# WP4

## Environmental impacts of new operational regimes

This work package will investigate the interdependencies between abiotic factors and major ecosystem services provided by reservoirs, using fish as indicator species for ecological status. The ecological effects of pumped storage regimes will likely vary depending on reservoir morphology, geographical variation in climate, catchment properties and species composition. By combining hydrodynamic and ecological models along a range of reservoir types, general predictions valid beyond short-term case studies will be possible. Work package 4 includes:

- Comparison of ecological communities exposed to various operational regimes
- Analysis of correlations between environmental factors across a range of reservoir types
- Modelling of hydrodynamics for selected reservoirs covering various reservoir types
- Combining results of the ecological model and hydrodynamic modelling and deduct guidelines for mitigation

**Task 4.1 – Modelling ecological consequences along environmental gradients**

The aim is to answer how typical regulation patterns impact reservoir ecology along common reservoir types and environmental gradients. This will be achieved by modelling fish communities exposed to a variety of present-day changes water level regimes, including natural lakes. Indicators of ecological condition will be abundance, population structure and habitat use of main fish species, available from NINA's database covering several hundred lakes and reservoirs across Norway. This will be expanded with data from other consortium members, before ecological conditions are modelled as a function of species composition, lake productivity, climate, lake morphology, recruitment conditions and operational regimes. While alterations in fish abundance reflects long-term disturbance, a more immediate response can be seen in the food web. Therefore, as a supplement to the database, we will include field sampling in 10-15 reservoirs, where gill nets are combined with hydro-acoustic and stable isotope analyses of fish and their prey.

**Task 4.2 – Modelling hydrodynamic changes introduced by new operational regimes**

Assessment of abiotic factors of environmental impacts and linking these to the biological mechanisms studied in Task 4.1 will be accomplished by studying how changes in water level fluctuations, currents and water temperature affect the main factors shaping biological processes in reservoirs, i.e. nutrient level, stratification and erosion. The hydrodynamics will be modelled in selected lakes with various characteristics along gradients with biological significance identified in Task 4.1. Stratification as well as temperature, nutrient and sediment relationships will be modelled by use of the 2D-model CE-QUAL-W241 in most of the selected water bodies. In some cases, the 3D-model GEMSS42 will be used for more detailed analysis, including ice conditions and how the littoral zone changes in area. Effects on erosion, ice formation and stability as well as turbidity will be assessed.

**Task 4.3 – Mitigating ecological effects of new operational regimes**

By combining the findings from the ecological and hydrodynamic modelling it will be possible to predict how future operational regimes influence ecological communities. This will be done in selected reservoirs, based on the case studies in Task 4.1 and 4.2. These predictions will be used to identify mitigation measures. Further, the potential impacts of pumping warmer nutrient-rich water from reservoirs on low elevation to colder nutrient-poor mountain reservoirs, including the risk of species invasion, will be assessed. WP4 will be an essential step in recommending an environmental design of future reservoir operations.