1. Australia's National River Health Program
2. Causal Criteria for determining ecological responses to management intervention

Richard Norris
eWater CRC & Institute for Applied Ecology, University of Canberra, Australia



Part 1 The 4 R's of Biomonitoring

Background in Australia

- Pressure to protection ecological values - bioassessment
- Development began 1993 as a research tool
- NRHP and Australian River Assessment System (AusRivAS) development based on RIVPACS
- National program managed by DEWH, applied by state/territory agencies
- Comparable results & widely available - many users
- Predict the aquatic macroinvertebrate fauna expected to occur at a site in the absence of environmental stress
- Currently supports three analyses and reporting;
  - Macroinvertebrate Predictive Modelling Software;
  - Physical and Chemical Reporting Software; and
  - Mapping and Reference Site Screening Module.

AUSRIVAS - Australian River Assessment System

- Nationally standardized system
- Some regionalization for climatic ranges but standard outputs
- Easy to use and interpret outputs
- Central management and access control

AUSRIVAS- components

METHODS

- Standardized methods for site selection, habitats, season, taxonomy, sampling, data analysis, QA/QC, training & accreditation
- Developed as a happy alliance (mostly) between states, feds & researchers

SOFTWARE

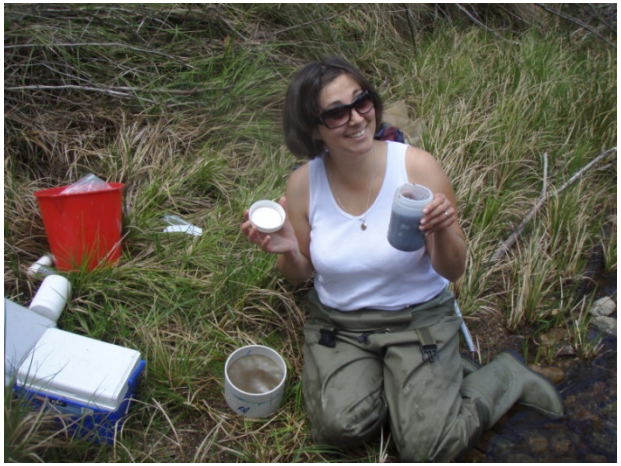
- Internet based and managed with access to models password controlled
- Central management and control over access

MODELS

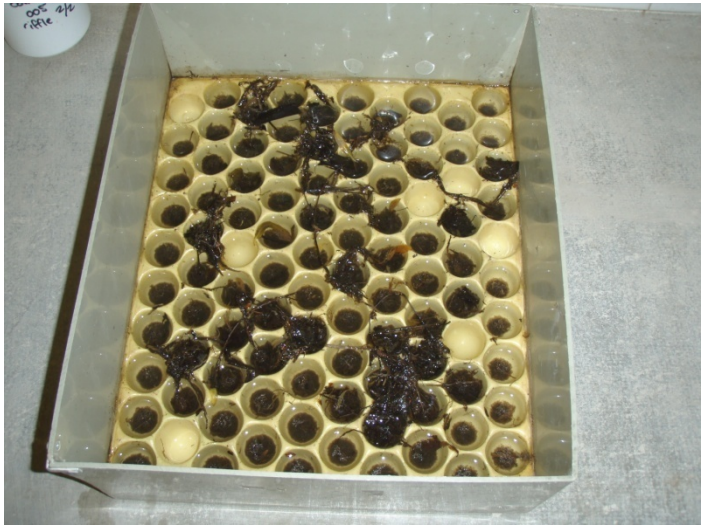
- 50 covering all of Australia - small derived data sets - final steps in analysis with client data
- Developed by, or in conjunction with, responsible state/territory agencies

National River Health Program

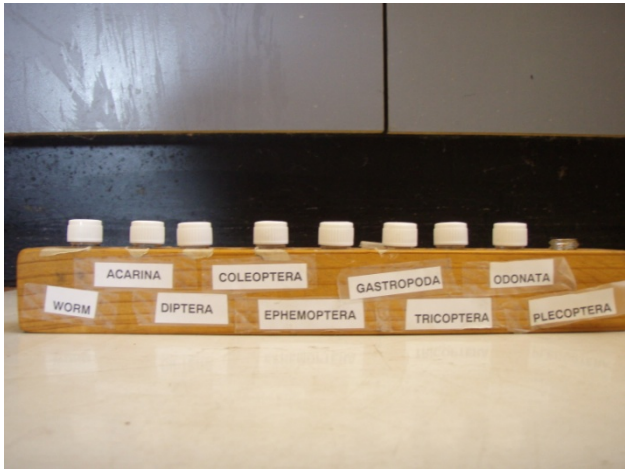
Field Methods



Lab Methods




EMERGENCY
EYE W


ACARINA
COLEOPTERA
GASTROPODA
ODONATA
WORM
DIPTERA
EPHEMOPTERA
TRICOPTERA
PLECOPTERA

Quality assurance/Quality Control

- Standardized methods with sampling and processing manuals ensure consistent sampling
- QA/QC methods for field & lab
- Training & accreditation – also linked to contracts
- Centralized management with regional ownership

AUSRIVAS- advantages

- Standard method with nationally comparable methods and results
- Updates to software and models available immediately
- Utilitarian platform to run complex analyses
- Web site with troubleshooting and advice
- Wide range of registered users
- Manuals with video clips included
- Can be updated with new developments

“Selling AUSRIVAS”

- AUSRIVAS formally adopted as a national indicator for State of the Environment Reporting at Federal and State levels in 1997-8
- AUSRIVAS being incorporated into new National Water Quality Guidelines in 1998/9
- AUSRIVAS being progressively adopted into state licensing and catchment management legislation

Lessons learned

- National coordination with regional ownership
- Standardized methods – field, lab, taxonomy
- Comparable outputs
- QA/QC necessary
- Training & accreditation
- Updating process & capacity

Part 2
Determining Cause & Effect

- River managers need to determine what caused the damage

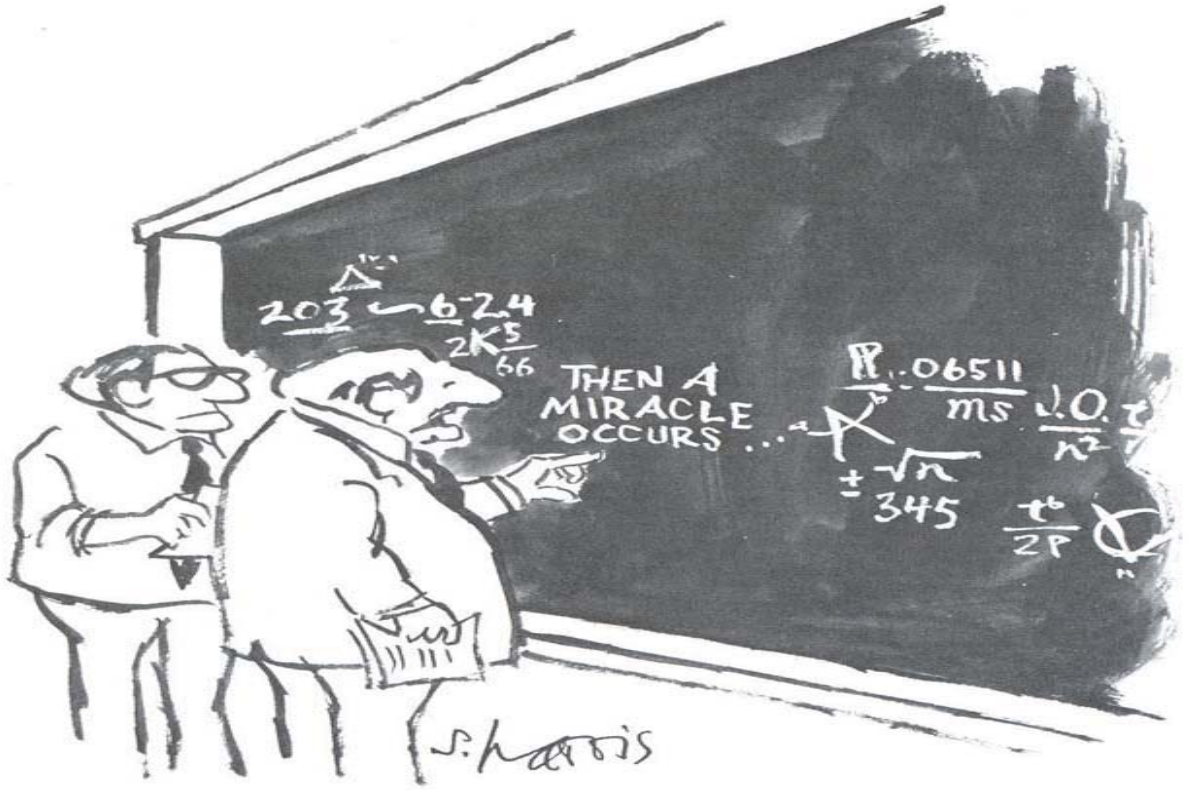
- Decision-makers need evidence that proposed management intervention will cause environmental benefits

Obstacles to determining causation in rivers

- A paucity of data at the site of interest
- Natural variability undermines the capacity to reach a conclusion about a causal relationship
- There is no replication because of large scales
- Experiments are not always possible

New challenges for decision-makers

- Expert opinion alone no longer acceptable



"I think you should be more explicit here in step two"

What decision makers and scientists need -

- An explicit way of organising and presenting causal evidence
- Logical, simple and transparent framework
- A consistent or standardised set of rules that can be automated
- A repeatable framework
- A framework that leads to a robust and informed conclusion
- Transparent, evidence based decision making

Historical examples of logic-based causal inferences

- Postulates of Jakob Henle and Robert Koch (1870's)
- Smoking causes lung cancer (US Department of Health, Education & Welfare 1964)
- Formalisation of the use of correlative evidence (Hill 1965)

Multiple Lines and Levels of evidence (MLLE)

What is MLLE?

Logical way of organizing evidence to make a causal inference

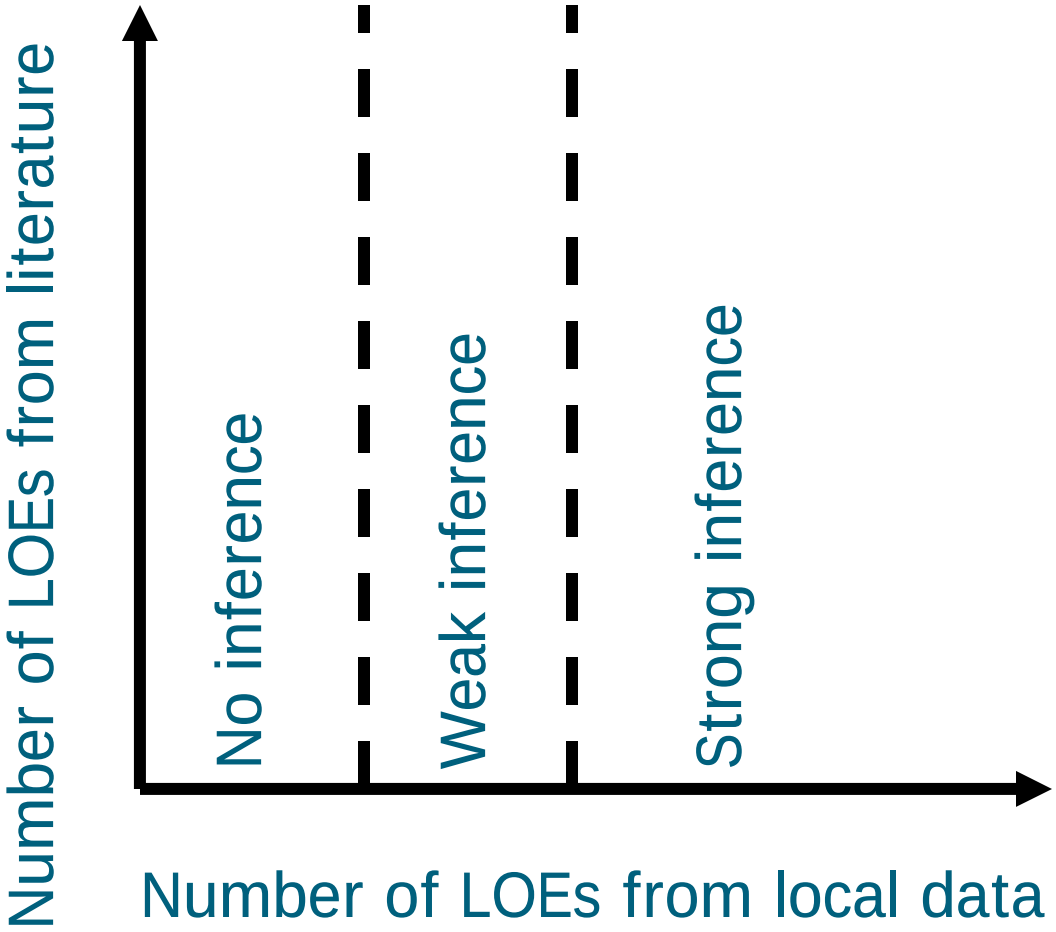
What is a line of evidence?

- An ecosystem attribute that is investigated in relation to a stressor e.g. tadpole abundance, macroinvertebrate species richness, macrophyte biomass, number of fish lesions

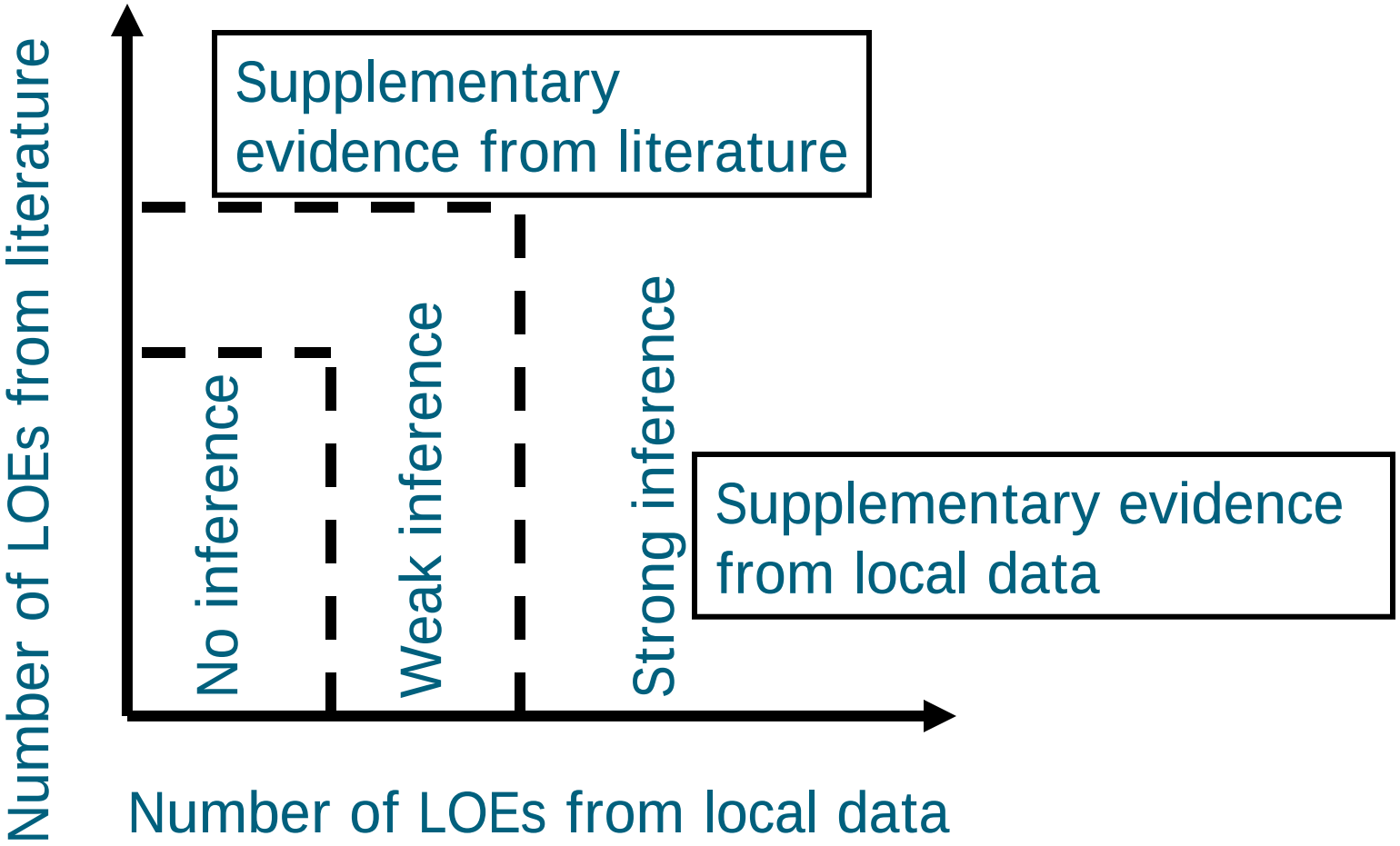
What is a level of evidence?

A level of evidence is the value of one of a number of criteria used to determine the case for inferring that a given human activity causes a given ecological change

Traditional way of making a causal inference



Making a causal inference using our MLLE approach



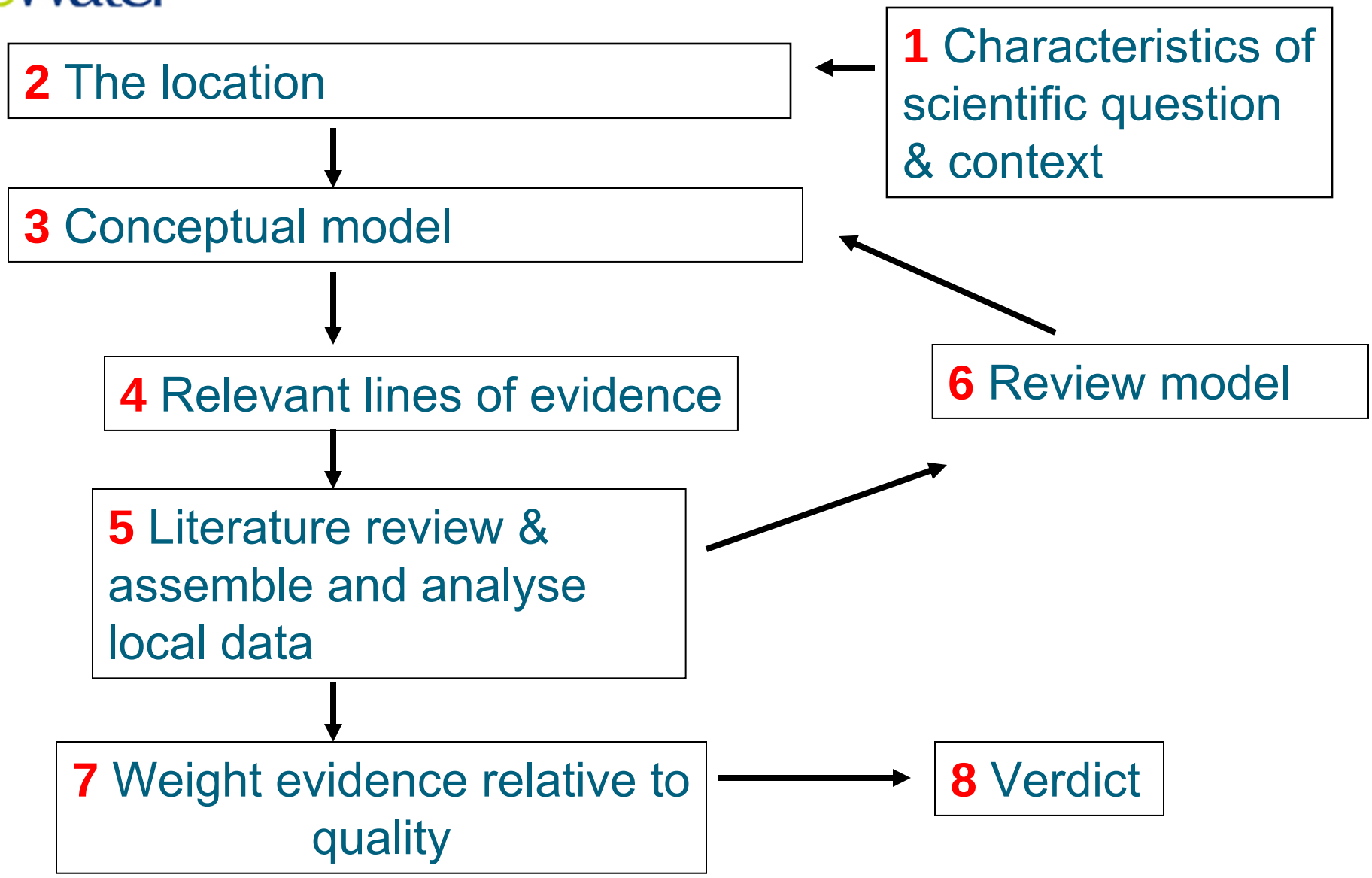
Developing our MLLE approach

- We can find no practical, generalizable examples of MLLE using the literature and local data in an explicit and objective way for environmental assessment
- Our approach:
  - Provides an explicit framework
  - Comparability and relevant to the environmental question
  - Weighting of inferential power of a study based on: study design, no. control & no of impact locations
  - Environmentally relevant subset of Hill's causal criteria
  - Developed software package to aid study evaluation

The causal criteria

Causal criterion	Description
Plausibility	Mechanism that could explain the relationship
Response	Evidence of the response following the agent
Dose response relationship with agent	Evidence of a dose response relationship between the agent & response
Consistency of association	Expected response ALWAYS occurs in the presence of the agent

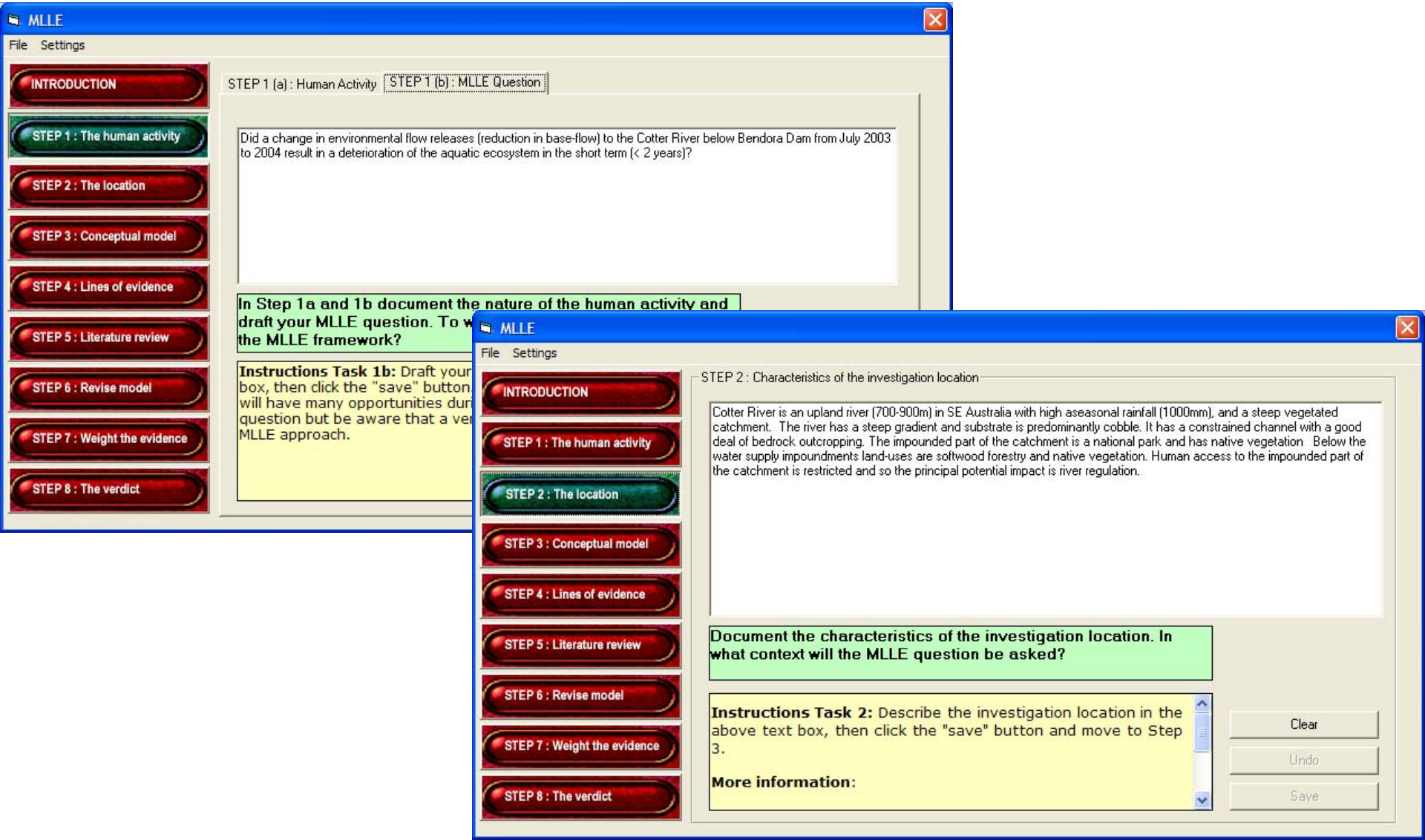
The MLLE framework



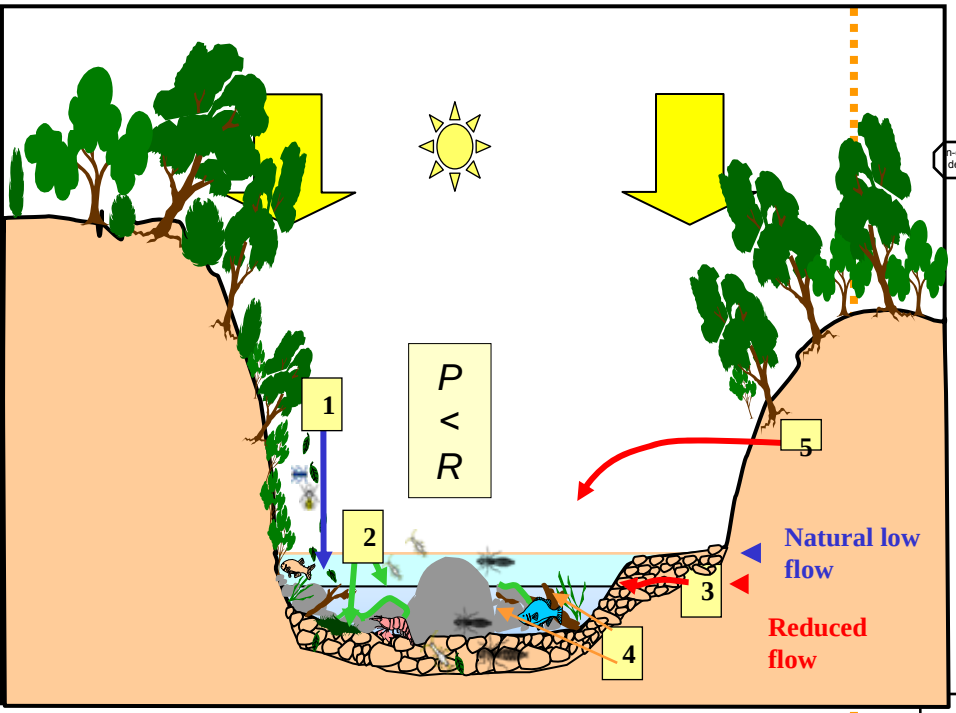
Transparent approach

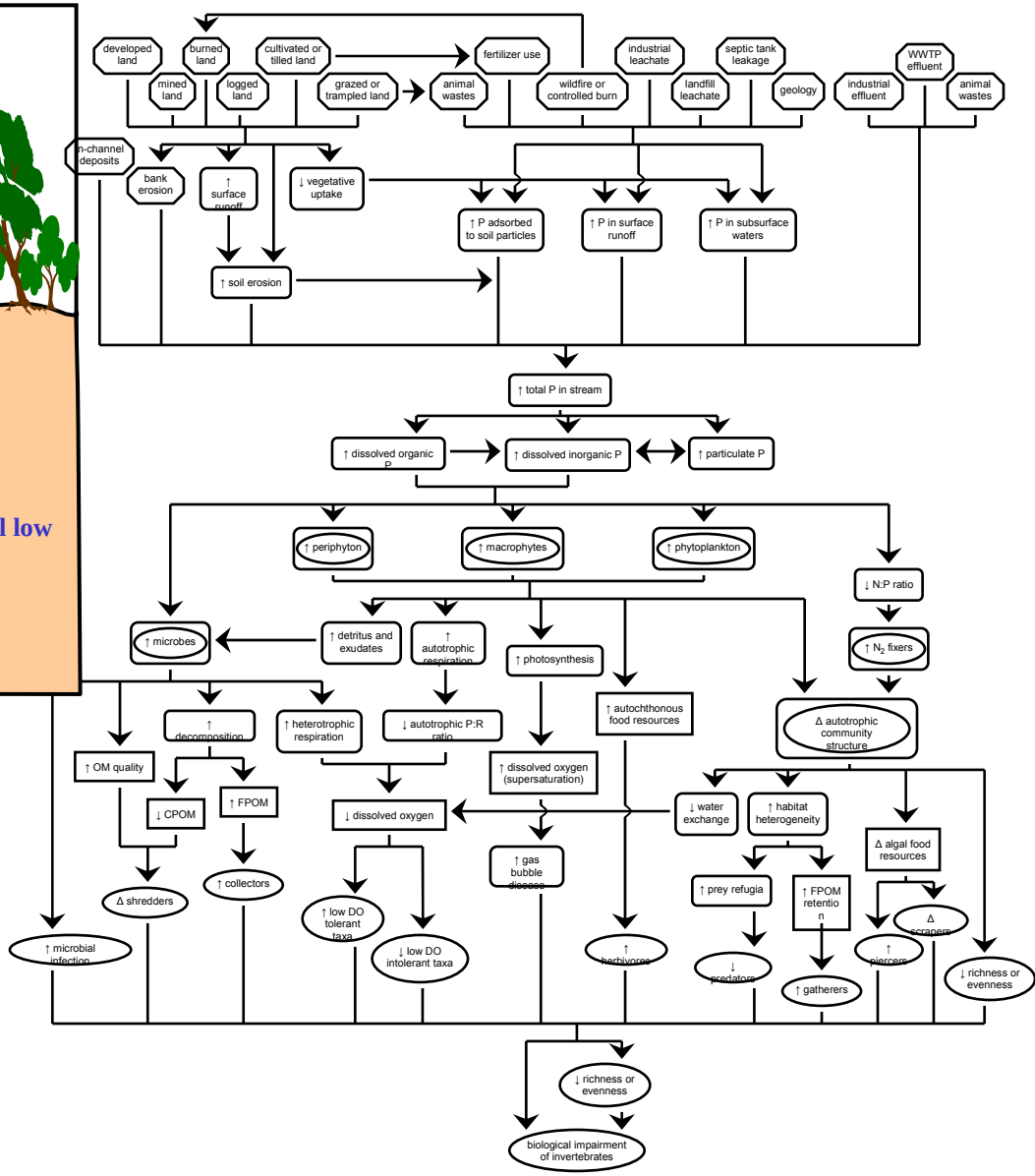
- Clear documentation & justification for each step
- Sources of evidence stated
- Transparency in evidence used
- Transparency in weighting of evidence
- Transparency in combining evidence
- Repeatable verdict

Steps 1 & 2 – Question/activity & location

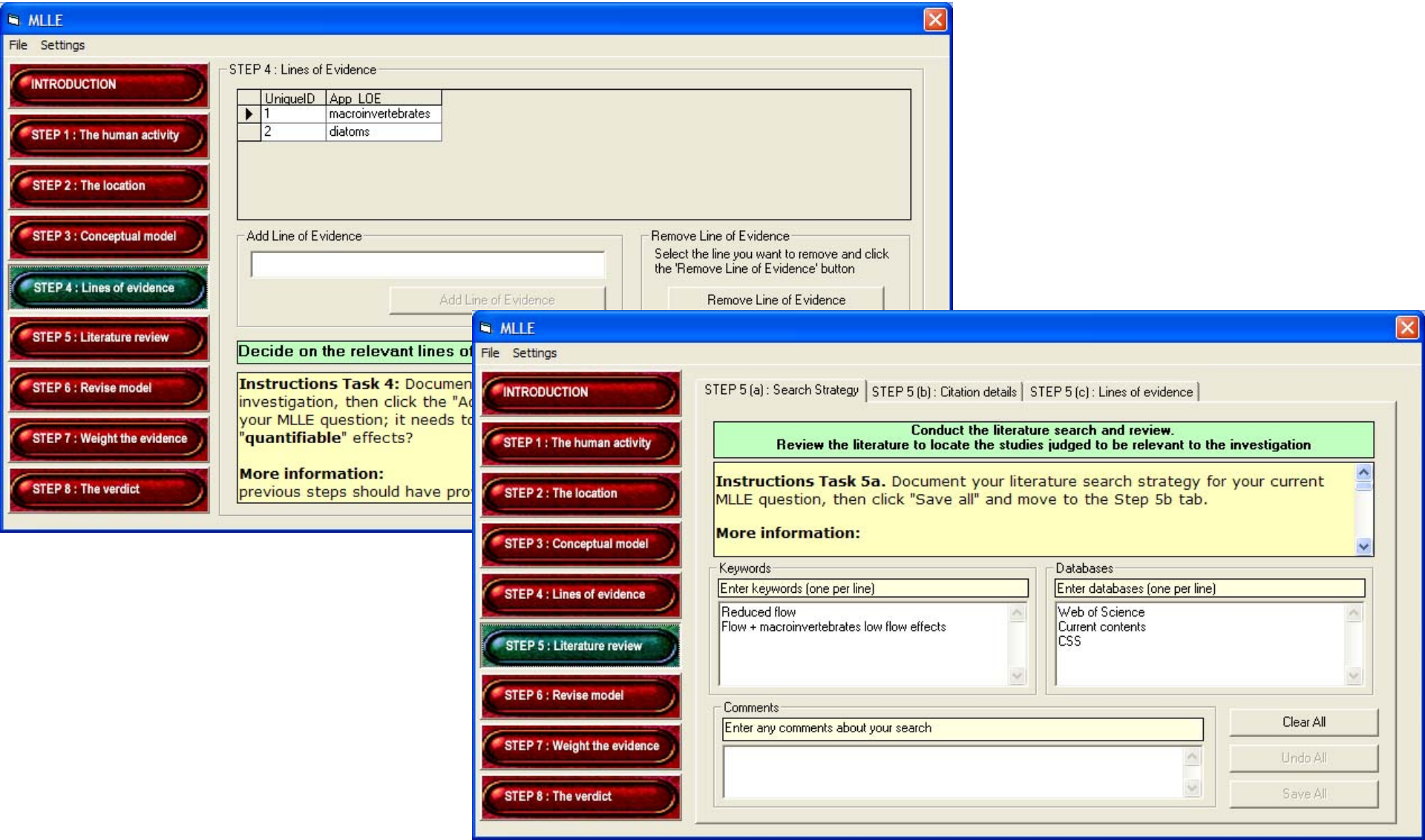


3 Conceptual models

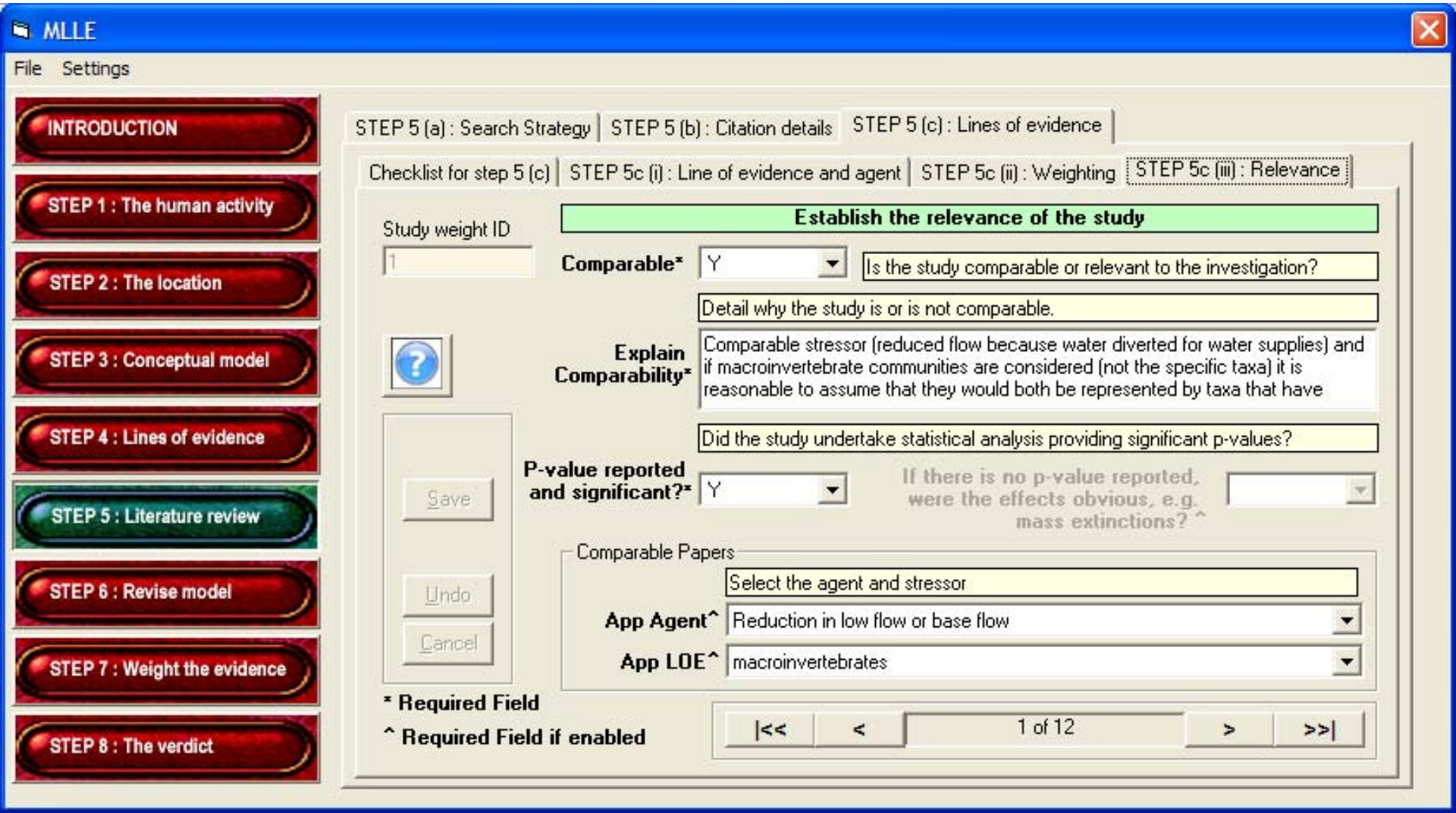




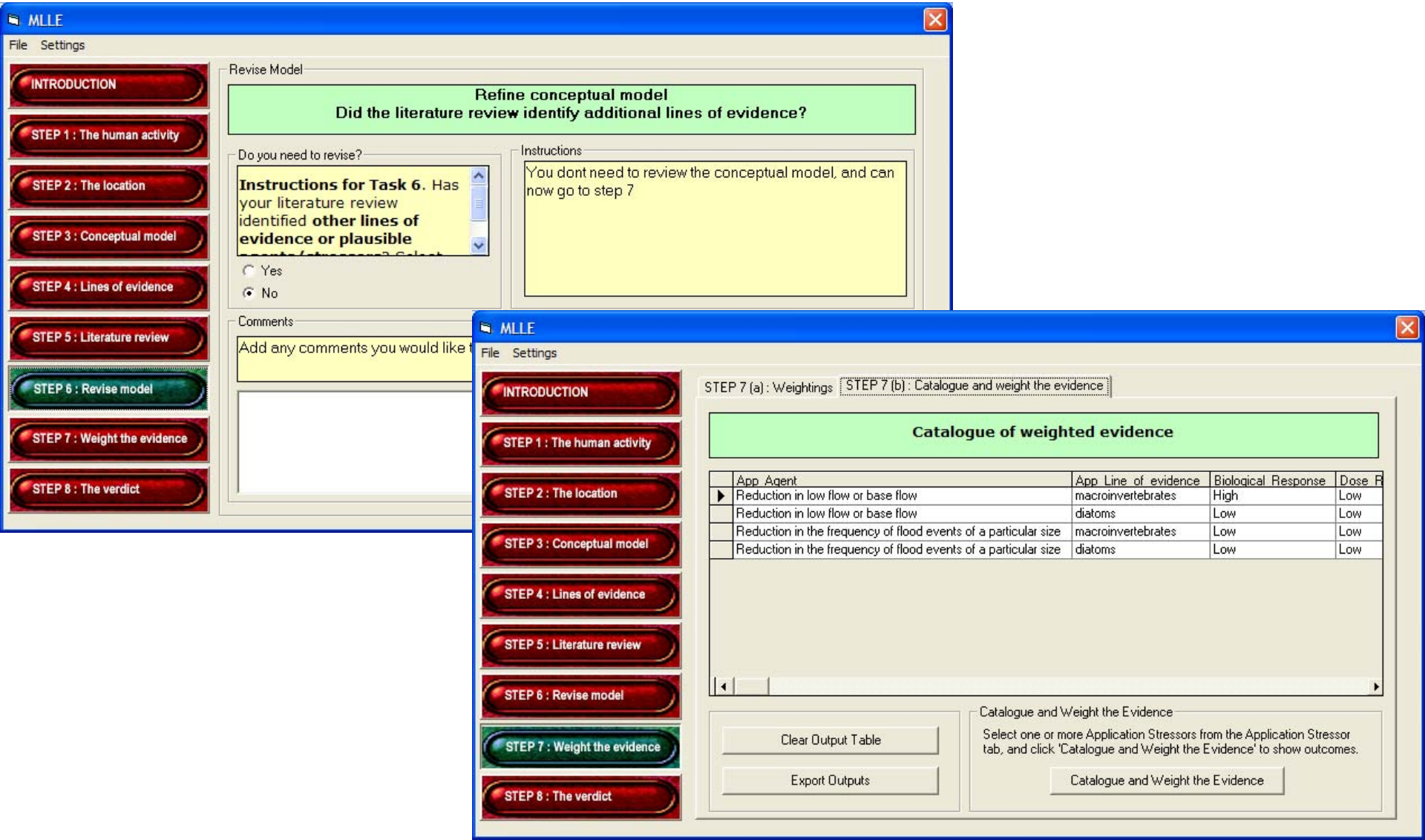
4 & 5 LoE & literature review



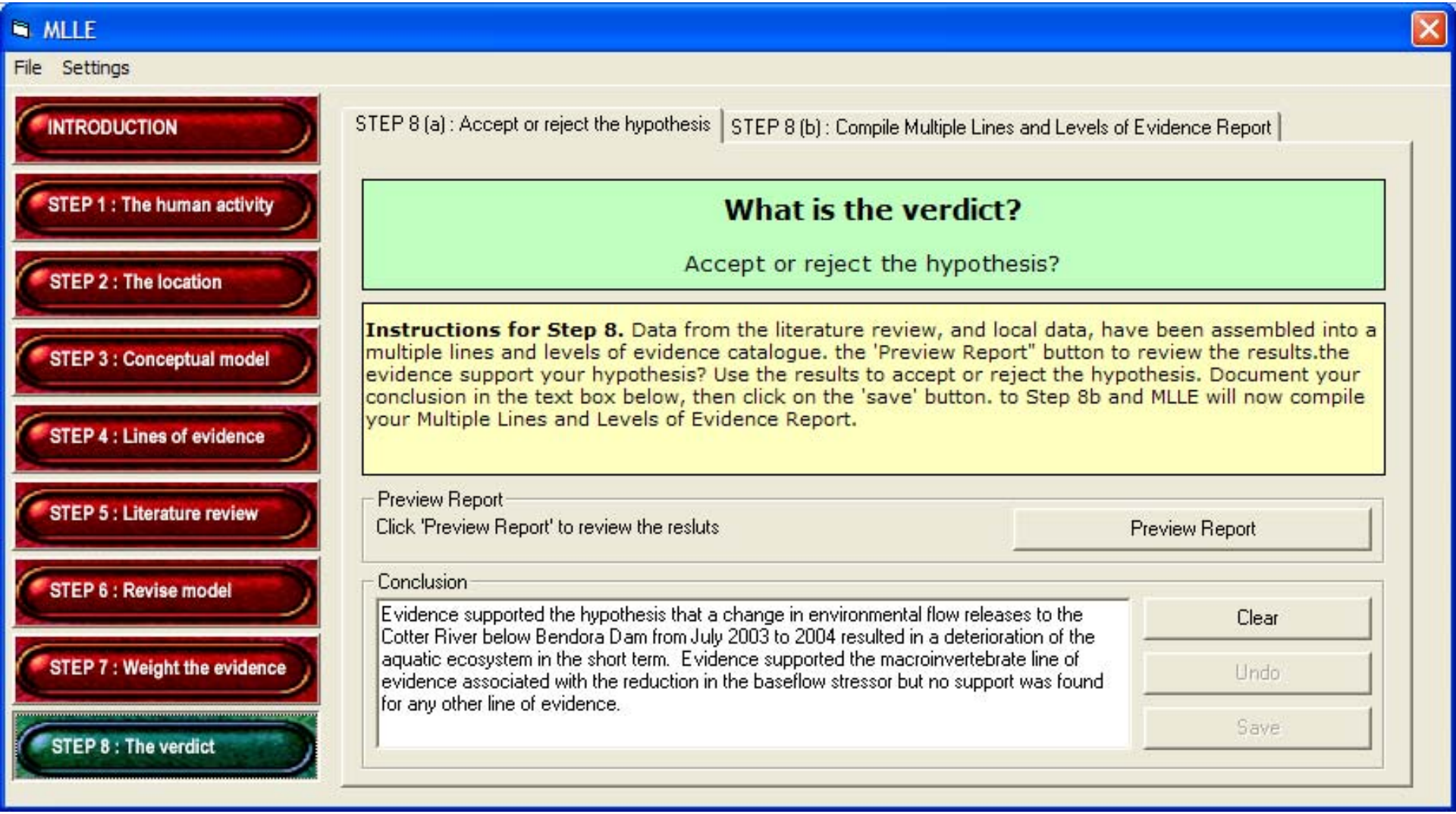
5 – search strategy, citations, LoEs, check, LoE & agent, weighting, relevance



6 & 7 Revise model, weight evidence



8 The verdict



Outputs

- All steps documented
  - Question
  - Location
  - Model
  - Thorough literature search in a framework
  - Quality of studies weighted
  - Combination of evidence
- Verdict transparent

Outcomes

- An objective method to include the literature in assessments
- Strong local data – less need for added evidence from the literature
- Weak local data – more need for added evidence from the literature