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WHAT ARE THE EFFECTS OF WOODED RIPARIAN ZONES ON STREAM TEMPERATURES AND STREAM BIOTA?

Systematic Review Protocol

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1. BACKGROUND

The riparian zone is the transition zone between a freshwater and terrestrial ecosystem (Naiman and Décamps 1997). The unique, dynamic and complex nature of riparian habitat means that it can support relatively high biodiversity and hence can be important for conservation management (Pusey and Arthington, 2003). Changes in land use and river regulation have meant that wooded riparian habitats next to rivers and streams have become less abundant over time. Different activities have contributed to this decline, such as logging for timber (Young, 2001) and livestock grazing and trampling (Belsky *et al*. 1999). Increasingly, there is concern that degradation of this habitat may lead to a reduction in the abundance and diversity of species in the aquatic environment (Pusey and Arthington, 2003).

The riparian zone can play a key role in the functioning of the aquatic ecosystem, affecting chemical, physical and biological processes (Naiman and Décamps 1997; Pusey and Arthington, 2003). Degradation of this environment therefore has implications for many different aspects of river function, such as a loss of bank stability leading to increased erosion and chemical leaching from the surrounding land. One potentially major impact of riparian habitat on stream functioning is on water temperature (Moore *et al*. 2005; Hannah *et al*. 2008). Riparian habitat can affect the level of solar radiation received by the stream and so removal of tree cover may lead to an increase in water temperature (Moore *et al.*, 2005). Increased stream temperature can have direct effects on poikilothermic organisms, such as fish, through changes in metabolism and ultimately mortality rates. There has been a particular concern that extreme summer temperatures, which may increase further with climate change, can increase fish mortality (Malcolm *et al*. 2008). However, changes in riparian habitat and temperature can have a diverse range of impacts on primary productivity and decomposition, and may lead to changes in the structure and functioning of the whole biotic community (Pusey and Arthington 2003; Durance and Ormerod, 2007), which increases the complexity of predicting the biological impact. A number of other factors, including stream flow rate and ground water inflow (Ward, 1985; Caissie, 2006), may also affect stream temperature, and affect the relative importance of riparian habitat for water temperature.

Management interventions have been proposed to limit the consequences of riparian degradation, such as the use of riparian buffer strips (Osborne and Kovacic, 1993; Haycock and Muscutt, 1995) or livestock exclusion fencing (Belsky *et al.* 1999). Empirical research has been carried out to explore the importance of the riparian habitat and several reviews have been published addressing issues on this topic such as the effects of logging (Young 2001) and livestock (Belsky *et al.* 1999) on stream and riparian ecosystems, and the relationship between stream temperature and forest harvesting (Moore *et al*. 2005). This review examines the relationship between wooded riparian cover and stream temperature and the impact on the diversity and abundance of stream biota in temperate zones. Systematic review methodology will be used to comprehensively search for data, critically appraise the quality of study and quantitatively synthesise and compare the outcomes of different studies.

2. OBJECTIVES OF THE REVIEW

2.1 Primary question

What are the effects of wooded riparian zones on stream temperature?

2.2 Secondary question

What are the effects of wooded riparian zones on the diversity and abundance of stream biota?

2.3 Components of the question

Subject	Intervention	Outcome
Stream Temperature Fish, amphibian, reptilian, invertebrate or phytoplankton communities in freshwater rivers or streams	Presence of trees in riparian zone: logging v unlogged planted v unplanted fenced v unfenced	**Primary** Change in water temperature **Secondary** Change in abundance or diversity of stream biota

3. METHODS

3.1 Search strategy

Multiple sources of information will be searched to capture a comprehensive and unbiased sample of the literature. The following electronic resources will be searched and results saved using bibliographical management software:

1) Agricola
2) CAB Abstracts
3) ConservationEvidence.com
4) Index to Theses
5) ISI Web of Knowledge (Web of Science and ISI Proceedings)
6) Science Direct
7) Copac

Searches will include the following English language search terms:

1) riparian AND fish*
2) riparian AND invertebrate*
3) riparian AND amphibian*
4) riparian AND reptile*
5) riparian AND (phytoplankton or diatom)
6) riparian AND zooplankton

7)riparian AND (stream temperature OR river temperature OR water temperature)
8) tree* AND (stream temperature OR river temperature OR water temperature)
9) tree* AND (river OR stream) AND shad*
10) riparian AND logg*
11) riparian AND harvest*
12) riparian AND graz*

An Internet search will also be performed using the following search engines; www.scirus.com, http://knb.ecoinformatics.org/index.jsp, www.google.com and www.dogpile.com. The first 50 hits (Word, spreadsheet, and/or PDF documents, where this can be separated) from each internet search will be examined for appropriate data.

Bibliographies of included material and any traditional reviews will be searched for relevant references. Searches will also be carried out within the web pages of relevant associations and organisations including the Freshwater Biological Association, Fisheries Research Services, Centre for Environment, Fisheries and Aquaculture Science, Environment Agency, Forestry Commission, Forest Research, Scottish Environment Protection Agency, the Countryside Council for Wales and the Tweed Foundation.

3.2 Study inclusion criteria

Study inclusion criteria are predefined to ensure an objective selection of the relevant literature. The following criteria will be used to assess the articles for relevance:

- **Relevant subject(s):** temperatures of streams or rivers; fish, amphibian, reptilian, or invertebrate communities within a temperate stream or river
- **Types of intervention:** Wooded reaches, or wooded catchments, natural or planted, in the riparian zone.
  Types of comparator: The presence of a comparator will not be essential for inclusion into the review. Specific comparisons of interest to the question are: logged vs. unlogged; fenced vs. unfenced (e.g. grazed) and planted vs. unplanted reaches or catchments.
- **Types of outcome:** changes in stream temperature (maximum, minimum, variability, mean); changes in number, biomass, distribution or diversity of stream biota.

Inclusion criteria will be applied initially on viewing the titles of articles. Articles remaining after this stage will be viewed, and inclusion criteria applied on title and abstract, and subsequently at full text. Where there is insufficient information to make a decision, it will be included into the next stage of the process. Two reviewers will independently examine a subset of these articles (approximately 25 % of the studies or 300, whichever is less) accepted at title; disagreement will be resolved by consensus, or following assessment by a third reviewer. Agreement between the two reviewers must be substantial (kappa=0.6) before the assessment proceeds.

3.3 Study quality assessment

Articles that meet the inclusion criteria after full text viewing will be critically appraised in terms of the quality and characteristics of the methodology. The effect of different methodologies on the study outcome could be explored in meta-analysis. Conclusions will be weighted by the quality of studies available.

3.4 Data extraction strategy

Data will be extracted where possible using a review-specific data extraction form, which will be piloted before use on a purposive sample of the articles. Data will be extracted on the study outcomes, methodology and where provided, reasons for heterogeneity, as identified in this protocol.

Potential reasons for heterogeneity:

Factors of the riparian zone:

- Length/Width of the riparian strip
- Type of trees e.g. deciduous or non-deciduous
- Native or non-native tree species
- Tree height/age/distance from edge
- Tree density
- Other riparian vegetation – presence/% cover
- Other land uses
- Potential confounding e.g. habitat degradation/pollution etc
- Aspect
- Method of vegetation/tree removal

Factors of the stream:

- Stream width/depth
- Flow rate
- Stream habitat type
- Distance from stream/river source
- Groundwater-surface water interactions
- Connectivity to other streams
- Hyporheic flows
- Level of dissolved O_2

Factors affecting temperature:

- Time of year and season
- Latitude
- Altitude
- Precipitation

Factors of the biota:

- Mobility and dispersal of species concerned

Authors will be contacted for any missing data. Where necessary, missing data will be imputed from summary statistics or inferred. If possible, sensitivity analysis will be used to explore the impact of any assumptions regarding imputed data.

3.5 Data synthesis

If sufficient data exists, meta-analysis will be carried out to determine the summary effect size and assess the level of heterogeneity between studies. Meta regression and sub-group analysis may be used to explore the factors creating the heterogeneity between studies using the variables identified within this protocol.

If insufficient data is available to allow meta-analysis, and for studies without comparators, studies will be described in qualitative tables, grouped by outcome.

4. POTENTIAL CONFLICTS OF INTEREST AND SOURCES OF SUPPORT

No conflicts of interest reported.

5. REFERENCES

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