ENVISION

# Uncertainty, knowledge and actor agency in nature conservation:

## A systematic qualitative review and assessment

Deliverable 4.1

Landscape image courtesy of Landsat/Copernicus

ENVISION is a 3-year research project that develops an inclusive approach to the management of protected areas with the aim of improving biodiversity and human well-being. We engage diverse groups of stakeholders of a protected area, such as recreational users, local residents, local businesses, land owners, agriculture, researchers or local governments and protected area managers.

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Findings from this report will be used as background for publications in international peer-reviewed, open access journals by the autor.

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# Index

## 1. Overview

The ENVISION literature review on uncertainty with conservation planning and managemet is made up by several tiers, where Deliverable 4.1 constitute tie A, and the latter steps under development to support and feed into the later WP 4 deliverables and final publications:

A. Overview: Approaches, frameworks and strategies to addressing uncertainty in formal nature protection and conservation. The first review provides information on current emphasis, gaps, or indications where there might be an alternative literature that needs to be identified and explored (relevant knowledge not yet fully connected to conservation planning).

B. Qualitative analysis (next step – towards D4.3): What uncertainties are recognised and what remedies are suggested (qualitative systematic review)
   a. Potential frameworks: IPBES, CAS
   b. Evidence, actors and governance
   c. Forecasting and strategy
   d. Boundary conditions
   e. Cross scale and cross boundary interactions
   f. Management and practice
   g. Drivers

C. Application in practice (still to be decided): Existing frameworks in our case study countries/EU and USA (policy/document analysis (in combination with limited systematic reviews)) and how they treat the emergent themes from A and B.
   a. Natura 2000
   b. National Parks
   c. MAB
   d. National nature protection frameworks

## 2. The systematic literature review

The literature reviews are organized using a combination of structural approaches, namely thematic, inverted pyramid, and the benchmark studies/frameworks. This means that the research is divided into sections representing both the conceptual subjects as well as the thematic categories for the topic on focus. The discussion of the related literature is organized accordingly while, when appropriate, starting from a broad perspective and then dealing with more and more specific perspectives from studies associated with the research problem (which in part will be informed by step A).

**Search strategy:** Two strings of enquiry were used for step A: 1) Formal protection AND conservation AND strategy OR formal protection AND planning AND conservation; and 2) biodiversity conservation AND planning OR biodiversity conservation AND strategy.

The narrative/qualitative review: Will be based on the categories/approaches identified and selected from the scoping review. Purposive sampling will be used for the final qualitative assessment/synthesis.

**Eligibility criteria:** For A (and B): Peer reviewed scientific literature in English. The systematic-scoping review is identifies and narrow down themes and knowledge fields for the qualitative review (B). Focus is on research, review and perspective papers that have development (theory, concepts or methods) or discussion of more holistic strategies or approaches as part of the study (not case studies that only apply a specific method or approach).

*Detailed criteria:*

- Is the study relating to terrestrial systems?
- Is it a report, review or perspective article?
- Does it address conservation planning?
- Is uncertainty explicitly addressed?
- Does it have a clear connection to biodiversity conservation?
- Does it include a scenario or future perspective?

Every article where the answer to all questions was 'yes' was read in full. Articles where all but one criteria were met where marked and kept for later reference. In addition, articles that discuss strategies for both biodiversity and related ecosystem services were included, but we excluded articles that only addressed ecosystem services such as management strategies for carbon stocks, human infrastructure, and food security. Review studies that explore climate impacts on ecosystem components and processes without making explicit recommendations for biodiversity management were excluded.

**Information sources:** For A, Web of Science was used. While Web of Science results can be limited by citation distributions, it reliably searches across publishers and does not bias towards journals published by any one company. While Web of Science may apply too much rigor in its searches, it was chosen over Google Scholar, which does not apply enough rigor in vetting included resources. In some cases, snowballing will be used to follow-up or check original sources.

Stage B will be more purposive and include more search pathways. The first, already listed in the excel file, was: biodiversity conservation AND protected area management AND uncertainty.

**Evaluation and summary synthesis:** Articles were coded according to both conceptual subjects and some thematic categories. The conceptual subjects had to do with how uncertainty was framed and hence open-ended. Thematic categories were more pre-defined, if not entirely closed.

*Conceptual*

- Variables of interest/in focus
- Sources of uncertainty
- Drivers of change
- Strategies for dealing with uncertainty
- Process uncertainty - Uncertainty at different stages of the planning/management process
- Barriers to implementation (of the strategies above rather than the overall approach)

*Thematic*

- Framework: open (e.g. adaptive management, strategic conservation planning)
- Conservation orientation: nature for nature, nature for people, nature for culture, mixes
- Alignment with overall societal goals and objectives: open (e.g. Rio, SDGs…)
- Purpose: Conceptual, analytical or practical + an open specification
- Dimensionality: social, ecological, social-ecological
- Theories (if made explicit): open
- Methods (if method oriented): open
- Scale: object or landscape
- If practice oriented: Governance recommendations – monocentric: community, coalition, government; polycentric: open
- Forecasting method(s): projections or models, narrative scenarios
- Case and context (if applicable): open
- Types of knowledge addressed: system, target, operational/transformative

**Reliability and validity:** Coding in A relatively simple and straight forward. B will require more people to reduce the risk of bias when applying a more interpretive analytical protocol.

**Data management:** Articles catalogued in Mendeley, systematic-scoping review in excel, organised according to the guiding questions (CAS, conceptual development, strategies for dealing with uncertainty, etc.). Search terms, guiding questions and codes in a separate excel file.

# 3. First findings and results

## 3.1 Dimensions of uncertainty

Framed by primarily climate change and other anthropogenically induced changes in the environment conservation planning and management implicitly or explicitly identify and address multiple sources of uncertainty. A primary concern is the lack of data on both patterns and trends for biodiversity as a whole as well as for species of particular concern. An estimate of the biodiversity (be it genetic, species, or ecosystem diversity) of any given area is associated with data (or epistemic) uncertainty, such as proxy definitions, measurement error, or model uncertainty (Regan *et al.* 2002). Second, species interactions and species-environment interactions are complex. Outcomes are often unknown or un-predictable even under current conditions and much more so in a different future. Here, the field of risk assessment specifically targets existing or potential hazards to environmental assets and attempts to quantitatively determining the likelihood of the adverse effect occurring and the consequences to priority environmental assets if such an event did occur (Pollino and White 2005). Even when information is available for all variables deemed relevant, data may be incompatible for technical reasons. Conservation planning has a strong tradition of computational-mathematical modelling, and data uncertainty (as well as simplification) leads to inherent uncertainty in the model assumptions. Beyond this basic data uncertainty, the literature points to linguistic ambiguity, complex risks, value-priority uncertainty and decision uncertainty. Concepts and proxies are often open to interpretation and hence discussion (Regan *et al.* 2002; Uggla *et al.* 2016). Value uncertainty is related to decision uncertainty and refers to conflicting normative goals and prioritizations. Inclusive conservation, with its implicit multiple objectives, is sensitive to differing opinions on the relative importance of different objectives, priorities again informed by contextual factors. The idea of framing draws upon the view that social problems are defined discursively, as a result of contestations and struggles among different actors as regards the significance of the problems. An important aspect is disagreement concerning types of warrants that support different views of the problems: what kind of evidence is accepted as sufficient and valid (e.g. Majone 1989). One of the most frequently recognised symptoms (with multiple causes) of uncertainty is indecision or inertia in decision making.

Beyond just dealing with (or trying to) uncertainty, several authors propose different ways to conceptualise and distinguish different types of uncertainty. Related literature on foresight, anticipation, CAS etc. will offer complementary information in Step B.

## 3.2 Conceptualisations

In their seminal article from 2002, Regan and co-authors list and describe two generic types of uncertainty: epistemic uncertainty and linguistic uncertainty. Both are conceptualised as compounds made up by multiple and distinguishable sources of uncertainty.

Epistemic uncertainty (and suggested remedies, from Regan et al. 2002):

- Measurement error: statistical techniques; intervals. Systematic error: recognize and remove bias.

- Natural variation: probability distributions; intervals. Inherent randomness: probability distributions.
- Model uncertainty: validation; revision of theory based on observation; analytic error estimation (for meta-models).
- Subjective judgment: degrees of belief; imprecise probabilities

Linguistic uncertainty (and suggested remedies, from Regan et al. 2002):

- Numerical vagueness: sharp delineation; super-valuations; fuzzy sets; intuitionistic, three-valued, fuzzy, paraconsistent and modal logics; rough sets.
- Non-numerical vagueness: construct multidimensional measures then treat as for numerical vagueness.
- Context dependence: specify context.
- Ambiguity: clarify meaning.
- Indeterminacy in theoretical terms: make decision about future usage of term when need arises.
- Under-specificity: provide narrowest bounds; specify all available data.

Taking a somewhat different approach, Haila, Henle and colleagues (Haila and Henle 2014; Haila *et al.* 2014) use semantical distinctions to identify and position different areas of uncertainty. The semantical space has three axes or dividers "The first such distinction was between uncertainty and risk. […] The second distinction was between epistemic uncertainty pertaining to knowledge and stochastic uncertainty pertaining to ontology of the world, customarily drawn in the context of sensitivity analysis (e.g. Saltelli *et al.* 2008). The third relevant distinction stems from the criteria of making decisions about uncertainty at a cut-point, as is routinely done in scientific practice, by drawing a distinction between type I (rejecting a true null hypothesis) and type II (accepting a false null hypothesis) error. This distinction has been amended by naming an error of third type that brings up qualitative aspects of uncertainty: type III error is made if the question asked is incorrect or irrelevant (e.g. Dunn 2001; Kriebel *et al.* 2001). The three distinctions presented above correspond to three dimensions of the semantic space of uncertainty. The dimensions are relatively independent of one another" Haila and Henle (2014, p. 31).

Based on these distinctions, Haila and Henle (ibid) point to the following five areas of sources [i] data; [ii] proxies; [iii] concepts; [iv] targets, policy and management; and [v] normative goals.*Data* is a close parallel to Regan and co-authors' (2002) epistemic uncertainty and concerns representativeness, methodological consistency. *Proxy* (or the *indicators* used to describe and simplify complex issues) is a representation, which raises the question of adequacy. A general problem with proxies is to know with enough certainty what they indicate. For example, interest groups may disagree on how many red-listed species 'should' be present in a particular system, whether current density will suffice to sustain the population in the future, and the extent to which the occurrence of red-listed species is really informative about the functional diversity of an ecosystem (Uggla et al. 2016). A whole range of proxies have been used in biodiversity research, from very general ones, such as species number and habitat area, to very specific ones, such as the presence of indicator or "umbrella" species. The relevance of a proxy is not only dependent on empirical support; it needs also be *conceptually* connected to the issue. A useful proxy requires conceptual support and coherence in the way the problem is frames. *Targets, policy* *and management* represent a conglomerate of factors pertaining to societal decision-making: assessing the situation, setting targets, formulating policies for reaching the targets, and implementing the policies into practical management. Finally, *normative goals* corresponds to Fischer's (1995) "ideological acceptability" (see next section) (Haila and Henle 2014).

More practical, Price and colleagues (2012) look at knowledge held by people, here experts, involved in foresighting or strategic decision making. Focussing on the process itself, the authors suggest three types of uncertainty that should be considered: modelled ecosystem stochasticity, uncertainty of an individual expert, and between expert uncertainty.

### 3.3 Knowledges and Uncertainty

As indicated above, uncertainty and knowledge are tightly interlinked. Thus, frameworks for specifying different types of knowledge are relevant both for identifying sources and types of uncertainty, as discussed above, and to find pragmatic solutions for dealing with uncertainty. One of the reasons why wicked problems are wicked is that they suffer from compound uncertainty, multiple layers of uncertainty which will likely interact to slow down the process of finding a 'solution' or way to handle the problem. Knowing what we do not – cannot – know and what we can do to move forward despite uncertainty is a core theme in the literature, although this is not always clearly articulated.

As a starting point for a discussion about what framework may be most useful for framing inclusive conservation I have picked two frameworks: one designed for informing policy and decision making and the other for understanding uptake and discourse. Partelow and Winkler (2016) identified three types of knowledge relevant to sustainability transformations: (1) system knowledge analysing and describing SES functionality and subsystem processes, (2) target knowledge assessing meaningful goals, visions, and pathways for sustainable human well-being and ecosystem functioning, and (3) transformative knowledge for implementing practical solutions (see also Hadorn *et al.* 2006; Brandt *et al.* 2013).

Second, Fischer (1995) introduced a useful scheme consisting of four potential types of warrants that can be used to argue for a case. Fisher's categories are primarily about the nature of knowledge and its uptake in public discourse. He names the most concrete level "type and quality of specialist knowledge" which is grounded in the epistemological approach and understanding of an issue. The second one is "technical and management expertise" which takes up the availability of the necessary practical skills. The third level is "societal vindication or public consent" which broadens the societal sphere considered to include public participation, stakeholder opinions and so on. The fourth level is "ideological acceptability" which addresses the question whether what is demanded is concordant with shared societal goal-settings.

With a background in natural sciences the conservation literature is primarily concerned with uncertainties in system knowledge and strategies for either reducing it or limit the implications (thus rendering decision making less 'sensitive' to uncertainty). Target knowledge comes as a second, leaving transformative knowledge somewhat under-represented (e.g. Pereira *et al.* 2019, for a longer discussion). This technical and management expertise is documented elsewhere, but apparently these studies use a different language.

### 3.4 Context sensitive conservation planning and management

Biodiversity conservation across administrative boundaries and including multiple interests increasingly require 'cross boundary management'', which looks to both the landscape connections and the relation between actors (Pouwels *et al.* 2011). Identifying different kinds of knowledges and strategies for dealing with uncertainty related to them is particularly important for understanding when and how this may matter in the overall governance of nature reserves. Despite a somewhat poor fit with a reality renowned for complexity and discontinuity, the policy-cycle approach provide a potentially useful description of policy making as a process that transcends particular institutions or policy designs. Recognising the different steps offers better openings for understanding when different actors can contribute in different ways and when different knowledge may be useful.

Althaus, Bridgman and Davis (2013) have elaborated the policy cycle idea in the Australian context as a series of steps:

1. Identifying issues – this occurs in two ways, through interest group representation (there is never a shortage of people telling government what to do) and/or the need for an overhaul of ineffective existing policy
2. Policy analysis – information, research, analysis and reflection are important to frame policy options
3. Identification of policy instruments – there is a need to consider the range of possible responses to the problem. Will it require new legislation, new programs or perhaps adjustment to internal operations of government?
4. Consultation to test the strength of the analysis – consultation is now generally presumed to take place both inside and outside government with both public and expert input. There is also coordination between agencies to ensure coherence of policy and in particular, consideration of the linkage between funding and the wider policy settings of government. <u>This is necessary to resolve issues between agencies and institutions with a shared interest in the field</u>
5. Decision – this is generally made through executive government and/or Cabinet
6. Implementation – in the stage the policy is given expression through legislation or programs
7. Evaluation – this stage is essential so government can gauge the effects of a policy and adjust or rethink the design of the policy

Similar to the policy cycle, adaptive management describes management as an evaluative, iterative learning process constantly moving from action to monitoring to assessment (and the opportunity to adapt). As with the policy cycle, adaptive management calls for stakeholder involvement (Wondolleck and Yaffee 2000). Of particular importance is the participation of stakeholders in assessing the resource problem and reaching agreement about its scope, objectives, and potential management actions (recognizing that differences of opinion about system responses may exist even with consensus on these issues) (Williams 2011). Adaptive management with its straightforward experimental approach to learning and adaptation is not designed to resolve conflicts. Instead, in the event that the nature and the cause of a conflict is in debate, and at the same time the degree of uncertainty about effective solutions is high, the management strategy needs to be based on communication, translocation, and mediation (Cash *et al.* 2003).

From this perspective, viewing policy and management as processes, most articles addressing conservation planning and management are limited in whom they speak to and what stages they address. The emphasis is on the first step, identification of areas for formal protection. Protected areas are often seen as insular units with one manager, which leaves out both cross boundary interactions (Schonewald-Cox *et al.* 1992; Pouwels *et al.* 2011) and the fact that management is often a concern of many stakeholders. The most common contextual factor included (and pointed to as an explanation for partial implementation and poor follow-up), explicitly and implicitly, is budget and the factors deciding it. Often, the implicit assumption seems to be that once land is protected the job is done. However, as more of the areas surrounding protected areas are developed, planners and managers seek new means by which collective solutions can be found.

## 3.5 Strategies for dealing with uncertainty

### 3.5.1 In general

Basically, strategies for dealing with uncertainty fall into two categories, reduce uncertainty (more, 'better' data as well as transparency and forefronting) and reduce the sensitivity to uncertainty (by, e.g. building anticipatory capacity and designing 'robust' options). As Pouwels et al. write, strategies can "either decrease uncertainties, with the aim of enhancing consensus building about solutions, or build consensus about beliefs, ambitions, and directions of solutions before starting research to decrease the uncertainties. Managers can opt for the pacification strategy by following an adaptive management approach, and the facilitation strategy by following a boundary management approach. The tools need to have "the right control knobs," which are compatible with the type of management action that managers can take" (Pouwels *et al.* 2011).

Inclusive conservation can address especially the need (and so far less discussed) for finding formats and forums for deliberation and joint decision making. As articulated by Perry (2015): Conservation strategies need to invest in several adaptation practices at any given site and ensure that the suite of practices includes ones appropriate fora range of temporal and spatial scales. Also, alternatives supported by specific subsets of stakeholders may be better than ones that attempt to please everyone (ibid). Dialogues and adaptive actions explicitly designed to incorporate different perspectives and value orientations recognise that adaptation is an experiment, and that it may not be possible to find a workable solution. A 'clumsy solution' may be highly inefficient, but effective; no voices are silenced and all are brought to constructive argumentation (Verweij *et al.* 2006)

Price et al. suggest that "integrating expert knowledge into scenario analysis and landscape modeling provides a mechanism for managing uncertain futures, allowing us to imagine future landscapes for which there may be no past analogues. This approach presents unique challenges – coupling technology with experts' imagination and creativity to produce useful outcomes can be difficult and sometimes infeasible with the available modeling tools." "The uncertainty of individual experts can be estimated through self-assessment techniques […], bounded sensitivity analysis […], and other statistical methods." (Price *et al.* 2012, p. 85). Following a similar vein, many authors suggest Bayesian logics and models as a way to relate to, and in some ways deal with, uncertainty (Pollino and White 2005; Landuyt *et al.* 2014).

Capturing different aspects of preparedness, proactive anticipation and reactive adaptation point to two central capacities for managing uncertainties. Scenarios are generally recognised as a way to prepare for the unexpected and to build both anticipatory and adaptive capacity. Especially Cook et al. (2014) offer a comprehensive set of recommendations and tools for working with scenarios(complemented by a "beyond knowledge" perspective in Pereira *et al.* 2019). Finally, one strategy for imbuing a strategy with resilience is to simultaneously advancing several alternatives rather than on attempting to protect specific variables(Perry 2015, among others).

### 3.5.2 Specific approaches

Optimisation has long been one of the guiding principles for conservation, especially for the selection of areas to protect. In recognition of this being a somewhat problematic approach when systems are in rapid change and the outcomes unknown or un-knowable, several add-on strategies are suggested to make the approach more flexible and context sensitive. For example, Haider and colleagues (2018) expand on what they call robust optimization, which "…is a principal method to address data uncertainty in mathematical programming formulations. This method has been successfully applied to solve many problems (under uncertainty) when the exact distribution for the data is unknown or difficult to determine or otherwise using stochastic optimization techniques is computationally impractical. In general, robust optimization is a conservative approach that seeks to protect the decision maker against the worst realizations of outcomes." (ibid, p. 289). Strange et al. (2006) instead apply optimisation iteratively in a dynamically changing system "where areas with valuable biodiversity cannot all be protected immediately due to budget restrictions and there is a probability of species extinction on reserved as well as non-reserved sites. Add to this the risk of land-use conversion facing all non-reserved areas. We furthermore introduce a new type of control by making the planning authorities have the option to sell reserved land on which biodiversity value has decreased. We formulate and solve this problem through stochastic dynamic integer programming. The current study shows that, due to the dynamic and stochastic nature of biodiversity evolution, the inclusion of a swapping option may increase overall efficiency." (ibid, p. 33) "

Adaptive management. Birgé et al. 2016 outline an "application of adaptive management for ecosystem services that explicitly accounts for cross-scale trade-offs in the production of ecosystem services. Our framework focuses on identifying key spatiotemporal scales (plot, patch, ecosystem, landscape, and region) that encompass dominant structures and processes in the system, and includes within- and cross-scale dynamics, ecosystem service trade-offs, and management controllability within and across scales" (ibid, p. 343). Furthermore, they suggest that adaptive management is particularly well suited to situations where controllability, as well as uncertainty, is high. More specifically, the contribution to the literature is the scale specific questions and the cross scale interactions. Heller and Zavaleta systematically reviewed this literature to explore what potential solutions it has identified for biodiversity consevation in the face of climate change. According to the authors, "several consistent recommendations emerge for action at diverse spatial scales, requiring leadership by diverse actors. Broadly, adaptation requires improved regional institutional coordination, expanded spatial and temporal perspective, incorporation of climate change scenarios into all planning and action, and greater effort to address multiple threats and global change drivers simultaneously in ways that are responsive to and inclusive of human communities. However, in the case of many recommendations the how, by whom, and under what conditions they can be implemented is not specified. We synthesize recommendations with respect to three likely conservation pathways: regional planning; site-scale management; and modification of existing conservation plans. We identify major gaps, including the need for (1) more specific, operational examples of adaptation principles that are consistent with unavoidable uncertainty about the future; (2) a practical adaptation planning process to guide selection and integration of recommendations into existing policies and programs; and (3) greater integration of social science into an endeavor that, although dominated by ecology, increasingly recommends extension beyond reserves and into human-occupied landscapes." (Heller and Zavaleta 2009, p. 1)

Alluded to but not described in detail (to be further studied):

Dynamic reserves (Strange *et al.* 2006)

Ecosystem based adaptation (Perry 2015)

Ecological Risk Assessment (Pollino and White 2005; Wardle *et al.* 2015; Williams *et al.* 2015)

Systematic conservation (Huang *et al.* 2014)

Zonation (Ruiz-Labourdette *et al.* 2010)

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