Marine Biodiversity Hub

National Environmental Science Programme

Guidelines for the Assessment of Cumulative Impacts

High Level Summary of Technical Report describing Guidelines for analysis of cumulative impacts and risks to the Great Barrier Reef for DAWE (Department of Agriculture, Water and the Environment).

Why is cumulative impact assessment important?

The Great Barrier Reef is an ecosystem under significant pressure from a number of threats, including climate change and a range of direct and indirect anthropogenic uses[1]. The reef has experienced widespread cumulative stress for several decades, and this is expected to continue. Cumulative impacts from a wide range of threats have been identified for many of the values in the GBR region, including coral reefs, seagrass meadows, mangrove forests, sharks, seabirds, dugongs and dolphins. The Outlook report[1] identifies many examples of where cumulative impacts from pressures are expected, but poorly understood – such as coastal development, pollutants, fisheries, cyclones and climate change.

When considering a proposed action in its broadest scope, the stages, components and related activities may interact with each other to combine as cumulative impacts on Matters of National Environmental Significance[2]. Actions may have a cumulative impact when the combined impacts of all the stages and components of an action (and all related activities and infrastructure) have a significant impact on the ecosystems and species within the area of the proposal. However, calculating the combined impacts of all the components of an action can be difficult and including the impacts from other sources increases the challenge. Within the GBR World Heritage Area the GBR Cumulative impact management policy[3] operates under the Reef 2050 plan and identifying pathways for implementation is an action under the Reef 2050 Long Term Sustainability Plan[4]. Within the broader marine environment, the cumulative impacts associated with shipping may also be included in these considerations[5]. The cumulative impacts of other pressures may combine with the potential impacts from shipping (eg underwater noise, grounding, spills).

The Reef 2050 Long Term Sustainability Plan will "Provide a clear and target-driven framework to support planning and assessment of development proposals" through the Cumulative Impact and Net Benefit policies to ensure cumulative impacts are managed below threshold levels and ensure protection and transmission of the Reef's Outstanding Universal Values. Identifying pathways for implementation of this policy remains a priority and this guidance provides a systematic and consistent approach to the estimation of cumulative impacts.

---

[1] Great Barrier Reef Marine Park Authority 2019, Great Barrier Reef Outlook Report 2019, GBRMPA, Townsville.

[2] Matters of National Environmental Significance, Significant impact guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999

[3] Great Barrier Reef Marine Park Authority 2018, Cumulative impact management policy, GBRMPA, Townsville.

[4] Reef 2050 Long-Term Sustainability Plan—July 2018, Commonwealth of Australia 2018

[5] North-East Shipping Management Plan.

The assessment of cumulative impacts is required to achieve net benefit outcomes – decisions or actions which result in a net benefit improvement to the condition and/or trend of a GBR environmental value or process[6].

The technical guidelines provide the detail needed to complete a cumulative impacts assessment under the cumulative impact management policy. It is consistent with the decision making principles of the Reef 2050 plan, maintaining and enhancing outstanding universal value, basing decisions on the best available science and delivering a net benefit to the ecosystem. The guidelines may be particularly helpful in determining the indirect and offsite impacts of actions.

How to use the guidance

The guidance provides a series of practical steps that describe the necessary data and methods to complete a cumulative impact assessment, consistent with the process outlined in the Cumulative Impact Management policy and the Net Benefit policy.

- The guidance is intended to be applied across the different scales of decision making and implementation, at strategic, tactical and operational levels.
- The guidance identifies a suite of tools and methods that can be applied and provides a checklist to assess the rigour of the assessment.
- The guidance points to additional resources and provides a glossary of terms to assist with implementation.

It is not meant to replace existing frameworks and guidance for standard environmental risk assessments, rather it is intended to provide the technical context for making plans, developing policies and guidelines and making decisions or undertaking actions.

For each step, this guidance provides criteria to select the appropriate tools or methods to use in cumulative impact analysis. The tools and methods identified will provide robust assessments and will reduce the uncertainty at each step. While a full and rigorous environmental risk assessment can take various forms and have many steps, this guidance is specifically designed to address analysis of cumulative impacts within a standard risk assessment framework.

[6] Great Barrier Reef Marine Park Authority 2018, Net Benefit Policy, GBRMPA, Townsville.

Step 1: Understanding Pressures

For the area under consideration (strategic, tactical or operational), the intensity and distribution of pressures should be mapped. This should include consideration of both the spatial intensity and the temporal pattern. This step will build the understanding of the drivers and pressures acting and the time scales that they are acting over.

CIMP Steps

Step 1a – Identify the relevant drivers, pressures and impacts; the space and time scale at which they occur; and any planning or project-specific contributions.

Net Benefit policy Step 1 - Identify Great Barrier Reef values, and desired outcomes relevant to your decision.

Pressure List - Table A1.1 – Pressures and impacts, their definitions and their risks to value

Information contained in the guidance

1. What types of pressures are there? Page 7
2. A checklist for pressures. Page 8 and included here in Annex I.
3. Useful sources of information and Key Resources. Page 10

Step 2: Understanding Values

The environmental values of the GBR have been described as having outstanding universal value. There are a great number of values identified in GBR, and the values of any location within the Reef can be ecological, social, cultural or heritage. All these values have a spatial component; thus, a practical approach to systematically assess cumulative impacts is to use habitats as a proxy for the values they contain. Values can be identified within these habitats as being derived from components (i.e., species, habitats, processes) of GBR ecosystems, and should be identifiable with conceptual system models.

CIMP Steps

Step1b - Identify affected values, the space and time scale at which they occur, and consider connectivity between values.

Step 2 - Determine the current condition of affected values, and their desired state.
Net Benefit Policy Step 1 and Identify causes of decline affecting the relevant Great Barrier Reef values

Values List - Table A4.1 - Key values and attributes of matters of national environmental significance

Information contained in the guidance

1. What types of values are there. Page 12
2. A checklist for values. Page 14 and included here in Annex II.
3. Useful sources of information and Key Resources. Page 17

Step 3: Conceptual Models of Key Habitats

Conceptual models need to portray the ecological system at a level of resolution that is tractable and useful to the purposes of the risk assessment, striking a balance between simplicity and complexity. The describe the system in the area being considered and the causal relationship between the pressures and values. Examples of conceptual models can be found in Section 6.8 of the GBR strategic assessment. Conceptual models for key ecosystems are in development through RIMREP.

CIMP Steps

Step 3 Examine the cause and effect of planning, program or project-specific impact contributions.

Net Benefit Policy Step 1 and 2 Consider the scale required to contribute effectively to improving the condition and trend.

Ecosystem Process List - Table A4.2 Key environmental processes relevant to matters of national environmental significance.

Information contained in the guidance

1. What is a conceptual model? Page 18
2. A checklist for a conceptual model. Page 19 and included here in Annex III.
3. Useful sources of information Page 20

Step 4: Zone of Influence

The zones of influence that define the spatial extent over which a pressure influences a value need to be mapped spatially but can also be presented in a tabular format. Iterative steps between identifying the zone of influence and defining the conceptual models may be required to ensure that derived assessment and measurement end-points are meaningful and measurable. Examples of a zone of influence can be found in section 6.8 of the GBR strategic assessment.

CIMP Steps

Step 3 Examine the cause and effect of planning, program or project-specific impact contributions.

Step 1a Identify the relevant drivers, pressures and impacts; the space and time scale at which they occur; and any planning or project-specific contributions.

Information Contained in the Guidance

1. What is a zone of influence? Page 21
2. Checklist for Zone of Influence Page 22 and included here in Annex IV.
3. Useful sources of information. Page 23

Step 5: Risk Assessment and Uncertainty

The existing impacts and potential risks of new activities or development projects that can potentially affect values need to be calculated. Cause-effect models can be used to identify measurement end-points for each of the assessment end-points associated with the values. The cumulative impact of existing and potential pressures should be calculated for each measurement endpoint. Risks of each new activity can be compared against the desired environmental condition.

CIMP Steps

Step 4 Undertake a risk assessment.

Steps 4a Use resilience and vulnerability risk analyses as a basis for understanding how ecosystem values are affected by multiple drivers and pressures in space and time.

Step 5 Compare the outcome of the assessment with the desired outcome for the state of the value or process and relevant standards and guidelines.

Net Benefit Policy Step 3 Consider the most appropriate approach to implementation, and how strategic and innovative approaches can help improve the effectiveness of achieving positive outcomes.

Information Contained in the Guidance

1. How to conduct a cumulative risk assessment. Page 23
2. A checklist for cumulative risk assessment. Page 29 and included here in Annex V.
3. Examples of the use of the checklist. Page 31

The NESP Marine Biodiversity Hub is funded by the Australian Government's National Environmental Science Program. Our goal is to assist decision-makers to understand, manage and conserve Australia's environment by funding world-class biodiversity science.

May 2021

Further information:
Piers Dunstan
CSIRO

T +61 3 6232 5382
E piers.dunstan@csiro.au

Annex - Checklist to identify strengths and weaknesses in Assessments of Cumulative Impacts

These checklists are included to aid in the identification of the strengths and weaknesses of any cumulative impacts and add an extra level of precaution to the assessment.

Annex I Check list for the assessment of Pressures

SPECIFIC QUESTIONS	**CAVEATS**
Data Availability	
Is there sufficient data available on pressures for the area of interest?	If no, consider not undertaking assessment until sufficient data is collected, modelled or sought through expert opinion OR apply the precautionary principle and assign high potential impact for those areas of interest with unknown pressures.
Are available data on different pressures at comparable spatial and temporal scales?	If no, caution needs to be taken to ensure that the spatial and temporal scale are appropriate to enable estimation of impact.
Is there data on the historical distribution and intensity of the pressures?	If no, historical impacts will not be able to be estimated.
Do the available pressure data have comparable resolutions for all pressures considered?	If no, differing resolutions may mean some pressures are given a higher weighting than would otherwise be expected.
Are empirical data available or are the data inferred, modelled, or based on expert option?	If empirical data is not available then additional questions should be addressed as below.

If the presence of the pressure is inferred from models or expert opinion, the following additional characteristics should be considered:	
Does the model/expert opinion incorporate uncertainty into the pressure estimate?	If no, additional caution should be applied to the estimate of pressure.
What is the confidence in the spatial prediction (if appropriate)?	If low, additional caution should be applied to the estimate of pressure.
What is the confidence in the temporal prediction (if appropriate)?	If low, additional caution should be applied to the estimate of pressure.
Does the model generate measurable outputs or scores that can be compared with observed pressure status?	If no, the model cannot be verified and should be treated with significant caution.
Does the model/expert opinion consider the maximum potential value of pressures?	If no, the maximum value of the pressure needs to be estimated so that the maximum potential impact can be calculated.
Does the model/expert opinion provide sufficient information to use to estimate potential impacts?	If no, the impacts of pressures need to be calculated for cumulative impact assessment.

Annex II: Checklist for the assessment of Values

SPECIFIC QUESTIONS	CAVEATS
Data Availability	
Is there sufficient data available on values for the area of interest?	If no, consider not undertaking assessment until sufficient data is collected, modelled or sought through expert opinion OR apply the precautionary principle and assign high potential impact for those areas of interest with unknown values.
Are data on values available on comparable spatial and temporal scales to the pressures?	If no, caution needs to be taken to ensure that the spatial and temporal scale are appropriate to enable estimation of impact.
Are baseline data available?	If no, historical impacts will not be able to be estimated, and it will be difficult to determine if an impact has occurred.
Do available data on values have comparable resolutions for all values?	If no, differing resolutions may mean some values are given a higher weighting than would otherwise be expected.
Are empirical data available or are the data inferred, modelled, or expert option?	If no, empirical data is not available then additional questions should be addressed.
If the presence of the values is inferred from models or expert opinion, the following additional characteristics should be considered:	
Is there a clear link between the outputs of the model and the values	If no, the model may not accurately predict where values occur.
Does the model incorporate uncertainty?	If no, additional caution is necessary as the reliability of predictions cannot be determined.
What is the confidence in the spatial prediction (if appropriate)?	If no, additional caution is necessary as the reliability of spatial predictions cannot be determined.

What is the confidence in the temporal prediction (if appropriate)?	If no, additional caution is necessary as the reliability of temporal predictions cannot be determined.
Does the model generate measurable outputs or scores that can be compared with observed environmental status?	If no, the model cannot be verified and should be treated with significant caution.
Are multispecies predictions used? If yes, the additional considerations below should be considered:	
Is it possible to robustly estimate how many multispecies groups there are (e.g. the number of assemblages, communities)?	If no, the exact number of assemblages/communities cannot be determined, and some areas may be over/under predicted.
Can the spatial distribution of multispecies groups be estimated?	If no, caution must be taken in generalising across a landscape/seascape.
Can the uncertainty in group membership and the spatial distribution of each group be estimated?	If no, additional caution is necessary as the membership of groups cannot be determined.
Can the species composition within each group be estimated?	If no, caution must be taken in extrapolating to species distributions
Can the environmental characteristics of each group (i.e. the functional form of the relationship between the group and the environmental covariates) be estimated?	If no, caution must be taken extrapolating into environments that are unsampled.

Annex III: Checklist for Conceptual Models of Key Habitats

SPECIFIC QUESTIONS	**CAVEATS**
Is the context of the conceptual model clearly defined?	
Does the conceptual model of the system capture the same temporal and spatial scales as desired for the assessment/of interest?	If no, caution needs to be taken to ensure that the spatial and temporal scale are appropriate to enable estimation of impact.
Are the spatial and temporal limits of the system clearly identified?	If no, additional consideration should be given to defining the limits to ensure that the model captures the relevant parts of the system for management.
Does the conceptual model include ecosystem components that adequately represent key species, habitats and processes (i.e., resource flows, ecological relationships, and disturbance regimes)?	If no, potential ecosystem impacts from pressures may not be well described.
Can you actually measure the outputs of the system, identify indicators and monitor the outcomes?	
Does the conceptual model describe how the pressures, values and ecosystem components relate to each other and interact?	If no, potential ecosystem impacts from pressures may not be well described.
Are the assessment endpoints (the ecosystem components that will be monitored) represented in the conceptual model?	If no, the direct impacts of pressures on ecosystem components they impact are not well described.
Are there alternative ways that pressures could impact values or alternatives for how the ecosystem might be structured?	If yes, then each different conceptual model should be considered in the assessment.

Annex IV: Checklist for Zone of Influence

SPECIFIC QUESTIONS	CAVEATS
Are Pressures linked to ecosystem components?	
Is the response variable of the dose-response relationship clearly represented in the ecosystem's conceptual model?	If no, the conceptual model should be reconsidered to ensure that identified responses variables are represented.
Is the zone of influence based on a well-defined dose-response type relationship (demonstrated and measured clear impact) relevant to the valued components of the ecosystem?	If no, care must be taken to ensure that the effect of pressures can be linked to values.
Are threshold values sufficiently detailed to address the biology of the response variable (e.g., do they address breakpoints in effects on key variables such as seagrass growth increasing or decreasing at relatively low or high levels of nutrients)?	If no, uncertainty about the threshold for a response should be considered.
Do threshold values address a range of effects that are relevant to management concerns and desired future conditions of associated values?	If no, additional caution is necessary as the reliability of predictions cannot be determined.
Is uncertainty in the dose-response relationship adequately assessed and documented?	
If based on empirical data, does the dose-response relationship included error bounds?	If no, uncertainty about the threshold for a response should be considered.
If based on modelling studies, is there documentation of variation in modelling results?	If no, additional evidence of the dose-response relationship should be sought.
If based on expert opinion, is there documentation of the elicitation process and attendant level of uncertainty?	If no, additional evidence of the dose-response relationship should be sought.

Does the zone of influence adequately address or document different sources of pressures relevant to the assessment?	
Is the granularity of the pressure data sufficient to address the pattern of distribution in the response variable of the dose-response relationship and the distribution pattern of valued components of the system?	If no, caution needs to be taken to ensure that the spatial and temporal scale are appropriate to enable estimation of impact.
Are concentrations or intensities of existing pressures adequately differentiated from pressures associated with proposed projects and plans of management?	If no, care needs to be taken to distinguish the effects pressures from other potential sources of impact.
Are anthropogenic sources of pressures adequately differentiated from natural or otherwise background levels of pressures (i.e., turbidity from a catchment includes natural sources from sediment transport but also from runoff associated with land use practices)?	If no, care needs to be taken to distinguish the effects pressures from other potential sources of impact.

Annex V: Checklist for cumulative risk assessment

Can the method predict the spatial distribution of cumulative impacts?	If no, if the expected spatial distribution of impacts is large then additional analysis may be necessary to predict all impacts.
Can the method identify alterations to ecosystem components and processes such as nutrient cycling, predation, habitat modification, sedimentation, light penetration?	If no, absence of understanding of key processes may mean that ecosystem responses are not well characterised.
Does the method imply the link between multiple pressures and values or is this explicitly described in the approach?	If implied, additional information will be necessary to ensure that the pressures cause a change in the values.
Can the proposed methods assess the indirect effects caused by the pressures on values?	If no, caution must be taken to ensure indirect effects (mediated through the ecosystem) that may change the magnitude and direction of change in values are accounted for.
Can the method assess facilitative effects of multiple pressures on values be detected?	If no, caution will need to be taken to ensure that pressures that facilitate impacts from other pressures are accounted for.
Can the method distinguish between masking, antagonistic, additive and synergistic links between multiple pressures and values?	If not, the full impact of pressures may not be properly estimated.
Are non-linear links between pressures and ecosystem components possible?	If no, inflection points and transitions in impact may not be well estimated.
Can the method distinguish between the impacts of a single pressure acting sequentially?	If no, assessment may not capture the full impact of pressures acting through time.
Can the method distinguish between the impacts of multiple pressures acting simultaneously or sequentially?	If no, assessment may not capture the full impact of pressures acting through space and time.
Can the method include future impacts in the predictions?	If no, it will not be possible to predict the future risks of pressures.
Can the method produce an estimate of uncertainty in the predictions in likelihood and consequence?	If no, additional caution is necessary as the estimate of impact and risk may not be accurate.
Can the method incorporate temporal variation and time lags?	If no, assessment may not capture the full impact of pressures acting through time.