How can logic modelling improve the planning, monitoring and evaluation of policy measures and wider interventions for multiple benefits?

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Glossary

Term	Definition
Adaptive management	Is the integration of project design, management, and monitoring, to provide a framework to systematically test assumptions, promote learning, and supply timely information for management decisions. It requires involvement of stakeholders and partners.
CAP Pillar I measures	Common Agricultural Policy Pillar I provide support to farmers' incomes.
CAP Pillar II measures	Common Agricultural Policy Pillar II is support provided for the development of rural areas.
Causal pathway	Causal pathway models specify each connection that you think might be relevant. You might specify that activity A affects short-term outcomes A and C, which in turn affect medium-term outcomes E and F, and long-term outcomes A and D. You might also expect that there will be feedback loops in your model.
CAMERAS	Coordinated Agenda for Marine, Environment and Rural Affairs Science.
Common Monitoring and Evaluation Framework	The current Common Agricultural Policy (CAP 2014-2020) offers a Common Monitoring and Evaluation Framework to measure the performance of the whole CAP (both Pillar I - direct payments to farmers and market measures and Pillar II - rural development measures). It is the compilation of rules and procedures necessary for evaluating the whole CAP.
Common Monitoring and Evaluation System	Provides the rules and procedures within the Common Monitoring and Evaluation Framework which relate to rural development (Pillar II of the CAP).
Counterfactual	Counterfactuals measure what would have happened in the absence of the intervention, and impact is estimated by comparing counterfactual outcomes to those observed under the intervention.
Empirical impact evaluation	Empirical impact evaluations use quantitative data to test whether a policy was associated with any significant changes in outcomes of interest. Various approaches are available which differ in their ability to control for other factors which might also affect those outcomes (the counterfactual, either directly measured or imputed) and hence in the confidence it is possible to place in the results.
General Binding Rule	The Water Environment (Diffuse Pollution) (Scotland) Regulations are referred to as the Diffuse Pollution General Binding Rules (DP GBRs). The seven DP GBRs focus solely on rural land use activities. All rural land users have a responsibility to ensure they are working in line with these DP GBR's.
Intervention logic	The intervention logic is the logical link between the problem that needs to be tackled (or the objective that needs to be pursued), the underlying drivers of the problem, and the available policy options (or the EU actions actually taken) to address the problem or achieve the objective. This intervention logic is used in both prospective Impact Assessments and retrospective evaluations.
Logic model	A representation of a programme theory, usually in the form of a diagram
Measures/Policy measures	Economic, environmental and social interventions that are part of a scheme e.g. Agri-Environment Climate Scheme of the Scottish Rural Development Programme.
Natura 2000 areas	Natura 2000 is a network of nature protection areas in the territory of the European Union. It is made up of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) designated respectively under the Habitats Directive and Birds Directive.
NESTA	Originally set up in 1998 by the UK Government the National Endowment for Science Technology and the Arts, was a public body designed to promote creativity, talent and innovation across a wide spectrum of areas and interests. It became an independent charity in 2012, and changed its name to Nesta. It now aims to become an international hub for innovators.
Priority catchments	Diffuse pollution priority catchments have been identified in the river basin management cycle for the Scotland and the Solway Tweed river basin districts. These are recognised as containing some of Scotland's most important waters (for drinking water, conservation, industry or tourism) but have been identified as failing water standards set by the European directives.

Programme (program) theory	An explicit theory of how an intervention is understood to contribute to its intended or observed outcomes; ideally includes a theory of change and a theory of action.
Rural Development Programmes	EU's rural development policy helps the rural areas of the EU to meet the wide range of economic, environmental and social challenges of the 21st century. Frequently called "the second pillar" of the Common Agricultural Policy (CAP).There are 118 different rural development programmes (RDP) in the 28 Member States for the 2014-2020 period, with 20 single national programmes and 8 Member States opting to have two or more (regional) programmes.
Rural Diffuse Pollution Plan for Scotland	Is an implementation plan to ensure that key stakeholders in Scotland work in a coordinated way to reduce diffuse pollution from rural sources; which will in turn help to protect and improve the water environment and deliver the targets set out in the river basin management plans for the Scotland and the Solway Tweed river basin districts.
Simulation based evaluation	Simulation modelling is one way in which the results of different evaluations of separate parts of the impact pathway or logic of an intervention can be combined and requires that the evidence relating to the different links in the logic model are expressed in quantitative terms (e.g. effect sizes).
Sustainable Development Goals	The Sustainable Development Goals, otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.
Systematic maps	Systematic Maps are overviews of the quantity and quality of evidence in relation to a broad (open) question of policy or management relevance. The process and rigour of the mapping exercise is the same as for systematic review except that no evidence synthesis is attempted to seek an answer to the question. A critical appraisal of the quality of the evidence is strongly encouraged but may be limited to a subset or sample of papers when the quantity of articles is very large.
Systematic reviews	A systematic review is a type of literature review that collects and critically analyses multiple research studies or papers.
Theory based evaluation	Theory-based evaluation approaches involve understanding, systematically testing and refining the assumed connection (i.e. the theory) between an intervention and the anticipated impacts. These connections can be explored using a wide range of research methods (both qualitative and quantitative), including those used in empirical impact evaluation.
Theory of change	The central processes or drivers by which changes comes about for individuals, groups, or communities.
Theory of action	The ways in which programs or other interventions are constructed to activate these theories of change.
WFD Programmes of Measures	The process of river basin management planning includes the preparation of programmes of measures at basin level for achieving the environmental objectives of the Water Framework Directive cost-effectively. The planning, implementation and evaluation of the programme of measures is an iterative process of river basin management plans on a six year cycle (2009, 2015, 2021, and 2027).

Executive summary

There is a need for vertical integration that connects the assessment of water policy measures in the field with monitoring and evaluation at the waterbody, national and European levels and the scientific evidence base. There is also a need for horizontal integration between land and water policies and their plans to deliver multiple benefits from policy measures e.g. Scottish Rural Development Programme. Logic modelling can assist with these two challenges.

A logic model (also known as 'intervention logic' or 'programme theory') is a common method for setting out a policy or project's objectives and intended outcomes. During the development of logic modelling over the past 50 years a wide range of terms have been used that include theory of change, log frames, and outcome and results chains. At its heart logic modelling is about the construction of a plausible and sensible model of how a measure, project or programme is supposed to work.

Logic modelling is widely used in the evaluation of projects and programmes in Scotland and internationally. Logic models are also starting to be used in health assessments to structure systematic reviews of the evidence base. However, there is scope for greater use of logic modelling in other policy areas, including for measures affecting land and water. This has recently been highlighted by senior European Commission officials. Logic models are required in EU Rural Development Programmes (RDPs) and water policy evaluations, and have been suggested as part of the evaluation of RDPs in the UK e.g. Defra's Countryside Stewardship Facilitation Fund. They have been applied to water resource planning in Australia. Recently, a United Nations report on lessons learned on water and climate change adaptation strategies recommended the use of logic modelling.

In this report, I am suggesting that logic modelling has the potential to improve the connections between policy and management needs on the effectiveness of measures with the scientific evidence base. As part of the RESAS Strategic Research Programme research project 'Assessment of the effectiveness of interventions to achieve increased effectiveness of water policy objectives' the next steps are: to start to apply results chain logic modelling within a WFD context. This will result in a follow-up research briefing and workshop in 2017 with the objective of gaining further feedback on the value of logic modelling to support the effectiveness of measures. I set out how logic modelling can be carried out using an approach that has been developed, applied and refined in a range of conservation situations over the past 15 years in the Conservation Measures Partnership Open Standards for adaptive management. This approach is based on the production of results chains linked to a conceptual model of the situation. A summary of how to produce results chain logic models is set out in an appendix.

1. Introduction

1.1. Assessing the effectiveness of policy measures

There are increasing calls from policy and management stakeholders in Scotland and internationally to improve our collective understanding of the effectiveness of individual measures at the field scale e.g. a single General Binding Rule (GBR), and of groups of measures in landscapes e.g. at the water body scale, and larger national and international schemes and programmes of measures e.g. Agri-Environment Climate Scheme (AECS). This general requirement spans a wide range of Scottish Government and European policies and their associated management planning cycles, including: EU Water Framework Directive 2000 (WFD), Flood Risk Management (Scotland) Act 2009 (FRM) and Scottish Rural Development Programme 2014-2020 (SRDP). The assessment of the effectiveness of policy and management measures is directly related to other types of environmental assessments that span detection of problematic situations to their improvement (Box 1).

Monitoring and evaluation of these policy measures e.g. AECS or GBR, and wider types of interventions e.g. management actions at a National Nature Reserve (NNR) is vital to demonstrating they work as planned, and that limited resources are being effectively targeted. In the UK, the Magenta book (H.M. Treasury, 2011) provides guidance on policy evaluations (see Box 2 for additional details). Individual European policies e.g. Common Agricultural Policy (CAP), provide specific guidance on monitoring and evaluation requirements. For example, the Common Monitoring and Evaluation System requires Member States to produce evaluation plans covering Pillar I and II measures. In terms of the WFD, the European Commission and Member States are preparing for evaluation of Programmes of Measures by 2019. Recently, senior European Officials have been calling for Member States to improve the "intervention logic" of their WFD Programmes of Measures[1]. SEPA are currently undertaking work to assess the effectiveness of measures at the waterbody scale for a range of diffuse pollutants. Logic modelling has been suggested to help develop targets for nature conservation and improve the evidence base for effective planning and management (Pressey et al., 2015).

In addition to the above policy guidance on evaluation, there is a large body of guidance on the theory and practice of evaluation. This literature emphasises the need for evaluation to be based on the logic or theory informing the original policy or intervention. As one of the leading practical textbooks says "it can be difficult to interpret results from an evaluation that has no program theory. (…) Despite careful evaluation, it can be impossible to interpret evaluation results correctly in the absence of program theory" (Funnell and Rogers, 2011, 5). Programme theory is "the construction of a plausible and sensible model of how a program is supposed to work" (Bickman, 1987, 5). A visual model of how a programme is supposed to work is often called a 'logic model'. Logic models are simply graphical descriptions of a system or a process, which are designed to identify important elements and relationships within that system or process. The UK Government Magenta book says "a common method for setting out the policy objectives and intended outcomes is to develop a logic model (also known as 'intervention logic' or 'programme theory')" (H.M. Treasury, 2011, 41).

Over the past five to ten years, there has been increased focus on improving the evidence base of how natural resource management interventions work. These initiatives range from large European research projects to the development of approaches for the assessment and synthesis of the evidence on an intervention's effectiveness (Table 1). In addition, countless smaller research projects have contributed to the evidence base on the effectiveness of interventions e.g. an AECS measure or GBR, in providing one or more benefits. Whilst such evidence-collection is undoubtedly vital, the information collected is not always explicitly related to the original policy and management rationale for the research. For example, a large amount of natural science projects are focussed on

[1] http://www.ewp.eu/wp-content/uploads/2016/06/Pavel-Misiga.-SDG6-EWP-conference.pdf

improving our understanding of hydrological, biogeochemical and ecological processes at a range of spatial and temporal scales. Policy and management driven assessments of the effectiveness of interventions are not always able to utilise this great wealth of scientific knowledge.

In this report, I am suggesting that logic modelling has the potential to improve the connections between policy and management needs on the effectiveness of land and water measures e.g. SRDP AECS measures, and wider interventions, with the scientific evidence base. The rest of this report explains more about what logic models entail, and what they can offer.

This report is the starting point to address three research questions:

- How can logic modelling help connect water and agricultural policy objectives and the scientific evidence base?
- Are logic models helpful in structuring the evidence base of individual interventions?
- Can logic models help assess the effectiveness of interventions at policy relevant scales e.g. water body scale for WFD?

Table 1. Examples of initiatives to collect evidence on the effectiveness of measures.

Type of initiative	**Examples**	**Link or reference**
Cross organisational activities	Alliance for Useful Evidence	www.alliance4usefulevidence.org
	UK Joint Water Evidence Programme	connect.innovateuk.org/web/jweg/
Synthesis reviews	Systematic reviews	(Pullin and Stewart, 2006)
	Systematic maps	(Randall et al., 2015)
Approaches to assessment of evidence	Weight of Evidence	(Weed, 2005) (Forbes and Calow, 2002)
	EcoEvidence	(Norris et al., 2011
	US EPA's CADDIS	(Norton et al., 2009)
	Evidence Assessment Tool	(Mupepele et al., 2016)
Online databases	Freshwater Information Platform	www.freshwaterplatform.eu/
European research projects focussed on improving the evidence base of measure effectiveness	Water bodies in Europe: integrative systems to assess ecological status and recovery (WISER)	www.wiser.eu
	Managing aquatic ecosystems and water resources under multiple stress (MARS)	www.mars-project.eu/
	ENVIEVAL evaluation of environmental impacts of rural development measures	www.envieval.eu

Box 1: Relationships between assessment of measure effectiveness and other types of assessment

This report focusses on 'outcome assessment', which is dependent on condition assessments (Figure 1). In terms of WFD and river basin management planning, then the condition of a water body is determined through the guidance set out in the Scottish Government Directions e.g. The Scotland River Basin District (Standards) Directions (Scottish Government, 2014). Increasingly the effectiveness of measures, mandatory e.g. General Binding Rules and targeted e.g. AECS, are increasingly planned, monitored and assessed at the water body scale.

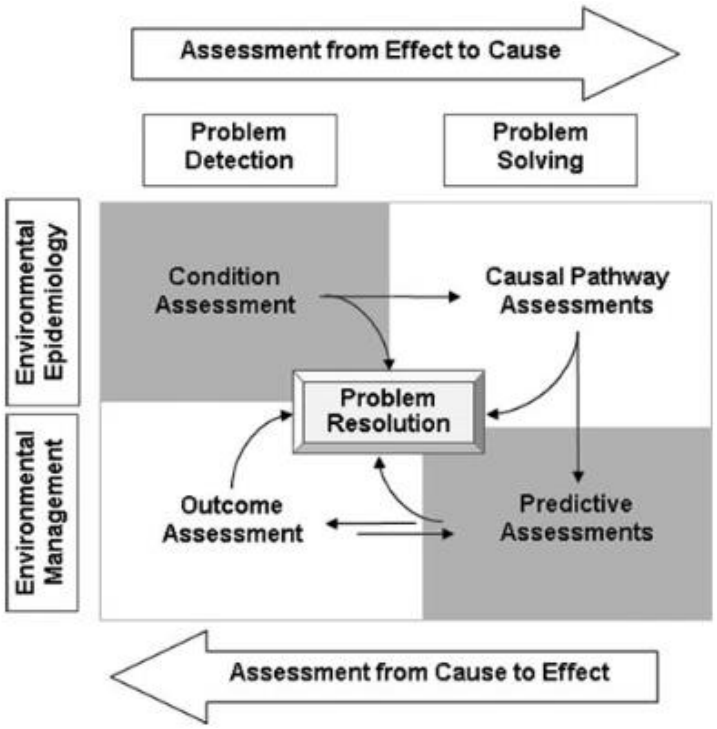


Figure 1. Four types of environmental assessment and their linkages from problem detection to resolution (from Cormier and Suter (2008)).

1.2 Approaches to evaluating effectiveness of policy measures and the role of logic modelling

Evaluation and assessment of the effectiveness of interventions needs to be considered at all stages of policy–making and implementation: from understanding the context, to developing the options, to getting to a decision, and making it happen (Hallsworth et al., 2011, 104). Here evidence, along with delivery and politics is a key component of successful policies (Hallsworth et al., 2011, 28). To understand the effectiveness of policy measures there is a need for a "clear, concise and convincing explanation of what you do, what impact you aim to have, and how you believe you will have it. It is a vital foundation of any programme, and a prerequisite for effective evaluation. For this reason, producing a Theory of Change [logic model] is an obligatory requirement for achieving Level 1 on Nesta's Standards of Evidence" (Nesta and TSIP, 2014, 1). Nesta's Standards of Evidence was their approach to measuring the impact of a range of practical innovation programmes and investments[2]. More specific to land and water measures, Defra in their strategy for evidence collection stressed that "the complex nature of some environmental policies, and the contexts in which they are

[2] http://www.nesta.org.uk/publications/nesta-standards-evidence

implemented, can make it particularly difficult to identify whether environmental initiatives are being implemented as intended and having impact" (Defra, 2014, 30).

There are three main approaches to evaluation: empirical impact evaluation, theory based evaluation, and simulation modelling based evaluation (Box 2), with logic models being central to theory based evaluations. A strength of theory based approaches is their ability to work in situations where a quantitative experimental research design is not possible. Conversely, a weakness of theory based approaches is that a counterfactual is not always possible or clearly described. Where what would have happened in the absence of the intervention is measured, and the impact is estimated by comparing counterfactual outcomes to those observed under the intervention.

2. Potential uses and benefits of logic models

There are several reasons why producing a logic model can assist in identifying key inputs, expected effects of activities, their outputs, outcomes and impacts (Table 2). In this report I focus on planning and evaluation of interventions, and their increasing use of logic models in guiding reviews and collection of evidence e.g. in systematic reviews.

Table 2. Potential uses of logic models in policy evaluation (H.M. Treasury, 2011, 42).

Guide reviews and collection of existing evidence and data, to identify areas of deficiency the evaluation may focus on.
Inform objectives of the evaluation and development of the research questions.
Guide the design of data collection and monitoring processes, so the correct information is available for evaluating the intervention.
Help understand how the intervention could have unintended consequences, guide additional data collection, evaluation objectives and framework.
Provide a transparent assessment framework within which existing evidence and the evaluation results can be combined to provide answers to the evaluation questions.

Logic models can also:

- help diverse stakeholders develop agreement on what they are trying to do and how;
- help improve plans by setting realistic objectives;
- illuminate gaps and opportunities for collaboration;
- support development of useful performance indicators to help assessment and reporting of progress;
- identify where and why programs are successful or unsuccessful; and
- aid learning across multiple sites, projects or evaluations (Funnell and Rogers, 2011, xx).

However, to achieve these benefits, care is needed as 'purposeful program theory' needs to be adapted based on a "thoughtful assessment of circumstances, asking in particular, 'who is going to use the program theory, and for what purposes?', and 'what is the nature of the intervention and the situation in which it is implemented?'" (Funnell and Rogers, 2011, xxi).

2.1 The use of logic modelling in planning and evaluation of interventions

Logic models can be used when designing and/or evaluating a wide range of interventions, ranging from broad policies to programmes and specific projects. Evaluations of policies, programmes, and projects often start with two questions: what are the objectives, intended outcomes and impacts of the policy/intervention; and what is the logic model (Crabb and Leroy, 2012). Logic models are a key part or representation of 'programme theory', which can support planning and evaluation of public policy. Programme theory is an explicit theory or model of how an intervention (e.g. measure, project, or policy) contributes to a chain of intermediate results and to the intended or observed

outcome. The role of logic models in UK policy evaluation is summarised in Box 2. A logic model will normally identify these aspects of a policy intervention (H.M. Treasury, 2011, 41):

- the issues being addressed and the context within which the policy takes place;
- the inputs, i.e. the resources (money, time, people, skills) being invested;
- the activities which need to be undertaken to achieve the policy objectives;
- the initial outputs of the policy;
- the outcomes (i.e. short and medium-term results);
- the anticipated impacts (i.e. long-term results); and
- the assumptions made about how these elements link together which will enable the programme to successfully progress from one element to the next.

Box 2: Role of logic models in different types of policy evaluation in the UK

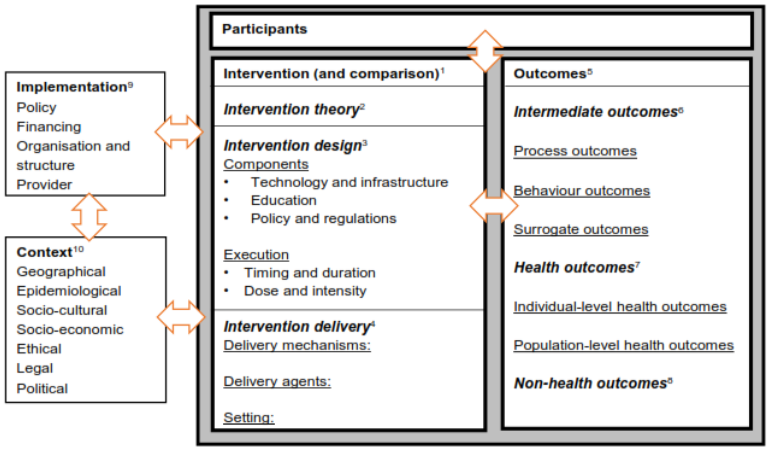
The development and application of logic models as part of programme theory of UK public policies is set out in the UK Government Magenta book (H.M. Treasury, 2011); for example: "Many evaluations of complex interventions or impact pathways will require a theory-based evaluation framework which seeks to triangulate evidence from multiple sources to test and refine the assumptions made in the logic model. Within this framework the evaluation could draw on evidence gathered through process evaluations and counterfactual impact evaluations as well as using analytical techniques, such as simulation modelling" (H.M. Treasury, 2011, 53).
The complexity of the logic model and importance of confounding factors influence the choice of evaluation approach. Where "detailed evaluation of changes in very complex systems (especially those with a significant geographical component) might only be possible through theory-based evaluation or simulation modelling" (H.M. Treasury, 2011, 46).
The Magenta Book sets out three main types of evaluation. Where "the choice of evaluation approach should be based on a statement of the policy's underlying theory or logic and stated objectives – how the policy was supposed to have its effect on its various target outcomes. The more complex the underlying logic, the more important it will be to account for other factors which might affect the outcome" (H.M. Treasury, 2011, 17).
The main types of evaluation are:

- 'process evaluation' assess whether a policy is being implemented as intended and what, in practice, is felt to be working more or less well, and why;
- 'impact evaluation' attempts to provide an objective test of what changes have occurred, and the extent to which these can be attributed to the policy; and
- 'economic evaluations' that compare the benefits of the policy with its costs.

2.2 Recent use of logic models in systematic evidence reviews.

Logic models can also support systematic evidence reviews, as suggested in UK guidance on policy evaluation (Table 2). Logic models are starting to be used in systematic review processes of health assessments: to conceptualise the focus of the review, to illustrate hypothesised causal linkages and identify intermediate outcomes, and to direct the review process (Anderson et al., 2011). A logic model in a systematic review can help structure the evidence and assumptions that underpin complex pathways from interventions to impact (Baxter et al., 2014). Different logic models can be used to conceptualise: the system (Figure 2A) and it interactions between participants, intervention and context; and the process (Figure 2B) that illustrates the processes and causal pathways that lead from interventions to multiple outcomes (Rohwer et al., 2016).

A



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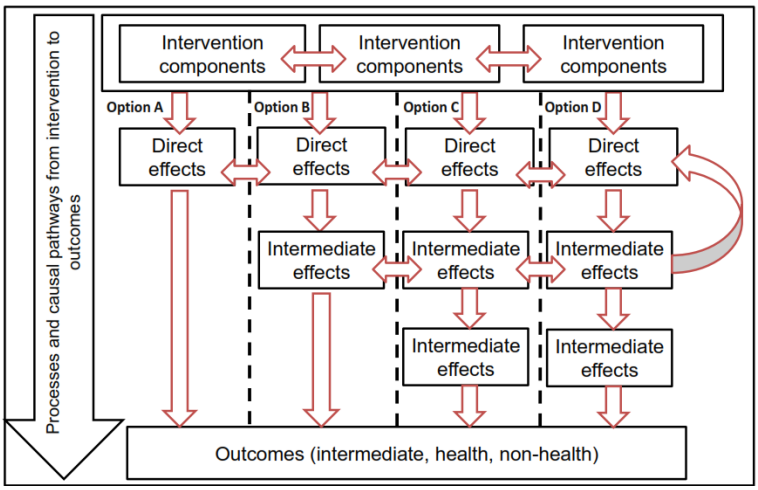


Figure 2. Use of logic models in systematic reviews to conceptualise: A) the system, and B) the process (Rohwer et al., 2016).

3. What is logic modelling and what types of logic models are there?

"A program theory is an explicit theory or model of how an intervention, such as a project, a program, a strategy, an initiative, or a policy, contributes to a chain of intermediate results and finally to the intended of observed outcome" (Funnell and Rogers, 2011, xix). It ideally has two components: a theory of change and a theory of action. Where a "theory of change is about the central processes or drivers by which change comes about (…) the theory of action explains how programs or other interventions are constructed to activate these theories of change " (Funnell and Rogers, 2011, xix).

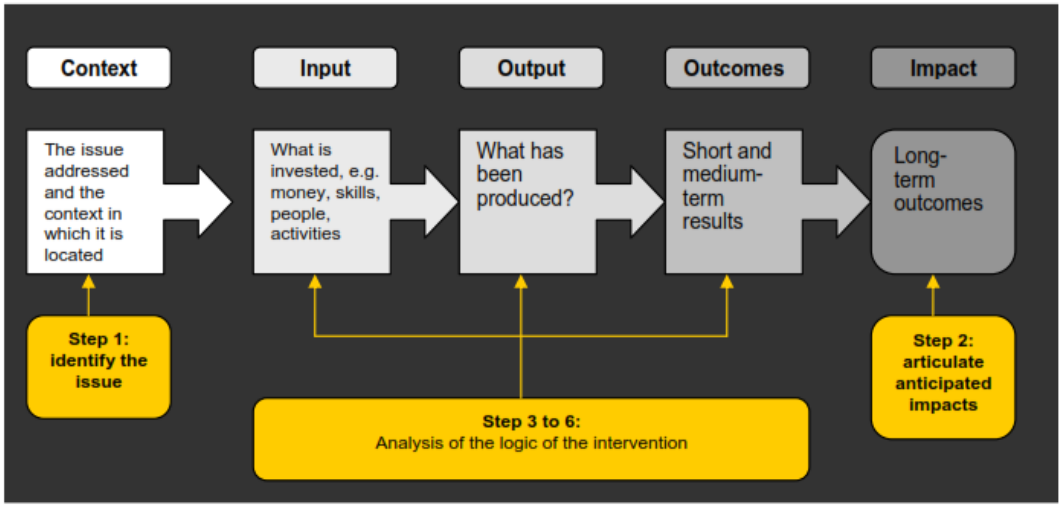
Over the past 50 years a range of projects have developed and applied logic models in planning and evaluation studies (Appendix 1 contains a brief history). The development and application of logic models as part of programme theory has led to the use of a range of related terms, for example: causal chains (Hall and O'Day, 1971), logical framework (logframe) (Practical Concepts, 1979), intervention logic (Nagarajan and Vanheukelen, 1997),Theory of action (Patton, 1997), Theory of change (Weiss, 1998), logic model (Rogers, 2004), logic mapping (Hills, 2010) and results chains (CMP, 2013).

An example of how to produce a logic model is presented in Box 3, which involves logic mapping (Hills, 2010).

Box 3: Tavistock Institute guide to Logic mapping

The Tavistock Institute produced a practical guide for Logic mapping in support of better transport evaluations for the UK Government (2010). Logic maps are developed by starting with the issue and considering the impact or change the intervention is intended to achieve, before working backwards through the steps required to achieve these objectives (Figure 3). A logic model provides a systematic and visual way to present the key steps to transforming inputs into activities that are designed to contribute to delivery of a set of impacts.

Figure 3. A logic model and steps to producing it (Hills, 2010, 8).



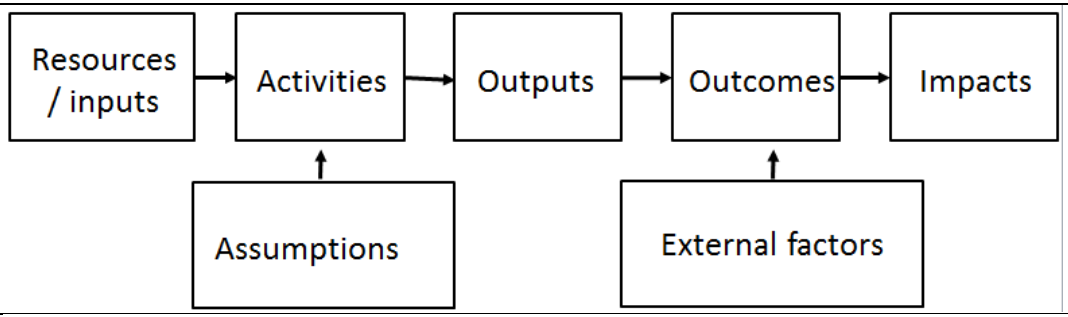
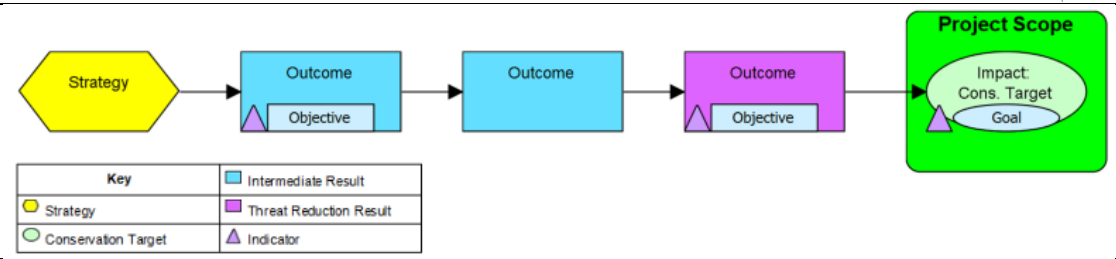
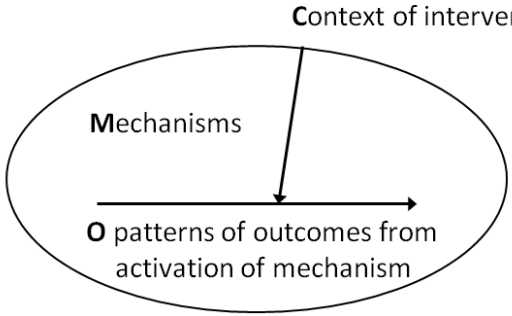
3.1 Types of logic models

There are three main types of diagram based logic models: pipeline, outcome (results) chains , and realist matrices (Funnell and Rogers, 2011, 32). Some of the key features of these different types of logic models are set out in Table 3.

There are several variations of pipeline and outcomes (results) chain logic models, these are summarised in Table 4. Funnell and Rogers (2011, 396) highlighted that "outcomes chain logic models are inherently more variable than pipeline models. "Pipeline logic models represent a programme theory as a linear process with inputs and activities at the start and long-term outcomes as the end. These vary based on the number of boxes for each level e.g. multiple activities, the number of components e.g. extra component for the context, and different labels e.g. what is done can be called processes or activities (Funnell and Rogers, 2011, 387-389).

In this research I am planning to use the outcomes (results) chain format of logic models (Margoluis et al., 2013). This approach has been widely applied in nature conservation over the past 15 years as part of the Conservation Measures Partnership Open Standards (CMP, 2013, Lamoreux et al., 2014). Though widely used in the practice of conservation management, there is little scientific literature on their use (Schwartz et al., 2012).

Table 3. Examples and key features of the three main types of logic models.

Type of logic model	Examples	Key features
Pipeline		Show inputs, activities, short-term and longer-term results often without explaining how the activities will produce the results. They are most useful when the results happen like a row of dominos (or at least with other processes out with the program).
Outcomes (results) chains		Focusses on outcomes. Emphasis on understanding the relationships and linkages as well as the component building blocks.
Realist matrices		Based on the identified generative mechanisms that result in outcomes in a particular context. Focuses on identifying conditions under which the theory will apply.

…

Table 4. Examples of variations of pipeline and outcomes chains logic models (adapted from (Funnell and Rogers, 2011, 391 and 398)).

Variations of pipeline logic models
Logical framework (logframe) is a four-component model of outputs, component objectives, outcomes (purpose), and impact (goal). A matrix is produced for each component, a description, indicators, means of verification, and assumptions.
W.K. Kellogg Foundation logic model is a five-compartment model of resources/inputs, activities, outputs, outcomes (results for participants), and impacts (results for the wider system or community).
University of Wisconsin logic model is a six-component model of inputs, activities, participation, and short-, medium, and long-term outcomes. External factors and assumptions are also shown.
Bennett's hierarchy is a seven-component logic model that represents changing behaviours through providing information. It is not a generic logic model like the Kellogg Foundation logic model. It specifies short-, medium- and long-term outcomes.
Variations of outcomes chain models
ActKnowledge/Aspen Institute Approach to Theory of Change include precondition outcomes that lead to the intended final result. It distinguishes between causal links that are expected to happen and those that require additional interventions.
People-centred logic model is based on Bennett's hierarchy, stating who will experience each of the levels.
Conservation Measures Partnership results chains based on outcomes and linked to a conceptual model.

4. Why are logic models needed to understand the effectiveness of measures for land and water management?

In addition to the general requirements for the use of logic models to structure theory-based and other types of evaluation (Box 2), and suggested uses of logic models in policy evaluation (Table 2). There are 1) an increasing number of calls for improving the practice of logic modelling for understanding the effectiveness of land and water policy measures, 2) increasing requirements for the use of logic models in evaluation of rural development and water policies, 3) increasing examples of the application of logic modelling to land and water measures internationally, and 4) use of logic models in climate change adaptation strategies. Here I briefly summarise these.

4.1 Calls for improving the intervention logic and effectiveness of land and water measures

Senior European officials and organisations have called for greater integration between land and water policies. In 2015, Pavel Misiga (Head of 'Clean Water (C1)' at DG Environment, European Commission) in his review of the WFD, suggested that across Europe, WFD Programmes of Measures were not leading to the desired improvement in water status, and there was a need to improve the intervention logic (logic models) of these, along with integrated assessment of how other policies contribute to the achievements of WFD objectives[3]. He reinforced these messages during a recent presentation on EU Water Policy and the sixth Sustainable Development Goal[4]. This goal is to ensure access to water and sanitation for all.

[3] http://www.ruhrverband.de/fileadmin/pdf/wissen/Fachveranstaltungen/Flussgebietsmanagement/2015/1-02_Misiga.pdf.).

[4] http://www.ewp.eu/wp-content/uploads/2016/06/Pavel-Misiga.-SDG6-EWP-conference.pdf

It is widely acknowledged there is a lack of integration between the intervention logic (logic models) and monitoring indicators of EU Rural Development Programmes (RDPs) and EU water policies e.g. WFD. During a recent meeting of European Commission Water Directors on the integration of WFD and Floods Directive (FD) into RDPs, they stated that recommendations for better integration of water policy and other policies e.g. agriculture (European Court of Auditors, 2014), had not led to a change in the Common Monitoring and Evaluation Framework of the RDPs: "indicators have remained the same, thus water quantity and morphology cannot be assessed, nor have the RDPs indicated how they link their RDP monitoring with the WFD and FD monitoring systems" (McCamphill, 2015, 6).

4.2 Increasing requirements for the use of logic models in evaluation of rural development and water policies

There are increasing requirements for the use of logic models in guidance on the monitoring and evaluation of EU RPDs and water policies e.g. WFD. The EU 2014-2020 RDPs have a greater emphasis on setting out the intervention logic that links programme objectives and operational activities, as described in the Common Monitoring and Evaluation System (CMES) (summarised in Box 4).

An example of how logic models could be used in the monitoring and evaluation of UK based RDPs was explored for Defra's Countryside Stewardship Facilitation Fund (CSFF) (Bennett et al., 2015). The authors looked at three options for evaluating the CSFF: an experimental/counterfactual approach, a theory of change approach (using logic models), or a combined approach. They suggested that a combined approach may be the best option. Appendix 2 contains a summary of their report.

There is also a need to evaluate the effectiveness of measures in the WFD river basin management plans. For the first cycle of these plans, the European Commission are carrying out an evaluation of the Programmes of Measures by 2019. This requires Member States to provide additional information on their Programmes of Measures: how the intervention logic was followed, and how effective they were. In Scotland, there are ambitious targets in the second river basin management plans to improve the status of surface freshwaters by 2021 and 2027. A recent Centre of Expertise for Waters (CREW) report that evaluated the Rural Diffuse Pollution Plan for Scotland used a Weight of Evidence approach (Weed, 2005): "in summary water quality monitoring alone is insufficient to provide an understanding of the diffuse pollution risks at play in a catchment. For example, despite sufficient FDP GBR uptake, expected improvements may be negated by increases in rainfall or land use change. Evaluation of the weight-of-evidence method in the trial catchments clearly shows the need for additional catchment evidence" (Akoumianaki et al., 2016, 3).

Box 4: Common Monitoring and Evaluation System, and Scottish Rural Development Programme

As part of the 2014-2020 EU RDPs, the previous Common Monitoring and Evaluation Framework has been revised to include the Common Monitoring and Evaluation System (CMES): with an increased emphasis on the intervention logic as "a methodological instrument which establishes the logical link between programme objectives and the operational actions envisaged. It shows the conceptual link from an intervention's input to its output and, subsequently, to its results and impacts. Thus intervention logic allows an assessment of a measure's contribution to the achievement of its objectives"(European Commission, 2013).

The CMES shall aim to: demonstrate the progress and achievements of rural development policy and assess the impact, effectiveness, efficiency and relevance of rural development policy interventions; contribute to better targeted support for rural development; and support a common learning process related to monitoring and evaluation. These general objectives are broken down to specific objectives, some of which are relevant to Pillars I and II. There are six priorities (specific objectives) for rural development, divided into a number of focus areas. For example those directly relevant to biodiversity, water and soil are:

- Focus area 4A: To what extent have RDP interventions supported the restoration, preservation and enhancement of biodiversity including in Natura 2000 areas, areas facing natural or other specific constraints and HNV farming, and the state of European landscape?
- Focus area 4B: To what extent have RDP interventions supported the improvement of water management, including fertilizer and pesticide management?
- Focus area 4C: To what extent have RDP interventions supported the prevention of soil erosion and improvement of soil management?

4.3 Increasing examples of the application of logic modelling to land and water measures internationally

In a recent book, Baldwin and Hamstead (2014) reviewed the current use and future potential of logic models in water resource planning in Australia. Though water resource plans often include a series of actions and sets of objectives: "unfortunately few water resource plans have explicitly stated logic models. This does not mean there is no logic in the plan. It rather means that the logic that was used to prepare the plan is scattered through the text of the plan and associated documents, or is not documented at all" (Baldwin and Hamstead, 2014, 67). The authors also highlighted that there may also be gaps and weaknesses in the plan logic, and performance indicators may be poorly designed.

Baldwin and Hamstead (2014, 66-67) suggested that logic models can be used: during development of water resources plans, to conceptualise what needs to be done and how it can be achieved; to communicate how the plan will help achieve the identified outcomes; for evaluation of implementation to enable corrective action as needed; and as a basis for initiating and for informing revision of the plan. They highlighted that there are a range of ways logic models can be expressed. Baldwin and Hamstead (2014) used the terminology and logic framework for objectives based on the World Bank (Team Technologies) Logic Framework Approach, and incorporating ecosystem service concepts from Plant *et al.* (2012). Further information on their approach is provided in Appendix 3.

Logframe approach to logic modelling has been used in other water resource studies e.g. (Mylopoulos et al., 2008). One recent application of a linear logframe suggested that outcome mapping approach to logic modelling may have greater flexibility in dynamic environments as they are process-orientated (Yamaswari et al., 2016).

4.4 Use of logic models in climate change adaptation strategies

A recent report on 'Water and climate change adaptation in transboundary basins: lessons learned and good practice' highlighted that "the evaluation framework and evaluating indicators for adaptation measures should be designed at the planning stage" (UNECE and INBO, 2015, 89). It stated that "the closely linked, but essentially separate, process of evaluation provides an independent assessment of how effective initiatives are in achieving set objectives" where a "basin-wide assessment is necessary to be able to implement a basin-wide adaptation strategy" (UNECE and INBO, 2015, 89) (Figure 3). Lessons learned in terms of monitoring and evaluation included the need to develop a theory of change i.e. logic model (Box 5).

Box 5: Lessons learned and good practice for water and climate change adaptation in transboundary basins (UNECE and INBO, 2015)

Lesson 60 Develop a theory of change.
"At the project and programme level, a level of change developed at the outset can help map the multiple pathways to the identified objectives, determine which pathway to choose and decide the relationship between the different components and the reported outcomes" (UNECE and INBO, 2015, 90).

Additional evaluation lessons were:
Lesson 61 Use a portfolio of monitoring and evaluation tools and be cautious in attributing impacts to climate shifts.
Lesson 62 Evaluate the effectiveness of adaptation measures.
Lesson 63 Establish mechanisms for regularly reviewing the assessments in order to ensure flexible adaptation.

Figure 3. Adaptive management framework for the development of a climate change adaptation strategy (UNECE and INBO, 2015, 4).

5. What is required for greater use of logic modelling to link policy measures and the evidence base?

As suggested in the introduction, I think logic modelling has the potential to improve connections between policy and management needs on the effectiveness of measures for multiple benefits with

the scientific evidence base. Outcome or results chain based logic modelling has widely been used in conservation practice and there is an increasing scientific literature on its potential and use (Schwartz et al., 2012, Margoluis et al., 2013, Pressey et al., 2015). There is potential for logic modelling to aid greater vertical integration between policies and their evidence base e.g. SRDP, and horizontal integration between different policy areas. For example, monitoring and evaluation of policy measures e.g. SRDP measures, transcends from evaluation activity carried out by the European Commission and Member States RDPs and water policies e.g. WFD, to a huge number of place based studies in individual catchments on single and multiple measures and wider interventions. In a UK context there is a need to improve the linkages between the evidence base and the Programmes of Measures in the river basin plans especially in the Priority catchments as highlighted by the recent CREW report on monitoring and evaluating the Rural Diffuse Pollution Plan (Akoumianaki et al., 2016), as there are ambitious targets in the second river basin management plans. This report has highlighted some of the calls for greater integration between agricultural and water policies from the European to water body levels (Section 4.1). The findings of this report suggest that common approaches to monitoring and evaluation of policy measures across different policies could aid this integration.

Concurrently with the increased focus on monitoring and evaluation of policies, over the past five years there have been several policies and strategies developed and implemented in Scotland concerning open digital data and information that are relevant to assessing the effectiveness of measures. For example, 'Scotland's Digital Future' the Scottish Government (2011) included an action focussed on developing proposals for releasing more government information and data for use by the public. Recently SNH (2015) and SEPA (2016) have developed and published open data publication policies and plans. They both plan to make all of their data available, as at least three star level of openness (e.g. csv file format) with an Open Government Licence, by the end of 2016. Logic modelling is increasingly supported by specialist software e.g. Miradi[5]. There is a need to link qualitative logic models with the underpinning evidence using digital technologies.

6. Next steps in this research on effectiveness of measures

As part of the RESAS SRP research project 'Assessment of the effectiveness of interventions to achieve increased effectiveness of water policy objectives' the next steps are: to start to apply results chain logic modelling within a WFD context. This will result in a research briefing by April 2017. A workshop will be held later in 2017 with the objective of gaining further feedback on the value of logic modelling to support the effectiveness of measures.

I plan to apply the logic modelling approach as used in the Conservation Measures Partnership Open Standards for adaptive management (CMP, 2013). This approach is based on the production of results chains (Table 3). A summary of how to produce results chain logic models is set out in Appendix 4 (Margoluis et al., 2013).

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[5] www.miradi.org/

Appendices

Appendix 1: Brief history of key developments in programme theory and the use of logic models

Table 5. Key developments in programme theory and use of logic models (adapted from (Funnell and Rogers, 2011, 16)).

Early developments in the 1960s and 1970s
Don Kirkpatrick's (1959) Four Levels of Learning Evaluation for training programmes is often quoted as being an early example of programme theory.
Edward Suchman (1967) said you need to examine achievements in terms of a 'chain of objectives'.
Daniel Stufflebeam's (1967) CIPP model set out interventions based on four categories (and questions based on): context, input, processes, and product.
Practical Concepts Incorporated (1979) report "The Logical Framework: A Manager's Guide to a Scientific Approach to Design and Evaluation." Highlighted the use of the logical framework (logframe) approach for planning and evaluation.
The German international development agency (GIZ) further developed the logframe for use by UN agencies. There were four components to the causal chain in the logframe: activities, outputs, purpose (rationale), and goal (higher-level objective). With each component including: a narrative description, objectively verifiable indicators, means of verification, and assumptions.
Hall and O'Day (1971) suggested the inclusion of intermediate measurement variables provided more realistic indicators, than just those based on final results.
Carol Weiss (1972) book 'Evaluation Research: Methods of Assessing Program Effectiveness' set out how multiple causal models (based on chains of objectives: causal chains) could be presented in a single diagram, for evaluation of teacher home-visiting program. Four or five intermediate objectives between activities and final objective were included.
Fitz-Gibbon and Morris (1975, 1) defined theory-based evaluation as "one in which the selection of program features to evaluate is determined by an explicit conceptualization of the program in terms of theory, a theory which attempts to explain how the program produces the desired effects."
Claude Bennett (1975) aimed to influence farmers and others through providing research-based information. His approach included seven components: inputs; activities; participation; reactions; changes in knowledge, aspirations, skills and attitudes; behaviour changes; and resulting changes in social, economic, and environmental conditions.
Increased used in the public sector since the 1980s
Some organisations applied program theory based on Suchman's (1967) ideas of chains of objectives. A key paper from the Roundtable on Comprehensive Community Development and Aspen Institute by Carol Weiss (1995) set out how theory–based evaluation using outcome chains could be useful for programs were experimental approaches were not possible.
Other organisation applied program theory based on a pipeline approach. A non-profit organisation The United Way (America, 1996) set out a four-box logic model for outcome measurement that included: inputs (resources and constraints), activities, outputs (services or products), and outcomes for participants. The W.K.Kellogg Foundation produced the Logic Model Development Guide (Kellogg, 2004) that included a linear template with five components: inputs, activities, outputs, outcomes, and impact. The Norwegian government international development agency produced a widely used logical framework approach (Norad, 1999). Norad have since switched to the less rigid Results Based Management, which uses logical planning models linking inputs and impacts by a results chain.

Innovations over the past 30 years
Ray Pawson and Nick Tilley (1997) in their book 'Realistic Evaluation' set out a realist approach to evaluation, where program theory is viewed based on linkages between context, mechanism, and outcome. Where context is vital for program theory, especially favourable contexts (implementation environments or types of participants).
Outcome mapping was developed by Sarah Earl, Fred Carden, and Terry Smutylo (2001) based on their work with Barry Kibel. Where outcome mapping is an approach where implementers of interventions cannot control impacts directly, but aim to influence these through the behaviour of boundary partners. This was further developed by Steve Montague, Gail Young and Carolyn Montague in terms of circles of influence. These include: operational influence, environment of direct influence, and the environment of indirect influence.
The pipeline approach was further developed. For example Steve Montague said logic models needed to include 'reach' i.e. for whom particular results were intended. Assumptions, external factors, needs, and priorities, as well as the desired participants were included in a generic logic model by the University of Wisconsin.
Current state
Program theory has been included in most approaches to evaluation, with many organisations referring to it and requiring it use in planning proposals and evaluations. The UK Magenta Book (H.M. Treasury, 2011) includes discussion of program theory to guide planning and evaluation. The European Commission also included a discussion on program theory in its guide to evaluation assessments.
Carol Weiss (logical framework approach) reviewed program theory and highlighted three issues of concern: lack of articulated theory about how change comes about, having a poor theory, and not using the theory to guide evaluations.
Funnell and Rogers (2011, 23) concluded their overview of the history of programme theory saying "this explosion of activity has produced great diversity in what program theory is called, how it is represented, and how it is used. (…) This rich diversity of experience presents a wide range of options at each stage, which can be quite confusing."

Appendix 2: Scoping study into the use of logic models for monitoring and evaluation of Defra Countryside Stewardship Facilitation Fund

Collingwood Environmental Planning recently carried out a scoping study into the monitoring and evaluation of the Countryside Stewardship Facilitation Fund (CSFF) for Defra (Bennett et al., 2015). They explored three main options for evaluating the CSFF: an experimental/counterfactual approach, a theory of change approach, or a combined approach. They suggested that a combined approach may be the best option.

The CSFF is similar to the SRDP Environmental Co-operation Action Fund, where facilitation must cover at least four adjoining holdings over at least 2000 hectares. They will help farmers and land managers to work cooperatively to deliver environmental priorities over a wider area. This fund aims to deliver shared environmental outcomes that go beyond an individual holding by providing support for facilitators to coordinate action amongst farmers and other land managers. The monitoring and evaluation needed to focus on three aspects of the CSFF: investment in facilitation lead to greater spatial coherence at the landscape scale, skilling of group members lead to additional delivery compared to individual holding scale, and do the benefits of supporting group cooperation at the landscape scale justify the costs.

Suggested evaluation questions were structured around key parts of logic models: inputs, activities/process, outputs, and outcome/impact. They provided a list of guiding principles for the design of the CSFF monitoring and evaluation study (Table 6), and a list of the main steps in developing a logic model to support an evaluation (Table 7).

Table 6. Guiding principles for the design of the CSFF monitoring and evaluation study (Bennett et al., 2015).

The focus is to assist with provision of evidence to answer key policy questions.
The approach will be based on those suggested in the Magenta Book.
The method should include: a logic model that reflects causal links / theory of change; clear evaluation questions; recognise the importance of context; and where appropriate, develop a counterfactual.
The approach should be consistent with overall monitoring and evaluation plan.
Existing information will be used where possible.
Aim to reduce burden on facilitators on undertaking monitoring and evaluation, and be proportional in effort and cost to the CSFF.
Enable learning on the effectiveness of facilitation.

Table 7. Main generic steps for the development of logic model to support an evaluation (Bennett et al., 2015).

Steps
Collate literature of relevance e.g. on the topic, including policy, guidance and existing monitoring and evaluation policy.
Review literature and identify possible logic model elements (inputs, activities, outputs, outcomes, and impacts).
Collate and analyse possible logic model elements, group these and identify possible key/critical elements. Identify possible causal processes and linkages between elements.
Write up initial logic model in an interim report and gather feedback.
Map out possible 'theory of change' between logic model elements and undertake literature review to evidence theoretical causal processes identified (where possible).
Develop finalised logic model and 'theory of change' taking account of feedback. Use the finalised logic model to scope evaluation approaches and possible data requirements and questions.

Appendix 3: Australian examples of using logic models in water resource planning

In a recent book, Baldwin and Hamstead (2014) reviewed the current use and future potential of logic models in water resource planning in Australia. They highlighted that there are a range of ways logic models can be expressed. Baldwin and Hamstead (2014) used the terminology and logic framework for objectives based on the World Bank (Team Technologies) Logic Framework Approach, and incorporated ecosystem service concepts from Plant *et al*. (2012): with the broad outcome on the right hand side, with one or more layers of intermediate outcomes. The Logical Framework Approach sets out the significant 'assumptions and risks', so as to be clear what is expected from the programme or plan. The chain of outcomes is often a hierarchy with lower outcomes contributing to higher levels. In the Logical Framework Approach the results hierarchy is mapped to the four levels of the narrative summary. Baldwin and Hamstead (2014, 72) suggested this was "a useful framework that distinguishes the processes and underlying logic that actually occur". Table 8 contains the structure and terminology of their approach.

Their approach included a situation analysis, then decisions are made in the 'objectives and logic' step on what the plan should achieve and how this should be carried out. Baldwin and Hamstead (2014, 137) "argue that a planning process is more effective if the objectives are explicitly and clearly stated in the early stages. Expressly understanding and stating the objectives provides a transparent foundation for developing management options and comparing them in relation to the extent they contribute to or impact on all of the objectives." Once the objectives and outputs have been identified they need to be presented so they are relevant for the planning process and locally relevant and specific for stakeholders. Plant *et al.* (2012) suggested expressing them based on the ecosystem service assessment carried out in the situation analysis. "Finally, an important method to test proposed objectives is to engage with stakeholders to assess whether they are understandable, sufficiently comprehensive and relevant " (Baldwin and Hamstead, 2014, 142).

Table 8. Logic framework and terminology used in Baldwin and Hamstead (2014).

Level	**Performance indicators and targets**	**Monitoring and evaluation**	**Key assumptions**
Objectives The desired benefits and associated services resulting from a combination of outputs of the plan and key assumptions.	Indicators that define the extent that the objectives are intended to be achieved, and the effectiveness of the outputs in contributing to achieving them.	Means for measuring and evaluating achievements of the indicators for objectives.	Assumed actions and influences outside of the scope of the plan, upon which the achievement of the objectives is also reliant.
Outputs Desired water regime characteristics that produce the plan's contribution to the objectives.	Indicators that define the extent that outputs are intended to be achieved, and the effectiveness of the strategies in achieving them.	Means for measuring and evaluating achievements of the indicators for outputs.	Assumed actions and influences outside of the scope of the plan, upon which the achievement of the outputs is also reliant.
Actions The means that the plan puts into place to achieve the outputs.	Indicators of the extent/efficiency of implementation of actions, and whether/how they achieved outputs?	Means for measuring and evaluating achievements of the indicators for actions.	Assumed inputs and resources necessary to implement the actions.

Appendix 4: How to produce a results chain through logic modelling

This review has highlighted a range of approaches to carrying out logic modelling and types of logic models that are produced (Tables 3 and 4, Box 3). Here I provide an overview of producing a type of logic model called a results chain, which is a variation of an outcome chain logic model, that is used in the Conservation Measures Partnership Open Standards for adaptive management (CMP, 2013, Margoluis et al., 2013). The Open Standards have been developed, applied and revised over the past 15 years in a wide range of conservation projects around the world.

To produce the results chain, first a conceptual model of the system e.g. water body catchment is produced highlighting the drivers, pressures, impacts and conservation targets (Figure 4). Here I provide a summary of the first two steps of the Open Standards approach to adaptive management, as these are critical steps in the production of results chain logic models.

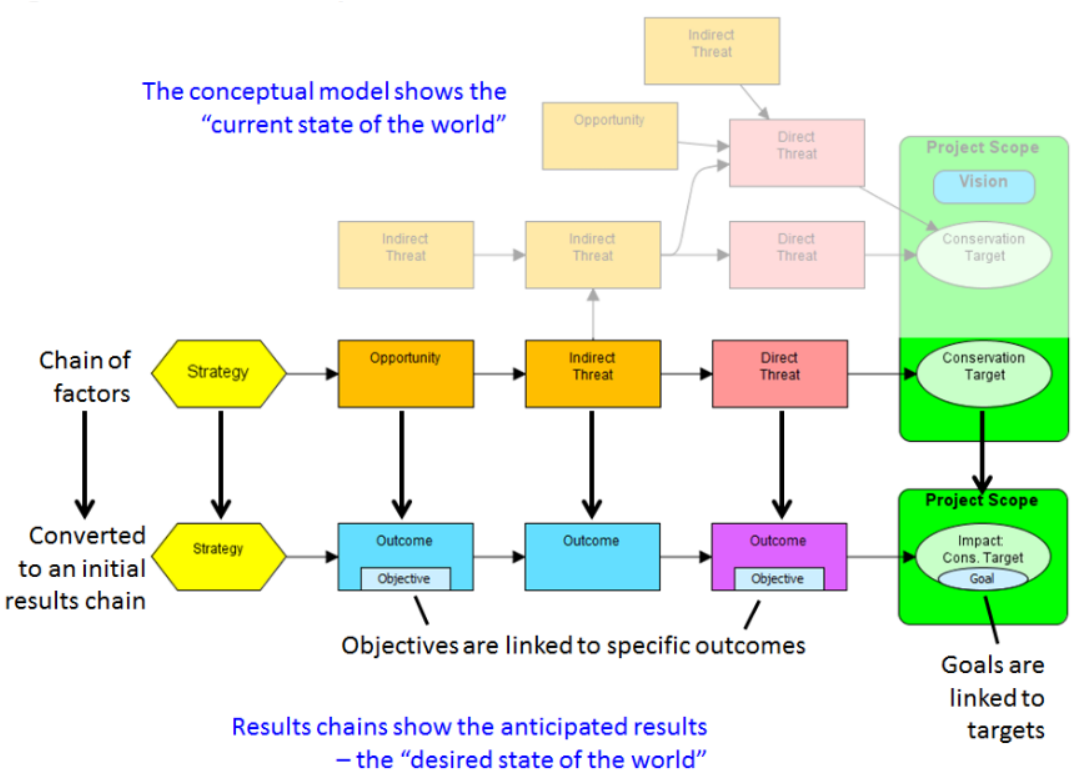

Figure 4. Demonstrating how a conceptual model of strategies, factors, direct threats (pressures) and conservation targets can be converted to a results chain (CMP, 2013, 21).

Step 1: Conceptualise

There is a need to first determine: what is the geographic e.g. water body and thematic scope, your vision of what you want to achieve, and the targets which will be the focus of the work e.g. achieving good ecological status of a water body. As part of this first step there is a need to determine the current status of each conservation target. Conservation targets (or features) can include biodiversity and human wellbeing targets depending on the scope and vision of the project. This can involve determining indicators for each key ecological attribute of each conservation target. Once priority conservation targets have been agreed, there is a need to identify direct threats that affect them. A synonym for 'threat' is 'pressure' (CMP, 2013, 12). Pressures are part of the drivers-state-impact-pressure conceptual model, which is used in WFD and river basin management plans, and other European policies. Pressures are primarily human activities that immediately degrade a conservation target. They can also be natural phenomena altered by human activities e.g. increase in

storm events due to climate change. It is important to determine the critical pressures, and these can be rated and ranked based on the extent or magnitude of the pressure, and severity or impact on the conservation target. A conceptual model is a way to represent relationships between conservation targets, pressures, opportunities and primary interests of stakeholders (Figure 5). This should identify the main cause and effect relationships that you assume exist.

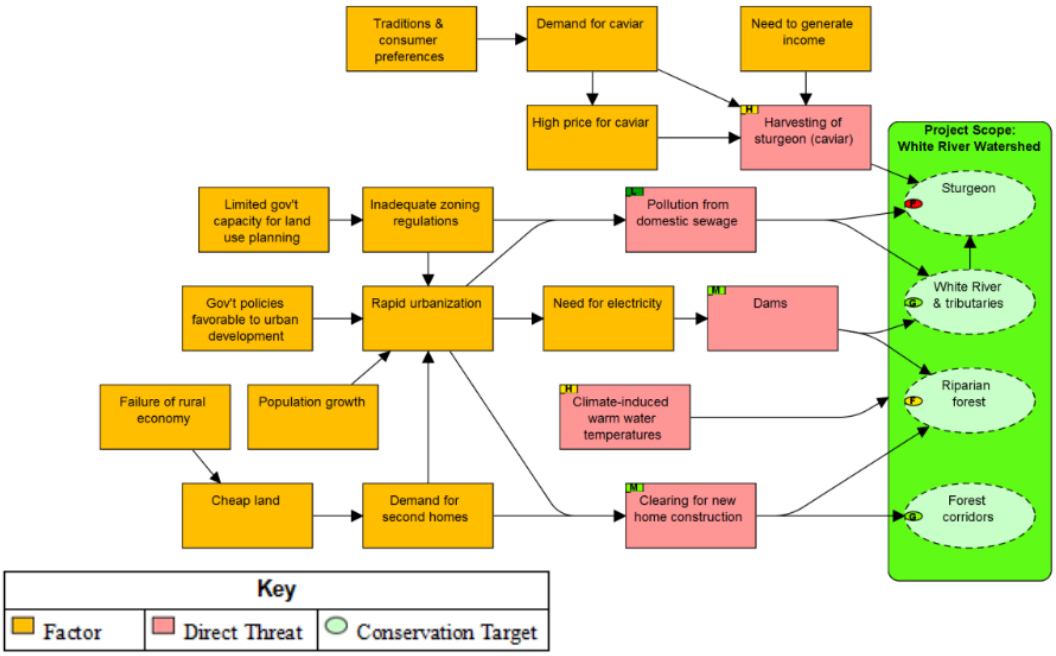

Figure 5. Example conceptual model for a catchment showing linkages between conservation targets, pressures (direct threats) and drivers (factors) (CMP, 2013, 15).

Human wellbeing targets are shown to the right of conservation targets, affected by the status of the conservation targets and the ecosystem services that depend on the ecological conservation (Figure 6).

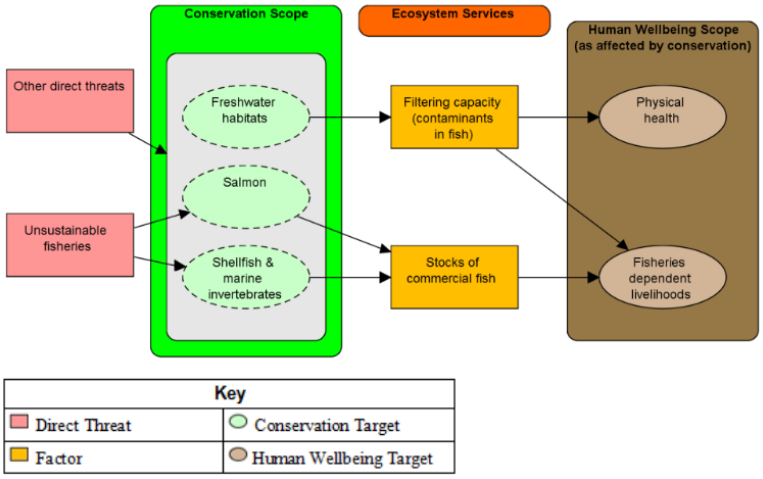

Figure 6. An example of part of a conceptual model that includes human wellbeing targets and ecosystem services (CMP, 2013, 16).

Step 2: Plan actions and monitor

Once basic parameters of the project have been set out, the next step is to define goals and strategies. This involves developing an action plan that includes project goals, strategies, objectives and assumptions. Where a goal is linked to the conservation targets and represents the long-term desired status. Once your objectives (goals) have been established, you should agree what needs to be done in terms of strategies and activities of where and how you will intervene. This involves prioritising what factors in your conceptual model require action. Once key intervention points have been prioritised you need to produce a list of potential strategies to address those intervention points and select those with greatest potential to achieve your project's goals (Figure 7). Where a strategy is a set of actions with a common focus e.g. habitat restoration and land protection; the final selection should meet the criteria of being linked, focused, feasible and appropriate (CMP, 2013, 20-21)

Once you have selected your strategies, you need to be clear how each strategy will enable you to achieve your conservation goals. This involves being explicit about the assumptions that demonstrate your belief in how these strategies will contribute to achieving your conservation goals. Producing results chain (logic model) is one way to set out these assumptions in a causal (if-then) progression from short and longer-term intermediate results that lead to long-term conservation results. Your conceptual model can be used as the basis for developing results chains, through setting out how your strategy affects the current and desired states (Figure 4). Results chains "are also a very useful tool for setting short-term objectives that lead to long term outcomes" (CMP, 2013, 23).

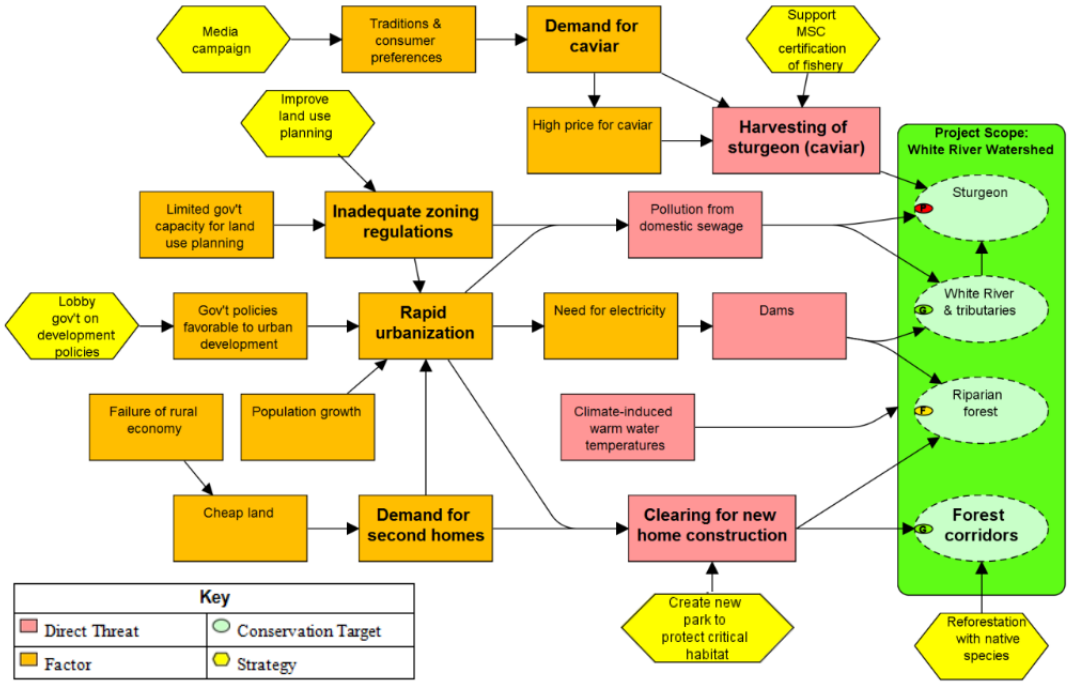

Figure 7. An example of a conceptual model with key intervention points (bold) and strategies (yellow).

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