More than meets the eye in seemingly random wild population abundances

In the wild, animal populations are not fixed but rather fluctuate in size over time in a seemingly random fashion. At first glance is there is no rhyme or reason to this apparent randomness, but we analyzed historical population data for marine species across 66 ecosystems and found some surprising patterns. First, the year-to-year growth rates of these diverse species do not follow a familiar bell curve but rather a so-called Laplace distribution, which is characterized by higher-than-expected probabilities of years with strongly positive or strongly negative growth. This can lead to “boom and bust” behavior for the individual populations (Fig. 1.), which is further complicated by our second observation of a “floor effect”, in which species with already low populations tend to remain low for many years thereafter.

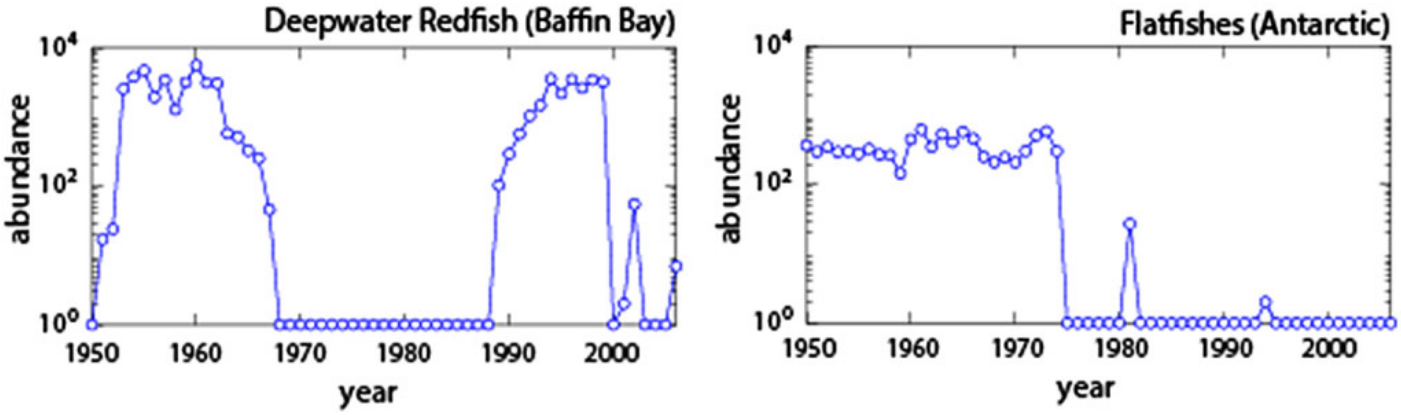

Fig. 1. Annual catch (in tons) over time for several species, showing the characteristic "boom and bust" behavior of the associated populations that arises from our observation of Laplace-distributed growth rates. Note the tendency for a species with low (near-zero) population to remain low in subsequent years, which we term the "floor effect".

Together, these two effects conspire to leave species vulnerable to swift declines in population that may take an inordinately long time to recover from. Third and finally, we find that growth is largely synchronized within each ecosystem, with a rise (or decline) in the population of one species often implying the same for those of the others in the same year. This indicates a higher likelihood of the otherwise unlikely simultaneous collapse of multiple populations. We were able to use our findings to craft a predictive model that improves upon existing estimates of extinction risks. Together, we expect this work to contribute to more sustainable fisheries management, and to a more accurate assessment of the risks faced by threatened species.

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