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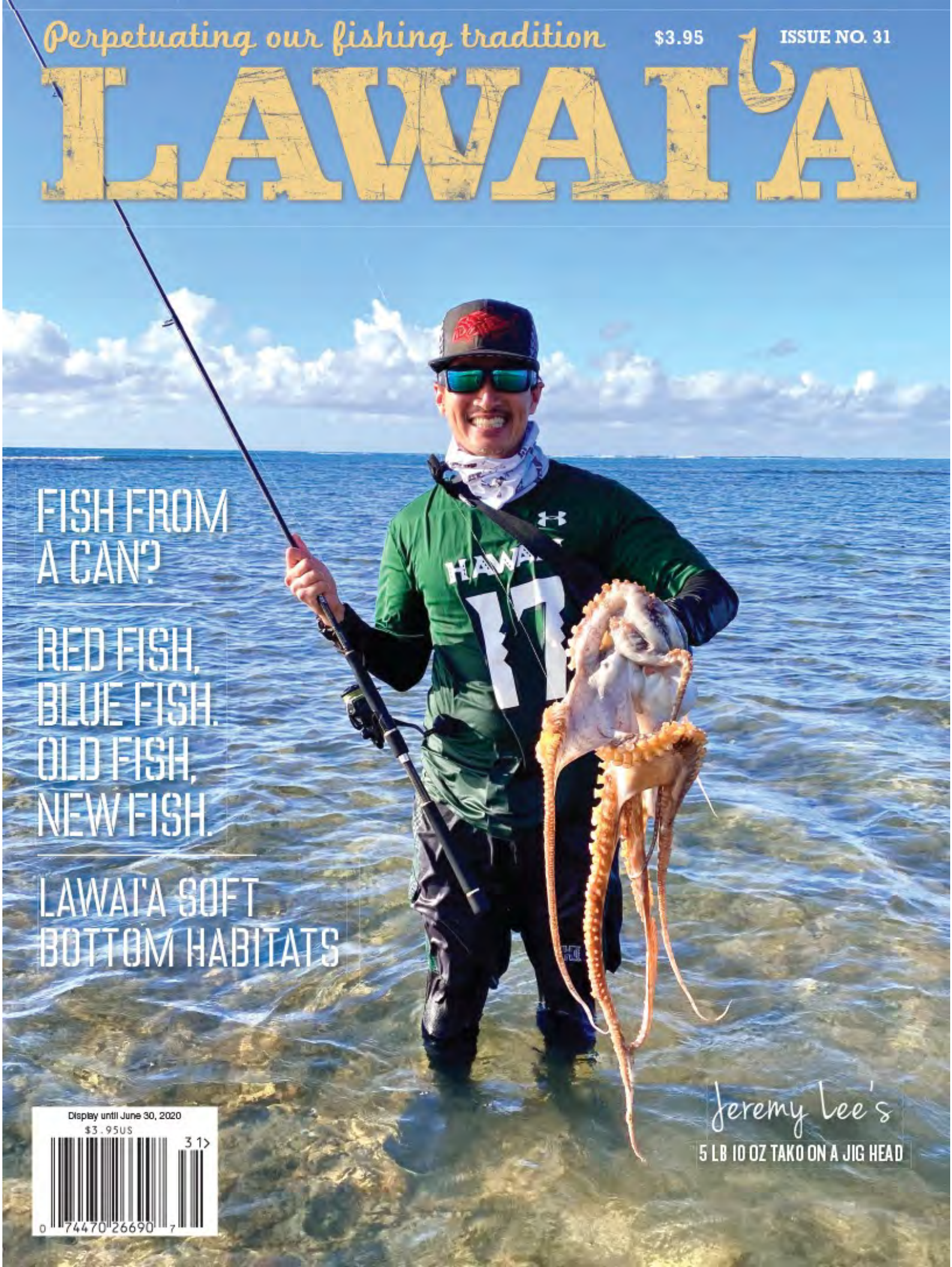

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Red Fish, Blue Fish. Old Fish, New Fish.

ONAGA CAN LIVE HALF A CENTURY IN THE HAWAIIAN ISLANDS

This big fish, a grander blue marlin (Makaira nigricans) at 1245 lbs., was caught off Oahu in 2009 and was aged to be just 20 years old (see Lawai'a Magazine No. 25). While this may be fortuitous for the fishery because the population can replenish itself quickly from fishing pressure, fast growth and a short lifespan are not always the case with other fishes. As it recently turned out, one of the most valuable deep-water snappers — the onaga (Etelis coruscans) or `ula`ula koa`e by its Hawaiian name — is a potentially old red fish.

By Allen H. Andrews, Ph.D.
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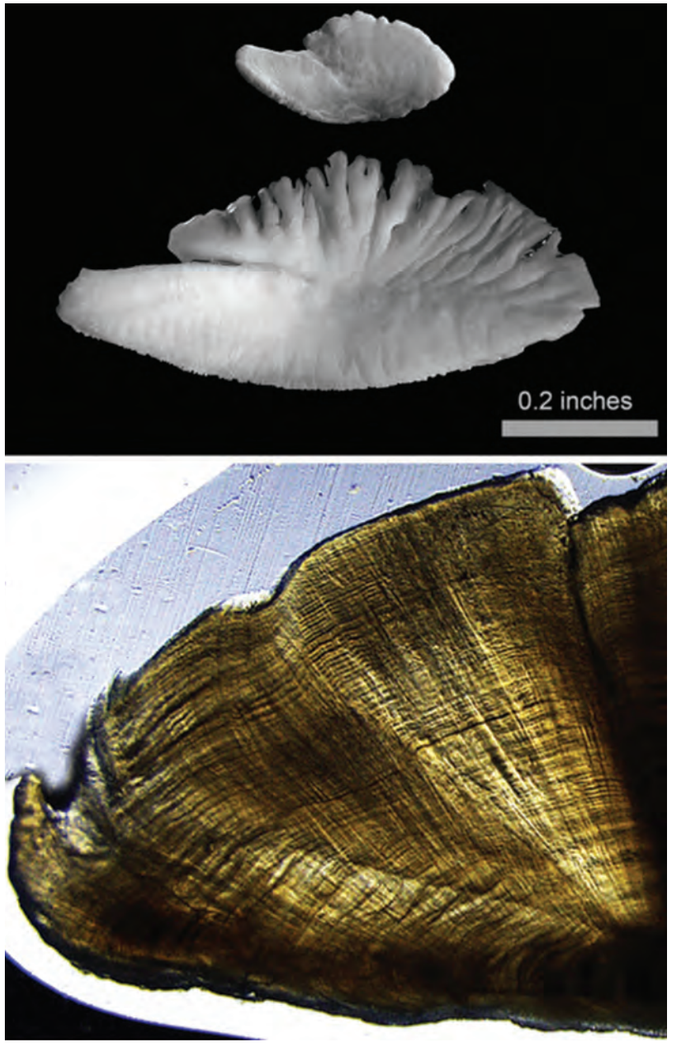
Onaga is prized among fishers of the Hawaiian Islands and it is a difficult fish to catch, even by those with the know-how. Its brilliant red color and long tail fins make it popular as a culinary display for celebratory banquets (see Lawai'a Magazine No. 11). Late in the year, the landings and value of onaga increase during the holiday season. The depths where onaga can be captured are formidable to most fishers, but those with the skill, proper gear, and a bit of luck can bring in a bounty from the deep waters offshore. Next time you are in Honolulu, look up at the tallest condominium complexes and imagine dropping your fishing line to a depth twice the height of those buildings! It seems to me that catching these elusive fish is quite a feat.

A rare close encounter with an onaga at nearly 600 feet was seen during the NOAA Okeanos Explorer surveys in the Mariana Islands in 2016. Often these fish pass through the narrow field of view of the submersible very quickly and are not seen again. Photograph courtesy of the NOAA Office of Ocean Exploration and Research (https://ocean-explorer.noaa.gov/okeanos/explorations/ex1605).

Brendt Chang is a local fisherman of Oahu and is one of the fortunate ones to know how and where to fish for onaga, one of the more important fishes of the Hawaiian Islands.

Onaga is one of the local bottomfish and is an important member of a management group called the Deep 7 — comprised of six snapper and one grouper species — where knowledge about the age, growth, and longevity is incomplete for most members, yet sustainable fishing practices often rely on this kind of information. As a researcher of fish life history, my expertise is with describing how fish grow and how long they can live (my personal website if you are interested - www.astrofish.me). It was in 2009 that I began working on the fishes of Hawaii after working on other fishes for more than 10 years in California and my first quarry was opakapaka (Pristipomoides filamentosus) — another member of the Deep 7 and the most valuable in terms of annual landings. While some previous studies had estimated that opakapaka can live up to either 5 or 18 years, the work I did proved that they can live more than 40 years. This finding was unexpected and initially this discovery was not accepted by some critics who could not believe that a snapper in the Hawaiian Islands could live that long. However, when the method I used to validate fish age was described in detail, many conceded that the new maximum age was true.

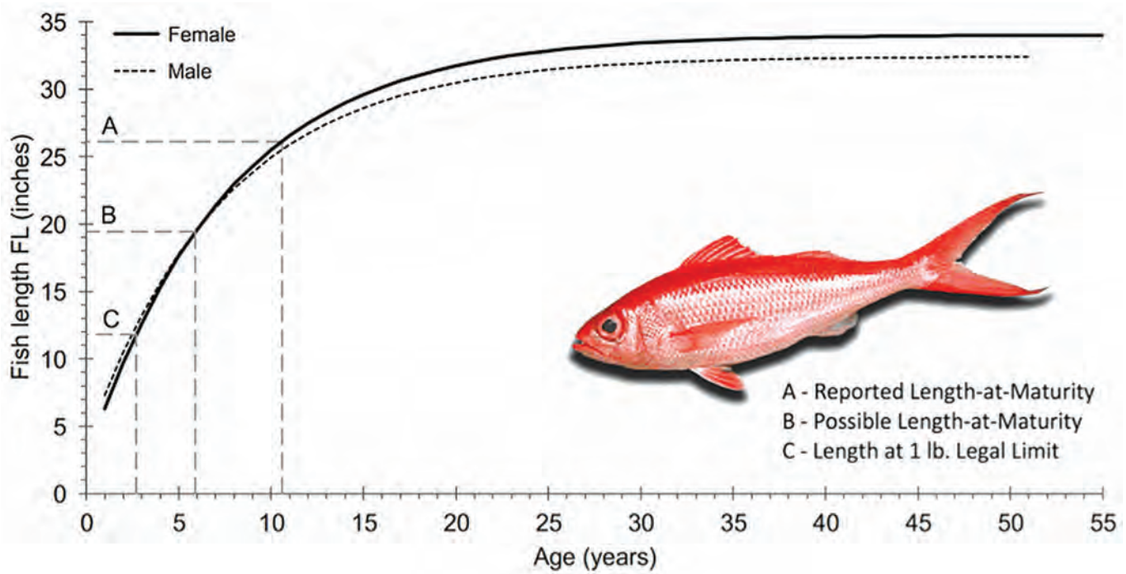
I use a unique method to determine fish age called “bomb radiocarbon dating” and researchers worldwide have used it to reveal greater ages and longevity than previously known for numerous fishes. The concept is simple, but making it work for each species can be challenging — you must measure the radiocarbon signal created by nuclear bombs in the 1950s and 1960s in the ear stone of the fish! The ear stone is a special structure called an otolith and it is used by a fish to hear and balance itself in the water. Some call it an ear bone, but this phrase is a bit of a misnomer because it does not grow like most bones — it grows like a mineral with a crystalline structure that is conserved over time. This means that the layers forming the otolith are like a marine chemistry record for where ever the fish lived — a clock in the ear of a fish. Perhaps you can imagine cutting one in half and seeing the growth layers, similar to what you see as growth rings in a cut tree. While these growth rings can be counted and you may think it will be one ring per year, this is not always true for fish because reading an otolith takes considerable effort, training, and ultimately you must decide on an age. It is the age interpretation that must be validated because the counting could be wrong and consequently, the life history would not be properly understood for management purposes.



It is the comparison of the birth year from growth ring counting with the date determined from ocean chemistry that reveals if the age estimate is accurate.

Pictured are two whole otoliths from onaga (Etelis coruscans) at the top, in which the uppermost otolith is from a 2-year-old onaga and the larger one is the adult that was aged to 55 years. The second image is a cross-section of the 55-year-old otolith showing the complex growth zone structure. With some practice, this otolith can be aged consistently to 55 years by counting the growth zones that you see here. Can you find 55 years of growth by counting the zones?

Recent work that I performed on onaga has led to cross-sectioned otoliths with growth rings that can be very thin and numerous (take a look at the otolith pictures). Counting these growth rings indicated it is possible that onaga can live more than half a century, but the counting must be validated because it is unknown how often the rings form. To do this, bomb radiocarbon dating was used on the earliest otolith growth — the center or birth-year material was extracted with a computerized device called a micromilling machine to measure the radiocarbon (see Lawai’a Magazine No. 29). Because the otolith records ocean chemistry the same way that reef building corals do, the radiocarbon measurement from the otolith can be compared to coral radiocarbon records — this provides a date that does not rely on counting growth rings. Hence, it is the comparison of the birth year from growth ring counting with the date determined from ocean chemistry that reveals if the age estimate is accurate. Sure enough, the ages estimated to be 23 to 55 years from growth rings were valid for fish 29 to 34 inches (12–21 lbs.) — onaga really can live more than half a century, but this finding is only part of the story for how this fish grows in Hawaiian waters.



This figure shows growth curves that describe how onaga (Etelis coruscans) can grow through their life. Note that as the fish gets bigger, growth slows down and then mostly stops for several decades, similar to how humans grow. The slowing of growth is often related to sexual maturity in fishes, and at this time it appears that female onaga may mature at 10-11 years of age, but there is another consideration before we know for certain.

Some may think the long life is bad news for fishermen and the fishery because the high longevity may make it more vulnerable to overfishing, but the contrary can be true under some circumstances. In the case of onaga, the fish that was over 50 years old was caught just 10 years ago, and yet onaga have been fished for a much longer time. The fact that several old fish were recently caught — 4 fish were over 40 years old in our study — is an indication the age structure of the population has held on to its oldest fish. For other species around the world, the oldest fish are rare or long gone when fishing pressure has been high. A good example of this kind of loss is with the over-exploited of orange roughy

In the case of onaga, the fish that was over 50 years old was caught just 10 years ago, and yet onaga have been fished for a much longer time.

(Hoplostethus atlanticus), a deep-sea fish from off New Zealand that can live more than 100 years. Onaga do not appear to have this kind of problem.

Rare at depth photo of an onaga (Etelis coruscans) that was taken during the NOAA Okeanos Explorer expeditions in 2016. Red laser points to the right of the fish are 10 cm apart, making this onaga ~70 cm FL (~28 inches) and mature as an upper-teenager. Image courtesy of the NOAA Office of Ocean Exploration and Research.

In addition, notice that this species is relatively fast growing to the point where it begins to mature and can reach maximum size as an upper-teenager (take a look at the growth curves). This means that it is difficult or impossible to determine the age of an onaga once it reaches a size of approximately 75 cm FL (30 inches) — onaga this size or greater can be 20 to more than 50 years old. One factor that is somewhat perplexing to fishery biologists about this species is the length and age at which this species appears to mature. Based on a study in the 1980s, onaga have been described to mature at a length of 66 cm FL (26 inches) — a length that is quite high relative to the maximum size of onaga reported in recent years for Hawaii (94 cm FL, 37 inches) — which correlates to an age of 10-11 years. To be clear on what length-at-maturity means, this is a length in which 50% of the females caught would be mature and capable of reproduction. The complication with this estimate is that it implies onaga are not as productive because of a large size and late age at maturity. For example, opakapaka were recently shown to reproduce at 3–4 years of age from an observed length-at-maturity of 41 cm (16 inches), which is 53% of maximum length, as opposed to 71% of maximum length for onaga. After some scrutiny of the onaga maturity data from the 1980s, I realized that the number of fish used to make this observation may not have been enough for an accurate size-at-maturity estimate. As a result, more gonads of female onaga are being collected to reassess length-at-maturity and to provide a more thorough assessment of onaga life history. Hence, while onaga can live many more years than originally perceived, the population dynamics of this species may be quite resilient in supporting a sustainable fishery well into the future. ʻo