE 104/07	924-963	2	36.2	0.0760	
26		1440	19-Feb-89	PE 104/24	866-930	2	36.2	0.0796	
27									
28			16-Feb-89					1.1446	
29						MEAN	35.6	0.0477	
30						SD	0.4	0.0145	
31						N	24.0		
32									
33	SP2								
34		1473	15-Feb-89	PE 104/07	924-963	2	36.3	0.0513	
35		1465	15-Feb-89	PE 104/07	924-963	2	36.6	0.0424	
36		1421	19-Feb-89	PE 104/23	860-911	2	36.7	0.0688	
37		1313	15-Feb-89	PE 104/04	942-983	2	36.8	0.0460	
38		1425	19-Feb-89	PE 104/23	860-911	2	36.8	0.0513	
39		1424	19-Feb-89	PE 104/23	860-911	2	36.8	0.0536	
40		1300	19-Feb-89	PE 104/21	920-1012	2	36.9	0.0792	
41		1355	15-Feb-89	PE 104/05	846-886	2	37.0	0.0442	
42		1361	15-Feb-89	PE 104/05	846-886	2	37.1	0.0458	
43		1398	16-Feb-89	PE 104/09	911-982	2	37.1	0.0546	
44		1385	16-Feb-89	PE 104/08	844-895	2	37.2	0.0481	
45		1389	18-Feb-89	PE 104/19	959-1021	2	37.3	0.0543	
46		1280	18-Feb-89	PE 104/18	791-899	2	37.3	0.0621	
47		1282	19-Feb-89	PE 104/21	920-1012	2	37.4	0.0486	
48		1420	19-Feb-89	PE 104/23	860-911	2	37.5	0.0577	
49		1327	15-Feb-89	PE 104/04	942-983	2	37.5	0.0625	
50		1321	15-Feb-89	PE 104/04	942-983	2	37.5	0.0753	
51		1422	19-Feb-89	PE 104/23	860-911	2	37.9	0.0536	
52		1436	19-Feb-89	PE 104/24	866-930	2	38.0	0.0515	
53		1466	15-Feb-89	PE 104/07	924-963	2	38.0	0.0579	
54									
55			17-Feb-89					1.1088	
56						MEAN	37.2	0.0554	
57						SD	0.467	0.0099	
58						N	20.0		

	A	B	C	D	E	F	G	H	I
1	Sample	Otolith Code	Date	Cruise	Depth (m)	Sex	Fish Length (cm)	Otolith Weight (g)	Section age
59	SP3								
60		1328	15-Feb-89	PE 104/04	942-983	2	38.1	0.0638	
61		1458	15-Feb-89	PE 104/07	924-963	2	38.2	0.0369	
62		1289	19-Feb-89	PE 104/21	920-1012	2	38.2	0.0427	
63		1445	19-Feb-89	PE 104/24	866-930	2	38.2	0.0557	
64		1433	19-Feb-89	PE 104/24	866-930	2	38.4	0.0456	
65		1297	19-Feb-89	PE 104/21	920-1012	2	38.6	0.0381	
66		1325	15-Feb-89	PE 104/04	942-983	2	38.6	0.0787	
67		1459	15-Feb-89	PE 104/07	924-963	2	38.8	0.0498	
68		1448	17-Feb-89	PE 104/16	957-1012	2	38.8	0.0660	
69		1446	19-Feb-89	PE 104/24	866-930	2	39.4	0.0504	
70		1454	19-Feb-89	PE 104/22	1052-1096	2	39.5	0.0457	
71		1314	15-Feb-89	PE 104/04	942-983	2	39.6	0.0776	
72		1455	19-Feb-89	PE 104/22	1052-1096	2	39.9	0.0576	
73		1286	19-Feb-89	PE 104/21	920-1012	2	40.0	0.0476	
74		1388	16-Feb-89	PE 104/08	844-895	2	40.0	0.0781	
75		1463	15-Feb-89	PE 104/07	924-963	2	40.0	0.0684	
76		1474	15-Feb-89	PE 104/07	924-963	2	40.0	0.0457	
77		1450	17-Feb-89	PE 104/16	957-1012	2	40.4	0.0431	
78									
79			17-Feb-89					0.9915	
80						MEAN	39.2	0.0551	
81						SD	0.791	0.0139	
82						N	18.0		
83	SP 4								
84		48	10-Aug-88	5 24	761	2	37.60	0.0530	
85		48	10-Aug-88	5 24	761	2	37.60	0.0512	
86		1422	19-Feb-89	PE 104/23	860-911	2	37.90	0.0536	
87		1424	19-Feb-89	PE 104/23	860-911	2	36.80	0.0536	
88		1389	18-Feb-89	PE 104/19	959-1021	2	37.30	0.0543	
89		1398	16-Feb-89	PE 104/09	911-982	2	37.10	0.0546	
90		1445	19-Feb-89	PE 104/24	866-930	2	38.20	0.0557	
91		45	10-Aug-88	5 24	761	2	34.70	0.0561	
92		45	10-Aug-88	5 24	761	2	34.70	0.0578	
93		34	10-Aug-88	5 24	761	2	37.20	0.0565	
94		34	10-Aug-88	5 24	761	2	37.20	0.0588	
95		36	10-Aug-88	5 24	761	2	36.00	0.0566	
96		36	10-Aug-88	5 24	761	2	36.00	0.0574	
97		1455	19-Feb-89	PE 104/22	1052-1096	2	39.90	0.0552	
98		1420	19-Feb-89	PE 104/23	860-911	2	37.50	0.0548	
99		1466	15-Feb-89	PE 104/07	924-963	2	38.00	0.0579	
100		43	10-Aug-88	5 24	761	2	38.20	0.0580	
101		43	10-Aug-88	5 24	761	2	38.20	0.0605	
102		45	24-Aug-88	5 33	635	2	35.20	0.0589	
103		45	24-Aug-88	5 33	635	2	35.20	0.0588	
104								1.0645	
105			27-Oct-88			MEAN	37.03	0.0562	
106						SD	1.35	0.0024	
107						N	20		
108									
109									
110	SP 5								
111		40	1-Aug-88	5 7 (880801)	754	2	32.30	0.0382	
112		40	1-Aug-88	5 7 (880801)	754	2	32.30	0.0387	
113		1429	19-Feb-89	PE 104/24	866-930	2	33.30	0.0384	
114		1429	19-Feb-89	PE 104/24	866-930	2	33.30	0.0393	
115		49	10-Aug-88	5 24	761	2	36.80	0.0385	
116		1417	19-Feb-89	PE 104/23	860-911	2	35.10	0.0388	

	A	B	C	D	E	F	G	H	I
1	Sample	Otolith Code	Date	Cruise	Depth (m)	Sex	Fish Length (cm)	Otolith Weight (g)	Section age
117		1270	18-Feb-89	PE 104/18	791-899	2	34.10	0.0390	
118		1270	18-Feb-89	PE 104/18	791-899	2	34.10	0.0370	
119		1416	19-Feb-89	PE 104/23	860-911	2	35.90	0.0394	
120		32	10-Aug-88	S 24	761	2	34.40	0.0404	
121		32	10-Aug-88	S 24	761	2	34.40	0.0417	
122		48	24-Aug-88	S 33	635	2	34.50	0.0408	
123		1351	15-Feb-89	PE 104/05	846-886	2	33.30	0.0412	
124		1351	15-Feb-89	PE 104/05	846-886	2	33.30	0.0418	
125		1471	15-Feb-89	PE 104/07	924-963	2	35.50	0.0412	
126		1276	18-Feb-89	PE 104/18	791-899	2	33.70	0.0414	
127		1276	18-Feb-89	PE 104/18	791-899	2	33.70	0.0427	
128		1426	19-Feb-89	PE 104/23	860-911	2	36.00	0.0450	
129		1316	15-Feb-89	PE 104/04	942-983	2	33.70	0.0419	
130		1316	15-Feb-89	PE 104/04	942-983	2	33.70	0.0424	
131		29	10-Aug-88	S 24	761	2	36.80	0.0419	
132		29	10-Aug-88	S 24	761	2	36.80	0.0416	
133		42	24-Aug-88	S 33	635	2	33.20	0.0421	
134		42	24-Aug-88	S 33	635	2	33.20	0.0439	
135		1465	15-Feb-89	PE 104/07	924-963	2	36.60	0.0424	
136									
137			3-Dec-88					1.0197	
138						MEAN	34.40	0.0408	
139						SD	1.40	0.0020	
140						N	25.00		
141									
142	SP 6								
143		1268	18-Feb-89	PE 104/18	791-899	2	32.20	0.0301	
144		1268	18-Feb-89	PE 104/18	791-899	2	32.20	0.0301	
145		1312	15-Feb-89	PE 104/04	942-983	2	35.80	0.0302	
146		43	24-Aug-88	S 33	635	2	33.70	0.0307	
147		43	24-Aug-88	S 33	635	2	33.70	0.0328	
148		1275	18-Feb-89	PE 104/18	791-899	2	32.50	0.0310	
149		1275	18-Feb-89	PE 104/18	791-899	2	32.50	0.0304	
150		47	10-Aug-88	S 24	761	2	35.40	0.0313	
151		47	10-Aug-88	S 24	761	2	35.40	0.0317	
152		1306	15-Feb-89	PE 104/04	942-983	2	30.50	0.0317	
153		1306	15-Feb-89	PE 104/04	942-983	2	30.50	0.0316	
154		54	24-Aug-88	S 33	635	2	29.80	0.0317	
155		54	24-Aug-88	S 33	635	2	29.80	0.0320	
156		1386	16-Feb-89	PE 104/08	844-895	2	34.80	0.0318	
157		1386	16-Feb-89	PE 104/08	844-895	2	34.80	0.0332	
158		1265	18-Feb-89	PE 104/18	791-899	2	31.80	0.0322	
159		1265	18-Feb-89	PE 104/18	791-899	2	31.80	0.0301	
160		1462	15-Feb-89	PE 104/07	924-963	2	33.90	0.0328	
161		1462	15-Feb-89	PE 104/07	924-963	2	33.90	0.0314	
162		36	24-Aug-88	S 33	635	2	32.00	0.0328	
163		36	24-Aug-88	S 33	635	2	32.00	0.0331	
164		1477	15-Feb-89	PE 104/07	924-963	2	36.00	0.0314	
165		1423	19-Feb-89	PE 104/23	860-911	2	33.10	0.0334	
166		1423	19-Feb-89	PE 104/23	860-911	2	33.10	0.0337	
167		1393	18-Feb-89	PE 104/19	959-1021	2	34.10	0.0336	
168		1393	18-Feb-89	PE 104/19	959-1021	2	34.10	0.0340	
169		27	10-Aug-88	S 24	761	2	33.40	0.0340	
170		27	10-Aug-88	S 24	761	2	33.40	0.0334	
171		55	24-Aug-88	S 33	635	2	33.80	0.0341	
172		55	24-Aug-88	S 33	635	2	33.80	0.0335	
173		1419	19-Feb-89	PE 104/23	860-911	2	35.20	0.0337	
174								0.9975	

	A	B	C	D	E	F	G	H	I
1	Sample	Otolith Code	Date	Cruise	Depth (m)	Sex	Fish Length (cm)	Otolith Weight (g)	Section age
175			8-Dec-88			MEAN	33.19	0.0322	
176						SD	1.68	0.0013	
177						N	31		
178									
179	SP7								
180		1388	16-Feb-89	PE 104/08	844-895	2	40.00	0.0819	
181		1325	15-Feb-89	PE 104/04	942-983	2	38.60	0.0852	
182		1440	19-Feb-89	PE 104/24	866-930	2	36.20	0.0796	
183		47	24-Aug-88	5 33	635	2	36.70	0.0822	
184		47	24-Aug-88	5 33	635	2	36.70	0.0867	
185		1457	15-Feb-89	PE 104/07	924-963	2	36.50	0.0826	
186		1457	15-Feb-89	PE 104/07	924-963	2	36.50	0.0877	
187		1278	18-Feb-89	PE 104/18	791-899	2	39.80	0.0803	
188		1273	18-Feb-89	PE 104/18	791-899	2	35.60	0.0922	
189		1273	18-Feb-89	PE 104/18	791-899	2	35.60	0.0881	
190		1329	15-Feb-89	PE 104/04	942-983	2	35.80	0.1096	
191		1329	15-Feb-89	PE 104/04	942-983	2	35.80	0.1097	
192								1.0658	
193			18-Jan-89			MEAN	36.98	0.0888	
194						SD	1.58	0.0104	
195						N	12		
196									
197									
198	SP 8								
199		1304	19-Feb-89	PE 104/21	920-1012	1	9.6	0.0015	
200		1304	19-Feb-89	PE 104/21	920-1012	1	9.6	0.0015	
201		1363	16-Feb-89	PE 104/08	844-895	2	10.4	0.0022	
202		1363	16-Feb-89	PE 104/08	844-895	2	10.4	0.0022	
203		1334	16-Feb-89	PE 104/11	911-964	1	10.5	0.0015	
204		1334	16-Feb-89	PE 104/11	911-964	1	10.5	0.0016	
205		1406	16-Feb-89	PE 104/09	911-982	1	10.5	0.0016	
206		1406	16-Feb-89	PE 104/09	911-982	1	10.5	0.0014	
207		1405	16-Feb-89	PE 104/09	911-982	1	10.6	0.0014	
208		1405	16-Feb-89	PE 104/09	911-982	1	10.6	0.0016	
209		1407	16-Feb-89	PE 104/09	911-982	1	10.8	0.0016	
210		1407	16-Feb-89	PE 104/09	911-982	1	10.8	0.0017	
211		1456	16-Feb-89	PE 104/10	1049-1089	2	10.9	0.0017	
212		1456	16-Feb-89	PE 104/10	1049-1089	2	10.9	0.0015	
213		1364	16-Feb-89	PE 104/08	844-895	1	11.0	0.0015	
214		1364	16-Feb-89	PE 104/08	844-895	1	11.0	0.0016	
215		1453	17-Feb-89	PE 104/16	957-1012	2	11.1	0.0023	
216		1453	17-Feb-89	PE 104/16	957-1012	2	11.1	0.0020	
217		1362	16-Feb-89	PE 104/08	844-895	1	11.2	0.0022	
218		1362	16-Feb-89	PE 104/08	844-895	1	11.2	0.0021	
219		72	1-Aug-88	5 7 (880801)	754	3	11.2	0.0027	
220		72	1-Aug-88	5 7 (880801)	754	3	11.2	0.0031	
221		1408	19-Feb-89	PE 104/23	860-911	2	11.4	0.0028	
222		1408	19-Feb-89	PE 104/23	860-911	2	11.4	0.0028	
223		1303	19-Feb-89	PE 104/21	920-1012	1	11.5	0.0019	
224		1303	19-Feb-89	PE 104/21	920-1012	1	11.5	0.0018	
225		1396	18-Feb-89	PE 104/19	959-1021	1	11.5	0.0023	
226		1396	18-Feb-89	PE 104/19	959-1021	1	11.5	0.0019	
227		1409	19-Feb-89	PE 104/23	860-911	1	11.5	0.0019	
228		1409	19-Feb-89	PE 104/23	860-911	1	11.5	0.0018	
229		7	1-Aug-88	5 7 (880801)	754	1	11.5	0.0029	
230		18	1-Aug-88	5 7 (880801)	754	1	12.2	0.0028	
231		18	1-Aug-88	5 7 (880801)	754	1	12.2	0.0026	
232		71	1-Aug-88	5 7 (880801)	754	3	12.3	0.0025	

	A	B	C	D	E	F	G	H	I
1	Sample	Otolith Code	Date	Cruise	Depth (m)	Sex	Fish Length (cm)	Otolith Weight (g)	Section age
233		11	1-Aug-88	S 7 (880801)	754	1	12.5	0.003	
234		11	1-Aug-88	S 7 (880801)	754	1	12.5	0.0031	
235		70	1-Aug-88	S 7 (880801)	754	3	12.8	0.0031	
236		70	1-Aug-88	S 7 (880801)	754	3	12.8	0.0031	
237		73	1-Aug-88	S 7 (880801)	754	3	12.8	0.0029	
238		73	1-Aug-88	S 7 (880801)	754	3	12.8	0.003	
239		47	1-Aug-88	S 7 (880801)	754	2	13.5	0.0038	
240		47	1-Aug-88	S 7 (880801)	754	2	13.5	0.0041	
241		31	1-Aug-88	S 7 (880801)	754	1	13.6	0.0034	
242		31	1-Aug-88	S 7 (880801)	754	1	13.6	0.0035	
243		44	1-Aug-88	S 7 (880801)	754	2	13.6	0.0044	
244		44	1-Aug-88	S 7 (880801)	754	2	13.6	0.0042	
245		65	1-Aug-88	S 7 (880801)	754	2	14.4	0.0045	
246		1333	17-Feb-89	PE 104/14	1085-1158	2	14.5	0.0066	
247		1333	17-Feb-89	PE 104/14	1085-1158	2	14.5	0.0062	
248		5	1-Aug-88	S 7 (880801)	754	1	15.2	0.0051	
249		5	1-Aug-88	S 7 (880801)	754	1	15.2	0.0055	
250		20	1-Aug-88	S 7 (880801)	754	1	15.3	0.0051	
251		20	1-Aug-88	S 7 (880801)	754	1	15.3	0.0051	
252		1332	17-Feb-89	PE 104/14	1085-1158	2	15.4	0.0069	
253		1332	17-Feb-89	PE 104/14	1085-1158	2	15.4	0.0069	
254		6	1-Aug-88	S 7 (880801)	754	1	15.4	0.0052	
255		6	1-Aug-88	S 7 (880801)	754	1	15.4	0.0051	
256		68	1-Aug-88	S 7 (880801)	754	2	15.4	0.0059	
257		68	1-Aug-88	S 7 (880801)	754	2	15.4	0.0062	
258		33	1-Aug-88	S 7 (880801)	754	1	15.6	0.0068	
259		33	1-Aug-88	S 7 (880801)	754	1	15.6	0.0067	
260		66	1-Aug-88	S 7 (880801)	754	2	15.6	0.0052	
261		1365	16-Feb-89	PE 104/08	844-895	1	15.7	0.0072	
262		1365	16-Feb-89	PE 104/08	844-895	1	15.7	0.0070	
263		25	1-Aug-88	S 7 (880801)	754	1	15.7	0.0056	
264		25	1-Aug-88	S 7 (880801)	754	1	15.7	0.0054	
265		12	1-Aug-88	S 7 (880801)	754	1	16	0.0058	
266		12	1-Aug-88	S 7 (880801)	754	1	16	0.0057	
267		27	1-Aug-88	S 7 (880801)	754	1	16.1	0.0067	
268		27	1-Aug-88	S 7 (880801)	754	1	16.1	0.0069	
269		67	1-Aug-88	S 7 (880801)	754	2	16.1	0.0071	
270		67	1-Aug-88	S 7 (880801)	754	2	16.1	0.0067	
271		28	1-Aug-88	S 7 (880801)	754	1	16.2	0.0059	
272		60	1-Aug-88	S 7 (880801)	754	2	16.2	0.0064	
273		4	1-Aug-88	S 7 (880801)	754	1	16.3	0.0063	
274		4	1-Aug-88	S 7 (880801)	754	1	16.3	0.0065	
275		16	1-Aug-88	S 7 (880801)	754	1	16.3	0.0061	
276		16	1-Aug-88	S 7 (880801)	754	1	16.3	0.0062	
277		21	1-Aug-88	S 7 (880801)	754	1	16.3	0.0058	
278		21	1-Aug-88	S 7 (880801)	754	1	16.3	0.0058	
279		1	1-Aug-88	S 7 (880801)	754	1	16.4	0.0063	
280		1	1-Aug-88	S 7 (880801)	754	1	16.4	0.0059	
281		3	1-Aug-88	S 7 (880801)	754	1	16.4	0.0061	
282		3	1-Aug-88	S 7 (880801)	754	1	16.4	0.0062	
283		37	1-Aug-88	S 7 (880801)	754	2	16.5	0.0067	
284		37	1-Aug-88	S 7 (880801)	754	2	16.5	0.0066	
285		39	1-Aug-88	S 7 (880801)	754	2	16.5	0.0058	
286		39	1-Aug-88	S 7 (880801)	754	2	16.5	0.0059	
287		8	1-Aug-88	S 7 (880801)	754	1	16.6	0.0066	
288		8	1-Aug-88	S 7 (880801)	754	1	16.6	0.0071	
289		15	1-Aug-88	S 7 (880801)	754	1	16.6	0.0076	
290		15	1-Aug-88	S 7 (880801)	754	1	16.6	0.0074	

	A	B	C	D	E	F	G	H	I
1	Sample	Otolith Code	Date	Cruise	Depth (m)	Sex	Fish Length (cm)	Otolith Weight (g)	Section age
291		69	1-Aug-88	5 7 (880801)	754	2	16.6	0.0065	
292		69	1-Aug-88	5 7 (880801)	754	2	16.6	0.0064	
293		26	1-Aug-88	5 7 (880801)	754	1	16.8	0.0071	
294		26	1-Aug-88	5 7 (880801)	754	1	16.8	0.0075	
295		42	1-Aug-88	5 7 (880801)	754	2	16.9	0.007	
296		55	1-Aug-88	5 7 (880801)	754	2	17	0.0067	
297		55	1-Aug-88	5 7 (880801)	754	2	17	0.0064	
298		17	1-Aug-88	5 7 (880801)	754	1	17.1	0.0067	
299		17	1-Aug-88	5 7 (880801)	754	1	17.1	0.0066	
300		19	1-Aug-88	5 7 (880801)	754	1	17.2	0.0082	
301		19	1-Aug-88	5 7 (880801)	754	1	17.2	0.0081	
302		36	1-Aug-88	5 7 (880801)	754	2	17.2	0.008	
303		36	1-Aug-88	5 7 (880801)	754	2	17.2	0.008	
304		48	1-Aug-88	5 7 (880801)	754	2	17.2	0.0075	
305		48	1-Aug-88	5 7 (880801)	754	2	17.2	0.0075	
306		1367	16-Feb-89	PE 104/08	844-895	2	17.3	0.0069	
307		1367	16-Feb-89	PE 104/08	844-895	2	17.3	0.0071	
308		29	1-Aug-88	5 7 (880801)	754	1	17.3	0.0063	
309		29	1-Aug-88	5 7 (880801)	754	1	17.3	0.0061	
310		13	1-Aug-88	5 7 (880801)	754	1	17.5	0.0061	
311		13	1-Aug-88	5 7 (880801)	754	1	17.5	0.0061	
312		1368	16-Feb-89	PE 104/08	844-895	2	17.8	0.0079	
313		1368	16-Feb-89	PE 104/08	844-895	2	17.8	0.0085	
314		1366	16-Feb-89	PE 104/08	844-895	2	18.2	0.0095	
315		1366	16-Feb-89	PE 104/08	844-895	2	18.2	0.0097	
316		34	1-Aug-88	5 7 (880801)	754	1	18.6	0.0069	
317		34	1-Aug-88	5 7 (880801)	754	1	18.6	0.007	
318		50	1-Aug-88	5 7 (880801)	754	2	18.7	0.0105	
319		50	1-Aug-88	5 7 (880801)	754	2	18.7	0.0108	
320		56	24-Aug-88	5 33	635	I	18.7	0.0071	
321		56	24-Aug-88	5 33	635	I	18.7	0.0071	
322		61	1-Aug-88	5 7 (880801)	754	2	18.8	0.0121	
323		61	1-Aug-88	5 7 (880801)	754	2	18.8	0.0121	
324		10	1-Aug-88	5 7 (880801)	754	1	19	0.0087	
325		10	1-Aug-88	5 7 (880801)	754	1	19	0.0085	
326		9	1-Aug-88	5 7 (880801)	754	1	19.2	0.0092	
327		9	1-Aug-88	5 7 (880801)	754	1	19.2	0.0094	
328		52	1-Aug-88	5 7 (880801)	754	2	19.3	0.0101	
329		57	1-Aug-88	5 7 (880801)	754	2	19.3	0.009	
330		57	1-Aug-88	5 7 (880801)	754	2	19.3	0.0095	
331		1256	18-Feb-89	PE 104/18	791-899	2	19.6	0.0129	
332		1256	18-Feb-89	PE 104/18	791-899	2	19.6	0.0129	
333		1337	15-Feb-89	PE 104/05	846-886	1	19.6	0.0112	
334		1337	15-Feb-89	PE 104/05	846-886	1	19.6	0.0109	
335		32	1-Aug-88	5 7 (880801)	754	1	19.6	0.0069	
336		32	1-Aug-88	5 7 (880801)	754	1	19.6	0.0068	
337		58	1-Aug-88	5 7 (880801)	754	2	19.6	0.0107	
338		58	1-Aug-88	5 7 (880801)	754	2	19.6	0.0106	
339		51	1-Aug-88	5 7 (880801)	754	2	19.9	0.0093	
340		51	1-Aug-88	5 7 (880801)	754	2	19.9	0.0092	
341		24	1-Aug-88	5 7 (880801)	754	1	20.1	0.0085	
342		24	1-Aug-88	5 7 (880801)	754	1	20.1	0.0081	
343		41	1-Aug-88	5 7 (880801)	754	2	20.2	0.0115	
344		41	1-Aug-88	5 7 (880801)	754	2	20.2	0.0111	
345		1330	14-Feb-89	PE 104/01	961-992	1	20.4	0.0123	
346		1330	14-Feb-89	PE 104/01	961-992	1	20.4	0.0127	
347		1369	16-Feb-89	PE 104/08	844-895	2	20.6	0.0091	
348		1369	16-Feb-89	PE 104/08	844-895	2	20.6	0.0091	

	A	B	C	D	E	F	G	H	I
1	Sample	Otolith Code	Date	Cruise	Depth (m)	Sex	Fish Length (cm)	Otolith Weight (g)	Section age
349		59	1-Aug-88	5 7 (880801)	754	2	20.6	0.0126	
350		59	1-Aug-88	5 7 (880801)	754	2	20.6	0.0128	
351		1339	15-Feb-89	PE 104/05	846-886	1	20.8	0.0088	
352		1339	15-Feb-89	PE 104/05	846-886	1	20.8	0.0085	
353		56	1-Aug-88	5 7 (880801)	754	2	20.8	0.0132	
354		56	1-Aug-88	5 7 (880801)	754	2	20.8	0.0129	
355		15	24-Aug-88	5 33	635	1	21.2	0.0138	
356		15	24-Aug-88	5 33	635	1	21.2	0.013	
357									
358									
359									
360								0.9942	
361			3-Oct-88	MEAN		MEAN=	15.86	0.0063	
362				STDEV		SD=	3.20	0.0032	
363						N=	158		
364									
365	SP9								
366		1370	16-Feb-89	PE 104/08	844-895	2	21.3	0.0147	
367		1370	16-Feb-89	PE 104/08	844-895	2	21.3	0.0153	
368		45	1-Aug-88	5 7 (880801)	754	2	21.4	0.013	
369		45	1-Aug-88	5 7 (880801)	754	2	21.4	0.0129	
370		1257	18-Feb-89	PE 104/18	791-899	1	21.7	0.0112	
371		1257	18-Feb-89	PE 104/18	791-899	1	21.7	0.0117	
372		1338	15-Feb-89	PE 104/05	846-886	2	21.7	0.0125	
373		1338	15-Feb-89	PE 104/05	846-886	2	21.7	0.0130	
374		53	1-Aug-88	5 7 (880801)	754	2	21.8	0.0116	
375		53	1-Aug-88	5 7 (880801)	754	2	21.8	0.0112	
376		1340	15-Feb-89	PE 104/05	846-886	1	21.9	0.0146	
377		1340	15-Feb-89	PE 104/05	846-886	1	21.9	0.0142	
378		35	1-Aug-88	5 7 (880801)	754	1	22.2	0.0152	
379		35	1-Aug-88	5 7 (880801)	754	1	22.2	0.0154	
380		31	24-Aug-88	5 33	635	2	22.4	0.0151	
381		31	24-Aug-88	5 33	635	2	22.4	0.0152	
382		41	24-Aug-88	5 33	635	2	22.4	0.0145	
383		41	24-Aug-88	5 33	635	2	22.4	0.0146	
384		1371	16-Feb-89	PE 104/08	844-895	2	22.9	0.0122	
385		1371	16-Feb-89	PE 104/08	844-895	2	22.9	0.0115	
386		1335	16-Feb-89	PE 104/11		1	23.5	0.0141	
387		1335	16-Feb-89	PE 104/11		1	23.5	0.0139	
388		1341	15-Feb-89	PE 104/05	846-886	1	23.6	0.0148	
389		1341	15-Feb-89	PE 104/05	846-886	1	23.6	0.0144	
390		1342	15-Feb-89	PE 104/05	846-886	1	23.6	0.0166	
391		1342	15-Feb-89	PE 104/05	846-886	1	23.6	0.0165	
392		54	1-Aug-88	5 7 (880801)	754	2	23.8	0.0161	
393		54	1-Aug-88	5 7 (880801)	754	2	23.8	0.0162	
394		62	1-Aug-88	5 7 (880801)	754	2	23.8	0.0127	
395		62	1-Aug-88	5 7 (880801)	754	2	23.8	0.0125	
396		38	1-Aug-88	5 7 (880801)	754	2	24.5	0.016	
397		38	1-Aug-88	5 7 (880801)	754	2	24.5	0.0154	
398		19	24-Aug-88	5 33	635	1	25.2	0.015	
399		19	24-Aug-88	5 33	635	1	25.2	0.0151	
400		38	24-Aug-88	5 33	635	2	25.6	0.0141	
401		38	24-Aug-88	5 33	635	2	25.6	0.0142	
402		1372	16-Feb-89	PE 104/08	844-895	2	26.2	0.0184	
403		1372	16-Feb-89	PE 104/08	844-895	2	26.2	0.0193	
404		1479	15-Feb-89	PE 104/07	924-963	1	26.3	0.0217	
405		1479	15-Feb-89	PE 104/07	924-963	1	26.3	0.0207	
406		63	1-Aug-88	5 7 (880801)	754	2	26.4	0.0161	

APPENDIX 3 SPIKY OREO SAMPLES

	A	B	C	D	E	F	G	H	I
1	Sample	Otolith Code	Date	Cruise	Depth (m)	Sex	Fish Length (cm)	Otolith Weight (g)	Section age
407		63	1-Aug-88	5 7 (880801)	754	2	26.4	0.0161	
408		20	24-Aug-88	5 33	635	1	26.4	0.0184	
409		20	24-Aug-88	5 33	635	1	26.4	0.0188	
410		37	10-Aug-88	5 24	761	2	27.2	0.0174	
411		27	24-Aug-88	5 33	635	1	27.4	0.019	
412		27	24-Aug-88	5 33	635	1	27.4	0.0189	
413		1410	19-Feb-89	PE 104/23	860-911	1	27.5	0.0213	
414		1410	19-Feb-89	PE 104/23	860-911	1	27.5	0.0198	
415		46	1-Aug-88	5 7 (880801)	754	2	27.6	0.0181	
416		5	24-Aug-88	5 33	635	1	27.6	0.0322	
417		5	24-Aug-88	5 33	635	1	27.6	0.0323	
418		1258	18-Feb-89	PE 104/18	791-899	1	28.1	0.0233	
419		1258	18-Feb-89	PE 104/18	791-899	1	28.1	0.0245	
420		10	24-Aug-88	5 33	635	1	28.4	0.0346	
421		10	24-Aug-88	5 33	635	1	28.4	0.0346	
422		1260	18-Feb-89	PE 104/18	791-899	2	28.5	0.0241	
423		1260	18-Feb-89	PE 104/18	791-899	2	28.5	0.0241	
424									
425								1.0009	
426			4-Nov-88	MEAN		MEAN	24.60	0.0173	
427				STDEV		SD	2.40	0.0055	
428						N	58.00		
429									

Appendix 4: Stable element analysis of barium and lead by ICP-MS in the otoliths of black, smooth and spiky oreos.

Species	Sample weight of Otoliths ANSTO	Ca ppm	Sr ppm	Ba ppm	Ba blank ppm	Ba ppm blank corrected	Pb ppm	Pb blank ppm	Pb ppm blank corrected	Ca ppm corrected	Sr ppm corrected	Ba ppm (mg/kg)	Pb ppm (mg/kg)	Sr/Ca	Pb/Ba
Black Oreo															
LH 4497 B1	1.05721	3955.00	32.00	12.30	11.40	0.90	0.0019	0.0055	-0.0036	374098	3027	85	-0.34	0.0081	-0.0040
LH 4496 B2	1.02324	3757.00	32.00	21.50	11.40	10.10	0.0019	0.0055	-0.0036	367167	3127	987	-0.35	0.0085	-0.0004
LH 4494 B4	1.02844	3779.00	33.00	11.20	11.40	-0.20	0.0020	0.0055	-0.0035	367450	3209	-19	-0.34	0.0087	0.0175
LH 4495 B5	1.12123	4398.00	35.00	11.60	11.40	0.20	0.0027	0.0055	-0.0028	392248	3122	18	-0.25	0.0080	-0.0140
LH 4489 B6	1.07438	4300.00	35.00	1.37	1.01	0.36	0.0019	0.0013	0.0006	400231	3258	34	0.06	0.0081	0.0017
LH 4490 B7	1.04572	3930.00	32.00	1.20	1.01	0.19	0.0016	0.0013	0.0003	375818	3060	18	0.03	0.0081	0.0016
LH 4491 B8	1.12563	4370.00	38.00	1.42	1.01	0.41	0.0012	0.0013	-0.0001	388227	3376	36	-0.01	0.0087	-0.0002
LH 4492 B9	1.08945	4230.00	37.00	1.14	1.01	0.13	0.0037	0.0013	0.0024	388269	3396	12	0.22	0.0087	0.0185
LH 4493 B10	1.09251	4260.00	37.00	1.06	1.01	0.05	0.0022	0.0013	0.0009	389928	3387	5	0.08	0.0087	0.0180
Smooth Oreo															
LH 4506 SM1	1.03849	3596.00	44.00	7.70	11.40	-3.70	0.0160	0.0055	0.0105	346272	4237	-356	1.01	0.0122	-0.0028
LH 4505 SM2	0.9856	3888.00	38.00	10.90	11.40	-0.50	0.0015	0.0055	-0.0040	394481	3856	-51	-0.41	0.0098	0.0080
LH 4504 SM3	1.07304	4067.00	42.00	12.30	11.40	0.90	0.0034	0.0055	-0.0021	379017	3914	84	-0.20	0.0103	-0.0023
LH 4503 SM4	0.94442	3528.00	39.00	12.00	11.40	0.60	0.0012	0.0055	-0.0043	373563	4130	64	-0.46	0.0111	-0.0072
LH 4498 SM 5	0.93685	3551.00	37.00	7.50	11.40	-3.90	0.0015	0.0055	-0.0040	379036	3949	-416	-0.43	0.0104	0.0010
LH 4499 SM6	1.03981	3775.00	38.00	11.00	11.40	-0.40	0.0017	0.0055	-0.0038	363047	3655	-38	-0.37	0.0101	0.0095
LH 4500 SM7	1.24489	4809.00	47.00	12.80	11.40	1.40	0.0039	0.0055	-0.0016	386299	3775	112	-0.13	0.0098	-0.0011
LH 4501 SM8 N	1.01933	3798.00	39.00	12.00	11.40	0.60	0.0015	0.0055	-0.0040	372598	3826	59	-0.39	0.0103	-0.0067
LH 4502 SM9 N	0.98943	3753.00	39.00	13.00	11.40	1.60	0.0024	0.0055	-0.0031	379309	3942	162	-0.31	0.0104	-0.0019
Spiky Oreo															
LH 2829 SP1	1.1292	4240.00	34.30	3.02	0.00	3.02	0.0058	0.0033	0.0025	375487	3038	267	0.22	0.0081	0.0008
LH 2830 SP2	1.108	4290.00	34.70	2.98	0.00	2.98	0.0036	0.0033	0.0003	387184	3132	269	0.03	0.0081	0.0001
LH 2831 SP3	1.067	4300.00	35.30	2.90	0.00	2.90	0.0056	0.0033	0.0023	402999	3308	272	0.22	0.0082	0.0008
LH 3545 SP4	1.1175	4500.00	37.00	1.60	1.20	0.40	0.0026	0.0066	-0.0040	402685	3311	36	-0.36	0.0082	-0.0100
LH 3546 SP5	1.0133	4040.00	32.00	1.70	1.20	0.50	0.0041	0.0066	-0.0025	398697	3158	49	-0.25	0.0079	-0.0050
LH 4186 SP6	0.99287	3720.00	28.40	1.46	1.13	0.33	0.0031	0.0022	0.0009	374671	2860	33	0.09	0.0076	0.0027
LH 4187 SP7	1.0633	4040.00	32.40	1.69	1.13	0.56	0.0027	0.0022	0.0005	379949	3047	53	0.05	0.0080	0.0009
LH 4188 SP8	0.98542	3700.00	29.10	1.37	1.13	0.24	0.0018	0.0022	-0.0004	375474	2953	24	-0.04	0.0079	-0.0017
LH 4189 SP9	0.99647	3500.00	26.60	1.35	1.13	0.22	0.0013	0.0022	-0.0009	351240	2669	22	-0.09	0.0076	-0.0041