



SEVENTH FRAMEWORK PROGRAMME

THEME 6: Environment (including Climate Change)



Adaptive strategies to Mitigate the Impacts of Climate Change on European Freshwater Ecosystems

Collaborative Project (large-scale integrating project)

Grant Agreement 244121

Duration: February 1st, 2010 – January 31st, 2014

Deliverable 2.3: Templates for reviews and common data analyses

Lead contractor: **Swedish University of Agricultural Sciences (SLU)**

Other contractors involved: **UDE, AU, CSIC, Alterra, NERC, BOKU, EMU, NIVA, UCL**

Due date of deliverable: **Month 6**

Actual submission date: **Month 18**

Work package: 2

Contributors: Leonard Sandin, Armin Lorenz, Daniel Hering, Esben Kristensen, Annette Battrup-Pedersen, Eugènia Martí, Piet Verdonschot, Francois Edwards, Astrid Schmidt-Kloiber, Peeter Nöges, Jannicke Moe, Helen Bennion, Stefano Larsen, Martin Kernan

Estimated person months: 2

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)
Dissemination Level (add X to PU, PP, RE or CO)

PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Abstract

The REFRESH reviews focuses on thresholds/references, indicators, and adaptation, mitigation, restoration of European rivers, lakes, and wetland ecosystems. The principal objectives are thus to identify thresholds in structure, function and biodiversity for the effects of temperature, low flows (rivers), low water levels (lakes, including impacts on salinity), changes in flooding regimes (riparian wetlands) and changes in nutrient and organic matter loads (all three ecosystem types). In the project we will then evaluate how the threshold concept and knowledge of specific thresholds can be incorporated into adaptation, mitigation and restoration strategies needed to achieve e.g. the objectives of the WFD and HD.

In work package 2-4 (focusing on rivers, lakes, and wetlands) the basis for successful reviews is a common review collection template as well as a common understanding of how the reviews will be completed. This deliverable therefore focuses on common decisions regarding: i) Focus of the reviews, ii) Database format and template for the reviews, iii) Definitions of review terms, iv) Scientific paper collection.

This deliverable has been produced with a main focus on work package 2 (Rivers). The information from the reviews in WP 2-4 is also an important input to WP5 (modelling), especially regarding ecological indicators including e.g. hydrochemical (nutrients, organic matter, sediment and oxygen) and ecological (gross primary production; system respiration; net primary production; chlorophyll a; and invertebrates, macrophytes, wetland plants, phytoplankton and fish functional groups and abundance).

It was early identified/decided that the reviews in WP 2-4 should (naturally) focus on the ecosystem types: rivers, lakes and wetlands. Within these types further definitions needs to be included (e.g. wetlands is only riparian wetlands) and also that we focus on the main water types that REFRESH focus on e.g. small streams and shallow lakes. In each of WP 2-4 the decisions will be taken on which of these types will be included in the reviews. The focus will also be on: thresholds / references, indicators, adaptation / mitigation / restoration and the drivers: temperature, hydrology, nutrients. Important in the review step is also to identify which of the climate change related stressors that are in fact manageable from an applied perspective, and which ones are not manageable.

The database itself will be built in Microsoft Excel because it is a tool that all partners have access to and it can without any expensive development costs be developed into the tool we need for the REFRESH reviews. The actual journal paper information will be stored in the Excel database, whereas further info regarding the journal papers such as abstract and links to pdf versions of the papers will be stored in Mendeley (a free academic referencing tool; <http://www.mendeley.com/>) or for those partners that wish to use commercial software such as EndNote (<http://www.endnote.com/>).

In order to collect a coherent set of papers that could also be used for further meta-analyses of the topics of REFRESH it is a clear advantage if a common set of review terms could be used, a list with suggestions forms part of the deliverable.

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Introduction

In REFRESH a number of different methods will be used to fulfil the project goals. These include literature reviews, analysing existing long-term and paleolimnological datasets, the collection of new data from field experiments as well as the use of different modelling techniques. The REFRESH reviews focuses on thresholds/references, indicators, and adaptation, mitigation, restoration of European rivers, lakes, and wetland ecosystems. The principal objectives are thus to identify thresholds in structure, function and biodiversity for the effects of temperature, low flows (rivers), low water levels (lakes, including impacts on salinity), changes in flooding regimes (riparian wetlands) and changes in nutrient and organic matter loads (all three ecosystem types). In the project we will then evaluate how the threshold concept and knowledge of specific thresholds can be incorporated into adaptation, mitigation and restoration strategies needed to achieve e.g. the objectives of the WFD and HD.

In work package 2-4 (focusing on rivers, lakes, and wetlands) the basis for successful reviews is a common review collection template as well as a common understanding of how the reviews will be completed. This deliverable therefore focuses on common decisions regarding:

- i) Focus of the reviews
- ii) Database format and template for the reviews
- iii) Definitions of review terms
- iv) Scientific paper collection

This deliverable has been produced with a main focus on work package 2 (Rivers). Similar review templates and a common discussion regarding the development of the reviews have been done in cooperation with WP3 (responsible EMU, Peeter Nöges) and WP4 (responsible FVB, Klement Tockner) as well as a number of partners in in WP2, WP3 and WP4 who are involved in the tasks 4-6 (i.e. the review and data analysis tasks) in these work packages. The information from the reviews in WP 2-4 is also an important input to WP5 (modelling), especially regarding ecological indicators including e.g. hydrochemical (nutrients, organic matter, sediment and oxygen) and ecological (gross primary production; system respiration; net primary production; chlorophyll a; and invertebrates, macrophytes, wetland plants, phytoplankton and fish functional groups and abundance).

Each of workpackage 2, 3 and 4 has three deliverables listed as reviews in the description of work, namely:

- i) Review on processes and effects of temperature regimes in rivers and threats due to climate change on current adaptive management and restoration efforts (WP2, deliverable 2.13, responsible SLU)
- ii) Review on processes and effects of droughts and summer floods in rivers and threats due to climate change on current adaptive management and restoration efforts (WP2, deliverable 2.14, responsible NERC)
- iii) Review on processes and effects of nutrients and organic material in rivers and threats due to climate change on current adaptive management and restoration efforts (WP2, deliverable 2.15, responsible CSIC)
- iv) Review on processes and effects of temperature regimes in lakes and threats due to climate change on current adaptive management and

- restoration efforts (WP3, deliverable 3.12, responsible AU)
- v) Review on processes and effects of changes in water level and salinity in lakes and threats due to climate change on current adaptive management and restoration efforts (WP3, deliverable 3.13, responsible METU)
 - vi) Review on processes and effects of nutrients and organic material in lakes and threats due to climate change on current adaptive management and restoration efforts (WP3, deliverable 3.14, responsible NERC)
 - vii) Review on processes and effects of temperature regimes on riparian wetland key functions and biodiversity: (1) Wetland biogeochemical functioning, (2) habitat provisioning, (3) connectivity and (4) biodiversity (WP4, deliverable 4.9, responsible FVB)
 - viii) Review on processes and effects of water level changes on riparian wetland key functions and biodiversity: (1) Wetland biogeochemical functioning, (2) habitat provisioning, (3) connectivity and (4) biodiversity (WP4, deliverable 4.17, responsible FVB)
 - ix) Review on processes and effects of nutrient load on riparian wetland key functions and biodiversity: (1) Wetland biogeochemical functioning, (2) habitat provisioning, (3) connectivity and (4) biodiversity (WP4, deliverable 4.18, responsible FVB).

As can be seen from the general objectives (reviews of thresholds/references, indicators, and mitigation, adaptation, restoration) it is not always clear how the individual reviews (i-ix above) will deliver the information needed to fulfil the overall goal of the reviews in WP2-4. One of the goals of the current deliverable is thus also to as much as possible make sure that when collecting data for the reviews, information needed to fulfil the overall goals is taken into account and collected in the review databases. This deliverable will not focus on templates for common data analyses as there is currently a greater need for a common review template in the REFRESH project, whereas the possible need for a common data analysis template will come later in the project.

Methods

The development of the review template and database described in this deliverable for use in WP2 that also forms a basis for the review templates and databases in WP3 and WP4 is built on experiences mainly from the Euroimpacs project (Project no. GOCE-CT-2003-505540) where UDE lead reviews on e.g. identification of indicators of climate change in rivers, lakes, and wetlands. In REFRESH the work started with a workshop held at the startup meeting in Antalya, Turkey, 22-26 march 2010 where Leonard Sandin (SLU), Daniel Hering (UDE), Klement Tockner and Stefano Larsen (FVB), Astrid Schmidt-Kloiber (BOKU), and Victor Beumer (Deltares). Here the general outline of the review as well as the initial discussion on what the review templates and databases should look like. Here it was also decided that Leonard Sandin (SLU, WP2), Peeter Nöges (EMU, WP3) and Klement Tockner (FVB, WP4) would take an overarching and bridging role in tasks 4-6 (including the reviews) of WP2-4 of the project.

After some continuation of the work and ad hoc meetings regarding the review templates and databases an e-mail discussion with all included people and institutes was held August 25-31 2010. Leonard Sandin summarised a number of questions that needed answers in order to successfully perform the reviews and the e-mail discussion was initiated using these questions. The initial questions regarding data templates and databases included:

- i) Do you agree with the suggested framework of the review study. In Antalya we discussed to stratify by:
 - Ecosystem type (rivers lakes wetlands)
 - Thresholds / References, Indicators, Adaptation / Mitigation / Restoration
 - Drivers: Temperature, Hydrology, Nutrients
- ii) How to agree a list of variables to be recorded in the review study? For this purpose, we should circulate the list used for BioFresh project, the adaptation of this list by Stefano Larsen and the list of climate-and-freshwater.info. If we do not discuss the details of these lists today, we should agree a clear schedule and responsibilities. The resulting list should of course be adapted to the framework.
- iii) Which sources to adress in the reviews?
- iv) We need to agree on the review procedure. In the first step regarding the integration among WP2-4
- v) Should we use a literature database

- vi) Suggestion from Daniel Hering (UDE): we should also agree about a frequent control - in BioFresh they had an update on the literature list each Friday.
- vii) Do we need to do more regarding the integration within the project at the moment, if so what?
- viii) Do we need to take the metaanalysis into consideration when setting up the the review templates?
- ix) There are some database building anticipated WP2 (BOKU), WP3 (UDE), WP4 (BOKU), is it clear how this building will be done has a format been decided

After this e-mail discussion the completion of the templates/database for reviews in WP2-4 was continued during the autumn of 2010 through further e-mail contacts and ad-hoc meetings among the people involved in the reviews.

Focus of the reviews

It was early identified/decided that the reviews in WP 2-4 should (naturally) focus on the ecosystem types: rivers, lakes and wetlands

Within these types further definitions needs to be included (e.g. wetlands is only riparian wetlands) and also that we focus on the main water types that REFRESH focus on e.g. small streams and shallow lakes. In each of WP 2-4 the decisions will be taken on which of these types will be included in the reviews.

The focus will also be on: thresholds / references, indicators, adaptation / mitigation / restoration and the drivers: temperature, hydrology, nutrients.

Important in the review step is also to identify which of the climate change related stressors that are in fact manageable from an applied perspective, and which ones are not manageable.

It has been stressed several times that it is key that we define the dependent variables very well. This will be done in a two-step manner: within each WP reviews working group all variables/factors for each of the ecosystem types will be collected (a first complete version for WP2 is included in this deliverable). Secondly we will look at these variables/factors together on a WP2-4 level as well and make sure that they are coherent during execution of the reviews.

For work package 2 the focus will be mainly on small-sized lowland streams in Europe, partly because these are among the most vulnerable stream ecosystem (to climate change) and also since this is the main focus for the REFRESH WP 2 field manipulation studies. Thus focusing the work package 2 reviews on small-sized lowland streams in Europe will benefit the other tasks 4-6 in work package 2 such as: develop indicator response models for (HD) river habitats that are vulnerable to climate change, develop tools for vulnerability assessment in managed and restored rivers, producing a handbook/guideline and a common (WP2-5) database for practical application and costs-effectiveness of indicators and measures, identify main drivers of recovery of biodiversity and ecosystem structure and functioning in rivers, provide tools for the development of adaptation, mitigation and restoration strategies. By focusing on a few relatively well-defined stream types we will use the available resources as cost-effective as possible with an output gaining the whole REFRESH project, including the work package 5 (modelling).

Database format and template for the reviews

Database tool

The database itself will be built in Microsoft Excel because it is a tool that all partners have access to and it can without any expensive development costs be developed into the tool we need for the REFRESH reviews. Also using Excel means that all partners can work individually adding data to the database and we can then easily aggregate the collected data into one common review database for further common analyses/outputs. The actual journal paper information will be stored in the Excel database, whereas further info regarding the journal papers such as abstract and links to pdf versions of the papers will be stored in Mendeley (a free academic referencing tool; <http://www.mendeley.com/>) or for those partners that wish to use commercial software such as EndNote (<http://www.endnote.com/>) (see below in the section scientific paper collection).

Main data descriptors

In order to collect the necessary review data in the database it is important to define a few main descriptors that needs to be collected and added to all journal papers that are added to the database. These include:

- i) Information about the journal paper itself (authors, title, journal, year published etc).
- ii) Information regarding the importance of the paper for the REFRESH reviews and for which part(s) of the reviews the paper is of use
- iii) Definition of the ecosystem type analysed in the paper (e.g. small streams, large rivers), where spatial extent of the study (e.g. one system, region, or larger part of e.g. Europe), this also includes e.g. maximum and minimum longitude and latitude of the study, and in which biome the study is performed
- iv) Information regarding the spatial and temporal scales that the study encompasses
- v) Definitions of drivers of change
- vi) Definition of responses e.g. chemical-physical, biological including functional
- vii) Is the reference condition approach used in the paper and how is it defined
- vii) Does the study include adaptation and restoration measures and e.g. are they successful, what are the costs related to these measures

Specific definitions of the data descriptors

To be able to collect data from the reviews in a coherent way so that it can be used both within each workpackage as well as by other workpackages within the REFRESH project it is important that the data descriptors/parameters collected are collected for all journal papers entered into the database and that all information that all people entering data into the database have a common understanding of the different parameters. Below is therefore a short list and description of all parameters for the WP2 review template.

1. ID

a unique ID code for every reference entry – will be decided by each reviewer

2. Author

Author information for the journal article entered into the database

3. Title

Full title of the journal article

4. Journal

Full journal title

5. Year

Publication year of the journal article, articles published in the years 2000 to 2010 will be included in the database

6. Concept of paper

Definition of the main concept of the journal article, i) conceptual, ii) data driven, iii) not specified, iv) not applicable

7. Utility for thresholds / reference conditions identification

Subjective judgment on the utility of the paper for identifying thresholds and or reference conditions. Defined as: i) High, ii) Intermediate, iii) Low, iv) Not applicable.

8. Utility for metadata analyses

Subjective judgment on the utility of the paper for metadata analysis of interest for the REFRESH project. Defined as: i) High, ii) Intermediate, iii) Low, iv) Not applicable.

9. Useful for pressure type

Definition of which type(s) of pressures of interest to REFRESH that is the focus of the journal article. The types are: i) Temperature, ii) Drought and flood, iii) Nutrients and organic matter, iv) Not applicable.

10.Ecosystem type

Definition of which type(s) of ecosystems of interest to REFRESH that is the focus of the journal article. The ecosystems are: i) River, ii) Lake, iii) Wetland, iv) Not applicable

11.Stream width

Definition of stream width(s) in the systems studied in the journal article. Defined as: i) <2 m, ii) 2-10 m, iii) > 10 m, iv) Diverse, v) Not applicable.

12.Catchment area

Definition of catchment area size(s) in the systems studied in the journal article. Defined as: i) 0-10 km², ii) 10-100 km², iii) > 100 km², iv) Diverse, v) Not applicable.

13.Nutrient status

Definition of nutrient status in the systems studied in the journal article. Defined as: i) Low nutrient, ii) Intermediate nutrient status, iii) High nutrient, iv) Diverse, v) Not applicable. ***N.B. A common definition of the nutrient status classes needs to be decided upon.***

14.Latitude northernmost

The northernmost sampling point in the system(s) studied in the journal article. Defined as between -90 and 90°, whole degrees, southern latitude negative.

15.Latitude southernmost

The southernmost sampling point in the system(s) studied in the journal article. Defined as between -90 and 90°, whole degrees, southern latitude negative.

16.Longitude westernmost

The westernmost sampling point in the system(s) studied in the journal article. Defined as between -180 and 180°, whole degrees, western longitude negative.

17.Longitude easternmost

The easternmost sampling point in the system(s) studied in the journal article. Defined as between -180 and 180°, whole degrees, western longitude negative

18. Altitude

Definition of the sampled altitude of the system(s) studied in the journal article. Defined as: i) < 200 m, ii) 200-800 m, iii) > 800 m, iv) Diverse, v) Not applicable.

19. Main catchment land-use

Definition of the main catchment land-use type in the system(s) studied in the journal article. Defined as: i) Agriculture, ii) Urban, iii) Forest, iv) Diverse, v) Not applicable.

20. Biome

Definition of the biome where the studied system(s) are found. Defined as: i) Equatorial, ii) Tropical, iii) Subtropical, iv) Mediterranean, v) Cold temperate, vi) Warm temperate, vii) Nemoral, viii) Continental, ix) Boreal, x) Polar, xi) Combination, xii) None, xiii) Not specified, xiv) Not applicable. ***N.B. I can not find the definitions of these biome types? What is the reference for these?***

21. Biogeographic region/realm

Definition of the biogeographic regions/realm where the studied system(s) are found. Defined as: i) Nearctic, ii) Neotropic, iii) Palearctic, iv) Afrotropic, v) Indo-malayan, vi) Oceania, vii) Australasia, viii) Antarctic, ix) Global, x) Not specified, xi) Not applicable. The definitions for the biogeographic regions are defined at:

http://en.wikipedia.org/wiki/Terrestrial_ecozone

22. Spatial scale

Definition of the spatial scales investigated in the studied system(s). Included scales are: i) Micro/mesohabitat, ii) Site, iii) Reach, iv) Catchment, v) Ecoregion, vi) Continental, vii) Global, Ecozone, viii) Not specified, ix) Not applicable. ***N.B. These scales has not yet been defined.***

23. Temporal scale

Definition of the temporal scales investigated in the studied system(s). Included scales are: i) < 1 month, ii) < 1 year, iii) years, iv) decades, v) centuries, vi) Not applicable, vii) Not specified.

24. Driver (regime based assessment)

These should focus mainly on regime alterations in the studied system(s), e.g. increase in average, range, timing etc. The drivers include: i) Temperature, ii) Hydrology, iii) Nutrient(s), iv) Interactions.

25. Secondary (other) driver

The study could also include a secondary (other driver): i) Temperature, ii) Hydrology, iii) Nutrient(s), iv) Interactions.

26. Response variables - indicators

At the moment response variables and/or indicators are kept together. Some of them will be unique to a particular ecosystem, others will be shared across ecosystems. The response variables include: Physico-chemical, biological (organism), biological – response indicator (e.g. species traits), and functional.

27. Physical-chemical response variables - indicators

The potential physical-chemical response variables – indicators in the studied system(s) include: i) oxygen saturation, ii) redox potential, iii) pH, iv) temperature, v) nutrient concentration, vi) C/P/N ratio.

28. Biological (organism group) response variables - indicators

The potential biological (organism group) response variables – indicators in the studied systems include: i) fish, other vertebrates; e.g. amphibians, birds), iii) invertebrates, iv) riparian plants, v) macrophytes, vi) zooplankton, phytoplankton, vii) phytobenthos, viii) bacteria, ix) others, x) all, not specified, xi) not applicable.

29. Biological response - indicators

The potential biological response– indicators in the studied systems include: i) species traits, ii) assembly composition, iii) diversity, iv) biomass, v) abundance, vi) richness, vi) not specified, vii) not applicable.

30. Functional - indicators

Potential functional indicators in the studied system(s) include: i) nutrient retention, ii) nutrient removal/denitrification, iii) decomposition, iv) primary production, v) nutrient spiralling, vi) food web structure/size, vii) not specified, viii) not applicable.

31. Direction of response

For each of the measured physico-chemical or biological response variable – indicator the direction of response should be recorded for each studied system. The response could be: i) increasing, ii) decreasing, iii) unimodal, iv) no response, v) not specified, vi) not applicable.

32. Change in thresholds

In addition to the direction of response, each study should also be evaluated to see if there is any threshold changes in each study: i) yes, ii) not assessed, iii) no.

33. Change in reference conditions

Further whether or not the reference condition changed in the study should be evaluated; i) yes, ii) no, iii) not relevant.

34. Restoration or management of the system(s)

In the next section different aspects of restoration and management of the studied system(s) should be recorded, these include: i) restoration and management measures, ii) methods, iii) effects, iv) impacts of climate change on success rates (direction), v) impacts of climate change on success rates (principal mechanism), vi) impacts of climate change on success rates (mechanism explained).

35. Restoration or management measure

The main restoration or management measure should be recorded (if applicable): i) physical improvements, ii) reducing nutrients, iii) hydrology, iv) biological (stocking), v) riparian, vi) catchment level, vii) a combination, viii) Other, ix) no, x) not relevant.

36. Restoration or management method used

Definition of the restoration or management method used in the studied system(s): i) re-meandering, ii) in-stream improvements, iii) nutrients, iv) buffer strips, v) fish stocking, vi) riparian tree planting, vii) land-use change, viii) a combination, ix) other – define.

37. Restoration or management effect

After the system has been restored or managed what was the effect on the response variable: i) decreased temperature, ii) decreased nutrient concentration, iii) increased water levels, iv) increased N/P ratio, v) decreased N/P ratio, vi) increased C/P ratio, vii) decreased C/P ratio, viii) increased C/N ratio, ix) decreased C/N ratio, x) macrophyte recovery, xi) macroinvertebrate recovery, xii) fish recovery, xiii) riparian vegetation recovery, xiv) combination, xv) Other, xvi) not known.

38. Impact of climate change on restoration or management success rate (direction)

If there is a climate change effect on the restoration or management success, then the direction of the rate should be recorded: i) CC supports effect, ii) CC counteracts the effect, iii) climate neutral, iv) not known.

39. Impact of climate change on restoration or management success rate (principal mechanism)

If there is a climate change effect on the restoration or management success, then the principal mechanism for how climate change affects the system should be recorded: i) direct temperature effect, ii) drought increased, iii) flooding increased, iv) changed hydrological regime, v) changed length of growing season, vi) changed nutrient loading, vii) changed salinity, viii) changed organic loading, ix) changed oxygen regime, x) not explained.

40. Impact of climate change on restoration or management success rate (mechanism explained)

If there is a climate change effect on the restoration or management success, then the principal mechanism for how climate change affects the system should be explained here.

41. Reference streams

Record whether or not the studied system(s) include reference streams or rivers: i) yes, ii) no, iii) not mentioned.

42. Reference method used

If the dataset contains references, how have these references been defined: i) spatial scale scheme, ii) paleoecology, iii) modelling, iv) expert judgement, v) historical data, vi) a combination, vii) other, viii) not applicable.

43. Physical-chemical reference conditions

If the reference conditions have been defined using physico-chemical variables: i) nutrients, ii) pH/alkalinity, iii) salinity, iv) hydrology, v) temperature, vi) toxic pollutants, vii) several, viii) not applicable.

44. Ecological reference conditions

If the reference conditions have been defined using ecological variables: i) phytoplankton, ii) phytobenthos, iii) macrophytes, iv) macroinvertebrates, v) fish, vi) zooplankton, vii) other, viii) several, ix) not applicable.

Definitions of review terms

In order to collect a coherent set of papers that could also be used for further meta-analyses of the topics of REFRESH it is a clear advantage if a common set of review terms could be used. The list below is far from exhaustive, but a starting point for further refinements and discussion (focusing on WP2).

Ecosystem type:

Stream*, river*, running water*

Focus of the reviews:

Threshold*, reference*, indicator*, adaptation*, mitigation*, restoration*

Drivers:

Temperature*, hydrolog*, drought*, flood*, nutrient*, climate change*

Response variables:

Chemical:

Oxygen*, redox potential*, pH, temperatur*, nutrient*, C/P/N ratio

Biological:

Fish*, vertebrate*, amphibian*, bird*, invertebrate*, riparian plant*/vegetation*, macrophyte*, zooplankton*, phytoplankton*, phytobenth*, bacteria

Functional:

Nutrient retent*, nutrient removal/denitrification*, decomposition, primary product*, nutrient spiralling, food web structure/size

Management measures/responses:

Re-meandering, in-stream improvements, buffer strips, fisk stocking, riparian tree planting, land-use change, water levels, recovery

