Where Do Young Fish Come From?

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Whitetail does -female deer- usually give birth to two fawns each spring. If you counted the number of does in late fall, doubled it, adjusted for the percentage of them that die through the winter and for the percentage of fawns still-born, you would have a good estimate of next spring's fawn production. What is more, if you could double the number of does, you would come close to doubling the number of fawns. A larger herd would mean less food per deer, so they would grow more slowly, fewer does would mature at six months old (most don't breed until they are eighteen months) and a higher percentage of fawns would be still-born or would die because their birth-weight was low. Still, if you could control the number of does in the herd, you would have quite a good grip on fawn production.

This is obvious. After all, it is true not only of deer but also -more or less- of armadillos, bears, cattle and many other land animals through to zebras. In some species, from cats to rats, pregnancy rates and litter sizes are more variable. But we can still get a fair idea of the number of young by counting the number of adults. This even works with some marine animals. Grey seal cows, for example, only have one pup per year each. Blackfish probably have one every two years. And most female sharks carry their young until they are born live, usually as a litter of a dozen or so pups. If you could count all the blue shark cows now, you could calculate roughly how many pups would be born next season, just as you could with coyotes or wolves.

But obvious as all this seems, it is **not** true of the vast majority of marine species. Codfish are a classic example. They do not carry live young, of course; codfish spawn eggs. And they do not just spawn one or two eggs, nor ten or even ten thousand. *A really big "mother" codfish can spawn ten **million** eggs - every year.* (Just before spawning, all of those eggs can amount to a third of her bodyweight; something like a 150 lb pregnant woman giving birth to a 50 lb baby!)

There is a reason why a whitetail doe only has two fawns a year. When they are born, they have to be ready to get up and run within a few hours or the coyotes would eat them. So the doe has to carry them in her womb while they grow and develop until they are ready to stand on their own feet. Even after they are born, she has to suckle them with rich milk so they continue to grow fast. Meanwhile, she has to guard and teach them until they can take care of themselves. *A doe simply cannot get enough energy from her own food to provide this much care for more than a couple of fawns per year.*

A female codfish puts at least as much of her food energy into her eggs as a doe does into her fawns; all of that weight of eggs has to be built up each year from the codfish's food. But instead of using her energy to give a couple of babies a good start in life, she spreads it among millions of eggs. Each one gets a tiny bit of yolk and a few droplets of oil -just enough food to get them started- but their mother cannot afford any more. She swims to the spawning ground of course, so her offspring can start life in the right part of the ocean. And she goes through her mating "dance" with a male, so her eggs have a good chance of being fertilized. After that, they are on their own while mom starts feeding to build up her strength for next year's eggs.

And these eggs are **tiny** - they have to be or their mother could never carry so many. Even after they are spawned, when they swell up with seawater, they are only about a millimetre across. A thousand of them would weigh under a gram, twenty thousand much less than an ounce.

These little eggs are left to take their chances in a hostile world. They float in the surface waters, where the young fish will find plenty of food when they hatch. But untold millions of predators wait there to feed in their turn on codfish eggs and young. Meanwhile, ocean currents sweep billions of eggs away from the spawning grounds; sometimes to nursery areas but often out to deep ocean where the young codfish die. **Life is short and brutal for a baby fish.**

Before mankind came along to fish them and mess up their populations, an average adult codfish spawned annually for several years after it matured; the females making more eggs per year as they grew larger. Their lifetime egg production may have averaged around fifty million each. (The very few fish that survived to live out their time might spawn almost as many as this in a single year but others would die after only one spawning of far fewer eggs.) For comparison, before we changed things, over her life an average whitetail doe had about twenty fawns in all. Yet, **on average, both the codfish and the doe produced exactly the same number of adults in the next generation: two - one male and one female**. That had to be, for otherwise the population would have increased year by year or else died away to nothing. So each new-born fawn had about a one-in-ten chance of making it to adulthood but each cod egg had only about one chance in twenty five million. The difference is a measure of how much energy does put into raising each of their young.

Why would codfish opt for such a wasteful way of reproducing themselves? Not all fish do. Redfish, for example, carry their eggs in their ovaries until the young hatch out and so they make do with only a few thousand eggs per year, instead of several million. Lobsters carry theirs around in much the same way, though they stick them to the outside of their bodies. Lumpfish glue their eggs onto rocks, where the male guards them and gives them a much better chance of survival, though at a terrible cost to their fathers. For codfish though, while nobody knows the details, it seems that spreading huge numbers

of tiny eggs around and then getting on with eating is just the most efficient option available. Hard though it may be to believe, codfish are simply better off making millions of tiny eggs than a few big ones. And so are most other marine species: haddock and mackerel, scallop and tuna, sea urchins and all.

But the most important difference between codfish and deer reproduction is not the cod's very poor chance of survival. It is that the survival of young cod is very much better in some years than others. Because a doe only has two fawns a year, she must take care that they survive whether the spring is warm or cold, and whether there are few coyotes or many. But the tiny cod eggs play a deadly lottery. Each one only has a little yolk and, after it hatches, it must find food within a few days or starve. Some years, the codfish get their timing right and there are plenty of minute animals in the water when the young fish (called "larvae") are ready to eat. Other years, spring comes late, there is little food and trillions of cod larvae starve. Sometimes the water the eggs are drifting in is full of jellyfish, which feast on the tiny fish. Sometimes it is clear of predators and the baby cod's chances are better. Sometimes this water is caught by the Gulf Stream and swept out into the Atlantic, while sometimes it is pushed to the inshore nursery grounds just when the young fish are ready to settle to the bottom.

The end result is that, in a "good" year, a young cod can have at least ten times the chance of surviving its first six months than its brothers and sisters had in a "bad" year. After six months of age, codfish survival is less variable, year-to-year, but the damage is already done. When the fish are old enough to be caught (when they "recruit"), year-classes spawned in "good" years still have ten or more times as many fish as those spawned in "bad" years - even when they all started with the same number of eggs produced by the spawning adults.

And this, finally, is the key point: **In deer and dogs, you can count the adults and estimate the number of young. In codfish and corals you cannot - because the survival from spawning to recruitment is so variable that even if you knew the number of eggs spawned you could only make a very poor guess at the numbers of recruits that would come from them.** A large number of spawners in a "bad" year will produce far fewer recruits than a much smaller stock would in a "good" year. This is not just theory. It has been seen time and again in fish stocks all over the world. And it is, just possibly, the most important fact in fisheries science.
