# Popular science summary of the PhD thesis

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| Title of the PhD thesis | Vertical migration: Structure and function of pelagic ecosystems |
| PhD school/Department | DTU Aqua |

## Science summary

My PhD project entitled “Vertical migration: Structure and function of pelagic ecosystems” deals with the diel vertical migrations of organisms in the water column. Diel vertical migration is the daily movement of marine organisms (zooplankton, fish…) between the surface of the oceans and deeper waters. Zooplankton typically reside at depths during daytime to avoid predation from visual organisms (there is more light close to the surface) and migrate to the surface at night to feed on small phytoplankton. Fish and other organisms feeding on zooplankton follow their prey and also migrate to the surface.

While this may be conceptually simple, the optimal migration pattern of each organism depends on the environmental conditions and on the migration patterns of all other organisms – prey, predators and conspecifics – through feedbacks that are hard to understand. The goal of my PhD was to develop a method taking explicitly these feedbacks into account to compute the optimal DVM patterns of all organisms of a food-web. The method relies on game theory, where each organism is seen as a player trying to optimise its fitness (a measure of how well it is doing) considering the behaviour of all other organisms.

This method allowed me to model and reproduce observed interlinked patterns of multiple organisms, for example the non-linear size-dependent diel vertical migration patterns of zooplankton in the California current and the reverse (day at the surface and night at depth) migration patterns of a small copepod in an American fjord.

I also modelled a pelagic community (from mesozooplankton to mesopelagic fish and large pelagic fish) and predicted their global vertical distribution. The prediction matched well the scattered observations available. I used this to examine the effect of diel vertical migrations on the global carbon cycle. By feeding close to the surface during day, and respiring and excreting fecal pellets at depth during night, organisms actively transport carbon to the depths, participating in reducing atmospheric $CO_2$ concentrations (a process called the active biological pump). I found that on a global scale, forage fish and especially mesopelagic fish are more important contributors to carbon sequestration than previously assumed. I argue that fish should be more systematically considered in global marine carbon cycle assessments than currently.