Based on these experiments, we found that the ribosome target stem of DU177 exhibited enhanced resistance against helix unwinding, such that the forward movement of the ribosome was hampered, resulting in an increased likelihood of frameshifting. Several base-base interactions (including base pairs and base triples) inside the DU177 structure contributed to the unwinding resistance. The base triples, which are distal to the ribosome target stem, formed the core of stabilization. The stabilization effect was then propagated to other base triples, including those proximal to the ribosome target stem and further to several specific bases in the loop juxtaposed to the stem. Thus, the unwinding resistance directly resulted from intercalation of the loop bases with the stem helix, but the intercalation was not established without other base triples. Such a hierarchical coordination among base-base interactions in an RF stimulator accounts, at least in part, for the nature of frameshifting.

In conclusion, by measuring one RNA molecule at a time, we detangled the complex interaction network inside RNA and identified the structural features that can lead to ribosomal frameshifting. The study helps us understand this fundamental biological reaction with insightful details.

Reference

Chen, Y., Chang, K., Hu, H., Chen, Y., Lin, Y., Hsu, C., Chang, Cheng-Fu, Chang, Kung-Yao, Wen, J. (2017). Coordination among tertiary base pairs results in an efficient frameshift-stimulating RNA pseudoknot. *Nucleic Acids Research, 45*(10), 6011 - 6022. DOI:10.1093/nar/gkx134

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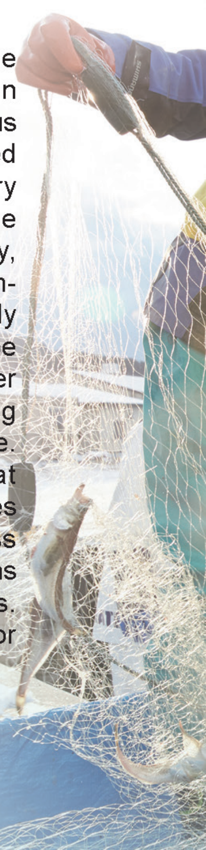
Overfishing induces aggregation of fishes through altering life history traits

Even distribution in diverse habitats can reduce the risk of extinction for a species. Understanding how a species is spatially distributed, including heterogeneity (variance), distribution range, and habitat types, is critical for the management, conservation and restoration of biodiversity. Previous studies have found that the geographical distribution of a population is affected by various factors, including the environmental and biological traits of the species.

One aspect of distribution that is rarely studied is the "aggregation potential" of a species. In 1961, ecologist Lionel Roy Taylor proposed that when the mean density of a population (*M*) increases, the population will be more aggregated in fewer places (higher variance *V*). He quantified and formulated this relationship as $V = aM^b$, which is known as Taylor's power law. The exponent *b* in Taylor's power law represents the aggregation potential – how the spatial variance (*V*) varies with a unit change in the mean density (*M*) of a population. For two species living in the same place, the species with a larger *b* will distribute more unevenly when its population size increases than the species with a smaller *b*.

What factors may cause the differences in the aggregation potential of a species? Previous theatrical studies have predicted that *b* is related to the life history traits of a species, such as the average body size, fecundity, maturation age, etc. For example, a species with a small body size and high fecundity may be able to produce a large number of offspring, but the offspring cannot travel far in a short time. Therefore, it is predicted that when the density of this species increases, it will distribute less evenly as most of the newborns will aggregate in a few places. However, empirical evidence for such a theory has been lacking.



Using 50-year survey data from the California Current ecosystem, Professor Chih-hao Hsieh, his student Ting-Chun Kuo and colleagues provided the first evidence that the life history traits of a species affect its aggregation potential (*Kuo, Mandal, Yamauchi, & Hsieh*, 2016). The authors calculated the aggregation potential (Taylor's exponent *b*) for 29 marine fish species in the California Current ecosystem and found that unexploited species with smaller size and generation time exhibit larger *b*, supporting the theoretical predictions. In contrast, this relationship is much weaker in species that have been fishery targets, indicating that exploited species have a higher aggregation potential than unexploited species with similar traits. The reason may be that fishing has degraded the size/age structure of the targeted species by selecting larger and older individuals; therefore, these exploited species perform more like species with smaller body size and lower fecundity. This research was published in the journal *Ecology*.

For the purposes of fisheries management, this finding indicates that once the size structure of an overfished population is altered and its aggregation potential has increased, the population will be more aggregated even when the population size bounces back. Consequently, the population's risk of extinction will increase since it tends to distribute in fewer places.

In addition to the changes in spatial pattern that were found in this study, species that suffer from size/age truncation (the average age or size of the population decreases because larger/older individuals are removed) have also been found to have lower population growth rate and be more sensitive to environmental changes. The reason is that larger, older individuals usually have better reproductive abilities: they can produce more and higher-quality eggs, and their offspring have higher survival rates. Once those "experienced" individuals become fewer, the growth rate of the population may become unstable and easily affected by environmental disturbances. The findings of this study indicate that once age/size truncation occurs, the population will become more vulnerable to environmental disturbance not only because of the fluctuation in population size over time but also because its uneven spatial distribution increases its extinction risk. The results of this study emphasize that fisheries managers must pay attention to the effects of fishing on the size and age structure and the spatial distribution of marine species.

Reference

Kuo, T., Mandal, S., Yamauchi, A., and Hsieh, C. (2015). Life history traits and exploitation affect the spatial mean-variance relationship in fish abundance. *Ecology, 97*(5), 1251–1259. DOI:10.1890/15-1270

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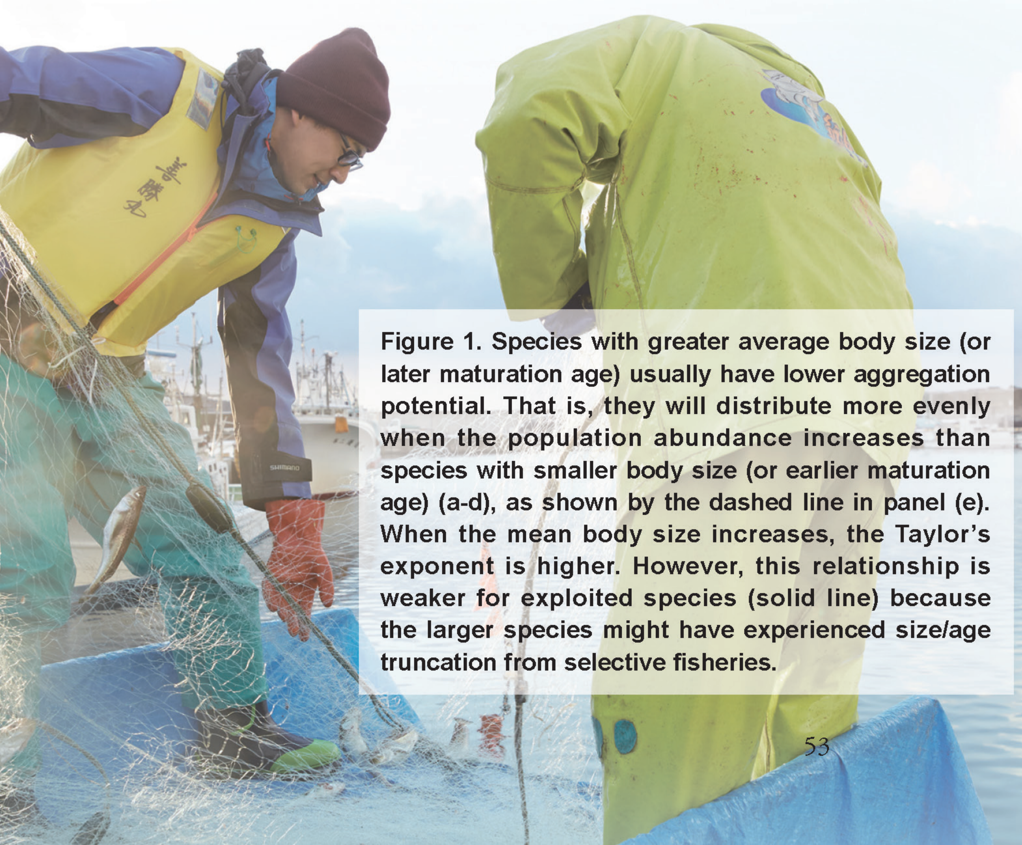

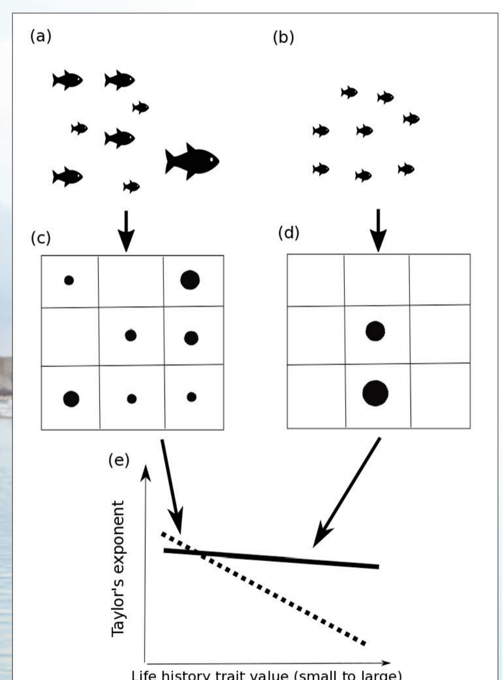

Figure 1. Species with greater average body size (or later maturation age) usually have lower aggregation potential. That is, they will distribute more evenly when the population abundance increases than species with smaller body size (or earlier maturation age) (a-d), as shown by the dashed line in panel (e). When the mean body size increases, the Taylor's exponent is higher. However, this relationship is weaker for exploited species (solid line) because the larger species might have experienced size/age truncation from selective fisheries.