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# Balancing coastal use and community values with management options

## Project partners

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## Pathway to impact

In partnership Great Barrier Reef Marine Park Authority (GBRMPA), the Queensland Departments of Agriculture Fisheries and Forestry (DAFF), Department of Science, Information Technology, Innovation and the Arts (DSITIA) and Environment and Heritage Protection (DEHP).

The project will work through the Local Marine Advisory Committees (LMACs) operating in Mackay and the Burdekin area. The LMAC is a voluntary community-based committee that provides local level advice on management issues about the Marine Park to GBRMPA.


The LMACs are experienced in providing a community forum for interest groups, government and the community to discuss issues around marine resources and are central to the stakeholder engagement process for this project.

This project is being run through the National Environmental Research Program Tropical Ecosystems Hub (NERP TE Hub) in partnership with the Great Barrier Reef Marine Park Authority, Department of Agriculture, Fisheries and Forestry, Department of Environment and Heritage Protection, Department of Science, Information Technology, Innovation and the Arts, Department of Environment and Heritage and James Cook University.

*The Australian Government funds the NERP to inform evidence-based policy and sustainable management of the Australian environment.*

### IN THIS ARTICLE

- [1. Project summary](#)
- 2. Project partners**



Mangroves are coastal forests that provide valuable nursery areas for juvenile fish and are an important source of nutrients.

### Fast Facts

- It is critical to balance coastal use and community values with management choices that support the conservation of diverse marine life and protect commercial interests.
- This project aims to identify the demands on the coast, the areas valued by the local community, and deliver an assessment of the impacts of different potential management strategies compared with present management systems.

### Contact Information

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### Related Links

[Our resilient coastal Australia](#)

[Dr Cathy Dichmont: leading fisheries and ecosystems research](#)

[Online survey for Mackay residents \[external link\]](#)

[NERP Tropical Ecosystems Hub \[external link\]](#)

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Figure 66: Project web page hosted by CSIRO and linking to online survey address

## Objectives survey flyer



National Environmental  
Research Program

## TROPICAL ECOSYSTEMS *hub*

How important is the coast to you?

We want to know what you think is important for the future of your coast.

Australia's national science agency, CSIRO, is leading a study to find out how people living in Mackay would like to see the coast managed in the future.

We are exploring coastal management choices and priorities from a community perspective. We are aiming to understand the balance between local community needs, conservation and commercial uses, and where they all overlap.

This is your opportunity to have your say and participate in an information session and survey.

Venue: Mercy College, corner of Penn Street and Juliet Street, Mackay

When: Tuesday, Wednesday and Thursday, 9–11 July, 6 to 8pm,  
light refreshments provided (participants attend one session only)

For further information or to register your interest contact:

The Great Barrier Reef Marine Park Authority

T: 07 4951 3454

E: [gbr-mse@csiro.au](mailto:gbr-mse@csiro.au)

W: [www.csiro.au/gbr-mse](http://www.csiro.au/gbr-mse)

This work is being undertaken as part of the National Environmental Research Program (NERP) Tropical Ecosystems Hub with the help from with community volunteers and the Great Barrier Reef Marine Park Authority's Mackay Local Marine Advisory Committee.

*The Australian Government funds the NERP to inform evidence-based policy and sustainable management of the Australian environment.*



Australian Government  
Department of Sustainability, Environment,  
Water, Population and Communities



Australian Government  
Great Barrier Reef  
Marine Park Authority



Figure 67: Flyer for the survey 3-day at Mercy College

MON 11 NOVEMBER 2013

### Mediaportal Report



#### Burdekin and Mackay have been chosen to gauge public attitudes towards the ...

ABC North Queensland, Townsville, 06:30 News, Newsreader

11 Sep 2013 6:33 AM

Duration: 0 min 48 secs - ASR AUD 99 - QLD - Australia - ID: W00054515069



Burdekin and Mackay have been chosen to gauge public attitudes towards the conservation and recreational and commercial use of coastal areas bordering the Great Barrier Reef by the CSIRO.

##### Interviewees

Kathy Dickmon(\*), Researcher, CSIRO

N/A ALL  
N/A MALE 16+  
N/A FEMALE 16+

#### Communities to help form coastal management policy

ABC Online, [www.abc.net.au](http://www.abc.net.au)

11 Sep 2013 3:26 PM

168 words - ASR AUD 1,706 - ID: 212794314

[Read on source website](#)

198,635 UNIQUE DAILY VISITORS  
2,681 AV. STORY AUDIENCE

#### Communities to help form coastal management policy

ABC Online, [www.abc.net.au](http://www.abc.net.au)

11 Sep 2013 1:18 PM

168 words - ASR AUD 1,708 - ID: 212776179

[Read on source website](#)

198,635 UNIQUE DAILY VISITORS  
2,681 AV. STORY AUDIENCE

#### Program preview:

##### - Discussion about the coastal survey that will be done by the CSIRO.

ABC Tropical North, Mackay, Mornings, Kim Kleidon

14 Oct 2013 9:06 AM

Duration: 0 min 50 secs - ASR AUD 103 - QLD - Australia - ID: W00054889329




Program preview:  
- Discussion about the coastal survey that will be done by the CSIRO.

N/A ALL  
N/A MALE 16+  
N/A FEMALE 16+



Figure 68: Media monitor of radio interviews and pickup thereof

Online survey front page



Identifying key objectives for the management of the Mackay inshore coastal area

**Project Description**

How important is the coast to you? We want to know what you think is important for the future of your coast. Australia's national science agency, CSIRO is leading a study to find out how people living in Mackay would like to see the coast managed in the future. The study is entitled 'Design and implementation of Management Strategy Evaluation for the Great Barrier Reef inshore (MSE-GBR)', and explores coastal management choices and priorities. We are aiming to understand the balance between local community needs, conservation and economic development, and where they all overlap. This survey is an opportunity to have your say.

Based on a bibliographic review and extensive consultation with stakeholders from the Mackay region, the project team developed a structured list of objectives which can all be considered in managing the inshore coastal area. This list is a tree with three main objective branches relating to (1) the protection and restoration of environmental assets; (2) improvement of governance systems; and (3) improvement of regional economic and social well-being. Each of these branches contains a number of sub-objectives.

The purpose of this survey is to obtain your views on the relative importance you think should be placed on these different objectives.

By clicking the "Yes" button below you indicate that you want to participate in the survey. We ensure your confidentiality by not making public the information you provide in this online survey. It will only take approximately 20 minutes to complete this online survey. The information will be kept at a secure location on the CSIRO network only accessible to a core team of people until Dec 2014.

The information you provide will be used for research purposes only, without reference to specific facts or events. For any reporting your individual information will not be presented - all information will be presented in summarised form based on collating all survey data. This summarised information will be from a large enough group that your individual data could not be inferred. The range of answers in this summarised form will also be represented rather than only the average or median.

The research team will provide feedback on how the collected information has been used through verbal and written feedback by the end of 2013.

It is your right to withdraw from the survey at any time and without having to provide a reason for the withdrawal if you wish to do so. However, if you have already submitted your anonymous response we will not be able to withdraw any submitted information from the study as we cannot identify individual responses.

Please exit this survey if you do not agree to participate in the research.

We can be contacted on GBR-MSE@csiro.au if you have any queries.

The research is funded through the Reef and Rainforest Centre by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities; CSIRO, the Great Barrier Reef Marine Park Authority; and the Queensland State Departments of Agriculture, Fisheries and Forestry; Department of Science, Information Technology, Innovation and the Arts; Department of Environment and Heritage Protection.

Final project reports would be provided to the different funding agencies and will also be made publicly available online at the end of the project. Journal publications would also be published in the scientific literature.

**\* 1. Do you agree to participate with the survey?**

☐ Yes

☐ No

Figure 69: Online survey front page

## Paper survey

# Your details



**Name:**

**Email:**

Please choose the group that you mostly associate with by checking (✓) the appropriate stakeholder group

### Stakeholder groups

Please tick ✓ only one

Commercial Fishing

Charter Fishing

Commercial seafood processing

Recreational Fishing

Diving

Tourism

Fisheries Management

Fisheries Compliance

Tackleshops, Recreational Service Industry

Marine Services Industry

Mining

Port Authority

Farmer

Grazier

Conservation organisation

Great Barrier Reef Marine Park Authority

Queensland Parks and Wildlife Service

NRM group

Local Government Councillors

State Government

Aboriginal & Torres Strait Islander

Local Resident

Scientists

Student - High School

Student - Tertiary

Other

Please indicate the region where you are located

**Region** **Please tick ✓ only one**

Torres Strait to Cairns

South of Cairns to Bowen

South of Bowen to Repulse Bay

Repulse Bay to Clairview (Mackay)

South of Yeppoon to Baffle Creek

South of Baffle Creek to Double Island Point

South of Double Island Point to Caloundra

Caloundra to the NSW Border

Other

# Example

Please indicate the relative importance of three different objectives for playing sports.

The total score should be **equal to 100**.

The indicator score for the individual objective has to be **at least one (1)** and CANNOT be zero (0)

Objective		100 points	Explanation of objective
1	Get fit	30	You want to maintain a level of fitness to stay healthy
2	Interact with your friends	10	This is an important opportunity to be with your friends every week
3	Have fun	60	The physical activity provides a high level of necessary fun in your otherwise busy life
		<b>TOTAL</b> 100	

OR

If you rate two the same please give them the same number of points

Objective		100 points	Explanation of objective
1	Get fit	1	You want to maintain a level of fitness to stay healthy
2	Interact with your friends	1	This is an important opportunity to be with your friends every week
3	Have fun	98	The physical activity provides a high level of necessary fun in your otherwise busy life
		<b>TOTAL</b> 100	



## High Level Objectives

Please indicate the relative importance of three different high level objectives. The total score should be equal to 100.

	Objective	100 points	Explanation of objective
1	Protect and restore inshore <b>environmental</b> assets		Overarching environmental objective for the region
2	Improve <b>governance</b> systems (i.e. leadership, institutions, rules and decision-making processes involved in managing inshore biodiversity)		Improve leadership, institutions, rules and decision-making processes involving government, citizens, public associations, private businesses, and non-governmental organisation, for the management of inshore biodiversity and its uses
3	Improve regional <b>economic</b> and <b>social</b> well-being		Improve the long-term well-being of the region's people by promoting economic growth, increasing social cohesion and increasing social capital
		TOTAL 100	



## Protect environmental assets

Please indicate the relative importance of three different objectives for protecting environmental assets. The total score should be equal to 100.

Objective		100 points	Explanation of objective
1.1	Improve ecosystem connectivity		Connectivity between catchment, fresh- and salt-water habitats
1.2	Improve water quality		Reduce sediment and nutrient runoff into waterways and reefs
1.3	Conserve inshore living resources		Ensure long-term conservation of the inshore living resources and their support systems
		100	

Objective		100 points	Explanation of objective
1.1.1	Reduce direct impacts of infrastructure and development		Minimise the negative impacts to biodiversity associated with the strong development currently occurring in the region
1.1.2	Minimise human induced changes in water flow regimes		Maintain water flow regimes to allow for catchment to coast connectivity
		100	

Objective		100 points	Explanation of objective
1.2.1	Ensure Reef Plan water quality targets are met		Meet regional water quality targets
1.2.2	Increase feral animal control and environmental friendly weed control strategies		Control invasive species to improve water quality. When possible weed control should avoid/minimise the use of chemicals
1.2.3	Reduce influx of pollutants		Reduce the use of chemicals used in agriculture and industry and its disposal in waterways. Also involves reduction of sediment and nutrient runoff
		100	

Objective		100 points	Explanation of objective
1.3.1	Sustainable human use of marine resources		Ensure sustainable harvesting of living resources; Reduce waste and human footprint of extractive activities, and improve re-use of by-products
1.3.2	Maintain habitat function and structure		Maintain/restore habitats for their biodiversity values
1.3.3	Reduce impacts on Threatened, Endangered, Protected (TEP)		Minimise accidental strikes and kills of fauna and flora (e.g. dugongs,

species

turtles, quolls)



100

## Improve governance systems

Please indicate the relative importance of three different objectives for improving governance systems. The total score should be equal to 100.

Objective		100 points	Explanation of objective
2.1	Increase management effectiveness		Increase the effectiveness of management systems by removing barriers to flexibility
2.2	Increase management support		Increase support towards inshore biodiversity management systems through increased management acceptability, increased stakeholder engagement, ensuring that management costs are sustainable and increase compliance with environmental and resource use regulations
2.3	Increase management integration		Improve integration of management in policy, regulation & implementation, at Local, State & Comm. levels
		100	

Objective		100 points	Explanation of objective
2.1.1	Remove regulatory barriers to flexibility (alternative harvesting techniques, zoning, diversification in the economy)		Remove regulatory barriers that impede creativity in the development of alternative techniques to harvest natural resources, to increase flexibility in zoning arrangements and remove regulatory barriers that impede the diversification of the economy
2.1.2	Increase compliance with environmental and resource use regulations		Discourage illegal, unreported & unregulated activities, & encourage compliance with existing regulations
		100	

Objective		100 points	Explanation of objective
2.2.1	Increase management acceptability		Increase management acceptability through rational & proportional legislation, & increased info dissemination
2.2.2	Increase stakeholder		Increase stakeholder engagement

	engagement and community ownership/stewardship
2.2.3	Sustainable financial costs


100

through involvement of private developers / corporate responsibility and community involvement in management to foster community ownership/stewardship
Minimise industry compliance costs & govt enforcement costs, including recoverable and non-recoverable total management costs and infrastructure costs

Objective		100 points	Explanation of objective
2.3.1	Increase policy integration		Coherent & integrated policies across Local, State and Commonw ealth levels
2.3.2	Increase regulatory integration		Coherent & integrated regulations across Local, State and Commonw ealth levels
2.3.3	Increase implementation integration		Coherent & integrated management implementation across Local, State and Commonw ealth levels
		100	

## Improve regional well-being

Please indicate the relative importance of three different objectives for improving regional well-being. The total score should be equal to 100.

Objective		100 points	Explanation of objective
3.1	Increase economic growth		Promotion of regional economic development, incl. natural resource based industries, to maintain / improve family livelihoods
3.2	Increase social cohesion		Increase regional community cohesion through minimising conflicts between stakeholders, conserving traditional activities & cultures and ensuring equitable access to inshore areas and resources
3.3	Increase social capacity		Increase social capacity to act, through health improvement and investment in social capital development
		100	

Objective		100 points	Explanation of objective
3.1.1	Improve regional economic development and industry diversity		Increase the regional flow of human & financial resources, develop efficient & integrated infrastructure, increase local market opportunities for local foods
3.1.2	Improve family livelihoods in the region		Enhancement of quality of life via increasing employment opportunities and family income
3.1.3	Ensure that natural resource based industries are profitable and sustainable		Maximise industry value, economic profits and productivity, and minimise price variability
		100	

Objective		100 points	Explanation of objective
3.2.1	Minimise conflicts between stakeholders		Minimise conflicts between different users of the inshore marine area and resources
3.2.2	Conserve traditional activities and cultures		Preserve the traditional and cultural relationships between natural resources and areas and local human cultures (aboriginal and non-aboriginal)
3.2.3	Ensure community equity		Ensure equitable access to inshore areas and resources
		100	

Objective		100 points	Explanation of objective
3.3.1	Improve workplace and family health and safety in the region		Improve safety in the workplaces, as well as physical and mental family health and safety in the region
3.3.2	Improve education, training, social infrastructure and networks		Improve social capital at both individual (education, training, ...) and collective level (physical infrastructure – hospitals, schools, ... - as well as networks and community groups) providing the regional community with the capacity to address development challenges and take advantage of emerging opportunities
		100	

### 13.2.3 MANAGEMENT STRATEGIES: CREATING IMPACTS

#### Queensland fisheries review letter entitled “Regional input to fisheries management is important”

Written for the Mackay Local Marine Advisory Committee Reference Group that supported the project “Design and implementation of Management Strategy Evaluation for the Great Barrier Reef inshore (MSE-GBR)”

#### Background

The Mackay LMAC Reference Group (RG) was formed as a sub-committee of the Mackay Local Marine Advisory Committee<sup>3</sup> (LMAC) to support a Department of Environment funded project that investigated factors driving inshore impacts on biodiversity and fisheries using an approach that allowed locals to provide input to coastal fisheries and biodiversity management

(<http://www.nerptropical.edu.au/project/mse-ghr>).

The project found that terrestrial activities such as urban and rural development, and other aquatic non-fisheries activities that include dredging have significant impacts on fisheries through changes to habitats, water flow, sediment and water quality. These impacts affect both fisheries productivity and fishers return with potential negative effects flowing to both commercial and recreational sectors (e.g. reduction in fish catches which affect industry profitability and also reduces the enjoyment from fishing for recreational fishers).

Most members of the RG were also Mackay LMAC members and included commercial fishers and traders, recreational fishers, council and port staff, and local farmers. Even though the RG may not be representative of all interest groups in the entire Mackay community, they are locals who are passionate about improving management in the Mackay region and who volunteered considerable time to support this project. The project team, led by CSIRO, included staff from DAFF, GBRMPA, DSITIA and DEHP who helped link relevant government agencies with the RG members. During an intensive 18 months investigating issues that affect the coastal zone, the RG developed possible management actions that could be undertaken to mitigate identified coastal zone risks. Throughout the deliberation process, the RG had access to experts on relevant topics such as the role of key habitats (seagrass, mangroves and inshore corals), urban and port development, and fisheries. They were also made aware of existing management arrangements in the region. Outlined below are the RGs key inputs to fisheries management in the Mackay region specifically, but these inputs are likely to be highly relevant to Queensland fisheries management and the reviewers of Queensland fisheries. Management options developed by this group for broader impacts not directly attributable to fisheries are not mentioned here as they are not managed by DAFF fisheries, but are an important context that should be kept in mind.

#### Major fisheries-related issues highlighted and suggested solutions:

1. Competition between the different industries and sectors is the primary issue of concern to fisheries management. This is especially the case in the coastal zone

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<sup>3</sup> LMACs are committees established by GBRMPA in GBR coastal regions to provide advice to GBRMPA, membership is by way of nomination for a 3 year period and they are broadly representative of relevant stakeholder groups although they may also contain independent members



where large changes to the coastal landscape are occurring through Port and Urban development and where most of the conflict occurs between the indigenous, recreational and commercial fishing sectors. Of special concern is the growing conflict between the recreational and commercial fishery, which is serious and at times very acrimonious in many local areas in Queensland.

- a. Allocation to different sectors would allow for more appropriate fisheries management. This should lead to more reasonable controls on recreational fisheries (rather than trying to manage through indirect tools only such as bag limits) and create transparency in the dialogue about which fisheries will be predominantly fished by one sector or the relative allocation to each sector. This may mean that recreational fishers have to contribute to a licence or tagging system as used in other States. The sectoral allocation proposition is of the highest priority.
  - b. Education about the relative merits of each sector is also important, but follows on from the above. Some aspects of the lack of mutual respect can be explained by a predominance of misunderstandings and can thus be addressed through targeted campaigns that explain, for instance, the strict management controls on the commercial fishery and how they contribute to locally eaten seafood, employment and the economy. Similarly, recreational fishing activity could be explained as an important pass-time for many families around having fun, enjoying family time together and getting some seafood, but not for semi-commercial purposes. Present education by DAFF concentrates mainly on explaining existing regulations. Although this is important it may overly concentrate on a single aspect of fisheries management.
2. Illegal and unregulated fishing is perceived to have increased here over time as the amount of compliance staff on the ground has decreased. This has meant that a sophisticated poaching system seems to be developing in various regions of Queensland. With few compliance staff in each location and the large geographic area they need to cover, there is a view that it is generally well known where compliance staff are patrolling on any given day and where they are not. Lack of investment in compliance staff and infrastructure is compromising good fisheries management both directly through decreased compliance and indirectly as a disincentive to comply by honest people.
  - a. Increased investment in compliance is required. Ideally this investment should concentrate on increasing the number of people on the ground, rather than investing in assets or management positions.
  - b. In reality, more resources may not be possible, meaning smarter compliance is needed using current resources. Presently risk assessments are mainly undertaken on a Queensland wide basis. However, the RG felt strongly that local knowledge is crucial for effective compliance and they expressed frustration at their inability to input to compliance risk assessment and strategy development. Locals know where the issues are and because local conditions drive many fisheries (especially in the inshore, e.g. local rainfall and barramundi). It is therefore suggested that mechanisms are needed to enable local input into illegal activities through direct engagement for example, FishWatch, into compliance risk assessments in different Queensland regions.

3. Regional versus State-wide management is a major issue, especially as there is a perception in smaller regions that South-East Queensland (SEQ) issues dominate. The lack of flexibility to undertake local management is hampered by the governance system that requires State-wide processes such as access licences and representation. Some fisheries may benefit from the ability to relocate from one region to another to remain economically viable. However, in the inshore zone this movement of "outsiders" into an area can become a major source of conflict. Locals want the flexibility to manage the resources on their doorstep. Several space-time allocation agreements between local commercial and recreational fishers have been unsuccessful due to the inability of the governance system to accommodate these good suggestions and the apparent ability of non-locals to disproportionately influence sensible development of local solutions. A compromise needs to be reached between flexible local arrangements and State-wide standards. This is a high priority. Other priorities include:
  - a. undertake a review of which fishery would benefit from a full or part devolution of management activities,
  - b. develop a governance system for these fisheries that overtly addresses the importance of local arrangements in the management of fisheries,
  - c. trial these arrangements in key fisheries, and
  - d. develop a stakeholder engagement system that allows for better local input.
4. The current Government is perceived as lacking independence on the decisions that are made. There is presently no representative stakeholder engagement process and thus no clarity exists as to how management decisions are made (or not). It is therefore necessary to consider:
  - a. Re-introducing stakeholder engagement committees such as the Resource Assessment Groups and Management Advisory Groups. Although these require resourcing, the benefits are seen to far outweigh the cost. If these traditional structures are no longer appropriate, some independent process is nevertheless essential for stakeholder buy-in to fisheries management.
5. Research priorities in Queensland are perceived to be dominated by SEQ priorities. This is partly due to the inability of local research ideas to be input to the system as there is no clear mechanism to feed in ideas to the process (bearing in mind that many/most fishers are not club or industry body members).
  - a. Develop a research priority process that allows bottom up, local input to research priorities.
6. Empowering locals (not only for regional management purposes) through stewardship programs is important for successful management, both to make effective decisions and to obtain support for these decisions.
  - a. Support existing stewardship groups such as the Reef Guardian Programs and/or develop specific fisheries-centric groups in different regions. These fisheries-centric groups should be adequately resourced.
7. Many departments have overlapping activities. For example, Parks' compliance staff, not empowered to deal with fisheries compliance, travel in areas where illegal fishing could occur. On-ground staff in all State and Commonwealth

Government agencies are much reduced in number, and sharing resources and tasks would greatly progress mutual management needs. This also applies to communication with the public, which is generally also independently undertaken by each agency, yet clear co-ordination of marine resource management objectives and communication strategies would be of mutual benefit.

- a. Develop synergies between GBRMPA, Parks, QDAFF through Inter-government Arrangement and Agreements. This should initially concentrate on on-ground activities such as compliance, littering etc.
- b. Synergise common messages of fisheries and marine resource management through the different agencies, especially between GBRMPA and DAFF. The priority here is to undertake education campaigns that aim to generate voluntary compliance and address allocation and mutual respect of different users of the marine estate.

## **In summary**

Regional input is crucial to the effective management of Queensland's fisheries. To achieve this, governance reform is required to stakeholder engagement, allocation, compliance and education processes. Some of these will require further resourcing, but others are more about being more cognisant of regional issues and benefits. However, it is essential that potential fisheries reform (especially in the coastal zone) should be seen in the broader context of multiple use management. Fishers are users of a socio-ecological system where they are often receivers of what others do. They are at the end of a catchment to coast system where other users can affect the system fishers rely on and they often are smaller industries compared to other more financially valuable interests. Open and constructive dialogue to create systems that cross into other's management processes are therefore essential for a vibrant fishing community – fisheries should not be seen as the lowest hanging fruit of ecosystem management.

## **Mackay Council letter**

18/12/2014

Our Ref: Outcomes from the CSIRO Project: "Design and implementation of Management Strategy Evaluation for the Great Barrier Reef inshore (MSE-GBR)"

Barry Omundson  
Mackay Regional Council CEO  
Mackay Regional Council  
Sir Albert Abbott Administration Building  
73 Gordon Street  
Mackay QLD

Dear Mr Barry Omundson,

This Letter was written for the Mackay Local Marine Advisory Committee Reference Group that supported the project "Design and implementation of Management Strategy Evaluation for the Great Barrier Reef inshore (MSE-GBR)".

## Background

The Mackay LMAC Reference Group (RG) was formed as a sub-committee of the Mackay Local Marine Advisory Committee<sup>4</sup> (LMAC) to support a Department of Environment funded project that investigated factors driving inshore impacts on biodiversity and fisheries using an approach that allowed locals to provide input to coastal fisheries and biodiversity management (<http://www.nerptropical.edu.au/project/mse-ghr>).

The project found that, with respect to their coast, the Mackay community values their environment highly, followed by good management, and then social and economic well-being. Currently, activities under the jurisdiction of Mackay Regional Council, such as urban and rural development, have significant impacts on coastal fisheries and biodiversity through changes to habitats, water flow, sediment, water quality and accidental deaths of iconic species. It is the view of the RG that these impacts affect (i) both fisheries productivity and **economic** return with potential negative effects flowing to both commercial and recreational sectors (e.g. reduction in fish catches which affect industry profitability and also reduces the enjoyment from fishing for recreational fishers), (ii) the capacity of communities to use the coastal zone for recreation and aesthetic enjoyment, and (iii) tourism.

Most members of the RG are also Mackay LMAC members and included commercial fishers and traders, recreational fishers, council and port staff, and local farmers. Even though the RG may not be representative of all interest groups in the entire Mackay community, they are locals who are passionate about improving management in the Mackay region and who volunteered considerable time to support this project. The project team, led by CSIRO, included staff from DAFF, GBRMPA, DSITIA and DEHP who helped link relevant government agencies with the RG members. During an intensive 18 months investigating issues that affect the coastal zone, the RG developed proposed management actions that could be undertaken to mitigate identified coastal zone risks. Throughout the deliberation process, the RG had access to experts on relevant topics such as the role of key habitats (sea grass, mangroves and inshore corals), urban and port development, and fisheries. They were also made aware of existing management arrangements in the region. Outlined below are the RGs key inputs to the Mackay region related to Council. Management options developed by this group for broader impacts not directly attributable to matters related to Council are not mentioned here as they are not managed by Mackay Regional Council, but are an important context that should be kept in mind.

It is important to note that this project concentrated on the coastal zone and not on the upper catchment. Furthermore, although many of the solutions highlighted below are known, this group highlights them as an issue i.e. what they are describing are their personal experiences on-the-ground living in Mackay.

## Major Council-related issues highlighted and suggested solutions:

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<sup>4</sup> LMACs are committees established by GBRMPA in GBR coastal regions to provide advice to GBRMPA, membership is by way of nomination for a 3 year period and they are broadly representative of relevant stakeholder groups although they may also contain independent members

1. Littering in the coastal zone of the Mackay region can be either through carelessness, such as plastic bags flying from boats on rough seas, and security helmets and pieces of coal falling into the sea, or deliberate, such as discarding of plastic bottles, cigarette butts and bags on land and in coastal waters. Littering affects habitat amenity and impairment, and has been linked to the deaths of iconic species. Littering occurs because of people's indifference about the effects of littering on the environment. Therefore behavioural changes are necessary to deal with littering in Mackay and the Council can play a key role in reducing littering through further direct actions and indirectly via changing people's behaviour. For example:
  - a. Emphasise the implementation of waste management strategies. Council can increase adequate signage for boats on the location of rubbish bins and responsible litter disposal and encourage green waste recycling to minimise the amount of litter being disposed. Education campaigns to minimise plastic bag usage is also an important action to reduce litter. Council should undertake stormwater studies to identify priority areas for Gross Pollutant Traps (GPTs) retrofitting/installation and build these new areas into the Council strategy. Another key measure that should be undertaken by Council is to maintain an asset register of GPTs and Water Sensitive Urban Design infrastructure after developers hand-over these to the Council, and undertake an analysis of their efficacy through establishing monitoring programs. This is critical in justifying investments in measures to reduce litter and improve water quality.
  - b. Custodianship. Mackay Regional Council could support and be part of regular beach clean-ups with volunteers and schools to remove litter/debris from the coast and also promote programs such as 'adopt a beach', for roads, parks, and drains to encourage individuals or groups to regularly clean particular areas in the Mackay region.
  
2. Introduced pests (weeds and animals) affect the abundance and composition of native species, which leads to ecosystem degradation resulting in habitat loss and impairment. Council can contribute to enhanced pest control via establishing pest surveys and monitoring programs to identify which species occur locally, understand if they are spreading and to where, and how they are affecting the environment. It is also essential that Council and stakeholders identify and agree on management options to deal with weeds and pests, supported by cost/benefit analysis. Council should work with farmers or other landholders to understand how weeds can be managed on their property as local conditions will influence the way pests are managed. These results should be communicated to the public.
  
3. Development: Coastal urban, industrial and aquaculture developments are causing ecosystem degradation in the Mackay region through sediment runoff and reduction of ecosystem connectivity. There are established and effective practices that can minimise effects of development on ecosystems, but in Mackay, wide knowledge about these practices is limited. The following actions were identified to support Mackay Regional Council deal with development:
  - a. Maintain an asset register for handover of sediment reduction infrastructure to Council from developers. Developers build infrastructure in

new developments to capture groundwater flows and reduce development impacts on the environment, but after a couple of years they hand over this infrastructure to Council who maintains them. It appears Council does not have the necessary information detailing which infrastructure was passed on from developers and their condition, so it appears that Council does not know what they own and what needs to be maintained. An asset register would be beneficial to assist Council to adequately budget to maintain such infrastructure. Funding for construction and maintenance of infrastructure could be sourced, for example, from the Australian Government water quality initiative program.

- b. Improve knowledge feedback to 'improve' best practices over time. It is essential that Council establishes research programs based on better monitoring and sampling to identify whether or not management actions are effective. Council should consider linking activities with existing surface water quality monitoring program from NQBP and identify in the State Planning Policy the objectives that are relevant to the region.
  - c. Commission flood studies to identify areas at risk and articulate these to the public for their information and comment as local knowledge of what happens in floods may add value to the reports. It is also important to promote knowledge of the role that low lying flood prone areas play in both the management of flood impacts as well as their environmental importance in ecological productivity i.e. fishery spawning and recruitment. The Council should also consider using freeware tools easily accessible by the community, such as Google Maps and Google Earth available on the Council web site, to show areas at risk from floods and inundation.
  - d. The Council should use water quality offset contributions to mitigate pollution from development. For example, via establishing monitoring programs and developing spatial tools to support management of water quality and quantity.
4. Improve resource management. Resource management in Mackay region is challenging because management processes and regulatory frameworks are disconnected and vary between Commonwealth, State and local governments in the Mackay region. Although progress has been made, much improvement is still possible. Disconnected and inconsistent management frameworks result in multiple and inconsistent approvals for activities, which reduces (i) environmental protection, (ii) fisheries resources and sustainability, (iii) habitat amenity, and (iv) species sustainability, and increases (i) habitat loss, degradation, and impairment, and (ii) risk of death or harm of iconic species. Mackay Regional Council can improve resource management through the following activities:
- a. Improve decision-making process by using fact-based decision-making. Council should invest in research about local solutions and apply lessons learnt from elsewhere: such as examples of cost-effective practices from around the GBR that are known to improve environmental conditions. The evaluation of the effectiveness of management actions (supported by a monitoring program) is also a key component of improving resource management. Council should pilot a project to demonstrate benefits of WSUD in developments to justify further investments. Benefits should be

- holistic by considering cumulative impacts (e.g. water quality, aesthetics, biodiversity, economic).
- b. Another key action from Council is to consider and adopt local knowledge in decision-making. There are cases in Mackay where improved and cost-effective practices used by farmers (e.g. riparian re-vegetation) were overruled by Council that decided to implement a hard solution (concrete channelization of stream) further upstream instead of supporting the local initiative. Council decision undermined the local initiative and also the investments made by NRM organisation to improve water quality through riparian vegetation.
  - c. Rather than create new legislation, enforce existing legislation within government and in the public especially those that deal with impacts of population growth, coastal development and aquaculture runoff on habitat loss. Mackay Regional Council should also increase resources to compliance and enforcement. It is important to identify how State and Council could better work together in terms of jurisdictions so that resources for compliance are optimised. For example, Council sometimes is better positioned to check compliance of State developments, but Council has no jurisdiction on State developments (e.g. roads).
  - d. Improve connectivity within the Mackay catchment. Council can commission studies to identify the type of bund walls and the need to improve connectivity through fish passages using basin assessments. Offsets can be used to address lack of connectivity through fish passages due to construction of bund walls and also to maintain mangrove community links to improve connectivity along the coastal and estuarine fringe.
  - e. Apply more widely existing urban design principles and soft solutions to reduce impacts of population growth/development on habitats. It can, for example further use the Internal WSUD working group in Council to identify problems and how they will be addressed in terms of better understanding effectiveness of wetlands, bio-retention, sediment basin, grass swales, grass pollution traps (GPT), vegetated drains, and establishment of drainage reserves and how to implement these actions in the Mackay region
5. Coordinated Education Campaigns. In the Mackay region, careless attitudes of some people towards the environment have been affecting fisheries and biodiversity in the coastal zone. Changing behaviour of some Mackay residents, government agencies and industry through educational campaigns is therefore paramount to improve water quality and reduce littering in the region. Council can promote change in cultural attitudes through the following actions:
- a. Educate community about the use of bike paths, walkways and alternative modes of transport as ways of substantially reducing traffic and the need to build new bridges and roads. Council already has a car-pooling system to reduce traffic in the roads that needs to be promoted and further used by the community (<http://www.mackayregioncarpool.org/>)
  - b. Develop an education program to change attitudes of society toward littering. For example, by including littering as an indicator of a regional report card system in the Mackay region. A regional water quality report card would be a valuable educational material to change cultural



- attitude. Additionally Council can develop signage showing connection of rubbish impact on reef – stencils on drains, green waste signs.
- c. Assign a waste officer to go to schools and organise tours about how the Council manages littering. For example, display litter collected in gross pollutant traps and display information about how rubbish is recycled in the Mackay Libraries.
  - d. Undertake education campaigns within different sections of the Mackay Council and link to successful programs in other Councils in QLD. Such campaigns should focus on education of Council staff about successful systems used elsewhere (e.g. Brisbane/Gold Coast), such as Water Sensitive Urban Design<sup>5</sup>, keyline planning<sup>6</sup>, wetlands bio-retention, sediment basin, grass swales, and vegetated drains to improve water quality. Mackay Council have established sediment control measures in the region as part of State Planning Policy and it would be beneficial to improve knowledge about other options available to reduce sediment runoff from development. Council should also promote education of compliance staff as they must be educated and diplomatic when dealing with the community. This is important because most people comply with legislation and courteous behaviour provides greater support of compliance activities. It is also important to promote compliance officer training in the legislation they are enforcing.

## In summary

Regional input is crucial to the effective management of the coastal zone of Mackay. To achieve this, direct actions to minimise littering, sediment/nutrient runoff from development and to control pests are essential. Improved resource management and educational campaigns are also critical to support stakeholder engagement, improve compliance and change behaviour of some Mackay residents. Some of these will require further resourcing, but others are more about being more cognisant of regional issues and benefits.

A key finding of this project is that, although much action is already been undertaken, further on-the-ground work is still needed and Mackay Regional Council can support on-the-ground initiative to deal with multiple-use management in the coastal zone. The overriding view is that much of the legislation, plans and strategies are in place; however, there is room for improvement in the areas of implementation, compliance and education.

Regards,

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<sup>5</sup> Water Sensitive Urban Design (WSUD) is about integrating water cycle management into urban planning and design. It looks to manage the impacts of stormwater from development.

<sup>6</sup> a technique for development of urban and rural landscapes that considers the topography to build infrastructure (hard or green) to maximise the beneficial use of water resources.

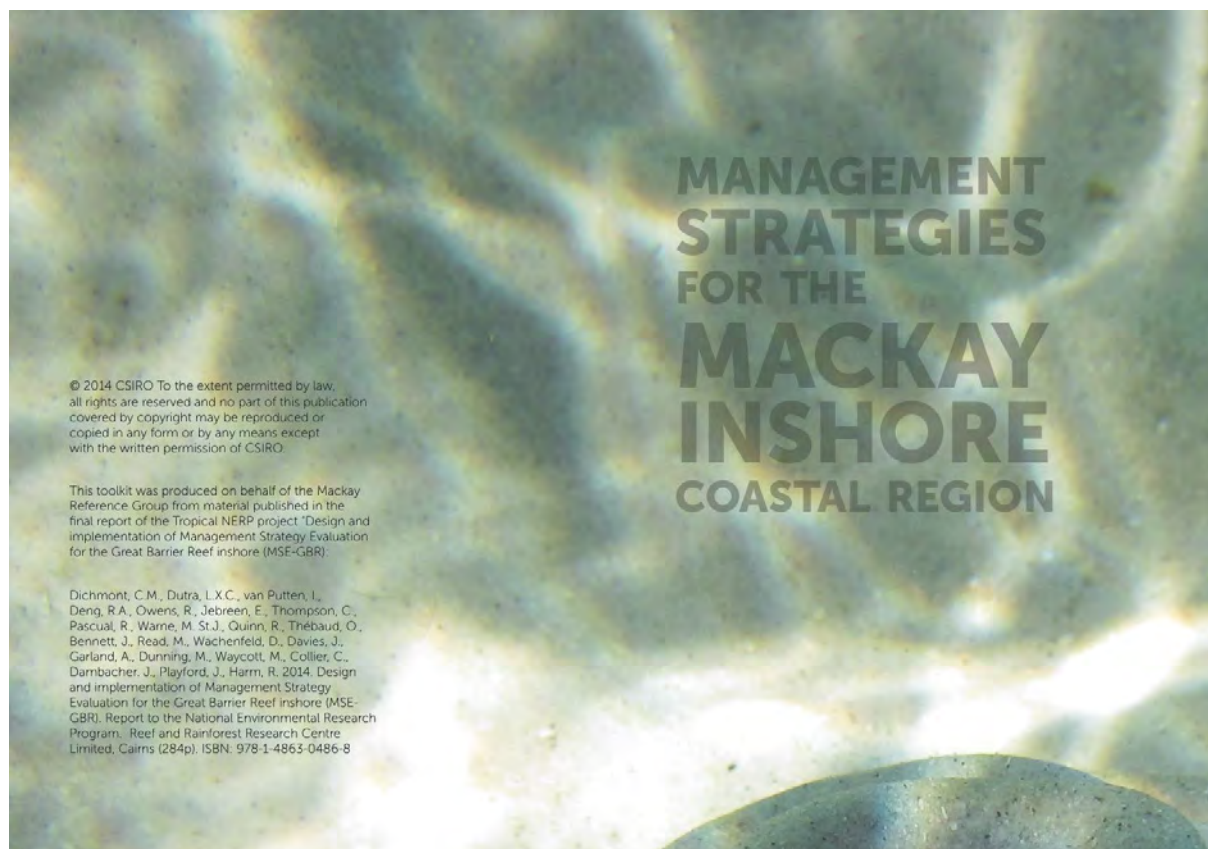
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## Management strategy cards

# MANAGEMENT STRATEGIES FOR THE MACKAY INSHORE COASTAL REGION

Supported by the Australian Government's  
National Environmental Research Program  
Project 9.2 Design and implementation  
of Management Strategy Evaluation  
for the Great Barrier Reef inshore (MSE-GBR)



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Dichmont, C.M., Dutra, L.X.C., van Putten, I., Deng, R.A., Owens, R., Jebreen, E., Thompson, C., Pascual, R., Warne, M., St.J., Quinn, R., Thébaud, O., Bennett, J., Read, M., Wachenfeld, D., Davies, J., Garland, A., Dunning, M., Waycott, M., Collier, C., Darnbacher, J., Playford, J., Hamm, R., 2014. Design and implementation of Management Strategy Evaluation for the Great Barrier Reef inshore (MSE-GBR). Report to the National Environmental Research Program. Reef and Rainforest Research Centre Limited, Cairns (284p). ISBN: 978-1-4863-0486-8

## INTRODUCTION

The inshore zone of Mackay contains key habitats that support biodiversity and fisheries, benefiting the local economy and community lifestyle. Cumulative impacts from mining, ports, agriculture and urban development influence habitats, and if not properly managed will cause adverse social and economic consequences.

This project has developed a Management Strategy Evaluation (MSE) framework with a community group and the Local Marine Advisory Committee (LMAC) from Mackay. This framework built understanding of the key human uses and drivers of change in the inshore Great Barrier Reef (GBR). Our objective is to inform GBR stakeholders of the likely consequences, costs and benefits of particular management decisions that aim to minimize the impacts on inshore biodiversity and fisheries.

This 4-year project found that, with respect to their coast, communities value their environment very highly, followed by good management, and then social and economic well-being. One key finding of the project is that local people should and can influence the management of their natural resources for future generations. Another finding is that, although much action is already being undertaken, much on-the-ground work is still needed.

## RESEARCH NEED

The management strategies presented in this kit are useful to a range of stakeholder organisations including local, state and federal government bodies, the fishing industry and other sectors, and conservation planners/managers.

These organisations include the Great Barrier Reef Marine Park Authority, the Department of Environment, the Queensland Departments of Environment and Heritage Protection and Agriculture, Fisheries and Forestry, the Queensland Seafood Industry Association and the Mackay Regional Council.

# THE MANAGEMENT STRATEGY KIT

This kit contains 12 cards that showcase the management strategies developed with a community group from Mackay.

Each card represents one of the management strategies, which consists of several actions. The strategies can be each read on their own or together, and are aimed at concerned members of Mackay community and at managers that make decisions in the region.

The overriding view is that much of the legislation, plans and strategies are already in place. However, there is room for improvement in the areas of implementation and compliance. A few people from Mackay are stepping way over the boundaries of acceptable behaviour, and as such it is affecting the community, the environment and government effectiveness and action in on-the-ground activities which are already stretched.

The management strategies address issues ranging from the cumulative impacts of littering, pests and weeds, fisheries management, protected species incidents, dredging, farming and urban and rural developments.

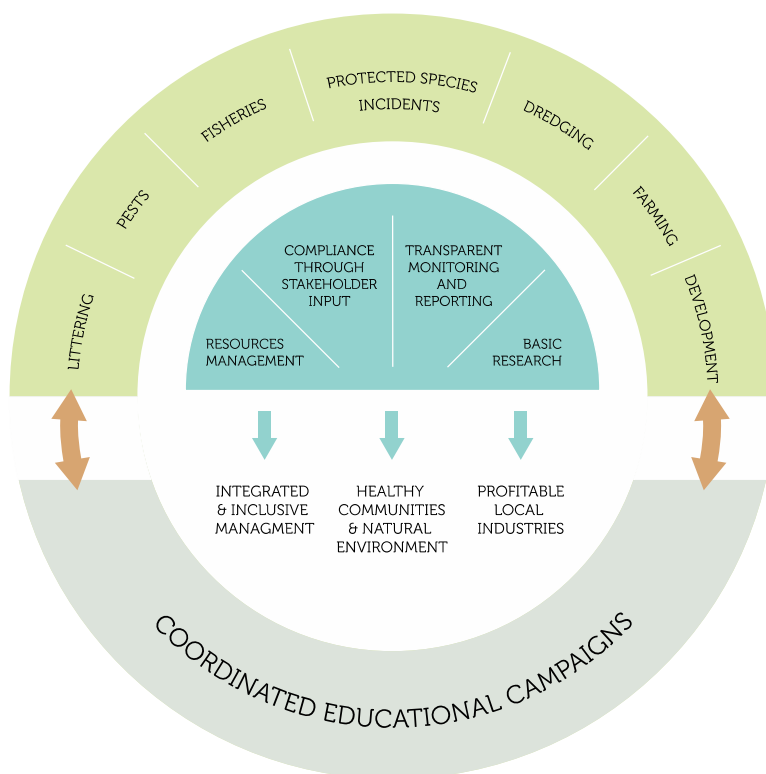
A key underlying theme is that all management actions can give rise to either **direct actions** on individual impacts, such as reducing littering and runoff from farms and development or through responses by means of **indirect actions** such as resource management, added compliance, and basic research.

**Coordinated educational campaigns** targeted at the local community, industries and government agencies is a key action that can help influence positive behaviour and attitudes towards inshore resources in the Mackay region. The final **outcomes** expected from the management strategies are:

- 1 Healthy communities and natural environment
- 2 Integrated and inclusive management
- 3 Profitable local industries

For easier visualisation, we created a diagram to represent the relationships between the direct actions, indirect responses, coordinated educational campaigns and desired outcomes. We like to call it **"THE WHEEL"**.

## THE WHEEL



# HOW TO USE THE CARDS

Management strategies are colour coded and divided in three categories according to **THE WHEEL**.

- **direct actions** in light green
- **indirect responses** in aqua-blue
- **coordinated educational campaigns** in grey

You can choose the strategies that you are interested in based on the colours of the cards.

Individuals and organisations will have different powers and jurisdictional responsibilities/abilities as to what they can do to achieve regional outcomes.

For example, with regards to littering, individuals can participate and coordinate beach clean-ups, with support from industry, government and non-government organisations. However, only Council can implement waste management strategies, but support from the public and industry is important.

Each card describes one of the management strategies presented in **THE WHEEL** and provides information regarding potential actions that can be undertaken to achieve regional outcomes.

This kit is essentially a communication device where the cards can be used as a tool to engage stakeholders to take on-the-ground actions.

**Search through the cards, read the suggested actions and think about how you or your community group can engage in or facilitate one of the suggested activities today!**

# ACKNOWLEDGEMENTS

This work would not have been possible without the incredible input from the **Mackay people**. Most notably, those that helped us tirelessly in Mackay as **members of the Mackay LMAC Reference group**.

Special mention must be made of **Carolyn Thompson, GBRMPA, Mackay**—her involvement and tireless work was probably the most significant factor allowing us to get real local traction.

This research was funded by the Department of Environment; the Commonwealth Scientific and Industrial Research Organisation; Queensland State Department of Agriculture Fisheries and Forestry; the Queensland State Department of Science, Information Technology, Innovation and the Arts; the Great Barrier Reef Marine Park Authority; the Queensland State Department of Environment, Heritage and Protection; and James Cook University.

## BOOKLET PHOTO CREDITS

Pages 2+3: *Light Sand* by Manuela Taboada

## CARDS PHOTO CREDITS

### Littering

*On Shore* by Manuela Taboada

### Pests

*Water Lettuce* by Reef Catchment / Mackay Region Natural Environment

Source: <https://flic.kr/p/c3pnEq>

### Fisheries

*Juvenile Barramundi* by Tim Marsden / Mackay Region Natural Environment

Source: <https://flic.kr/p/c3pj2A>

### Protected Species

*Marine Turtle* by Klaus Stiefel | Source: <https://flic.kr/p/czC21m>

### Dredging

*Dredge Gear* by Snthony DeLorenzo | Source: <https://flic.kr/p/da1a6B>

### Farming

*Sugar Cane Afternoon* ©iStock.com/Tammy616

### Development

*Mackay* by Reef Catchment / Mackay Region Natural Environment

Source: <https://flic.kr/p/c3n4RQ>

### Resource Management

*Sand Treasures* by Manuela Taboada

### Compliance Through Stakeholder Input

*School of Big Eye Trevallies* by Fugmt10 | Source: <https://flic.kr/p/7ofuoh>

### Transparent Monitoring & Reporting

*Searching for Shipwrecks* by NOAA National Ocean Service

Source: <https://flic.kr/p/7pdXCm>

### Investment in Basic Research

*Barriere Riff* by Originalwanna, based on NASA ISS Imagery ISS007-E-14874 |

Source: <http://commons.wikimedia.org/wiki/File:Barriere-Riff.jpg?uselang=en-gb>

### Coordinated Educational Campaigns

*Joint Effort* by Manuela Taboada

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December, 2014

Art Direction and Graphic Design  
Manuela Taboada



**Australian Government**

**Department of the Environment**



National Environmental  
Research Program  
*TROPICAL ECOSYSTEMS hub*





## WHAT CAN WE DO TOGETHER TO MINIMISE LITTERING?

## ■ Implement waste management strategies

Enforce adequate signage on boats and boat ramps on location of rubbish bins and responsible litter disposal.

Encourage green waste recycling.

Reduce plastic bag usage through education campaigns.

Undertake stormwater studies to identify priority areas for Gross Pollutant Traps (GPTs) retrofitting/ installation and build into strategy.

Develop an asset register of GPTs and Water Sensitive Urban Designs (WSUDs), and undertake an analysis of their efficacy.

## ■ Custodianship

Continue promoting attendance at national clean-up days.

Undertake regular beach clean-ups with volunteers and schools to remove litter/debris from the coast.

Continue the GBRMPA Future Leader Eco Challenge program that encourages students to participate in projects about sustainable living and environmental protection.

Promote programs such as 'adopt a beach', for roads, parks, and drains to encourage individuals or groups to regularly clean particular areas in the Mackay region.

## ■ Better design of industrial &amp; government operational procedures

Make the management of littering explicit in industrial management principles and design procedures to reduce littering during activities (e.g. security hats falling during works in the jetty of coal terminal).

Implement procedures found in Water Quality Improvement Plan on managing littering.

## LITTERING

In the Mackay region, littering can be either deliberate (discarding of plastic bottles, cigarette butts, and bags on land and in coastal waters), or as a consequence of careless behaviour (plastic bags flying from boats on rough seas and security helmets and pieces of coal falling into the sea).

Littering affects habitat amenity and impairment, and also leads to deaths of iconic species. Littering occurs because of people's indifference about the effects of littering on the environment. Therefore behavioural changes are necessary to deal with littering in Mackay

On Shore by Manuela Taboada, 2013

## WHAT CAN WE DO TOGETHER TO IMPROVE PEST MANAGEMENT?

## ■ Develop and implement regional weed and pest management plans while learning from existing programs

## ■ Establish pest surveys and monitoring programs

Undertake an analysis of which species occur locally, if they are spreading and to where, and how they are affecting the environment for more effective monitoring.

## ■ Improve soil health by re-using weeds

Replace present weed control with more environmentally friendly methods. For example weeds can be used to re-mineralise the soil (medium to long-term) as most weeds, especially water weeds, are a very beneficial addition to compost.

## ■ Identify and agree on management options to deal with weeds and pests that is supported by cost/benefit analysis

Work with farmers or other land holders to understand how weeds can be managed on their property.

## ■ Decrease use of chemicals

Reduce the usage of pesticides/herbicides.

Follow guidelines from Water Quality Improvement Plan.

Burn the weeds to ashes (peppering) and use the ashes as a spray.

Implement effective biological control, including micro-biotic control—not just bugs.

Understand ecosystem impacts from pest management to identify unwanted flow on effects.

## ■ Work together with GBRMPA and NRM groups to follow established guidelines and management plans

Promote partnerships between research organisations, local universities and businesses to develop and implement strategies to manage pests.

Use a collaborative approach to control weeds instead of blaming another party.

## PESTS

Introduced pests—weeds and animals—affect the abundance and composition of native species, which leads to ecosystem degradation resulting in habitat loss and impairment.

Water Hyacinth by Reef Catchment / Mackay Region Natural Environment  
Source: https://pic.twitter.com/3p1a30



## WHAT CAN WE DO TOGETHER TO ENCOURAGE SUSTAINABLE FISHING?

## ■ Deliver consistent communication campaigns

Re-emphasise existing communication campaigns directed towards allocation issues in the inshore zone using facts about Mackay, the reasons for recreation fishing (enjoyment) and the role of fisheries for the people and the economy.

Link communication strategies between GBRMPA and QDAFF to send consistent and harmonised messages about regulation, management and best behaviour.

Improve targeted advertising on the above fishing messages by getting local support through interviews of local fishers and other community members on local radio programs.

Simplify ID discussions in web sites.

## ■ Improve coordination between local fishers and managers

## ■ Modify compliance risk assessments

Modify risk assessments so that they include local knowledge and environmental characteristics (e.g. seasonality of fishing).

Enhance the Fishwatch hotline so that it links to local offices in time and enhances the DAFF compliance risk assessment in order for compliance activities to be better focused.

## ■ Revisit bag and size limits

Tighten and simplify bag limits especially slot limits for iconic target species in similar groups (e.g. flathead and grunter).

Apply bag limits to the boat not just individuals; for example having a boat limit that is twice the individual limit.

Reduce upper slot size limits especially for king salmon and barramundi.

## ■ Promote flexibility in management to incorporate regional changes in permits, legislation, and zoning for trawling

Move the existing seagrass closure within Hillsborough channel to a nearby site as the seagrass bed has relocated.

Allow local input into management systems through clear and transparent communication processes and representation bodies.

## ■ Tackle illegal fishing

Increase the recreational fishery use fund (RUF) to enforce good rules.

Increase value of fines for illegal fishing so as to create a disincentive to fish illegally.

## ■ Promote environmental branding to sell and market commercial products that are sustainably harvested

## FISHERIES

In Mackay, high numbers of recreational fishers, driven by the mining sector, have increased fishing effort. This growth in number of fishers, combined with greed and disrespectful behaviour of some individuals, has led to unnecessary competition and conflicts between commercial and recreational fishers.

Existing behaviour of some fishers toward each other and the environment has also led to illegal activities by fishers which affect fishery resources and sustainability. The perceived reduction in compliance presence, due to the decrease in the number of fisheries officers based in Mackay, has exacerbated this situation. In addition, some of the existing legislation is inadequate for the appropriate control of some species and habitats, which in combination with illegal fishing activities, increases effort on fishery resources (with negative long-term consequences on fishery resources and sustainability) and degrades coastal habitats in the Mackay region.

The present situation of narrow research funding focusing on iconic species (rather than the broader suite of species of interest to this sector) is also an important issue that needs to be addressed to maintain long-term sustainability of a range of important fishery resources in the region.

The Queensland Government is undertaking a wide-ranging independent review of fisheries management and compliance to deliver a better system for the state's commercial and recreational fishers. It is anticipated that the Government will receive the review in early December 2014.

## WHAT CAN WE DO TOGETHER TO LOOK AFTER PROTECTED SPECIES?

## ■ Trial dugong friendly nets in Dugong Protected Area B

Conduct trials of dugong friendly nets that can inform industry about their use specific to local situations.

Investigate and collate existing industry changes to fishing gear that may already reduce capture of dugongs.

Use Reef Guardian Program to help improve net practices with industry.

Identify champion in local area to trial new gears to reduce deaths of protected species to see what works.

## ■ Trial new propeller designs to protect protected species

Trial folding up propellers—soft plastic propeller designed not to cut animals/people in accidents; won invention of the year prize.

Trial other methods of modification to the propeller to reduce turtle strikes.

## ■ Review the use of offshore gillnet use in Dugong Protected Area B

Especially with respect to bottom set nets and the use of mechanical reels allowing for shorter soak times.

## ■ Use lead core rope and refine float line loop to reduce entanglement potential

## PROTECTED SPECIES INCIDENTS

Mackay is well endowed with a large number of iconic species, many of which are also declared as threatened, endangered and protected. Every year protected species such as dugongs, turtles and dolphins are killed. They can be accidentally caught in fishnets, illegally fished, or stricken by boats, causing loss of biodiversity in the region.

Indigenous fishing of protected species requires further investigation given issues related to (i) non-indigenous people claiming to be indigenous and therefore illegally fishing indigenous resources, and (ii) potential impacts of traditional fishing on stocks.

Marine Turtle by Klaus Stiefel | Source: <https://iucn.org/price/23m>



## WHAT CAN WE DO TOGETHER TO BETTER MANAGE DREDGING?

## ■ Thorough and transparent assessments on locations for dumping spoil

Decision on disposal sites (inshore versus offshore) needs to be transparent to the public and thoroughly investigated.

Investigate alternatives to utilise dredge spoil.

Time dredge operations to make sure it does not coincide with other dredging operations nearby.

## ■ Avoid the need for dredging

Investigate options to avoid/minimise dredging.

Consider costs, location, environment, logistics of alternatives to dredging, such as barge to transport coal to ships.

## ■ Undertake an education and information program targeted at the local community to explain the activities of the Port and how these are being managed

Provide greater transparency to the community by providing greater access to information and data collected by the Port.

Undertake a science program that uses the monitoring data for modelling to investigate Port and cumulative impacts.

## ■ Research into land options for dredge spoil (although local options are limited)

Use modelling and cost benefit analysis to investigate options for depositing dredge spoil on land not in water (e.g. industrial estate in Mackay Harbour).

Investigate the use of spoil to back fill holes from the mines—train is empty on return.

## ■ Apply strategic management control systems to dredge when water clarity is low

Identify a trigger to control how long dredging can run—monitor turbidity while dredging is underway and use data to identify such trigger points.

## ■ Remove the existing window for dredge spoil dumping timing and investigate the optimal window time design that fits the local conditions adaptively but also consider the Port, environment and other users' needs

## DREDGING

Dredging is an important activity to maintain access to Ports, which benefits the regional economy. However, dredging can directly remove species and re-suspend sediments, which increases turbidity, reduces light penetration and impacts benthic organisms (e.g. corals, sponges).

Prolonged sedimentation and turbidity can affect species composition and abundance and may also alter habitats such as coral reefs.

Impacts of dredging can be managed to improve environmental protection and minimise habitat loss.

Dredge Gear by Anthony Delorenzo | Source: <https://lic.kr/p/0a3a68>

## WHAT CAN WE DO TOGETHER TO MINIMISE RUNOFF?

## ■ Improve on-farm procedures to minimise run-off

Provide information on target spraying of chemicals and/or bio-inputs (spray at the right time).

Establish buffer zones in crops to minimise spray drift and investigate the optimal design of such buffer zones, which includes minimal maintenance.

Use nutrient management techniques to manage application, timing and quantity of nutrients in crops.

## ■ Implement the Water Quality Improvement Plan (WQIP)

Use the WQIP as an educational tool to farmers as it provides valuable and clear guidelines, measurements and targets to be achieved, and also potential actions that farmers can use to reduce farm runoff.

## ■ Promote on-farm best practices

Use farm and crop specific tractor traffic management to reduce soil compaction.

Continue to use cane trash blanketing and its conversion to humus.

## FARMING

In Mackay, coastal farming is important. Some farms in the lower catchments are even surrounded by suburbs as Mackay has grown in size. Sediment, nutrient, pollutant and chemical runoff from farms can affect fisheries and biodiversity in the reefs of the Mackay region. In recent years farming practices have improved in Mackay, which reduced runoff to coastal waters, but some on-farm practices can still be improved.

The main causes of farm runoff are: a) the agriculture activity itself which requires land clearing and use of chemicals, and b) lack of knowledge about (i) dosage of chemicals and (ii) on-farm best practices to minimise runoff.

Sugar Cane Afternoon ©Stock.com/Ta



## WHAT CAN WE DO TOGETHER TO MANAGE DEVELOPMENT?

■ **Maintain an asset register for hand-over of infrastructure to Council from developers**

Create an asset register of infrastructure passed on from developers to Council. Developers build infrastructure in new developments to reduce impacts on the environment. After a couple of years developer hand-over this infrastructure to Council who maintains them. At the moment the Council does not have the necessary information to know exactly which infrastructure was passed on from developers and their condition.

Investigate alternatives to maintain infrastructure built by developers and handed over to Council to minimise impacts on ecosystems. An asset register would be beneficial to assist Council to adequately budget to maintain such infrastructure. Ongoing investment in the register is needed.

■ **Target Australian Government water quality initiative program to enhance water quality in waterways of Mackay**■ **Improve knowledge feedback to 'improve' best practices over time**

Understand whether and how practices and ideas from places with different climates could work in Mackay.

Create conditions for groups to share data and knowledge and provide feedback to each other.

Establish research programs based on better monitoring and sampling to identify whether or not management actions are effective. Consider linking with existing surface water quality monitoring program from NQBP.

Identify State Planning Policy objectives that are relevant to the region and investigate how these could be implemented.

■ **Commission flood studies to identify areas at risk and articulate to public for inclusion of local knowledge**

Promote knowledge on the role that low lying flood prone areas play in both the management of flood impacts as well as their environmental importance in ecological productivity i.e. fishery spawning and recruitment.

Consider using freeware tools easily accessible by the community, such as Google Maps and Google Earth, to show areas at risk from floods and inundation.

■ **Use water quality offset contributions to mitigate pollution from developments**

## DEVELOPMENT

Coastal urban, industrial and aquaculture development are causing ecosystem degradation in the Mackay region through sediment runoff and reduction of ecosystem connectivity. There are established and effective practices that can minimise effects of development on ecosystems, but in Mackay wide knowledge about these practices is limited.

Reef Catchment / Mackay Region Natural Environment / JRC 01/13/2014

## WHAT CAN WE DO TOGETHER TO IMPROVE RESOURCE MANAGEMENT?

■ **Improve connectivity within the Mackay catchment**

Identify location and type of bund walls and the need to improve connectivity through fish passages using basin assessments.

Use offsets to address lack of connectivity due to construction of bund walls.

Maintain mangrove community links to improve connectivity along the coastal and estuarine fringe.

■ **Enforce existing legislation**

Within government and in the public especially legislations that deal with impacts of population growth, coastal development and aquaculture runoff on habitat loss.

Increase resources to compliance and enforcement, or provide local input into risk assessments.

■ **Improve decision-making process**

Use fact-based decision-making

Consider local knowledge in decision-making.

Apply lessons learnt from elsewhere such as examples of cost-effective practices from around the GBR that have been known to improve environmental conditions.

Achieve holistic outcomes from actions by considering cumulative impacts (e.g. water quality, aesthetics, biodiversity, economic).

Improve coast-wide understanding of cumulative impacts related to multiple dredging and seasonal river runoff in the Mackay area.

Move towards a code of practice that can be either regulatory or non-regulatory.

Pilot project to demonstrate benefits of WSUD in developments and justify further investments.

Fund the implementation of a monitoring program to measure effectiveness of management actions (e.g. installation of artificial wetlands) aimed at improving, for example, water quality. This will allow management agencies to justify further investments.

Fund and undertake research about alternative solutions to improve water quality and their impacts to support decisions.

## RESOURCE MANAGEMENT

Resource management in Mackay region is challenging because management processes and regulatory frameworks are disconnected and vary between Commonwealth, State and local governments in the Mackay region. Although progress has been made, much improvement is still possible.

Disconnected and inconsistent management frameworks result in multiple and inconsistent approvals for activities, which reduces (i) environmental protection, (ii) fisheries resources and sustainability, (iii) habitat amenity, and (iv) species sustainability, and increases (i) habitat loss, degradation, and impairment, and (ii) death of iconic species.

Reef Catchment / Mackay Region Natural Environment / JRC 01/13/2014



## WHAT CAN WE DO TOGETHER TO IMPROVE COMPLIANCE?

## ■ Enforce existing rules/legislation

Ensure compliance risk assessments include local knowledge on key compliance priorities across all fisheries in the region.

Identify how State and Council could better work together in terms of jurisdictions so that resources are optimised. For example, Council sometimes is better positioned to check compliance of State developments, but Council has no jurisdiction on State developments (e.g. roads).

## ■ Increase the number of compliance staff in State Government

Direct funds from other areas to increase number of compliance staff in State Government. In Queensland State it is not possible to have self-funded compliance staff positions as no incentive-based positions are allowed.

## ■ Increase resources for compliance as a whole, not only number of staff, but also boats, cars, etc.

## ■ Establish and promote a community-based reporting system

Establish a reporting hotline for Council, similar to FishWatch, which could be used for reporting people that do not comply with legislation. The community reporting system can be done via advertisement of hot lines on the council website. This action needs to consider costs of an officer on call after hours (nights, weekends), plus costs associated with mobile phone and maintenance of website compared to the benefit of potentially increased compliance.

Similar to already undertaken by some agencies, publish names of non-compliant people in the newspaper.

## COMPLIANCE THROUGH STAKEHOLDER INPUT

Existing rules and legislation are effective to deal with fisheries resources, habitat loss associated with fisheries activities, and industrial and coastal development. However, these rules and legislations are not always enforced, which may increase illegal fishing, sale of products on the black market and increase runoff from developments. These illegal activities can affect fishery resources and sustainability, and degrade or impair coastal habitats.

The current small number of compliance staff within governments poses a big challenge to resource and habitat sustainability. For example, illegal fishers follow the movements of compliance staff and know where they are, so they can break the laws without being caught. It is necessary to improve compliance through local stakeholder input on risk assessments so compliance efforts can be better planned and tailored to local conditions even within existing budgets.

School of Big Eye Trevallies by Fugr10 | Source: <https://flic.kr/p/7d1uon>

## WHAT CAN WE DO TOGETHER TO ENCOURAGE TRANSPARENCY?

## ■ Promote information and data sharing with public

Facilitate information and data sharing between industries and with the public so as to improve management of the inshore GBR, to influence perceptions related to development and to support a more evidence-based decision making process. Knowledge sharing should be mandatory and independently managed.

Make data sharing conditional to approval processes. The big problem involved in accessing and sharing data/information from Environmental Impact Assessments and Consultancies is related to IP and commercial in-confidence contracts.

## ■ Establish a report card system for water quality

Use a report card system with clear and consistent methods to support more transparent dissemination of information to the public.

## ■ Understand expectations and public perceptions about coastal issues

Run surveys with the broader community to understand their perceptions and expectations about the coast, for example with regards to the perception of communities in relation to risks of shipping in the GBR.

## TRANSPARENT MONITORING &amp; REPORTING

There are several programs collecting data in the inshore coastal zone of Mackay as part of environmental licences (e.g. air quality and marine data for Port activities) and research. Collecting data is expensive and therefore often subject to IP and commercial-in-confidence contracts, which hinders data sharing between organisations and the general public. Developers are cautious in making data publicly available because it can get 'twisted' or misinterpreted depending on who is doing the analysis.

Most data and information from existing monitoring programs in the Mackay region is not easily accessible by the general public, which causes perception problems about the actual impacts of development in general.

The public needs transparent and coordinated access to monitoring reporting as a way of understanding what the issues really are and their magnitude. This is important in dealing with issues related to multiple and inconsistent approval processes, public perception and misconception, and cumulative impacts.

Searching for Shipwrecks by NOAA National Ocean Service  
Source: <https://flic.kr/p/7d0XCM>



## WHAT CAN WE DO TOGETHER TO STIMULATE BASIC RESEARCH?

## ■ Undertake more basic research on...

Fish aggregation areas (e.g. king salmon)

Species that are not presently iconic or high profile as these are increasingly targeted and little is known about their biology, distribution and the fisheries' catch and effort. These species may become important in the future (e.g. grunter and abalone in WA).

Stocking of marine species and evaluate the role of existing stocking contributions to catch.

Spawning size of the grunter species as they are heavily targeted in North QLD.

## ■ Facilitate a process where local input could be obtained to influence research priorities of the QLD Fisheries Research Advisory Board (FRAB), which needs to consider local views

Write up submissions for next FRAB call, which incorporates local views from Mackay, focusing on the following legislation changes:

- Revisit bag and size limits.
- Tackle illegal fishing.
- Increase the recreational fishery use fund (RUF) to enforce good rules (e.g. enforcement of legislation against illegal fishing activities).
- Increase value of fines for illegal fishing so as to create a disincentive to fish illegally.

## ■ Promote flexibility in management to incorporate regional changes in permits, legislation, and zoning for trawling

Move the existing seagrass closure within Hillsborough channel to a nearby site as the seagrass bed has relocated.

Provide input to reviews that affect the local community to promote the importance of local engagement and regional management in fisheries.

## ■ Fund research to support decisions about how to allocate resources to different sectors and how to realistically apply it

## INVESTMENT IN BASIC RESEARCH

Predicted population growth in Mackay and associated expansion of fish markets (more people buying fish) could threaten fishery resources and sustainability. More coordinated basic research is therefore needed to increase fishery sustainability, but this is particularly challenging because current funding for research is small, highly competitive, and focuses mainly on iconic and high profile species. Basic research on non-iconic species is also important because these may become important in the future.

Barriere Reef by Originalwanna, based on NASA's Image (ISS007-E-14874) | Source: <http://commons.wikimedia.org/wiki/File:Barriere-Reef.jpg?uselang=en-gb>

## WHAT CAN WE DO TOGETHER TO EDUCATE THE COMMUNITY?

## ■ Promote change in cultural attitude

Emphasise that recreational fishing is about enjoyment through, for example, fishing shows and the Reef Guardian program.

Use regional radio for local stories about enjoyment in recreational fishing and importance of commercial fisheries.

Stimulate the use of bike paths, walkways and alternative modes of transport as ways of reducing traffic and the need to build new bridges and roads.

Promote the Council online system already in place for car-pooling: [mackayregioncarpool.com](http://mackayregioncarpool.com)

Develop an education program to change attitudes of society toward littering.

Produce education newsletters and editorials about adequate disposal of litter.

## ■ Educate public, especially youth, about the need for responsible resource allocation

Provide educational material to students from across different domains (engineering, planning, natural resources management etc) on existing understandings about downstream impacts of management actions and their consequences on natural systems; provide case studies of major failures and successes for discussion.

Start education programs at schools about the importance of seafood and fishing.

Educate fishers and the broader community about the need for different allocation for different fishing sectors as a way of reducing competition for fish resources.

Educate the recreational sector and public about the commercial fishery and the extent of fishing controls already in place.

## ■ Create education campaigns to reduce accidental deaths of protected species

Use Reef Guardian program to facilitate education campaign focusing on improved fishing practices to minimise accidental deaths of protected species.

Educate population about new technologies to minimise injury/deaths from boat strikes— such as plastic propellers— and develop a funding program to test these.

## ■ Undertake an education and information program targeted at the local community to explain the activities of the Port and how these are being managed

Provide greater transparency to the community by providing greater access to information and data collected by the Port.

## ■ Integrated educational and communication campaigns using traditional and social media

## COORDINATED EDUCATIONAL CAMPAIGNS

In the Mackay region careless attitudes of some people towards the environment, unnecessary competition between commercial and recreational fishers and unawareness of improved farming practices to reduce runoff have been affecting fisheries resources and sustainability (e.g. buying from black market, excessive fishing pressure and conflicts), and degrading coastal habitats.

Changing behaviour of some Mackay residents, government agencies and industry through educational campaigns supports all management strategies described above and is therefore paramount to reduce conflicts and competition between and within fishing sectors, improve water quality and reduce littering.

Joint Effort by Manu and Roboada

### 13.2.4 DISCUSSION

In terms of obtaining information as to which of the many methods of obtaining survey respondents, word of mouth was a common way that people in Mackay got to hear about the survey (Figure 70). Other successful methods was using email from various interested parties such as within Council and Ports, and conservation groups – in way very similar word of mouth.

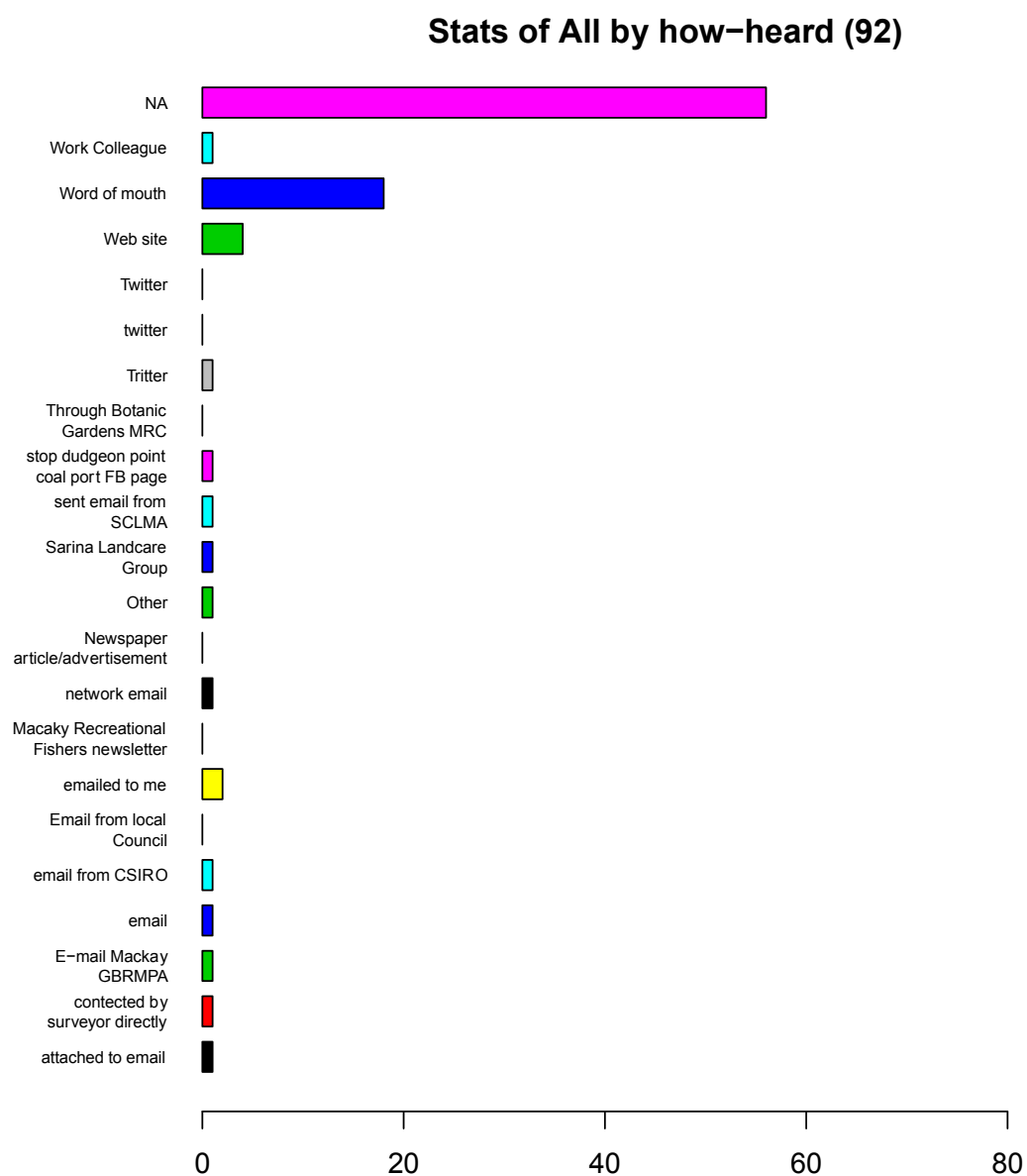
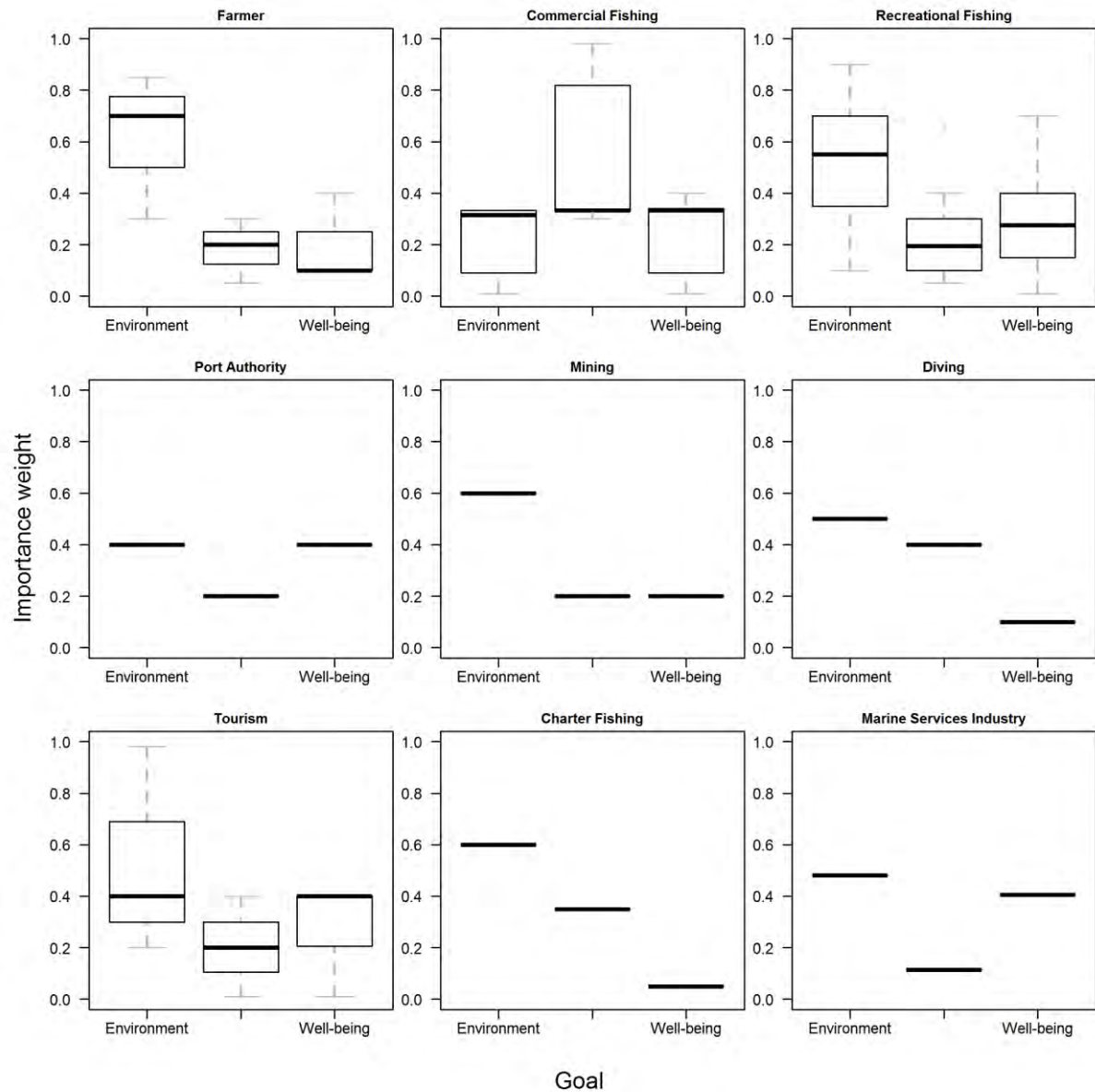


Figure 70. Number of Mackay respondents in the objective weightings survey with respect to how they heard about the survey.

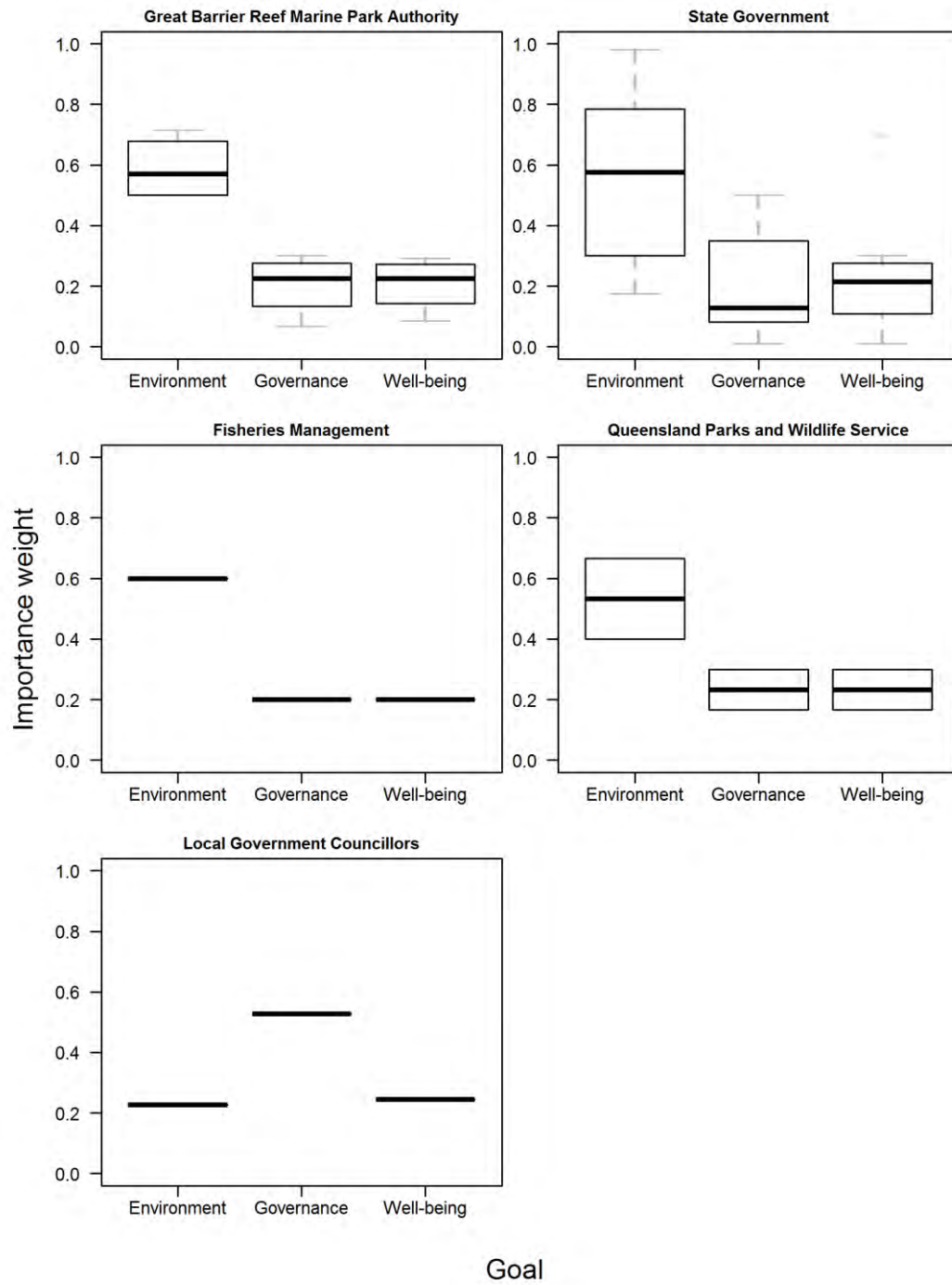
# 14Appendix A: Relative weights of goals per individual stakeholder groups.

## 1. Resource Users

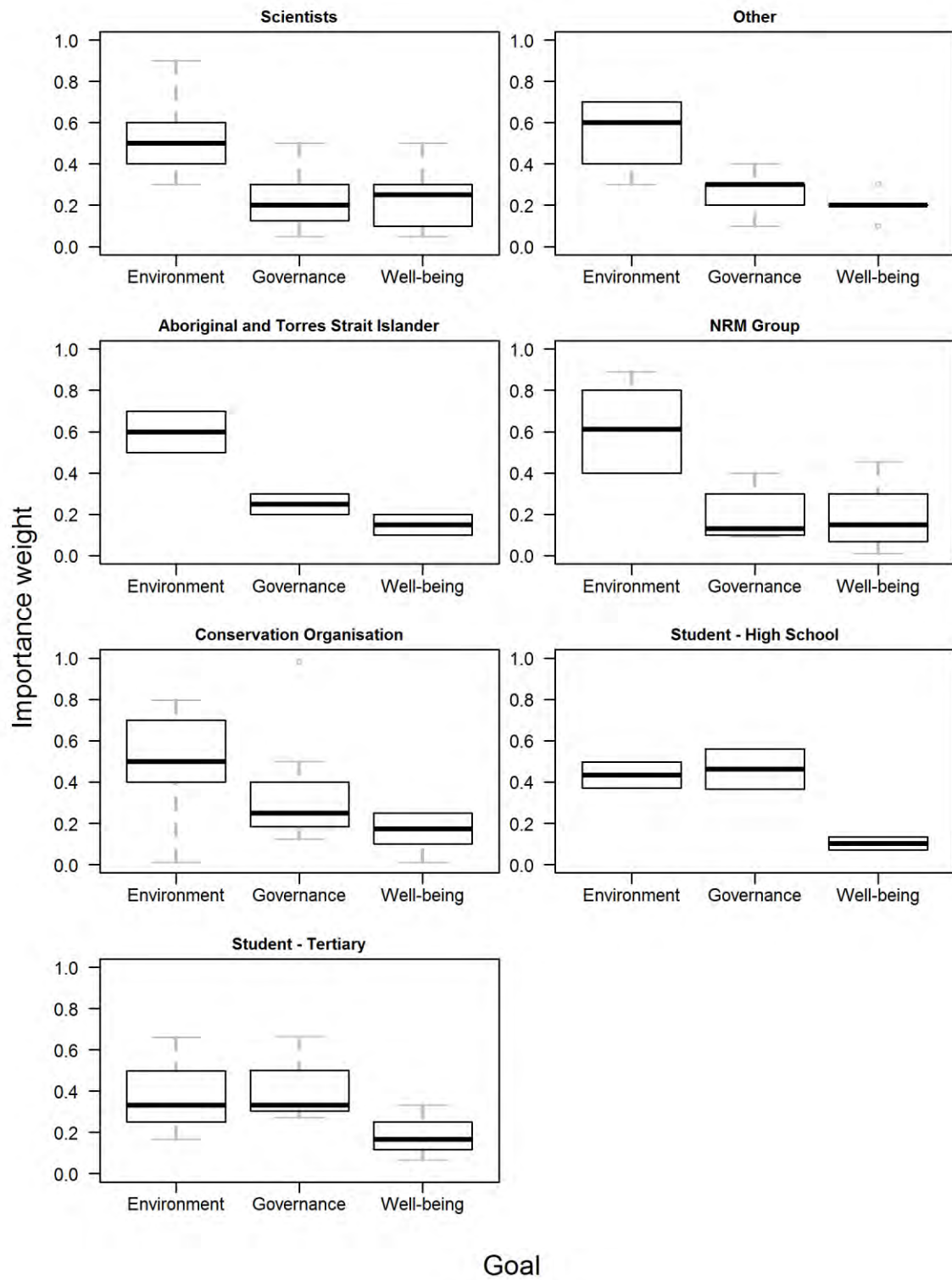




## 2. Government



### 3. Other



# 15Appendix B: Supplementary material of Mackay process

## 15.1 LMAC RG Membership

Table S.1: Membership (without names) of the Mackay Reference Group RG. Those in bold were regular members; others were invited members with few or no attendances

Position/Affiliation
Conservation Volunteers; LMAC member
<b>Great Barrier Reef Marine Park Authority; LMAC member</b>
Councillor Mackay City Council; LMAC chair
Queensland Department of Agriculture, Fisheries and Forestry
<b>Recreation in inshore and offshore; cane farmer; LMAC member</b>
<b>Queensland Department of Agriculture, Fisheries and Forestry</b>
<b>Mackay Turtle Watch Association; LMAC member</b>
Sustainability Officer - Mackay City Council (left Council)
Canegrowers Mackay; LMAC member
<b>Farmer; cattleman; LMAC member</b>
Great Barrier Reef Marine Park Authority
Great Barrier Reef Marine Park Authority
Reef Catchments; LMAC member
<b>Queensland Bulk Ports environmental officer; LMAC member</b>
<b>Retired; Previously - state management roles; recreational fisher; LMAC member</b>
<b>Environmental officer - Mackay City Council</b>
<b>Commercial fisher; Seafood distributor; LMAC member</b>
<b>Great Barrier Reef Marine Park Authority</b>
Queensland Department of National Parks, Recreation, Sport and Racing
Indigenous representative (resigned membership)
<b>Agronomist; LMAC member (recently deceased)</b>
<b>Aquarium trade commercial fisher</b>

## 15.2 Supplementary methods

Table S.2: Example impact assessment scoring sheet for managers' workshop against high-level goals for some of the management strategies

Objectives	Address littering through education, legislation and operating procedures	Develop and implement weed and pest management plans for regions	Education - best development practices	Education - farm best practices	Education - fishery campaign	Education - improving governance	Improve compliance	Improve governance through better planning, assessment and regulation	Legislation changes of allocation and sustainability of fishery issues	Management for dugong
1.1.1 Reduce direct impacts of infrastructure and development										
1.1.2 Minimise human induced changes in water flow regimes										
1.2.1 Ensure Reef Plan water quality targets are met										
1.2.2 Increase feral animal control and environmental friendly weed control strategies										
1.2.3 Reduce influx of pollutants										
1.3.1 Sustainable human use of marine resources										
1.3.2 Maintain habitat function and structure										
1.3.3 Reduce impacts on Threatened, Endangered, Protected (TEP) species										
2.1.1 Remove regulatory barriers to flexibility (alternative harvesting techniques, zoning, diversification in the economy)										
2.1.2 Increase compliance with environmental and resource use regulations										
2.2.1 Increase management acceptability										
2.2.2 Increase stakeholder engagement and community ownership/stewardship										
2.2.3 Sustainable financial costs										
2.3.1 Increase policy integration										

2.3.2 Increase regulatory integration										
2.3.3 Increase implementation integration										
3.1.1 Improve regional economic development and industry diversity										
3.1.2 Improve family livelihoods in the region										
3.1.3 Ensure that natural resource based industries are profitable and sustainable										
3.2.1 Minimise conflicts between stakeholders										
3.2.2 Conserve traditional activities and cultures										
3.2.3 Ensure community equity										
3.3.1 Improve workplace and family health and safety in the region										
3.3.2 Improve education, training, social infrastructure and networks										

<b>Scale</b>	<b>-3: Considerably worse than current situation</b>	<b>-2: Moderately worse than current situation</b>	<b>-1: Slightly worse than current situation</b>	<b>0: Same as current situation</b>	<b>1: Slightly better than current situation</b>	<b>2: Moderately better than current situation</b>	<b>3: Considerably better than current situation</b>
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<b>Confidence score (1-5)</b>	<b>1: Very unsure</b>	<b>2: Fairly uncertain</b>	<b>3: Moderately certain</b>	<b>4: Fairly certain</b>	<b>5: Certain</b>		
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Table S.3: Impact assessment scoring sheet for managers' workshop against high-level goals

Management Strategies	Ecological	Governance	Social	Economic
1. Address littering through education, legislation and operating procedures				
2. Develop and implement weed and pest management plans for regions				
3. Education - best development practices				
4. Education – on farm best practices				
5. Education - fishery campaign				
6. Education - improving governance				
7. Improve compliance by obtaining local stakeholder input				
8. Improve resource management through better planning, assessment and regulation				
9. Legislation changes to allocation and sustainability of fishery issues				
10. Management for protected species				
11. Reduce impacts of dredging				
12. Support, facilitate and coordinate basic research				
13. Transparent (to public) and coordinated monitoring reporting				
Confidence (score 1-5)				

Scale	-3: Considerably worse than current situation	-2: Moderately worse than current situation	-1: Slightly worse than current situation	0: Same as current situation	1: Slightly better than current situation	2: Moderately better than current situation	3: Considerably better than current situation
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Confidence score (1-5)	1: Very unsure	2: Fairly uncertain	3: Moderately certain	4: Fairly certain	5: Certain
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## 15.3 Supplementary results

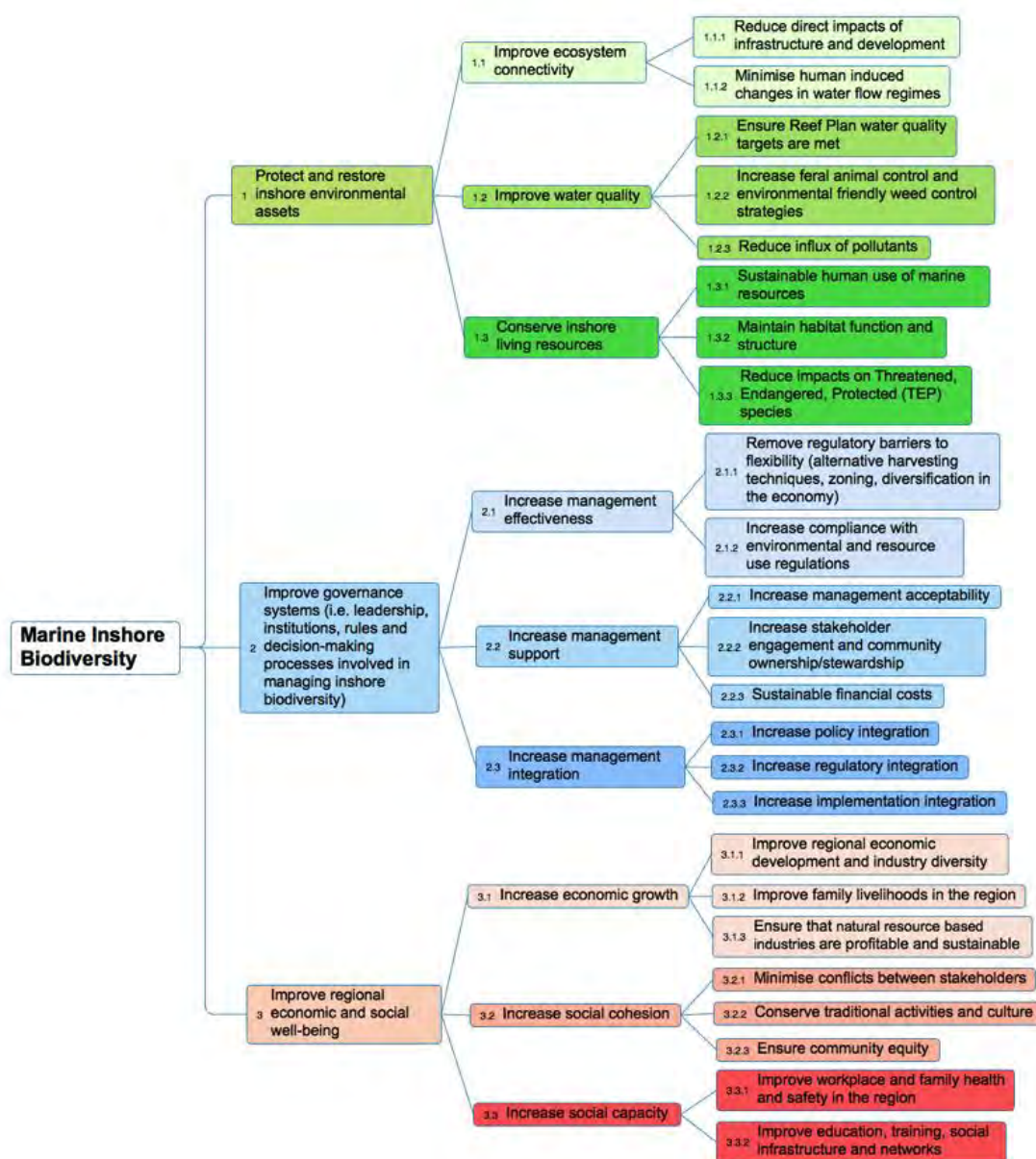


Fig S.1: Objective hierarchy for inshore biodiversity management in the Mackay region, based on input from the Mackay Reference Group and LM AC.

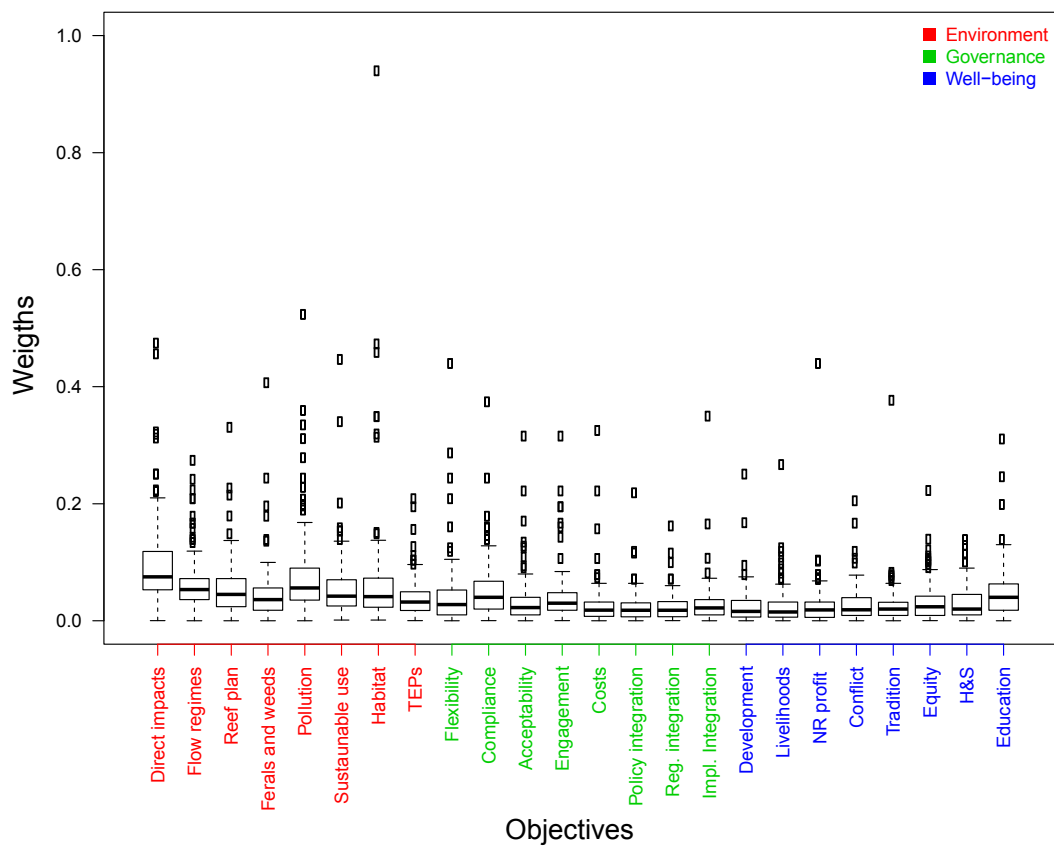


Fig S.2: Box and whisker plot of the objective weighting results from all respondents.



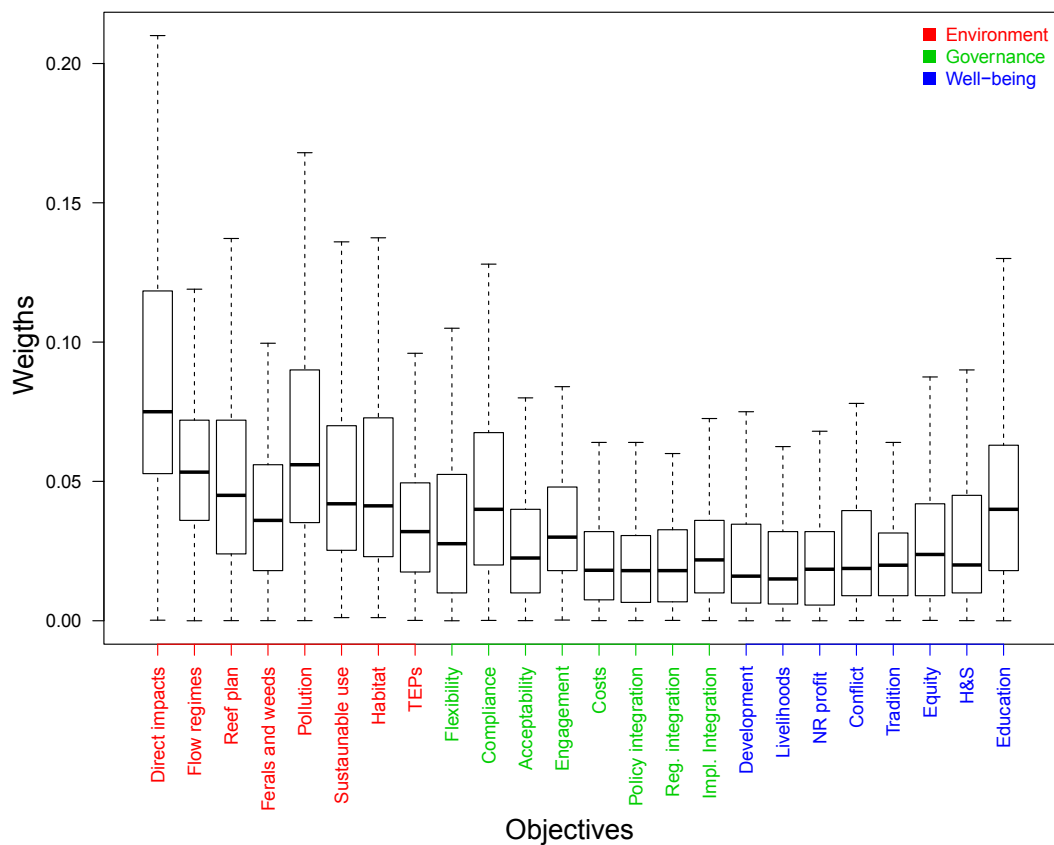


Fig S.3: Box and whisker plot of objective weighting from all respondents but without the extreme value outside the whisker shown, for clarity

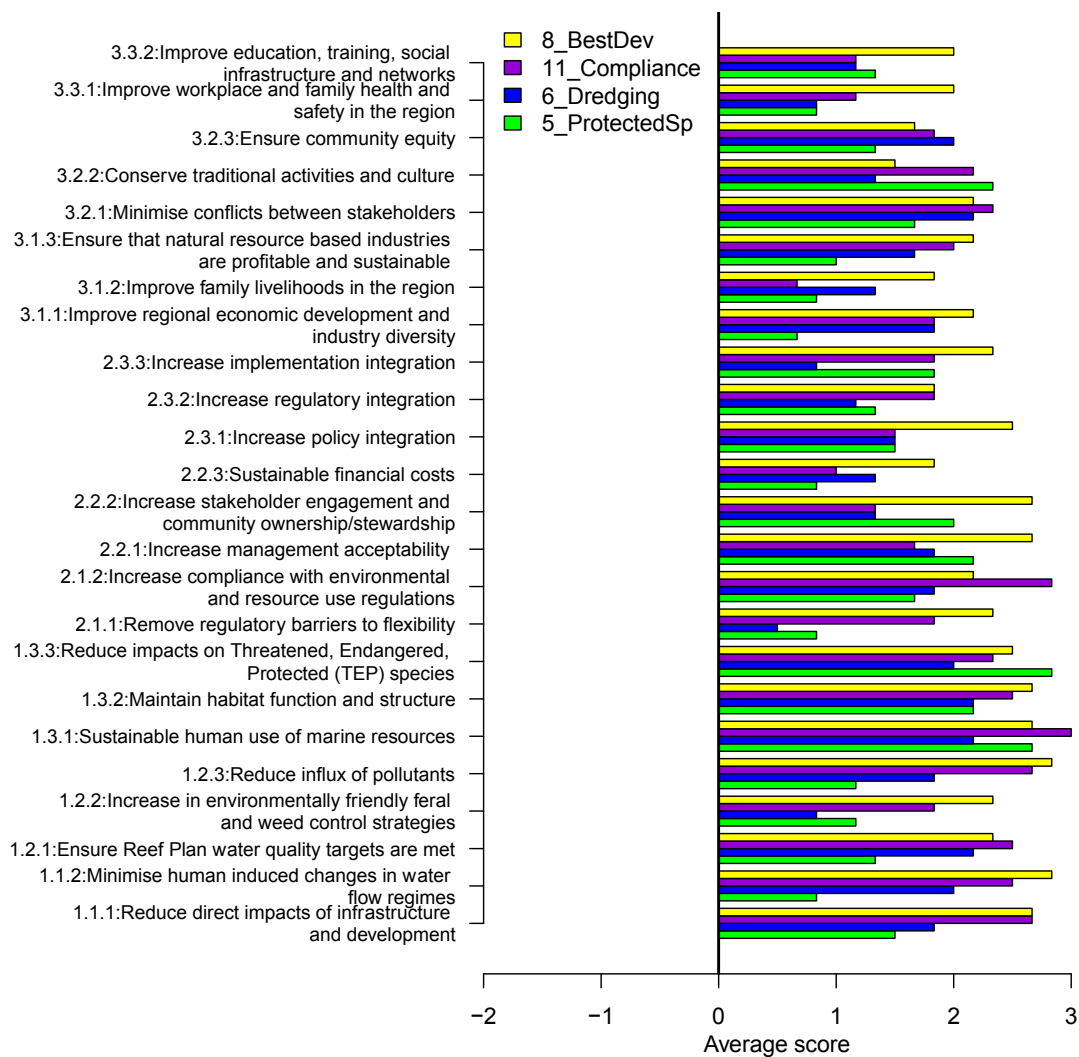


Fig S.5: Average impact score by the RG at objective level for the top two most important and the worst rated management strategies.

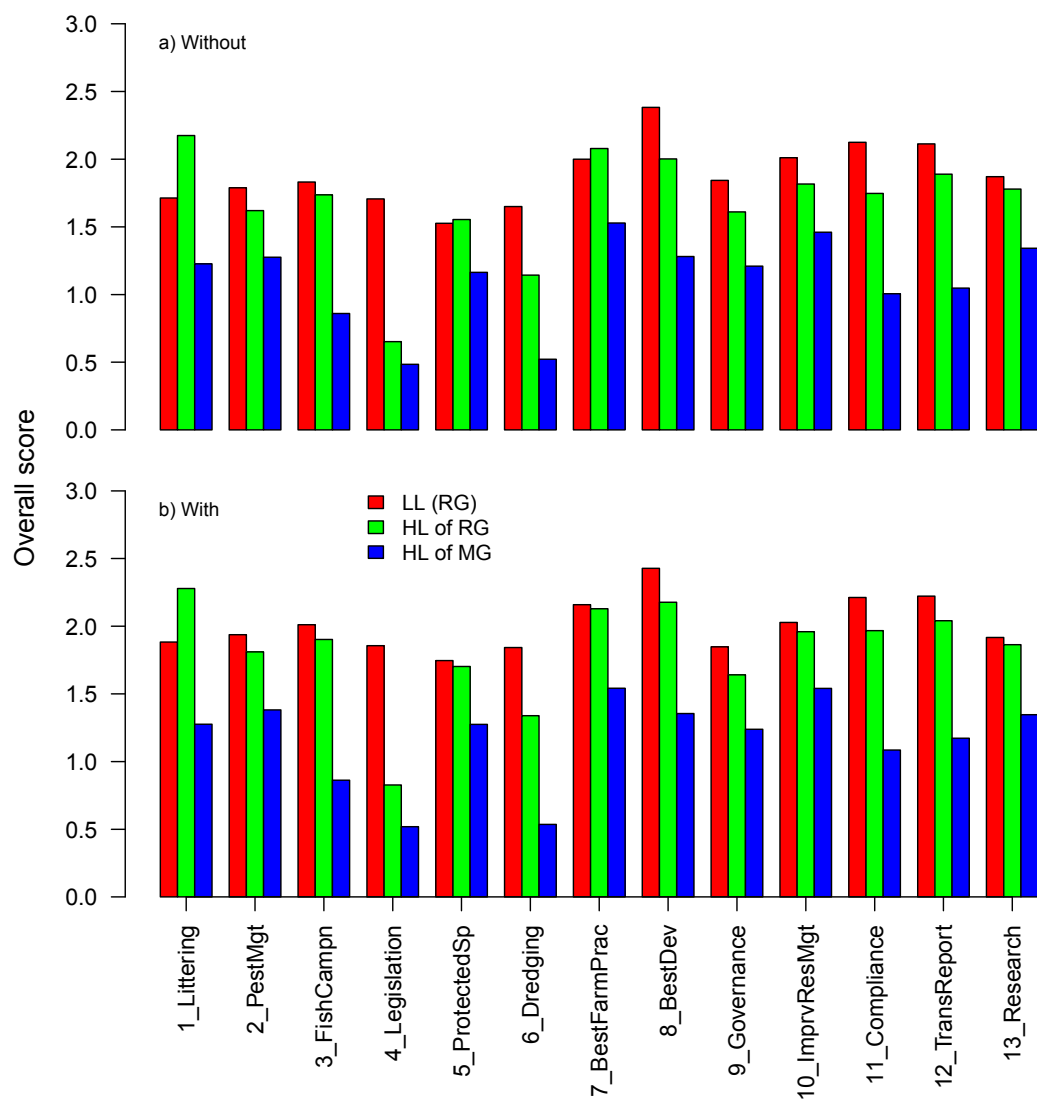


Fig. S.6: Average impact assessment scores (-3 to +3) without considering Confidence scores (top) and with confidence scores (bottom) formed from i) the scores undertaken at the objective level (LL) prior to the management workshop by the RG, ii) the RG scores undertaken at the goal level (HL) at the management meeting, iii) HL scores of the managers at the management meeting.

# 16 Appendix C: Generic survey from generic objectives

## Your details

**Name:**

**Email:**

Please choose the group that you mostly associate with by checking (✓) the appropriate stakeholder group

Stakeholder groups	Please tick ✓ only one
e.g. Commercial Fishing	
Other	

Please indicate the region where you are located

Region	Please tick ✓ only one
E.g. Mackay	
Other	

## High Level Objectives

Please indicate the relative importance of three different high level objectives. The total score should be equal to 100.

Objective		100 points	Explanation of objective
1	Maintain and improve <b>environmental</b> assets		Overarching environmental objective for the region
2	Improve <b>management</b> effectiveness to ensure long term sustainable resource use and availability		Improve leadership, institutions, rules and decision-making processes involving government, citizens, public associations, private businesses, and non-governmental organisation, for the management of ins hore biodiversity and its uses
3	Improve regional <b>economic and social</b> well-being now and into the future		Improve the long-term well-being of the region's people by promoting economic growth, increasing social cohesion and increasing social capital
		<b>TOTAL</b> <b>100</b>	

## Maintain and improve environmental assets

Please indicate the relative importance of three different objectives for protecting environmental assets. The total score should be equal to 100.

Objective		100 points	Explanation of objective
1.1	Improve biodiversity		Improve connectivity between catchment, fresh- and salt-water habitats and reduce impacts
1.2	Conserve coastal living resources and their use		Ensure long-term conservation of the ins hore living resources and their support systems
1.3	Improve water quality and ensure adequate water quantity		Reduce sediment and nutrient runoff into waterways and reefs and efficient water use.
		100	

Objective		100 points	Explanation of objective
1.1.1			
1.1.2			
1.1.3			
		100	

Objective		100 points	Explanation of objective
1.2.1			
1.2.2			
1.2.3			
		100	

Objective		100 points	Explanation of objective
1.3.1			
1.3.2			
1.3.3			
		100	

## Improve management effectiveness

Please indicate the relative importance of three different objectives for improving governance systems. The total score should be equal to 100.

Objective		100 points	Explanation of objective
2.1	Encourage and improve community participation and create co-management solutions		Increase support towards inshore biodiversity management systems through increased management acceptability, increased stakeholder engagement, ensuring that management costs are sustainable and increase compliance with environmental and resource use regulations
2.2	Implement and increase flexible and pro-active approach to natural resource management		Increase the effectiveness of management systems by removing barriers to flexibility
2.3	Increase support for management solutions and increase the effectiveness of management integration		Improve integration of management in policy, regulation & implementation, at Local, State & Commonwealth levels
		100	

Objective		100 points	Explanation of objective
2.1.1			
2.1.2			
2.1.3			
		100	

Objective		100 points	Explanation of objective
2.2.1			
2.2.2			
2.2.3			
		100	

Objective		100 points	Explanation of objective
2.3.1			
2.3.2			
2.3.3			
		100	



## Improve regional well-being

Please indicate the relative importance of three different objectives for improving regional well-being. The total score should be equal to 100.

Objective		100 points	Explanation of objective
3.1	Promote sustainable growth of industry sectors and create local employment		Promotion of regional economic development, including natural resource based industries, to maintain / improve family livelihoods
3.2	Increase social capacity and sense of ownership		Increase social capacity to act, through health improvement and investment in social capital development
3.3	Increase equity and improve access		Increase regional community cohesion through minimising conflicts between stakeholders, conserving traditional activities & cultures and ensuring equitable access to inshore areas and resources
		100	

Objective		100 points	Explanation of objective
3.1.1			
3.1.2			
3.1.3			
		100	

Objective		100 points	Explanation of objective
3.2.1			
3.2.2			
3.2.3			
		100	

Objective		100 points	Explanation of objective
3.3.1			
3.3.2			
3.3.3			
		100	

# 17 Appendix D: Analytical Hierarchical Process (AHP) versus Hierarchical point allocation (HPA)

## 17.1 Introduction

AHP (119) is based up on the construction of a series of pairwise comparison matrices, which compare goals, sub-goals and objectives to one another. The Hierarchical Point Allocation method (HPA) (108, 115) uses a combination of the Point Allocation (PA) (124, 125) method and AHP. The AHP is a pairwise comparison of all combinations at each level of the objective hierarchy. In order to ensure that the responses conform to basic logic (e.g. if  $A > B$  and  $A > C$  then  $C$  can not be greater than  $A$ ), a test for this is required. If the respondents are inconsistent by more than 10% they have to change their score until this value was less than 10%. This conforms to the AHP method.

## 17.2 Method

The AHP method was first tested on a group of scientists in Brisbane. The code was simplified in terms of its look and feel, and was seen as optimal. The RG were asked to undertake the AHP survey.

To obtain the relative importance scores (weighting scores) of the objectives from the Mackay community, the AHP method was used in the early part of the objective weighting survey where a 3-day in person session was held at Mercy College, Mackay. This was to allow the team to get direct feedback from the respondents on how well they understood the survey and whether the use of a computer based system (the AHP was undertaken in Excel™) was a problem.

1. During the first night, the team found that there was strong negative reaction from the respondents about the survey method. The main issue was that the respondents felt the AHP method was manipulating them into providing a result by design rather than using their own original score. Some left the survey incomplete whereas others completed it but felt the score did not reflect their views. The team helped the latter group by enabling them to understand how to achieve their wanted score and remain consistent.
2. A second issue was that the Excel™ platform was perceived as tedious and long-winded. The team also found that the macros did not work on all Excel™ platforms particularly on Apple™ machines.
3. In all cases, the survey took more than 30 minutes, which was reasonable given the size of the hierarchy. However this was still seen as a big commitment.

It should be noted that there were also some respondents that found the survey reasonably easy to us.

The next day the team decided to change the method altogether. Although the PA method is well known, it does have another issues if there are many objectives i.e. that of repeatability (124, 125). Since there were 24 objectives, it was clear that the PA method applied to this survey would likely suffer from lack of repeatability, which means the scores were more reflective of opinions of the person for that moment.

A new method was developed that was a combination of the AHP and PA – called Hierarchical Point Allocation. It uses the PA allocation method (here we used 100 points) but these are applied to each part of the hierarchy rather than only at the objectives level. Mathematically this is analysed exactly the same as the AHP except for the very first step where the comparison scores are turned into a proportion.

A paper version and a web version of HPA were introduced the next few days with great success in terms of respondent's happiness with their scores, their time commitment (about 10 minutes) and the ease of the technology. People were asked whether they would volunteer to also undertake the AHP survey straight afterward. Most understood the mathematical similarity and could transcribe their HPA scores directly into the AHP. This meant they were always consistent. Due to this turn around in the method being widely accepted, all surveys thereafter were this method and technology. This means that the majority of importance surveys were conducted by using this method. To test the second method the RG was asked to complete the HPA paper survey.

This means that in the Mackay region, some respondents did AHP or HPA only and others did both (either directly after each other or with a month gap in the case of the RG), which allowed for in-depth analysis of the two methods. Furthermore, in order to investigate the factors of influence on the survey results and provide more experimental design into the process, extra surveys were conducted internally by a small group of people from CSIRO. Some staff always undertook the AHP before the HPA; whereas others did it the other way. They did not know which sequence they would get before hand. In addition, to test for temporal consistency some staff repeated the same method on the same survey over took.

To be able to compare the results of the two methods, all survey results were collated regardless of the methods used. Each of the survey was scrutinized to identify its respondent, date/time and method used to pair up the groups in three sequences: 1) AHP first and then HPA ("AHP2HPA") next but with a time gap of a few days to a few weeks; 2) HPA first and then AHP immediately thereafter ("HPA2AHP"); 3) AHP to HPA ("AHP2HPA") immediately thereafter.

The following analyses were conducted:

- 1) Boxplot of the importance weighting scores for objectives/ goals in pairs of two methods for each group - looking the patterns similarity;
- 2) Score differences – vertical plots for objectives between the methods for each group – looking at what the differences related to the groups.
- 3) Cumulative score differences for the goals and objectives – looking at the differences related to the groups and sequences of the objectives.
- 4) Variance analysis for all objectives per people by groups – looking at the all the scores variances of the two methods from each participant
- 5) Objective analysis of part of the hierarchy where there was one pairwise comparison i.e. two branches – looking at variances and cumulative score differences
- 6) Three-branch objectives analysis – focus on the objectives which have a three branch structure. Looking at variances and cumulative score differences

- 7) Multiple surveys both with AHP and HPA on single people – looking at the factor of time/date influences
- 8) Multiple surveys with HPA on two people at different time – looking at the factor of time and people influences.

## **17.3 Results**

### **17.3.1 IMPORTANCE WEIGHTING SCORES.**

Figure 71, Figure 72 and Figure 73 show the box-plots of the importance scores for the objectives, whereas group HPA2iAHP exhibits least deviation between AHP. Figure 74, Figure 75, Figure 76 show the box-plots of the importance scores for the goals. These figures show quite consistent results in terms of trends from the weighting scores.

### **17.3.2 IMPORTANCE WEIGHTING SCORE DIFFERENCES BETWEEN THE TWO METHODS**

Three group's results for lower level objectives are illustrated in Figure 77. It demonstrates that HPA2iAHP has fewer differences, which suggests that HPA would be helpful to guide people doing AHP survey without feeling manipulated. Other groups' results show large differences between scores showing that there are contradictory opinions of the same objectives depending on method used. This is most likely because of the difficulties in balancing the scores when doing AHP.

It is possible that sequence of the objectives also could contribute to the differences. The cumulative differences curves for objectives are steep in the beginning and tend to stabilise towards the end of the survey for most of the participants (Figure 78). This might be due to the participants' learning to balance the AHP over time (and therefore objective). However the curves (Figure 79) show that there are fewer differences for the group HPA2iAHP and bigger deviations on the "Governance" and "Well-being" for the other two groups.

### **17.3.3 VARIANCE ANALYSIS CONDUCTED TO LOOK AT THE SCORES GIVEN BY PARTICIPANTS**

The variance in this case represents the range of the scores of objectives for each of participants. Big variance could be due to the participant's extreme opinions on different objectives and also may come from the influence of the different survey platforms. Figure 80 shows the variances of the important scores of all objectives from two survey methods for each of participants. In most cases, the variances from the AHP method are consistently higher than those from the HPA. It suggests that the higher variances may be influenced by the AHP method. Interestingly to see, in the group AHP2iHPA, all variances are lower than other groups. It might be because these group people are mostly scientist and they are more familiar with the methods and therefore less diversified on the opinions to the objectives.

To test whether undertaking the more simpler pairwise comparison in the AHP (which will always be consistent) scores similar to the HPA, a comparison of two-branch and three-branch scores were made. Figure 81 shows the variances of the importance

scores of the two-branch lower level objectives. Most notable are that the values from group of AHP2iHPA almost always have the AHP positive. The cumulative two-branch objective score difference curves (Figure 82) also indicate there are big differences in the group of AHP2iHPA. These results suggest that the AHP is also influential on the scores for two-branch objectives.

Figure 83 shows the variances of importance scores of the three-branch objectives. The variances from AHP look consistently similar to that of the HPA for most participants (with a few of exceptions) and the variances in the group of AHP2iHPA are mostly lower than that from other groups. The cumulative three-branch objective score difference curves (Figure 84) exhibits very similar trends as that for all objectives (Figure 78).

### **17.3.4 TIME FACTOR INFLUENCES ON THE SCORE.**

To test whether time was influential on the scores, Figure 85 shows the results from a suite of surveys on single project member at different time using the different methods. The plots compare the differences between each survey objective score and the mean values of all the surveys within the same methods. Generally, the differences are reasonably small considering the time interval being a day, a week and some more than a month. For HPA method it shows almost perfect consistency whereas AHP drifted over time especially at the beginnings of the objectives. It could be due to the unfamiliarity of AHP platform at start of the use of this method but may also be due to being unclear of the respondent's opinions at the start and these becoming more consolidated with time.

Two people from the project team participated in a series of multiple surveys using the HPA method. In Figure 86, the scientist on the right hand side exhibited a small degree of deviation from mean value of the multiple surveys for the objectives, which suggests the opinions changing following time line, but due to the small degree of differences the results may not be conclusive. On the left panel, the person shows a very consistent and persistent opinion. In general the differences are not considered significant.

## **17.4 Conclusions**

1. It is easier and quicker to fill the survey questionnaire of HPA;
2. There was higher stakeholder trust of the HPA results and balancing the AHP means many people feel they are being manipulated;
3. Technology is easier for HPA whether scoring on paper or using the web form, whereas the AHP required a bit more computer skills especially if balancing is required;
4. No consistent bias in the difference of score irrespective of method or objective;
5. There are consistently bigger score variances for AHP method, which indicate the AHP methods consistently making people fill a bigger range of the scores;
6. Some individuals have different outcomes (even at the goal level) in terms of priorities but there is a smaller difference between the two methods in the outcomes if people do the HPA first;
7. There was no significant influence on the importance weighting scores for either method due whether there were time gaps of a day or weeks among

the multiple surveys experiment; however, the HPA method results exhibit more stable properties than that of the AHP, and the HPA method would be helpful to guide AHP survey.

8. Two-branch objectives comparisons suggest the different scores of the AHP and the PHA was quite similar as no balancing was required for the AHP irrespective of the sequence of methods (AHP2HPA or HPA2AHP). On the other hand, the three-branch objective scoring was much easier with the HPA and resulted in bigger variances with the AHP method. Although variance increases, the relative weighting pattern is not affected as the three-branch results exhibited a similar pattern as that from all the objectives. It should be noted that most of the hierarchy consisted of three branches (18 out of 24) in this case study; and
9. The HPA is a good replacement and for the hierarchy we tested was superior to the AHP. The HPA only is therefore recommended as it is mathematically the same as the AHP, is more accepted, and easier and quicker to undertake).

## 17.5 Figures

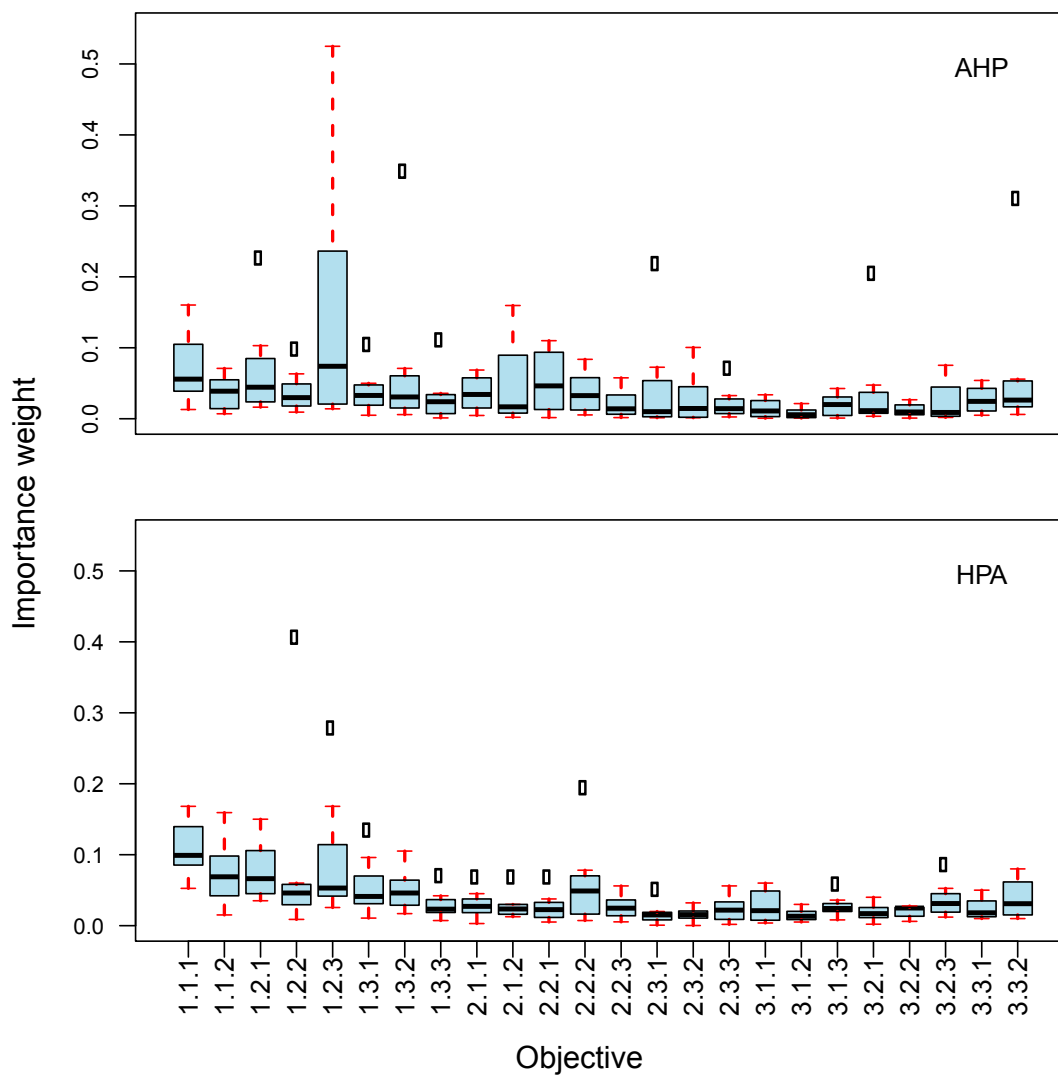


Figure 71: Boxplot of objective importance weighting scores AHP2HPA



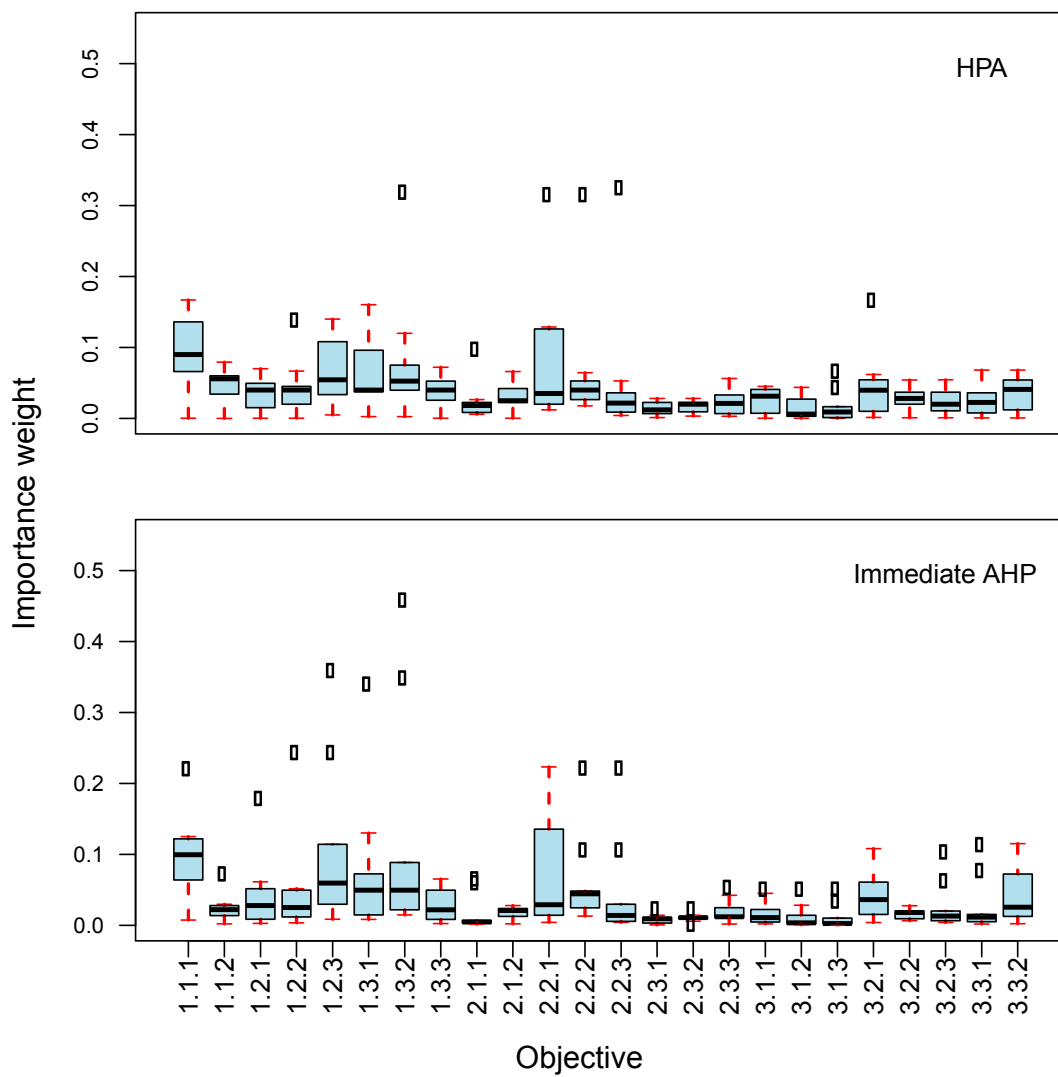


Figure 72: Boxplot of objective importance weighting scores HPA2iAHP

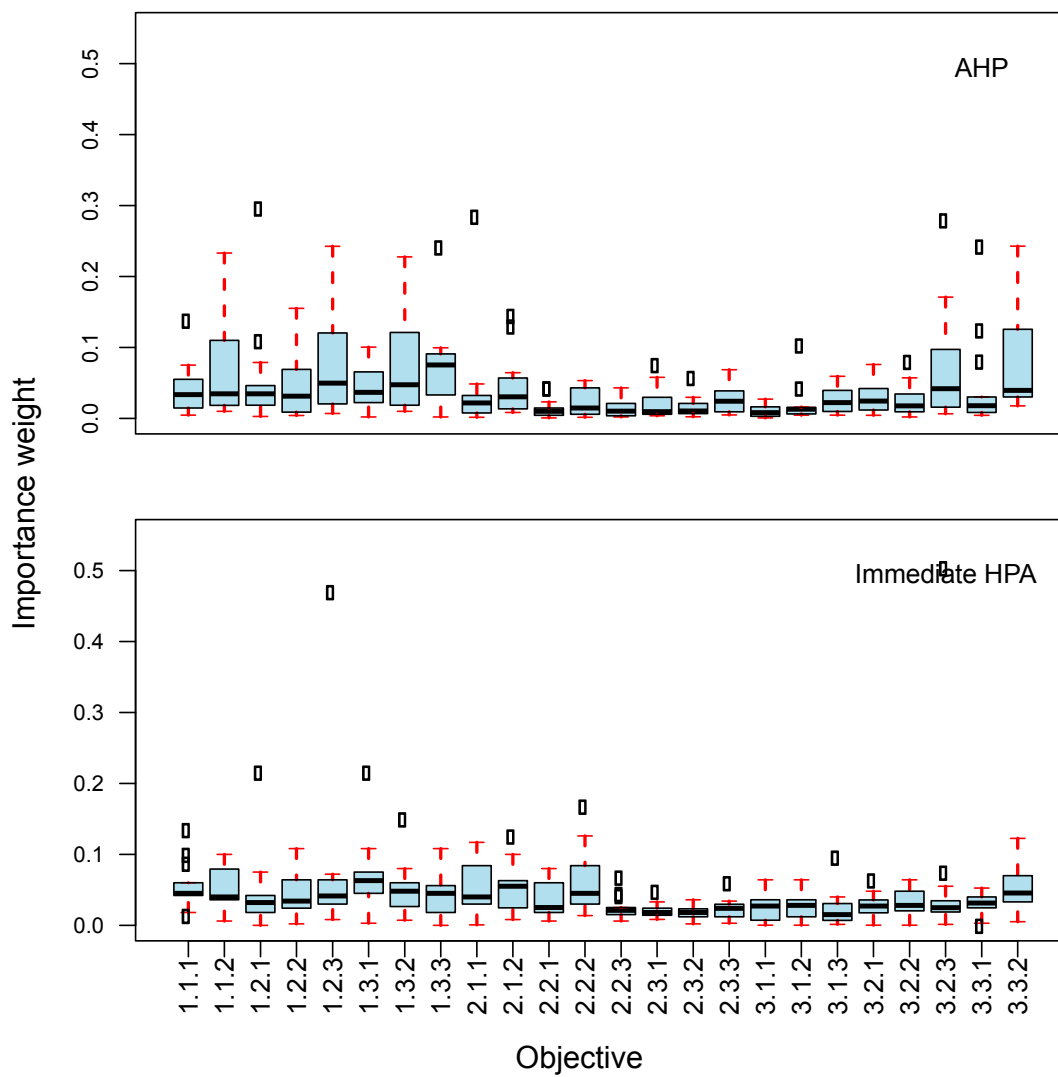


Figure 73: Boxplot of objective importance weighting scores AHP2iHPA

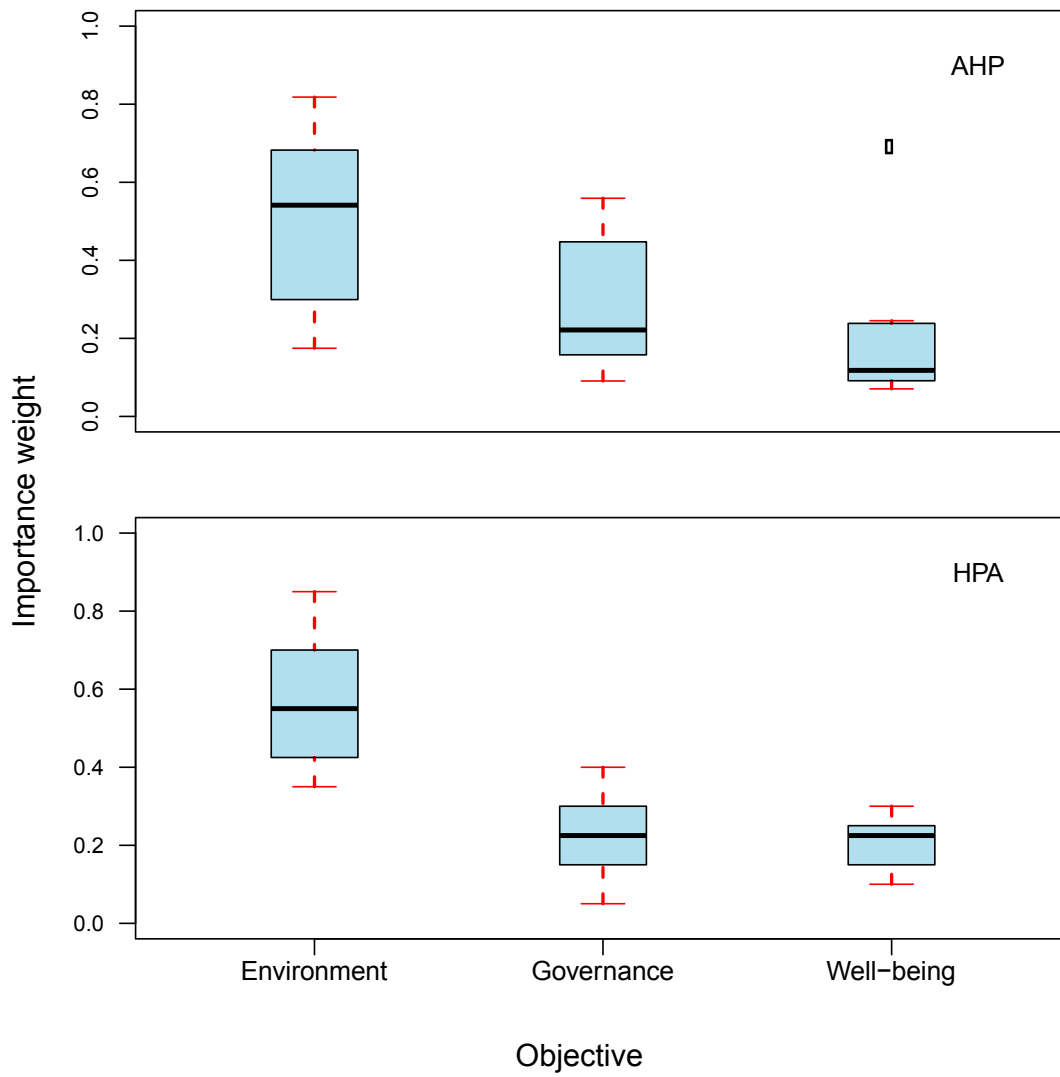


Figure 74:Boxplot of goals importance weighting scores AHP2HPA

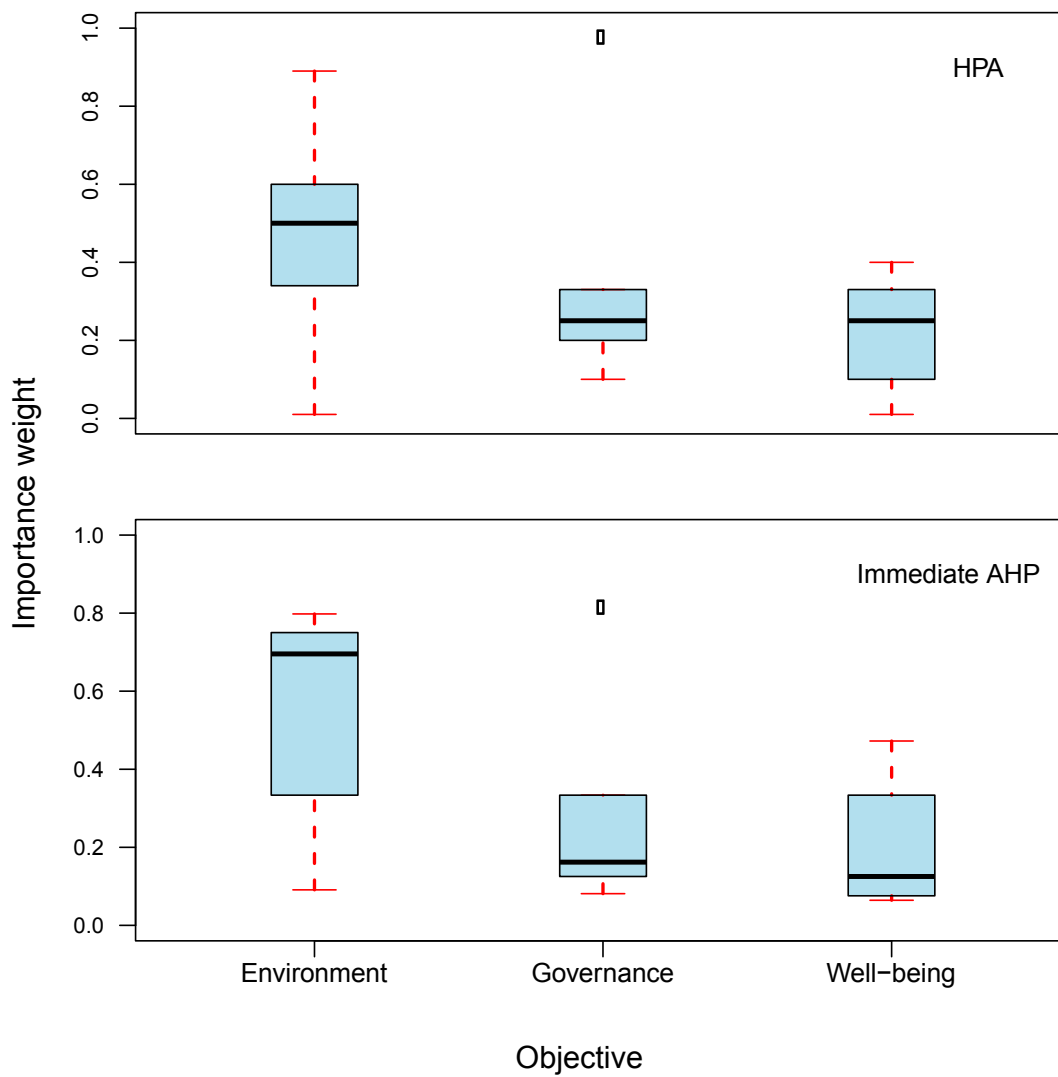


Figure 75: Boxplot of goals importance weighting scores HPA2iAHP

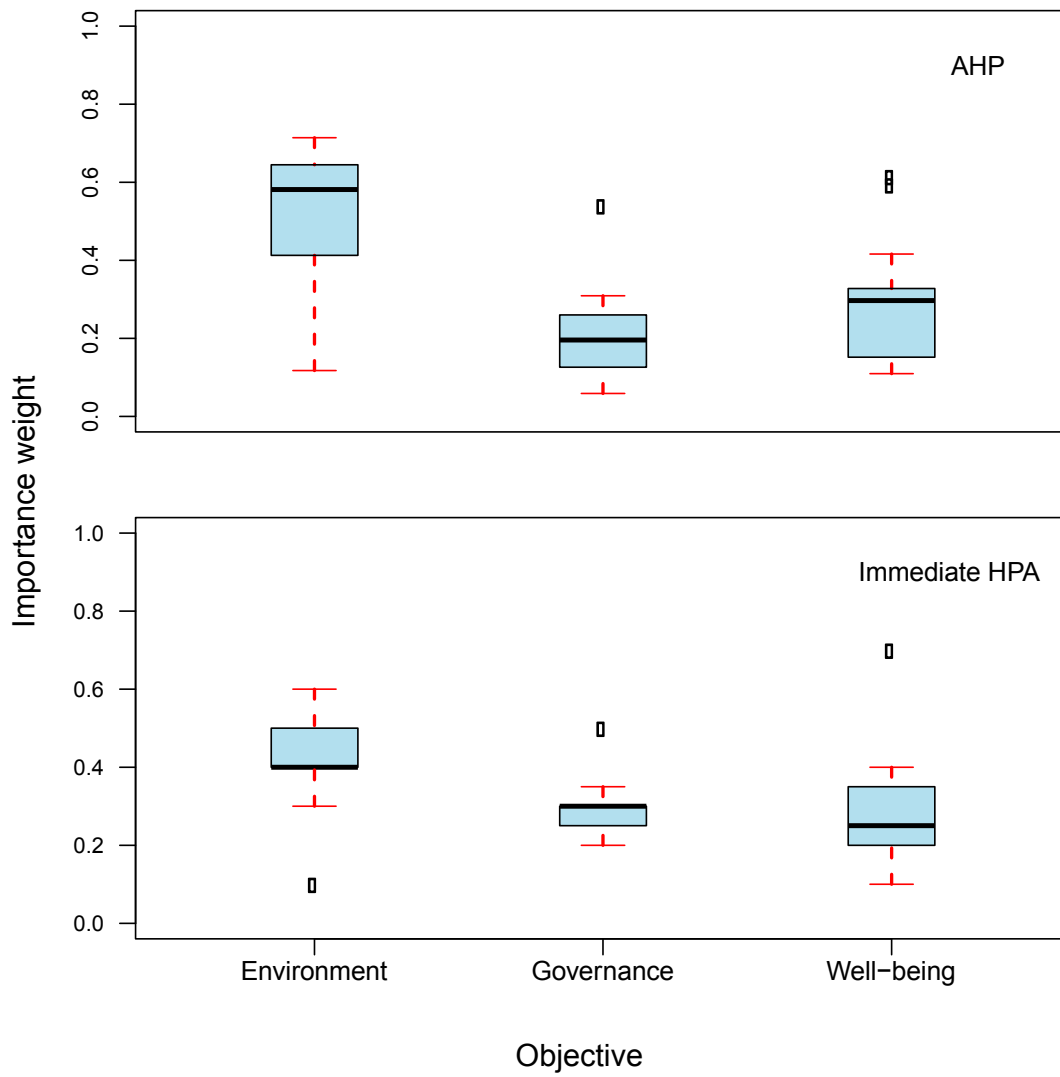


Figure 76: Boxplot of goals importance weighting scores AHP2iHPA

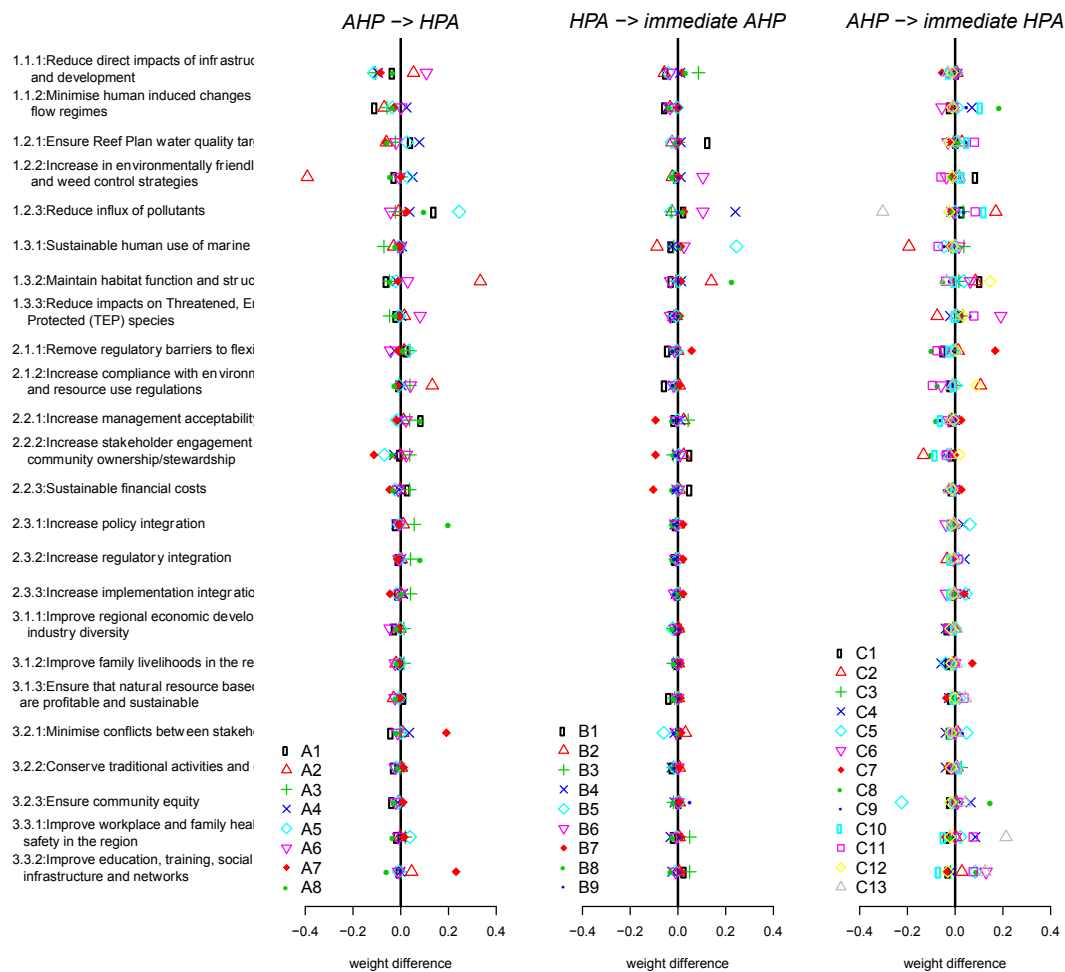


Figure 77: Objective importance weighting score differences ( $W_{ahp} - W_{hpa}$ ) between the survey pairs of 1) AHP2HPA; 2) HPA2iAHP and 3) AHP2iHPA



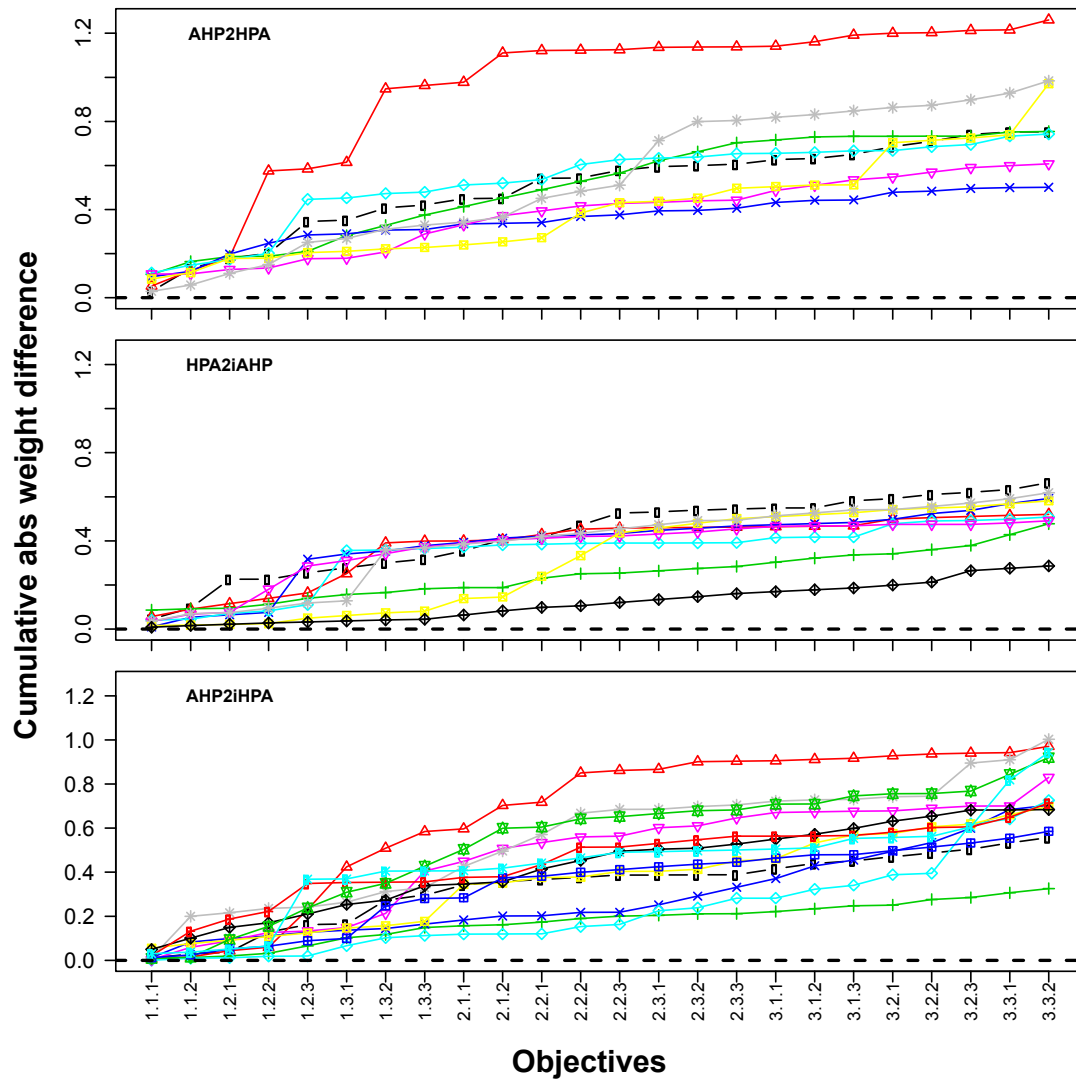


Figure 78: Objective cumulative absolute importance weighting score differences between the survey pairs of 1) AHP2HPA; 2) HPA2iAHP and 3) AHP2iHPA. Colors represent the respondents.

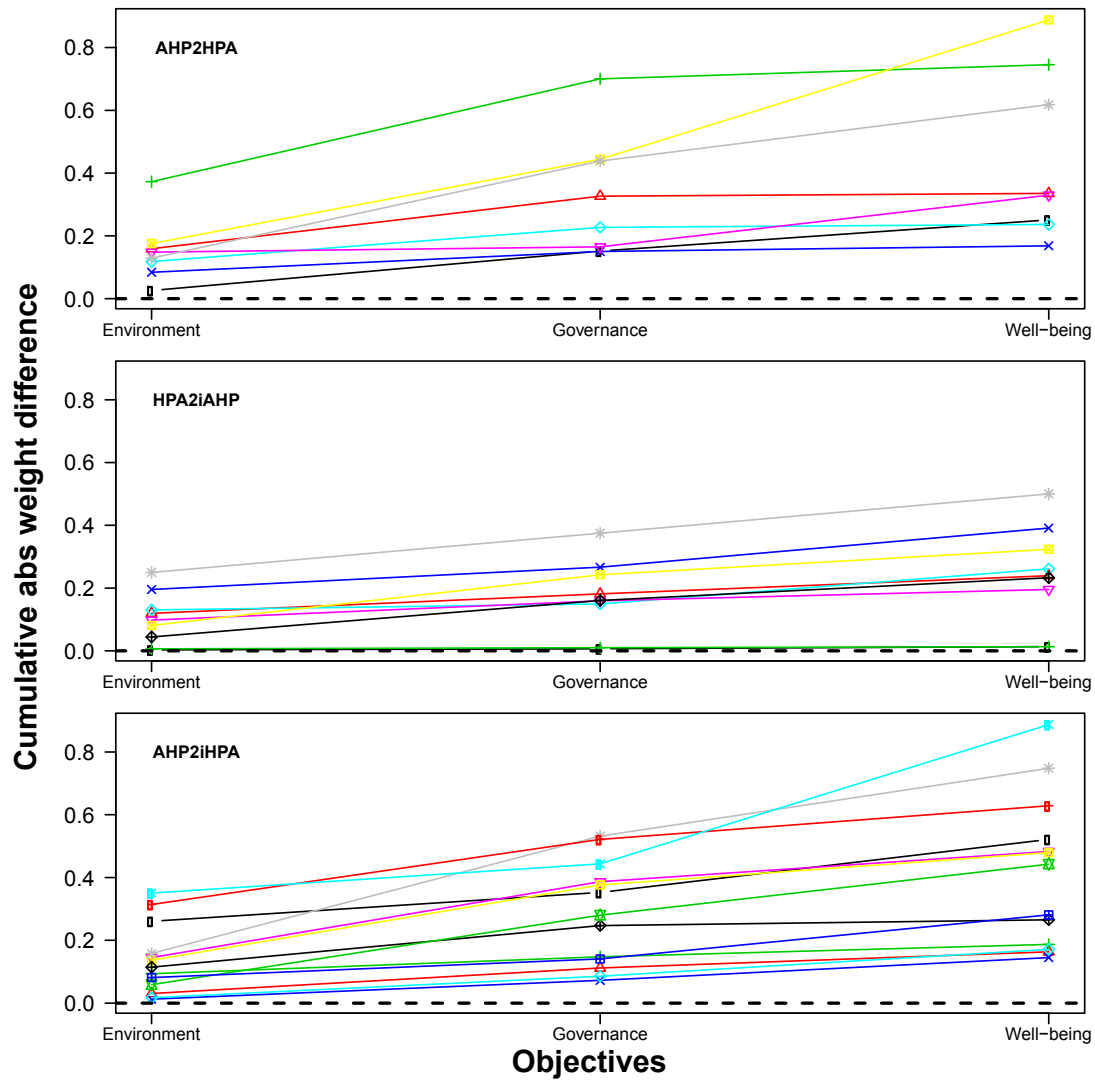


Figure 79: Goal cumulative absolute importance weighting score differences between the survey pairs of 1) AHP2HPA; 2) HPA2iAHP and 3) AHP2i HPA. Colors represent each respondent.

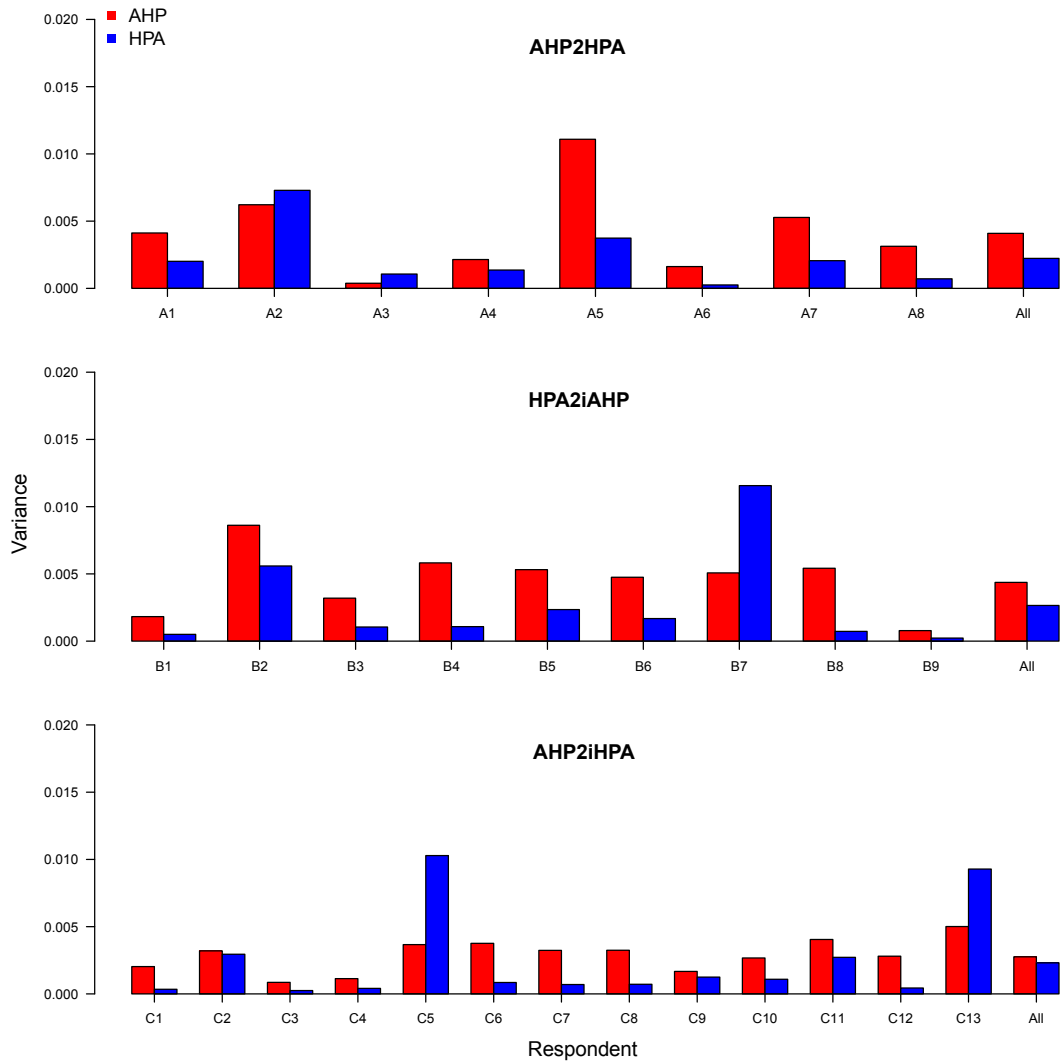


Figure 80: Variances of all objectives importance weighting score against each respondents for the survey pairs of 1) AHP2HPA; 2) HPA2iAHP and 3) AHP2iHPA.

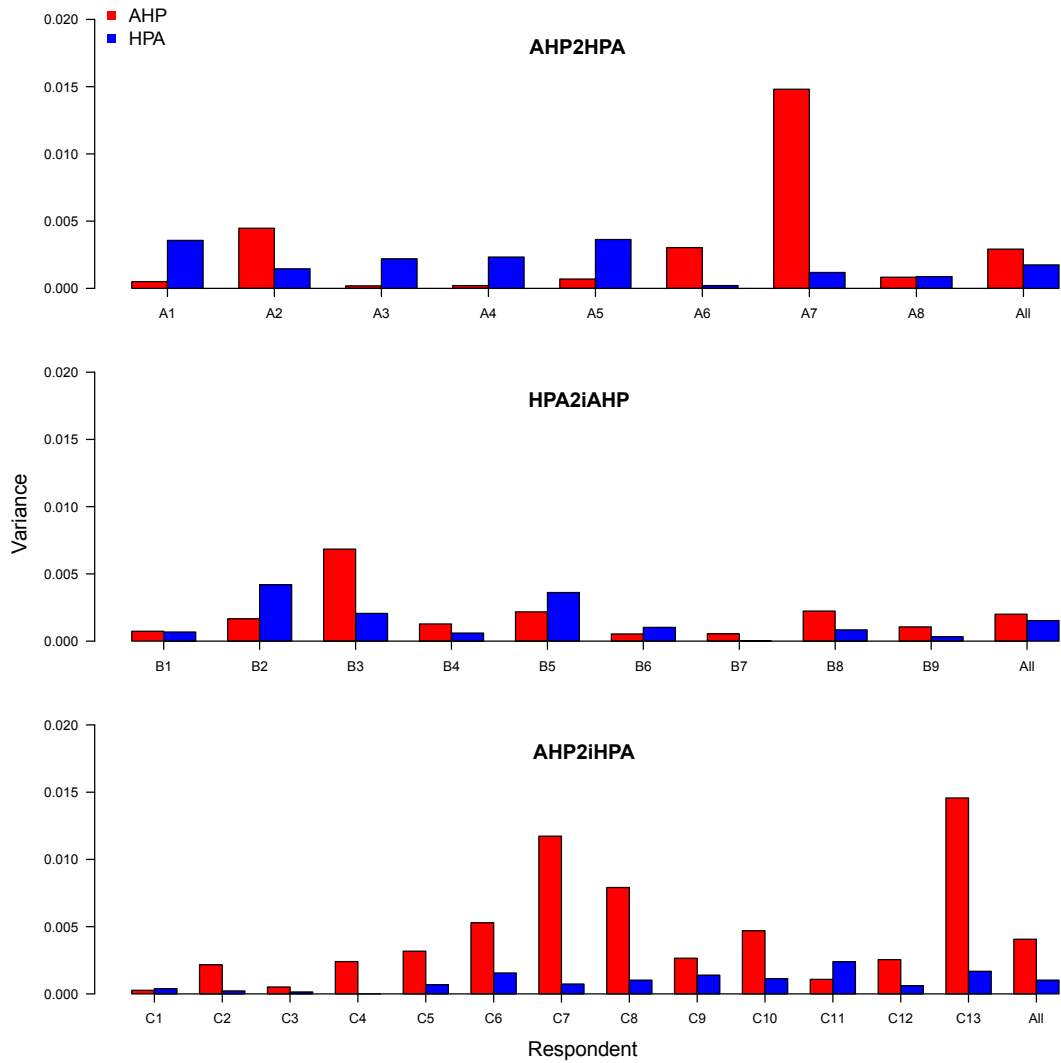


Figure 81: Variances of two-branch objective importance weighting score against each respondent for the survey pairs of 1) AHP2HPA; 2) HPA2iAHP and 3) AHP2iHPA.

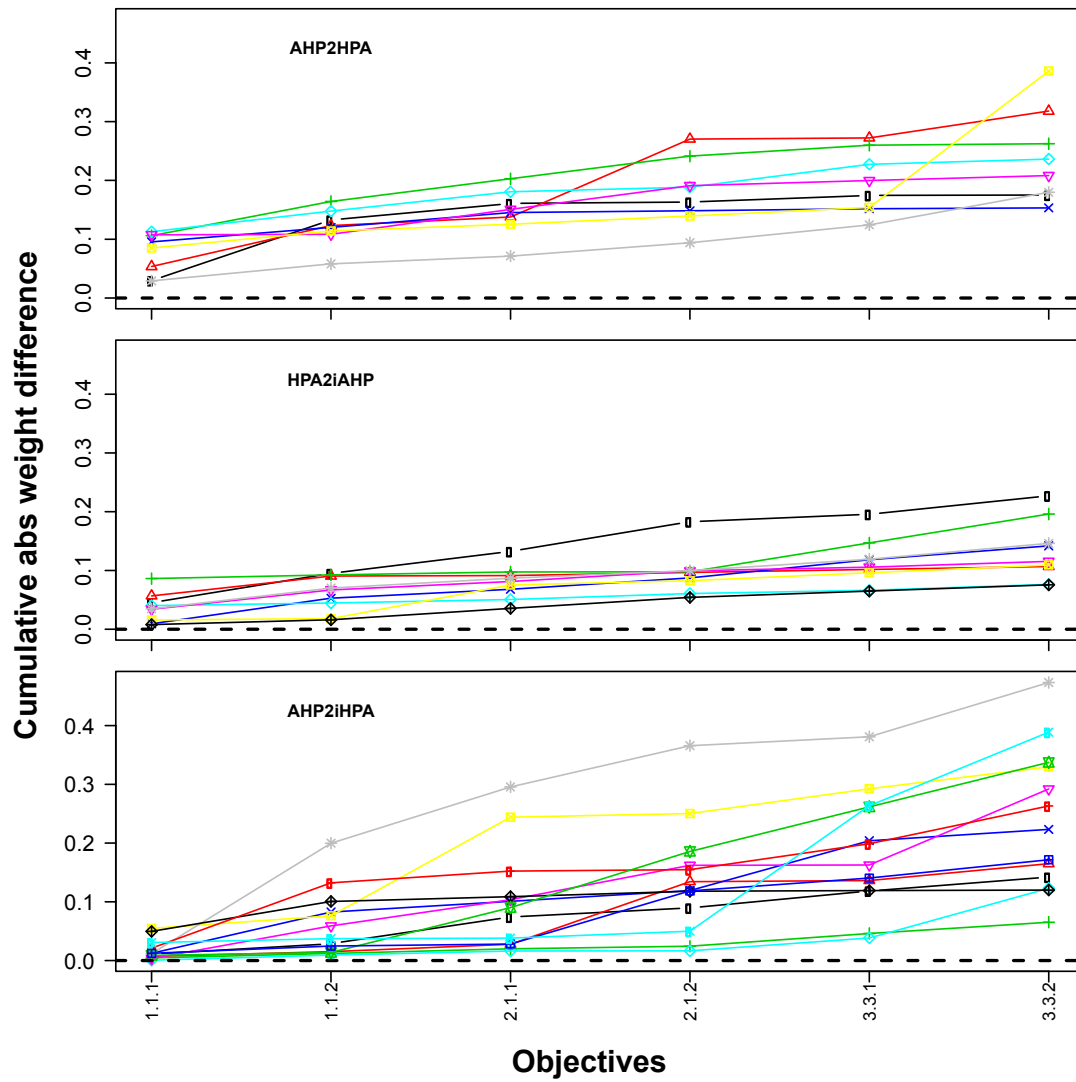


Figure 82: Cumulative two-branch objectives importance weighting score differences between the survey pairs of 1) AHP2HPA; 2) HPA2iAHP and 3) AHP2iHPA.

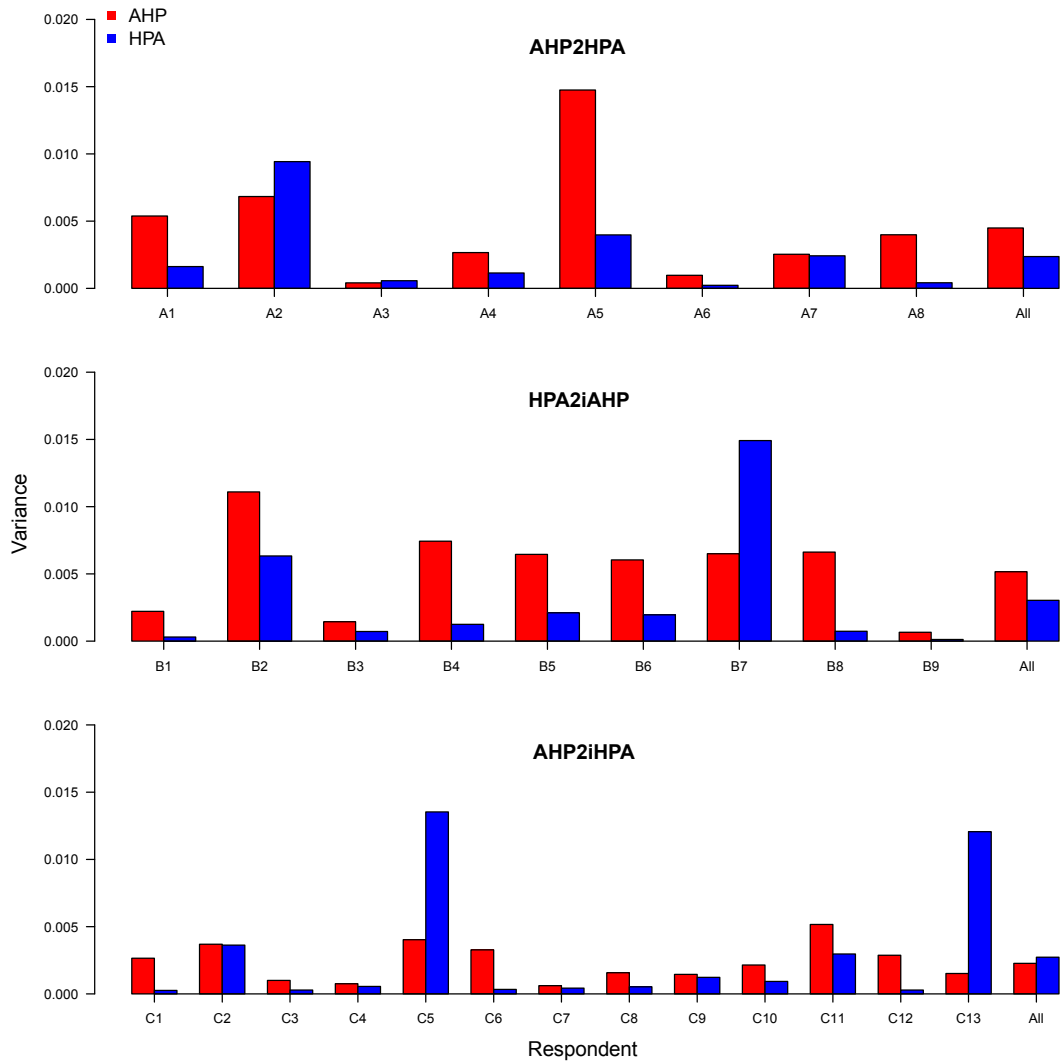


Figure 83: Variances of three-branch objective importance weighting score against each respondents for the survey pairs of 1) AHP2HPA; 2) HPA2iAHP and 3) AHP2iHPA.



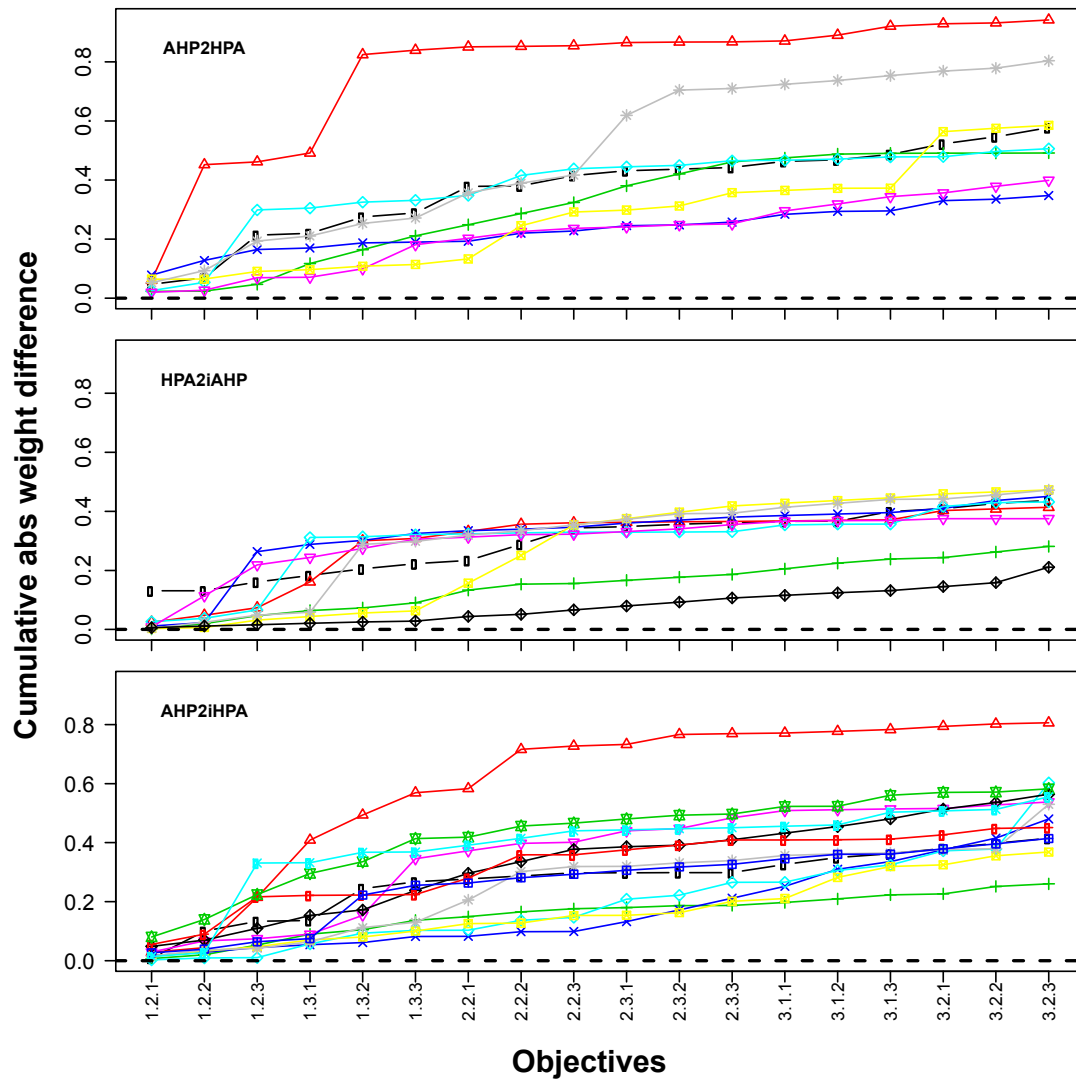


Figure 84: Cumulative absolute three-branch objectives importance weighting score differences between the survey pairs of 1) AHP2HPA; 2) HPA2iAHP and 3) AHP2iHPA.

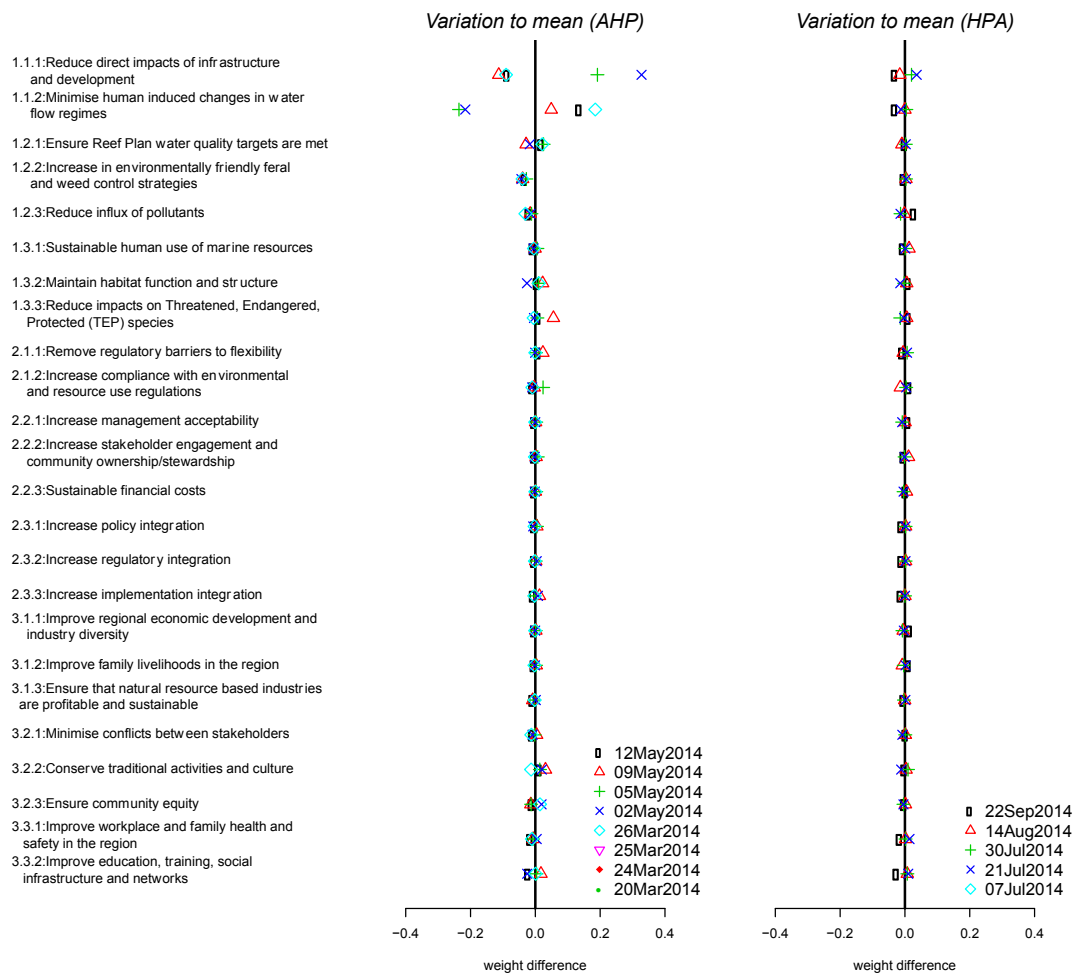


Figure 85: Variation to the mean scores from two different kinds of multiple surveys at different times by one project team member

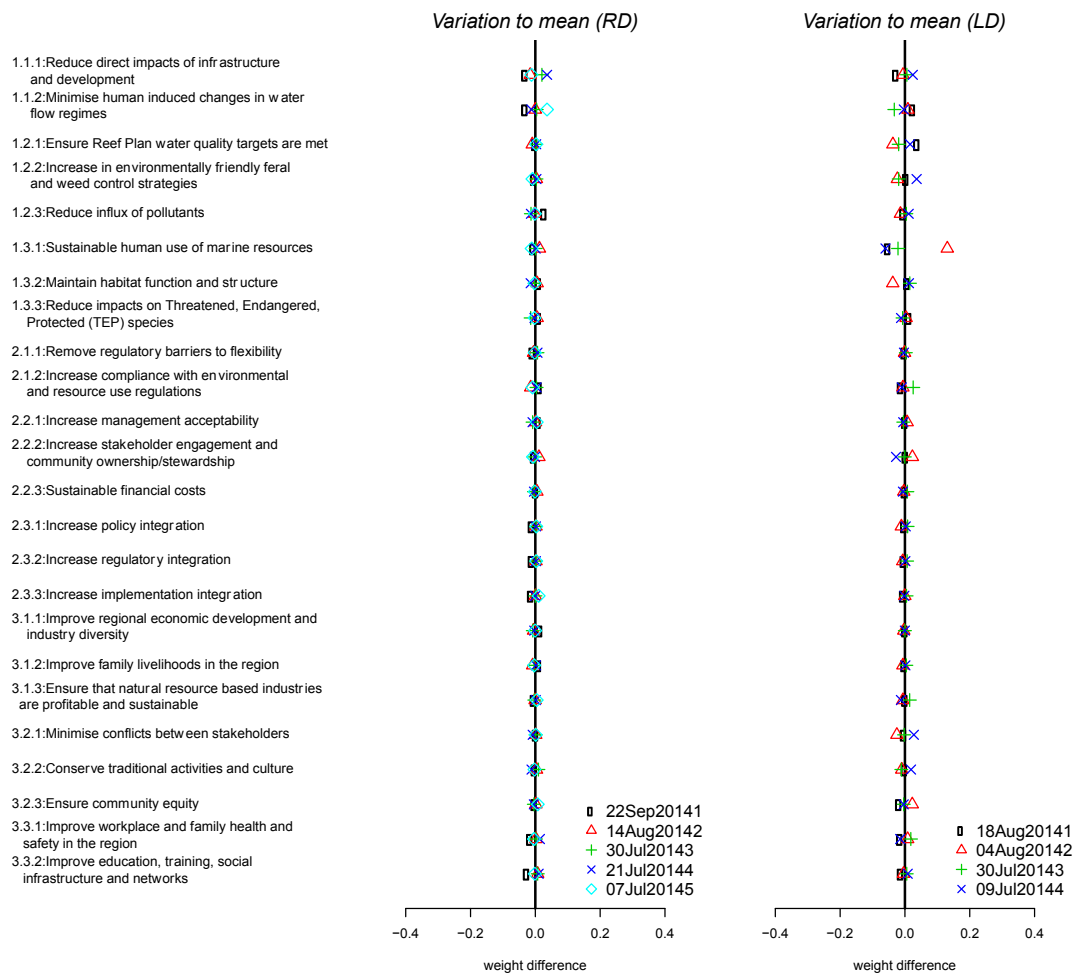


Figure 86: Variation to the mean scores from the multiple HPA surveys at different times by two project team members

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