03/2016

MARS fact sheet #06

MARS PROJECT
Managing Aquatic ecosystems and water Resources under multiple Stress

HyTEC: investigating the effects of pulse releases of water from hydropower on aquatic life

Hydropeaking and Thermopeaking

Hydropower plants often produce electricity in response to energy demands. This means that their energy production can be intermittent and changeable, which in turn causes pulse releases of water downstream into river systems. This causes rapid and short-term fluctuations in water speed, depth and quantity downstream – a process termed hydropeaking – which can affect the ecology and hydromorphology of the rivers exposed to such changeable and often unpredictable regimes. Fluctuations in water flow caused by releases from hydropower reservoirs can also alter the temperature of the river downstream – causing reductions in summer and increases in winter – a process termed thermopeaking. Hydropeaking and thermopeaking from hydropower releases are now widespread and common occurrences in many European mountain rivers and streams.

HyTEC experiments in the Austrian Alps

A team of researchers from the European Union MARS Project are carrying out ongoing experiments on the effects of hydropeaking and combinations of hydropeaking and thermopeaking on aquatic life at a facility known as HyTEC close to Lake Lunz in the Austrian Alps.

HyTEC site near Lake Lunz, Austria

The team have studied how algae, macroinvertebrate and fish populations are impacted by hydropower releases, using a series of experimental channels where variables such as water flow and temperature can be controlled and ecological responses monitored.

The effects of hydropeaking and nutrient addition on benthic algae growth

Benthic algae are a key component of aquatic food webs. They are useful indicators of stream water quality, and their short lifecycles mean that algae populations can provide ongoing, responsive records of environmental change. Frequent hydropeaking events can affect the growth of benthic algae and affect their community structures and ability to colonise new habitats. Algae can be washed away in floods, or left exposed in areas close to the shoreline drying up after a flood. The MARS team simulated hydropeaking events for one hour each day for a month in four experimental channels. One channel was kept as a control, one had nitrogen added, one had phosphorous added, and one had both phosphorous and nitrogen added. These nutrient additions were used to investigate the multiple stress effects of hydropeaking in stream ecosystems affected by nutrient pollution.

Antagonistic relationships between hydropeaking and nutrient addition

After a month, where no nutrients were added, algal growth was significantly higher in the channels with no hydro- or thermopeaking, compared to those where it was simulated. Where no hydro- or thermopeaking was simulated, algal growth was highest in the channels where phosphorous had been added. A shift in the assemblage was observed in these high growth channels from diatom-dominated to non-diatom algae (chlorphyta)-dominated.

However, where both hydro- and thermopeaks were simulated and nutrients were added, there were no significant differences in algal growth between the different channels. This means that one hour of hydro- and thermopeaking each day cancelled out any potential algal growth following nutrient addition, most likely because nutrient concentrations were diluted and washed away. This is termed an antagonistic relationship between stressors.

The effects of hydropeaking and thermopeaking on macroinvertebrate drifting

Macroinvertebrates are animals without a backbone that can be seen with the naked eye: taxa such as mayflies, beetles, caddisflies, dragonflies, worms and crustaceans. They are important links in the food web between producers (such as algae) and consumers (such as fish). Many macroinvertebrates are sensitive to water quality and so their populations provide excellent indicators for environmental change.

Some macroinvertebrate species 'drift' across and along a stream's course throughout their lifecycles, (re)colonising habitats. This drifting behaviour is increasingly recognised by scientists as an important process in shaping ecosystem structure and function in rivers and streams.

The MARS team used experimental channels to study how hydropeaking and thermopeaking affected drifting behaviour of marcoinvertebrate taxa, and how this behaviour differed during the day and during the night.

Drifting highest at night under hydropeaking and thermopeaking

The first results from their experiments indicate significant differences between macroinvertebrate drifting behaviour in response to hydropeaking, thermopeaking and time of day.

Drifting behaviour was highest where only hydropeaking was simulated, and was lower under combined hydropeaking-thermopeaking conditions. For both simulations, drifting behaviour was highest at night, and significantly higher than drifting behaviour of macroinvertebrates in the control experiments under normal conditions.

The team identified specific drifting traits for macroinvertebrate species. Those that were likely to drift tended to be swimming surface taxa with small body sizes and cased caddisflies. On the other hand, those less likely to drift were clinging or burrowing interstice taxa, with large body sizes and caseless caddisflies.

Initial results for ongoing research at HyTEC

This initial research from the HyTEC experiments has indicated that hydropeaking and thermopeaking have significant effects on the growth of benthic algae and on the drifting behaviour of macroinvertebrates in stream ecosystems.

The HyTEC experiments on hydropeaking continue, with ongoing research questions including: 1) whether macroinvertebrate drift behaviour effects juvenile fish populations; and 2) whether hydropeaking and thermopeaking affects the top-down control of macroinvertebrates on benthic algae.

Links

http://hydropeaking.boku.ac.at/hytec.htm

http://mars-project.eu/