Summary
Ecological systems are subject to random phenomena. In the Trondheim collaboration, we computed the effects of harvesting and competition in the population synchrony scale. These results provide new tools for a better management of harvesting and conservation. This collaboration continues now in the framework of the SUSTAIN Norwegian project for the sustainable management of terrestrial, freshwater, and marine ecosystems. In the Bergen collaboration, we have address the size and nutrient scaling of phytoplankton, and their relations to their internal traits. These results describe phytoplankton composition, and will be relevant to understand the dynamics of fisheries resources. Also in this collaboration we have studied the parasite infection risk of salmon at different situations. These results will help reduce the parasite infection risk of farm and wild salmon. This second collaboration is now in search for new funding to continue research.

Population synchrony scale
Populations fluctuations are synchronized over a certain distance $l$. This correlation scale, in many cases, is given by the correlation scale of the environmental fluctuations $l_e$ (Moran effect [1]), and it is increased in the presence of migration [2]

$$ l^2 = l_e^2 + \frac{m^2}{r} $$

Thus, the population synchrony scale $l$ increases when the growth $r$ is smaller, and when migration is stronger (due to a greater fraction of population involved in migration $m$, or to longer migration distances $l_m$).

Effect of the harvesting
We show in Ref. [3] that constantly harvesting a fraction $\beta$ of a species increases its population synchrony scale to

$$ l^2 = l_e^2 + \frac{m^2}{r - \beta} $$

Effects of competition
Competition generally increases the population synchrony scale of on species, whereas it decreases it for the other species. Thus, in general, competition enhances differences in population synchrony scales [3].

Phytoplankton scaling
We obtained the following relation for the phytoplankton size as a function of the nutrient concentration

$$ r(\mu m) = 0.036 S^{0.86}(\text{molecules } \mu m^{-3}). $$

We also expect from uptake data that the number of porters (entrance points of nutrients) scales with size as

$$ n = 338 r^{1.56}(\mu m), $$

and the handling time inverted by a Porter with each nutrient as

$$ h(r) = 1.90 \times 10^{-3} r^{0.90}(\mu m). $$

(See Ref. [4], where we used the model previously derived in Ref. [5])

Cost model
We shown that an effective porter cost of

$$ V_{\text{cost}}(\text{molecules s}^{-1}) = 1.81 n^{1.64}, $$

in the uptake rate, implies the previous scaling of the number of porters with size.

Implications for fisheries resources
Phytoplankton is a key source of nutrients for the marine food chain, and fisheries are mainly located in phytoplankton rich areas. Our results provide tools for a deeper understanding of phytoplankton composition and dynamics, and their implications for fisheries.

Salmon parasite model
We shown that there is an optimal salmon speed which minimizes the parasite infection risk [5].

Implications for salmon management
This information provides clues for optimal situations of salmon farms in the appropriate fjord currents to reduce salmon parasite infection.

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