

FRESHWATER WORKSHOP



1. Freshwater proceedings
2. Appendix 1 - Participant's List
3. Appendix 2 – Presentation by J.Conradie
4. Appendix 3 – National Biodiversity Monitoring and Reporting Framework



Workshop Proceedings

Monitoring Freshwater Biodiversity

02 October 2007
Boardroom, Biodiversity Building, SANBI Pretoria

1.1. Welcome and Introduction to the workshop

Jessica Conradie welcomed all the participants and asked them to introduce themselves and briefly describe what they do. The list of the participants is attached as appendix 1 to these proceedings.

Jessica then gave a presentation outlining the background and introducing the framework, the framework is attached as appendix 3. The presentation gave an overview on monitoring of biodiversity and the role which SANBI is playing in monitoring and reporting to the Minister, the presentation is attached as Appendix 2 to these proceedings.

In her presentation Jessica outlined the aims of the workshop as follows:

- To review the indicators that have been developed to assess the status of freshwater biodiversity.
- To discuss the best strategy to get data required to calculate the selected indicators. SANBI would like to consolidate and co-ordinate existing monitoring activities as much as possible and only embark on new data collection where critical data gaps are identified.
- To identify if there are any gaps in the existing framework, and discuss how best to mitigate them.
- To develop draft metadata about these indicators.

Questions and Comments based on Jessica's presentation

Question - Dean Impson (Cape Nature Conservation): Is the main purpose to advise the Minister or are we just monitoring without any specific target market? We should choose our indicators to aim at the target market.

Answer - Mandy Driver (SANBI): This is a packaging issue that does not affect the indicators you select. The main purpose is have a set of indicators that will show a clear picture on what is happening with our biodiversity. This is not just a management and implementation audit.

Comment – Dean: South Africa is being faced with a capacity or skills shortage. It seems as if we need to improve the current capacity situation to achieve good results at the end.

Comment - Dana Grobler (C.A.P.E): There is enough data with good indicators, even though some data was not primarily developed for biodiversity, e.g. River Health Programme. The main issue is with capacity. And at present it seems as if we are just monitoring but there is nothing which is being done.

Question: Are we monitoring against a specific target?

Answer: We are monitoring at the broad scale but it should be linked to the National target which is 20% of Freshwater ecosystems conserved.

Comment - Roger Bills (SAIAB): We must consider the issue of scale (river health programme). What scale we have to use at the national level, which data is available and on what scale? We need to be careful when it comes to scale and try to standardize the data that we are using, i.e. if we are using national scale data we should apply it to our indicators, and not find ourselves in a situation where both national and provincial scale are used.

Comment – Dana: If we are tracking progress towards our biodiversity targets then we move away from the River Health Programme. The RHP gives us a good overall picture but does not assist in tracking targets.

Comment - Neels Kleynhans (DWAF): The RHP is wider than just biodiversity. Also need to be monitoring whether e.g. the ecological reserve is meeting the requirements to keep a river in an A or B or whatever state

2. Discussion of the various threats identified in the framework and monitoring them in the freshwater environment

2.1. *Habitat Loss and degradation*

Jessica explained that this section deals with indicators of habitat loss and degradation in freshwater ecosystems and outlined the current indicators. She further explained that degradation is defined as reversible change in an ecosystem and loss as irreversible change. She asked for comments on whether these definitions made sense in the freshwater environment and how they could be interpreted.

Comment – Dean: It is not so easy to define habitat loss in freshwater ecosystems as it is in terrestrial ecosystems. One of the drivers in freshwater ecosystems is water quality. He suggested that we should use degradation rather than using loss in freshwater ecosystems because it is very rare to find habitat which is completely lost (i.e. irreversible changes) in freshwater ecosystems but they are often degraded which is reversible after mitigation. The only habitat loss in freshwater ecosystems which is irreversible is in urban areas due to development where you have activities such as canalization.

Workshop Proceedings: Monitoring Freshwater Biodiversity, 02 October 2007

Comment – Dana: Habitat loss can be tricky to define in freshwater ecosystems because even though degraded ecosystems can be rehabilitated to their former physical state, biodiversity which was there is completely lost. So we need to be specific on this issue, are we looking at biodiversity loss or at physical loss because these two issues have different impacts or effects. He then suggested that we should use habitat degradation rather than habitat loss, but not ignoring the fact that some freshwater ecosystems have been completely lost in urban areas.

Question: Which scale are we using for freshwater ecosystems, are we using the quaternary catchments?

Answer – Neels: Quaternary catchments are what DWAF uses – but it's a modelling unit rather than an ecological unit, but you can superimpose the ecological stuff over that.

Comment - Hermine Roux (Northwest DACE): Data has also been collected at QC for a long time.

Comment – Neels: When you assess the QC according to the main stem, you miss a lot of the biodiversity

Comment – Dean: We need to use the River Health Programme since it is accepted nationally and it is the only available information for the status of rivers in the country.

Comment: The Present Ecological State (PES) Classes (A-F Classes) used by the RHP are done at Quaternary or Sub-Quaternary catchment scale. There are PES Classes for some smaller rivers / tributaries but not across the entire country e.g. Western Cape has for some of their tributaries.

Comment – Dana: The data for Western Cape is good because of their active river health but this data is not available for the whole country. He felt that using this data would be a problem since most of the provinces do not have comparable data on that scale.

Comment - Roger : Need to say whether you're talking about loss of the river functioning or loss of biodiversity.

Question – Jessica: It has been indicated to me that the F class can be seen as lost whilst C, D and E are seen as degraded. Is this a generally accepted viewpoint?

Answer: The PES Classes represent deviation from the perceived natural conditions (reference state). Whether you can attain it again is a separate consideration. Thus, we should not try and interpret A-F classes as lost and degraded but rather use them as is in our indicators.

Question – Jessica: What about habitat integrity, do we have to include it as one of the indicators of habitat loss and degradation?

Answer: Integrity is a good surrogate for biodiversity. Habitat integrity analysis can be done as part of the river health programme, by looking at **hydrology, geomorphology** and **physiochemistry**. The river health Integrated Habitat integrity index is used in determining the PES classes of rivers. It is based on 17 variables of in-stream and riparian habitat integrity.

Comment – Neels: DWAF has developed an Index of Habitat Integrity for wetlands which Mbavhi is aware of.

Comment – Mbavhi Mukhoro (SANBI): working for wetlands looks at both the gains and losses. They are using wetland assessment tools which are regularly updated. But their assessments have left out the riparian areas, so there is a big push to include them under wetlands. In terms of categories working for wetlands will be using the same categories to classify the level of degradation as is used in rivers, namely:

Workshop Proceedings: Monitoring Freshwater Biodiversity, 02 October 2007

- A- Natural
- B- Largely natural
- C- Modified
- D- Largely modified
- E- Seriously modified
- F- Critically modified

Suggestion: Habitat fragmentation needs to be added as a separate indicator or add it to an existing threat since at the moment it is not captured by the PES classes.

Comment – Neels: We need to follow an approach that allows one to go to a finer and finer resolution over time.

2.2. *Invasive Alien Species*

Jessica explained the current indicators being used under Invasive Alien species. She explained that the first step being undertaken is to make a list of all invasive species and classify them into the following categories:

- **Naturalized** – alien species that are propagating on their own without any human intervention
- **Invasive – naturalized species** that are having significant detrimental effects on indigenous biodiversity e.g. black wattle, lantana, etc.
- **Extra-limital**— these are species that are indigenous to a part of South Africa but are naturalized / invasive outside of their natural range of occurrence.
- **Surveillance** – these are alien species that are not yet naturalized / invasive but whose life history traits / behaviour elsewhere in the world suggest that they pose a potential threat in SA.

Jessica then explained the CSIR has been contracted to calculate the extent and degree of invasion for a few important invasive species. She then invited comments / questions from the group.

Comment - Roger : Such an inventory of all invasive species has not yet been done and would be useful.

Comment – Dean: We need to increase focus on mapping the severity of the problems since invasive alien species are mainly affecting the river systems. There is good data on fish but we need to look at getting the data updated regularly. This is an area where we can make a big difference by getting things back to a healthy state.

Comment - Minnelise Levendal (CSIR): CSIR is doing a project at the moment to come up with priority species and areas per biome to direct WfW clearing efforts. (Brian von Wilgen and Greg Forsyth (project leader))

Comment: For plants we can concentrate on severely invaded areas. We may need to have a workshop to decide which these areas are.

Comment – Dana: Working for Water (WFW) has put out various contracts to map IAS. It is quite an intensive data collection exercise to get what you want.

Question – Jessica: Are the proposed categories for invasive species acceptable or how would you change them?

Workshop Proceedings: Monitoring Freshwater Biodiversity, 02 October 2007

Comment – Roger: There is no need to use categories for invasive species since the impacts are the same. He then suggested that we should categorize invasive species based on terrestrial and aquatic since they spread differently and this would provide good data for monitoring.

Comment - Mandy: Let's look at the severe ones first and on the next report we can include other categories.

Comment – Roger: It doesn't make sense to have a separate category for species that are outside their natural range. Some species are quickly a serious problem (e.g. small mouth bass), whereas others take decades before the impacts are felt.

Comment – Dean: I don't like "naturalised". Rather go with severe, moderate, surveillance.

It was agreed that experts would have to be consulted on the construction and / or updating of the lists. Some experts were suggested but others will be contributed by e-mail later. Suggested experts were Agricultural Research Council Plant Protection Research Institute (ARC PPRI) and Centre for Invasion Biology (CIB) for rivers and Fred Ellery and Donovan Kotze for wetlands.

2.3. Harvesting

Jessica briefly introduced the proposed indicators and invited comments / questions from the group.

Comment: It seems as if we are only focusing on harvesting of species alone, but we should also look at abiotic things which have the same effects as harvesting of the species. For example sand mining needs to be included.

Comment – Mandy: Sand mining needs to fall under habitat degradation rather than under harvesting. For now let's leave out those issues that are not currently causing problems and report on the issues that are currently causing problems and on the next report we can take a step further and try to include other issues.

Comment – Dana: Sand mining and peat harvesting is not a problem currently in South Africa but north of our border it is a big issue, where it can be classified under habitat loss.

Comment – Dean: For freshwater we need to develop a list of the harvested resources for freshwater.

Question - Dana: Is peat mining harvesting or habitat loss?

Answer – Roger: It depends on the magnitude, it can be either harvesting or habitat loss. For example in the northern part of the country, it is a big issue and can be classified as habitat loss rather than harvesting. The conservation agencies currently have the most data on this.

Comment – Dean: I can provide the list of names of people to contact and work on this area.

2.4. Flow Modification

Once again Jessica outlined the suggested indicators and invited questions / comments from the group. She specifically asked for input on the proposal that Mean Annual Runoff (MAR) be used as a good measure of flow modification.

Comment – Neels: It is very difficult to get current MAR. Relatively easy to get natural MAR. There is data on changes relative to reference condition. Can model natural MAR and look at how its changed over time – but this is difficult and expensive, not easy to get this data for everywhere. Rather use rating of how flow modification has changed over time.

Comment – Dean: Nice to know (i) where your in stream dams are.; (ii): where have in stream flow requirements (IFR) been done for dams; (iii): Which ones have IFRs implemented.

Comment – Dana: There is a danger of thinking that if IFRs have been implemented then the ecological reserve is being complied with and this is not the case.

Comment – Neels: DWAF has data on larger dams but there are hundreds of farm weirs that there is presently no data for.

Comment – Minnelise: Jeanne Nel from CSIR has recently mapped dams, but found a problem that dams were mapped at a different scale from rivers. She couldn't get data to map weirs.

Comment: A first stab at an indicator is average unimpounded river length per catchment but this is too crude.

Comment – Neels: There's a subcomponent of the Integrated Habitat Integrity index (IHI) called the Hydrological Modification Metric that we can use. Looks at changes in base flow. However, floods are also important and not sure if they are included in this sub-component. IHI also includes a fragmentation index – called a change in the connectivity of the system. The IHI is calculated based on data such as Land Cover with expert knowledge included where available. All of these indices can be broken down by primary catchment.

Comment – Dana: We should look at free-flowing rivers.

Comment – Dean: We could measure fragmentation by looking at the number of dams that have fish ladders.

Comment - Jessica : This would be a response indicator, we can include it there.

Question – Jessica: Is the river health programme centralized?

Answer – Hermine: It is centralized somewhere

Comment – Dana: The link between some of these indicators and biodiversity is quite weak, and in some cases it goes both ways (the discussion about weirs being refugia when over abstraction takes place, dams being pollution sinks)

Comment – Mandy: What are the indicators (number of impoundments, number of transfers and the volume?) to use for flow modification.

Comment – Neels: We can use information from DWAF on the dams where compliance was reached and where ecological reserve was done and in stream flow requirements.

Comment – Dana: For response indicators: Ask DWAF for a list of dams for which IFRs are done, for which operating rules have been drawn up, and which are being implemented and monitored. Use this as a mechanism to highlight the issue.

Workshop Proceedings: Monitoring Freshwater Biodiversity, 02 October 2007

2.5. *Climate Change*

Jessica once again introduced the proposed indicators and invited questions and comments from the group. She specifically highlighted the issue of water temperature and asked the group to give some input on the importance of water temperature in monitoring climate change.

Comment – Dana: Number of extreme events would be a good indicator of climate change. This will indicate if we do experience reduced flow in the West and increased flow in the East as predicted. We don't have good historic data on water temperature. So, if we start monitoring it now it may be problematic to link an increase to climate change.

Comment – Dean: Even if we don't have historic data it would be good to monitor water temperature, we should start now.

Comment - Nick Rivers-Moore (KZN Wildlife): Related to water temperature – number of days above a certain threshold.

Comment – Dana: There is data from data loggers for the last 7 or 8 years, but their primary purpose is to measure flow pressure, so you'd need to go back and relate the water temp to the water depth – this would require some work

Comment - Nick : A surrogate for temperature could be number of cholera or billharzia outbreaks

Comment: There's a WRC project that's looking at extreme events between the 1920s and 2005.

Comment – Roger: You get small data loggers for temperature that are very cheap.

Comment - Dana: Those are good – the problem at the moment is that the data loggers are being stolen.

Comment: we should choose areas to measure temperature that are likely to experience changes(?) e.g. Mpumalanga and Western Cape.

Comment – Dana: Use WR90 (Water Resources 1990) - has now been updated to 2005 – it would be possible to pull out extreme events from this data – needs to be extracted and interpreted.

Comment – Dana: Another option is we could identify species at the extreme of their distribution and look at how they change.

Question – Jessica: Who in DWAF deals with these issues?

Answer: Barbara Weston, Hygrometry section in each region and monitoring committee in each region. Should also look at whether there are WRC projects (NRM has a project on cheaper loggers – wiring

Question – Mandy: What are the extreme events?

Answer – Jessica: Extreme events are floods and droughts. One monitors their frequency and severity.

Comment – Dana: There's evidence that dams contribute to carbon emissions(?) so hydroelectricity is not as clean an energy source as one might think.

2.6. *Pollution*

Jessica outlined the proposed indicators and requested comments / questions from the group. She specifically highlighted that we would like to have indicators that show the effects of pollution on biodiversity, not just pollution levels in the environment.

Comment – Dean: Two good indicators would be SASS (South African Scoring System) and number and severity of fish kills (proposed indicator too complicated). SASS data is collected well in a large part of the country and is easily available. SASS is an ecological indicator of water quality based on the responses of micro invertebrates to different water quality variables.

Comment – Neels: University of Northwest (Bill Harding) is developing a new DIATOM(?) index, that will be included in the RHP. Gives a direct indicator of impact on biodiversity (?)

Comment - Dean : We can also use *E. coli* levels, especially in urban areas.

Comment – Dana: There are four major issues with regards water pollution, namely eutrophication / nutrient levels; sedimentation / turbidity; microbiological levels and salinisation. Many of these variables are already being monitored by DWAF, Brendon Hohls is the person to speak to. We need to relate these variables to their effects on biodiversity, not just report them as such. For example, eutrophication has a negative impact on biodiversity.

Comment – Neels: The RHP is very broad. The idea is to use it to pick up problems and then focus on those particular areas.

Comment – Dean: Mustn't lose sight of our urban rivers. *E. coli* levels in some of them are extremely hazardous. This is being collected in urban centres. Want to make urban rivers places that people go to.

Comment – Dean: Endocrine disrupters are also an important issue, but hard to monitor. Perhaps it is something we could look at at a later stage.

Comment – Dana: The term pollution here does not refer to water quality (in the sense of water that's nice for people), it's about a change from the reference condition

2.7. *GMOs*

Jessica outlined the proposed indicators and said that it was her view that they were mainly relevant to the Terrestrial environment as they dealt with genetically modified agricultural crops. The group agreed and the discussion moved on to the next section of the framework.

2.8. *Hybridization*

Jessica once again outlined the proposed indicators and asked for comments / questions from the group.

Comment: We should identify areas and species where this has already occurred and those where there is a high probability of it occurring in the future.

Comment: Indicators could be number of documented cases of hybridisation, number of places where it has occurred or number of introductions. The place in the catchment where introductions occur is also important – upper catchment / lower catchment.

Question – Mandy: Is the indicator number of species or number of places? Or extent?

Comment – Dean: We have data for number of places

Conclusion: A good indicator would be Number of species (definitely introduced, definitely hybridised, suspected hybridised. For those that we know: an indication of the extent (likelihood of expansion severe, moderate or slight)

3. Monitoring the status of freshwater species

Jessica explained that the proposed indicators could be divided into two broad groups. Firstly, those monitoring the overall status of species and secondly those monitoring particular aspects of a specific species. She explained that for monitoring the overall status of species the IUCN red-list categories were a good indicator as they are internationally recognized and are applied consistently across different taxa and environments. She invited questions / comments from the group.

Comment – Dean: When looking at the IUCN categories we should not forget about the Data Deficient species as a lot of fish species fall into this category.

Question – Dean: For which species will we need to collect the data for the indicators for monitoring specific species? Will it be critically endangered species for example?

Answer – Jessica: Not all indicators are relevant for all species. For now we will only consolidate data where it is available so we can get a full picture of what is available. At a later stage SANBI may identify key data gaps and actively fill these gaps.

Comment: IUCN lists have been done for fish, crabs, molluscs, some lepidoptera, dragonflies, frogs, and some plants

4. Monitoring the status of freshwater ecosystems

Once again Jessica outlined the proposed indicators. She highlighted that the main indicator in this section is the status of ecosystems. SANBI is in the process of developing criteria for and identifying threatened ecosystems.

Comment – Dean: Are we only listing these ecosystems, what about monitoring them for future purposes

Comment: We can use the same criteria as listing for monitoring and try to integrate the two (reporting and monitoring). A draft set of criteria have been developed and is in the process of testing by the CSIR. The criteria are as follows:

- Ecological integrity – the proportion of each river type, how much is being lost
- Rate of loss in ecological integrity
- Ecosystem with limited original extent or exceptional sensitivity PLUS imminent threat
- Threatened species association
- Habitat fragmentation
- Priority areas for meeting explicit biodiversity targets as defined in a SBP.

Comment – Roger: The current 400 river types in South Africa do not make sense, we need to narrow down since it would be difficult to monitor all 400 types.

Comment - Umesh Bahadur (SANBI): At the moment there is nothing to include for wetlands . The currently available layer for wetlands has a lot of errors and we have no baseline for wetlands as this is the first time they have been mapped.

Comment – Roger: We should not only map wetlands but also some other features such as waterfalls.

Comment – Dean: Working for Wetlands can get good ground truthed data for Western Cape wetlands from Cape Nature Conservation .

Comment – Nick: River length is problematic as it depends largely on the scale on which rivers are mapped. River length needs to be tied to the scale of mapping and the stream order, otherwise it is not useful.

The items up to this point were completed in less than the allocated time, so it was decided to look at the other areas of the framework as well, namely Responses, Institutional capacity and Socio-economic issues

5. Responses

Jessica outlined the proposed indicators and asked for comments from the group.

Comment – Dana: The key issue is compliance monitoring, looking at the adherence to management policies. The implementation of the reserves, the indicator would be the determination of reserves and the number of reserves implemented according to the management plans. Proportion of the reserves that are implemented

Comment – Dean: Include public awareness, lack of awareness is the major threat to our biodiversity

Comment – Hermine: We could add an indicator on the number of water-use licenses turned down because of the ecological reserve, the number of sewerage plants that meet current capacity requirements and we should add something about whether there is a systematic approach to monitoring whole catchments.

Comment – Dean: We should add an indicator on the number of effectively capacitated Catchment Management Agencies e.g. the number of CMAs established or the number of CMA staff tasked with resource protection.

Comment – Umesh: We could add an indicator on the number of Wetland forums that are functional – they are all provincial forums.

Comment: We should add an indicator on the number of management plans for rivers in private reserves.

6. Institutional Capacity

Jessica outlined the proposed indicators and invited comments from the group.

Comment – Dean: We need to look at the existing number of biodiversity institutions and develop new ways of working together. Also we need to break down budgets in terms of the following

- Monitoring
- Prevention
- Awareness
- Education

Comment – Roger: We need to track the number of accredited courses / degrees successfully completed and the number of certified practitioners. WE should also look at the number of research publications with management implications.

Comment – Dean: We could disaggregate the number of publications by reports, peer-reviewed articles and popular articles.

7. Socio Economic Issues

Jessica outlined the proposed indicators and invited comments from the group.

Comment – Dean: We could have an indicator on the cost of rehabilitating a 1km stretch of river.

Comment: The fly-fishing industry is switching from trout and Bass to indigenous yellowfish and this is an economically very valuable industry.

Comment – Nick: We should add the number of graduates in the sector that find employment in the sector.

Comment: We should try and look at how society buys into the conservation estate – areas managed as private reserves.

8. Identifying and filling gaps in the framework

Jessica explained that this section of the workshop was for the group to identify any overall gaps they felt existed in the framework or propose any new indicators. She also invited people to raise any issues they felt were still unresolved.

No gaps or additional indicators were identified.

Nick raised the issue of the reference condition, saying that describing this as natural was not clear enough and he thought we needed to tie it to a specific time period, such as pre-colonial times. Hermine and Dean said that natural was the state a system would be in if there were no major impacts on it, it was not the same as pristine but that most experts agreed on what it was. Nick was more comfortable with this. It was pointed out that in the monitoring framework we need to use the term reference condition in an explicit and consistent way.

9. Conclusions and closing

Jessica thanked all the participants for attending the workshop and their valuable inputs and wished them all a safe trip home.

Workshop on Monitoring Freshwater Biodiversity - Participant's List

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Monitoring South Africa's Freshwater Biodiversity

Jessica Conradie

Why do we need a framework?

CHAPTER 2

SOUTH AFRICAN NATIONAL BIODIVERSITY INSTITUTE

11. Functions

(1) The Institute—

(a) must monitor and report regularly to the Minister on—

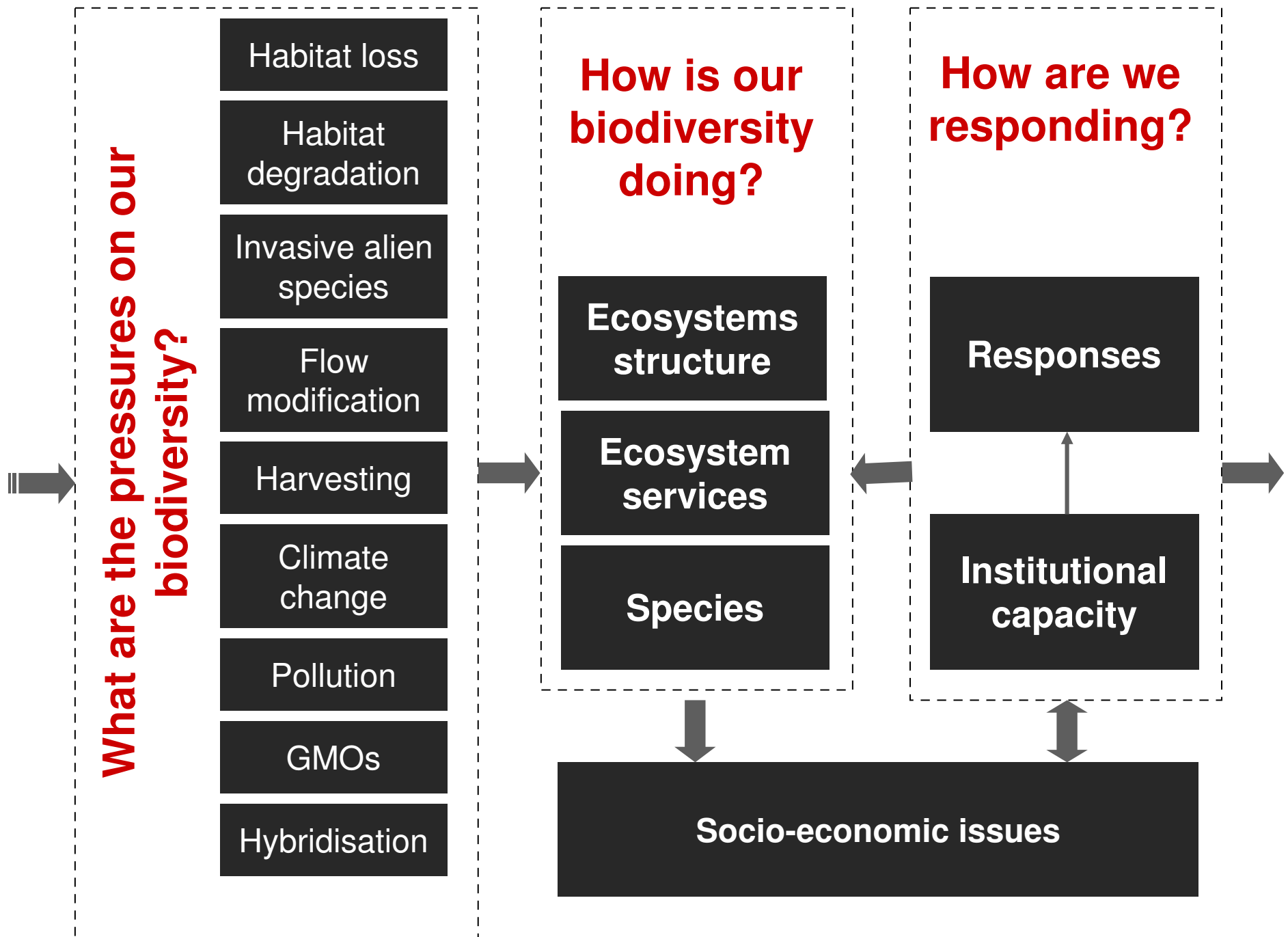
(i) the status of the Republic's biodiversity;

(ii) the conservation status of all listed threatened or protected species and listed ecosystems; and

(iii) the status of all listed invasive species;

(b) must monitor and report regularly to the Minister on the impacts of any genetically modified organism that has been released into the environment, including the impact on non-target organisms and ecological processes, indigenous biological resources and the biological diversity of species used for agriculture;

(c) may act as an advisory and consultative body on matters relating to biodiversity to organs of state and other biodiversity stakeholders;



Approach

Consolidation and co-ordination of existing
monitoring
New data collection only where critical data
gaps are identified
National-scale, overview

National M&R vs Ecological monitoring

- Nationwide, simple statistical summaries
- Detailed studies focused on specific questions

How do we monitor?

Using indicators:

- Latin verb indicare meaning to disclose or to point out
- *“Measures or metrics based on verifiable data that convey information about more than just themselves”*
- Statistic not a species

What makes a good indicator?

- Have an agreed, scientifically sound meaning;
- Provide a representative picture;
- Be responsive to changes in the environment;
- Have a sound and practical measurement process;
- Be measurable over time;
- Be relevant or answer important questions; and
- Be relatively easily understood.

Indicator metadata

- Indicator Name
- Definition
 - Explain what you mean by the indicator name
- Underlying definitions
 - Define any terms you used in the definition that require clarification / further explanation
- Units
 - In what units should this be measured?

Indicator metadata

- Data Required
 - What data is required to calculate this indicator?
- Possible Data Sources including contact people where possible
 - Where / from whom could we obtain this data? Or, is it not available currently
- Methodology & formulas
 - How would this indicator be calculated?

Indicator metadata

- Relevance
 - What important questions / issues does this address?
- Limitations
 - What does this indicator tell us / what false impressions may it create?
- Who would like to help us?
 - Is there any individual or organisation who would like to assist us in further exploring this indicator?

Habitat Loss

Aspect	Terrestrial	Wetlands	Rivers	Estuarine	Marine	Coastal	
Habitat Loss = Irreversible	Extent of area lost disaggregated by replacement land cover class, biome and province	Extent of area lost disaggregated by replacement land cover class, biome and province	Percentage of river length with a habitat integrity index of E or F disaggregated by in-stream and riparian index and by ecoregion and province	Percentage of estuaries in E or F ecological state class (?), disaggregated by marine bioregion and province	Area: Trawled, Mined, Dredged, Reclaimed, Dumping sites, mariculture (Disaggregated by bioregion?)	Percentage of coastline transformed by development. Area mined.	NOTE coast=above low water mark to 1km inland?, Transformation depends on time scales
	Number and proportion of IUCN listed species threatened by habitat loss.						

Key

 **High priority indicators**

 **Lower priority indicators**

Data may be available from State of Environment reports

Illustrative indicator - may not be constant over the long-term

Habitat degradation

Aspect	Cross-cutting	Terrestrial	Wetlands	Rivers	Estuarine	Marine	Coastal
Habitat Degradation = Reversible and includes fragmentation and land degradation where possible				Percentage of river length with a habitat integrity index of C or D disaggregated by in-stream and riparian index and by ecoregion and province			
	Number and proportion of IUCN listed species threatened by habitat degradation.	Extent of area in each degradation category disaggregated by biome and province	Extent of area in each ecological state category ? (once methodology developed) disaggregated by biome and province		Percentage of estuaries in C or D ecological state class (?), disaggregated by marine bioregion and province	Suggestions: Oil & Gas production blocks, No. of wellheads, Area under mining concessions less area actually mined (Diamond & other), Area under open system mariculture	Suggestions: Area under mining concessions less area actually mined (Diamond & other) ? Areas of influence of sediment barriers eg. Breakwaters, measure of access

Invasive Alien species

Aspect	Cross-cutting	Terrestrial	Wetlands	Rivers	Estuarine	Marine	Coastal
	Number of invasive alien species disaggregated by taxa and by naturalised, transformer, extra-limital and surveillance species	Extent and degree of invasion by biome and province	Extent and degree of invasion by biome and province	Extent and degree of invasion by WMA/ecoregion	Extent and degree of invasion by marine bioregion	Extent and degree of invasion	Extent and degree of invasion (<i>Mytilus</i> only at present)
	Number and proportion of IUCN listed species threatened by invasive alien species.					(number of visiting ships)	

Flow modification

Aspect	Cross-cutting	
	<u>Percentage of catchments in which water abstraction infringes on the ecological reserve</u>	Total percentage reduction in MAR disaggregated into quaternary catchments
	<u>Ground water abstraction versus ground Water recharge</u>	
	Number / volume of impoundments	
	Number and proportion of IUCN listed species threatened by flow modification.	
	No. of artificial breaches of estuaries	
	No. of estuaries affected by canalisation, multi-span bridges or breakwaters	
Sewage discharges into estuaries that alter flows		

Harvesting

Aspect	Cross-cutting	Marine	Existing data
	Total number of species harvested disaggregated by type of harvesting and whether population is collapsed, overexploited, optimally harvested or in unknown state (see table below that lists types of harvesting)	Indicator is as for cross cutting but bycatch and incidental mortality can be types of harvesting. Suggested that population relative to pristine population be used with cut-offs, eg. below 25% being collapsed. Assessments older than 5 years could be disregarded - revert to unknown.	Stock assessments done for: Hakes, Kingklip, soles, sardine, anchovy, west coast & south coast rock lobster, squid, abalone. Linefish status reports - every 5 years
	Number of harvested species listed as threatened on IUCN red data lists, disaggregated by type of harvesting		
	Total mass harvested		
	<i>Some charismatic examples of harvested species and the stories surrounding them could be used as illustrations.</i>		
	Number and proportion of IUCN listed species threatened by harvesting.		

Types of Harvesting
Hunting
Fishing (commercial, recreational, subsistence, shark control)
Collectors (beetles, lizards, Cycads, Harworthias, aquarium fishes, seashells)
Commercial use of terrestrial species
Traditional use (muthi woodcarvings firewood, brooms)
Poaching
Subsistence use of terrestrial species
Bycatch
Incidental mortality

Climate Change

Aspect	Cross-cutting	Rivers	Marine
	<i>Number of species that have undergone changes linked to climate change disaggregated into categories (e.g. phenological changes, range shifts etc..) and further disaggregated according to whether the changes were advantageous or not. Some of these species can be selected and used as illustrations where necessary</i>	Water alkalinity	Suggestions: Sea surface temperature, upwelling intensity / wind (Distribution shifts?, Ocean acidification, SAEON input, Coral bleaching - no. of degree heating weeks / year or bleaching season, no. of days exceeded bleaching threshold)
	<i>Number and proportion of IUCN listed species threatened by climate change</i>	Water temperature	
	<u>UV radiation</u>		
	Sea level rise		

Pollution

Aspect	Cross-cutting	Marine	Note- how to capture risk e.g.. High risk tankers in SA EEZ
	Number of individuals (or, preferably, where possible percentage of the population of a species) affected by pollution disaggregated into those that die, those that require rehabilitation and any other necessary categories.	Suggestions: No. of industrial pipelines / check CSIR & mcm (fish processing waste) Heavy metal monitoring in shellfish - mcm No. of dumping permits No of catastrophic events egg. oil spills, blowouts etc (No. of artificial reefs) ?PCBs Organochlorides? PSSAs? Mariculture? Coastal cleanup stats	
	Extent of natural habitat requiring rehabilitation after pollution events	<u>Number of blue flag beaches</u>	
	Number of major pollution events that have an impact on biodiversity.		
e.g. non-target species poisoned	Number of species affected by pollution disaggregated into categories of how they are affected (e.g. non-target species poisoned).		
	Number and proportion of IUCN listed species threatened by pollution		

?	Some indicator of industrial pollution levels (?)	
	Some indicator around sewage spillages	
	<u>Quantity of fertilisers sold annually</u>	
	<u>Quantity of herbicides and pesticides sold annually</u>	

GMOs

Aspect	Cross-cutting
	Number of GMOs commercially released
	Proportion of the total planted area that is planted under GMO crops, disaggregated by type of crop
	Number and proportion of IUCN listed species threatened by GMOs.

NOTE: DEAT is busy with a project on assessing the impacts of

Hybridisation

Aspect	Cross-cutting
	Number of indigenous species affected by hybridisation, disaggregated by those that hybridise with cultivated species, alien invasives, extra-limital species and indigenous species.
	Number and proportion of IUCN listed species threatened by hybridisation.

Note - in marine - yellowtail & k

Ecosystem structure

Aspect	Terrestrial	Wetlands	Rivers	Estuarine	Marine	Coastal	
	Number and extent of vegetation types that meet the criteria for listing in each ecosystem status category (i.e. CR, EN, VU or LT) disaggregated by biome and by province	Number and extent of wetlands that meet the criteria for listing in each ecosystem status category (i.e. CR, EN, VU or LT) disaggregated by ecoregion and province	Number and length of river types that meet the criteria for listing in each ecosystem status category (i.e. CR, EN, VU or LT) disaggregated by ecoregion and province	Number and extent of estuaries that meet the criteria for listing in each ecosystem status category (i.e. CR, EN, VU or LT) disaggregated by marine bioregion and province	Number and extent of biozones that meet the criteria for listing in each ecosystem status category (i.e. CR, EN, VU or LT) disaggregated by marine bioregion		Build on NSBA, refine inshore patterns, Could use "indicator" taxa to report on ecosystem status
	Relative biodiversity intactness index						
	Proportion of area which is under biodiversity compatible land use						

NOTE: We will monitor using the same criteria to those that are used for listing, except we will not use criteria that cannot be applied at the level of vegetation types.

Ecosystem services

Still to be developed -
Jessica to chat to Bob
Scholes and John
Donaldson

Species

Aspect	Cross-cutting
Overall status of species	Number and status of IUCN red-listed species disaggregated by taxa
	Genetic diversity of selected species

No. of th
Not to b

Aspect	Cross-cutting
Status of specific species	Genetic diversity of selected species
	<i>Distribution of selected species</i> Population size Recruitment success (fecundity) Sex ratio Proportion of the population in each or a selected age / state class Index of the harvested product e.g. size of bulbs, weight of fish etc. Percentage of original habitat lost Fragmentation index for remaining suitable habitat versus that of original extent of suitable habitat Proportion of the population on privately-owned land and state land Proportion of the population which is genetically pure

These indicators originated from a process initiated by DEAT to develop indicators to monitor the status and trends of species

important
not useful
not useful

threatened taxa (expert workshop)
be disaggregated by no. of species

nt for taxa dependant on threatened nursery habitats or taxa that fall through the habitat "net"

ful in marine

ful in marine

Responses

	Response	Action indicator	Effectiveness indicator
National Environmental Management Biodiversity Act (NEMBA)	NEMBA listing of ecosystems	Number of ecosystems listed	Area of listed ecosystems restored / rehabilitated
			Extent of habitat lost in listed ecosystems
			Area of threatened ecosystems restored / rehabilitated.
	NEMBA listing of species	Number of species listed disaggregated by status, environment (i.e. terrestrial, wetland, river, estuarine, coastal, marine) and province	
			Number of known non-compliances with permit conditions
	IAS strategies (Including WFW, regulations & listing)	Number of IAS incorporated into operational management plans	Extent of area cleared / kept clear of alien invasive species
		Number of bio control agents introduced for IAS control	
		Number of introduction pathways covered by operational management plans	
	Publishing bioregional plans	Number of bioregional plans published and area covered	
			Extent of habitat lost in critical biodiversity areas
	Biodiversity Management Plans for Species	Number of species management plans published	
			Number of species with published plans whose populations are improving
	Biodiversity Management Plans for Ecosystems	Number of ecosystem management plans published	
			Number of ecosystems with published management plans whose condition is improving
	Access and Benefit-sharing agreements	Number of Access and Benefit-sharing agreements concluded	

National Environmental Management Protected Areas Act	Protected Area Network	Extent of the PA network	Extent to which biodiversity targets are met by the PA network
			Percentage of Pas that monitor their management effectiveness
			Number and proportion of IUCN red-listed species that have at least one occurrence in a Protected Area disaggregated by Protected Area Type
	Stewardship	Extent of biodiversity targets under protection	
		Number of stewardship agreements signed	
National Environmental Management Act	EIAs	Proportion and number of EIAs approved / rejected / appealed per province	Proportion of approved RODs that reflect biodiversity priorities
Non-legislative responses	IUCN Red-listing of species	Number of red-lists compiled and up-to-date	Number of species which improve in conservation status
		Number of taxa assessed in the last five years	
	Biodiversity Education Programmes	Number of learners visiting Biodiversity education programmes	?
	Biodiversity-friendly business (e.g. mainstreaming, fisheries management, certification, hunting, sustainable harvesting)	Number of businesses with ISO14001 certification; Number of production sectors that have biodiversity-friendly industry standards	Proportion of producers who comply with these standards
	Climate Change mitigation	Proportion of energy use from "green" sources	
	Climate Change adaptation	Number of ecological corridors identified in published bioregional plans	Extent of these corridors still intact
	GMOs	Number of species represented in the National Gene Bank	
	CITIES	Number of species on CITIES appendices	
	Restoration of ecosystems	Indicators need to be developed still	

	<i>ex situ conservation initiatives</i>	Number of indigenous species in ex situ collections (Botanic Gardens, Zoological Gardens, Aquaria, Seed Banks, Captive breeding facilities etc.) as a percentage of those deemed to require such conservation	
Bioregional and ecosystem programmes	Bioregional programmes	Number of bioregional programme co-ordination units housed in SANBI	
			Effectiveness as measured by bioregional programme M&E frameworks
	Working for Wetlands	Number and extent of wetlands rehabilitated	?

Institutional capacity	
Aspect	Indicator
Current Human Capacity	Natural Scientists / capita
	Number of SACNASP registered scientists disaggregated by specialisation
	Number of taxonomists disaggregated by taxon
	Number of ecologists and/or extension staff employed by conservation agencies / departments and private sector (reported separately for each)
	Proportion of PDIs in management positions in the biodiversity sector?
	Natural scientists per number of government employees at each sphere of government
	Number of staff in each sphere of government whose primary function is biodiversity / environmental management
	Number of staff dedicated to enforcement separate by Marine/ Terrestrial and Freshwater
	Number of staff employed in biodiversity-focused NGO's
	Number of public volunteers involved in atlasing projects
	Number of staff dedicated to negotiating and servicing stewardship agreements
Financial Capacity	Budget spend on environmental education and awareness
	Budget spent on scientific education
	Budget allocation to biodiversity management for each sphere of government
Development of future human capacity	Number of postgraduate degrees obtained in biological / earth / environmental sciences

Socio-economic issues

Aspect	Indicator
	Partial economic valuation of biodiversity - what is our biodiversity worth to us?
	Number of economic incentives to encourage sustainable use of biodiversity
	<i>Population trends of economically important species</i>
	Jobs in biodiversity management disaggregated by skills level and sector
	Contribution to GDP from the commercial fishing industry
	Jobs in biodiversity-related EPWP (WFW, WFWe, Greening the Nation)
	Jobs in ecotourism
	<u>Contribution to GDP from ecotourism</u>
	Number of people whose livelihood is derived from the muti industry
	Number of visitors to Protected Areas disaggregated by South African and foreign visitors