

### Does size really matter and how do fish do it?

Recently whilst conducting angler surveys, as part of a recreational fishery assessment program, I was informed by some anglers that there is no way that they could be having an impact on the fish numbers. When asked why they thought this they responded by saying: "Because the fish are continuously breeding. They must be producing more offspring than we can catch!" Unfortunately, it's not that simple and although fish have developed a wide and fascinating array of reproductive styles and strategies to ensure successful reproduction. One thing they don't do is breed all the time. So how and when do they do it?

Fish like all other animals are genetically programmed to breed and the success of any fish species is determined by the ability of its members to reproduce successfully in a fluctuating environment. We can say that the minimum requirement for successful reproduction would be the eventual replacement of a spawning pair by an equally successful pair. In order to do so three objectives have to be achieved: (1) Survival of a portion of the young must be ensured through either force of numbers, concealment or protection. (2) The earliest feeding stages must be placed in close proximity to food and in an environment in which they are equipped to survive, and (3) the juveniles must have eventual access to the living space of the adults. With this in mind three main breeding strategies, representing different approaches to ensure survival of the young, can be identified within fishes. Breeding is energy expensive and these sectors also differ in the way the fish expend their energy to breed (i.e. many small eggs to fewer large eggs with increasing parental care).

On the one end of the scale we have the Non-guarders – those fish that broadcast masses of eggs into the environment with no further parental involvement. These fish put energy into producing thousands of small eggs with a short embryonic phase and a prolonged free-floating energy gathering larval stage. A good example of this type of breeding is shown by the ocean sunfish (*Mola mola*) which is estimated to produce an enormous 28 million eggs per year. However, larval survival, largely dependent on chance encounters with food and passive avoidance of predators, is typically low. To enhance survival some pelagic spawners have developed strategies whereby they spawn in environmentally suitable areas at the right time. A prime example being that of the geelbek which coincide their breeding migration up the east coast with that of the annual sardine run. In this way the adults can continue to feed whilst migrating, they spawn in the warm waters off KwaZulu-Natal which promotes quick embryonic development, and the larval fish drift back down within the close inshore waters arriving in the nutrient and food rich water of the Eastern Cape. Juveniles live in the Eastern Cape for about 2 years before moving to the Western Cape where they stay until they are sexually mature and can join the adult population (5 to 9 years) on the annual breeding migration.

The second main breeding strategy incorporates the guarders. These fish are characteristically less fecund (that is they produce fewer eggs) but greater energy is spent in some sort of parental protection. An example that many tropical divers may have come across is the Titan trigger fish. These fish lay their eggs on the substrate and then

guard the area around and the column of water above the nest. During this period the adults can be highly aggressive tackling both fish and divers that stray too close. If any of you have experienced this you will agree with me when I say that a territorial Titan trigger fish is a formidable foe.

The third guild consists of the bearers both internal, like many shark species (which typically give birth to only a couple of young), and external. A good example of an external bearer is the barbel or white seacatfish (*Galeichthys feliceps*) – a fish that most recreational anglers have at some point caught but none really want to catch. What most people may not know is that this species is a mouthbrooder and it is the male that does all the hardwork!

Spawning occurs between September and December each year with males and females pairing up. The female releases between 50 and 60 eggs which she holds in her pelvic fins whilst the male fertilizes them. The male then takes the fertilized eggs into his mouth and incubates them for up to 80 days until they hatch. However, the ordeal is still not over as the male retains the young in his mouth for a further 55 days or until the yolk sack has been fully absorbed. Not only has the male been unable to feed for 140 days but during the last period of incubation the young start to feed on the mucus of the male's mouth cavity!! It's been calculated that from the time of fertilization until release of young the male loses about 24% of his body weight. Talk about sacrifice! So why do it this way? Well it is very unlikely that the females would be able to invest energy into egg development, mouthbrood them to full-term (with no food of her own) and then still recover in time to spawn the following season. By splitting the cost of reproduction between the males and females allows yearly reproduction and maintenance of stable populations.

A different method of splitting reproductive energy costs between male and females is seen within the seabream or Sparidae family. This family comprises many of the prized recreational linefish species including the red steenbras, dageraad, roman, white steenbras, musselcracker and red stumpnose so it is perhaps pertinent to explain a bit more. In most fishes, reproduction follows the normal pattern in that the sexes are separate from the start of their development. On the other hand hermaphroditism, defined as: "A single individual that reproduces normally as both sexes, either simultaneously or sequentially", is considered to be abnormal. However, there are many families in which hermaphroditism is not only common, but also functional. The family Sparidae being one of them. A number of species within this family exhibit sequential hermaphroditism in that some species change sex from functional females to functional males (protogyny), while other species do the reverse changing from males into females (protandry). For example roman will first mature as females (around 20cm in size) before changing sex to males at around 30cm in size. So why do they do it this way and what is the advantage? Ultimately sex change is an alternative reproductive style that allows an individual to maximize its lifetime reproductive success by first reproducing as one sex at a particular time in life and as the other sex at a later stage. Furthermore, the predominance of females in protogynous species (those that reproduce as females first then males) increases the population fecundity (the potential number of offspring within the population). Very simply there are more females therefore more eggs. Protandric species

on the other hand increase the individual's fecundity (potential number of offspring from an individual) due to the straightforward fact that larger females can produce more eggs. Both scenarios, with different reproductive strategies, result in similar outcomes and maintenance of populations.

Fishing whether it be recreational or commercial effectively increases the mortality rate of a natural population. If fisheries are adequately managed and compliance with regulations high this is not normally a problem. The underlying idea is that you can remove a portion of a population without impacting its ability to continue to reproduce and replace those being removed. However, when fishing mortality becomes too great we see a rapid decrease in fish abundance. In comparisons between fish populations inside and outside of marine protected areas (MPA) many research findings have shown that populations of targeted species are not only more abundant within the MPA but both the average and maximum fish size is larger. Remember that an increase in size results in an exponential increase in reproductive output. Furthermore, fished populations can also begin to show a change or skewing in the sex ratio's, a situation of either fewer males or females. Think for example of the red roman which first matures as a female and then a male. The size limit for roman is 30cm which means that all the legal fish you take are all in fact males. Constantly removing the larger male fish begins to skew the sex ratio towards an increase in females. Skew the ratio too much and again you are impacting the ability of that population to effectively reproduce.

Ultimately, the success and continuation of any species depends on successful reproduction and given the number of fish species (21 000 species = 48% of all vertebrates), and the diversity of habitats they occupy it is not surprising the various and fascinating ways they have developed in which to do it. And yes, for some species size really does count and in more ways than one!