River infrastructure can **facilitate** the **introduction** and **establishment** of non-native species.

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Background:

Non-native species and river infrastructure (e.g. dams, weirs, and culverts) are both key threats to freshwater biodiversity [1]. These stressors commonly co-occur, and there is increasing recognition that infrastructure can influence the success of non-native species at each stage of the invasion process [2,3] (i.e. during transport, introduction, establishment and spread [4]). Understanding the influence of infrastructure on the success of aquatic invasive species is necessary for effective management decisions. Therefore, this study used a meta-analytic approach to address two key objectives: 1) Determine the overall effect of river infrastructure on aquatic non-native species at each stage of the invasion process, and 2) For each invasion stage, to identify variation in the magnitude of the overall effect between different: a) taxonomic groups, b) climatic regions, and c) infrastructure characteristics.

Methods:

Standardised literature searches (defined using PRISMA [5] and CEE [6] guidelines) conducted across 3 databases and 11 relevant reviews.

Titles, abstracts, and then full texts screened to identify relevant studies (see 'Extra Information' for relevance criteria).

Hedge's *g* calculated, and then recorded alongside information regarding climate, taxonomy and infrastructure characteristics.

Publication bias assessed using Egger's test and visual assessment of funnel plot asymmetry.

Overall effects quantified by fitting random-effects models with restricted maximum likelihood (REML) approach.

Individual random effects models (categorical) or meta-regression (continuous) used to identify influence of additional variables.

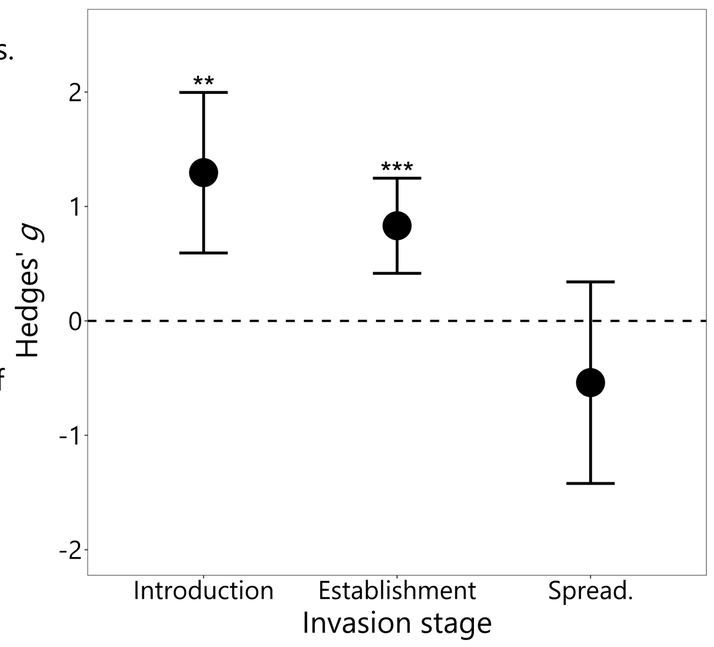

Fig. 1 – Overall effect sizes and 95% CIs at each invasion stage.

Key Results:

1. River infrastructure had a **strong, positive effect** on introduction and establishment, but **no effect on spread** (Fig. 1).

2. The magnitude of the effect was **not influenced** by climate, taxonomy or infrastructure characteristics.

3. **Strong biases** towards temperate regions (Fig. 2A) and fish (Fig. 2B).

Management Implications:

1. Removing river infrastructure may limit introductions and establishment of aquatic non-native species.

2. Focusing construction in heavily invaded regions may help to minimise likelihood of invasion in pristine areas.

3. Impounded areas may act as 'invasion hubs', and therefore should be treated as important management targets.

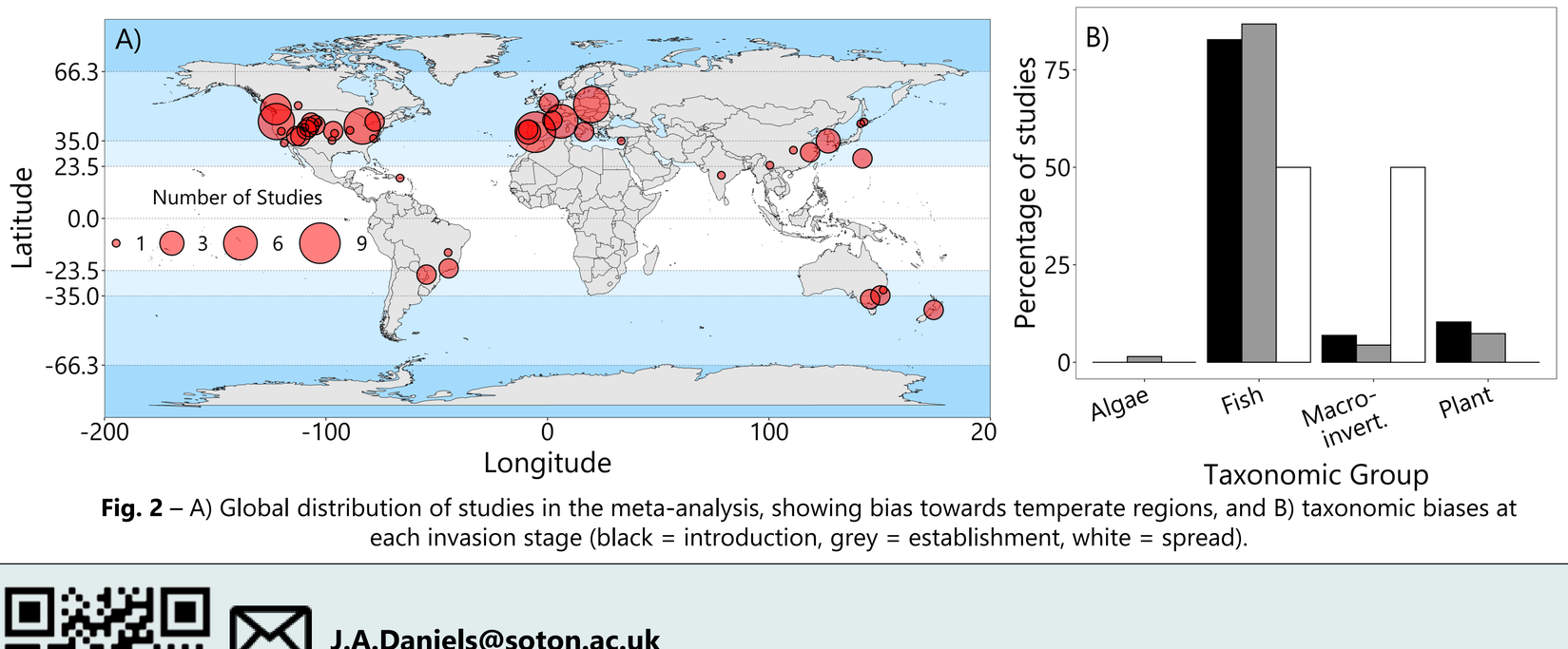

Fig. 2 – A) Global distribution of studies in the meta-analysis, showing bias towards temperate regions, and B) taxonomic biases at each invasion stage (black = introduction, grey = establishment, white = spread).

Extra Information:

Screening Process:

5518 titles and abstracts screened.

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217 full texts assessed for eligibility.

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45 studies included in quantitative synthesis (103 data points)

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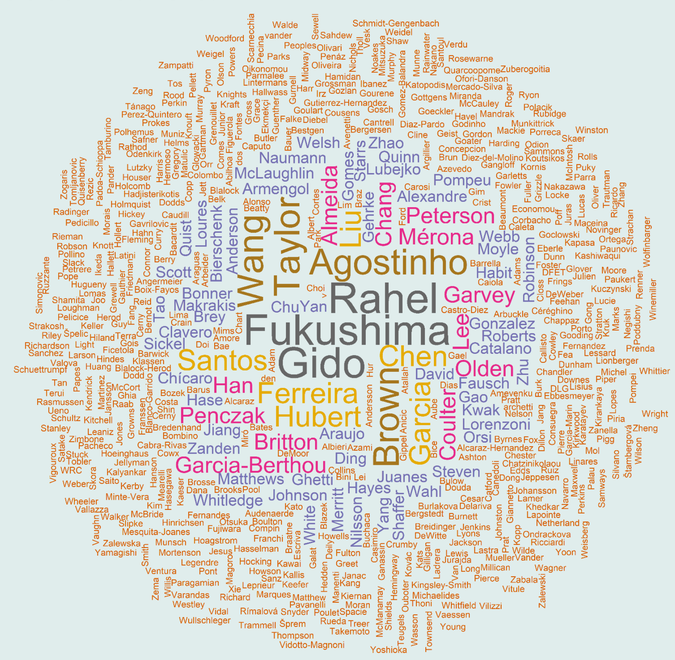
29 data points for **introduction**. | 68 data points for **establishment**. | 6 data points for **spread**.

Relevance Criteria:

Category	Criteria for Inclusion
Species	The species studied is recognised as non-native in the study and is contained in the Global Register of Introduced and Invasive Species.
Habitat	The study was conducted in a freshwater habitat.
Infrastructure	The treatment area of the study must include at least one form of anthropogenic in-stream structure (e.g. dams, weirs and culverts). Natural barriers and behavioural barriers were not considered.
Control	The study utilised a relevant control site that was not influenced by any anthropogenic infrastructure.
Data	The study reported either 1) raw data, 2) summary data for treatment and control sites, 3) exact *p* values accompanied by sample size or degrees of freedom, or 4) a graphical form of any of these data sources.

Included Authors:



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