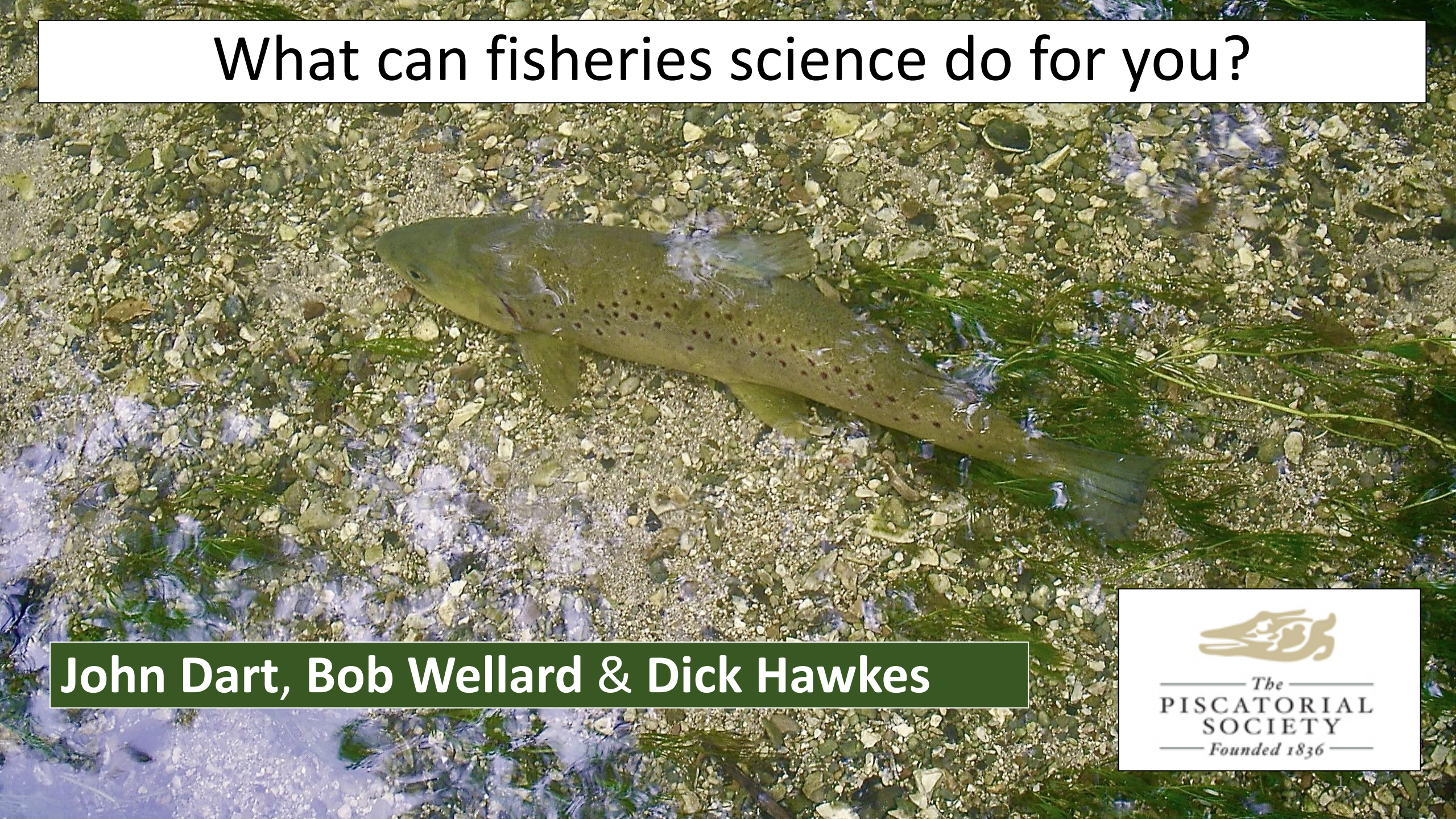
What can fisheries science do for you?



John Dart, Bob Wellard & Dick Hawkes

The PISCATORIAL SOCIETY
Founded 1836

AIMS

Focused on our **wild trout & grayling**

Fish biology & ecology: to improve fishing success

Fish protection: close season, biosecurity, catch & release

Environment optimisation: evaluating water quality and river maintenance

River restoration: causes of poor fisheries and the remedies

Preferred habitat and movement: trout vs grayling

- **Adults**: **grayling** prefer open water with a gravel bottom, avoiding heavy weed. **Trout** prefer more cover (undercut banks, tree roots and weed).
- **At dusk**: **grayling** move into shallower slower water to feed
- **Winter**: both move into deeper slower water in winter
- **Shoaling**: **grayling** (unlike trout) shoal with similar sized individuals
- **Migration:**
  - Both move little in good habitat like our chalk streams
  - Both may migrate distances to spawning gravels BUT grayling are less efficient than trout over barriers - a 40 cm weir permitted 36% of grayling vs 84% of trout

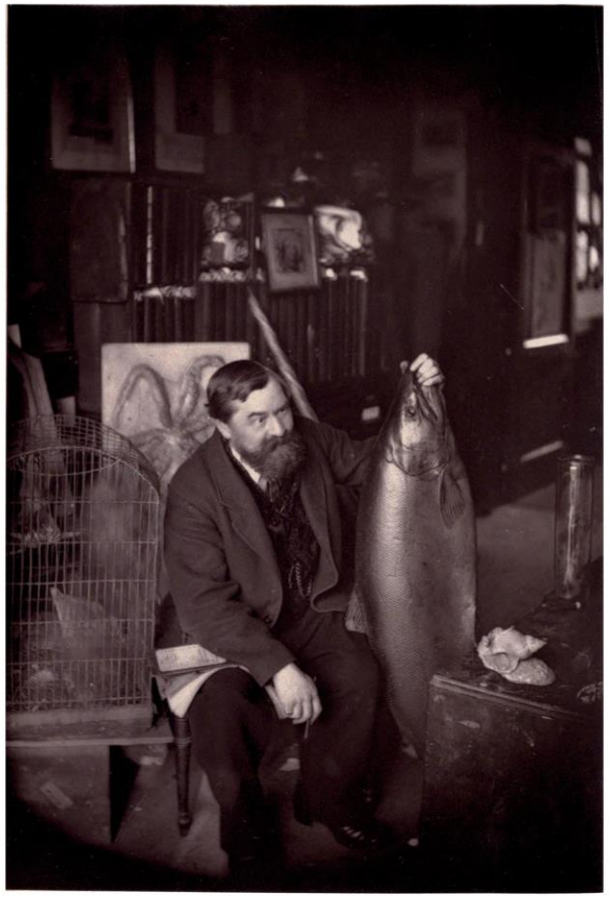
[Armstrong, Kemp et al. 2003, Lucas and Bubb 2005, Riley 2006, Kemp, Vowles et al. 2017, Cove, Taylor et al. 2018]

Preferred food: trout and grayling

- **Juveniles** all require small prey like chironomids and copepods
- **Both species are carnivorous** feeding on:
  - All life stages of aquatic flies: upwings, sedges, stoneflies, diptera (e.g. daddies &midges)
  - Crustaceans (gammarus, hoglice) & molluscs (snails, bivalves)
  - Worms: earth & freshwater (tubifex, leeches & flatworms)
- **Grayling feed less** than trout **on terrestrials** (ants, aphids, beetles)
- **Small trout** (2-years and 8-10 ins) **eat fish**, amphibians & crayfish
- **Both** eat what's available of their preferred foods: **"match the hatch/other food source" to catch more fish**

[Frost and Brown 1972, Cove, Taylor et al. 2018]

The close season legislation(England) passed in 1878: drafted by a scientist [& Pisc Soc member]



Wading over spawning grounds has severe effects on hatching trout eggs & probably grayling also [Roberts and White 1992]

Press release

Anglers reminded of start of 2024 coarse fishing close season

The Environment Agency is reminding anglers that the annual close season for coarse fishing is now in place.

From: Environment Agency
Published 15 March 2024

The Environment Agency is reminding anglers the 2024 coarse fishing close season gets underway today (Friday 15th March).

The spring and early summer months provide a period for freshwater fish such as dace, barbel and chub to spawn, allowing the fish to lay and fertilise their eggs. During this time, anglers are prohibited from fishing for these species in rivers, streams and drains, as well as some canals and stillwaters, so that breeding adults are given the chance to recover and thrive.

[Frost and Brown 1972, Cove, Taylor et al. 2018]

Trout: spawn **Nov-Jan** (earlier in North), **fry emerge from gravels in about April**
Grayling: spawn **Feb-Apr** (earlier in South), **fry emerge after 1-2 months in Mar (South), Jun (North)**

Biosecurity: avoid introducing non-native species

Avoid introducing non-native species & disease (freshwater)

Amongst those of top concern to EA: Killer shrimp & Topmouth gudgeon

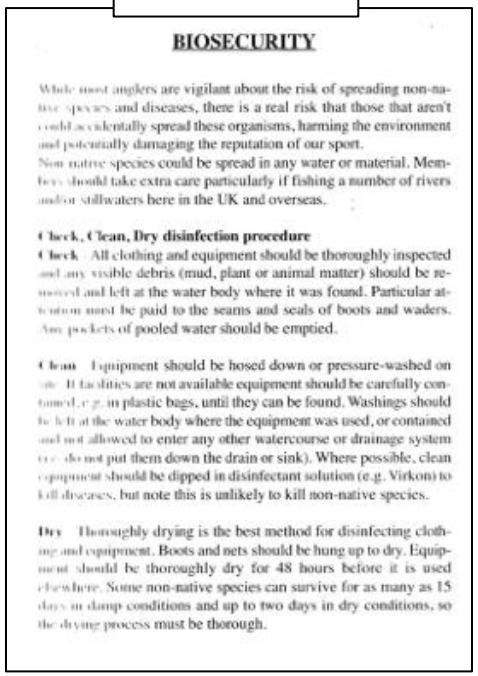
Probably best known to us: Signal crayfish (plague) & Himalayan Balsam

Signal

White-clawed

The Non-native species secretariat (NNSS) UK

Year Book



BIOSECURITY

While most anglers are vigilant about the risk of spreading non-native species and diseases, there is a real risk that those that aren't could accidentally spread these organisms, harming the environment and potentially damaging the reputation of our sport.
Non native species could be spread in any water or material. Members should take extra care particularly if fishing a number of rivers and/or stillwaters here in the UK and overseas.

Check, Clean, Dry disinfection procedure

Check All clothing and equipment should be thoroughly inspected and any visible debris (mud, plant or animal matter) should be removed and left at the water body where it was found. Particular attention must be paid to the seams and seals of boots and waders. Any pockets of pooled water should be emptied.

Clean Equipment should be hosed down or pressure-washed on site. If facilities are not available equipment should be carefully contained, e.g. in plastic bags, until they can be found. Washings should be left at the water body where the equipment was used, or contained and not allowed to enter any other watercourse or drainage system (i.e. do not put them down the drain or sink). Where possible, clean equipment should be dipped in disinfectant solution (e.g. Virkon) to kill diseases, but note this is unlikely to kill non-native species.

Dry Thoroughly drying is the best method for disinfecting clothing and equipment. Boots and nets should be hung up to dry. Equipment should be thoroughly dry for 48 hours before it is used elsewhere. Some non-native species can survive for as many as 15 days in damp conditions and up to two days in dry conditions, so the drying process must be thorough.

Optimum catch & release: what do studies tell us?

Mortality of C&R

- Grayling: little available for arctic grayling 4-5% probably irrelevant
- Brown trout (3 studies): about 8% (+/- 4%)
- Rainbow trout: maybe much worse at 25%
  - Larger fish probably higher mortality
  - High water temperatures exacerbate as do longer handling times and air exposure

Sublethal effects

- In 6-30% of trout, with eye injuries in 10%

Optimum catch & release: 6 points to remember

1. Barbless hooks

2. Knotless rubber nets

3. Keep fish in water

4. <**10 secs only** out of water
>10 secs = measurable effect
>120 secs = higher mortality

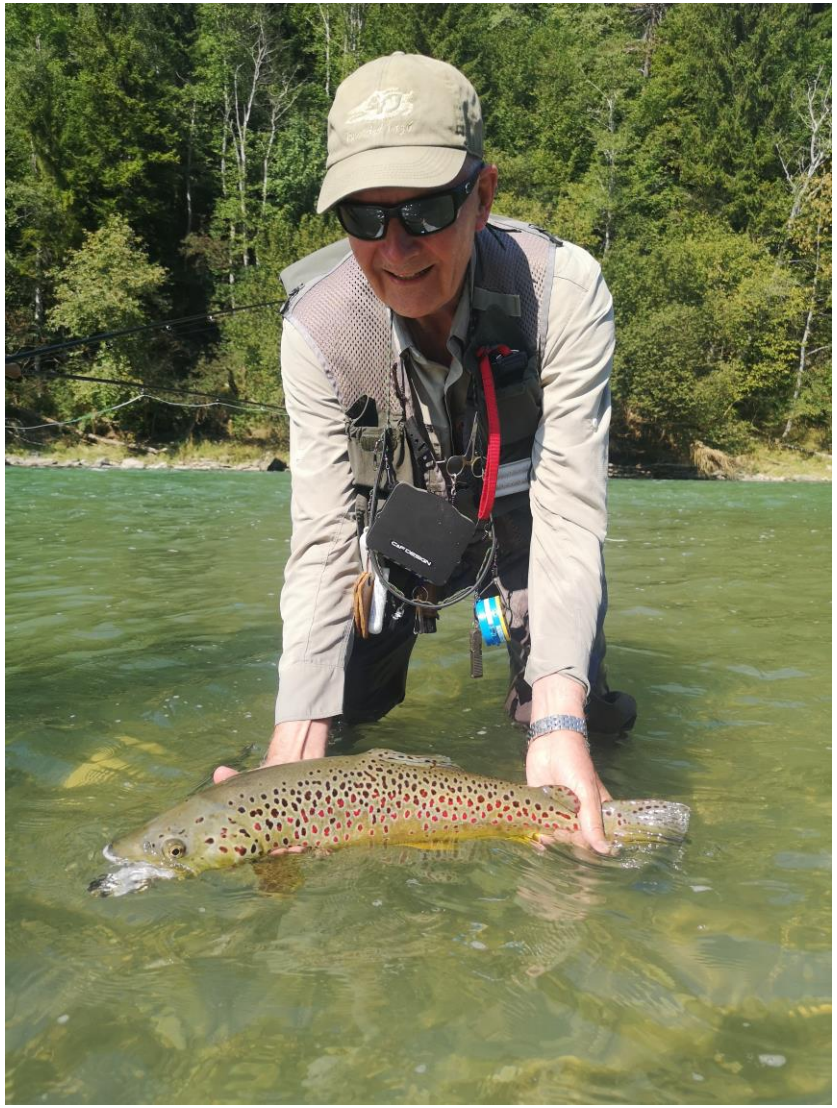
5. Keep hands wet

6. Recover fish on release

Optimum catch & release: available guidelines

Good guidelines are available from:

- Wild Trout Trust website https://www.wildtrout.org/
- Keep Fish Wet website: https://www.keepfishwet.org/
  - Minimise air exposure
  - Eliminate contact with dry surfaces
  - Reduce handling time



[Lennox, Cooke et al. 2017, Pinder, Harrison et al. 2019, Taylor and White 1992, Meka 2004, Bartholomew and Bohnsack 2005, Cooke and Suski 2005, Arlinghaus, Cooke et al. 2007, Lennox, Cooke et al. 2017, Pinder, Harrison et al. 2019]

Optimising habitat: **water quality problems**

- **Domestic animal flea treatments**: fipronil & imidacloprid (a **neonicotinoid** very toxic to insects (1 treat enough to kill 60 million bees). **Farming use**: EU banned but UK permits use for sugar beet
  - Now found in most of our rivers. 24 agencies calling for a ban: Rivers Trust, Wildlife trusts, some Vet organisations. **Write to your MP**
- **Sewage farm overflows**: Contribute to Anglers Trust & Surfers against Sewage campaign
- **Farm and industrial drains, leaking septic tanks**

What can we do? REPORT **AND** Measure

Optimising habitat: **reporting problems**

REPORT pollution

Hotlines: **EA & SEPA** 0800 80 70 60 **Wales** 0300 65 3000

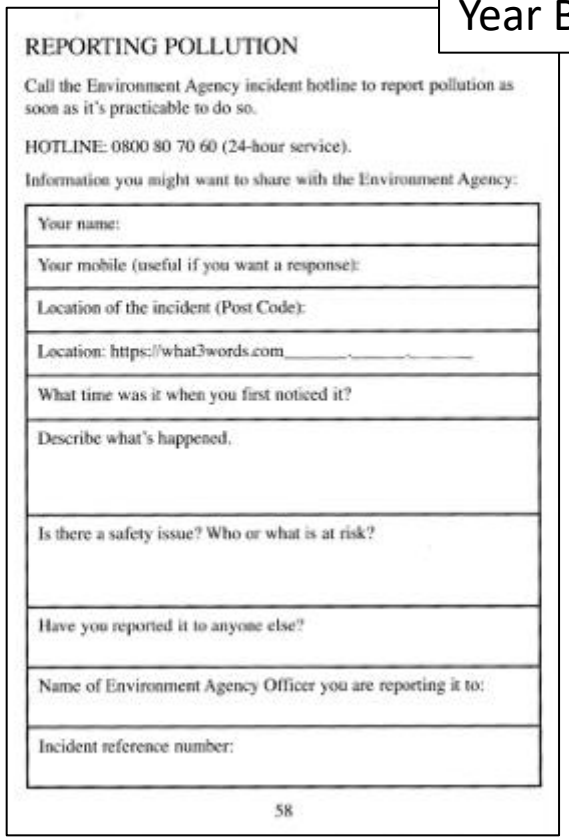
Describe the location verbally or better:

What3words location or **Grid Reference**

"Locate me" on the OS Maps App or **online** at gridreferencefinder.com

- What is/was happening?
- Who is/was responsible for the incident?
- When did the incident take place?

Year Book



REPORTING POLLUTION

Call the Environment Agency incident hotline to report pollution as soon as it's practicable to do so.

HOTLINE: 0800 80 70 60 (24-hour service).

Information you might want to share with the Environment Agency:

Your name:
Your mobile (useful if you want a response):
Location of the incident (Post Code):
Location: https://what3words.com/_____._____._____
What time was it when you first noticed it?
Describe what's happened.
Is there a safety issue? Who or what is at risk?
Have you reported it to anyone else?
Name of Environment Agency Officer you are reporting it to:
Incident reference number:

58

Optimising habitat

MEASURE pollution

WATER QUALITY TESTING measures

Physical: temp, siltation/turbidity

- **High sediment levels** (agriculture & industry) destroy spawning sites & bind toxic chemicals

Chemical: pH, dissolved oxygen

- **Pesticides** (usually only specialized testing)

Biological: bacteria & nutrients (phosphate & nitrate)

- **Phosphorous:** main source of over nutrification leads to choking algal growth, reduced dissolved O_2, & toxins (blue-green algae)
- **Organic enrichment** wastewater & farm runoff depletes oxygen as its degraded by bacteria

Flow: low flow (e.g. drought, abstraction, weirs) enhances pollution & sediment deposits

Three methods are in use

Test kits: **intermittent** water testing

Angling Trust water quality monitoring kit

- Phosphates
- Nitrates
- Temperature
- pH
- Turbidity
- Ammonia
- Electrical Conductivity: anions (chloride, nitrate, sulphate) and cations

Spot sampling will miss short term severe pollution events

- Cost about £100 for monthly sampling
- For citizen science
- Results not accepted by regulatory bodies

BUT raises public and regulatory awareness

Not pesticides or flow

Sondes: continuous simultaneous remote testing

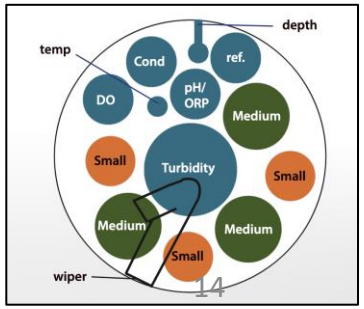
11-13 sensors in one instrument

- **Chemical O_2 demand**: capacity to oxidise ammonia & nitrate (urine)
- **Biological O_2 demand**: bacterial oxygen needed to breakdown
- **Dissolved oxygen**
- **Turbidity** & **Total dissolved solids**
- **Tryptophan**: total bacterial load
- **Most chemicals of interest**
- **pH**
- **Temperature**

Cost about 15K

- Solar powered data transmitted to a remote receiver
- Real time monitoring
- In theory 6 monthly servicing & calibration
- **In practice a device used in an EA trial on our waters only worked 60% of the time**

Not pesticides or flow



Invertebrate monitoring: continuous testing

Invertebrates are affected by different types of pollution: both in the short and long term

Using known sensitivities monitoring can measure:

- **Chemical**: unidentified chemical pollution
- **Siltation**: high sediment levels
- **Phosphorous**: over nutrification
- **Organic enrichment:** wastewater & farm runoff
- **Flow:** low flows

Developed in the UK used internationally

EA & EU: a Water Framework Directive tool

UK citizen science networks:

The Riverfly Partnership — 104 catchments

WildFish SmartRivers — 122 rivers

How indicator invertebrates are used to measure pollutants

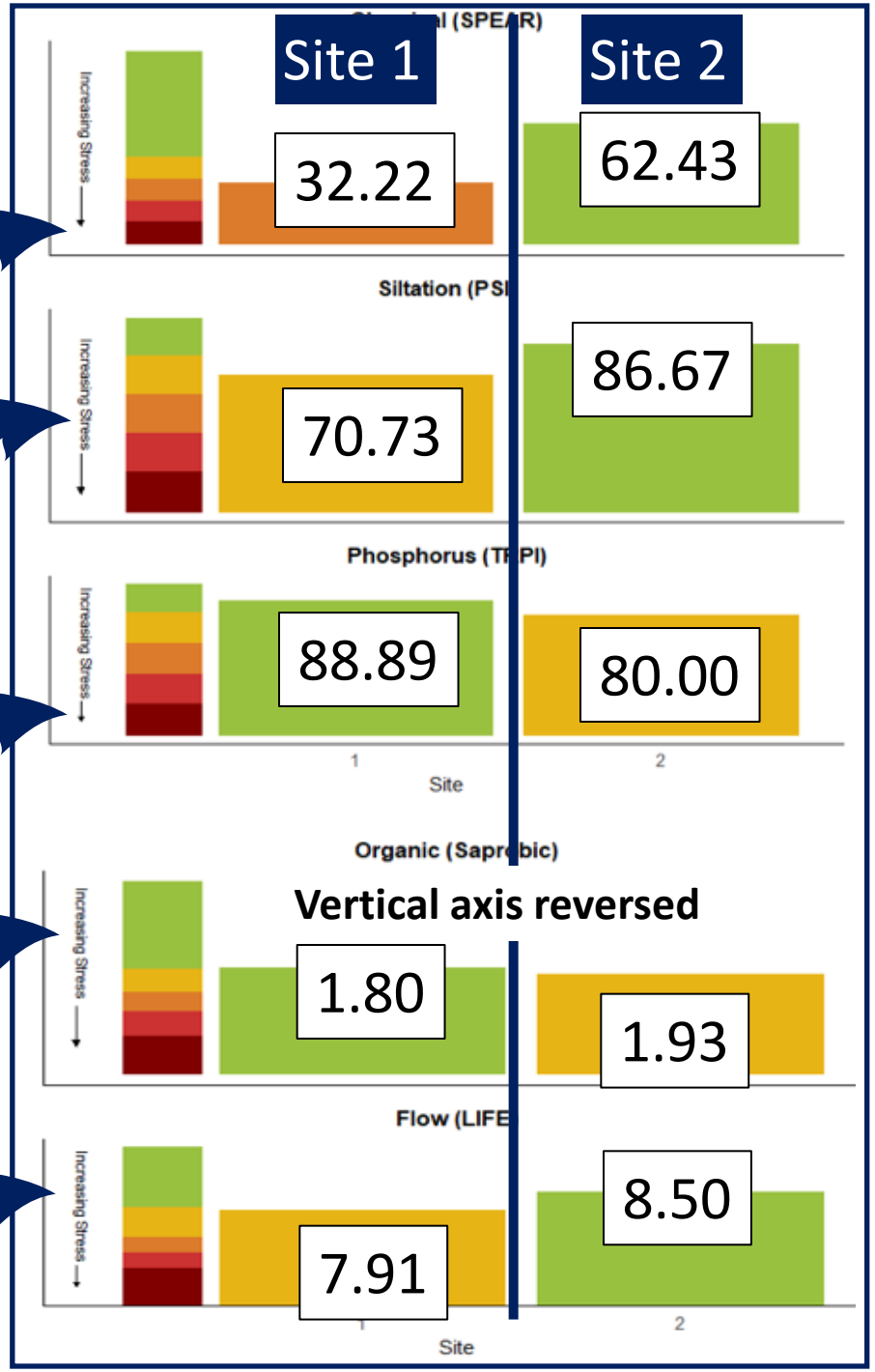
- **Chemical**: the **SPEAR** index [**SPE**cies at **R**isk from pesticides] typically **EPT** species. **E**phemeroptera or upwings, **P**lecoptera or stoneflies and **T**ricoptera or caddis flies/sedges).
- **Siltation**: the **PSI** index (**P**roportion of **S**ediment-sensitive **I**nvertebrates) e.g. **EPT** species & damselflies.
- **Phosphorous**: the **TRP Index** (**T**otal **R**eactive **P**hosphorus **I**ndex) species sensitive to nutrient load e.g. **EPT** & Gammarus.
- **Organic**: the **Saprobic** index - organisms feeding on or tolerant to dead organic matter - worms, midge larvae, leeches, snails & mussels).
- **Flow:** the **LIFE** index (**L**otic **I**nvertebrate **F**low **E**valuation). Lotic species live in flowing water e.g. **EPT** species & Gammarus.

How are the samples taken: a standardized method

The RIVPACS (River Invertebrate Prediction & Classification System) technique:
3 min kick-sampling & 1 min hand search

How to interpret the results

- **Chemical pollution**: (SPEAR index) **A low score is bad** ideally >45
- **Siltation**: (PSI Index) **A low score is bad** ideally >80 and of concern <61.
- **Phosphorous**: (TRPI) **A low score is bad** ideally >80
- **Organic**: (Saprobic index) **A high score is bad** ideally <1.8
- **Flow**: (LIFE index) **A low score is bad** ideally >8



SmartRivers water quality scores

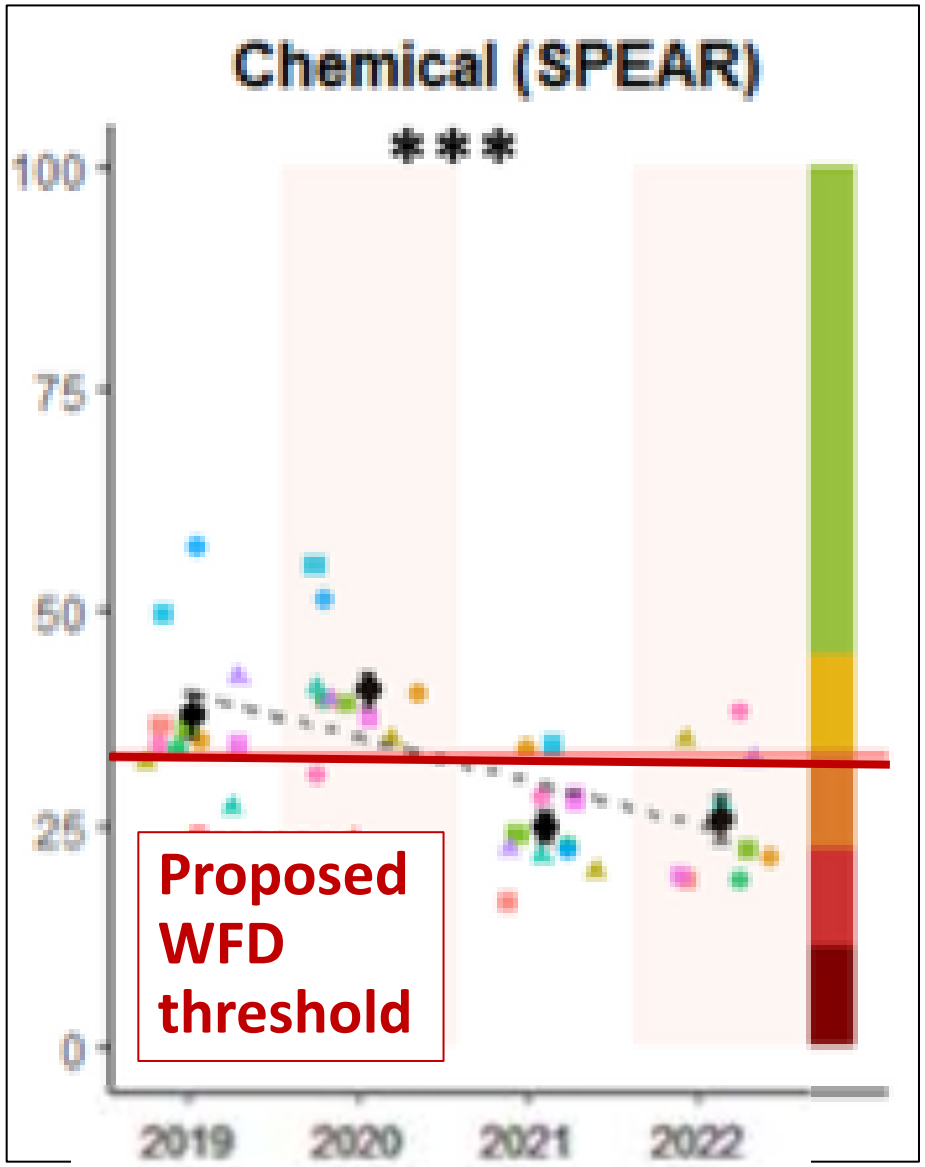
Site 1: Goodworth Clatford

Site 2: Fullerton

Spring 2024

Scores	Site 1	Site 2
PSI	70.73	86.67
TRPI	88.89	80.00
SPEAR	32.22	62.43
Saprobic	1.80	1.93
LIFE	7.91	8.50

SmartRivers Avon 5-year water quality analysis trends



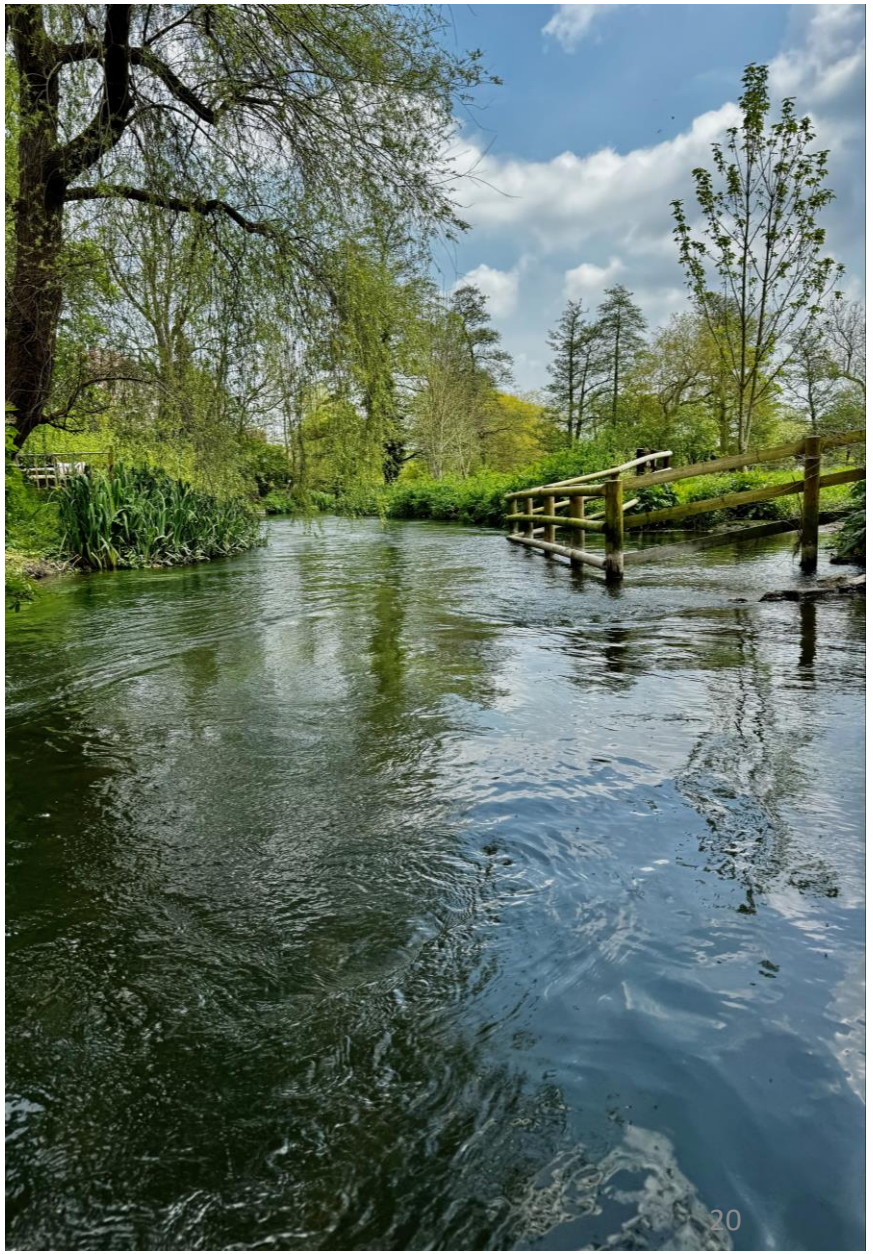
- Chalk Pit
- Compton
- Ham Hatches
- Kingfisher Mill
- Little Durnford
- Moor Hatches
- Netheravon (Lower)
- Netheravon (Upper)
- Queensbury Bridge
- Stonehenge
- Stratford Bridge

Chemical impact
Measured by SPEAR: using upwings, stoneflies & sedges as indicators

Habitat problem management: fencing

Fencing banks off from livestock reduces:

- Faecal pollution
- Over-widening from erosion
- Protects bankside vegetation from grazing



Tree & fishing bank maintenance

Both trees and bankside vegetation provide shade, food, refuges from predators [including fishers]

Ideally only fish one bank & keep trees on sections of non-fishing bank

Limited & intelligent weed cutting

Sanctuary areas

For trout: weed, bankside vegetation & woody debris are expected to provide more fish to catch (when feeding)!

For grayling: don't prefer cover (unlike trout) - reduce fishing pressure by limiting access - retain high bankside vegetation in places & fish only one bank

Retain in-river trees (large woody debris)

Increases flow at apex:

Scours gravels deeply at apex, cleans spawning sites below

Silt trap behind

Both increase habitat complexity **ALSO**

- A predator refuge
- Substrate for insects and plants
- Good evidence base
- Cheap to do

Predator control

Otter diet: wild salmonids 10-20% crayfish & bullhead replacing eels

Mink diet: largely birds & mammals

Pike diet: prefer cyprinids. Trout catches were little impacted by pike culling and pike numbers were not reduced – we stopped in 2010.

Cormorants: a problem since moving inland in 1980's. In Denmark (not UK) trout & grayling badly depleted in some rivers

Saw toothed ducks may be a problem.

NOTE: otters & birds are protected

Pike [Britton, Pegg et al. 2006, Grant and Harrington 2015, Britton, Berry et al. 2017, Moorhouse-Gann, Kean et al. 2020, Mann 1985], Mink [Jacobsen 2005, Harper, Watson et al. 2020] Cormorants [Jepsen, Ravn et al. 2018]

Hydrogeology: the effects of past river modifications

Straightening and dredging (for drainage & flood prevention):

- removes substrate – the gravels needed for spawning
- creates a uniform bed

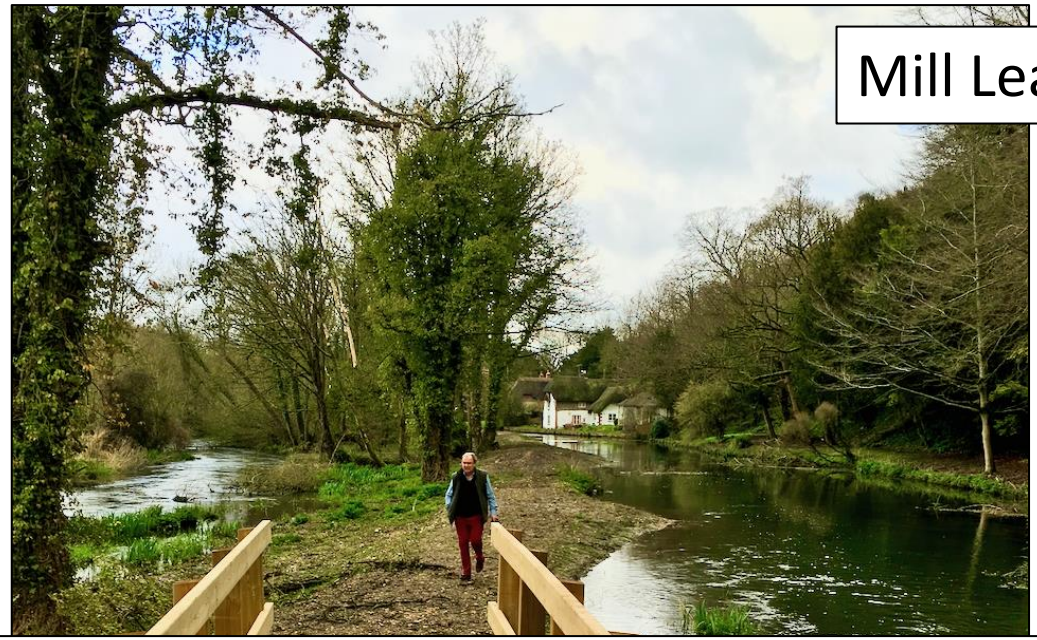
Resulting in:

- linear flows NOT the diverse flow rates needed to optimise habitat for fish, macrophytes and invertebrates
- deeper, less oxygenated water during low flow period and washouts in high flow periods

Hatches and bank raising effects (for industrial/agricultural purposes): create impoundments & low flow, promoting siltation

All are detrimental to salmonids

Straightened and dredged



Mill Leat

Avon true river channel (L) & elevated leat (R)

Weir & hatches: obstruct fish passage & reduce upriver flow - increasing siltation

Hydrogeology problems: reversal as part of large-scale fishery restorations

- Avoid during the breeding & spawning seasons
- Create or enhance suitable spawning gravels for trout and grayling
- Provide a diverse “mosaic” of habitat to provide environment for all life stages (sun, shade, fast riffles, slow flow areas, variable depth and refuges)
- Increase flows promoting natural scouring & macrophyte growth are usually optimal for trout but not for grayling
- Introduce large woody debris for food and predator protection.
- Retain backwaters for insects & other fish (minnows, roach & perch)

Large scale restoration examples

- Overwide degraded channel managed by introducing whole trees
- Shows clean gravel in pinched segments and silt trap below trees resulting in a more complex habitat

Large scale restorations

2021

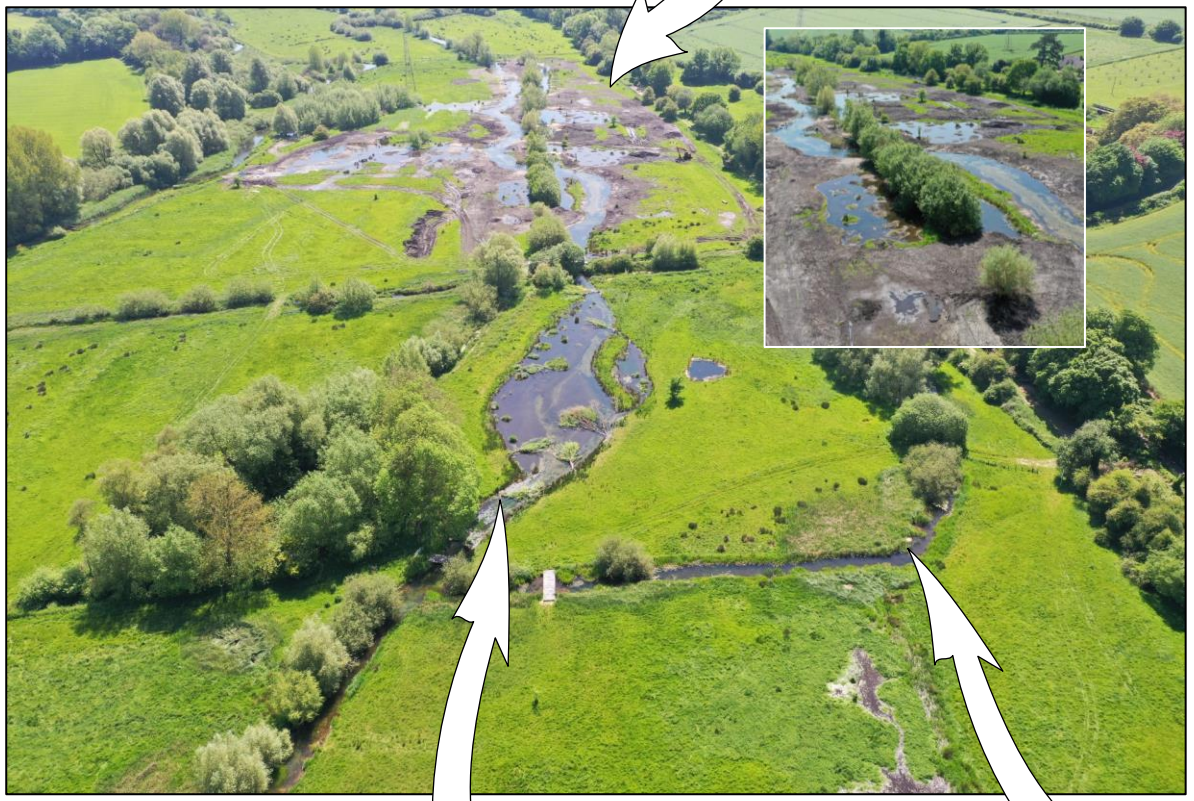
Straight carrier

Main river

Dog leg carrier

Straight carrier replaced by meanders & a wetland

2022-24



New wetland

Dog leg carrier retained as a backwater

There are very few studies on the effects chalk stream restorations: **do these restorations work?**

We have part-funded a PhD, now in her last year, doing a before and after impact study on our Anton restoration.

Some aims:

- What is the salmonid response to the “light touch” restoration (our large tree insertion)
- Which restoration features can provide thermal buffering against rising water temperature
- How are the new channels colonized by fish and invertebrates
- Does increased habitat diversity increase invertebrate biodiversity

2 more PhD’s funded by the Test and Itchen Catchment partnership will study the effects of the next phases of the restoration

SUMMING UP

- Some biology to improve your fishing & protect the fish
- How to report, identify & evaluate water quality problems
- Rationale for our fishery maintenance and restoration

With clean, cold, fast flowing water our fish do well

BUT we have challenges:

- **Water quality**: agriculture, agrichemicals, pesticides & pharmaceuticals - **pressure government using our data**
- **Climate change**: increasing water temperatures, flooding and drought - **we can mitigate this with our fishery management**

References for Hordern talk

Slide 3 Preferred habitat

- (Armstrong, Kemp et al. 2003, Lucas and Bubb 2005, Riley 2006, Kemp, Vowles et al. 2017, Cove, Taylor et al. 2018)

Slide 4 Preferred food, breeding periods:

- (Frost and Brown 1972, Cove, Taylor et al. 2018)

Slide 5 Wading over redds and spawning

- (Roberts and White 1992) (Frost and Brown 1972, Cove, Taylor et al. 2018)

Slide 7-9 Catch and Release

- (Lennox, Cooke et al. 2017, Pinder, Harrison et al. 2019,Taylor and White 1992, Meka 2004, Bartholomew and Bohnsack 2005, Cooke and Suski 2005, Arlinghaus, Cooke et al. 2007, Lennox, Cooke et al. 2017, Pinder, Harrison et al. 2019 and my notes on the "Effects of fishing pressure on trout and grayling" in the Website Library, Scientific papers section

Slide 12 on veterinary treatments: https://theriverstrust.org/about-us/news/flea-mergency-pet-treatments-taking-a-bite-out-of-the-health-of-englands-rivers

Slides 16-20 Invertebrate monitoring

- (Chadd and Extence 2004, Water_Framework_Directive_United_Kingdom_Technical_Group 2021, Murray-Bligh and Griffiths 2022, Humbert, Kuehne et al. 2023) and the Riverfly partnership website and my notes in the Website Library, Scientific papers section

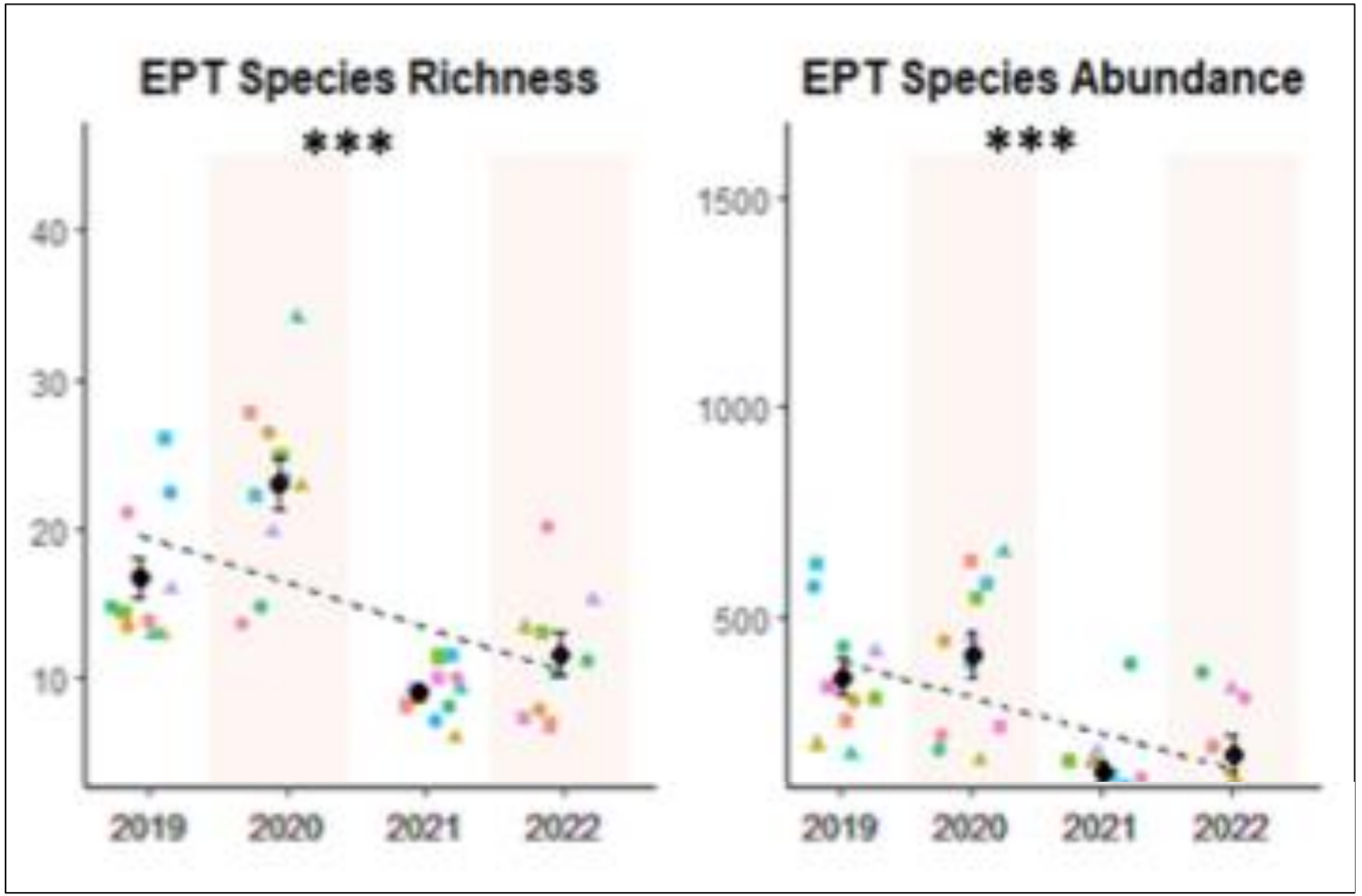
Slide 26 Woody Debris

- (Burgess and Bider 1980, Gurnell, Gregory et al. 1995, Riley and Fausch 1995, Culp, Scrimgeour et al. 1996, Hilderbrand, Lemly et al. 1998, Urabe and Nakano 1998, Flebbe 1999, Philip and Quinn 2001, Lehane, Giller et al. 2002, Neumann and Wildman 2002, Zika and Peter 2002, Stewart, Bayliss et al. 2006, Sweka and Hartman 2006, Niles 2010, Newson, Sear et al. 2012, Enefalk, Watz et al. 2017, Sievers, Hale et al. 2017) and my notes in the Website Library, Scientific papers section

Slide 27 Slides on predators

- Pike (Britton, Pegg et al. 2006, Grant and Harrington 2015, Britton, Berry et al. 2017, Moorhouse-Gann, Kean et al. 2020, Piscatorial Soc pike study 1980-1985: Mann 1985
- Mink (Jacobsen 2005, Harper, Watson et al. 2020)
- Cormorants (Jepsen, Ravn et al. 2018) The BTO website: https://www.bto.org/understanding-birds/birdfacts/cormorant

SmartRivers Avon 5-year water quality trends 2019-2022



SHOWS: significant** declines in species diversity & abundance since 2020 after an upturn from 2019-20

Chalk pit, Moor hatches & Kingfisher Mill are the best sites

Example of a key:

Invertebrates affected by UK river pollution incidents

With their sensitivities to different types of pollution

Organism size

For most taxa there is a considerable range in length; however, individuals at the top end of the scales will be encountered rarely.

Pollution tolerance key

1 Very tolerant
2 Tolerant
3 Average sensitivity
4 Sensitive
5 Very sensitive

Insecta: Mayfly larva

- Most water bodies
- Actively swims/darting motion
- Three thread-like tails
- Obvious gills

4 Oil
5 Pesticide
5 Organic
5 Ammonia

- Mostly in rivers with good water quality
- Very high value to anglers

Insecta: Stonefly larva

- Fast flow
- Crawls or darting motion
- Two thread-like tails

4 Oil
5 Pesticide
5 Organic
5 Ammonia

- In rivers with very good water quality
- High value to anglers

Insecta: Cased Caddis larva

- Most water bodies
- Crawls or swims, dragging case
- Sand/gravel cases often attached to surfaces

4 Oil
5 Pesticide
5 Organic
4 Ammonia

- Generally in rivers with good water quality
- High value to anglers

Insecta: Caseless Caddis larva

- Most water bodies
- Crawls or wriggles
- May have tufts of gills

3 Oil
5 Pesticide
4 Organic
4 Ammonia

- Generally in rivers with good water quality
- High value to anglers

Crustacea: Freshwater shrimp

- Most water bodies
- Active swimmer
- Flattened from side to side
- Orange colour when moribund or dead

4 Oil
5 Pesticide
3 Organic
4 Ammonia

- In waters of moderate to good quality
- High value to anglers

Insecta: Damselfly and dragonfly larva

- Slow flow
- Crawls or laboured swimming
- Large eyes – three spines or plates at tail

4 Oil
5 Pesticide
4 Organic
5 Ammonia

- In waters of moderate to good quality
- Moderate value to anglers

Crustacea: Water hog louse

- Most water bodies
- Crawls
- Looks like a wood louse

3 Oil
5 Pesticide
2 Organic
4 Ammonia

- In waters of bad to good quality. Numbers increase with organic enrichment
- Low value to anglers

Sites

1: Compton

2: Netheravon (Upper)

3: Netheravon (Lower)

4: Durrington

5: Stonehenge

6: Queensbury Bridge

7: Ham Hatches

8: Moor Hatches

9: Chalk Pit

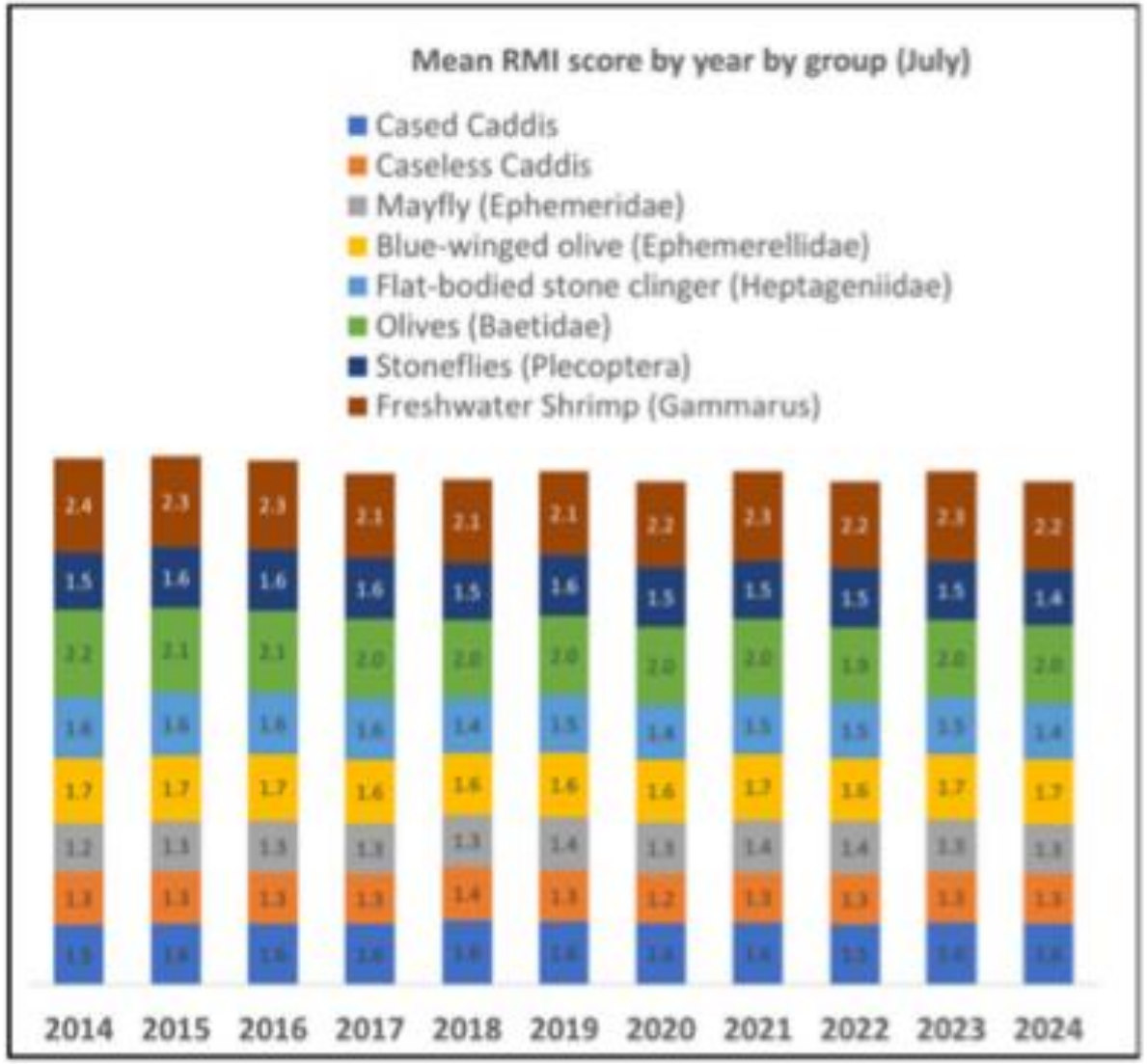
10: Kingfisher Mill

11: Little Durnford

12: Stratford Bridge

Riverfly monitoring initiative (RMI)

Identifies 8 taxa only: 7 EPT + Gammarus



High RMI scores

Team	River	Site	RMI score
Cressbrook & Litton Fly Fishing Club	Wye (Derbyshire)	Locked Bridge	19
Torridge ARMI Group	Torridge	Haytown Bridge	19

Trigger level scores

Team	River	Site	NGR	Trigger level	RMI score
Tees Rivers Trust ARMI	Alwent Beck	A2	NZ 14994 18150	4	1
Bristol Avon Rivers Trust	Chew Stoke Stream	Chew Stoke Waterfall	ST 54480 61440	8	7
Surrey Wildlife Trust	Gatwick Stream	Gatwick 1 D/S Tinsley Green Road Bridge	TQ 29135 39826	3	1
SDNPA Meon ARMI	Meon	Meon Springs Fisheries	SU 64951 21791	5	4

Indices of whole river health from invertebrate monitoring

- **BMWP** (Biological Monitoring Working Party) scores each invertebrate family from 1-10 depending on pollution tolerance, summed to give a total score.
- **BMWP NTAXA** (**N**umber of scoring **TAXA**) divides BWMP value by the number of scoring taxa
- **CCI** (**C**ommunity **C**onservation **I**ndex) includes both sample diversity & the species rarity. Good water quality sites can score lower if the conservation value is poor
- **WHPT** (**W**alley **H**awkes **P**aisley **T**rigg Index): used by EA, SmartRivers & *Extended* Riverfly to variable extent
  - Uses 33 taxa with classified to species level with abundance: typical readout is >100 species.
- **WHPT ASPT** (**A**verage **S**core **P**er **T**axon): a summary metric indicating richness & rarity - it's the WHPT score divided by the number of families sampled

Scores	Site 1	Site 2
PSI	70.73	86.67
TRPI	88.89	80.00
SPEAR	32.22	62.43
Saprobic	1.80	1.93
LIFE	7.91	8.50
BMWP	132.00	170.00
CCI	8.86	17.25
NTAXA (BMWP)	22.00	23.00
WHPT	134.00	179.20
WHPT ASPT	6.09	7.47

[Chadd & Extence 2004, Murray Bight & Griffiths 2022, Humbert, Kuehne et al 2023, Water_Framework_Directive_UK_Technical_Group] SmartRivers, Riverfly partnership]