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Title

Sec.I: Age, growth, and radiometric age validation of the blackgill rockfish, *Sebastes melanostomus*; Sec.II: Age validation of the canary rockfish (*Sebastes pinniger*) using the disequilibria of lead-210 and radium-226

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Abstract Section I:

As nearshore fish populations decline, many commercial fishers have shifted effort to deeper continental slope habitats to target fishes for which biological information is limited. One such fishery that developed in the northeastern Pacific Ocean in the early 1980s was for the blackgill rockfish, *Sebastes melanostomus*, a deep-dwelling (300-800 m) species that congregates over rocky pinnacles, mainly from Southern California to southern Oregon. Growth zone-derived age estimates from otolith thin sections were compared to ages obtained from the radioactive disequilibria of ^{210}Pb , relative to its parent, ^{226}Ra , in otolith cores of blackgill rockfish. Age estimates were validated up to 41 years, with a strong pattern of agreement supporting a longevity exceeding 90 years. Age and length data fitted to the von Bertalanffy growth function indicate blackgill rockfish are slow-growing ($k = 0.040$ females, 0.068 males) and that females grow slower than males, but reach a greater length. Age at 50% maturity, derived from previously published length-at-maturity estimates, was 17 years for males and 21 years for females. The results of this study agree with general life history traits already recognized for many *Sebastes* species, such as long life, slow growth, and late age at maturation. These traits may undermine the sustainability of blackgill rockfish populations when heavy fishing pressure, such as that which occurred in the 1980s, is applied.

Abstract Section II:

The canary rockfish (*Sebastes pinniger*) has been an important part of the recreational

and commercial rockfish fisheries from southeast Alaska to Southern California for a long time, but stocks have declined considerably over the past few decades. Based on age estimates from otoliths and other structures, longevity estimates vary from just over 20 years to more than 80 years. For the purpose of monitoring stocks, age composition is routinely estimated by counting growth zones in otoliths using the break-and-burn technique; however, age estimation procedures and high longevities for this species remain largely unvalidated. Typical age validation techniques have limited application for the canary rockfish because they are deep dwelling and appear to be long-lived fish. In this study we have taken the unaged otolith of the pair from aged fish and have measured the disequilibria of lead-210 (^{210}Pb) and radium-226 (^{226}Ra) as an indicator of age estimate accuracy. The technique proved successful in determining a minimum longevity of about 51 years and provided strong support for the estimation procedures used to determine longevity at over 80 years.

California Sea Grant funded publications that pre-date and resulted from this study are listed below. Please contact Allen H. Andrews at allen.andrews@noaa.gov for further information.

Andrews, A.H., K.H. Coale, J.L. Nowicki, C. Lundstrom, Z. Palacz, E.J. Burton and G.M. Cailliet. 1999. Application of an ion-exchange separation technique and thermal ionization mass spectrometry to ^{226}Ra determination in otoliths for radiometric age determination of long-lived fishes. *Can. J. Fish. Aquat. Sci.* 56:1329–1338 (R/F-148)

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Andrews, A.H., G.M. Cailliet, K.H. Coale, K.M. Munk, M.M. Mahoney and V.M. O'Connell. 2002. Radiometric age validation of the yelloweye rockfish (*Sebastes ruberrimus*) from southeastern Alaska. *Mar. Freshwater Res.* 53:139–146 (R/F-148)

Kerr, L.A., A.H. Andrews, B.R. Frantz, K.H. Coale, T.A. Brown and G.M. Cailliet. 2004. Radiocarbon in otoliths of yelloweye rockfish (*Sebastes ruberrimus*): a reference time series for the coastal waters of southeast Alaska. *Can. J. Fish. Aquat. Sci.* 61:443–451.

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Andrews, A.H., E.J. Burton, L.A. Kerr, G.M. Cailliet, K.H. Coale, C.C. Lundstrom and T.A. Brown. 2005. Bomb radiocarbon and lead-radium disequilibria in otoliths of bocaccio rockfish (*Sebastes paucispinis*): a determination of age and longevity for a difficult-to-age fish. *Proceedings of the 3rd International Symposium on Otolith Research and Application.* *Mar. Freshwater Res.* 56:517–528.

Kerr, L.A., A.H. Andrews, B.R. Frantz, K.H. Coale, T.A. Brown, K. Munk and G.M. Cailliet. 2005. Age validation of quillback rockfish (*Sebastes maliger*) using bomb radiocarbon. *Fish. Bull.* 103(1):97–107.

Kerr, L.A., A.H. Andrews, G.M. Cailliet, T.A. Brown and K.H. Coale. 2006. Investigations of $\Delta^{14}\text{C}$, $\delta^{15}\text{N}$, and $\delta^{13}\text{C}$ in vertebrae of white shark (*Carcharodon carcharias*) from the eastern Pacific Ocean. *Environ. Biol. Fish.* 77:337–353.

Ardizzone, D.A., G.M. Cailliet, L.J. Natanson, A.H. Andrews, L.A. Kerr and T.A. Brown. 2006. Application of bomb radiocarbon chronologies to shortfin mako (*Isurus oxyrinchus*) age validation. *Environ. Biol. Fish.* 77:355–366.

Andrews, A.H., L.A. Kerr, G.M. Cailliet, T.A. Brown, C.C. Lundstrom and R.D. Stanley. 2007. Age validation of canary rockfish (*Sebastes pinniger*) using two independent otolith techniques: lead-radium and bomb radiocarbon dating. *Mar. Freshwater Res.* 58:531–541.