FRESHMAN: Management of freshwater ecosystems in a changing climate - effectiveness of restoration measures

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Methods and procedures

Freshwater ecosystems (watercourses and lakes) belong to the environments most modified by human use (Nilsson et al. 2008). Climate change will also transform freshwater ecosystems (Hein et al. 2011, Ström et al. 2012, Schneider et al. 2013), calling for review of their future management to ensure biodiversity protection and provision of important ecosystem services and functions. Additional pressure on freshwaters may come from efforts to mitigate against climate change. For example, the required shift to renewable energy sources to reduce greenhouse gas emissions will increase the demand for hydropower (REN21 2017), resulting in more intense flow regulation with negative consequences for regulated stream and lake ecosystems (Bejarano et al. 2017). At the same time, legal and public demands to improve the ecological status of freshwater ecosystems are increasing, calling for restoration actions. However, whether such actions will be effective or relevant in a future climate is poorly understood.

The purpose of this project is to evaluate how methods for restoration of streams and lakes and adjoining riparian ecosystems will respond to climate change, and analyse available options to manage biodiversity and ecosystems functions and services from streams and lakes in the face of climate change. Our aims fall into three areas: the toolbox (restoration measures), the challenges (threats and conflicts) and recommendations:

The toolbox: What will be the effectiveness and relevance of restoration methods for freshwater ecosystems in a future climate? Will the methods be effective in securing biodiversity and ecosystem functions of freshwater ecosystems in a future climate?

The challenges: How will restoration needs change in a future climate? How will actions to mitigate against climate change, e.g. by increasing production of renewable energy sources such as hydropower affect freshwater ecosystems? How to manage streams and lakes to obtain multiple ecosystem services? How does the position in the catchment of restoration actions affect its effectiveness, that is, how are areas upstream and downstream affected by a specific restoration action?

Recommendations: Guidance and recommendations for prioritizing and implementing restoration measures in the future: How to choose among restoration measures, contribute to climate mitigation and adaptation, and enhance multiple use of freshwater ecosystems?

These issues will be address in three work packages (WP) focusing on (1) review of restoration measures; (2) analysis of future pressures and management challenges; (3) synthesis and recommendations, described under the Management heading.

Competence and experience of the applicants

We are well equipped for the task of synthesizing scientific literature on restoration and conservation of freshwater ecosystems, as well as integrating views and opinions from leading experts in various disciplines through our previous experience with similar tasks. Together, we have experience of leading multiple research projects aimed at analysing and synthesising ecosystem responses to restoration of freshwater environments, quantifying effects of human use and remaining natural values in freshwaters, along with work to find a method to prioritise among restoration measures to enhance freshwater ecosystems. In addition, we are leading projects implementing restoration measures to improve ecological conditions in freshwater ecosystems.

We led one of three projects in the research programme "*Power and Life in Water*" (www.elforsk.se/Kraft-och-liv-i-vatten/), funded by Energiforsk, the Swedish Agency for Marine and Water Management and the Swedish Energy Authority. The aim of the project was to produce a model for how to prioritise among measures to improve the ecological conditions of regulated rivers. This implied reviewing and evaluating the effectiveness of restoration measures used to enhance the ecological status of conditions in catchments with regulated flow, presented in a the report Jansson et al. (2017). We also presented a methodology for assessing the restoration needs and natural values in regulated catchments (Renöfält et al. 2017), and a method for calculating costs and benefits of implementing various restoration measures, including environmental flows, based on predictions of habitat gains for target species and costs (Widén et al. 2017).

We also reviewed natural values and restoration opportunities in river and stream reaches with reduced discharge in a project for the Swedish Agency for Marine and Water Management, resulting in the report Renöfält et al. (2015).

We initiated and led the Ume River project, which pioneered assessment of restoration opportunities and needs in a large catchment, and developed new methods for restoration actions. The project resulted in inventories and restoration assessments for the entire catchment, presented in Widén et al. (2016). The restoration work is now formalised in the Association for Collaboration in the Ume River ("Föreningen Samverkan Umeälven"), coordinating ecological restoration activities in the catchment, where the applicants are chair (ÅW), deputy chair (BMR) and vice chair (RJ) in the board. The association is open to all, and local fish management associations and representatives of NGOs are members. We also have restoration projects funded by and in collaboration with the hydropower companies Statkraft and Vattenfall.

We both have experience of leading work quantifying ecosystem services. RJ coordinated a research project funded by the Nordic Councils of Ministers assessing the effects of climate change on biodiversity and goods and services from natural ecosystems in the Barents Region (northern Norway, Sweden and Finland and north-western Russia) where we synthesized the effects of climate change in an effort where leading experts in the field met in consecutive workshops with the results reported in review papers (e.g., Jansson et al. 2015). BMR was leader of a cluster group at the Stockholm International Water Institute/Swedish Waterhouse, focusing on securing water for ecosystems and human well-being. The main objective of this work was to foster collaboration among various sectors in society, particularly between academia and practitioners and policy writers, and to disseminate knowledge about water related issues to the general public.

We also have long experience in synthesising a body of scientific work into review papers, where leading workshops as a part of the process to integrate experience and opinions of multiple experts was an important aspect as outlined above, examining topics focussing on conservation and restoration of freshwater ecosystems, including effects of hydropeaking on riparian ecosystems (Bejarano et al., in press), invasive species (Catford and Jansson, 2014), effects of climate change on riparian ecosystems (Nilsson et al. 2013), opportunities for e-flow implementation (Renöfält et al. 2010 and criteria for successful river restoration (Jansson et al. 2005).

The main applicant, Roland Jansson (RJ), has formally collaborated with 57 scientists from 15 countries outside of Sweden in completed projects leading to at least one scientific publication. RJ was head organizer of the *2nd International Symposium on Riverine Landscapes* 2004, with 26 invited speakers and participants from 17 different countries. RJ recently took the initiative (as one of six applicants) to the EU COST Action network "CONVERGES" (Knowledge conversion for enhancing management of European riparian ecosystems and services) which was funded. The network aims to bring together the diverse body of knowledge that exists across Europe about riparian vegetation in order to create a new synthesis that will help overcome barriers and lack of communication among stakeholders in riparian research and management and help to mitigate several environmental issues that affect COST Countries. The network consists of researchers and managers from 26 countries (more may be added). The second applicant, Birgitta Malm Renöfält (BMR), has collaborated with various leading international researchers on e-flows, as well as representatives of national and international NGOs. BMR is also a representative in the working and reference group on best available hydropower technique from an ecological perspective at the Swedish Agency for Marine and Water Management. Her focus in this group is on balancing the need between hydropower production and the flow requirements of riverine ecosystems. This group consists of various stakeholders, representing local and regional management authorities, as well as power companies and researchers.

In addition to the projects leading synthesis and workshop activities, we have both led several projects focussing on topics relevant for restoration and management of stream ecosystems, with the aim e.g. of evaluating the effects of climate change on riparian ecosystems, ecosystem consequences of dam removal and effects of river regulation.

To conclude, we argue that considering the short time frame available for the project, and since we think that synthesizing existing literature on restoration measures needs to be complemented by analyses of likely future challenges and approaches allowing multiple use of ecosystems, a project where a limited number of researchers synthesize the knowledge and knowledge gaps with input from leading experts is more efficient than a consortium of experts from all relevant fields.

Management

The project is divided into three work packages (WP) described below.

WP1 Effectiveness and relevance of restoration measures in a future climate

To evaluate the relevance and effectiveness of restoration measures in a future climate, we will review the scientific literature (including so called "grey literature") to identify restoration measures to improve ecological conditions in lakes or streams and evaluate how it will be affected by climate change. For each restoration measure identified, we will collect and summarise information regarding its mechanism, target ecosystem, purpose, and level of scientific support of its effectiveness.

We will analyse the evidence that the identified restoration measures proposed to bring ecosystems loser to a desired state are effective. We will use information from the scientific literature, assessing the evidence that a restoration measure would be effective in falling degrees of certainty:

1. Evidence from restoration evaluations that a restoration measure has improved ecosystem processes or created habitat for specific species.
2. Evidence that a process negatively affected can be manipulated in the wanted direction by a restoration measure
3. Evidence that there is a casual connection between a process that has been degraded, and the restoration measure.

In addition, we will assess to what degree the restoration measure has been found to succeed in bringing the ecosystem to the desired state. That is, establishing that a restoration measure has a detectable effect is separate from drawing conclusions on the magnitude of the effect, in analogy with the difference between statistical significance and effect size.

We will classify restoration measures into three groups depending on the type of effect into (1) primary measures, that affect ecological processes, (2) secondary measures, that aims to create physical habitat conditions for species, and (3) tertiary measures, consisting of measures to introduce missing taxa using stocking, seeding or planting. We will also record the target ecosystem type of the restoration measure, which problem or type of degradation the measure is designed to alleviate, and information on the importance of position in the catchment for the effect of the measure. Based on this information, we will explore the expected effects of climate change on (1) the method, (2) the target ecosystem, and assess the relevance of the measure in a future climate

This work is facilitated by our recent work summarising scientific evidence for the effectiveness of various measures to improve conditions in regulated rivers (Jansson et al. 2017). We will expand this work to include all restoration measures used or suggested for streams and lakes, and add on the information described above. The primary output of this review process will be a list of restoration measures with information on:

- Target ecosystem (type of ecosystem where the measure is implemented)
- Mechanism proposed to why the measure would result in enhancement
- Importance of position in the catchment
- Purpose of the restoration measure, i.e. the problem it intends to fix
- Level of scientific support
- Effectiveness in a future climate – will the restoration work?
- Relevance in a future climate – is the restoration measure solving a relevant problem?

Based on this, we will be able to identify knowledge gaps and formulate hypotheses about the likely effects of climate change on restoration measures and the opportunities for implementing them. The results of this process will be presented in a scientific paper in an international, peer-reviewed journal, and in a Swedish report.

WP2 Future pressures and management challenges

To help management of freshwater ecosystems in a future climate, the review of future of restoration measures needs to be complemented by analyses of future challenges expected for freshwater environments. Climate change is expected to result in increasing conflicts over uses of freshwater environments (Palmer et al. 2008): The transition to renewable electricity production means that the importance of hydropower will increase, having the ability to store water and respond to short-term changes in electricity demand (REN21 2017). There are also increasing demands to conserve and restore freshwater ecosystem functions and biodiversity, as well as providing services such as recreation, domestic water and protection against floods and draughts. Climate change will transform freshwater ecosystems and alter on-going uses by changing hydrological regimes and by freshwater species adjusting their geographic ranges in response to warming (Ström et al. 2012, Catford & Jansson 2014). To fill the knowledge gaps about these conflicts, we plan to (1) provide scenarios of future hydropower production and opportunities for implementing environmental flows (e-flows) in regulated river systems, and (2) synthesise experiences of approaches to accommodate multiple use of ecosystem services in freshwater ecosystems in a literature review.

(1) Scenarios of hydropower production and environmental flow opportunities in a future climate

To provide information about conflicts between hydropower use and restoration of freshwater ecosystems, we will produce scenarios of hydropower production with different e-flow options using projections of future flows. For each of the e-flow alternatives, we also predict restoration benefits as the areal gain in habitat for aquatic and riparian organisms. The result is predictions of changes in hydropower production and habitat availability for freshwater organisms expected in the future.

We will use projections of future flows from the SWECLIM project, where global circulation models were downscaled to Scandinavia, with future run off as one of the outputs (Andréasson et al. 2004). Hydropower production and e-flow potential is modelled in the production optimisation software ProdRisk, produced by SINTEF (www.sintef.no). The software is used by hydropower companies to enable running the multiple hydropower stations in a catchment to maximise production and profits given technical and legal constraints. In ProdRisk, water is routed through the river system taking the capacity of all reservoirs and power stations into account. Stochastic dual dynamic programming is used to find a solution that maximizes hydropower production given the constraints and parameters in the model. These constraints and parameters are e.g. the storage capacity of reservoirs, the minimum flow to drive the turbines in a power station or its maximum capacity, and the price for electricity at different times during the day. In brief, the solution is achieved by dividing the overall problem into smaller optimization problems, which are solved by using linear programming and coordinated by using on the principle of Benders decomposition.

We will take advantage of our previous work using ProdRisk in the regulated Ume River system, where we pioneered using the tool also for evaluating the costs of various options for e-flows (Widén et al. 2016, 2017). We did this by adding additional constraints to the technical and legal ones, describing how water is allocated to maintain ecosystems. This was done using real flow data from the latest decades. Now, we will switch to using projections of future flows. We will run a set of scenarios with different conditions assumed:

1. Null model. The model is run with present flows and constraints, for comparison.
2. No e-flow alternative. The model is run with future flows but present water allocation rules. This will demonstrate how much extra electricity the increase in discharge could give.
3. Current e-flow options. This scenario will use the set of e-flow options deemed feasible under present hydrological conditions. It will show whether or not e-flows will become "cheaper" in the future, costing less in terms of production loss.
4. With options for e-flows as projected for the future, with additional e-flow options deemed needed or realistic to implement in the future.

The position in the catchment is important when calculating both the benefits and costs of e-flow options, as water is received from upstream and is routed downstream.

An additional advantage of using the Ume River as a model system is that we can estimate how much the gain in the area of aquatic and riparian habitats will be for each e-flow alternative, given previous inventories of natural values and habitat conditions (Widén et al. 2016, Renöfält et al. 2017). These inventories represent years of inventories, and means that a lot will be achieved in the project, despite the short project duration. The ProdRisk modelling will be performed by Åsa Widén at SINTEF in Trondheim. Following that, predictions of gains in habitat area are estimated, based on previous inventories of natural values.

(2) Synthesis of approaches to accommodate multiple use of ecosystem services in freshwater ecosystems

How to balance and reconcile different types of resource extraction and ecosystem service provision will always be context dependent and vary among sites. At the same time, the need to balance multiple needs is general, and there is potential to learn from experiences in other types of systems and situations (Acreman et al. 2014, Strayer & Dudgeon 2010) with relevance for Swedish conditions. Therefore, we will review approaches to multiple use of ecosystem services in freshwater ecosystems to help finding methods to balance ecosystem protection and restoration.

Management of ecosystems may need to change as a result of (1) changes in the extrinsic ecosystems, (2) changes in what we want from them, and (3) the tools available to realise our demands. We will review and synthesize examples of changes in the governance and management of freshwater ecosystems resulting from changes in either or several of theses factors. For each example found, we will:

- record the types of changes and the ecosystem type,
- management methods,
- ecosystem services,
- geographic region and

- human impacts involved.

Such an empirical database of management options in different conditions forms a basis for discussing management and governance options in a future climate for Swedish freshwater ecosystems. The review work will be done by Roland Jansson and Birgitta Malm Renöfält.

Deliverables: (1) Scenarios for potential increases in power production or e-flow measures in regulated river catchments with future flows. The results will be presented in a scientific paper. (2) A review of governance options in response to various human impacts, ecosystem services and management types of freshwater ecosystems. This will be presented in a review paper in a peer reviewed scientific journal.

WP3 Synthesis and recommendations

WP3 acknowledges the need for input from multiple stakeholders and disciplines to be able to provide guidance on how to manage freshwater systems in a future climate. Here, we will present the preliminary results of WP1 and WP2 to a working group consisting of experts from multiple disciplines and stakeholders, which will then strive for reaching a synthesis with management recommendations, identification of conflicts among stakeholders, and need for new knowledge.

There will be two subgroups within the working group, one focussing on streams and the other on lake ecosystems since management options, restoration measures and stakeholders often are different between the two types. The working group will consist of the following competences, altogether being about 15 persons:

- The project leaders (being stream ecologists with experience from northern, regulated rivers and of plants)
- Researchers being experts on fish, lake and stream food webs, and macroinvertebrates
- Representatives from the Swedish Agency for Marine and Water Management and the Swedish Environmental Protection Agency
- Representatives from County Administrations
- Hydropower company representatives
- Farming representative
- Representatives from NGOs (Älvräddarna and Worldwide Fund for Nature)

With this composition we have opted for involving practitioners rather than social scientists that are experts on governance and management, prioritising hands-on experience over theoretical conceptualization.

The working groups will discuss and provide input to the work produced in the other work packages, and synthesize the results by providing guidance and identifying knowledge gaps:

1. Discussion of the results of the restoration measure review, synthesis of lessons learnt and identification of knowledge gaps
2. Discussion of scenarios of future hydropower production and opportunities for e-flow implementation in regulated rivers
3. Discussion of the results of the review of approaches to multiple use of ecosystem services
4. Synthesis work, formulating guidance and recommendations, and identification of knowledge gaps most pressing to fill.

The working group meets and discusses the results, formulating guidance where the group can reach consensus on the best way forward, or declaration of conflicts in cases where there are disagreements. Thus, the working group may not agree on a single best management strategy, but will in those cases identify and clarify the nature of the disagreement or conflict. The guidance and statements are presented by the project leaders in drafts of two papers, one focusing on lakes and the other stream ecosystems, which is circulated to the group members, who can edit and provide comments until all can agree on the final version.

The ultimate goal of this process is to highlight the relative merits of management to meet various ecosystem services, and approaches that can accommodate multiple values, including climate adaptation and mitigation.

Deliverables: Two papers summarising the guidance and recommendations as well as the conflicts and need for new knowledge identified, one focussing on stream and one on lake ecosystems will be published in a scientific, peer-reviewed journals.

Activity plan

Below we list the main activities and when they will occur or be finalised. Work package 1 and 2 will run in parallel, running up to the workshop in WP3 to be held in January 2019.

Activity	**Time period**
WP1 Review and synthesis of restoration measures	
Literature search and review	Jan – June 2018
Data summary completed	June 2018
First draft finalised	Nov 2018
Workshop discussion	Jan 2019
Swedish report finalised	June 2019
Scientific paper finalised	June 2019
WP2 Scenarios of future hydropower and e-flow opportunities	
Model runs in ProdRisk	Jan – Mar 2018
Predictions of habitat availability	Apr – June 2018
Summary of results completed	Sep 2018
Workshop discussion	Jan 2019
First draft finalised	Mar 2019
Swedish report finalised	June 2019
Scientific paper finalised	June 2019
WP2 Literature review of examples of multiple ecosystem service use	
Literature search and review	Jan – June 2018
Data summary completed	June 2018
First draft finalised	Nov 2018
Workshop discussion	Jan 2019
Swedish report finalised	June 2019
Scientific paper finalised	June 2019
WP3 Recommendations and guidance	

Draft of literature reviews and scenario results sent to workshop participants	Nov 2018
Workshop	Jan 2019
Draft of synthesis report completed	Apr 019
Manuscript review by workshop participants	Apr – May 2019
Synthesis report finalised	June 2019
Scientific paper finalised	June 2019

Open access data and scientific papers

New primary data will not be produced in the project, but we will make the summary data stemming from the literature reviews and the scenario results in WP2 available in attachments to the scientific papers published. *Five scientific papers* in international, peer-reviewed journals will be produced in the project:

1. Literature review of the relevance and effectiveness of restoration measures to improve freshwater ecosystems presented in a scientific paper in an international, peer-reviewed journal
2. Scenarios for potential increases in power production or e-flow measures in regulated river catchments with future flows will be presented in a peer-reviewed international scientific journal.
3. A review of governance options in response to various human impacts, ecosystem services and management types of freshwater ecosystems will be presented in a review paper in a peer-reviewed international scientific journal.
4. Two papers summarising the guidance and recommendations as well as the conflicts and need for new knowledge identified, one focussing on stream and one on lake ecosystems will be published in a scientific, peer-reviewed journals.

The papers will be drafted during the project period, to be submitted to scientific during 2019. We will also write a *report in Swedish* presenting all of the above material to be finalised at the end of the project period.

Communication

The results from all three work packages are relevant for water and conservation management authorities, hydropower companies, environmental courts and NGOs active in riverine ecosystem conservation and restoration. *The Swedish Agency for Marine and Water Management* is responsible for setting standards defining ecological status of water bodies, and producing guidelines for how to achieve it. *Hydropower companies* are responsible for implementing actions, and *regional water authorities* and *county administrations* are responsible for superintending management actions. In addition, the results will be relevant for court cases in *the Land and Environmental Court*, which can expect a rapid increase in the number of court cases about hydropower, as environmental measures to implement the Water Framework Directive will often require changes to existing court decisions (vattendomar), in addition to all cases where there are demands to balance environmental and power production interests. NGOs like *Älvräddarna* and *WWF* are engaged in both court cases as well as in restoration work in regulated rivers, and the project results may help their work, providing arguments, background information and give examples of management methods.

The goal of the communication is to alert the stakeholders to the existence of the results, and to ensure that each stakeholder group know how to access the information relevant to them. Formation of the working group in WP3 with representatives of various stakeholders implies that input from relevant stakeholder parties is integrated into the project during the project period. This means that we can ensure the relevance of the issues addressed and realism of the guidance produced. Moreover, it will ensure early spread of the project results within the organisations engaged in the project.

We will spread the results of the project using several platforms and communication outlets: *Five scientific papers* will be submitted to international, peer-reviewed journals, with open access possibility. At the end of the project, we will produce a *report in Swedish*, with a summary of approximately 10 pages geared towards the public, with the main results explained for lay persons. We will set up a *project website*, with information about the project in Swedish and English and contact details to the people involved. We will publish information about the progress of the project, including press releases and reports on the website, along with summary information of the report at the end of the project. At the time of the stakeholder meetings, and the end of the project in association with release of the Swedish report and publication of scientific papers, *press releases* will be produced and media contacted. First, media contact will be about the issues and the process rather than the results, but the in association with release of reports and papers, the project results will be the focus, summarising the main results and conclusions explained to lay persons

In previous projects, we have had project websites and published press releases in conjunction with e.g. publication of papers. This often results in interviews in e.g. radio and newspapers, contributing to further spread. In addition, project results are presented at conferences both geared towards researchers and practitioners. Excursions to display e.g. restoration activities are a recurrent feature.

Budget

	SEK year 1	SEK year 2	Total
Project costs			
1. Salaries			
Roland Jansson	275800.00	135842.00	411 642.00 kr
Birgitta Malm Renöfält	245156.00	120748.00	365 904.00 kr
Åsa Widén	74824.00	36853.00	111 677.00 kr
2. Travels			
Travels (e.g. participation in conferences and meetings)	87100.00	42900.00	130 000.00 kr
3. Other costs			
Other project costs (Use new row for each cost)	6700.00	3300.00	10 000.00 kr
4. Cummunication			
4.1. Open access publications	10281.00	5064.00	15 345.00 kr
Total 1-4	699 861.00 kr	344 707.00 kr	1 044 568.00 kr
5. Overhead costs			
Overhead costs at the university/college/institute where the funds will be administered **(%)** Use column E "Total"			44%
Total sum	1 005 000.40 kr	494 999.25 kr	1 499 999.65 kr

Explanations for budget posts

Salaries

Roland Jansson
Position as lecturer and Associate professor in ecology at Umeå University. Salary for 50% of full time during the project period including LKP 52.46%. RJ will lead the project, draft the paper in WP1 with BMR and ÅW, be responsible for review of approaches to reconciling ecosystem service provision and hydropower production relevant to Swedish conditions in WP2, and draft the policy paper in WP3.

Birgita Malm Renöfält
Position as researcher in ecology at Umeå University. Salary for 50% of full time during the project period. BMR will draft the paper in WP1 with RJ and ÅW, be responsible for the paper listing flow regime variables important for ecosystem functions in riverine systems, and how these are expected to be altered in a future climate in WP2, and organise the workshop in WP3.

Åsa Widén
PhD-student at Umeå University, with RJ and BMR being supervisors. Funding for 2.5 months full-time of her PhD-position. ÅW will perform the ProdRisk analyses in WP1 and participate in drafting a paper reporting the results of the scenarios.

Running costs

Travel costs for workshop participants. – Costs for travel for 15 participants in the workshop.

Lodging for workshop participants. – Lodging, food and conference localities during the workshop.

Computer and software. – Costs for computer hardware, printer and software licenses, such as statistical applications.

Literature and publication costs. – Scientific literature needed in the project. Costs for journal page charges and publication fees.

Indirect costs

Costs for administration etc. at Umeå University, calculated as 33.6% of the sum applied for.

Premises costs

Costs for the offices at the Department of Ecology and Environmental Science at Umeå University according to the department policy for premises charges (calculated as 10% overhead on external funding).

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Curriculum Vitae – Roland Jansson

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Personal data: Born 14 February 1967. Male. Married. Two children. Swedish citizen.

Research interests: variation in species richness in space and time; stream ecology and ecological restoration of rivers; the role of long-term climate change in evolution and its importance in explaining large-scale biogeographical patterns in organism traits, geographic range-sizes and diversity of species.

University degree: 1994, Bachelor in Science with a major in biology.

Doctoral degree: 2000, plant ecology, Umeå University.

Post-doctoral position: 2000-2001, Open University, UK. Advisor: Jonathan Silvertown.

Senior lecturer (Docent): 2007.

Current position: University lecturer (universitetslektor), Umeå University since 2009-01-01. 85% research and 15% teaching.

Postdoctoral and graduate student supervision: Advisor for three postdocs, main supervisor for four and assistant supervisor for three PhD-students that have defended their theses. Currently main supervisor for one PhD-student and assistant supervisor for another two.

Awards: Young Researcher Award (SEK 2,000,000) from Umeå University, 2008; Carl XVI Gustaf's 50-yr foundation for science, technology & environment (Carl XVI Gustafs 50-årsfond för vetenskap, teknik och miljö), 2004; Royal Skyttean Society's (Kungliga Skytteanska Samfundet) award to a young and distinguished researcher at Umeå University, 2003.

Major grants received

EU COST Action (one of six applicants), 2017-21, aproximately SEK 5,000,000
Formas, 2017-2019, SEK 2,999,724
Statkraft, 2015-2018, SEK 540,000.
Swedish Energy Authority, Swedish Agency for Marine and Water Management, Energiforsk, 2015-2017, SEK 4,600,000.
Worldwide Fund for Nature, 2014, SEK 200,000.
Formas, 2009-11, SEK 2,446,000.
Young Researcher Award (Umeå University), 2008, SEK 2,000,000.
The Swedish Research Council (VR), 2008-10, SEK 1,620,000.
Nordic Council of Ministers, 2007-09, SEK 1,800,000 (with Christer Nilsson).
Formas, 2004-06, SEK 2,349,000 (with Christer Nilsson).
Formas, 2002-05, SEK 2,726,000 (assistant professorship).
STINT, 2000, SEK 409,000 (postdoc grant).
Funding for convening a symposium from VR, Formas, etc., 2004, SEK 600,000.

Current funding

Formas, 2017-2019, SEK 2,999,724
Swedish Energy Authority, Swedish Agency for Marine and Water Management, Energiforsk, 2015-2017, SEK 4,600,000.
Statkraft, 2015-2018, SEK 540,000.

Appointments

Expert judge in the Swedish land- and environmental court in court cases involving water management and hydropower issues.
University representative in the board of the foundation of the arboretum "Arboretum Norr".

Bibliometric summary

I have 59 papers in peer-reviewed journals and one book chapter, 28 of these papers were published the last 5 years. I have 3061 citations in Web of Science (WoS) and 4637 citations in Google Scholar Citations (GSC). Nine papers in WoS have been cited more than 100 times. Journals published in with highest impact factors: *Science, PNAS, Ecology Letters, Annual Review of Ecology and Systematics, Biological Reviews*. Two of my papers are designated ”highly cited papers” in WoS (top 1% in their fields, papers published in 2009 and 2013). My h index is h = 26 (WoS) or h = 32 (GSC).

Opponent and examination committees at PhD defenses

Opponent at the PhD defense of Kent Olesen, Århus University. External reviewer for PhD-theses at University of Melbourne and Macquarie University, Australia, 2012 and 2015. Member of 10 examination committees at PhD defenses at Stockholm University (3), Mid-Sweden University (1), Swedish Agricultural University (3) and Umeå University (3).

Editorial appointments and journal reviewer

Scientific editor and leader of the editorial advisory board for the ecology section of Encyclopedia of Life Sciences (Wiley), the world’s largest article-based encyclopedia in life sciences. Member of Faculty of 1000 Biology (Spatial and Landscape Ecology) 2004-2011. Guest editor for a Special Issue of Freshwater Biology, published 2007 (vol. 52, issue 4, “Restoring freshwater ecosystems in riverine landscapes”). Member of the editorial board of The Scientific World Journal 2010-2014. Reviewer for 21 scientific journals, such as American Naturalist, Ecology, Ecology Letters, Ecosystems, PNAS, Proceedings of the Royal Society, London Ser. B.

Evaluator for universities and research councils

Evaluator of research proposals for The Netherlands Organisation for Scientific Research (climate change and evolution, 2007), Swiss NSF (ecosystem services, 2013), Norwegian Research Council (ecology and biodiversity, 2013) and Formas (biodiversity, 2013). Expert evaluator of positions for Århus University (Associate professorship position in geospatial ecoinformatics, 2015) and University of Gävle (lectureship in plant ecology, 2011).

Invited speaker at symposia

British Ecological Society Meeting, Plymouth 2004. Kaamos Symposium, Oulu University, 2009. International Biogeography Society Meeting, Miami, 2011. International Biogeography Society Meeting, Bayreuth, 2015.

Symposium organizer

Head organizer of the 2nd International Symposium on Riverine Landscapes, with 26 invited speakers and participants from 17 different countries. The meeting resulted in two special issues in scientific journals (Freshwater Biology and Ecology and Society), and additional ideas and opinion papers.

List of publications 2007-17 – Roland Jansson

Journal impact factors (2016) and number of citations in Web of Science are given in parentheses after each publication. 2936 citations in total, 2217 without self-citations.

PEER-REVIEWED ARTICLES

First-authored papers

Jansson, R., C. Nilsson, E. C. H. Keskitalo, T. Vlassova, M.-L. Sutinen, J. Moen, F. S. Chapin III, K. A. Braathen, M. Cabeza, T. V. Callaghan, B. van Oort, H. Dannevig, I. Bay-Larsen, R. A. Ims, and P. E. Aspholm. 2015. Future Change in the Supply of Goods and Services from Natural Ecosystems: Prospects for the European North. ***Ecology and Society*** 20:32. [IF=2.9, No. citations: 2]

Catford, J.A.* & **R. Jansson***. 2014. Drowned, buried and carried away: effects of plant traits on the distribution of native and alien species in riparian ecosystems. ***New Phytologist*** 204:19-36. (invited Tansley review) [IF=7.2, No. citations: 20]
** the authors contributed equally to the paper*

Dynesius, M* & **R. Jansson***. 2014. Persistence of within-species lineages: a neglected control of speciation rates. ***Evolution*** 69:923-934.
** the authors contributed equally to the paper* [IF=4.0, No. citations: 26]

Jansson R., G. Rodríguez-Castañeda & L. E. Harding. 2013. What can multiple phylogenies say about the latitudinal diversity gradient? A new look at the tropical conservatism, out-of-the-tropics and diversification rate hypotheses. ***Evolution*** 67:1741-1755. [IF=4.0, No. citations: 46]

Jansson, R. 2009. Extinction risks from climate change: macroecological and historical insights. ***F1000 Biology Reports*** 1:44. [No. citations: 1]

Jansson, R. & T.J. Davies. 2008. Global variation in diversification rates of flowering plants: energy versus climate change. ***Ecology Letters*** 11:173-183. [IF=10.8, No. citations: 73]

Jansson, R. 2007. Review of Restoring Colorado River Ecosystems: A Troubled Sense of Immensity, written by R. W. Adler. ***Écoscience*** 14:544. [IF=1.4]

Jansson, R., C. Nilsson & B. Malmqvist. 2007. Restoring freshwater ecosystems in riverine landscapes: the roles of connectivity and recovery processes. ***Freshwater Biology*** 52:589-596. [IF=3.9, No. citations: 69]

Jansson, **R.**, H. Laudon, E. Johansson & C. Augspurger. 2007. The importance of groundwater discharge for plant species richness in riparian zones. ***Ecology*** 88:131-139. [IF=4.7, No. citations: 30]

Papers by students and postdocs in the research group

Note that up to last year, we have not placed any significance in being last author, meaning that I have generally been second author on the papers where my PhD students or postdocs are lead authors.

Bejarano M.D., **R. Jansson**, Nilsson. 2017. The effects of hydropeaking on riverine plants: a review. ***Biological Reviews***, in press. [IF=10.3, No. citations: 0]

Rodríguez-Castañeda, G., A.R. Hof, **R. Jansson**. 2017. How bird clades diversify in response to climatic and geographic factors. ***Ecology Letters*** 20:1129-1139. [IF=10.8, No. citations: 0]

Frainer A., L.E. Polvi, **R. Jansson**, B.G. McKie. 2017. Enhanced ecosystem functioning following stream restoration: the roles of habitat heterogeneity and invertebrate species

traits. ***Journal of Applied Ecology***, published online (DOI: 10.1111/1365-2664.12932) [IF=4.7, No. citations: 0]

Blume-Werry, G., **R. Jansson**, A. Milbau. 2017. Root phenology unresponsive to earlier snowmelt despite advanced above-ground phenology in two subarctic plant communities. ***Functional Ecology***, published online (DOI: 10.1111/1365-2435.12853) [IF=5.2]

Hof, A. R. G. Rodríguez-Castañeda, A. M. Allen, **R. Jansson,** C. Nilsson. 2016. Vulnerability of subarctic and arctic breeding birds. ***Ecological Applications*** 27:219-234. [IF=4.5, No. citations: 0]

Kuglerová, L., K. Botková & **R. Jansson**. 2016. Responses of riparian plants to habitat changes following restoration of channelized streams. ***Ecohydrology*** in press. [IF=2.1, No. citations: 2]

Fuentes-Hurtado, M, A. R. Hof & **R. Jansson**. 2016. Paleodistribution modeling suggests glacial refugia in Scandinavia and out-of-Tibet range expansion of the Arctic fox. ***Ecology and Evolution*** 6:170-180. [IF=2.5, No. citations: 1]

Kuglerová, L., M. Dynesius, H. Laudon & **R. Jansson**. 2016. Relationships between plant assemblages and water flow across a boreal forest landscape: a comparison of liverworts, mosses, and vascular plants. ***Ecosystems*** 19:170-184. [IF=3.8, No. citations: 2]

Dietrich A.L., C. Nilsson & **R. Jansson.** 2016. A phytometer study evaluating the effects of stream restoration on riparian vegetation. ***Ecohydrology*** 9:646-658. [IF=2.1, No. citations: 1]

Kuglerová, L., **R. Jansson**, R.A. Sponseller, H. Laudon & B. Malm-Renöfält. 2015. Local and regional processes determine plant species richness in a river-network metacommunity. ***Ecology*** 96:381-391. [IF=4.7, No. citations: 13]

Dietrich, A. L., C. Nilsson, **R. Jansson**. 2015. Restoration effects on germination and survival of plants in the riparian zone: a phytometer study. ***Plant Ecology*** 416: 465-477. [IF=1.5, No. citations: 6]

Kuglerová, L., A. Ågren, **R. Jansson** & H. Laudon. 2014. Towards optimizing riparian buffer zones: ecological and biogeochemical implications for forest management. ***Forest ecology and Management*** 334:74-84. [IF=2.8, No. citations: 23]

Dietrich, A.L., L. Lind, **R. Jansson** & C. Nilsson. 2014. The use of phytometers for evaluating restoration effects on riparian soil fertility. ***Journal of Environmental Quality*** 43:1916-1925. [IF=2.2, No. citations: 9]

Ström, L, **R. Jansson** & C. Nilsson. 2014. Invasibility of boreal wetland plant communities. ***Journal of Vegetation Science*** 25:1078-1089. [IF=3.2, No. citations: 1]

Kuglerová, L., **R. Jansson**, A. Ågren, H. Laudon & B. Malm-Renöfält. 2014. Groundwater discharge creates hotspots of riparian plant species richness in a boreal forest stream network. ***Ecology*** 95:715-725. [IF=4.7, No. citations: 21]

Dietrich A.L., C. Nilsson & **R. Jansson.** 2013. Phytometers are underutilised for evaluating ecological restoration. ***Basic and Applied Ecology*** 14:369-377. [IF=2.7, No. citations: 8]

Rodríguez-Castañeda, G., A.R. Hof, **R. Jansson** & L.E. Harding. 2012. Predicting the fate of biodiversity using species' distribution models: enhancing model comparability and repeatability. ***PLOS ONE*** 7: e44402. [IF=3.1, No. citations: 17]

Helfield, J.M., J. Engström, J.T. Michel, C. Nilsson & **R. Jansson**. 2012. Effects of River Restoration on Riparian Biodiversity in Secondary Channels of the Pite River, Sweden. ***Environmental Management*** 49:130-141. [IF=1.7, No. citations: 15]

Hof, A.R., **R. Jansson** & C. Nilsson. 2012. Future climate change will favour non-specialist mammals in the (sub)Arctics. ***PLOS ONE*** 7:e52574.
[IF=3.1, No. citations: 20]

Hof, A.R., **R. Jansson** & C. Nilsson. 2012. The usefulness of elevation as a predictor variable in species distribution modelling. ***Ecological Modelling*** 246:86-90.
[IF=2.3, No. citations: 24]

Hof, A. R., **R. Jansson** & C. Nilsson. 2012. How biotic interactions may alter future predictions of species distributions: future threats to the persistence of the arctic fox in Fennoscandia. ***Diversity & Distributions*** 18:554-562. [IF=6.1, No. citations: 35]

Ström, L., **R. Jansson**, & C. Nilsson. 2012. Projected changes in plant species richness and extent of riparian vegetation belts as a result of climate-driven hydrological change along the Vindel River in Sweden. ***Freshwater Biology*** 57:49–60.
[IF=3.9, No. citations: 23]

Engström, J., **R. Jansson** & C. Nilsson. 2011. Effects of river ice on riparian vegetation. ***Freshwater Biology***, 56:1095-1105. [IF=3.9, No. citations: 10]

Ström, L., **R. Jansson**, C. Nisson, M.E. Johansson & S. Xiong. 2011. Hydrologic effects on riparian vegetation in a boreal river: an experiment testing climate change predictions ***Global Change Biology*** 17:254-267. [IF=8.4, No. citations: 17]

Engström, J, C. Nilsson & **R. Jansson**. 2009. Effects of stream restoration on dispersal of plant propagules. ***Journal of Applied Ecology*** 46:397-405.
[IF=4.7, No. citations: 22]

Catford, J.A., **R. Jansson** & C. Nilsson. 2009. Reducing redundancy in invasion ecology by integrating hypotheses into a single theoretical framework. ***Diversity & Distributions***, 15:22-40. (ESI Highly cited paper) [IF=6.1, No. citations: 304]

Helfield, J., S. Capon, C. Nilsson, **R. Jansson** & D. Palm. 2007. Restoration of rivers used for timber-floating: effects on riparian plant diversity. ***Ecological Applications*** 17:840-851.
[IF=4.5, No. citations: 40]

Papers coauthored with other senior researchers

Dawson, M.N., J.C. Axmacher, C. Beierkuhnlein, J.L. Blois, B.A. Bradley, A.F. Cord, J. Dengler, K.S He, L.R. Heaney, **R. Jansson**, M.D. Mahecha, C.Myers, D. Nogués-Bravo, A. Papadopoulou, B. Reu, F. Rodríguez-Sánchez, M.J. Steinbauer, A. Stigall, M.-N. Tuanmu, D.G. Gavin. 2017. A second horizon scan of biogeography: Golden Ages, Midas touches, and the Red Queen. ***Frontiers of Biogeography*** 8(4) (10.21425/F58429770)

Nilsson C., **R. Jansson**, L. Kuglerová, L. Lind & L. Ström. 2013. Boreal riparian vegetation under climate change. ***Ecosystems*** 16:410-410 [IF=3.8, No. citations: 14]

Dawson, M. N., A. C. Algar, A. Antonelli, L. M. Dávalos, E. Davis, R. Early, A. Guisan, **R. Jansson**, J.-P. Lessard, K. A. Marske, J. L. McGuire, A. L. Stigall, N. G. Swenson & D. G. Gavin. 2013. An horizon scan of biogeography. ***Frontiers of Biogeography*** 5(2):fb_18854. http://www.escholarship.org/uc/item/9rp9c1qk
The authors contributed equally to this paper

Merritt, D.M., C. Nilsson & **R. Jansson**. 2010. Consequences of propagule dispersal and river fragmentation for riparian plant community diversity and turnover. ***Ecological Monographs*** 80:609-626. [IF=8.0, No. citations: 38]

Nilsson, C., R.L. Brown, **R. Jansson** & D. M. Merritt. 2010. The role of hydrochory in structuring riparian and wetland vegetation. ***Biological Reviews*** 85:837-58
[IF=10.3, No. citations: 146]

Nilsson, C., **R. Jansson**, E.C.H. Keskitalo, T. Vlassova, M.-L. Sutinen, J. Moen & F.S. Chapin III. 2010. Challenges to adaptation in northernmost Europe as a result of global climate change. ***Ambio*** 39:81-84. [IF=2.3, No. citations: 5]

Renöfält, B. M., **R. Jansson** & C. Nilsson. 2010. Effects of hydropower generation and opportunities for environmental flow management in Swedish riverine ecosystems. ***Freshwater Biology***, 55:49-67. [IF=3.9, No. citations: 79]

Nilsson, C., **R. Jansson**, B. Malmqvist & R.J. Naiman. 2007. Restoring riverine landscapes: the challenge of identifying priorities, reference states, and techniques. ***Ecology and Society*** 12 (1): 16. [IF=2.9, No. citations: 26]

BOOKS

Hof, A. R., **R. Jansson**, C. Nilsson. 2015. Future of biodiversity in the Barents Region. TemaNord 2015:519. Nordic Council of Ministers, Copenhagen, Denmark.

REPORTS IN SWEDISH

Jansson R., E. Degerman, Å. Widén, B.M. Renöfält. 2017. *Evidensbaserade åtgärder för att* restaurera ekologiska funktioner i reglerade vattendrag: vad finns i verktygslådan? Report to Energiforsk.

Widén Å., **R. Jansson**, B.M. Renöfält, E. Degerman, D. Wisaeus. 2017. Ekologisk reglering. Report to Energiforsk.

Renöfält B.M., Å. Widén, **R. Jansson** & E. Degerman. 2017. Identifiering av påverkan, åtgärdsbehov och åtgärdspotential i vattendrag påverkade av vattenkraft. Report to Energiforsk.

Renöfält B.M., J. Ahonen & **R. Jansson**. 2015. Ekologisk återställning i helt eller delvis torrlagda fåror i anslutning till vattenkraftverk. Havs- och Vattenmyndigheten Rapport 2015:22.

Widén, Å., **R. Jansson**, M. Johansson, M. Lindström, L. Sandin, D. Wisaeus. 2016. Maximal Ekologisk Potential i Umeälven. Report from the Ume River Project.

Jansson, R. 2008. Bedömning av ekologisk potential i utbyggda vatten i Norrland. Report to the Swedish Water Authorities.

Five most cited publications

Dynesius, M.*, & **R. Jansson***. 2000. Evolutionary consequences changes in species geographical distributions driven by Milankovitch climate oscillations. ***Proceedings of the National Academy of Sciences, USA*** 97:9115-9120. [IF=9.7, No. citations: 476]

Catford, J.A., **R. Jansson** & C. Nilsson. 2009. Reducing redundancy in invasion ecology by integrating hypotheses into a single theoretical framework. ***Diversity & Distributions*** 15:22-40. [IF=6.1, No. citations: 304]

Jansson, **R.***, & M. Dynesius*. 2002. The fate of clades in a world of recurrent climatic change: Milankovitch oscillations and evolution. ***Annual Review of Ecology and Systematics*** 33:741-777. [IF=9.5, No. citations: 208]

Jansson, **R.**, C. Nilsson, M. Dynesius, & E. Andersson. 2000. Effects of river regulation on river-margin vegetation: a comparison of eight boreal rivers. ***Ecological Applications*** 10:203-224. [IF=3.8, No. citations: 172]

Jansson, R. 2003. Global patterns in endemism explained by past climatic change. ***Proceedings of the Royal Society, London B*** 270:583-90 [IF=4.8, No. citations: 166]

** The authors contributed equally to the work*

CV FOR BIRGITTA MALM RENÖFÄLT

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Personal data: Born 19 July 1966. Female. Married. Two children. Swedish citizen.
PhD degree: 2005-03-02, plant ecology. Title: *Vegetation patterns and processes in riparian landscapes*. Supervisor: Prof. Christer Nilsson.
Current employment:

- 2015.01.01- ongoing: Employed full time as research assistant at the Department of Ecology and Environmental Science, Umeå University
- 2010.02.01– 2014.12.31: Employed full time as Assistant Professor at the Department of Ecology and Environmental Science, Umeå University, on the FORMAS funded project "Optimization of flow management in regulated rivers".
- (on leave) 2009.10.01- on going: Employed part time (60%) as research assistant at the Department of Ecology and Environmental Science, Umeå University

Employment history (1995 to present)

- 2005.05.01-2009.09.30: Employed part time (75%) as research assistant at the Department of Ecology and Environmental Science, Umeå University (projects funded by EU, WWF, The Swedish Environmental Protection Agency and SIDA).
- 2007.04 – 2009.12.31: Employed part time (25%) by the Swedish Water House as a co-leader of a cluster group working with the concept of environmental flows.
- 1996.07.01−2004.11.14: PhD-student at the Department of Ecological Botany/Ecology and Environmental Science, Umeå University.

Supervision of PhD-students:

Assistant supervisor for PhD-student Anna Lejon, started 2006 finished her PhD June 2012.

Assistant supervisor for PhD-student Lenka Kuglerova, started 2010, finished March 2015

Assistant supervisor for PhD-student Åsa Widén, started 2016

National and international assignments

- Expert judge in the Swedish land- and environmental court in court cases involving water management and hydropower issues. 2016 – ongoing
- University representative "programrådet för Vindelälvens naturcentrum" 2014-ongoing
- Assigned by Havs och Vattenmyndigheten to co-lead a pilot project on ecological potential in by-pass channels in regulated rivers: Finished, Report published in

- Assigned by Havs och Vattenmyndigheten to produce report on Best Available Technique for environmental flow design in regulated rivers. Finished, Report published Dec 2013.
- Steering committee member in The Swedish Hydrological Council. 2012 - 2015
- Leader of a "cluster group" within the Swedish Water House working on the concept of environmental flows. 2007-2010
- Steering committee member of the Global Environmental Flows Network 2008-2010
- Assigned as a committee member of the Swedish Environmental Protection Agency and the Swedish Board of Fisheries reference group for VERS (vägledning till ekologisk restaurering, guidance for ecological restoration) in 2007.

Publications

Peer reviewed articles in international journals.

Kuglerová L., Jansson, R., Sponceller, R.A., Laudon, H. and **Malm-Renöfält, B.** 2015. Local and regional processes determine plant species richness in a river-network metacommunity. *Ecology* **96**:381-391

Kuglerová L., Jansson, R., Ågren, A., Laudon, H. and **Malm-Renöfält, B** 2014. Groundwater discharge creates hotspots of riparian plant species richness in a boreal forest stream network. *Ecology* **95**:715–725.

Jörgensen D. **and Renöfält, B.M.** 2013. Damned If You Do, Dammed If You Don't: Debates on Dam Removal in the Swedish Media. *Ecology and Society* **18** (1): 18.

Renöfält, B.M, A. Lejon, M. Jonsson, and C. Nilsson. 2012. Long-term taxon-specific responses of macroinvertebrates to dam removal in a mid-sized Swedish stream. *River Research and Applications*. **29:**1082-1089

Renöfält, B.M., R. Jansson, and C. Nilsson. 2010. Effects of hydropower generation and opportunities for environmental flow management in Swedish riverine ecosystems. *Freshwater Biology*, **55**:49-67.

Lejon, A. **B.M. Renöfält** and C. Nilsson. 2009. Conflicts Associated with Dam Removal in Sweden. *Ecology & Society*, **14**:2.

Nilsson, C. and **B. M. Renöfält**. 2008. Linking Flow and Water Qualities in Rivers: a challenge to adaptive catchment management. *Ecology & Society*, **13**(2):18

Renöfält B.M. and C. Nilsson. 2008. Landscape scale effects of disturbance on riparian vegetation. *Freshwater Biology*. **53**:2244-2255

Renöfält, B. M., D. M. Merritt, and C. Nilsson. 2007. Connecting variation in vegetation and stream flow: the role of geomorphic context in vegetation response to large floods along boreal rivers. *Journal of Applied Ecology* **44**: 147-157.

Renöfält, B. M., C. Nilsson, and R. Jansson. 2005. Spatial and temporal patterns of species richness in a riparian landscape. *Journal of Biogeography* **32**: 2025-2037.

Renöfält, B. M., R. Jansson, and C. Nilsson. 2005. Spatial patterns of plant invasiveness in a riparian corridor. *Landscape Ecology* **20**:165-176.

Jansson, R., C. Nilsson and **B. M. Renöfält.** 2000. Fragmentation of riparian floras in rivers with multiple dams. *Ecology* **81**: 899-903.

Book chapters and reports with international coverage

Renöfält, B.M., C. Nilsson. 2007. Hydroecological patterns of change in riverine plant communities Capter 18 in *Ecohydrology: past, present and future*. Ed: P.J Wood, D.M Hannah, J.P Sadler. Whiley.

A. Forslund, **Renöfält, B.M.,** K. Meijer, L. Korsgaard, M.E. McClain, K. Cross, T. Farell, S. Davidson, S. Barchesi and M. Smith, * 2009. *Securing water for ecosystems and human wellbeing.* Swedish Water House Report. (*all authors contributed equally).

Reports in Swedish.

Jansson R., E. Degerman, Å. Widén, **B.M. Renöfält**. 2017. *Evidensbaserade åtgärder för att restaurera ekologiska funktioner i reglerade vattendrag: vad finns i verktygslådan*? Report to Energiforsk.

Widén Å., R. Jansson, **B.M. Renöfält**, E. Degerman, D. Wisaeus. 2017. *Ekologisk reglering*. Report to Energiforsk.

Renöfält B.M., Å. Widén, R. Jansson & E. Degerman. 2017. *Identifiering av påverkan, åtgärdsbehov och åtgärdspotential i vattendrag påverkade av vattenkraft*. Report to Energiforsk.

Renöfält B.M. and Jansson, R. *Ekologisk återställning i helt eller delvis torrlagda fåror i anslutning till vattenkraftverk*. Havs och vattenmyndighetens Rapport 2015:22

Renöfält B.M. and Ahonen, J. 2013. *Ekologiska flöden och ekologiskt anpassad vattenreglering: Underlag till vägledning om lämpliga försiktighetsmått och bästa möjliga teknik för vattenkraft.* Havs- och vattenmyndighetens rapport 2013:12

Nilsson, C and **B. M. Renöfält.** 2009. *Mygg och Bti i nedre Dalälven: Utvärdering av ett vetenskapligt uppföljningsprogram*. Rapport till Naturvårdsverket.

Carlborg, E., **B.M. Renöfält** and C. Nilsson. 2007. *Förutsättningar för storskalig restaurering av sötvattensmiljöer i norra Sveriges skogs- och älvlandskap.* PM. Naturvårdsverket.

Renöfält, B.M., N. Hjerdt, C, Nilsson. 2006. *Restaurering av vattendrag i ett landskapsperspektiv: en syntes från "Second International Symposium on Riverine Landscapes".* Naturvårdsverkets rapport 5565

Renöfält, B.M, C. Nilsson. 2006. Miljöanpassade flöden – Sammanställning av forskning och utveckling med avseende på flödesregimer. Elforsk rapport.