

Fish habitat research and management program

**Balancing community needs with those of fisheries resources
and fish habitats - 2016 & beyond**

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Summary

Sustainable fisheries require healthy, diverse, extensive and connected fish habitats, including those in and around coastal communities. Targeted management responses and research informs and shapes the management direction for coastal fish habitats under pressure from increasing development and rising populations.

As part of its role in managing Queensland's fish habitats and dependent fisheries, the Department of Agriculture and Fisheries (DAF) has developed and established the Fish Habitat Research and Management (FHRM) Program. This program identifies, prioritises, coordinates, encourages and supports fish habitat research and management projects in Queensland. Its objectives, and research and management streams, also help to integrate DAF's priorities and commitments¹ involving projects to offset the impacts of development on fish habitats and fisheries resources.

DAF's FHRM Program is available online with project summaries². Outcomes are incorporated into DAF's fish habitat management activities and in advice provided to other resource and planning managers (e.g. local government).

¹ Pre 1 July 2014 fisheries offsets (financial offsets) delivery managed by DAF.

² Appendix 1 *Examples of projects* and Appendix 2 *Summaries of completed projects* are available online at <https://www.daf.qld.gov.au/fisheries/habitats/research-and-scholarships/fish-habitat-research-and-management-program>

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Overview

Fisheries Queensland of the Department of Agriculture and Fisheries manages the State's fish, fish habitats and fisheries under the principles of ecologically sustainable development to ensure long-term environmental, economic and social benefits³. Protection of fish habitats is delivered under the *Fisheries Act 1994* and Fisheries Regulation 2008 through specific measures, including:

- protection of marine plants;
- declaration and management of Fish Habitat Areas (FHAs)⁴;
- management of waterway barriers and fish passage; and
- restoration and rehabilitation of disturbed habitats.

Management and technical assessment of impacts to marine plants, declared FHAs and fish passage is governed by planning and fisheries legislation. The Department of Agriculture and Fisheries (DAF) is responsible for assessing developments that may impact fisheries resources and fish habitats (refer *Sustainable Planning Act 2009* and State Development Assessment Provisions – Module 5). DAF also manages statutory self-assessable development codes, fisheries authorities, compliance and administers fisheries offset project funding received by DAF as financial offsets⁵. In managing fish habitats, DAF supports approaches to achieve balance between community and fisheries needs and has developed the Fish Habitat Research and Management (FHRM) Program. A range of research and management projects is recognised under the FHRM Program (external projects and projects administered and/or delivered by Fisheries Queensland and Queensland Government agencies).

DAF's FHRM Program communicates research and management priorities and directions and was established in 2004. External and internal fish habitat priorities and reviews⁶ have progressively informed the FHRM Program framework, based on the following fish habitat management *needs*:

- characterisation of critical habitats for juvenile stages of key fish species;
- protected habitat (e.g. through declared FHAs) to restrict development and maintain stocks;
- fish friendly designs to incorporate into development;
- quantification of the ecological, economic and social values of re-establishing and rehabilitating fish habitats; and
- habitat documentation and reporting (e.g. health and resources condition).

The identified fish habitat management *needs* form the five (5) research/ management streams of the FHRM Program (see Table 1). Priorities⁷ for listed (potential) project areas are indicated as 'High',

³ 'Fish' is used in its broadest sense, as defined in the *Fisheries Act 1994* (the Act) and includes finfish, crustaceans and molluscs. 'Principles of ecologically sustainable development' are defined in the *Fisheries Act 1994*.

⁴ Declared fish habitat areas (FHAs) and related policies are managed by the Department of National Parks, Sport and Racing. (<http://www.npsr.qld.gov.au/managing/habitat-areas>)

⁵ Development approval conditions may include environmental offset requirements to counter balance unavoidable development impacts. Deeds of Agreement are in place between DAF and development proponents where offset funding has been paid (*Fisheries Act 1994*). DAF offset funding administration is limited to applications prior to 1 July 2014.

⁶ Principally originating from the Marine Fish Habitat Research Strategic Plan 2000-2002 (Kirkwood 2000) and related habitat recommendations of published fisheries habitat research and management reviews (DAFF 2012a; Enram Enterprises 2010; and Cappo *et al.* 1998). FRDC projects and reviews (e.g. Sheaves *et al.* 2013, FRDC 2013, 2014 & 2015,) and existing plans (National Marine Science Committee 2015) and Science and Research Priorities (Office of the Queensland Chief Scientist 2015) are also relevant.

⁷ Determined from the input of independent and departmental researchers and managers as part of the 2011 departmental Fish Habitat Researcher survey (DAFF 2012a) and in reference to more recent ecological community priorities e.g. fish habitats listed as vulnerable ecological communities (*Environment Protection and Biodiversity Conservation Act 1999* listings).

'Medium' or 'Low' under each research/ management stream. The FHRM Program provides an open platform to integrate smaller applied projects within a larger research and management agenda⁸, and to communicate and promote results to key stakeholders.

The FHRM Program also summarises potential fisheries project areas as a base for DAF's offset project discussions and for DAF's consideration of allocation of project funding. Fisheries Queensland uses the FHRM Program to direct research and management priorities linked to funding received under formal agreements (including offset funding and acquittals) and to promote project outcomes.

Marine or freshwater fisheries projects may be linked to offsets required where fish habitat removal or impacts to fish passage cannot be avoided. Previously negotiated fisheries offsets conditioned on development approvals issued under the *Sustainable Planning Act 2009* may require DAF to select suitable fish habitat offset projects to receive offset funding that is administered by DAF. This may require calls for suitable projects advertised through expressions of interest. Fisheries Queensland may consider offset projects where projects clearly demonstrate a capacity to deliver, for example fish habitat rehabilitation and management or fish habitat research. On this basis, research projects involving fish habitat investigation, analysis and data interpretation for management application would be eligible. Environmental monitoring projects (e.g. marine plant or water quality monitoring projects) would fall outside the scope of eligibility as offset projects.

FHRM Program objectives

The FHRM Program objectives are to:

1. develop and improve best practice 'habitat-sensitive' technologies that minimise the effects of development on fish habitats and that support protecting and managing fish habitats;
2. improve understanding of anthropogenic or natural impacts on fish habitats and fishery species;
3. improve understanding of the relationships between fish species and fish habitats;
4. foster post-graduate fish habitat research project opportunities with Queensland universities and other research providers; and
5. communicate priorities for eligible projects in tandem with DAF's calls for projects advertised as expressions of interest (fisheries offset funding administered by DAF) specifically including:
 - i. Fish habitat rehabilitation;
 - ii. Fish habitat management;
 - iii. Fish habitat mapping; and
 - iv. Applied Fish Habitat Research.

The FHRM Program is integrated to address fish habitat management and research directions throughout Queensland. Fish habitat investigations of non-impacted fish habitats also allows for

⁸ Ideally, research projects may be augmented through co-operation and collaboration with other research funding programs such as Fisheries Research and Development Corporation (<http://www.frdc.com.au/>) and Advance Queensland Research Fellowships (<http://advance.qld.gov.au/uni-researchers/research-fellowships.aspx>). This approach highlights the links with industry, research providers and stakeholder organisations.

comparison with impacted fish habitats and in setting a baseline to assess, and where possible avoid, future impacts (examples of this include seagrass research and mapping).

The FHRM Program also recognises stakeholder participation contributes to research/ management projects leading to outcomes that avoid/ minimise impacts of development on fish habitats (see objective 1 above). An example of this is the adoption of co-management outcomes developed in conjunction with Marine Plant (Fish Habitat) Management Strategies (MPMS)⁹.

FHRM Program research/management streams

The following research/management streams address principal processes and issues affecting fish habitats and fisheries productivity (priorities are listed in Table 1, below).

- Stream 1 – Fish habitat utilisation
- Stream 2 – Impacts on fish habitats
- Stream 3 – Innovative structure design for fish habitats
- Stream 4 – Rehabilitation of fish habitats
- Stream 5 – Habitat data for response management

The research/ management streams are discrete but linked for improved fish habitat management outcomes.

Table 1 FHRM Program research/ management streams and priorities

Research/Management streams and priorities [(H) = High, (M) = Medium, (L) = Low]
<p>1. Fish habitat utilisation</p> <ul style="list-style-type: none"> a. Relative productivity of adjacent fish habitats (H) <ul style="list-style-type: none"> i. Mangroves, seagrass and saltmarsh communities; freshwater habitats (wetlands and in-stream) (H) ii. Rocky reefs; algal communities; bare tidal/intertidal flats/substrate (M) iii. Saltpan communities (H/M) b. Importance of fish habitat connectivity (H) c. Role of habitat mosaics (M) d. Ecosystem services (H) <ul style="list-style-type: none"> i. Quantify fisheries specific ecosystem services of fish habitat (H) ii. Habitat-fisheries production modelling (M)
<p>2. Impacts on fish habitats</p> <ul style="list-style-type: none"> a. Size and management of buffers (H) b. Acid sulfate soil runoff (M/ L) c. Sewage discharge (L) d. Catchment development and runoff (H) e. Climate induced community changes (H/M)

⁹ MPMS are in place (Cairns, Bundaberg, Fraser Coast and Maryborough) and are under development (Townsville, Mackay and Brisbane).

Research/Management streams and priorities [(H) = High, (M) = Medium, (L) = Low]
<ul style="list-style-type: none"> f. Mangrove (M) <ul style="list-style-type: none"> i. Trimming (M/L) ii. Dieback (M) g. Saltmarsh (M) <ul style="list-style-type: none"> i. Burning (M/L) ii. Mowing (M/L) iii. Grazing (M) h. Seagrass (M) <ul style="list-style-type: none"> i. Smothering (H) ii. Scouring (M) i. Algae - Fisheries impacts, benefits and management (M/L) j. Quantification of fish habitat losses/gains at various spatial scales (H/M) k. Barriers to fish migration (man-made) (H) l. Barriers to fish migration (weed chokes) (M)
<p>3. Innovative structure design for fish habitats</p> <ul style="list-style-type: none"> a. Human access – jetties, piers, pontoons (M) b. Fish access – culverts, crossings, floodgates, saltwater barrage levees (H) c. Stabilisation – banks, levees; groynes, revetments (M) d. Drainage and discharge – stormwater and sewage networks/ outlets (M) e. Flow – dams, weirs (H) f. Grazing – ponded pastures (M) g. Pest control – runnels (L) h. Reduced impacts – moorings (L)
<p>4. Rehabilitation of fish habitats</p> <ul style="list-style-type: none"> a. Habitat mosaic (i.e. connectivity between multiple habitat types) (H) b. Marine plant communities (M) <ul style="list-style-type: none"> i. Mangrove (H/M) ii. Seagrass (H) iii. Saltmarsh (H) iv. Algal (M) c. Shallow intertidal flats (M) d. Rocky reefs (M) e. Yabby banks (L) f. Saltpan (M) g. Restoration of fish passage/ connectivity – mechanisms/ benefits (H)
<p>5. Habitat data for response management¹⁰</p> <ul style="list-style-type: none"> a. Mapping (H) b. Habitat condition analysis (H)

¹⁰ 'Co-management and delivery' was included as a priority under the 2012 FHRM Program and is now acknowledged more generally within the overall program (see 'FHRM Program objectives' and 'Roles of organisations, community, groups and others' of this document.)

Stream 1 – Fish habitat utilisation

Management objectives – relative importance of fish habitats and nature and extent of fish habitats to be protected, specifically to determine

- relative productivity of adjacent fish habitats
- utilisation patterns of different fish habitats
- importance of fish habitat connectivity and availability

Possible projects

- Productivity of different fish habitats
 - Mangroves - fisheries recruitment comparison analyses using mangrove type and patch size and relative value to recruitment of different patches (e.g. why is one patch of mangrove more valuable in terms of recruitment than another patch of mangrove?)
 - Understanding the values of different seagrass communities (i.e. high versus low density/ patchiness of seagrass)
 - What environmental conditions are required to maintain healthy fish habitats?
 - What are the limits of acceptable change in fish habitats and habitat quality for viable productive fisheries?
 - How does water quality impact on fish diversity and productivity in different habitats?
 - What impacts do pest species have on habitat utilisation?
 - Ecosystem-level relationships between species in inshore areas
 - Ecosystem services provided by habitats to estuarine and great barrier reef ecosystems
 - True ecosystems services values for Queensland's fish habitats and or marine park ecosystems
 - Modelling productivity of habitat under various connectivity scenarios (i.e. drought/flood)
 - Carbon sequestration and values of marine plant communities to the local/global carbon economy (e.g. as carbon sinks); quantify and determine fish habitat primary productivity pathways, including fisheries species at higher trophic levels
 - Fish habitat carrying capacity and assemblage diversity of freshwater and marine habitats and fish habitats adjacent to different land uses (e.g. port /industrial/ infrastructure/ urban/ agricultural/ forestry/ national park); enhancement in impounded (man-made) waters
 - Nursery habitats and identification of key areas for different fisheries species
- Relative importance of habitat linkages and fish access and use at different times and life cycle stages
 - saltmarsh, mangroves, and seagrass mosaic
 - Freshwater/ fluvial/ lacustrine/ palustrine fish habitats
 - unvegetated tidal areas (mudflats, saltpan, sand)
- How do changes in fish habitats influence changes in fish populations?

- Monitor and evaluate fish habitat status and function
- Evaluate ecosystem services
- Behaviour of different Queensland fish species at different fish passage structures i.e. culverts, weirs etc
- Biology of fish habitats e.g. seagrass dynamics including seed bank characteristics in disturbed areas)

Stream 2 – Impacts on fish habitats

Management objectives – impacts of human activities or natural events on fish habitats, specifically to determine

- impacts of human activity and discern these from natural events
- chronic/ episodic pollutant (large oil spills, herbicides, nutrients, marine debris) induced community impacts and land use impacts on fisheries productivity within fish habitats (quantification of fish habitat losses (clearing) at various spatial scales)
- criteria for limited modification of marine plants to minimise impacts to fish habitats
- resilience of marine plants to recover from modification or natural events (and document this)
- criteria for buffer design and location

Possible projects

- Productivity - How current threats and impacts affect the resilience of habitat mosaics (at landscape scales).
 - Water quality influence on fisheries productivity/ species diversity
 - Which land uses impact on fisheries productivity/ species diversity?
 - Develop integrated empirical models/ habitat risk analysis (at landscape scales) to future resilience (eutrophication, climate change and pollution impacts) of habitat mosaics already affected through current threats and cumulative impacts
 - Harvest impacts, non-lethal impacts of reduced water quality, salinity, climate change and sedimentation
 - Resilience of coastal habitats to cumulative impacts and climate change; Improving and maximising the resilience of fish habitats
 - Risk analysis of agricultural pollution (including herbicide runoff) on fish habitats - freshwater wetlands, mangroves, saltmarsh and seagrasses
 - Investigate and manage impacts on fisheries productivity for species dependent on freshwater wetlands
 - What are the effects of mangrove trimming/ hedging, or crown lifting on fish production?
 - How does grazing compromise fisheries productivity of saltmarshes?
 - What are beneficial uses of treated waste water or aquaculture discharge on productivity of marine plants?

- Algal communities – responses, impacts, benefits and management
- Thresholds and tools to protect and assess fish habitats during developments
- Landward and poleward migration of marine plant communities in relation to sea level; best practice for climate change adaptation including associated population assemblages/dynamics changes
- Abiotic and biotic and connectivity influences between natural ecosystem habitats, and downstream flows (directional influences) from catchment lands
- Optimal size and management of buffers
- Stability of shorelines as intertidal fish habitat and their buffering of subtidal fish
- Mangrove communities - inundation frequency, seedling density and diversity, erosion, burial, defoliation, stem damage, sedimentation, dieback cause and recovery
- Saltmarsh communities - inundation frequency, erosion, burial, removal
- Seagrass communities - light deprivation, dredging, elevated nutrients, shading due to turbidity (dredging/runoff), removal, scouring/ sedimentation effects in combination – anthropogenic dredging of a channel (removal), anthropogenic sedimentation, impacts related to invasions by introduced species, recovery after flood silt deposition
- Mitigating the effects of: Acid Sulfate Soils runoff; and sewage outfall impacts

Stream 3 – Innovative structure design for fish habitats

Management objectives – to design/ install sympathetic structures within fish habitats, specifically to

- investigate the use of existing and future structures as artificial fish habitats
- improve design of and best practice in construction of structures to enhance their fish habitat functions

Possible projects

- Optimising design of access structures - jetties, piers, pontoons, moorings, etc., to reduce impacts on natural fish habitats e.g. the effects of shading on and physical disturbance to the substrate
- Optimising design of structures to provide artificial habitats for fish
- Design of fish-friendly culverts, floodgates (waterway barriers)
- How are marine plants utilised to stabilise banks, levees and groynes?
- Optimal levee and bank design to promote littoral fauna and flora communities
- Address implications of downstream flows on fish habitats
- Reduce impacts of marinas and canals on fish assemblages
- Recruitment and recovery rate of marine plants following removal of structures

- Habitat enhancement (linked to Stream 4) to increase carrying capacity of certain fish stocks. (e.g. impoundments, enhancement of habitat (e.g. rocky reef construction, snagging etc) and to reduce predation of fingerlings, provide territories and breeding habitats for cod or biofilm feeding substrates for mullet)
- Enhance alternate habitat types to compensate habitat loss by development e.g. artificial reef construction
- Actions to remediate priority problem structures (including structures identified in conjunction with instream structure inventories¹¹) leading to improved fish habitat quality and fish access to habitats

Stream 4 – Rehabilitation of fish habitats

Management objectives – effective rehabilitation measures, specifically to develop

- improvements in best practice rehabilitation technology
- criteria for making decisions about rehabilitation (e.g. rehabilitation vs. natural regeneration)

Possible projects

- What is the relative success of transplanting versus natural regeneration of marine plants?
- What influences specific post-restoration survival of marine plants?
- Sediment accretion by mangroves relative to flood levels
- Rehabilitation of fish habitat mosaics
- Rehabilitation of specific fish habitats (e.g. recovery of mangrove and saltmarsh communities following reintroduction of tidal flows)
- Success of replacement fish habitats – yabby banks, rocky reefs, shallow intertidal flats
- Benefits and issues associated with rehabilitation projects
- Measuring success of rehabilitation projects
- Productivity
 - Habitat rehabilitation to mitigate impacts of climate change on fish stocks
 - Riparian and wetland areas baseline information - catchment community access for on-ground rehabilitation
 - Document best practice or methods for rehabilitation of fish habitats
 - Effects of habitat enhancement/ waterway rehabilitation on fisheries production/ fish numbers

¹¹ Refer Department of National Parks, Recreation, Sport and Racing 2014 Guidelines for conducting an inventory of instream structures in coastal Queensland (<http://www.nprsr.qld.gov.au/managing/pdf/fish-habitat-guideline.pdf>) and the Queensland Spatial Catalogue (<http://qspatial.information.qld.gov.au>) provides a GIS layer of instream structures associated with the inventory reports (enter "Queensland Fish Habitat Area Instream Structure Inventory Data" (with quotation marks) to search).

Stream 5 – Habitat data for response management

Management objectives – mapping and habitat condition analysis for fish habitats specifically to develop

- comprehensive fish habitat mapping for the State Planning Policy¹²
- criteria for research assessment and monitoring of habitat condition and health

Possible projects¹³

- mapped product development (mapping to detect fish habitat changes, spatial information tools) for fisheries management needs (including development assessment, planning and research)
- Investigate and report habitat resilience and functional capacity and longer term fish habitat viability in response to global climate change and direct human pressures (linked to Stream 3)
- Establish research capacity for rapid response to significant events affecting fish habitats.
- Condition and health of fish habitat communities
- Productivity - What areas of habitat exist that provide the necessary connectivity between the catchment and the coast?
 - Report historical and projected anthropogenic impacts on fish habitats; plot/ compare define the trajectory of anthropogenic impacts over time
 - Status (including condition & extent) of fish habitats

Roles of organisations, community, groups and others

Adoption of fish habitat protection and regulation measures in Queensland also requires contributions from regional/ local fish habitat management practices and research to help with response to change and for knowledge. Building on adaptive fish habitat management responses relies on valuable input from key stakeholders such as communities, traditional land owners, landholders, fishers, government agencies and natural resource management groups. This input may be in the form of identifying needs and responding through planning or implementation of fish habitat rehabilitation and/or management delivered through on ground projects. Projects delivered through applied research rely on research and education institutions, researchers and consultants, and create opportunities to improve our fish habitat knowledge.

¹² Refer State Planning Policy (<http://www.dilgp.qld.gov.au/planning/state-planning-instruments/state-planning-policy.html>) and State Interest Guideline - Agriculture April 2016 for guidance i.e. *Protecting fisheries resources from development that compromises long-term fisheries productivity and accessibility* (refer to "Economic Growth" to access <http://www.dilgp.qld.gov.au/resources/guideline/spp/spp-guideline-agriculture.pdf> for guidance).

¹³ Examples only. DAF recognises projects are underway or have been led by key researchers and managers, including but not limited to: development of wetland/ habitat classification tools (see WetlandInfo (Queensland) <http://wetlandinfo.ehp.qld.gov.au/wetlands/>); preparation of seagrass atlases (see Carter *et al* 2016); marine plant mapping by the Queensland Herbarium of the Department of Science, Information Technology and Innovation (see <http://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/components/flora/mangroves/mangrove-moreton.html>); management by the Department of National Parks, Sport and Racing (e.g. declared Fish Habitat Network Strategy 2015-2020 (<http://www.nprsr.qld.gov.au/managing/pdf/declared-fha-strategy2015-20.pdf>) and through Declared Fish Habitat Area Network Assessment Reports); and fish habitat vulnerability mapping by the former Department of Agriculture, Fisheries and Forestry (see reports for Moreton Bay and Townsville (<https://www.daf.qld.gov.au/fisheries/habitats/research-and-scholarships/fish-habitat-vulnerability-mapping-in-coastal-queensland>) for further information).

Recognised benefits (a pre-requisite for implementing fish habitat research and management)

The purpose and benefit of undertaking research¹⁴ and management projects need to be clearly articulated, for example, the project outcomes and benefits applicable to fishing sectors, local governments and the community as a whole can include:

- essential information for fish habitat management;
- improved understanding of the roles of fish habitats in supporting fisheries;
- knowledge on the impacts of human activities on fish habitats;
- improved understanding of connectivity between habitats and the function of habitat mosaics;
- better assessment of impacts of development applications on fish habitats;
- support for ecological sustainable development of Queensland's fisheries;
- safeguarding healthy estuarine and marine ecosystems; and
- addressing fishing sectors' and community concerns about habitat degradation and fisheries production.

Communication of research and management project outcomes

Outcomes of projects included in the FHRM Program (DAFF 2012b) are communicated online at <http://www.daf.qld.gov.au/fisheries/habitats/research-and-scholarships/fish-habitat-research-and-management-program> (and in subsequent updates).

References

Cappo, M, Alongi, DM, Williams, DMcB and Duke N 1998, *A review and synthesis of Australian fisheries habitat research: major threats, issues and gaps in knowledge of coastal and marine fisheries habitats*, Fisheries Research and Development Corporation project #95/055, Australian Institute of Marine Science Volumes 1-3, 633pp.

Carter, A. B., McKenna, S. A., Rasheed, M. A., McKenzie L, Coles R. G. (2016) *Seagrass mapping synthesis: A resource for coastal management in the Great Barrier Reef World Heritage Area*. Report to the National Environmental Science Programme. Reef and Rainforest Research Centre Limited, Cairns, 22 pp.

Department of Agriculture, Fisheries and Forestry 2012a, *Fish Habitat Researcher Survey: Fish habitat review Finding 2*, Fisheries Queensland, 17 pp.

Department of Agriculture, Fisheries and Forestry 2012b, *Project summaries – Fish Habitat Research and Management Program, Balancing community needs with those of fisheries resources and fish habitats – 2012 & beyond*, 50 pp.

Department of National Parks, Recreation, Sport and Racing 2014 Guidelines for conducting an inventory of instream structures in coastal Queensland, viewed 13 November 2015, <<http://www.nprsr.qld.gov.au/managing/pdf/fish-habitat-guideline.pdf>>.

¹⁴ Emerging fish habitat based opportunities for science and research investment may also be guided by the published R.E.D.S. Decision Rules for investment of the Office of the Queensland Chief Scientist (<http://chiefscientist.qld.gov.au/strategy-priorities/decision-rules-for-investment>).

Enram Enterprises 2010, *An Independent review of fish habitat policy and process in Queensland*. Prepared for the Department of Employment, Economic Development and Innovation, October 2010, 57 pp.

Fisheries Research and Development Corporation 2015 National Marine Science Plan, viewed 16 October 2015, <<http://frdc.com.au/environment/NMSC-WHITE/Pages/default.aspx>>.

Fisheries Research and Development Corporation 2014 National Marine Science Plan: White Paper on Green Engineering and Marine Urban Development National Marine Science Plan Urban Coastal Environments Theme White Paper, viewed 16 October 2015, <<http://frdc.com.au/environment/NMSC-WHITE/Pages/Environments.aspx>>.

Fisheries Research and Development Corporation 2013 *Revitalising Australia's Estuaries – the business case for repairing coastal ecosystems* FRDC project #2012/036, viewed 5 November 2015, <<http://frdc.com.au/research/Documents/2012-036-Business-Case.pdf>>.

Kirkwood, J 2000 Marine Fish Habitat Research Strategic Plan 2000-2002 – a whole of ecosystem approach, QDPI Information Series QI00064, 10 pp.

National Marine Science Committee 2015, National Marine Science Plan *Driving the development of Australia's blue economy*, viewed 16 October 2015, <<http://frdc.com.au/environment/NMSC-WHITE/Documents/NMSP%202015-2025%20report.pdf>>.

Office of the Queensland Chief Scientist 2015 Revised Queensland Science and Research Priorities, viewed 16 October 2015, <<http://www.chiefscientist.qld.gov.au/images/documents/chiefscientist/qld-science-n-research-priorities-2015-2016.pdf>>.

Sheaves, M, Abrantes, K, Johnston, R, Owens, R, Read, M, Saunders, T and Wulf, P 2013, *The life-cycle habitat requirements of coastal fisheries species; identifying key knowledge gaps and research needs*, FRDC Project No. 2012/037, James Cook University.

Wegscheidl C, Sheaves M, McLeod I and Fries J 2015, *Queensland's saltmarsh habitats: values, threats and opportunities to restore ecosystem services*, Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER) Publication, James Cook University, Townsville, 25 pp.