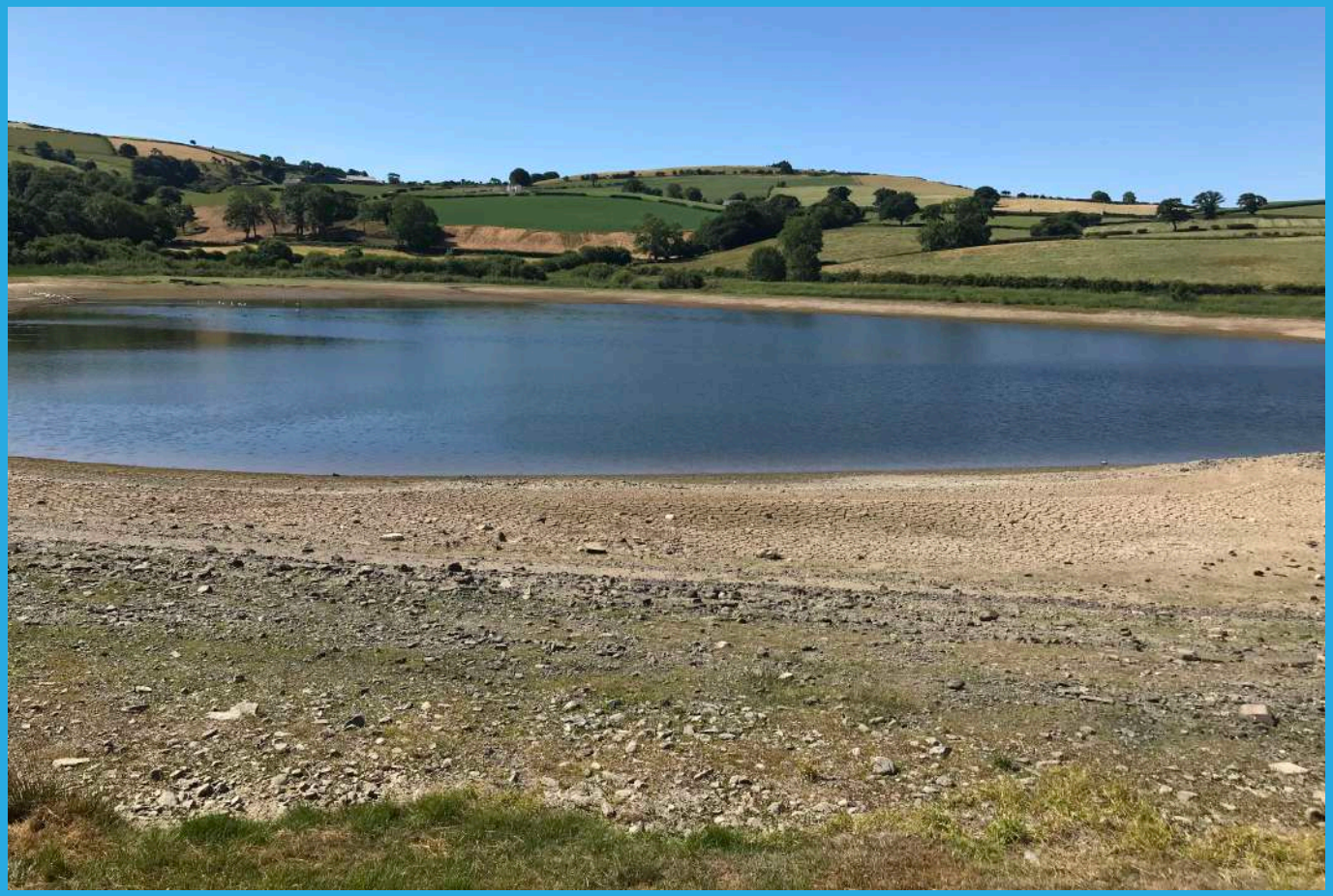
Drawing down the risk – protecting fish populations during reservoir drawdown



IFM Specialist Conference - Fish, Flows and Climate Resilience

Tom House – Freshwater Ecologist, Arup Manchester

ARUP

Introduction

The potential ecological risks of reservoir drawdown on downstream riverine habitat are well understood and there is growing awareness within the industry of the risks and ways to minimise ecological impacts.

Varying degrees of effort are afforded to assessing the adverse effects of drawdown on the reservoir ecosystem itself and access to connected fish habitat.

Periods of extended drawdown likely to increase in future as a result of climate change induced drought and planned maintenance/decommissioning of aging reservoir infrastructure (dams, spillways)

Drawdown has the potential to impact on fish populations directly and indirectly by altering the complex reservoir ecology (invertebrates, macrophytes, algae, zooplankton) upon which fish rely, through altered hydromorphological, physico-chemical conditions.

Contents

1. Increasing requirement for reservoir drawdown

2. What are the potential risks / impacts on reservoir ecology / fish?

3. How are the risks assessed and monitored? Legislative framework.

4. How can the risks to fish be minimised and monitored?

1. Periods or prolonged drawdown –set to increase?

Temporary drawdown for maintenance - aging infrastructure, stringent dam safety regulations = increased maintenance / repair works (e.g. spillway, dam structure)

Fish / eel pass construction

Permanent modification / decommissioning

- Ecological drive to remove dams to 'unlock' habitat and 'reconnect' our river systems
- Strong economic driver to reduce costs, many reservoir are out of service and so decommissioning/reduction likely to increase

Temporary drawdown in relation drought conditions / climate change

- Increasing water demand coupled with increased propensity for climate-related drought

ARUP

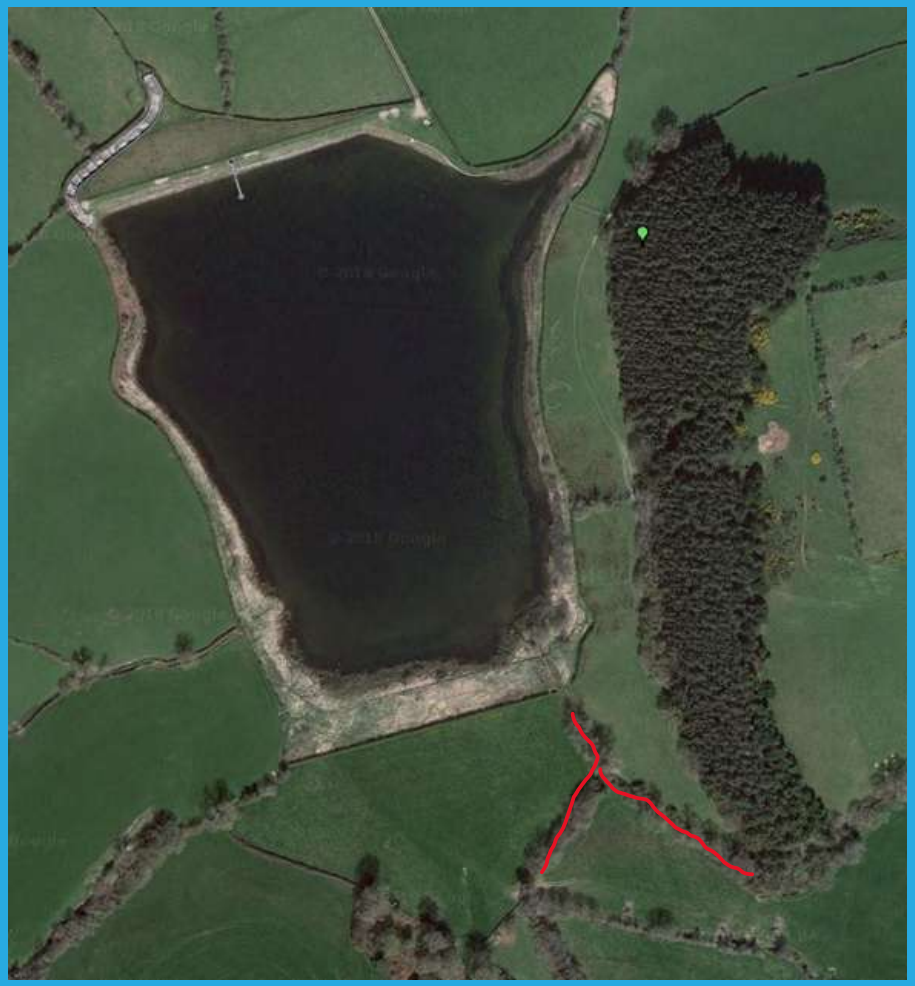
2. Potential risks / impacts

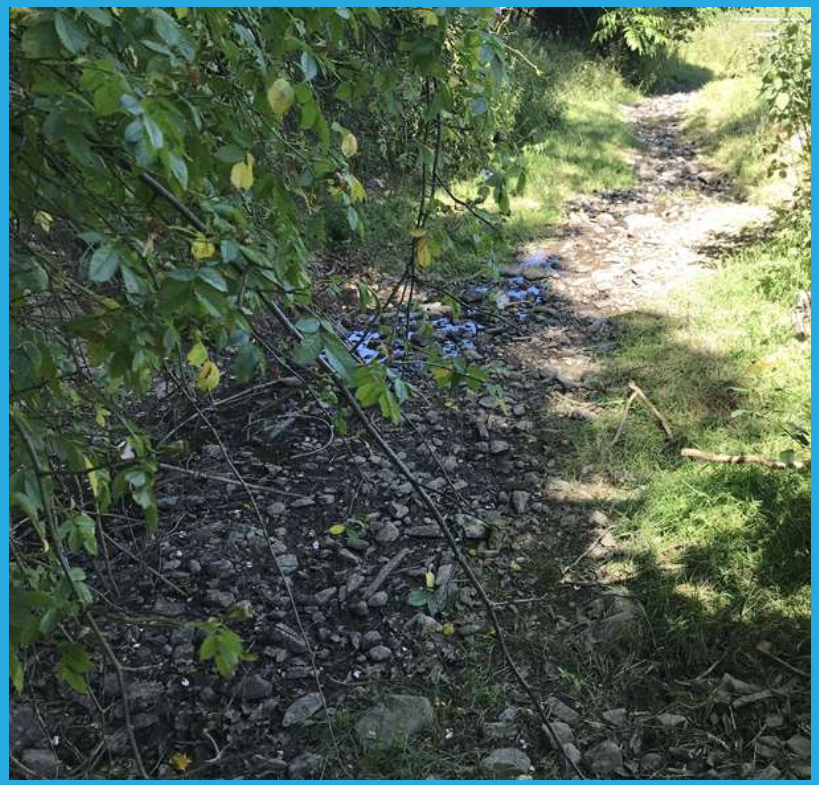
Access to tributaries and marginal reservoir habitat

- Many fish species living in reservoirs, including brown trout, are potamodromous, migrating into inflow streams during spawning season in response to changes in temperature, photoperiod, river flow.
- Tributaries and marginal area of the reservoir also offer optimal nursery habitat for juvenile.
- Access to spawning / nursery habitat can be restricted during periods of drawdown with potential impacts on recruitment.
- So what are the implications of disconnecting this habitat from the reservoir during drawdown? Will trout spawn in the reservoir? Are they that adaptable?
- Migration occurs on a variety of scales - tagging studies have tracked fish migrating large distances from reservoirs in lowland systems, but smaller often less obvious tributaries that feed upland reservoirs are also important too

ARUP

Impacts – habitat connectivity

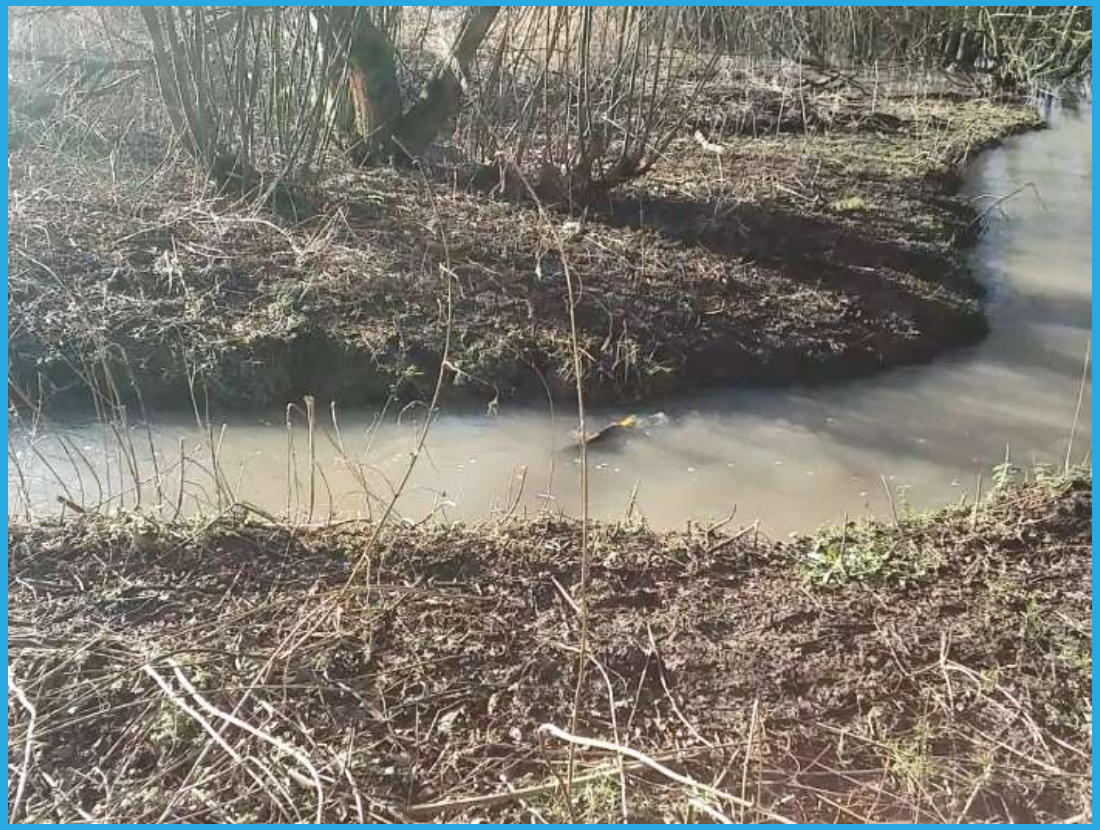




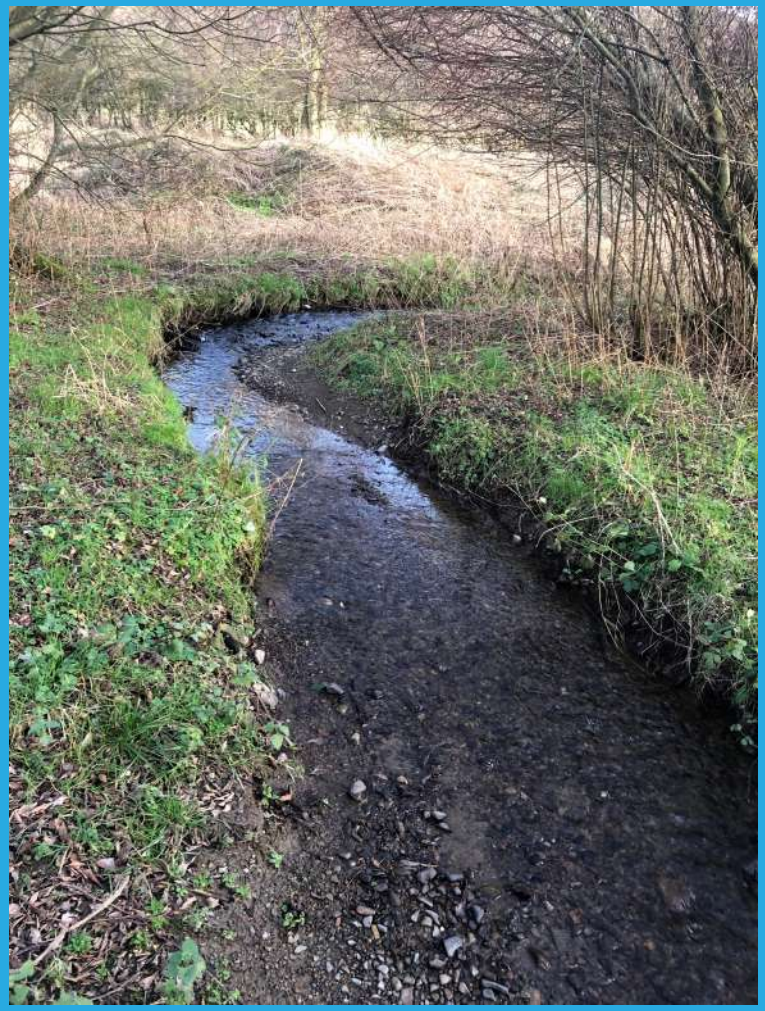
Ephemeral inflow stream

ARUP

Impacts – habitat connectivity



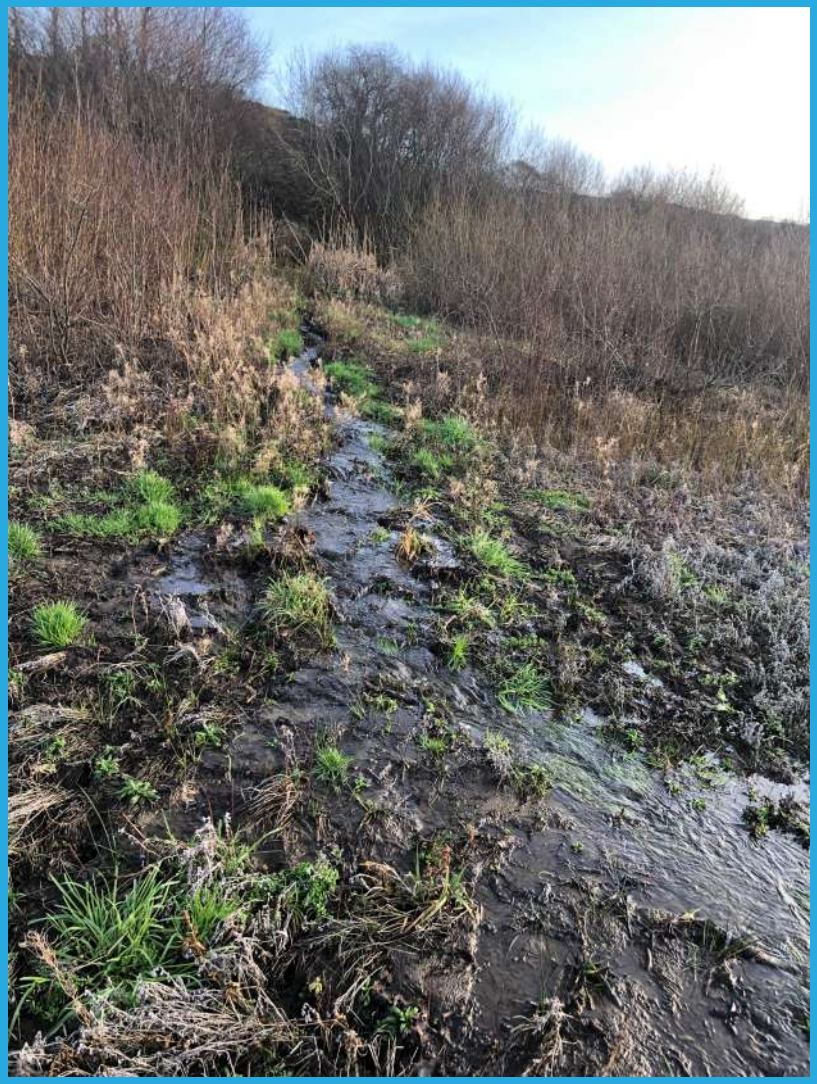
Winter flow



Summer flow

ARUP

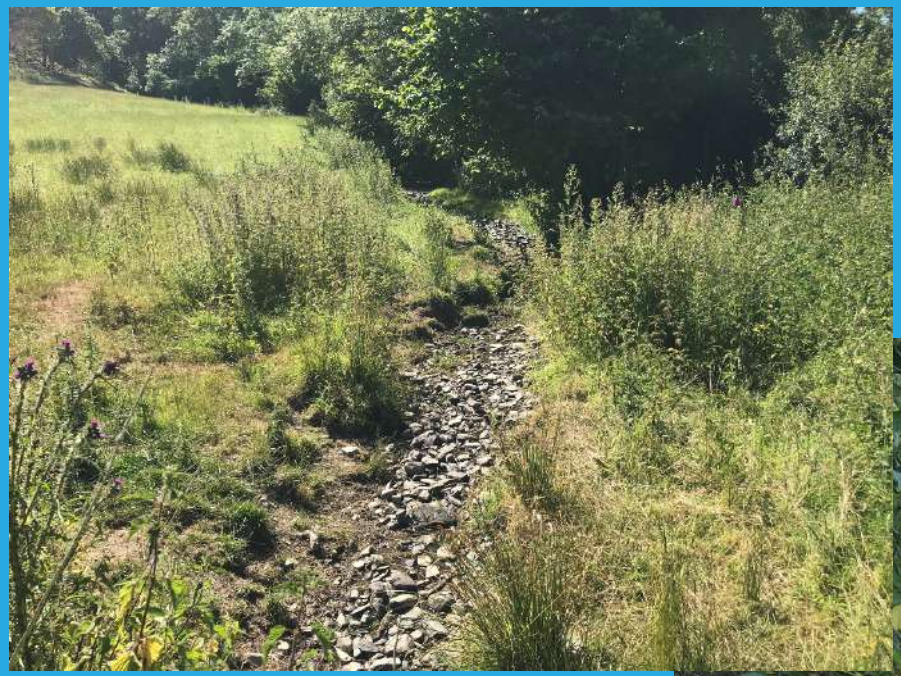
Impacts – habitat connectivity

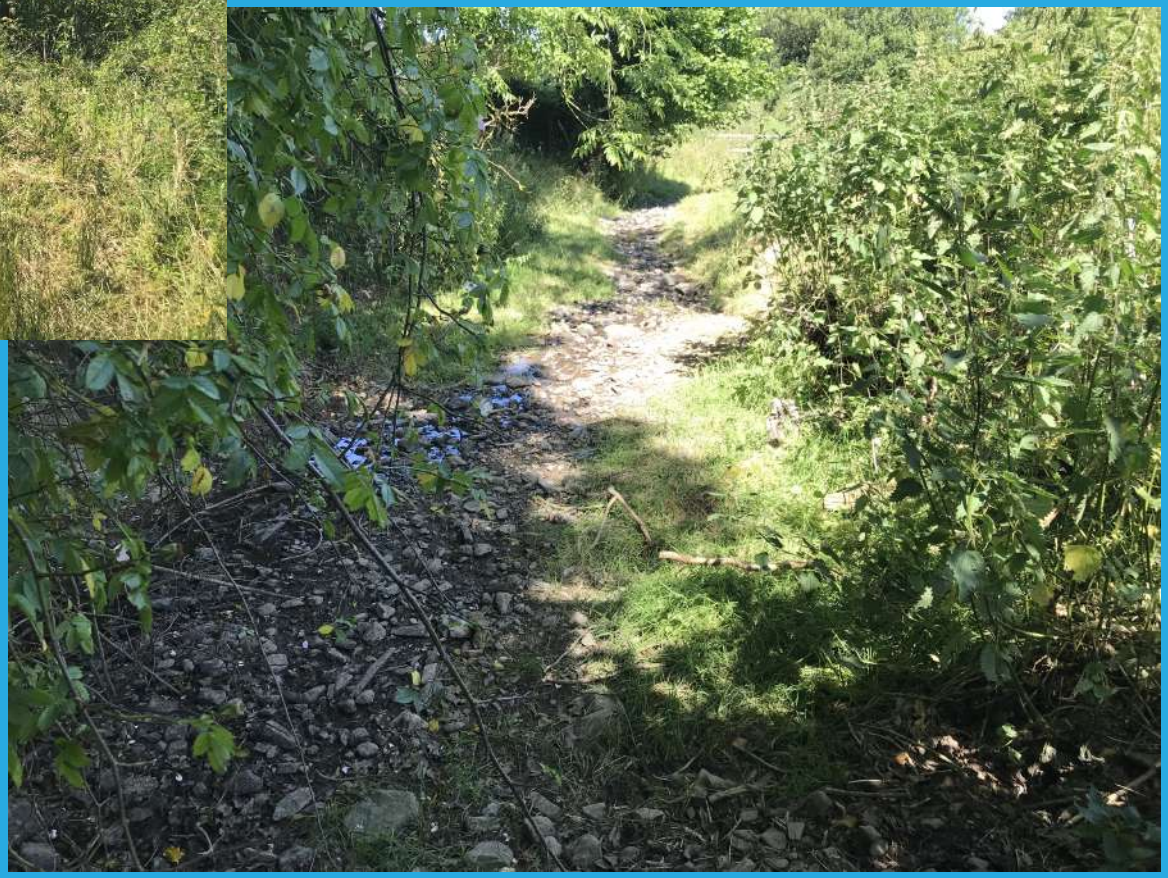


No access to gravel spawning substrate in stream, no defined channel

ARUP

Considerations – seasonal assessment



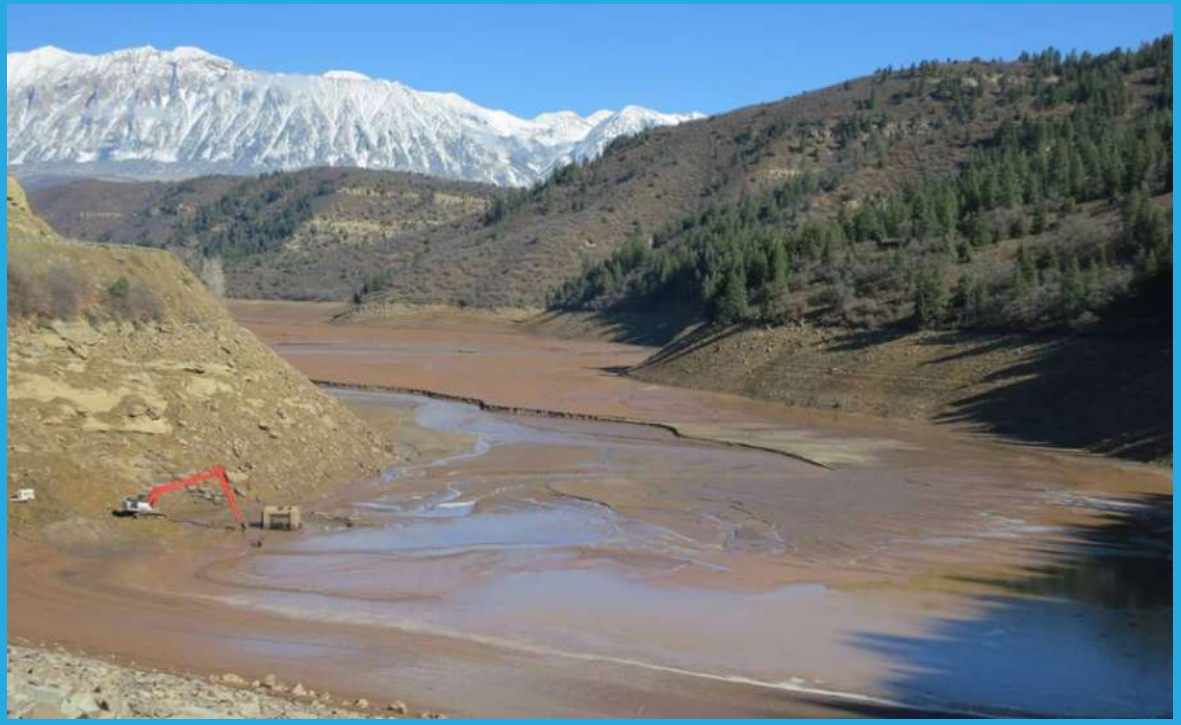


Not just river habitat - reduced access to marginal nursery habitat and cover – potential for increased predation

ARUP

Impacts – water quality

Water turbidity - resuspension of lake sediments and erosion of newly exposed substrate = increased turbidity affecting algae and zooplankton composition.



Water temperature – reduced volume of reservoir = quicker response to extreme conditions (cooling / warming), associated DO issues. Potential risk to salmonids in summer.

ARUP

Impacts – water quality

Increased nutrients – erosion of exposed lake sediments has the potential to release bound-up nutrients promoting the growth of filamentous and planktonic algae.

Dissolved oxygen – algal blooms have the potential to affect reservoir oxygen levels. Photosynthesis during the day = supersaturation, respiration at night causes oxygen crash.

ARUP

Impacts – food availability

Macroinvertebrate abundance – reduction / change in macroinvertebrate habitat has the potential to alter species composition and abundance.

Zooplankton and algae – changes in depth, light penetration and water quality as a result of drawdown will impact on the species composition and abundance. This can be very important in upland (nutrient poor) systems.

ARUP

3. How are the risks assessed and monitored? Complex legislative framework.

The level and type of assessment required to drawdown will depend upon the species/receptors present at the site and/or the site designation.

Habitats Directive - HRA

A number if reservoir sites within the UK are designated as “oligotrophic lake habitat”. Here the of a drawdown on the designated macrophyte assemblage will need to be assessed through a Habitat Regulations Assessment. Mitigation to protect qualifying plant species (such as a staged drawdown) will often have indirect befits for fish.

Water Framework Directive (WFD)

Typically the impacts of drawdown are assessed through the **(WFD)** compliance assessment process.

ARUP

WFD Assessment

Under the WFD, all proposed schemes with the potential to impact upon WFD-designated water bodies must be assessed to ensure:

- *no deterioration of the current status or potential of any WFD quality elements; and*
- *no prevention of future attainment of the 'good' status or potential objectives of any WFD quality elements.*

Typically a WFD assessment/screening would form an appendix to the consent application for the works.

WFD assessment should consider risk of deterioration on river waterbodies downstream of the reservoir also.

Drawdown of reservoirs on smaller rivers require an Ordinary Watercourse Consent (obtained through the Local Authority or Internal Drainage Board) or anon Main Rivers through Environmental Permit (obtained through the EA/NRW)

ARUP

WFD Assessment

Under WFD reservoirs are typically designated as:
Heavily modified lake waterbodies or *Artificial lake waterbodies*

Some reservoirs are not listed as discrete features and simply form part of a river waterbody. This can poses a change for the assessment.

Crucially WFD does not distinguish between natural lakes and Artificial / Heavily Modified waterbodies, and are classified/assessed using the same biological elements which are:

1.1.2. Lakes

Biological elements

Composition, abundance and biomass of phytoplankton

Composition and abundance of other aquatic flora

Composition and abundance of benthic invertebrate fauna

Composition, abundance and age structure of fish fauna

ARUP

Assessing the impacts – WFD Receptors

The assessment also needs to include the hydromorphological elements and physico-chemical elements supporting the biological elements.

Many of these have the potential to be affected by reservoir drawdown

Hydromorphological elements supporting the biological elements

- Hydrological regime
  - quantity and dynamics of water flow
  - residence time
  - connection to the groundwater body
- Morphological conditions
  - lake depth variation
  - quantity, structure and substrate of the lake bed
  - structure of the lake shore

Chemical and physico-chemical elements supporting the biological elements

General

- Transparency
- Thermal conditions
- Oxygenation conditions
- Salinity
- Acidification status
- Nutrient conditions

ARUP

When should a drawdown be subject to the WFD assessment process?

By definition reservoir levels fluctuates based on water demand and level of precipitation.

Ultimately the need for a WFD assessment should be agreed in consolation with the regulator as part of the consenting process, but things to consider include;

1. Fish species / stocking regime – a self sustaining population of wild brown trout should be afforded greater consideration that a stocked population.

2. Timing / season – prolonged drawdown in winter months where in a typical year reservoir levels would be higher needs greater consideration.

3. Scale of drawdown – how atypical is the drawdown compared with the typical reservoir regime? How long will the drawdown last?

ARUP

Monitoring impacts – blunt tools / no baseline

Monitoring impacts of drawdown on fish population quantitively is challenging.

No baseline -whilst fish is biological quality element for lakes and reservoirs, fish populations are rarely monitored as part of the WFD monitoring / classification process.

Ecological status of reservoirs are typically classified under WFD based on other receptors (e.g. phytoplankton or littoral invertebrates) and/or water quality (nutrient) sampling.

Monitoring impacts is challenging - greatest potential long-term impact to fish population is reduced recruitment. But techniques for assessing population structure quantitatively in reservoirs are limited. E.g. fyke netting, marginal seine netting, hydroacoustics offer limited scope to robustly assess impact of drawdown.

ARUP

How can the risks to fish be minimised?

Timing – drawdown can be timed to suit the species present. Winter drawdown for coarse fish species, summer drawdown for salmonids.

Baseline – baseline data can help to predict impacts.

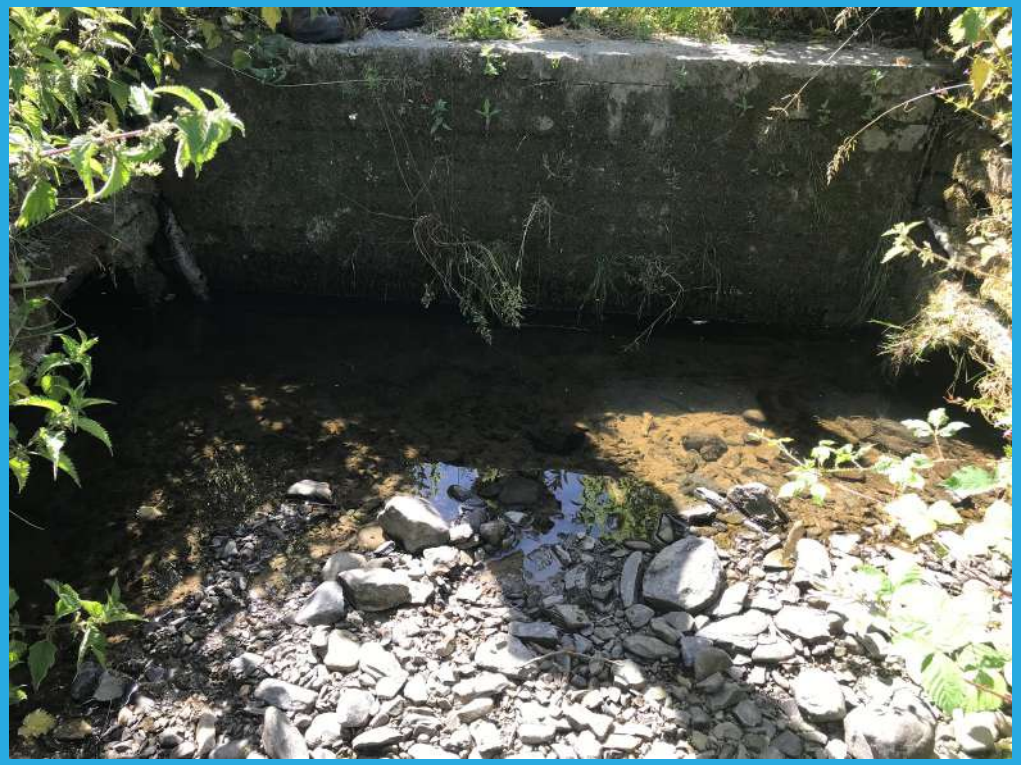
- Water quality – DO, nutrient, temperature stratification
- Algal sampling – Understanding the species present within the reservoir can help assess the risk of blooms. Different algal groups bloom at different times of the year.
- Sediment sampling – understand risks posed by mobilisation of exposed sediments.

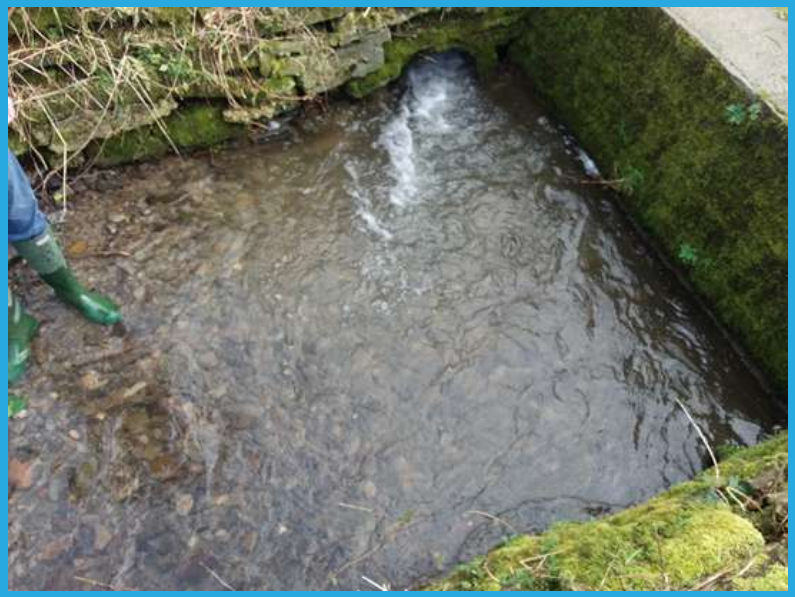
Bathymetry

- The extent and location sediment may allow the risks of exposed sediment becoming mobilised to be assessed.
- Bathymetric data can also be used calculate the depth and spatial extent of the remaining water allowing an assessment of the risk posed to fish to be made.

ARUP

Enhancement – habitat improvements





Thanks for listening….

ARUP