INDICATIVE STORM BAY ENVIRONMENTAL MONITORING PROGRAM

SYNOPSIS

An indicative broadscale environmental monitoring program (BEMP) and a localised lease-specific monitoring program have been developed by the Environment Protection Authority (EPA) and Planning Authority (PA) in consultation with the Institute for Marine and Antarctic Studies (IMAS) and Commonwealth Scientific Industry Research Organisation (CSIRO) to monitor key environmental indicators within and adjacent to marine farming lease areas and throughout Storm Bay, south-east Tasmania. The main objective of the proposed monitoring programs is to provide an understanding of interactions between salmonid farming and the receiving environment. This is to be achieved through monitoring key environmental stressors/indicators at varying temporal and spatial scales to determine the quantum of change from the background environment of the Storm Bay region. Similar environmental monitoring programs have been implemented in other marine farming regions in Tasmania with the overall aim of monitoring the combined effects of multiple salmonid farming operations to better inform management decisions in a whole of ecosystem context. The results of this monitoring program will be used in the ongoing adaptive management framework for salmonid farming in Storm Bay.

ADAPTIVE MANGEMENT

Marine farming in Tasmania is managed under an adaptive monitoring and management regime. This process allows for adjustment of management framework (based on environmental performance indicators) with the aim of sustainable development. Such decisions require comprehensive environmental monitoring and the establishment of robust datasets to accurately inform regulatory bodies for effective management. This process builds appropriate environmental performance indicators (representative of ecosystem health/condition) to ensure that critical ecosystem signals are observed and acted upon promptly and appropriately through mechanisms developed in the adaptive management framework.

ENVIRONMENTAL MONITORING

In general, all types of input-based marine aquaculture in Australia involve some form of environmental monitoring. The extent of structured sampling programs for environmental performance indicators is usually scaled to the expected levels of production. These programs are mostly focused on benthic impacts and water quality in the immediate vicinity of farms. However, this approach does not capture the combined effects of multiple marine farming operations on ecosystem dynamics and therefore overarching environmental changes may not be directly observed. Tasmania is currently one of the only jurisdictions in Australia with a specific requirement for ongoing broadscale monitoring.

TASMANIAN BEMP's

The conceptual design of broadscale environmental monitoring for the salmonid industry in Tasmania was first developed by Thompson et al. (2008). The study focused on the connected waterways of the Huon estuary and D'Entrecasteaux channel and developed a broad suite of environmental performance indicators to be monitored across multiple sites. This involved data collection on the physical, chemical and biological characteristics of the system and assessment of spatial and temporal patterns of water and sediment quality. The resultant BEMP has now been operating for 9 years. This dataset provides a significant body of information that is used by the regulatory authority, industry and stakeholders to assess ecological condition and to support adaptive management strategies. In addition, the Huon estuary and D'Entrecasteaux BEMP has provided some validation of initial biogeochemical modelling and showed that whilst there was some evidence of farm effects in some areas, the system did appear to be coping with the current level of farming activity.

STORM BAY BEMP

Similar to other marine farming regions in Tasmania, it is the PA's intent that a BEMP consistent with requirements of the EPA be established for Storm Bay. The objective of the BEMP will be to provide data to enable key chemical, physical and biological indicators of ecosystem condition to be monitored and the degree of change from background levels of these indicators to be determined to inform adaptive management responses. This will provide a fully integrated environmental monitoring program that spans all Marine Farm Development Plan (MFDP) areas containing licensed finfish marine farming leases in the Storm Bay region. The proposed BEMP will build on existing environmental monitoring arrangements focusing on the key areas of water and sediment quality, and surrounding reef systems across a range of sites throughout and adjacent to Storm Bay.

While it is recognised that dissolved nutrient emissions will vary in space and time in relation to production cycles, total emission load, and the seasonal variation in regional hydrodynamics, the proposed annual combined biomass production and associated nutrient output is significant. Therefore, the PA engaged IMAS to undertake nutrient dispersion modelling to estimate the spatial distribution of nutrients from proposed salmonid farming activities in the region. The assessment used CONNIE3 (a decision support tool developed by CSIRO) which integrates hydrodynamic modelling and particle tracking to provide detailed and high resolution nutrient dispersion estimates from proposed salmonid farming activities in Storm Bay. The results indicate that Storm Bay is a highly connected and dynamic waterway and dispersal of dissolved nitrogenous outputs from salmonid farming in this region is likely to be far reaching. Estimates suggest that associated dissolved nutrients may extend east to Tasman Island and southward of Storm Bay. As such, the EPA have determined monitoring sites across and beyond the estimated dispersion range are required to determine the degree of ecosystem condition change attributable to salmonid farming activities. These include broadscale, inshore and deepwater reef monitoring sites (Figure 1).

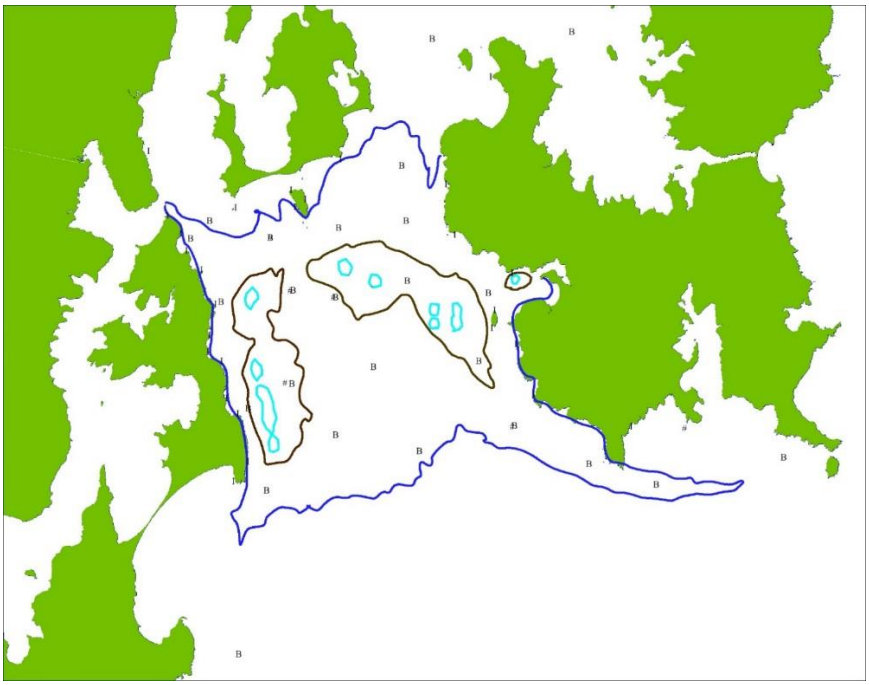

Figure 1: Proposed BEMP monitoring locations for the Storm Bay region and modelled CONNIE3 annualised dispersion output of dissolved nitrogen (ammonium) for surface waters (0-15m depth range) showing the 95th, 80th and 50th percentiles based on an annual 40,000 tonne biomass. Where; B = Broadscale monitoring sites (i.e. water quality and benthic monitoring); I = Inshore reef monitoring sites; # = Deepwater reef monitoring sites. Sites illustrated here do not include Local/Near scale sites for water quality and benthic monitoring.

Based on the ANZECC (2000) guidelines the area within the 80th percentile contour (brown contour on Figure 1) are more likely to show an environmental effect when farms are operating at a combined 40,000 tonne biomass. The area below the 50th percentile contour represents the region where there is least likely to be any observable effect and where water quality is most likely to be comparable to background.

TYPE OF ENVIRONMENTAL MONITORING AT IDENTIFIED SITES

In determining (or subsequent review of) the frequency, extent and type of monitoring required, the EPA will consider a range of information, such as the scientific systems and sampling technology relevant to the Storm Bay environment and past monitoring results. Thus, the BEMP may be altered from time to time to ensure that it continues to provide valuable environmental information to support an adaptive management approach to salmonid farming in Storm Bay consistent with the resource management and planning system of Tasmania.

On the basis of currently available information, including the assessment of the CONNIE3 dispersion modelling for Storm Bay, the nominated monitoring sites will extend over multiple spatial scales in relation to distance from proposed leases and include; 'near-scale' (within and adjacent to proposed marine farming lease areas i.e. Figures 2 and 3), 'intermediate' (<5km), and 'far-field' (>5km) (i.e. intermediate and far-field sites detailed in Figure 1).

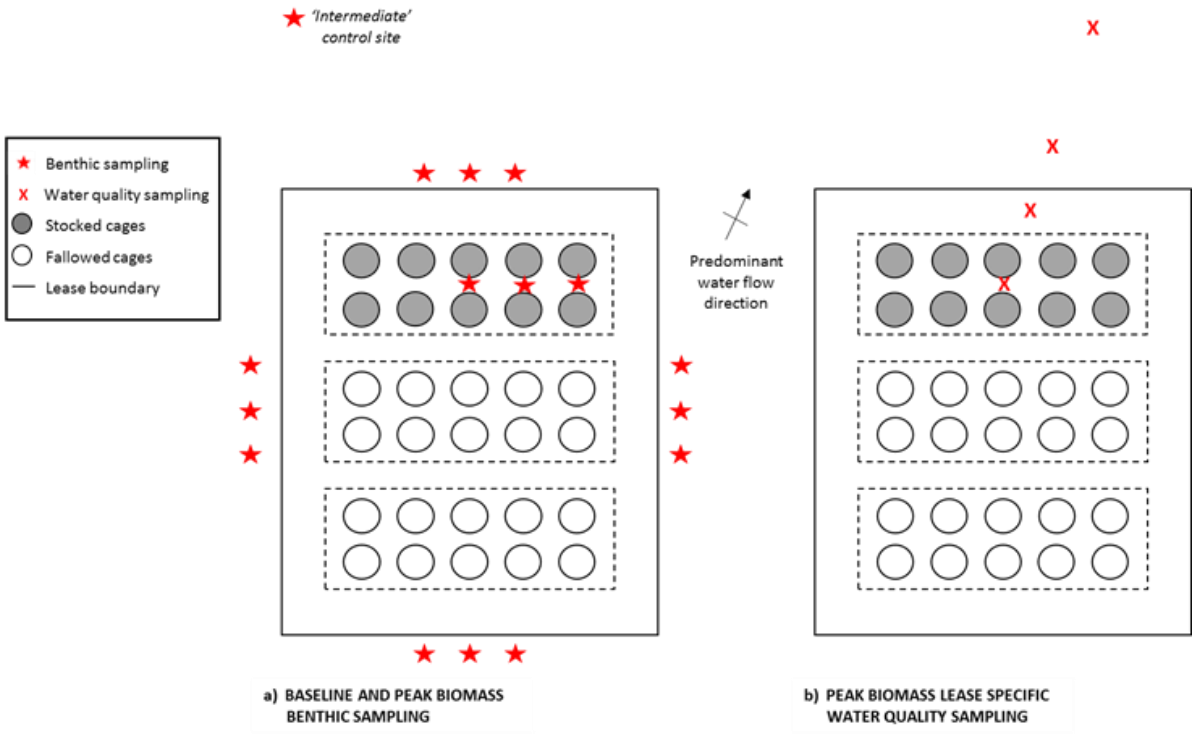

Figure 2: Hypothetical finfish marine farming lease area showing location of local/near scale monitoring sites for a) indicative benthic monitoring at baseline and at peak biomass, b) peak biomass/nitrogen output water quality monitoring.

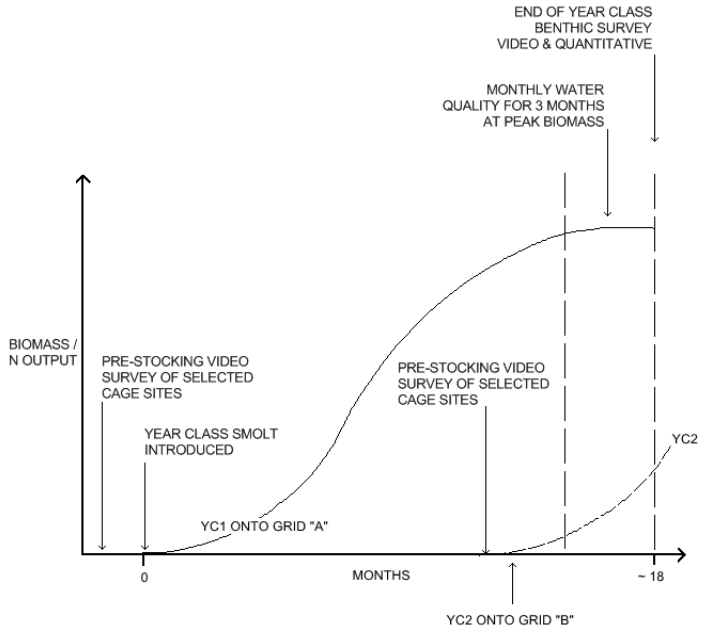

Figure 3: Production time line identifying scheduled indicative benthic and water quality monitoring surveys relative to each year class grow out.

Each nominated monitoring site is categorised into the following areas of environmental focus including; water quality, benthic condition, inshore/offshore reef impacts, or a combination. Protocols for monitoring water and sediment quality are well established (Thompson et al. 2008) and the frequency/design for the nominated Storm Bay BEMP are detailed in Table 1a, b and Table 2a, b.

Table 1: Indicative Storm Bay water quality monitoring program design. a) monitoring parameters b) spatial extent, frequency of monitoring and indicator trigger levels. Refer to Figure 1 for spatial distribution of sampling intermediate and far field sites.

a)

water quality monitoring	*Parameters monitored*	*Sampling method*	*Sampling depth*
Nutrients	Nutrients Total Nitrogen Nitrogen Kjeldahl Phosphorus Nutrients Dissolved Ammonia (TAN) Nitrate Nitrite Nitrate + Nitrite Phosphorus (DRP) Silicate (SMR) Dissolved Organic Carbon (DOC)	Niskin bottle	Sampling at surface, 10 metres from the surface and one metre above seabed.
Water Chemistry	Dissolved Oxygen [saturation + mg/L] temperature salinity turbidity (NTU)	Sonde profiler	To be collected at two scales depending on proximity to lease; • Local/Near scale – surface, every metre for first 10 metres, then every 5 metres thereafter and bottom. • Intermediate to Broad scale – surface and every 5 metres thereafter and bottom.
Phytoplankton	Cell count Taxonomy Relative abundance Chlorophyll *a*	12m depth Integrated sampler	Top 12m of water column

b)

Spatial scale	*Distance relative to proposed site(s)*	*Frequency*	*Sampling design*	*Indicators and trigger levels*
Local/Near-scale	within and adjacent to Lease area	Lease-specific monthly sampling over 3 months of peak biomass/nitrogen output	Refer figure 2 (b) and 3. Sample sites located at the centre of cage grid, 50m from cage grid, 35m from lease boundary and 500m from cage grid in line with predominant flow. Sampling for: • **Nutrients** • **Water chemistry** • **Phytoplankton**	Guideline limit levels derived using pre-development data collected from reference stations across the region and prescribed in licence. Indicative limits for: ***Nutrients:80th percentile of reference conditions*** ***Water Chemistry: 20th to 80th percentile range of reference conditions*** ***Chl a – 3x median Chla concentration.***
Intermediate	within 5 km	Monthly as part of regional BEMP	Sampling for: • **Nutrients** • **Water chemistry** • **Phytoplankton**	Guideline limit levels derived using pre-development data collected from reference stations across the region and prescribed in licence. ***Substantial shift in background conditions at a site specific or regional scale will warrant further investigation.***
Far-field	>5km	Monthly as part of regional BEMP	Sampling for: • **Nutrients** • **Water chemistry** • **Phytoplankton**	Guideline limit levels derived using pre-development data collected from reference stations across the region and prescribed in licence. ***Substantial shift in background conditions at a site specific or regional scale will warrant further investigation***

Table 2: Indicative Storm Bay benthic monitoring program design. a) monitoring parameters b) spatial extent, frequency of monitoring and indicator trigger levels.

a)

Benthic monitoring survey	*Component*	*Parameters monitored*	*Sampling method*
Quantitative benthic survey*	*Biological*	Macrofauna	Benthic grabs
	Sediment chemistry	Redox Sulphide organic content particle size	Benthic grabs and cores
underwater video	*Visual assessment*	Benthic habitat	Underwater video assessment using Remotely Operated Vehicle (ROV)

b)

Spatial scale	*Distance relative to proposed site(s)*	*Survey type and frequency*	*Sampling design*	*Indicators and trigger levels*
Local/Near-scale	Within and adjacent to Lease area	Baseline benthic sampling and underwater video survey, followed by a repeat survey at completion of each year class grow out.	Refer figure 2 (a) and 3 Biological, sediment chemistry and visual components collected at prescribed cage and 35m compliance sites.	Prescribed in licence as a lease specific monitoring condition.
		pre-stocking underwater video assessment at cage sites prior to introduction of next year class	Refer Figure 1 Underwater video at prescribed cage sites	Prescribed in licence as a lease specific monitoring condition
Intermediate	Within 5 km	Baseline benthic survey and underwater video survey, followed by a repeat survey at completion of each year class grow out.	Refer Figure 1	Prescribed in licence as a lease specific monitoring condition
Far-field	>5km	Annual quantitative benthic survey as part of regional BEMP	Refer Figure 1	Prescribed in licence as a regional monitoring condition

In the context of inshore/offshore reef impacts, there are currently no established protocols to monitor the effects of salmonid farming. In 2015, a research project (FRDC 2016-024 'Managing ecosystem interactions across differing environments: building flexibility and risk assurance into environmental management strategies) was initiated to investigate environmental monitoring strategies for new farming areas in Tasmania; with Storm Bay being one of the key sites selected for the study. This research aims to define specific protocols that would be suitable for assessing acute and chronic changes in reef systems. Currently, there are three potential monitoring approaches;

- Full reef biodiversity surveys (Reef Life Survey methods) to identify approaches for monitoring chronic changes in reef ecology.
- Key species surveys – targeted evaluation of settlement plates and specific faunal assemblages. This approach has the potential to be applied to assessment of both chronic and acute changes.
- Rapid assessment approaches – based on visual assessment of changes in assemblages using fixed photographic quadrats. This being specifically designed to focus on identification of acute impacts, but as the images are archived this may also be relevant to determination of longer term changes.

At the conclusion of this project in late 2018 optimal methods for monitoring the effects of salmonid farming on reef ecosystems will be defined and considered in the context of ongoing reef ecosystem assessment. In such circumstances that methodological approaches are not finalised within expected timeframes, full reef biodiversity surveys will be required at each nominated 'inshore' or 'deep water' reef monitoring sites. Frequency and design of inshore and offshore reef impacts are tentatively outlined in Table 3a and b. Leases are not permitted over rocky substrates. If any reef ecosystems are identified within 500m of a lease area, these sites may be selected for monitoring.

Table 3: Indicative Storm Bay reef monitoring design. a) monitoring parameters b) spatial extent, frequency of monitoring and indicator trigger levels. Refer to Figure 1 for spatial coverage of sampling.

a)

Marine vegetation	*Parameters monitored*	*Parameters monitored*	*Sampling method*
inshore and deep water reef monitoring	*Biological*	Reef community structure including taxonomy and abundance of: Macrophytes Invertebrates fish	Quadrats, diver and ROV transects, quantitative assessment/species counts

b)

Spatial scale	*Distance relative to proposed site(s)*	*Survey type and frequency*	*Sampling design*	*Indicators and trigger levels*
Local/Near-scale	NA	NA	NA	NA
Intermediate	Within 5 km	**Inshore reef** Baseline assessment using Reef Life Survey methodology. To be repeated at 5 yearly interval. Rapid assessment method to be used on an annual basis for inshore reef **Deep reef** Annual underwater video assessment	Refer Figure 1	Prescribed in licence. To be established following completion of FRDC project 024
Far-field	>5km	As for near scale	Refer Figure 1	Prescribed in licence as a regional monitoring condition

CONCLUSION

Overall, the key indicators, habitats surveyed, along with the spatial and temporal extent of the proposed Storm Bay BEMP is greater than those of other established MFDP areas. This is in response to knowledge gained from established BEMP programs, incorporation of advances in survey techniques and the inclusion of multiple lines of evidence to provide for more robust adaptive management decisions and improved environmental sustainability. As such, baseline and regular monitoring information proposed here will provide valuable information on how the ecosystem is assimilating soluble and particulate emissions associated with the proposed salmonid farming development and therefore guide management decisions with the best available scientific information.

REFERENCES

Australian and New Zealand Environment and Conservation Council, and Agriculture and Resource Management Council of Australia and New Zealand (2000) Water and sediment quality guidelines for fresh and marine water quality.

Thompson,P., Wild-Allen, K., Macleod, C., Swadling, K., Blackburn, S., and Volkman, J. (2008). Monitoring the Huon Estuary and D'Entrecasteaux Channel of the Environmental Effects of Finfish Aquaculture. Aquafin CRC Technical Report (CRC Project 4.2(2)/ FRDC Project 2004/074), Tasmanian Aquaculture & Fisheries Institute, Hobart, Tasmania, Australia (2008).