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OPPORTUNITIES AND CHALLENGES FOR HARMONIZATION OF GLOBAL INDICATORS FOR THE CONVENTION ON BIOLOGICAL DIVERSITY AND THE RAMSAR CONVENTION ON WETLANDS

I. INTRODUCTION

1. As part of his work in response to decision XI/3, paragraph 16, of the Conference of the Parties, the Executive Secretary is herewith making available for comment a submission from the United Nations Environment Programme - World Conservation Monitoring Centre (UNEP-WCMC). The work will help inform the next consideration of the development and use of indicators and associated monitoring systems by the Subsidiary Body on Scientific, Technical and Technological Advice as mandated in decision XI/3, paragraph 16. Comments may be sent directly to UNEP-WCMC by email to Philip.Bubb@unep-wcmc.org.

2. The document is made available in the format and language in which it was received by the Secretariat.

* UNEP/CBD/SBSTTA/18/1.

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Opportunities and Challenges for Harmonisation of Global Indicators for the Convention on Biological Diversity and the Ramsar Convention on Wetlands

KEY FINDINGS

i. There is a wide scope for having indicators of benefit for both the Ramsar Convention on Wetlands and the Convention on Biological Diversity. At the level of their Strategic Plans the Conventions have many common subject areas, with the Ramsar Convention's Strategic Plan Goals 1 or 2 contributing to 17 of the 20 Aichi Biodiversity Targets, and at least 28 of the global indicators for the Aichi Biodiversity Targets could be relevant to these common areas.

ii. A majority of the existing global indicators for the Aichi Biodiversity Targets can have wetland disaggregations produced, to make them relevant to decision-making and reporting for the Ramsar Convention. Consultations within the Biodiversity Indicators Partnership (BIP) found that at least 18 indicators could meaningfully be disaggregated to cover wetlands, and for many of these trend analysis and versions for multiple scales were possible.

iii. Calculations in this paper of a Red List Index for wetland species and of abundance trends in wetland species from the Living Planet Database illustrate the high potential for adapting global indicators to the specific needs of the Ramsar Convention. Both indicators can be disaggregated by taxonomic class and by biogeographic region when sufficient data is available.

iv. The main challenges to producing wetland versions of existing indicators are: the availability of suitable and sufficient data on wetland locations and species; differing definitions of wetlands; and a lack of a standard or agreed spatial data set of the world's wetlands.

v. Significant progress could be made in producing wetland versions of existing indicators based on existing data with appropriate investment of funding.

This brief review suggests that it may be valuable to explore further the opportunities to harmonize the use of biodiversity and ecosystem services indicators by intergovernmental agreements and processes.

INTRODUCTION

This document is a contribution by UNEP-WCMC to considerations on harmonisation of indicators between the biodiversity-related Multilateral Environmental Agreements (MEAs) at the global-scale. Its intended audience is the agencies involved in developing such indicators for MEA reporting, including MEA secretariats and their scientific advisory bodies, Parties to the MEAs, and organisations that produce indicators.

This paper first briefly discusses the motivations for harmonisation of indicators across MEAs and some key terms. It then explains the method and results of an analysis of how the indicators in the Biodiversity Indicators Partnership used for reporting for the Convention on Biological Diversity (CBD) could also be utilised for the Ramsar Convention on Wetlands. This analysis includes two examples of versions of existing global indicators calculated to be relevant for Ramsar Convention goals. This experience is then used to identify opportunities and challenges for harmonising the use of global-scale indicators represented in the Biodiversity Indicators Partnership suite for potential use by the Ramsar Convention on Wetlands.

It should be noted that this study is only intended to be exploratory and provide examples of the issues and possibilities for indicator harmonisation among biodiversity-related MEAs, and is not intended as a comprehensive analysis for any particular MEA.

This paper reports on work up to May 2014 by UNEP-WCMC (www.unep-wcmc.org) with financial support of the Finnish Ministry of Environment, and is an activity of the Biodiversity Indicators Partnership (BIP www.bipindicators.net). UNEP-WCMC is very grateful to the Secretariats of the CBD and Ramsar Convention the Partners of the BIP as well as the Ramsar Scientific and Technical Review Panel (STRP) for their information and advice in producing this document. For further information and feedback on this work please contact philip.bubb@unep-wcmc.org

Why promote harmonisation of MEA indicators?

A dictionary definition of harmonisation is "to make consistent or compatible"[1]. In the specific case of harmonising indicators for MEAs this can mean using or adapting the same indicators for more than one MEA, where they share common objectives or subject areas. Therefore, a major motivation for common or harmonised indicators is to simplify the burden on countries of tracking and reporting on their implementation of multiple MEAs. Ideally there will be some indicators and datasets which countries can use and adapt for reporting and decision-support in more than one MEA, and so reduce costs and effort. Such multiple uses of indicators also increase the demand and justification for the data collection systems which indicators require, and whose long-term maintenance is often a challenge.

Definitions and uses of indicators for MEAs

The definition of an indicator that UNEP-WCMC and BIP encourages is, "a measure based on verifiable data that conveys information about more than itself in relation to a specific purpose."[2] Indicators are purpose-dependent and the interpretation or meaning given to the data depends on the purpose or issue of concern. Their development or selection should preferably start with identifying the issue or decision-making need that the indicator will address and the use of the indicator.

For MEAs a principal use of indicators is to help track progress towards the achievement of goals and targets, such as the global Aichi Biodiversity Targets in the Strategic Plan for Biodiversity 2011-2020[3]. The indicators may be a key part of the evidence in reports such as the Secretariat of the CBD's 'Global Biodiversity Outlook'[4], and the Ramsar Convention's planned 'State of the World's Wetlands Report'.

Indicators can also be communication tools that summarise information to:

- help understand the current and past status of biodiversity, and why it may be changing,
- help decide on the most appropriate goals, policies and actions to address an issue,
- raise awareness about an issue,
- help assess the progress and effectiveness of policy decisions and actions to address an issue, as part of adaptive management.

Indicators for the CBD and Ramsar Convention

CBD decision XI/3[5] adopted a framework of indicative indicators for assessing progress towards the goals of the Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets. Information for these and other indicators that can already be calculated at the global scale has been compiled by the Biodiversity Indicators Partnership (BIP), which was established in 2007 as a global initiative to bring together organisations around the purpose of monitoring progress towards international biodiversity targets. Descriptions of the indicators produced by the Partners of the BIP are available at http://www.bipindicators.net/globalindicators, and the BIP's 'Aichi Targets Passport' publication presents calculations for a suite of global-scale indicators that are relevant to the Aichi Biodiversity Targets[6].

The Ramsar Convention on Wetlands' mission statement is, "conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world". The Convention has a Strategic Plan for 2009-2015[7] with five Goals and 27 Strategies with Key Result Areas. The Strategic Plan does not specify indicators for assessing impact or outcomes, although initial indicators for evaluating some of the ecological outcomes resulting from implementation of the Convention were recommended to Parties in Annex D

1 http://www.oxforddictionaries.com/definition/english/harmonize

2 http://www.bipindicators.net/resources/nationalindicatordevelopment

3 https://www.cbd.int/sp/

4 https://www.cbd.int/gbo3/

5 https://www.cbd.int/sp/indicators/

6 http://www.bipindicators.net/resource/aichipassport

7 http://www.ramsar.org/pdf/strat-plan-2009-e-adj.pdf

to Resolution IX.18 in 2005. The five Goals, number of Strategies for each Goal (in brackets), and their 'Outcome Sought' in the current Ramsar Convention Strategic Plan are:

1) Wise Use of Wetlands (10)

   Outcome Sought: The wise use of all wetlands being achieved in all Parties, including more participative management of wetlands, and conservation decisions being made with an awareness of the importance of the ecosystem services provided by wetlands.

2) Wetlands of International Importance (7)

   Outcome Sought: Parties designating and managing Ramsar sites within their territories with a view to supporting an international network of Wetlands of International Importance, fully implementing their reporting commitments under Articles 3 and 8.2, and using the Montreux Record as part of the Convention's governance process, as appropriate.

3) International cooperation (5)

   Outcome Sought: Parties developing their coherent national approaches to the implementation of the Ramsar Convention in such a way as to benefit from developing effective partnerships with related conventions and international agencies and with other Parties to the Convention on Wetlands.

4) Institutional capacity and effectiveness (4)

   Outcome Sought: Increasing success of the Convention in achieving the conservation and wise use of wetlands, as measured by agreed effectiveness indicators, and increased recognition of the Convention's achievements by other sectors of governments and civil society.

5) Membership (1).

   Outcome Sought: All countries eligible for accession to have joined the Ramsar Convention by 2015.

It should be noted that the current Ramsar Convention Strategic Plan runs to 2015 and so its goals and needs for impact indicators may in the future be modified, particularly through consideration of the emerging post-2015 development agenda (e.g. Sustainable Development Goals) of which biodiversity conservation is a part.

STEPS USED TO EXAMINE OPPORTUNITIES FOR INDICATOR HARMONISATION

This study was conducted through the following steps, summarised in Figure 1, to examine the potential and lessons for harmonisation of global-scale indicators between the CBD and Ramsar Convention:

1. Identify the common purposes or subject areas of the two Conventions for which indicators could be useful at the level of their current Strategic Plans. The Appendix to the Ramsar Strategic Plan 2009-2015 lists the Strategies that contribute to each of the Aichi Biodiversity Targets. This information was used to identify which Aichi Biodiversity Targets had linkages with the Ramsar Goals. For the scope of this exploratory study only the linkages with Ramsar Goals 1 and 2 were analysed, as these have the majority of the Strategies that address implementation of the Convention.
2. Identify the existing global indicators used to monitor progress towards the Aichi Biodiversity Targets for the CBD which have data available and have been calculated. This is the suite of indicators compiled by the BIP and which are presented at www.bipindicators.net and in the 'Aichi Passport'.
3. For each Aichi Biodiversity Target that can be contributed to by Ramsar Goals 1 and 2 (from step 1) select the existing global indicators for these Aichi Targets (from step 2), to provide a list of potential common indicators for the CBD and Ramsar Convention.

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8 http://www.ramsar.org/cda/en/ramsar-documents-resol-resolution-ix-1-annex-d/main/ramsar/1-31-107%5E23547_4000_0__

4. Examine which of the potentially common indicators from step 3 could be modified, or their data further analysed, to create a wetland 'version' of the indicator of use for the Ramsar Convention. This analysis was conducted through discussion with the BIP Partners responsible for these indicators, and the indicators considered in this study are those for which responses were obtained from the Partners.

From the list of potential common indicators identified through steps 1 to 3, two indicators, the Red List Index (RLI) and the Living Planet Index (LPI), were selected for calculation, in consultation with the Ramsar Secretariat and the Ramsar STRP. This was with the aim of exploring the feasibility of such an analysis and provide examples of the results. The analysis for the Red List Index was conducted by BirdLife International and for the Living Planet Index by Zoological Society of London.

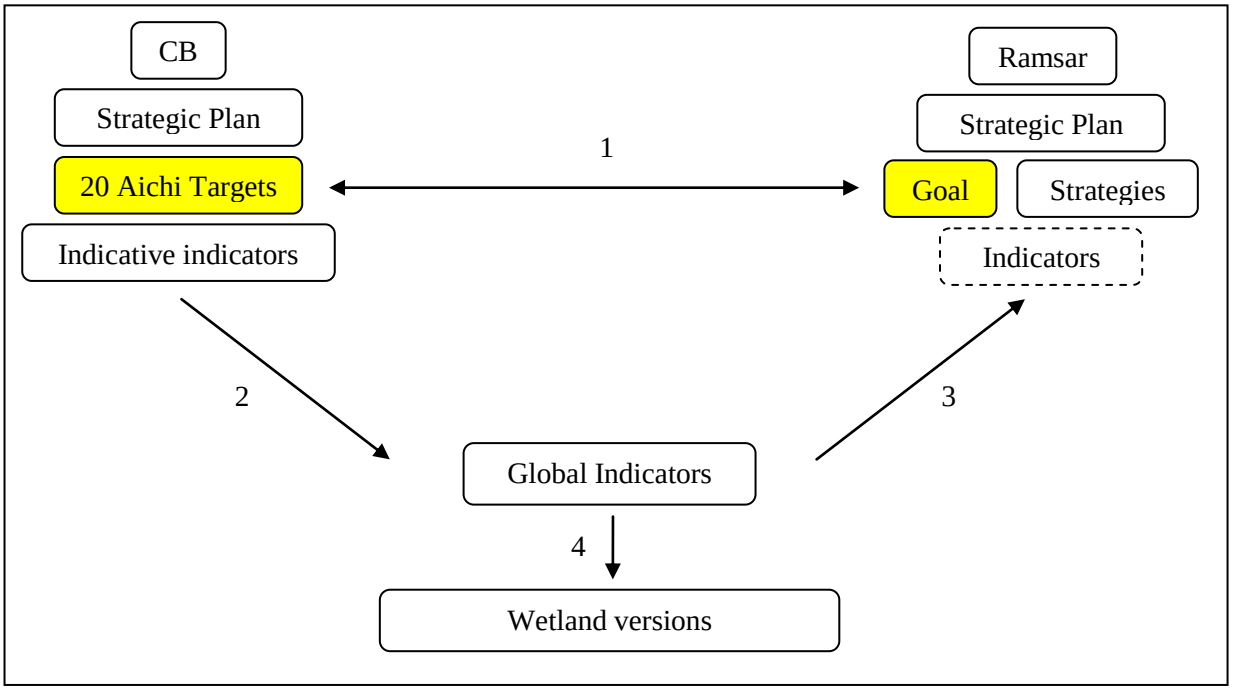

Figure 1. Diagram of the steps 1 to 5 and components of the CBD and Ramsar Convention Strategic Plans in the examination of the indicator harmonization potential.

RESULTS

The results of steps 1, 2 and 3 are presented in Table 1. The results of the fourth step, to assess which of the potentially common global indicators for the CBD and Ramsar Convention could be disaggregated or further analysed to address wetlands specifically, are presented in Table 2. The results of the Red List Index for wetland species and the population abundance trends in wetland species from the Living Planet Database are presented in Annex 1.

Opportunities for adapting existing global indicators for relevance to the Ramsar Convention:

i. There are a great many common subject areas in the Strategic Plans of the Ramsar Convention and the CBD, with the Ramsar Convention's Strategic Plan identifying its Goals 1 or 2 as contributing to 17 of the 20 Aichi Biodiversity Targets (Table 1). This shows that there is a very wide scope and potential for having indicators that could be of benefit for both Conventions. Four of the Aichi Biodiversity Targets were identified in the Ramsar Strategic Plan as being contributed to by both Goals 1 and 2:
   - Target 4 - Use of natural resources
   - Target 6 – Sustainable fisheries
   - Target 10 – Vulnerable ecosystems
   - Target 19 – Biodiversity knowledge

ii. At total of 28 of the existing global indicators for the Aichi Targets could potentially also be relevant to the Goals of the Ramsar Convention Strategic Plan (Table 1), because of the overlap in the Convention's Goals and Targets. This demonstrates that there is considerable scope for adapting indicators used for CBD reporting to support the reporting and decision-making needs of the Ramsar Convention.

iii. The range of subjects covered by the existing global indicators which could have wetland disaggregations produced is broad, with examples for Aichi Biodiversity Targets for the Strategic Goals A to D of the Strategic Plan for Biodiversity 2011-2020. Examples include Ecological Footprint for Strategic Goal A, Living Planet Index for Strategic Goal B, Coverage of protected areas for Strategic Goal C, and Biodiversity for food and medicine for Strategic Goal D.

iv. A majority of the existing global indicators for the Aichi Biodiversity Targets can have wetland disaggregations produced, to make them more directly relevant to the needs of the Ramsar Convention. Consultations with 23 of the relevant BIP Partners for the potentially relevant indicators found that 18 of the indicators could meaningfully be disaggregated to a wetland level, whilst this was not possible for 5 indicators and no response was obtained for 1 indicator (Table 2). For 17 of the indicators the production of a trend analysis for wetland data was also considered feasible and meaningful.

v. Data permitting, several of the global indicators have the potential for wetland versions to be produced for multiple scales of sub-global, national, regional, and individual wetlands. Examples include Cumulative human impact on marine ecosystems, Living Planet Index, Management effectiveness of protected areas, Nitrogen deposition, Trends in invasive alien species, and Water quality index for biodiversity.

vi. The results of two species-based indicators, a Red List Index for wetland species and of population abundance trends in wetland species from the Living Planet Database (Annex 1), are illustrations of the significant potential for both global-scale and thematic wetland disaggregations of existing global indicators. While both indicators can be disaggregated by taxonomic class and by biogeographic region if sufficient data is available, it should be noted that they were considered, of the indicators for which breakdown was possible, the most feasible to disaggregate.

Challenges for adapting existing global indicators for relevance to the Ramsar Convention:

Consultations with the BIP Partners identified some challenges in producing a wetland 'version' or disaggregation of their indicator:

i. Data suitability was one of the major concerns raised, as creating wetland disaggregations results in indicators relying on a narrow dataset, potentially reducing the reliability of the indicator.

ii. A few of the BIP Partners reported that to produce a wetland version of their indicator would require a calculation involving a GIS analysis with a data layer of the location of the world's wetlands. Two examples of such indicators are nitrogen deposition and the management effectiveness of protected areas. However, there is not yet a standard or agreed data layer for the world's wetlands.

iii. There may be an issue of different definitions of a wetland used in the calculation of different indicators, with the broad wetland definition in the Ramsar Convention requiring further detail in some cases.

iv. In some cases BIP Partner considered that the wetland level of disaggregation was not an appropriate scale for their indicator. The River Fragmentation Index, for example, has its input data calculated at the basin scale (large basins), with it making little sense to disaggregate at any further levels due to the transboundary effects of upstream fragmentation effects. This indicator therefore would only be relevant at the basin scale, not individual wetlands. However, if rivers

are classified as wetlands, as they are by the Ramsar Convention, then the indicator is obviously relevant.

v. Often, the most significant resource required to produce a wetland version of an indicator is funded staff time of the indicator development agency, whether this is to produce a one-time analysis for a particular report or for periodic reporting.

vi. The selection and calculation of wetland versions of existing indicators needs to first have an identified purpose for the indicator, such as use in the forthcoming 'State of World's Wetlands' Report, or for assessing the progress or impact of a Strategy.

Ramsar Convention Goals **Aichi Biodiversity Targets**	**Goal 1** **Wise Use of Wetlands**	**Goal 2** **Wetlands of International Importance**
Target 1 – Awareness of biodiversity values	**Biodiversity Barometer**	
Target 2 – Integration of biodiversity values	***No indicator yet available***	
Target 3 – Incentives	***No indicator yet available***	
Target 4 – Use of natural resources	**Ecological Footprint** **Status of species in trade** **Wild commodities index**	**Ecological Footprint** **Status of species in trade** **Wild commodities index**
Target 5 – Loss of habitats		
Target 6 – Sustainable fisheries	**Wild commodities index** **Red List Index** **Living Planet Index** **Wild Bird Index** **Marine Trophic Index** **Proportion of fish stocks in safe biological limits** **Number of MSC certified fisheries**	**Wild commodities index** **Red List Index** **Living Planet Index** **Wild Bird Index** **Marine trophic index** **Proportion of fish stocks in safe biological limits** **Number of MSC certified fisheries**
Target 7 – Areas under sustainable management	**Area of forest under sustainable management: certification** **Area of agricultural ecosystems under sustainable management**	
Target 8 – Pollution	**Loss of reactive nitrogen to the environment** **Nitrogen deposition**	
Target 9 – Invasive alien species	**Trends in invasive alien species**	
Target 10 – Vulnerable ecosystems	**Climatic impacts on European birds** **Cumulative human impacts on marine ecosystems** **Ocean health index** **Red list index**	**Climatic impacts on European birds** **Cumulative human impacts on marine ecosystems** **Ocean Health Index** **Red list index**
Target 11 – Protected areas		**Management effectiveness of protected areas** **Coverage of protected areas** **Protected area overlays with biodiversity**
Target 12 – Preventing extinctions		**Red List Index** **Living Planet Index** **Wild Bird Index** **Wildlife Picture Index**
Target 13 – Genetic diversity		
Target 14 – Essential ecosystem services	**Biodiversity for food and medicine** **Health and wellbeing of communities directly dependent on ecosystem goods and services**	

Target 15 – Ecosystem resilience	***No indicator yet available***	
Target 16 – Nagoya Protocol on ABS		
Target 17 - NBSAPs	**Status of NBSAPs**	
Target 18 – Traditional knowledge	**Status and trends of linguistic diversity and numbers of speakers of indigenous languages** **Index of linguistic diversity** **Vitality Index of Traditional Environmental Knowledge**	
Target 19 – Biodiversity knowledge	***No indicator yet available***	***No indicator yet available***
Target 20 – Resource mobilisation		

Table 1. The Aichi Biodiversity Targets which are contributed to by Goals 1 and 2 of the Ramsar Convention Strategic Plan 2009 – 2015 (shown in green) and the existing indicators for the Aichi Biodiversity Targets that could also be relevant to assess progress towards these Ramsar Convention Strategic Goals.

Indicator	Is it meaningful to disaggregate this indicator to a wetland level?	Is trend analysis possible and meaningful?	Which scales of disaggregation is the available data suitable for?
Area of forest under sustainable management: Certification	Yes	No response	Theoretically all, but data biases might make this less possible
Area of forest under sustainable management: degradation and deforestation	Yes	Yes	No response
Biodiversity for food and medicine	Yes	Yes	No response
Coverage of protected areas	Yes	Yes	Global, Sub global, Regional, National, Site
Cumulative human impact on marine ecosystems	Yes	Yes	Global, Sub global, Regional, National, Site
Ecological Footprint	Yes	Yes	No response
Extent of forests and forest types	Yes	Yes	No response
Extent of marine habitats	Yes	Yes	No response
Forest Fragmentation	No response	No response	No response
Global Wild Bird Index	No	Further information needed.	Further information needed.
Living planet index	Yes	Yes	Global, Sub global, Regional, National, Site
Management effectiveness of protected areas	Yes	Yes – To an extent.	Global, Sub global, Regional, National, Site
Marine Trophic Index	No	Yes	No response
Nitrogen deposition	Yes	Yes	Global, Sub global, Regional, National, Site
Protected area overlays with biodiversity	Yes	Yes	Global, Sub global, Regional, National, Site
Red List Index	Yes	Yes	
River Flow Regulation	Yes	No response	Basin, large sub-basins.
River Fragmentation	Yes	No response	Basin, large sub-basins.
Status of species in trade	Yes	Yes	
Trends in invasive alien species	Yes	Yes	Global, Sub global, Regional, National, Site
Water quality index for biodiversity	Yes	Yes	Global, Sub global, Regional, National, Site
Wild Commodities Index	Extent of human use – Yes. Harvest index – No	Yes	
Wildlife Picture Index	No		

Table 2. Analysis of existing global indicators which can be used for reporting for the Aichi Biodiversity Targets and Ramsar Convention Goals 1 and 2, and their potential for wetland versions to be produced. 'No response' signifies that information for this question was not obtained from the indicator agency.

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ANNEX 1 – TWO EXAMPLES OF GLOBAL INDICATORS CALCULATED FOR RELEVANCE TO THE RAMSAR CONVENTION ON WETLANDS

Red List Index for wetland species

The Red List Index (RLI) shows trends in the survival probability of the sets of species. It is based on data from the IUCN Red List: the number of species in each Red List category of extinction risk, and the number moving categories between assessments owing to genuine improvement or deterioration in status (Butchart *et al.* 2004, 2007).

RLIs can be calculated for wetland species that are relevant to the Ramsar Convention, i.e. those that occur regularly in or are dependent upon inland waters, coastal wetlands, and shallow seas, including coral reefs (the habitats listed in the Ramsar Classification System for "Wetland Type" as approved by Recommendation 4.7 and amended by Resolution VI.5 of the Conference of the Contracting Parties). Data are available for 2,391 birds (1988-2012), 2,308 amphibians (1980-2004), 475 mammals (1996-2008), and 845 corals (1996-2008) in these habitats (excluding Data Deficient species and those classified as Extinct by the 1980s).

RLI trends are negative for all four taxonomic groups with available data (Figure 3), meaning that overall, wetland species are increasingly moving towards extinction in these groups, and that conservation successes are being increasingly outweighed by worsening pressures. Among the groups, declines have been fastest for corals (driven by bleaching events linked to ocean acidification and warming), while index values are lowest for amphibians, indicating that they are under greatest threat (in particular through the negative impacts of chytrid fungus). The latest update – for birds to 2012 – shows a continuation in declines that have been tracked since the late 1980s. Unsurprisingly, an aggregated trend line for all four groups (calculated following the methods of Butchart *et al.* 2010) shows a downward trend. These trends are likely to be mirrored in other groups, for which RLIs are in preparation.

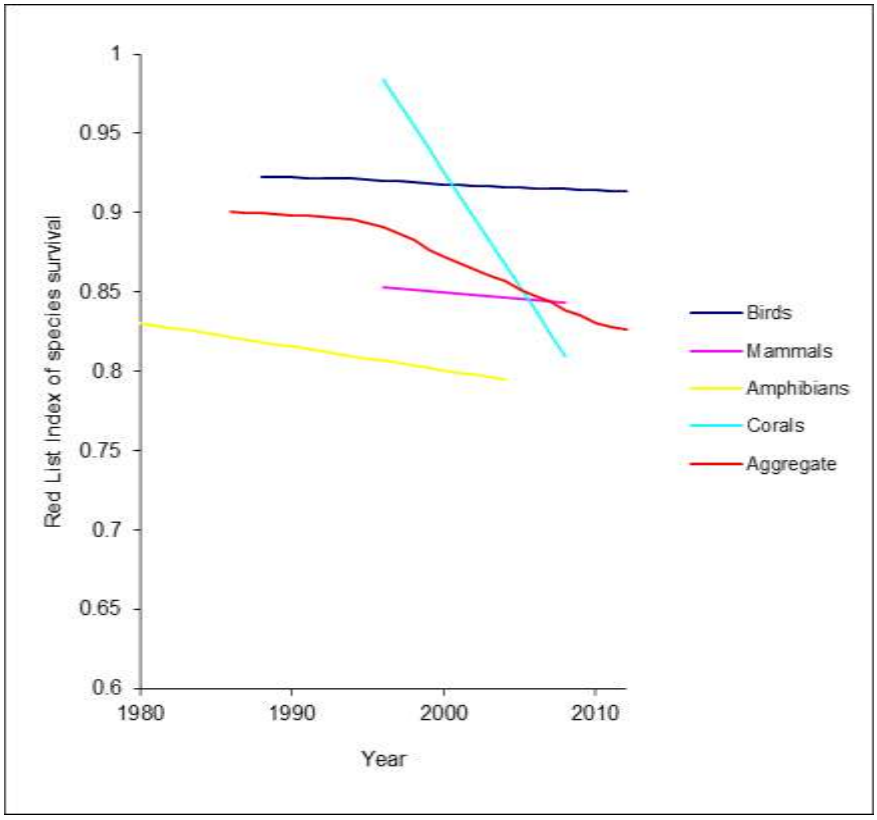

Figure 2. Red List Index of species survival for wetland birds, mammals, amphibians, corals and in aggregate.

The CBD Aichi Target 12 calls for preventing "the extinction of known threatened species" and improving "their conservation status, particularly of those most in decline", while the Ramsar Convention also has an aim to conserve wetland species effectively through safeguarding the most important wetland sites. The RLI for wetland species shows that there is little sign of progress towards achieving these aims, as the trends would need to become positive to reflect an overall improvement in the conservation status of these species. However, analyses in Butchart *et al.* (2006) and Hoffmann *et al.* (2010) show that that the declines would have been even steeper in the absence of conservation efforts.

The strength of an RLI for wetland species is that it is the only indicator available reflecting trends in the status of nearly all wetland species worldwide in each taxonomic group. Limitations for the RLI for wetland species are that it is only moderately sensitive to changes in the survival probability of the sets of species, and that trends for other taxonomic groups (e.g. wetland reptiles, plants, and invertebrates) are not yet available.

Population abundance trends in wetland species from the Living Planet Database

Introduction

This study used subsets of data taken from the Living Planet Database (LPD) to identify trends in vertebrate biodiversity within wetlands, using the Living Planet index (LPI) method. The LPD holds more than 12,000 records on trends in vertebrate population abundance from all over the world (McRae et al. 2012). The power of this data set comes from the large amount of ancillary information accompanying each record. This allows indicators to be created for specific subsets of data, to respond to pressing questions in science policy, ecology and conservation (e.g. migratory species, Latham et al. 2009 and species in the Arctic, Eamer et al. 2012). These indices have the advantages of an established, peer-reviewed methodology and produce a final indicator that is tailored specifically to the questions most pertinent to the audience, highly sensitive to annual changes in anthropogenic pressure and with the added advantage that it is easy to communicate to a wide range of stakeholders.

The LPD can be disaggregated in a number of ways that are potentially pertinent to those interested in the conservation of wetlands and the species they support. Despite the extensive number of records within the LPD, however, there are discrepancies in data availability between taxonomic groups, across time and in different regions of the world (Zamin et al. 2008). These biases in data availability may affect the conclusions drawn from the data and so need to be considered when selecting indicators for any group.

This study presents indices of trends in abundance for:

- Freshwater species;
- Populations living within Ramsar-designated wetlands, plus trends disaggregated into tropical and temperate indices.

These two indices have been chosen to illustrate the potential and issues for using the LPD and LPI method to report on and examine trends in vertebrate populations of relevance to wetlands.

Methods

Data collection

The data held within the LPD comes from vertebrate populations collected from peer reviewed scientific literature, online databases and grey literature (e.g. government reports). Each population time series must contain data points for at least 2 separate years, collected using comparable methods across years. Units must be a count of population size or reliable proxy thereof. Each species' population in the LPD is assigned to a realm according to geographic location. For index calculation purposes population data from Indo-Malaya, Australasia and Oceania are combined into a single group: Indo-Pacific. Similarly, amphibians and reptiles are combined into a single group the 'herpetiles' and Cephalaspidomorphi, Sarcopterygii, Actinopterygii are combined into 'fish'.

Populations are assigned as either 'tropical' (located in Indo-Malaya, the Neotropics, the Afrotropics, Australasia or Oceania) or 'temperate' (located in the Nearctic or Palearctic). Each population is checked to see if it falls within a protected area as listed within the World Database on Protected Areas

(WDPA, www.protectedplanet.org) and the attributes of any relevant protected areas are captured (e.g. category, designation).

Index calculation

Index values are calculated using a generalised additive modelling framework and confidence limits are calculated around each index value using a bootstrap resampling technique (Loh et al. 2005; Collen et al 2009). Each index value is calculated from the rate of change for all populations within that year since the previous year. Trends for freshwater populations are aggregated first to the species level then to the class and realm level. This aggregation weights species of the same class within the same biogeographic realm (Afrotropical, Palearctic, Nearctic, Neotropical and IndoPacific: combined Indo-Malayan, Oceania and Australasia). The baseline year from which changes are measured from is 1970 and this has a value of 1. A rise in the trend line indicates a positive rate of change from one year to the next indicating an increase in abundance, the steepness of the rise indicates the magnitude of that change. So, a downward slope in the index shows a negative rate of change, indicating a decrease in abundance. Due to a lag in publication time, data availability for recent years tends to be lower. Most indices published using the LPI method are 'cut-off' about 5 years before the present. Here, we have chosen to show index results up to 2011 but have included information on data availability and bootstrapped confidence limits to indicate where trend estimation suffers from a lack of data.

All analyses were run in R vers 3.0.2 (R Core Team 2014).

Index weighting

The index for freshwater species is weighted by the known distribution of taxa within the freshwater system. Population trends within taxonomic classes are weighted according to the representation of that class within each biogeographic realm (if birds comprise 30% of known species within the Palearctic, for example, then those bird populations can only contribute 30% to the index for that realm). The realms are then weighted according to the representation of that realm within the freshwater system (the most species rich realm is the Neotropics so this carries most weight within the freshwater index). This allows the index to better represent the proportion of species richness from each taxonomic class and realm contributing to the final index. Unweighted indices may over represent data from some groups, such as birds, and relatively species poor but well-known realms such as the Palearctic. By estimating species richness for each taxonomic class and each realm the index can be weighted to give a more accurate estimate of trends while accounting for data availability.

Index of change in population abundance of freshwater species between 1970 and 2011

Freshwater species are defined as species which spend the majority of their time in freshwater and rely on freshwater to survive and reproduce (McRae et al 2012), and this includes data on mammals, birds, amphibians, reptiles and fishes.

Overall, the Index of change in population abundance of freshwater species abundance has declined by 70% between 1970 and 2011 (Figure 1; Index value in 2011 = 0.299), with bootstrapped 95% confidence limits between 23% and 42%. This means on average each population has lost 70% of the individuals between its first and last measurement (in reality some populations will have fared better and others much worse). Using a weighted index shows a marked change in trend from previous calculations in overall trends in freshwater biodiversity (see for example McRae et al 2012) where unweighted trends showed a decline in abundance for freshwater species of c. 30%. The number of data points contributing to the index on a yearly basis declines sharply after 2002 and estimates for 2010/2011 should be treated with caution due to this fact.

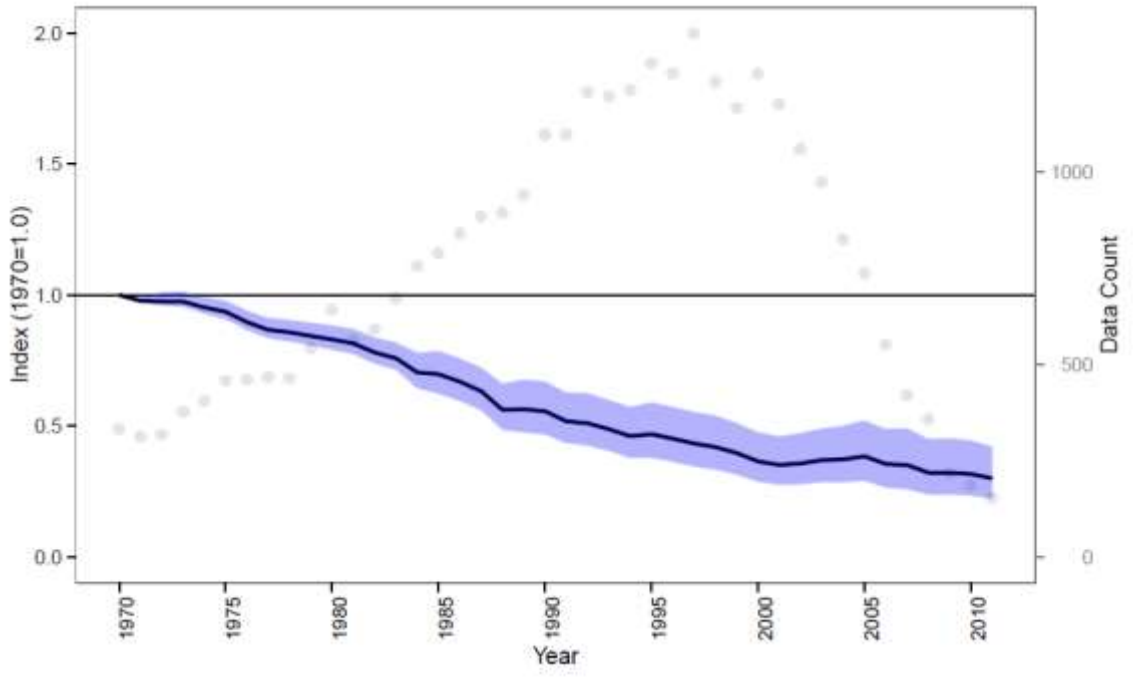

Figure 1. Index of change in population abundance of freshwater species between 1970 and 2011. . Light blue shading show 95% confidence limits on index estimate (10,000 bootstrap repetitions). Index is set to 1 in 1970. Grey points show the number of data points per year contributing to the index (right axis).

Index of change in abundance of populations in Ramsar wetlands of international importance

The LPD contains 1,250 populations from 458 species located in sites designated as Ramsar wetlands of international importance. The data set is comprised of 1,005 populations of birds, 77 mammal populations, 36 herpetiles populations, and 132 fish populations. Data comes from 74 countries and contains population abundance trends from 7.9 % of Ramsar sites worldwide (172 sites from a possible 2,174).

By 2011 average trends in abundance had increased by 40% (Figure 2; Index value in 2011 = 1.398). Lower data availability towards 2011 means the confidence limits are wider for more recent years.

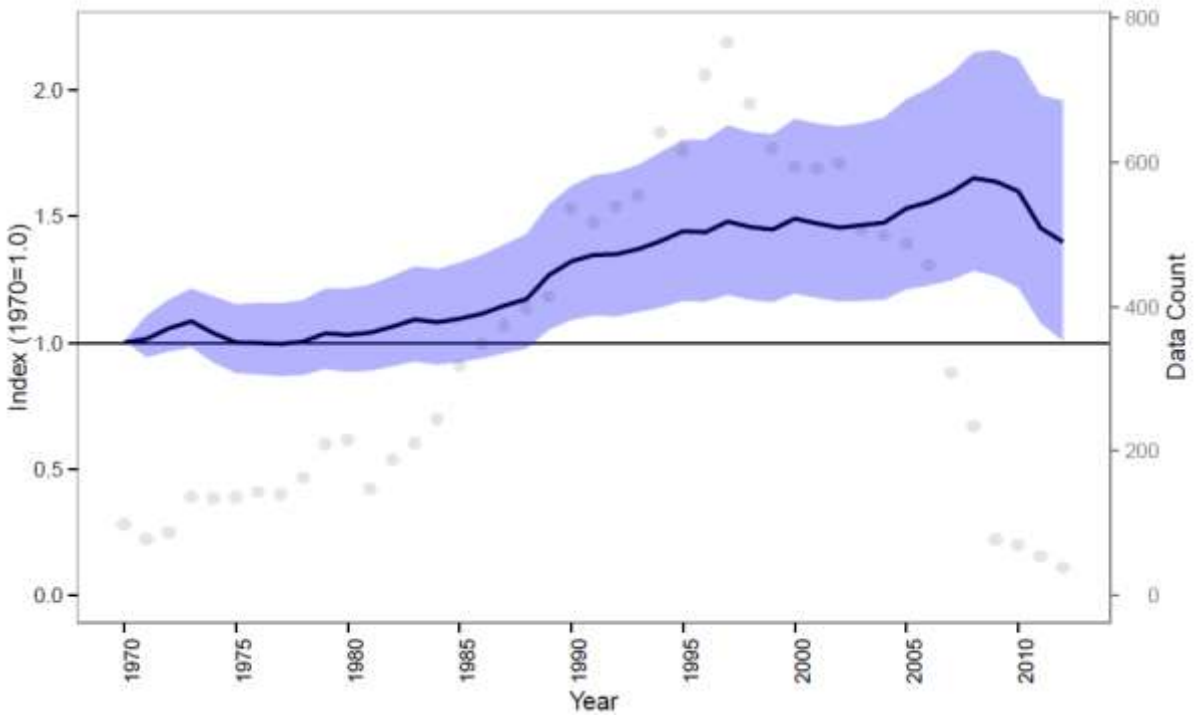

Figure 2. Index of change in abundance of populations in Ramsar wetlands of international importance between 1970 and 2011. Light blue shading show 95% confidence limits on index estimate (10,000 bootstrap repetitions). Index is set to 1 in 1970. Grey points show the number of data points per year contributing to the index (right axis).

Trends in Ramsar sites disaggregated into tropical and temperate regions show a marked difference from the overall picture (Figure 3). Populations located in temperate region have, on average, doubled between 1970 and 2011 (Figure 3a; Index value in 2011= 2.44 - from 310 species and 890 populations) abundance trends in tropical regions have declined by approximately 70% (Figure 3b; Index value = 0.282 in 2011 - from 205 species and 360 populations).

Data availability for the overall index is low for the last 10 years (Figure 2) but availability from temperate sites is double that found in tropical sites (Figure 3). The spread of tropical and temperate sites differs. Tropical Ramsar sites within the LPD are widely spread across the Afrotropics, Neotropics and Asia, and temperate Ramsar sites are largely sited within Europe.

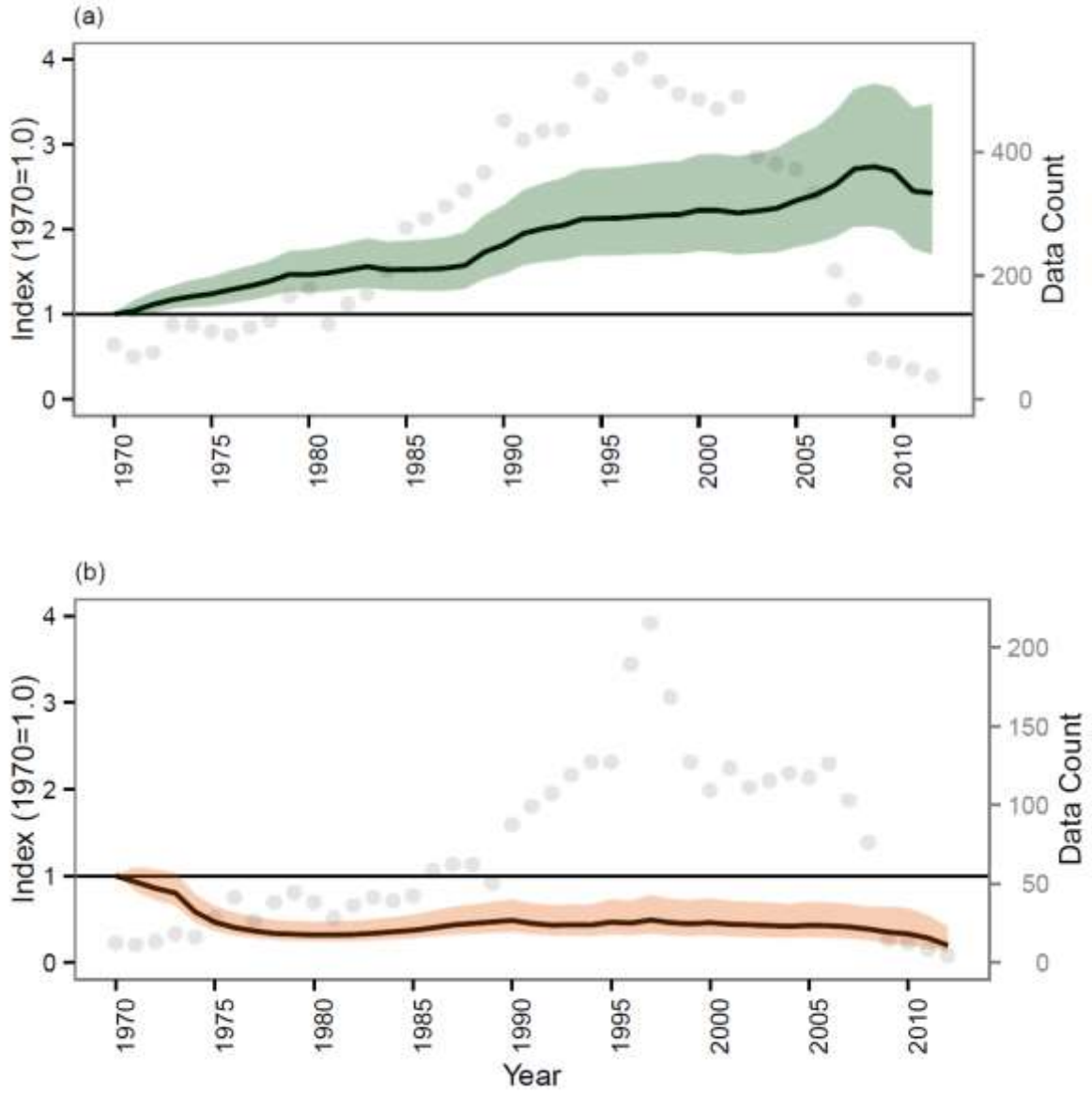

Figure 3. Index of change in population abundance of populations in Ramsar wetlands of international importance between 1970 and 2011 disaggregated into temperate (a. green shading) and tropical (b. Orange shading). Index is set to 1 in 1970. Shading show 95% confidence limits on index estimate (10,000 bootstrap repetitions). Grey points show the number of data points per year contributing to the index (right axis).

Discussion

Analyses

This study presents indices of trends in abundance for freshwater species, and for populations living within Ramsar protected wetlands which have also been disaggregated into tropical and temperate indices. These two indices have been chosen to illustrate the potential and issues for using the LPD and LPI method to report on and examine trends in vertebrate populations of relevance to wetlands.

Where data availability allows, these abundance trends can be further disaggregated by taxonomic class, such as mammals, birds, fishes, and herpetiles (reptiles and amphibians). The data can also be disaggregated by biogeographic realm. Alternative definitions of wetland species may be used, such as species reliant on inland waters as defined by the CBD, or species of birds, mammals and amphibians for which wetland habitat is classified as essential during the Red List classification process. Analyses of population trends abundance may also be conducted for subsets of wetland species, such as

waterfowl species defined by Wetland International as bird species ecologically dependent on wetlands by Wetlands International.

The population time series in the LPD may also be analysed in terms of whether they fall within a protected area and Ramsar sites specifically, as listed within the World Database on Protected Areas. Once populations falling inside a Ramsar site are identified further filtering of the dataset needs to occur, to identify species dependent on wetlands.

Data availability

Data availability for wetland vertebrate populations tends to be lower for the tropics and for less well-studied taxonomic groups such as amphibians, freshwater fish and reptiles. Data availability peaks in 2000 and declines steadily thereafter. Low data availability beyond 2011 means that trends can only be robustly interpreted before 2010. In general, however, confidence limits on wetland indicators provide support to the trajectory of biodiversity trends and there is much scope to further develop these indicators and provide useful tools with which to measure progress towards CBD targets.

New data collection techniques, the advent of a new online version of the LPD, which allows users to input their own data, and plans to engage with citizen science schemes, will boost data availability for recent years creating more dynamic indicators which quickly reflect conservation management actions.

In addition, opportunities also exist to develop this data set to include wetland dependent fish under the Ramsar definition of wetlands, using habitat definitions from Fishbase (www.fishbase.org) and to refine all analyses beyond broad classifications (i.e. trends in specific wetland biomes or fine scale habitats).

Methods

New methodological advances in the calculation of indices, such as the weighting system demonstrated here in the freshwater index (Figure 1), have the potential to be further applied to increase the reliability of wetland indicators. Weighting indices can be calculated to create indicators that account for factors such as, a) the proportion of species richness they represent, b) the proportion of protected area they hold data for, c) the proportion of wetland biomes considered in any indicator. While population abundance indices will always be driven by data availability, these new techniques allow indicators to better represent the ecosystems and habitats they are derived from.

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