



Cefas R&D on non-native freshwater fishes to inform policy: pathways, dispersal, impacts, risk analysis and detection

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Research to inform policy



Why non-native species ?

Non-native species (NNS) are recognised as a potential major threat to native species, ecosystem function and ecosystem services

To address the risks posed by NNS, Defra requires:

- Tools to identify invasive species and assess the risks of entry, establishment, dispersal & impacts
- Evidence on pathways, establishment processes and impacts to inform NNS risk assessments & policy advice to Defra (+ other UK & EU bodies)

Research to inform policy

Invasion risks under current and future climates



Research in
Invasion Biology

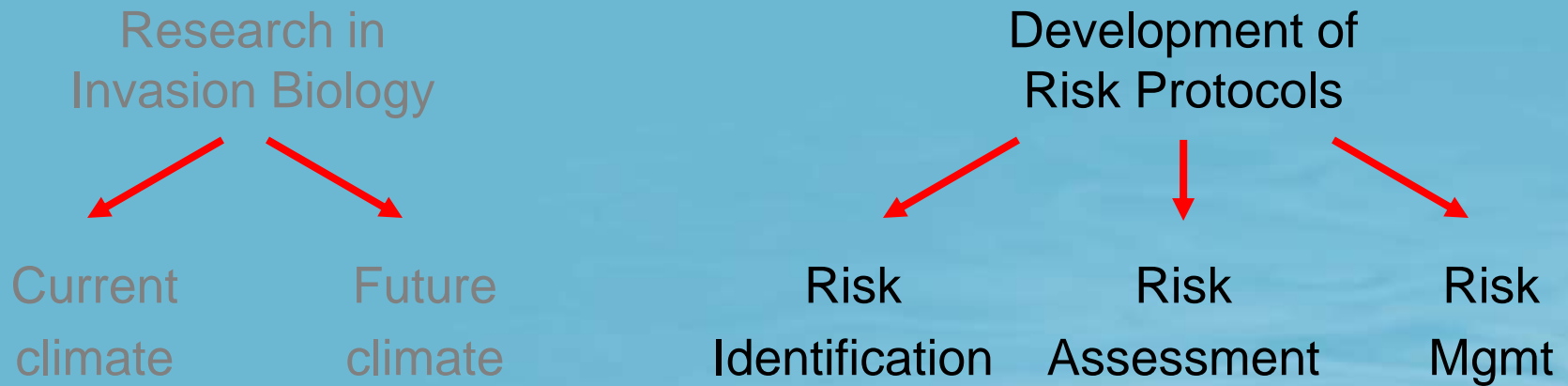


Current
climate

Future
climate

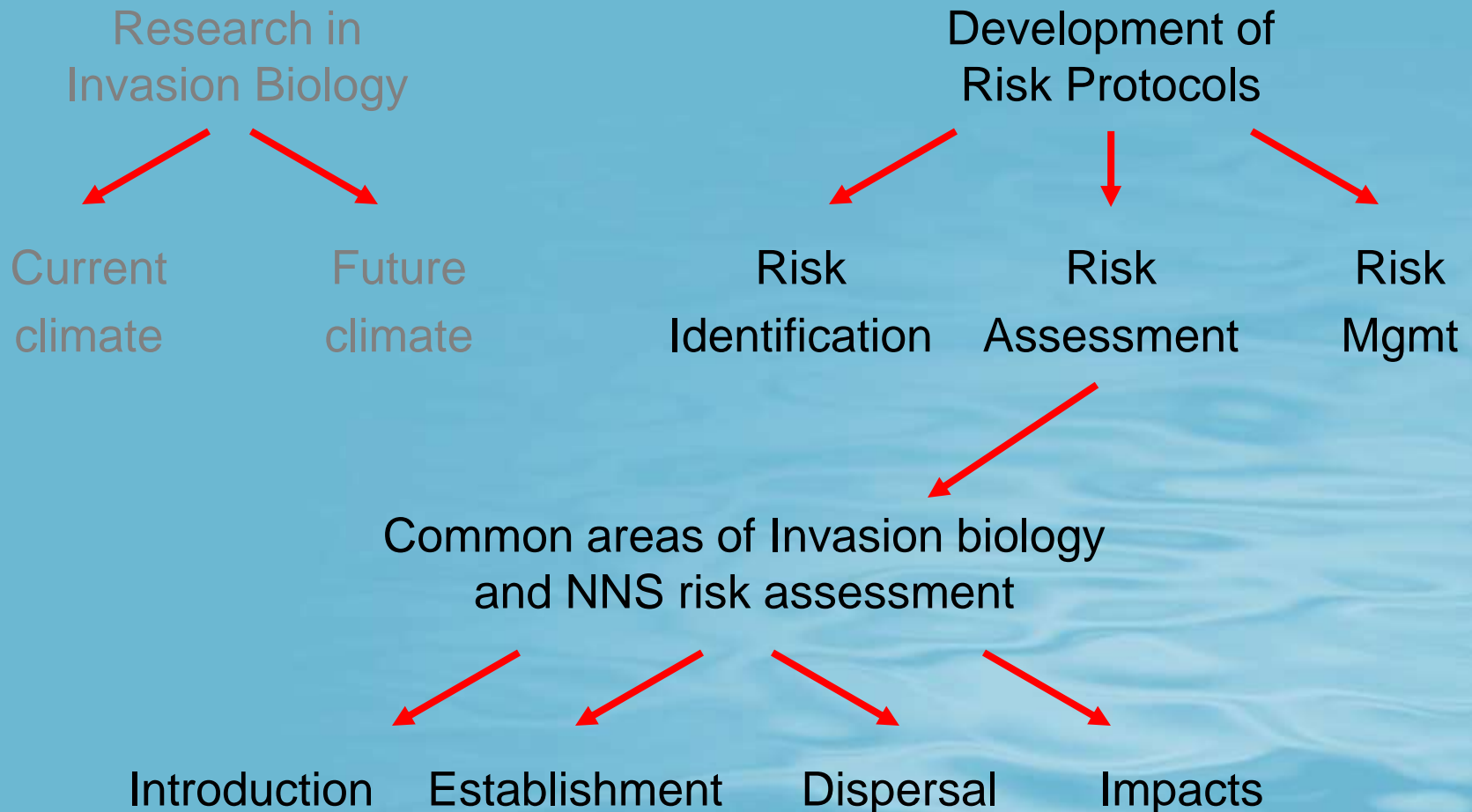
Research to inform policy

Invasion risks under current and future climates



Research to inform policy

Invasion risks under current and future climates



Risk identification tools

Cefas R&D of decision support tools

Invasiveness screening of fish, inverts, amphibia:

E.g. Fish screening tool (FISK) v2 covers all climates:

- Bolt-on for GB & EC (ASR) NNS risk schemes
- Applied in at least 16 countries across 5 continents

Informs Policy:
ILFA and UK-TAG
(WFD), with
similar function
where applied
elsewhere



**Non-native Freshwater Fish
Risk Screening Kit (FISK) v2**

Risk identification tools

Cefas R&D of decision support tools



Invasiveness screening marine invertebrates:
Coming soon MI-ISK v2 for establishing a target species list



**Non-native Marine invertebrates
Risk Screening Kit (Mi-ISK) v2**

Full NNS risk analysis

Cefas R&D of decision support tools



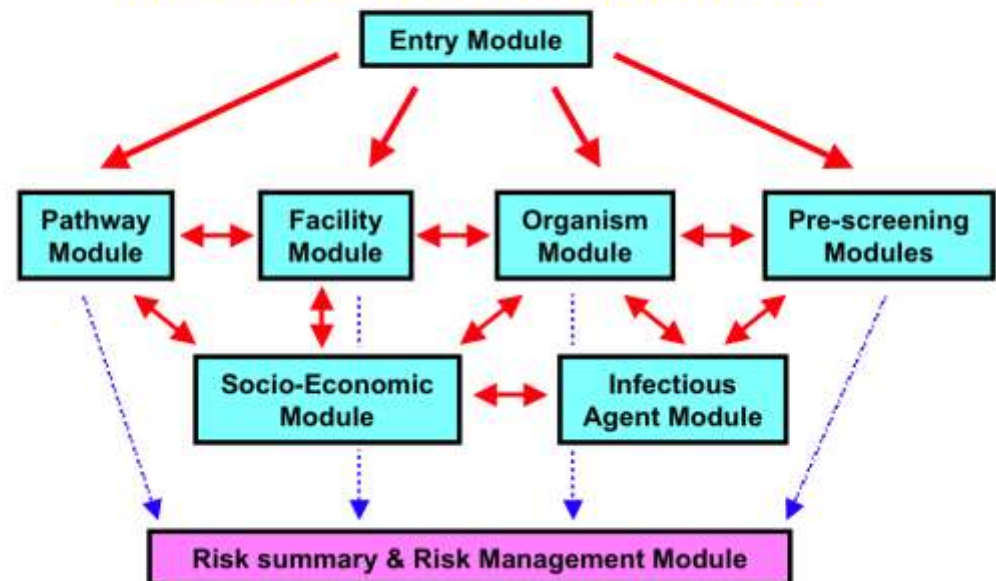
NNS risk schemes adapted from EPPO scheme:

- UK \Rightarrow GB NNS scheme (NAPRA)
- For ASR implementation (ENSARS)

Informs advice:

- UK delegates on ICES WG (ITMO)
- Membership GB NN Risk Analysis Panel (NNRAP)

European Non-native Species in Aquaculture Risk Assessment Scheme (ENSARS)



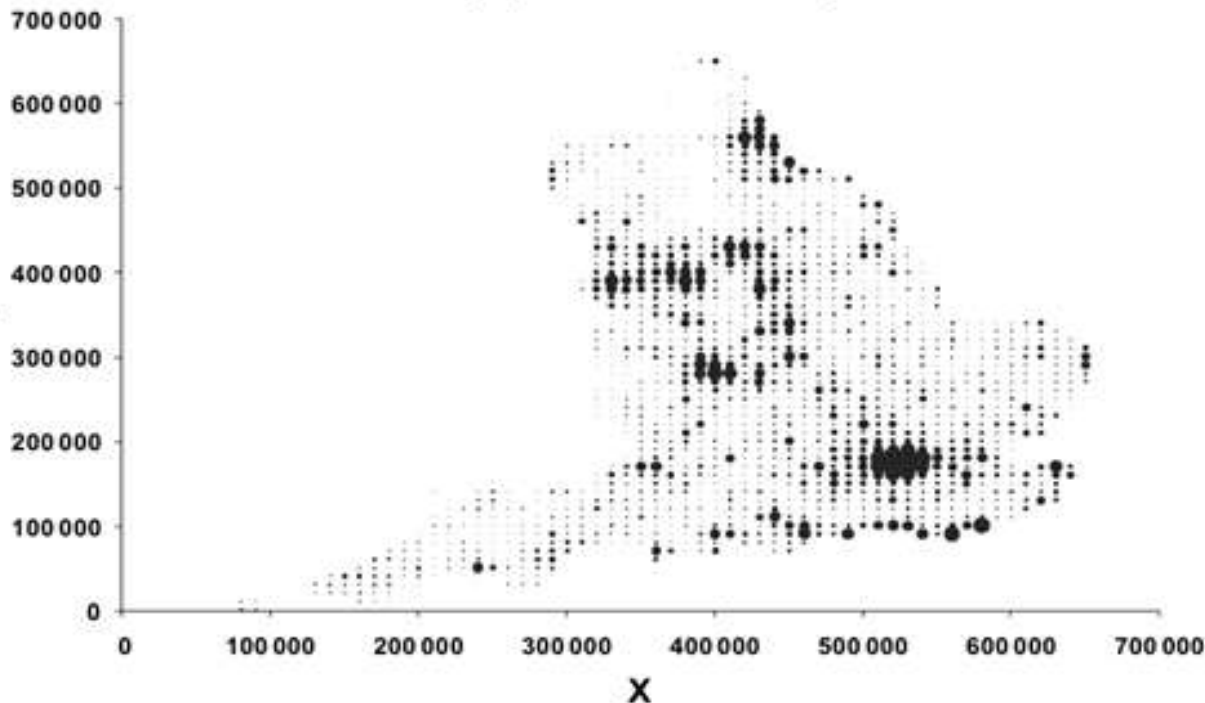
Pathway analysis

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- Introductions are a function of human population density



Human population density



Copp *et al.* (2010)
Aquat. Conserv.

Cefas

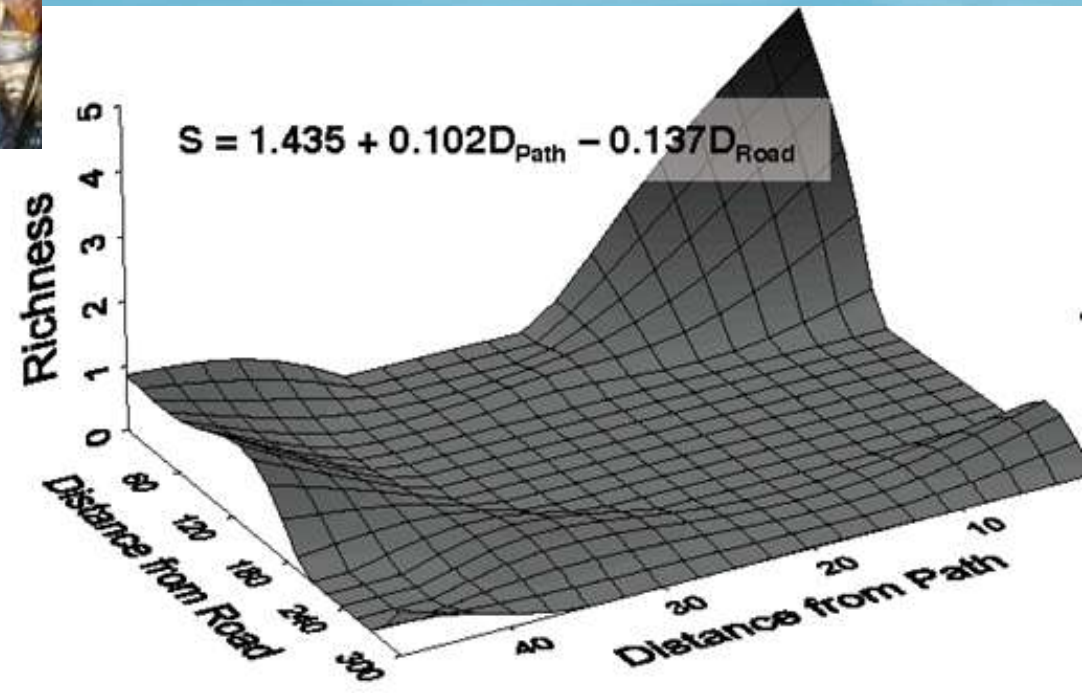
Human-related pathways

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- If fish species are imported (pet or ornamental use), then will eventually be found in the wild (e.g. ponds close to roads receive abandoned pet fish)

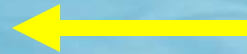


topmouth gudgeon



Copp et al. (2005)
J. Appl. Ichthyol.

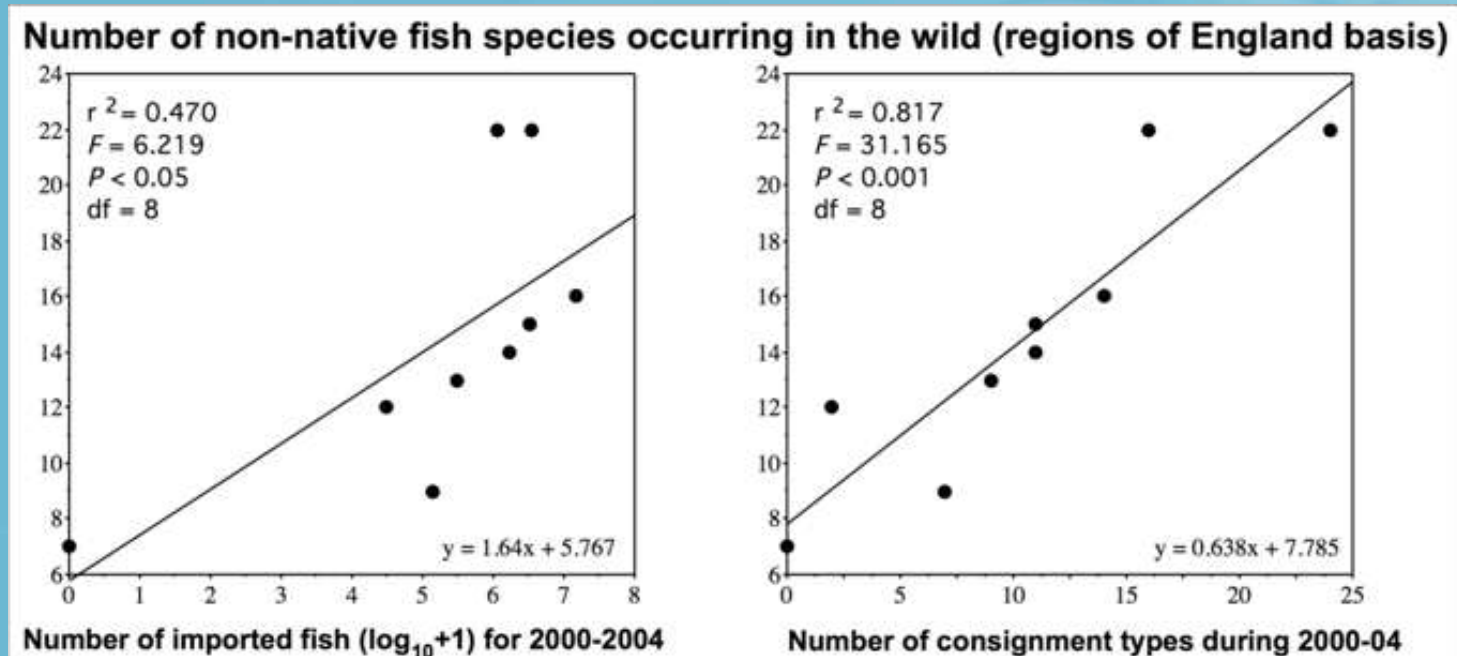
Fish abandonment – caught red handed



Human-related pathways

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- Data from fish import database at Cefas-Weymouth reveal that the more frequent and diverse the imports, the more likely that some will establish in the wild



Horizon scanning to inform policy

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Potential new invasives: Ponto-Caspian fishes and invertebrates have spread via ship ballast water and as 'hull foulants'

Ponto-Caspian gobies pose threat to native bullhead (protected species under Species & Habitats Directive)

Influence of climate change ?

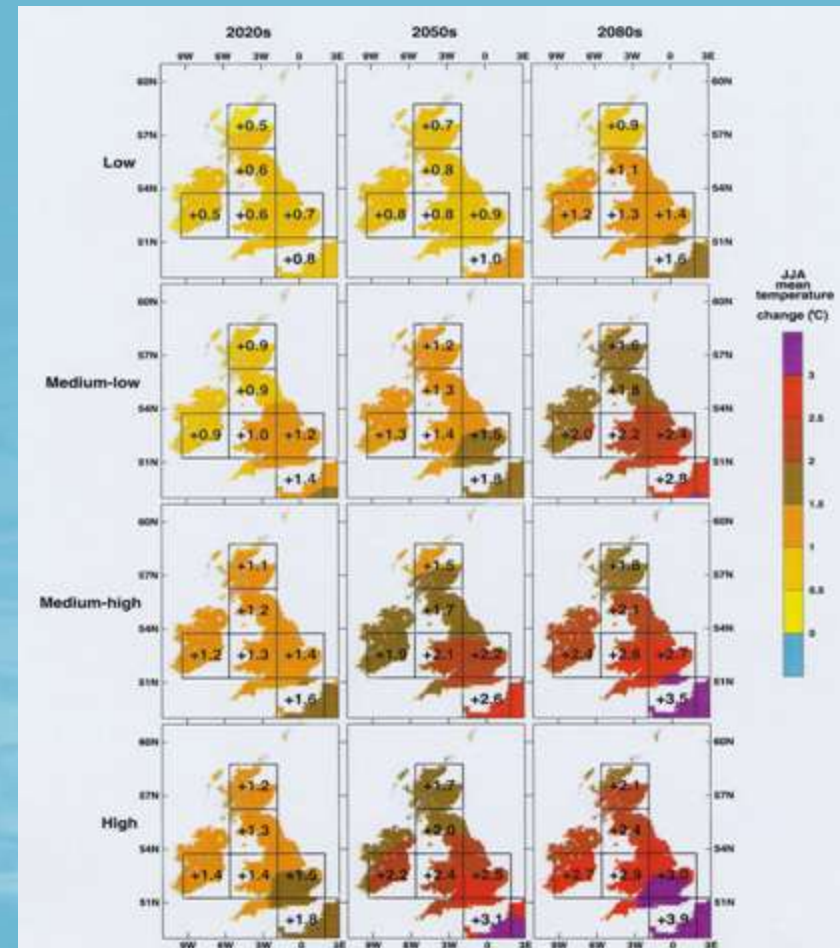


Impacts of climate change

Cefas R&D on non-native freshwater fishes

Climate change is a major policy driver

- Increased water temperature (1.5–3.0°C)
- Increased variability in river discharge patterns



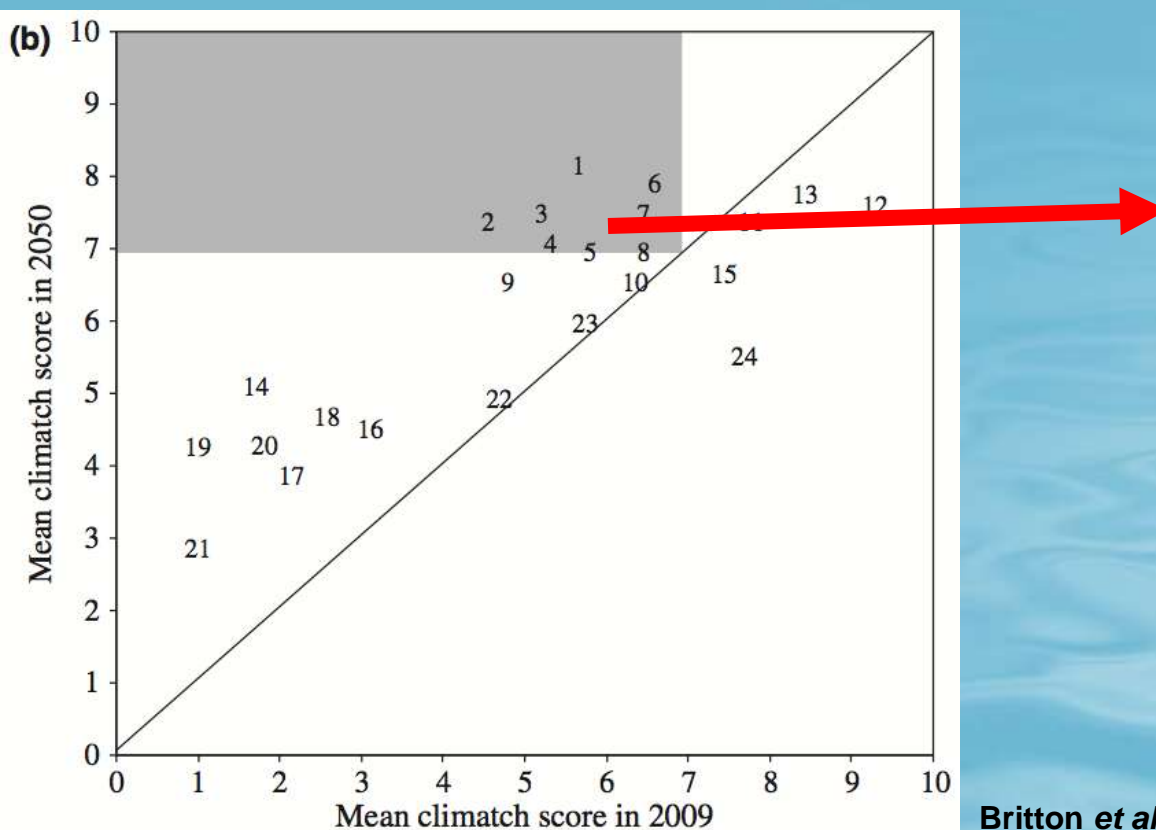
Climate change modelling

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- Climate modelling: six existing NN fishes predicted to benefit (become invasive) from climate warming:

- Pumpkinseed
- Goldfish
- Fathead minnow
- Bitterling
- Common carp
- European catfish



Climate change experiments



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Predicted benefits to pumpkinseed confirmed in pond experiments: **Greater size and enhanced survivorship** suggest switch to invasive state in warmer climate

Assumed pumpkinseed impacts on native perch NOT confirmed in pond experiments: **No effect on perch growth** \Rightarrow Both species shifted diet to repartition available food



Zięba *et al.* (2010) *J. Fish Biol.*

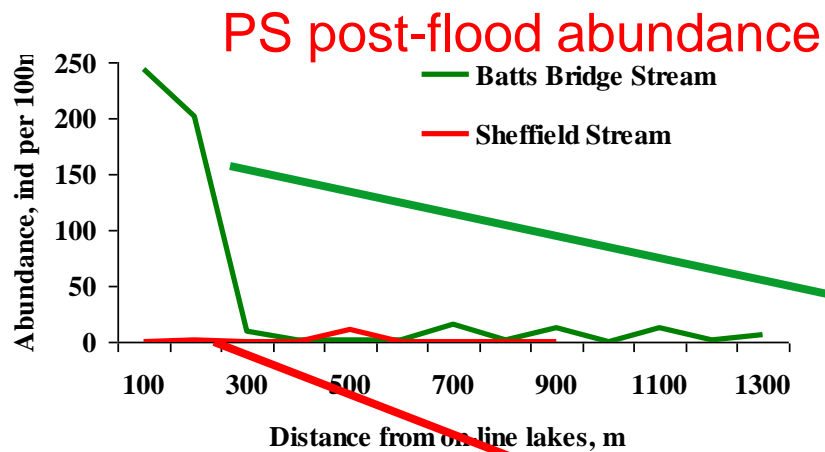
Fobert *et al.* (2013) *Ecol. Freshwat. Fish*

Impacts of climate change



Enhanced natural dispersal via floods & spates

- Escapement rate determined by type of outflow



Simple weir

Standing
pipe
outflow



Cefas

Impacts of climate change

Enhanced establishment and dispersal



Example of **new population** due to discharge variability (climate warming):

- Modelling revealed pumpkinseed escapement is a function of rain/spate/flood events.



Impacts of climate change

Enhanced establishment and dispersal



Example of **new population** due to discharge variability (climate warming):

- Modelling revealed pumpkinseed escapement is a function of rain/spate/flood events.
- New pumpkinseed population found after July 2007 flood in a tributary of the Sussex Ouse



Source population
(in trout fishery)



New established
population in
flooded garden
pond

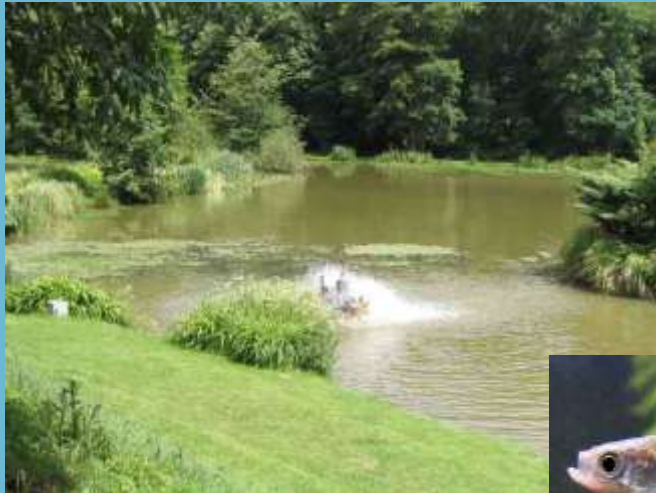
Cefas

Human-assisted dispersal

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Contaminated angler's gear can aid dispersal:

- E.g. sunbleak introduction to a fishery in East Sussex probably as eggs attached to keep net(s)
- But, research needed to assess likelihood & intensity of dispersal along pathway



Keep nets & stink bags

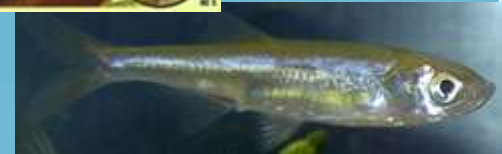


Non-native impacts

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Demonstrated impacts:

- Diseases are a common impact: e.g. sunbleak found to host existing Cat. II parasites (Weymouth)
- Competition: e.g. Ponto-Caspian racer goby out-competes native bullhead in aquaria and in the field
- Aggressive behaviour: e.g. In Spanish streams, pumpkinseed force native fishes to change habitat, but in English streams trout and PS partition pool habitat



Ecosystem modelling

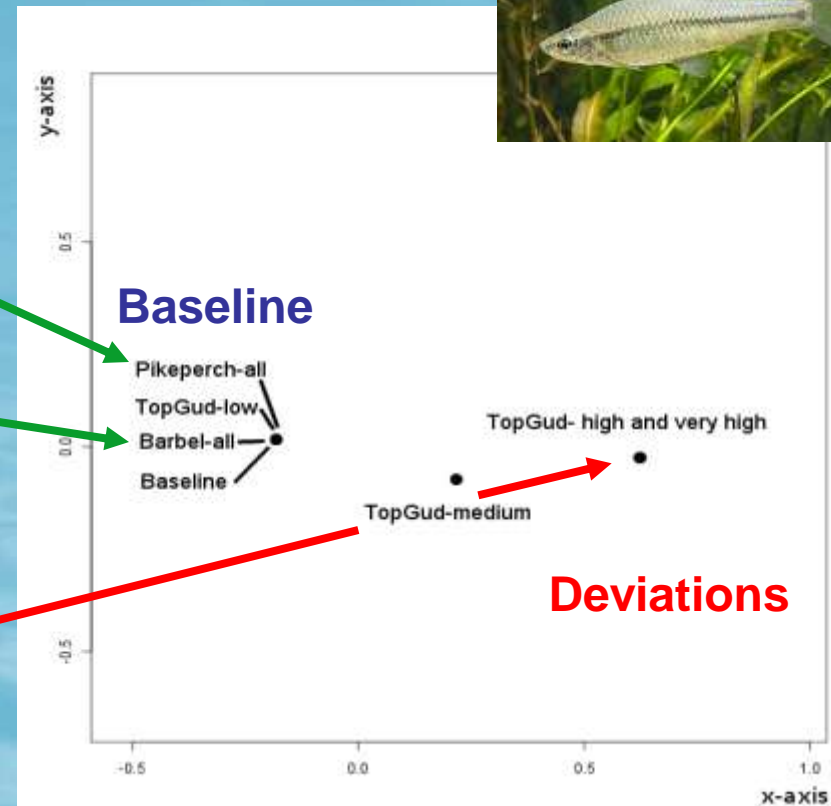
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- NNS introduction impacts on River Frome food web assessed by adding species:

+ top non-native predator:
limited impact

+ large translocated native
(barbel): no impact

+ small competitor
(topmouth gudgeon):
greatest impact



e-DNA detection of NNS

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Environmental (e-DNA) detection (Phil Davison)

Initial target species:

- Topmouth gudgeon (TMG)
- Sunbleak
- Pumpkinseed
- Fathead minnow



Initial results:

- Developed primers successfully detected four species in aquarium trials and TMG in field trials
- On-going lab trials to refine water filtration techniques
- Field trials with other species planned for 2014–2015

Molecular tools to ID NNS



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Do we have a new NN fish for the ILFA list?

- Crucian carp: native or introduced w/ com. carp
- Initial genetics work (Univ. Hull & Cefas) indicated crucian carp is probably native
- However, recent genetics modelling indicates English crucian pops. here \approx 675 yrs, same era of documented introduction of common carp
- Carbon dating of pond core samples (with scales) planned to provide physical evidence

Acknowledgements & Questions



Principal collaborators



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Environment Agency

FSBI

Natural England

NATO

Norfolk Biodiversity Partnership

Scottish Government

Cefas

Establishment of new PS pops in water bodies after floods



Growth & life-history traits of Watersmeetsmeel pop

- \uparrow juvenile growth
 - \downarrow age at maturity
- i.e. shift towards invasive

