

Fish Ageing Precision Articles

04 November, 2018

Acre, M. R., C. Alejandrez, J. East, W. A. Massure, S. Miyazono, J. E. Pease, E. L. Roesler, H. M. Williams, and T. B. Grabowski. 2017. Comparison of the precision of age estimates generated from fin rays, scales, and otoliths of Blue Sucker. *Southeastern Naturalist* 16:215–224.

Adams, J., and D. Kerstetter. 2014. Age and growth of three coastal-pelagic tunas (Actinopterygii: Perciformes: Scombridae) in the Florida Straits, USA: Blackfin Tuna, *Thunnus Atlanticus*, Little Tunny, *Euthynnus Alletteratus*, and Skipjack Tuna, *Katsuwonus Pelamis*. *Acta Ichthyologica et Piscatoria* 44:201–211.

Allman, Robert J., Gary R. Fitzhugh, K. J. Starzinger, and R. A. Farsky. 2005. Precision of age estimation in Red Snapper (*Lutjanus Campechanus*). *Fisheries Research* 73:123–133.

Anderson, J., A. Morison, and D. Ray. 1992a. Age and growth of Murray Cod, *Maccullochella Peelii* (Perciformes: Percichthyidae), in the Lower Murray-Darling Basin, Australia, from thin-sectioned otoliths. *Marine and Freshwater Research* 43:983–1013.

Anderson, J., A. Morison, and D. Ray. 1992b. Validation of the use of thin-sectioned otoliths for determining the age and growth of Golden Perch, *Macquaria Ambigua* (Perciformes: Percichthyidae), in the Lower Murray-Darling Basin, Australia. *Marine and Freshwater Research* 43:1103–1128.

Andrade, H. A. 2004. Age and growth of the Searobin (*Prionotus Punctatus*) in Brazilian waters. *Bulletin of Marine Science* 75:1–9.

Andrews, A. H., G. M. Cailliet, and K. H. Coale. 1999. Age and growth of the Pacific Grenadier (*Coryphaenoides Acrolepis*) with age estimate validation using an improved radiometric ageing technique. *Canadian Journal of Fisheries and Aquatic Sciences* 56:1339–1350.

Artero, C., D. Murie, C. Koenig, R. Berzins, C. Bouchon, and L. Lampert. 2015. Age, growth, and mortality of the Atlantic Goliath Grouper *Epinephelus Itajara* in French Guiana. *Endangered Species Research* 28:275–287.

Aschenbrenner, A., M. O. Freitas, G. R. A. Rocha, R. L. de Moura, R. B. Francini-Filho, C. Minte-Vera, and B. P. Ferreira. 2017. Age, growth parameters and fisheries indices for the Lane Snapper in the Abrolhos Bank, SW Atlantic. *Fisheries Research* 194:155–163.

Balazik, M. T., S. P. McIninch, G. C. Garman, and R. J. Latour. 2012. Age and growth of Atlantic Sturgeon in the James River, Virginia, 1997–2011. *Transactions of the American Fisheries Society* 141:1074–1080.

Barada, T. J., A. J. Blank, and M. A. Pegg. 2011. Bias, precision, and processing time of otoliths and pectoral spines used for age estimation of Channel Catfish. *American Fisheries Society Symposium* 77:723–731.

Barbieri, L. R., M. E. C. Jr, and C. M. Jones. 1994. Age, growth, and mortality of Atlantic Croaker, *Micropogonias Undulatus*, in the Chesapeake Bay region, with a discussion of apparent geographic changes in population dynamics. *Fishery Bulletin* 91:1–12.

Barreto, R. R., R. P. Lessa, F. H. Hazin, and F. M. Santana. 2011. Age and growth of the Blacknose Shark, *Carcharhinus Acronotus* (Poey, 1860) off the northeastern Brazilian Coast. *Fisheries Research* 110:170–176.

Bauerlien, C. J., M. R. Cornett, E. A. Zielonka, D. P. Crane, and J. S. Bulak. 2018. Precision of calcified structures used for estimating age of Chain Pickerel *Esox Niger*. *North American Journal of Fisheries Management* 38.

Beckman, D. W. 2002. Comparison of aging methods and validation of otolith ages for the Rainbow Darter, *Etheostoma Caeruleum*. *Copeia* 2002:830–835.

Beckman, D. W., A. L. Stanley, J. H. Render, and C. A. Wilson. 1990. Age and growth of Black Drum in

- Louisiana waters of the Gulf of Mexico. Transactions of the American Fisheries Society 119:537–544.
- Beckman, D. W., C. A. Wilson, and A. L. Stanley'. 1988. Age and growth of Red Drum, *Sciaenops Ocellatus*, from offshore waters of the northern Gulf of Mexico. Fisheries Bulletin, U.S. 87:17–28.
- Besler, D. A. 1999. Utility of Scales and Whole Otoliths for Aging Largemouth Bass in North Carolina - PDF. Proceedings of the Annual Conference of the Southeastern Fish and Wildlife Agencies 53:119–129.
- Bishop, S. D. H., M. P. Francis, C. Duffy, and J. C. Montgomery. 2006. Age, growth, maturity, longevity and natural mortality of the Shortfin Mako Shark (*Isurus Oxyrinchus*) in New Zealand waters. Marine and Freshwater Research 57:143–154.
- Blackwell, B. G., T. M. Kaufman, and T. S. Moos. 2016. An assessment of calcified structures for estimating Northern Pike ages. North American Journal of Fisheries Management 36:964–974.
- Bokhutlo, T., O. L. F. Weyl, K. Mosepele, and G. G. Wilson. 2015. Age and growth of Sharptooth Catfish, *Clarias Gariepinus* (Burchell, 1822) (Clariidae), in the Lower Okavango Delta, Botswana. Marine and Freshwater Research 66:420.
- Boughamou, N. 2014. Otolithometry and scalimetry – two valid methods to describe the growth of Peacock Wrasse, *Symphodus Tinca* (Actinopterygii: Perciformes: Labridae) from eastern Algeria. Acta Ichthyologica et Piscatoria 44:285–293.
- Boxrucker, J. 1986. A comparison of the otolith and scale methods for aging White Crappies in Oklahoma. North American Journal of Fisheries Management 6:122–125.
- Braaten, P. J., M. R. Doeringsfeld, and C. S. Guy. 1999. Comparison of age and growth estimates for River Carpsuckers using scales and dorsal fin ray sections. North American Journal of Fisheries Management 19:786–792.
- Braccini, J. M., B. M. Gillanders, T. I. Walker, and J. Tovar-Avila. 2007. Comparison of deterministic growth models fitted to length-at-age data of the Piked Spurdog (*Squalus Megalops*) in south-eastern Australia. Marine and Freshwater Research 58:24–33.
- Breeggemann, J. J., C.-A. Hayer, J. Krause, L. D. Schultz, K. N. Bertrand, and B. D. S. Graeb. 2014. Estimating the ages of Mountain Sucker *Catostomus Platyrhynchus* from the Black Hills: Precision, maturation, and growth. Western North American Naturalist 74:299–310.
- Brenden, T. O., E. M. Hallerman, and B. R. Murphy. 2006. Sectioned pelvic fin ray ageing of Muskellunge *Esox Masquinongy* from a Virginia river: Comparisons among readers, with cleithrum estimates, and with tag-recapture growth data. Fisheries Management and Ecology 13:31–37.
- Brennan, J. S., and G. M. Cailliet. 1989. Comparative age-determination techniques for White Sturgeon in California. Transactions of the American Fisheries Society 118:296–310.
- Brouder, M. J. 2005. Age and growth of Roundtail Chub in the Upper Verde River, Arizona. Transactions of the American Fisheries Society 134:866–871.
- Brown, P., C. Green, K. P. Sivakumaran, D. Stoessel, and A. Giles. 2004. Validating otolith annuli for annual age determination of Common Carp. Transactions of the American Fisheries Society 133:190–196.
- Brusher, J., and J. Schull. 2009. Non-lethal age determination for juvenile Goliath Grouper *Epinephelus Itajara* from southwest Florida. Endangered Species Research 7:205–212.
- Bubley, W. J., J. Kneebone, J. A. Sulikowski, and P. C. W. Tsang. 2012. Reassessment of Spiny Dogfish *Squalus Acanthias* age and growth using vertebrae and dorsal-fin spines. Journal of Fish Biology 80:1300–1319.
- Buckmeier, D. L., E. R. Irwin, R. K. Betsill, and J. A. Prentice. 2002. Validity of otoliths and pectoral spines for estimating ages of Channel Catfish. North American Journal of Fisheries Management 22:934–942.
- Buckmeier, D. L., N. G. Smith, and K. S. Reeves. 2012. Utility of Alligator Gar age estimates from otoliths,

- pectoral fin rays, and scales. *Transactions of the American Fisheries Society* 141:1510–1519.
- Bwanika, G. N., D. J. Murie, and L. J. Chapman. 2007. Comparative age and growth of Nile Tilapia (*Oreochromis Niloticus* L.) in lakes Nabugabo and Wamala, Uganda. *Hydrobiologia* 589:287–301.
- Calis, E., E. H. Jackson, C. P. Nolan, and F. Jeal. 2005. Preliminary age and growth estimates of the Rabbitfish, *Chimaera Monstrosa*, with implications for future resource management. *Journal of Northwest Atlantic Fishery Science* 35:15–26.
- Carlson, J. K., and I. E. Baremore. 2005. Growth dynamics of the Spinner Shark (*Carcharhinus Brevipinna*) off the United States southeast and Gulf of Mexico coasts: A comparison of methods. *Fishery Bulletin* 103:280–291.
- Cerdenares-Ladrón De Guevara, G., E. Morales-Bojórquez, and R. Rodríguez-Sánchez. 2011. Age and growth of the Sailfish *Istiophorus Platypterus* (Istiophoridae) in the Gulf of Tehuantepec, Mexico. *Marine Biology Research* 7:488–499.
- Chater, I. 2015. Otolith growth and age estimation of Bastard Grunt, *Pomadasys Incisus* (Actinopterygii: Perciformes: Haemulidae), in the Gulf of Tunis (Central Mediterranean). *Acta Ichthyologica et Piscatoria* 45:57–63.
- Choat, J., and L. Axe. 1996. Growth and longevity in acanthurid fishes; An analysis of otolith increments. *Marine Ecology Progress Series* 134:15–26.
- Conrath, C. L., J. Gelsleichter, and J. A. Musick. 2002. Age and growth of the Smooth Dogfish (*Mustelus Canis*) in the northwest Atlantic Ocean. *Fishery Bulletin* 100:674–682.
- Copeland, T., M. W. Hyatt, and J. Johnson. 2007. Comparison of methods used to age Spring-Summer Chinook Salmon in Idaho: Validation and simulated effects on estimated age composition. *North American Journal of Fisheries Management* 27:1393–1401.
- Dawson, H. A., M. L. Jones, K. T. Scribner, and S. A. Gilmore. 2009. An assessment of age determination methods for Great Lakes larval Sea Lampreys. *North American Journal of Fisheries Management* 29:914–927.
- Debicella, J. M. 2005. Accuracy and precision of fin-ray ageing for Gag (*Mycteroperca microlepis*). *Masters of Science, Florida*.
- DeMartini, E. E., J. H. Uchiyama, R. L. Humphreys Jr., J. D. Sampaga, and H. A. Williams. 2007. Age and growth of Swordfish (*Xiphias Gladius*) caught by the Hawaii-based pelagic longline fishery. *Fishery Bulletin* 105:356–367.
- Dembkowski, D. J., D. A. Isermann, and R. P. Koenigs. 2017. Walleye age estimation using otoliths and dorsal spines: Preparation techniques and sampling guidelines based on sex and total length. *Journal of Fish and Wildlife Management* 8:474–486.
- Driggers, W., J. Carlson, B. Cullum, J. Dean, and D. Oakley. 2004. Age and growth of the Blacknose Shark, *Carcharhinus Acronotus*, in the western North Atlantic Ocean with comments on regional variation in growth rates. *Environmental Biology of Fishes* 71:171–178.
- Dutka-Gianelli, J., and D. J. Murie. 2001. Age and growth of Sheepshead, *Archosargus Probatoccephalus* (Pisces: Sparidae), from the northwest coast of Florida. *Bulletin of Marine Science* 68:69–83.
- Efitre, J., D. J. Murie, and L. J. Chapman. 2016. Age validation, growth and mortality of introduced *Tilapia Zillii* in Crater Lake Nkuruba, Uganda. *Fisheries Management and Ecology* 23:66–75.
- Eklund, J., R. Parmanne, and G. Aneer. 2000. Between-reader variation in Herring otolith ages and effects on estimated population parameters. *Fisheries Research* 46:147–154.
- Erhardt, J. M., and D. L. Scarnecchia. 2013. Precision and accuracy of age and growth estimates based on fin rays, scales, and mark-recapture information for migratory Bull Trout. *Northwest Science* 87:307–316.
- Erickson, C. M. 1983. Age determination of Manitoban Walleyes using otoliths, dorsal spines, and scales.

North American Journal of Fisheries Management 3:176–181.

Esteves, E., P. Simões, H. M. Silva, and J. P. Andrade. 1995. Ageing of Swordfish, *Xiphias Gladius* Linnaeus, 1758, from the Azores, using sagittae, anal-fin spines and vertebrae. ARQUIPÉLAGO. Ciências Biológicas e Marinhas= Life and Marine Sciences 13:39–51.

Ewing, G. P., J. M. Lyle, R. J. Murphy, J. M. Kalish, and P. E. Ziegler. 2007. Validation of age and growth in a long-lived temperate reef fish using otolith structure, oxytetracycline and bomb radiocarbon methods. Marine and Freshwater Research 58:944–955.

Ewing, G. P., D. C. Welsford, A. R. Jordan, and C. Buxton. 2003. Validation of age and growth estimates using thin otolith sections from the Purple Wrasse, *Notolabrus Fucicola*. Marine and Freshwater Research 54:985–993.

Farley, J. H., A. J. Williams, N. P. Clear, C. R. Davies, and S. J. Nicol. 2013. Age estimation and validation for South Pacific Albacore *Thunnus Alalunga*. Journal of Fish Biology 82:1523–1544.

Farrell, E. D., S. Mariani, and M. W. Clarke. 2010. Age and growth estimates for the Starry Smoothhound (*Mustelus Asterias*) in the Northeast Atlantic Ocean. ICES Journal of Marine Science 67:931–939.

Faust, M. D., J. J. Breeggemann, S. Bahr, and B. D. Graeb. 2013. Precision and bias of cleithra and sagittal otoliths used to estimate ages of Northern Pike. Journal of Fish and Wildlife Management 4:332–341.

Fernando, A. V., C. R. Peacock, B. W. Baker, and M. A. Eggleton. 2014. Ageing precision and error analysis of whole-view and sectioned otoliths in Largemouth Bass and Spotted Bass. Journal of the Southeastern Association of Fish and Wildlife Agencies 1:75–82.

Ferri, J., J. Brčić, F. Škeljo, L. Sršen, and A. Uvodić. 2017. A preliminary study on the age and growth of the Argentine, *Argentina Sphyræna* (Actinopterygii: Osmeriformes: Argentinidae) from the eastern Adriatic Sea. Acta Ichthyologica et Piscatoria 47:365–369.

Flain, M., and G. J. Glova. 1988. A test of the reliability of otolith and scale readings of Chinook Salmon (*Oncorhynchus Tshawytscha*). New Zealand Journal of Marine and Freshwater Research 22:497–500.

Fleming, W. L., and W. J. Stark. 2018. Precision of age estimates using three different aging methods for Walleye (*Sander Vitreus*) in Cedar Bluff Reservoir, Kansas. Transactions of the Kansas Academy of Science 121:427–434.

Fossen, I., O. T. Albert, and E. M. Nilssen. 2003. Improving the precision of ageing assessments for Long Rough Dab by using digitised pictures and otolith measurements. Fisheries Research 60:53–64.

Francis, M. P., and C. Ó. Maolagáin. 2000. Age, growth and maturity of a New Zealand endemic shark (*Mustelus Lenticulatus*) estimated from vertebral bands. Marine and Freshwater Research 51:35–42.

Francis, M. P., C. Ó. Maolagáin, and D. Stevens. 2001. Age, growth, and sexual maturity of two New Zealand endemic skates, *Dipturus Nasutus* and *D. Innomatus*. New Zealand Journal of Marine and Freshwater Research 35:831–842.

Gallagher, C. P., K. L. Howland, and R. J. Wastle. 2016. A comparison of different structures and methods for estimating age of northern-form Dolly Varden *Salvelinus Malma Malma* from the Canadian Arctic. Polar Biology 39:1257–1265.

Gallagher, M. J., and C. P. Nolan. 1999. A novel method for the estimation of age and growth in rajids using caudal thorns. Canadian Journal of Fisheries and Aquatic Sciences 56:1590–1599.

Gallagher, M. J., M. J. Green, and C. P. Nolan. 2006. The potential use of caudal thorns as a non-invasive ageing structure in the Thorny Skate (*Amblyraja Radiata* Donovan, 1808). Environmental Biology of Fishes 77:265–272.

Gburski, C. M., S. K. Gaichas, and D. K. Kimura. 2007. Age and growth of Big Skate (*Raja Binoculata*) and Longnose Skate (*R. Rhina*) in the Gulf of Alaska. Environmental Biology of Fishes 80:337–349.

Geraghty, P. T., W. G. Macbeth, A. V. Harry, J. E. Bell, M. N. Yerman, and J. E. Williamson. 2014. Age and

growth parameters for three heavily exploited shark species off temperate eastern Australia. *ICES Journal of Marine Science* 71:559–573.

Gillanders, B. M., D. J. Ferrell, and N. L. Andrew. 1999. Aging methods for Yellowtail Kingfish, *Seriola Lalandi*, and results from age- and size-based growth models. *Fishery Bulletin* 97:812–827.

Glass, W. R., L. D. Corkum, and N. E. Mandrak. 2011. Pectoral fin ray aging: An evaluation of a non-lethal method for aging gars and its application to a population of the threatened Spotted Gar. *Environmental Biology of Fishes* 90:235–242.

Goldman, K. J., and J. A. Musick. 2006. Growth and maturity of Salmon Sharks (*Lamna Ditropis*) in the eastern and western North Pacific, and comments on back-calculation methods. *Fishery Bulletin* 104:278–292.

Goldman, K. J., S. Branstetter, and J. A. Musick. 2006. A re-examination of the age and growth of Sand Tiger Sharks, *Carcharias Taurus*, in the western North Atlantic: The importance of ageing protocols and use of multiple back-calculation techniques. *Environmental Biology of Fishes* 77:241–252.

Goosen, A. J. J., and M. J. Smale. 1997. A preliminary study of age and growth of the Smoothhound Shark *Mustelus Mustelus* (Triakidae). *South African Journal of Marine Science* 18:85–91.

Gregg, J. L., D. M. Anderl, and D. K. Kimura. 2006. Improving the precision of otolith-based age estimates for Greenland Halibut (*Reinhardtius Hippoglossoides*) with preparation methods adapted for fragile sagittae. *Fishery Bulletin* 104:643–648.

Griffin, K. M., Z. S. Beard, J. M. Flinders, and M. C. Quist. 2017. Estimating ages of Utah Chubs by use of pectoral fin rays, otoliths, and scales. *Western North American Naturalist* 77:189–194.

Gu, P.-h., J.-g. Xiang, Y.-f. Chen, Y.-l. Li, J. Tang, S.-g. Xie, and Y. Chen. 2013. A comparison of different age estimation methods for the Northern Snakehead. *North American Journal of Fisheries Management* 33:994–999.

Gumus, A., D. Bostanci, S. Yilmaz, and N. Polat. 2007. Age determination of *Scardinius Erythrophthalmus* (Cyprinidae) inhabiting Bafra Fish Lakes (Samsun, Turkey) based on otolith readings and marginal increment analysis. *Cybiuim* 31:59–66.

Haas, R. E., and C. W. Recksiek. 1995. Age verification of Winter Flounder in Narragansett Bay. *Transactions of the American Fisheries Society* 124:103–111.

Haglund, J. M., and M. G. Mitro. 2017. Age validation of Brown Trout in driftless area streams in Wisconsin using otoliths. *North American Journal of Fisheries Management* 37:829–835.

Hale, L. F., and I. E. Baremore. 2013. Age and growth of the Sandbar Shark (*Carcharhinus Plumbeus*) from the northern Gulf of Mexico and the western North Atlantic Ocean. *Gulf of Mexico Science* 31:28–39.

Hammers, B. E., and L. E. Miranda. 1991. Comparison of methods for estimating age, growth, and related population characteristics of White Crappies. *North American Journal of Fisheries Management* 11:492–498.

Harry, A. V., A. J. Tobin, and C. A. Simpfendorfer. 2013. Age, growth and reproductive biology of the Spot-tail Shark, *Carcharhinus Sorrah*, and the Australian Blacktip Shark, *C. Tilstoni*, from the Great Barrier Reef World Heritage Area, north-eastern Australia. *Marine and Freshwater Research* 64:277–293.

Henderson, A. C., A. I. Arkhipkin, and J. N. Chtcherbich. 2004. Distribution, growth and reproduction of the White-Spotted Skate *Bathyraja Albomaculata* (Norman, 1937) around the Falkland Islands. *Journal of Northwest Atlantic Fishery Science* 35:79–87.

Herbst, S. J., and J. E. Marsden. 2011. Comparison of precision and bias of scale, fin ray, and otolith age estimates for Lake Whitefish (*Coregonus Clupeaformis*) in Lake Champlain. *Journal of Great Lakes Research* 37:386–389.

Hill, K. T., G. M. Cailliet, and R. L. Radtke. 1989. A comparative analysis of growth zones in four calcified structures of Pacific Blue Marlin, *Makaim Nigricans*. *Fishery Bulletin*. U.S. 87:829–843.

Hining, K. J., J. L. West, M. A. Kulp, and A. D. Neubauer. 2000. Validation of scales and otoliths for

- estimating age of Rainbow Trout from southern Appalachian streams. *North American Journal of Fisheries Management* 20:978–985.
- Hobbs, J.-P. A., A. J. Frisch, S. Mutz, and B. M. Ford. 2014. Evaluating the effectiveness of teeth and dorsal fin spines for non-lethal age estimation of a tropical reef fish, Coral Trout *Plectropomus Leopardus*. *Journal of Fish Biology* 84:328–338.
- Holmes, B. J., V. M. Peddemors, A. N. Gutteridge, P. T. Geraghty, R. W. K. Chan, I. R. Tibbetts, and M. B. Bennett. 2015. Age and growth of the Tiger Shark *Galeocerdo Cuvier* off the east coast of Australia. *Journal of Fish Biology* 87:422–448.
- Horn, P. 2002. Age and growth of Patagonian Toothfish (*Dissostichus Eleginoides*) and Antarctic Toothfish (*D. Mawsoni*) in waters from the New Zealand subantarctic to the Ross Sea, Antarctica. *Fisheries Research* 56:275–287.
- Howland, K. L., M. Gendron, W. M. Tonn, and R. F. Tallman. 2004. Age determination of a long-lived coregonid from the Canadian North: Comparison of otoliths, fin rays and scales in Inconnu (*Stenodus Leucichthys*). *Annales Zoologici Fennici* 41:205–214.
- Hoxmeier, R. J. H., D. D. Aday, and D. H. Wahl. 2001. Factors influencing precision of age estimation from scales and otoliths of Bluegills in Illinois reservoirs. *North American Journal of Fisheries Management* 21:374–380.
- Hubert, W. A., G. T. Baxter, and M. Harrington. 1987. Comparison of age determinations based on scales, otoliths and fin rays for Cutthroat Trout from Yellowstone Lake. *Northwest Science* 61:32–36.
- Hurley, K. L., R. J. Sheehan, and R. C. Heidinger. 2004. Accuracy and precision of age estimates for Pallid Sturgeon from pectoral fin rays. *North American Journal of Fisheries Management* 24:715–718.
- Huveneers, C., J. Stead, M. B. Bennett, K. A. Lee, and R. G. Harcourt. 2013. Age and growth determination of three sympatric Wobbegong sharks: How reliable is growth band periodicity in Orectolobidae? *Fisheries Research* 147:413–425.
- Hyndes, G. A. 1992. Influence of sectioning otoliths on marginal increment trends and age and growth estimates for the Flathead *Platycephalus Speculator*. *Fishery Bulletin, U.S.* 90:276–284.
- Ihde, T. F., and M. E. Chittenden Jr. 2002. Comparison of calcified structures for aging Spotted Seatrout. *Transactions of the American Fisheries Society* 131:634–642.
- Isermann, D. A., J. J. Breeggemann, and T. J. Paoli. 2018. Evaluation of anal fin spines, otoliths, and scales for estimating age and back-calculated lengths of Yellow Perch in southern Green Bay. *Journal of Great Lakes Research*.
- Isermann, D. A., J. R. Meerbeek, G. D. Scholten, and D. W. Willis. 2003. Evaluation of three different structures used for Walleye age estimation with emphasis on removal and processing times. *North American Journal of Fisheries Management* 23:625–631.
- Isermann, D. A., M. H. Wolter, and J. J. Breeggemann. 2010. Estimating Black Crappie age: An assessment of dorsal spines and scales as nonlethal alternatives to otoliths. *North American Journal of Fisheries Management* 30:1591–1598.
- Jackson, N. D., J. E. Garvey, and R. E. Colombo. 2007a. Comparing aging precision of calcified structures in Shovelnose Sturgeon. *Journal of Applied Ichthyology* 23:525–528.
- Jackson, Z. J., M. C. Quist, J. G. Larscheid, E. C. Thelen, and M. J. Hawkins. 2007b. Precision of scales and dorsal spines for estimating age of Common Carp. *Journal of Freshwater Ecology* 22:231–239.
- Johnson, A. G., L. A. Collins, J. Dahl, and M. S. Baker. 1995. Age, growth, and mortality of Lane Snapper from the Northern Gulf of Mexico. *Proceedings of the Annual Conference of the Southeastern Fish and Wildlife Agencies* 49:178–186.
- Jones, C. D. 2009. Age and growth of Spiny Icefish (*Chaenodraco Wilsoni* Regan, 1914) off Joinville-Durville

Islands (Antarctic Peninsula). CCAMLR Science 16:115–130.

Khan, M. A., and S. Khan. 2009. Comparison of age estimates from scale, opercular bone, otolith, vertebrae and dorsal fin ray in *Labeo Rohita* (Hamilton), *Catla Catla* (Hamilton) and *Channa Marulius* (Hamilton). Fisheries Research 100:255–259.

Khan, M. A., S. Khan, and K. Miyan. 2011a. Precision of aging structures for Indian Major Carp, *Cirrhinus Mrigala*, from the River Ganga. Journal of Freshwater Ecology 26:231–239.

Khan, S., M. Afzal Khan, and K. Miyan. 2011b. Comparison of age estimates from otoliths, vertebrae, and pectoral spines in African Sharptooth Catfish, *Clarias Gariepinus* (Burchell). Estonian Journal of Ecology 60:183–193.

Khan, S., M. A. Khan, and K. Miyan. 2013. Evaluation of ageing precision from different structures of three threatened freshwater fish species, *Clarias Batrachus*, *Heteropneustes Fossilis* and *Wallago Attu*. Folia Zoologica 62:103–109.

Khan, S., M. A. Khan, K. Miyan, and F. A. Lone. 2015. Precision of age estimates from different ageing structures in selected freshwater teleosts. Journal of Environmental Biology:507–512.

Killgore, K. J., J. J. Hoover, J. P. Kirk, S. G. George, B. R. Lewis, and C. E. Murphy. 2007. Age and growth of Pallid Sturgeon in the free-flowing Mississippi River. Journal of Applied Ichthyology 23:452–456.

King, J., and R. McPhie. 2015. Preliminary age, growth and maturity estimates of Spotted Ratfish (*Hydrolagus Colliei*) in British Columbia. Deep Sea Research Part II: Topical Studies in Oceanography 115:55–63.

King, S. M., S. R. David, and J. A. Stein. 2018. Relative bias and precision of age estimates among calcified structures of Spotted Gar, Shortnose Gar, and Longnose Gar. Transactions of the American Fisheries Society 147:626–638.

Klein, Z. B., T. F. Bonvecchio, B. R. Bowen, and M. C. Quist. 2017. Precision and accuracy of age estimates obtained from anal fin spines, dorsal fin spines, and sagittal otoliths for known-age Largemouth Bass. Southeastern Naturalist 16:225–234.

Koch, J. D., M. C. Quist, and K. A. Hansen. 2009. Precision of hard structures used to estimate age of Bowfin in the upper Mississippi River. North American Journal of Fisheries Management 29:506–511.

Koch, J. D., K. D. Steffensen, and M. A. Pegg. 2011. Validation of age estimates obtained from juvenile Pallid Sturgeon *Scaphirhynchus Albus* pectoral fin spines. Journal of Applied Ichthyology 27:209–212.

Kocovsky, P. M., and R. F. Carline. 2000. A comparison of methods for estimating ages of unexploited Walleyes. North American Journal of Fisheries Management 20:1044–1048.

Koenigs, R. P., R. M. Bruch, R. S. Stelzer, and K. K. Kamke. 2015. Validation of otolith ages for Walleye (*Sander Vitreus*) in the Winnebago system. Fisheries Research 167:13–21.

Kotas, J. E., V. Mastrochirico, and M. Petrere Junior. 2011. Age and growth of the Scalloped Hammerhead shark, *Sphyrna Lewini* (Griffith and Smith, 1834), from the southern Brazilian coast. Brazilian Journal of Biology 71:755–761.

Kruse, C. G., W. A. Hubert, and F. J. Rahel. 1997. Using otoliths and scales to describe age and growth of Yellowstone Cutthroat Trout in a high-elevation stream system, Wyoming. Northwest Science 71:30–38.

Kruse, C., C. Guy, and D. Willis. 1993. Comparison of otolith and scale age characteristics for Black Crappies collected from South Dakota waters. North American Journal of Fisheries Management 13:856–858.

Kusher, D. I., S. E. Smith, and G. M. Cailliet. 1992. Validated age and growth of the Leopard Shark, *Triakis Semifasciata*, with comments on reproduction. Environmental Biology of Fishes 35:187–203.

LaBay, S. R., and T. E. Lauer. 2006. An evaluation of the accuracy of age estimation methods for southern

- Lake Michigan Alewives. *North American Journal of Fisheries Management* 26:571–579.
- Labay, S. R., J. G. Kral, and S. M. Stukel. 2011. Precision of age estimates derived from scales and pectoral fin rays of Blue Sucker. *Fisheries Management and Ecology* 18:424–430.
- Laine, A. O., W. T. Momot, and P. A. Ryan. 1991. Accuracy of using scales and cleithra for aging Northern Pike from an oligotrophic Ontario lake. *North American Journal of Fisheries Management* 11:220–225.
- Lepak, T. A., D. H. Ogle, and M. R. Vinson. 2017. Age, year-class strength variability, and partial age validation of Kiyis from Lake Superior. *North American Journal of Fisheries Management* 37:1151–1160.
- Lessa, R., and P. Duarte-Neto. 2004. Age and growth of Yellowfin Tuna (*Thunnus Albacares*) in the western equatorial Atlantic, using dorsal fin spines. *Fisheries Research* 69:157–170.
- Lessa, R., F. M. Santana, and R. Paglerani. 1999. Age, growth and stock structure of the Oceanic Whitetip Shark, *Carcharhinus Longimanus*, from the southwestern equatorial Atlantic. *Fisheries Research* 42:21–30.
- Logsdon, D. E. 2007. Use of unsectioned dorsal spines for estimating Walleye ages. *North American Journal of Fisheries Management* 27:1112–1118.
- Lombardi-Carlson, L., G. Fitzhugh, C. Palmer, C. Gardner, R. Farsky, and M. Ortiz. 2008. Regional size, age and growth differences of Red Grouper (*Epinephelus Morio*) along the west coast of Florida. *Fisheries Research* 91:239–251.
- Long, J. M., and W. L. Fisher. 2001. Precision and bias of Largemouth, Smallmouth, and Spotted Bass ages estimated from scales, whole otoliths, and sectioned otoliths. *North American Journal of Fisheries Management* 21:636–645.
- Long, J. M., C. T. Holley, and A. T. Taylor. 2018. Evaluation of ageing accuracy with complementary non-lethal methods for slow-growing, northern populations of Shoal Bass. *Fisheries Management and Ecology* 25:150–157.
- Lowerre-Barbieri, S. K., M. E. C. Jr, and C. M. Jones. 1993. A comparison of a validated otolith method to age Weakfish, *Cynoscion Regalis*, with the traditional scale method. *Fishery Bulletin* 92:555–568.
- Ma, B., Y. Nie, K. Wei, B. Xu, W. Gan, X. Zhu, J. Xu, L. Deng, and Y. Yao. 2017. Precision of age estimations from otolith, vertebra, and opercular bone of *Gymnocypris Firmispinatus* (Actinopterygii: Cypriniformes: Cyprinidae) in the Anning River, China. *Acta Ichthyologica et Piscatoria* 47:321–329.
- Maceina, M. J., and S. M. Sammons. 2006. An evaluation of different structures to age freshwater fish from a northeastern US river. *Fisheries Management and Ecology* 13:237–242.
- Marriott, R. J., and B. D. Mapstone. 2006. Geographic influences on and the accuracy and precision of age estimates for the Red Bass, *Lutjanus Bohar* (Forsskal 1775): A large tropical reef fish. *Fisheries Research* 80:322–328.
- Marriott, R., and M. Cappel. 2000. Comparative precision and bias of five different ageing methods for the Large Tropical Snapper *Lutjanus Johnii*. *Asian Fisheries Science* 13:149–160.
- Matić-Skoko, S., J. Ferri, F. Škeljo, V. Bartulović, K. Glavić, and B. Glamuzina. 2011. Age, growth and validation of otolith morphometrics as predictors of age in the Forkbeard, *Phycis Phycis* (Gadidae). *Fisheries Research* 112:52–58.
- Matta, M. E., and D. R. Gunderson. 2007. Age, growth, maturity, and mortality of the Alaska Skate, *Bathyraja Parmifera*, in the eastern Bering Sea. Pages 203–217 in D. A. Ebert and J. Sulkowski, editors. *Biology of Skates*. Springer, Dordrecht.
- McAuley, R. B., C. A. Simpfendorfer, G. A. Hyndes, R. R. Allison, J. A. Chidlow, S. J. Newman, and R. C. J. Lenanton. 2006. Validated age and growth of the Sandbar Shark, *Carcharhinus Plumbeus* (Nardo 1827) in the waters off Western Australia. *Environmental Biology of Fishes* 77:385–400.
- McDougall, A. 2004. Assessing the use of sectioned otoliths and other methods to determine the age of the centropomid fish, Barramundi (*Lates Calcarifer*) (Bloch), using known-age fish. *Fisheries Research*

67:129–141.

Meeuwig, M. H., and J. M. Bayer. 2005. Morphology and aging precision of statoliths from larvae of Columbia River basin Lampreys. *North American Journal of Fisheries Management* 25:38–48.

Metcalf, S. J., and S. E. Swearer. 2005. Non-destructive ageing in *Notolabrus Tetricus* using dorsal spines with an emphasis on the benefits for protected, endangered and fished species. *Journal of Fish Biology* 66:1740–1747.

Morehouse, R. L., S. B. Donabauer, and A. C. Grier. 2013. Estimating Largemouth Bass age: Precision and comparisons among scales, pectoral fin rays, and dorsal fin spines as nonlethal methods. *Fisheries and Aquaculture Journal* 04.

Morison, A. K., J. Burnett, W. J. McCurdy, and E. Moksness. 2005. Quality issues in the use of otoliths for fish age estimation. *Marine and Freshwater Research* 56:773–782.

Morrow, J. V., J. P. Kirk, K. J. Killgore, and S. G. George. 1998. Age, growth, and mortality of Shovelnose Sturgeon in the Lower Mississippi River. *North American Journal of Fisheries Management* 18:725–730.

Moulton, P. L., T. I. Walker, and S. R. Saddlier. 1992. Age and growth studies of Gummy Shark, *Mustelus Antarcticus* Gunther, and School Shark, *Galeorhinus Galeus* (Linnaeus), from Souther Australian Waters. *Marine and Freshwater Research* 43:1241–1267.

Murie, D. J., and D. C. Parkyn. 2005. Age and growth of White Grunt (*Haemulon Plumieri*): A comparison of two populations along the west coast of Florida. *Bulletin of Marine Science* 76:73–93.

Murie, D. J., D. C. Parkyn, W. F. Loftus, and L. G. Nico. 2009a. Variable growth and longevity of Yellow Bullhead (*Ameiurus Natalis*) in the Everglades of south Florida, USA. *Journal of Applied Ichthyology* 25:740–745.

Murie, D. J., D. C. Parkyn, L. G. Nico, J. J. Herod, and W. F. Loftus. 2009b. Age, differential growth and mortality rates in unexploited populations of Florida Gar, an apex predator in the Florida Everglades. *Fisheries Management and Ecology* 16:315–322.

Murie, D., D. Parkyn, C. Koenig, F. Coleman, J. Schull, and S. Frias-Torres. 2009c. Evaluation of finrays as a non-lethal ageing method for protected Goliath Grouper *Epinephelus Itajara*. *Endangered Species Research* 7:213–220.

Natanson, L. J., and N. E. Kohler. 1996. A preliminary estimate of age and growth of the Dusky Shark *Carcharhinus Obscurus* from the South-West Indian Ocean, with comparisons to the western North Atlantic population. *South African Journal of Marine Science* 17:217–224.

Natanson, L. J., and G. B. Skomal. 2015. Age and growth of the White Shark, *Carcharodon Carcharias*, in the western North Atlantic Ocean. *Marine and Freshwater Research* 66:387.

Natanson, L. J., B. J. Gervelis, M. V. Winton, L. L. Hamady, S. J. B. Gulak, and J. K. Carlson. 2014. Validated age and growth estimates for *Carcharhinus Obscurus* in the northwestern Atlantic Ocean, with pre- and post management growth comparisons. *Environmental Biology of Fishes* 97:881–896.

Natanson, L. J., J. J. Mello, and S. E. Campana. 2002. Validated age and growth of the Porbeagle Shark (*Lamna Nasus*) in the western North Atlantic Ocean. *Fishery Bulletin* 100:266–278.

Natanson, L. J., J. A. Sulikowski, J. R. Kneebone, and P. C. Tsang. 2007. Age and growth estimates for the Smooth Skate, *Malacoraja Senta*, in the Gulf of Maine. *Environmental Biology of Fishes* 80:293–308.

Neves, A. 2015. Age and growth of Small Red Scorpionfish, *Scorpaena Notata* (Actinopterygii: Scorpaeniformes: Scorpaenidae), a common discard species from the Portuguese fishery. *Acta Ichthyologica et Piscatoria* 45:13–20.

Niewinski, B. C., and C. P. Ferreri. 1999. A comparison of three structures for estimating the age of Yellow Perch. *North American Journal of Fisheries Management* 19:872–877.

Nuevo, M., R. J. Sheehan, and R. C. Heidinger. 2004. Accuracy and precision of age determination techniques

- for Mississippi River Bighead Carp *Hypophthalmichthys Nobilis* (Richardson 1845) using pectoral spines and scales. *Archiv für Hydrobiologie* 160:45–56.
- Oele, D. L., Z. J. Lawson, and P. B. McIntyre. 2015. Precision and bias in aging Northern Pike: Comparisons among four calcified structures. *North American Journal of Fisheries Management* 35:1177–1184.
- Officer, R. A., A. S. Gason, T. I. Walker, and J. G. Clement. 1996. Sources of variation in counts of growth increments in vertebrae from Gummy Shark, *Mustelus Antarcticus*, and School Shark, *Galeorhinus Galeus*: Implications for age determination. *Canadian Journal of Fisheries and Aquatic Sciences* 53:1765–1777.
- Oplinger, R. W. 2015. Hard structure aging precision and length-at-age data from two Northern Leatherside Chub populations. *Intermountain Journal of Sciences* 21:1–9.
- Orlov, A. M., E. F. Kulish, I. N. Mukhametov, and O. A. Shubin. 2011. Age and growth of Spiny Dogfish *Squalus Acanthias* (Squalidae, Chondrichthyes) in pacific waters off the Kuril Islands. *Journal of Ichthyology* 51(1):42–55.
- Ozcan, E., and N. Basusta. 2018. Preliminary study on age, growth and reproduction of *Mustelus Mustelus* (Elasmobranchii: Carcharhiniformes: Triakidae) inhabiting the Gulf of Iskenderun, north-eastern Mediterranean Sea. *Acta Ichthyologica et Piscatoria* 48:27–36.
- Peltonen, H. 2002. Age determination of Baltic Herring from whole otoliths and from neutral red stained otolith cross sections. *ICES Journal of Marine Science* 59:323–332.
- Perry, R. C., and J. M. Casselman. 2012. Comparisons of precision and bias with two age interpretation techniques for opercular bones of Longnose Sucker, a long-lived northern fish. *North American Journal of Fisheries Management* 32:790–795.
- Phelps, Q. E., K. R. Edwards, and D. W. Willis. 2007. Precision of five structures for estimating age of Common Carp. *North American Journal of Fisheries Management* 27:103–105.
- Pierce, S. J., and M. B. Bennett. 2009. Validated annual band-pair periodicity and growth parameters of Blue-spotted Maskray *Neotrygon Kuhlii* from south-east Queensland, Australia. *Journal of Fish Biology* 75:2490–2508.
- Piercy, A. N., J. K. Carlson, J. A. Sulikowski, and G. H. Burgess. 2007. Age and growth of the Scalloped Hammerhead Shark, *Sphyrna Lewini*, in the north-west Atlantic Ocean and Gulf of Mexico. *Marine and Freshwater Research* 58:34.
- Polat, N., and A. Gümüş. 1996. Ageing of Whiting (*Merlangius Merlangus Euxinus*, Nord., 1840) based on broken and burnt otolith. *Fisheries Research* 28:231–236.
- Polat, N., D. Bostanci, and S. Yilmaz. 2005. Differences between whole otolith and broken-burnt otolith ages of Red Mullet (*Mullus Barbatulus Ponticus* Essipov, 1927) sampled from the Black Sea (Samsun, Turkey). *Turkish Journal of Veterinary and Animal Science* 29:429–433.
- Polat, N., D. Bostanci, and S. Yilmaz. 2011. Comparable age determination in different bony structures of *Pleuronectes Flesus Luscus Pallas*, 1811 inhabiting the Black Sea. *Turkish Journal of Zoology* 25:441–446.
- Porta, M. J., R. A. Snow, and D. E. Shoup. 2018. Comparison of Saugeye age estimates and population characteristics using otoliths and dorsal spines. *Journal of the Southeastern Association of Fish and Wildlife Agencies* 5:23–29.
- Power, G. R., P. A. King, C. J. Kelly, D. McGrath, E. Mullins, and O. Gullaksen. 2006. Precision and bias in the age determination of Blue Whiting, *Micromesistius Poutassou* (Risso, 1810), within and between age-readers. *Fisheries Research* 80:312–321.
- Puchala, E. A., D. L. Parrish, and D. H. Ogle. 2018. Size and age of stonecats in Lake Champlain; estimating growth at the margin of their range to aid in population management. *North American Journal of Fisheries Management* 38.
- Quist, M. C., Z. J. Jackson, M. R. Bower, and W. A. Hubert. 2007. Precision of hard structures used to

- estimate age of riverine Catostomids and Cyprinids in the upper Colorado River basin. *North American Journal of Fisheries Management* 27:643–649.
- Raitaniemi, J., E. Bergstrand, L. Flöystad, R. Hokki, E. Kleiven, M. Rask, M. Reizenstein, R. Saksgård, and C. Ångström. 1998. The reliability of Whitefish (*Coregonus Lavaretus* (L.)) age determination - differences between methods and between readers. *Ecology of Freshwater Fish* 7:25–35.
- Ribot-Carballal, M., F. Galván-Magaña, and C. Quiñónez-Velázquez. 2005. Age and growth of the Shortfin Mako Shark, *Isurus Oxyrinchus*, from the western coast of Baja California Sur, Mexico. *Fisheries Research* 76:14–21.
- Rice, J. S., V. F. Gallucci, and G. H. Kruse. 2009. 14. Evaluation of the precision of age estimates for Spiny Dogfish. Pages 161–168 in V. F. Gallucci, G. A. McFarlane, and G. G. Bargmann, editors. *Biology and Management of Dogfish Sharks*. American Fisheries Society.
- Rien, T. A., and R. C. Beamesderfer. 1994. Accuracy and precision of White Sturgeon age estimates from pectoral fin rays. *Transactions of the American Fisheries Society* 123:255–265.
- Robillard, S. R., and J. E. Marsden. 1996. Comparison of otolith and scale ages for Yellow Perch from Lake Michigan. *Journal of Great Lakes Research* 22:429–435.
- Romine, J. G., R. D. Grubbs, and J. A. Musick. 2006. Age and growth of the Sandbar Shark, *Carcharhinus Plumbeus*, in Hawaiian waters through vertebral analysis. *Environmental Biology of Fishes* 77:229–239.
- Ross, J. R., J. D. Crosby, and J. T. Kosa. 2005. Accuracy and precision of age estimation of Crappies. *North American Journal of Fisheries Management* 25:423–428.
- Rude, N. P., W. D. Hintz, J. D. Norman, K. L. Kanczuzewski, A. J. Yung, K. D. Hofer, and G. W. Whitledge. 2013. Using pectoral fin rays as a non-lethal aging structure for Smallmouth Bass: Precision with otolith age estimates and the importance of reader experience. *Journal of Freshwater Ecology* 28:199–210.
- Sabah, and M. A. Khan. 2014. Precise age estimation and growth of three Schizothoracinae fishes from Kashmir valley. *Zoology and Ecology* 24:16–25.
- Schill, D. J., E. R. J. M. Mamer, and G. W. LaBar. 2010. Validation of scales and otoliths for estimating age of Redband Trout in high desert streams of Idaho. *Environmental Biology of Fishes* 89:319–332.
- Schrank, S. J., and C. S. Guy. 2002. Age, growth, and gonadal characteristics of adult Bighead Carp, *Hypophthalmichthys Nobilis*, in the Lower Missouri River. *Environmental Biology of Fishes* 64:443–450.
- Seibert, J. R., and Q. E. Phelps. 2013. Evaluation of aging structures for Silver Carp from Midwestern U.S. rivers. *North American Journal of Fisheries Management* 33:839–844.
- Sharp, D., and D. R. Bernard. 1988. Precision of estimated ages of Lake Trout from five calcified structures. *North American Journal of Fisheries Management* 8:367–372.
- Silva, E. A., and D. J. Stewart. 2006. Age structure, growth and survival rates of the commercial fish *Prochilodus Nigricans* (bocachico) in North-eastern Ecuador. *Environmental Biology of Fishes* 77:63–77.
- Simpfendorfer, C. A., J. Chidlow, R. McAuley, and P. Unsworth. 2000. Age and Growth of the Whiskery Shark, *Furgaleus Macki*, from Southwestern Australia. *Environmental Biology of Fishes* 58:335–343.
- Simpfendorfer, C. A., R. B. McAuley, J. Chidlow, and P. Unsworth. 2002. Validated age and growth of the Dusky Shark, *Carcharhinus Obscurus*, from western Australian waters. *Marine and Freshwater Research* 53:567–573.
- Sipe, A. M., and M. E. Chittenden Jr. 2002. A comparison of calcified structures for aging Bluefish in the Chesapeake Bay region. *Transactions of the American Fisheries Society* 131:783–790.
- Skomal, G. B., and L. J. Natanson. 2003. Age and growth of the Blue Shark, *Prionace Glauca*, in the north Atlantic Ocean. *Fisheries Bulletin, U.S.* 101:627–639.
- Smith, B. J., D. J. Dembkowski, D. A. James, and M. R. Wuellner. 2016. A simple method to reduce

interpretation error of ages estimated from otoliths. *The Open Fish Science Journal* 9:1–7.

Smylie, M., V. Shervette, and C. McDonough. 2016. Age, growth, and reproduction in two coastal populations of Longnose Gars. *Transactions of the American Fisheries Society* 145:120–135.

Snow, R. A., M. J. Porta, and J. M. Long. 2018. Precision of four otolith techniques for estimating age of White Perch from a thermally altered reservoir. *North American Journal of Fisheries Management* 38:725–733.

Soekoe, M., F. van der Bank, and N. Smit. 2013. Determining the most suitable method of otolith preparation for estimating the age of Tigerfish, *Hydrocynus Vittatus* in the Pongolapoort Dam, South Africa. *African Zoology* 48:187–192.

Soeth, M., L. F. Fávoro, H. L. Spach, F. A. Daros, A. E. Woltrich, and A. T. Correia. 2018. Age, growth, and reproductive biology of the Atlantic Spadefish *Chaetodipterus Faber* in southern Brazil. *Ichthyological Research*.

Sotola, V. A., G. A. Maynard, E. M. Hayes-Pontius, T. B. Mihuc, M. H. Malchoff, and J. E. Marsden. 2014. Precision and bias of using opercles as compared to otoliths, dorsal spines, and scales to estimate ages of Largemouth and Smallmouth Bass. *Northeastern Naturalist* 21:565–573.

Spiegel, J. R., M. C. Quist, and J. E. Morris. 2010. Precision of scales and pectoral fin rays for estimating age of Highfin Carpsucker, Quillback Carpsucker, and River Carpsucker. *Journal of Freshwater Ecology* 25:271–278.

Stevenson, J. T., and D. H. Secor. 2000. Age determination and growth of Hudson River Atlantic Sturgeon, *Acipenser Oxyrinchus*. *Fishery Bulletin* 98:153–166.

Stewart, N. D., M. J. Dadswell, P. Leblanc, R. G. Bradford, C. Ceapa, and M. J. W. Stokesbury. 2015. Age and growth of Atlantic Sturgeon from the Saint John River, New Brunswick, Canada. *North American Journal of Fisheries Management* 35:364–371.

Stewart, T. R., D. H. Ogle, O. T. Gorman, and M. R. Vinson. 2016. Age, growth, and size of Lake Superior Pygmy Whitefish (*Prosopium Coulterii*). *The American Midland Naturalist* 175:24–36.

Stolarski, J. T., and K. J. Hartman. 2008. An evaluation of the precision of fin ray, otolith, and scale age determinations for Brook Trout. *North American Journal of Fisheries Management* 28:1790–1795.

Stolarski, J. T., and T. M. Sutton. 2013. Precision analysis of three aging structures for amphidromous Dolly Varden from Alaskan arctic rivers. *North American Journal of Fisheries Management* 33:732–740.

Stransky, C., S. Gudmundsdottir, T. Sigurdsson, S. Lemvig, K. Nedreaas, and F. Saboridorey. 2005. Age determination and growth of Atlantic redfish (*Sebastes Marinus* and *S. Mentella*): Bias and precision of age readers and otolith preparation methods. *ICES Journal of Marine Science* 62:655–670.

Sulikowski, J. A., S. B. Irvine, K. C. DeValerio, and J. K. Carlson. 2007. Age, growth and maturity of the Roundel Skate, *Raja Texana*, from the Gulf of Mexico, USA. *Marine and Freshwater Research* 58:41–53.

Sulikowski, J. A., J. Kneebone, S. Elzey, J. Jurek, P. D. Danley, W. H. Howell, and P. C. W. Tsang. 2005. Age and growth estimates of the Thorny Skate (*Amblyraja Radiata*) in the western Gulf of Maine. *Fisheries Bulletin, U.S.* 103:161–168.

Sun, C.-L., S.-P. Wang, and S.-Z. Yeh. 2002. Age and growth of the Swordfish (*Xiphias Gladius* L.) in the waters around Taiwan determined from anal-fin rays. *Fishery Bulletin* 100:822–835.

Sun, C.-L., S.-Z. Yeh, C.-S. Liu, N.-J. Su, and W.-C. Chiang. 2015. Age and growth of Black Marlin (*Istiompax Indica*) off eastern Taiwan. *Fisheries Research* 166:4–11.

Svedäng, H., H. Wickström, M. Reizenstein, K. Holmgren, and P. Florenius. 1998. Accuracy and precision in eel age estimation, using otoliths of known and unknown age. *Journal of Fish Biology* 53:456–464.

Sylvester, R. M., and C. R. Berry. 2006. Comparison of White Sucker age estimates from scales, pectoral fin

- rays, and otoliths. *North American Journal of Fisheries Management* 26:24–31.
- Škeljo, F., J. Brčić, V. Vuletin, and J. Ferri. 2015. Age and growth of the Axillary Wrasse, *Symphodus Mediterraneanus* (L.) from the eastern Adriatic Sea. *Marine Biology Research* 11:780–784.
- Škeljo, F., J. Ferri, J. Brčić, M. Petrić, and I. Jardas. 2012. Age, growth and utility of otolith morphometrics as a predictor of age in the Wrasse *Coris Julis* (Labridae) from the eastern Adriatic Sea. *Scientia Marina* 76:587–595.
- Tribuzio, C. A., G. H. Kruse, and J. T. Fujioka. 2010. Age and growth of Spiny Dogfish (*Squalus Acanthias*) in the Gulf of Alaska: Analysis of alternative growth models. *Fishery Bulletin* 108:119–135.
- Tribuzio, C. A., M. E. Matta, C. Gburski, C. Blood, W. Bubley, and G. H. Kruse. 2018. Are Pacific Spiny Dogfish lying about their age? A comparison of ageing structures for *Squalus Suckleyi*. *Marine and Freshwater Research* 69:37–47.
- Tyszko, S. M., and J. J. Pritt. 2017. Comparing otoliths and scales as structures used to estimate ages of Largemouth Bass: Consequences of biased age estimates. *North American Journal of Fisheries Management* 37:1075–1082.
- Vandergoot, C. S., M. T. Bur, and K. A. Powell. 2008. Lake Erie Yellow Perch age estimation based on three structures: Precision, processing times, and management implications. *North American Journal of Fisheries Management* 28:563–571.
- Vilizzi, L., K. Walker, T. Jain, D. McGlennon, and V. Tsymbal. 1998. Interpretability and precision of annulus counts for calcified structures in Carp, *Cyprinus Carpio* L. *Fundamental and Applied Limnology* 143:121–127.
- Wakefield, C. B., J. M. O'Malley, A. J. Williams, B. M. Taylor, R. S. Nichols, T. Halafihi, R. L. Humphreys, J. Kaltavara, S. J. Nicol, and S. J. Newman. 2017. Ageing bias and precision for Deep-water Snappers: Evaluating nascent otolith preparation methods using novel multivariate comparisons among readers and growth parameter estimates. *ICES Journal of Marine Science* 74:193–203.
- Walsh, M. G., A. P. Maloy, and T. P. O'Brien. 2008. Comparison of Rainbow Smelt age estimates from fin rays and otoliths. *North American Journal of Fisheries Management* 28:42–49.
- Watkins, C. J., T. J. Ross, R. S. Hardy, and M. C. Quist. 2015. Precision of hard structures used to estimate age of Mountain Whitefish (*Prosopium Williamsoni*). *Western North American Naturalist* 75:1–7.
- Watson, G., and M. J. Smale. 1999. Age and growth of the Shortnose Spiny Dogfish *Squalus Megalops* from the Agulhas Bank, South Africa. *South African Journal of Marine Science* 21:9–18.
- Weber, M. J., and M. L. Brown. 2011. Comparison of Common Carp (*Cyprinus Carpio*) age estimates derived from dorsal fin spines and pectoral fin rays. *Journal of Freshwater Ecology* 26:195–202.
- Welch, T. J., M. J. van den Avyle, R. K. Betsill, and E. M. Driebe. 1993. Precision and relative accuracy of Striped Bass age estimates from otoliths, scales, and anal fin rays and spines. *North American Journal of Fisheries Management* 13:616–620.
- Wells, R. D., S. Kohin, S. L. Teo, O. E. Snodgrass, and K. Uosaki. 2013. Age and growth of North Pacific Albacore (*Thunnus Alalunga*): Implications for stock assessment. *Fisheries Research* 147:55–62.
- Whiteman, K. W., V. H. Travnichuk, M. L. Wildhaber, A. DeLonay, D. Papoulias, and D. Tillett. 2004. Age estimation for Shovelnose Sturgeon: A cautionary note based on annulus formation in pectoral fin rays. *North American Journal of Fisheries Management* 24:731–734.
- Williamson, C. W., and R. R. Dirnberger. 2010. A comparison of techniques using dorsal spines to estimate Sauger age. *North American Journal of Fisheries Management* 30:1016–1019.
- Wilson, C. A., and D. L. Nieland. 2001. Age and growth of Red Snapper, *Lutjanus Campechanus*, from the Northern Gulf of Mexico off Louisiana. *Fishery Bulletin* 99:653–664.
- Winker, H., O. L. F. Weyl, A. J. Booth, and B. R. Ellender. 2010. Validating and corroborating the deposition

- of two annual growth zones in asteriscus otoliths of Common Carp *Cyprinus Carpio* from South Africa's largest impoundment. *Journal of Fish Biology* 77:2210–2228.
- Wintner, S. P. 2000. Preliminary study of vertebral growth rings in the Whale Shark, *Rhincodon Typus*, from the east coast of South Africa. *Environmental Biology of Fishes* 59:441–451.
- Yamaguchi, A., T. Taniuchi, and M. Shimizu. 1996. Age and Growth of the Starspotted Dogfish *Mustelus Manazo* from Tokyo Bay, Japan. *Fisheries science* 62:919–922.
- Yates, J. R., C. J. Watkins, and M. C. Quist. 2016. Evaluation of hard structures used to estimate age of Common Carp. *Northwest Science* 90:195–205.
- Yigin, C. C., and A. Ismen. 2016. Age and growth of Spiny Dogfish *Squalus Acanthias* (Squalidae: Chondrichthyes) in the North Aegean Sea. *Pakistan Journal of Zoology* 48:1185–1191.
- Zhu, X., R. J. Wastle, K. L. Howland, D. J. Leonard, S. Mann, T. J. Carmichael, and R. F. Tallman. 2015. A comparison of three anatomical structures for estimating age in a slow-growing subarctic population of Lake Whitefish. *North American Journal of Fisheries Management* 35:262–270.
- Zymonas, N. D., and T. E. McMahon. 2009. Comparison of pelvic fin rays, scales and otoliths for estimating age and growth of Bull Trout, *Salvelinus Confluentus*. *Fisheries Management and Ecology* 16:155–164.

Ignore After This

Maceina and Sammons (2006) Fossen et al. (2003) Murie et al. (2009c) Koenigs et al. (2015) Brenden et al. (2006) Marriott and Cappel (2000) Khan et al. (2013) Polat and Gümücs (1996) Polat et al. (2011) Kotas et al. (2011) Morison et al. (2005) Goldman et al. (2006) Vilizzi et al. (1998) Lepak et al. (2017) Erhardt and Scarnecchia (2013) Gallagher et al. (2016) Herbst and Marsden (2011) King et al. (2018) Raitaniemi et al. (1998) Robillard and Marsden (1996) Snow et al. (2018) Wakefield et al. (2017) Zymonas and McMahon (2009) Sabah and Khan (2014) Rude et al. (2013) Morehouse et al. (2013) Klein et al. (2017) Sotola et al. (2014) Howland et al. (2004) Faust et al. (2013) Quist et al. (2007) Porta et al. (2018) Sylvester and Berry (2006) Debicella (2005) Stransky et al. (2005) Hoxmeier et al. (2001) Oplinger (2015) Watkins et al. (2015) Khan et al. (2011b) Khan et al. (2015) Smith et al. (2016) Ross et al. (2005) Long and Fisher (2001) Isermann et al. (2010) Phelps et al. (2007) Hurley et al. (2004) Isermann et al. (2003) Oele et al. (2015) Silva and Stewart (2006) Jones (2009) Breeggemann et al. (2014) Logsdon (2007) Buckmeier et al. (2002) Stewart et al. (2016) Rien and Beamesderfer (1994) Vandergoot et al. (2008) Power et al. (2006) Dutka-Gianelli and Murie (2001) Svedäng et al. (1998) Eklund et al. (2000) Sulikowski et al. (2007) Hill et al. (1989) Buckmeier et al. (2012) Stolarski and Hartman (2008) Peltonen (2002) Anderson et al. (1992a) Natanson et al. (2007) Jackson et al. (2007a) Gumus et al. (2007) Marriott and Mapstone (2006) McDougall (2004) Brennan and Cailliet (1989) Anderson et al. (1992b) Dawson et al. (2009) Khan and Khan (2009) Barbieri et al. (1994) Meeuwig and Bayer (2005) Niewinski and Ferreri (1999) Sulikowski et al. (2005) Matta and Gunderson (2007) Haas and Recksiek (1995) Rice et al. (2009) Horn (2002) Barada et al. (2011) Gburski et al. (2007) Andrews et al. (1999) Calis et al. (2005) Ewing et al. (2003) Gallagher et al. (2006) Walsh et al. (2008) Carlson and Baremore (2005) Kruse et al. (1997) Gregg et al. (2006) Natanson et al. (2002) Esteves et al. (1995) Tribuzio et al. (2010) Nuevo et al. (2004) Boxrucker (1986) Welch et al. (1993) Kruse et al. (1993) Brown et al. (2004) Allman, Robert J. et al. (2005) Flain and Glova (1988) Choat and Axe (1996) Soekoe et al. (2013) Ewing et al. (2007) Andrade (2004) Hammers and Miranda (1991) Glass et al. (2011) Braaten et al. (1999) Spiegel et al. (2010) Hubert et al. (1987) Whiteman et al. (2004) Metcalf and Swearer (2005) Weber and Brown (2011) DeMartini et al. (2007) Schrank and Guy (2002) Labay et al. (2011) Sun et al. (2002) Stolarski and Sutton (2013) Copeland et al. (2007) Khan et al. (2011a) Koch et al. (2009) Seibert and Phelps (2013) Sharp and Bernard (1988) Perry and Casselman (2012) Zhu et al. (2015) Tyszkowski and Pritt (2017) Haglund and Mitro (2017) Gu et al. (2013) LaBay and Lauer (2006) Blackwell et al. (2016) Stewart et al. (2015) Kocovsky and Carline (2000) Laine et al. (1991) Bubley et al. (2012) Lowerre-Barbieri et al. (1993) Sipe and Chittenden Jr (2002) Kusher et al. (1992) Wells et al. (2013) Brusher and Schull (2009) Koch et al. (2011) Hobbs et al. (2014) Cerdaneres-Ladrón De Guevara et al. (2011) Bauerlien et al. (2018) Isermann et al. (2018) Hyndes (1992) Beckman et al. (1990) Wilson and Nieland (2001) Ma et al. (2017) Tribuzio et al. (2018) Ozcan and Basusta (2018) Chater (2015) Neves (2015) Ferri et al. (2017) Boughamou (2014) Adams and Kerstetter (2014) Williamson and Dirnberger (2010) Erickson (1983) Farley et al. (2013) Polat et al. (2005) Fernando et al. (2014) Soeth et al. (2018) Acre et al. (2017) Hining et al. (2000) Beckman (2002) Škeljo et al. (2012) Matić-Skoko et al. (2011) Gallagher and Nolan (1999) Francis et al. (2001) Henderson et al. (2004) Orlov et al. (2011) Yigin and Ismen (2016) Francis and Maolagáin (2000) Officer et al. (1996) Škeljo et al. (2015) Gillanders et al. (1999) Ihde and Chittenden Jr (2002) Lessa and Duarte-Neto (2004) Killgore et al. (2007) Besler (1999) Yates et al. (2016) Jackson et al. (2007b) Schill et al. (2010) Murie et al. (2009b) Smylie et al. (2016) Bwanika et al. (2007) Murie and Parkyn (2005) Long et al. (2018) Balazik et al. (2012) Stevenson and Secor (2000) Aschenbrenner et al. (2017) Harry et al. (2013) Bokhutlo et al. (2015) Efitre et al. (2016) Artero et al. (2015) Murie et al. (2009a) Lombardi-Carlson et al. (2008) Beckman et al. (1988) Brouder (2005) Puchala et al. (2018) Fleming and Stark (2018) Dembkowski et al. (2017) Johnson et al. (1995) Morrow et al. (1998) Winker et al. (2010) Griffin et al. (2017) Goldman and Musick (2006) Braccini et al. (2007) McAuley et al. (2006) Moulton et al. (1992) Pierce and Bennett (2009) Hale and Baremore (2013) Simpfendorfer et al. (2002) Bishop et al. (2006) Wintner (2000) Watson and Smale (1999) Conrath et al. (2002) Goosen and Smale (1997) Farrell et al. (2010) Yamaguchi et al. (1996) Romine et al. (2006) Lessa et al. (1999) Natanson and Kohler (1996) Holmes et al. (2015) Simpfendorfer et al. (2000) Barreto et al. (2011) Sun et al. (2015) King and McPhie (2015) Huveneers et al. (2013) Geraghty et al. (2014) Natanson and Skomal (2015) Natanson et al. (2014) Piercy et al. (2007) Ribot-Carballal et al.

(2005) Skomal and Natanson (2003) Driggers et al. (2004)