WATER QUALITY INDICATORS

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WHAT ARE WATER QUALITY INDICATORS

Water quality is a commonly used phrase these days. The word "*quality*", biologically speaking, refers to the general health of an environmental aspect - in the case of 'water quality' it refers to the health of a body of water, such as a river, a pond, a lake or the ocean.

Determining the best ways to measure water quality can be complicated. Whatever tool is ultimately used must not only take into account the unique physical, chemical and biological characteristics of the specific body of water, but must also be reliable and able to be repeated over and over again.

The tools scientists use to measure water quality are called '*indicators'*. In other words, an '*indicator'*, in biological terms, is some environmental feature that can be measured and whose measurements change with changes in the environmental conditions. It, thereby, gives a clue to changes in the water quality.

Possible Water Quality Indicators

Biological – fish, algae, plants,

Chemical – pesticide, herbicides, oxygen

Physical –suspended sediment

Indicators can be almost anything found in the natural environment - including things that are biological, chemical or physical. It just depends on the situation. Ideally, one indicator can be used for a variety of different locations so that different areas can be compared.

Determining what is the best water quality indicator to use is the challenge that researchers are facing. This is the specific question that researchers from the MTSRF are trying to answer – exactly which specific water quality indicators should be used in the Wet Tropics region (Theme 3, Program 7 – Water Quality). They are investigating a wide range of aquatic organisms, including macrophytes (plants), macroinvertebrates and fish.

WHY DO WE CARE ABOUT WATER QUALITY IN THE WET TROPICS REGION?

The most obvious answer is that the Wet Tropics waterways must remain healthy in order to support a healthy rainforest ecosystem. However, the less obvious reason is to maintain the health of the Great Barrier Reef (GBR).

Since the streams and rivers from the Wet Tropics drain into the GBR, anything that comes down the waterways ends up on the reef. So, if the rivers and streams are not healthy, then the reefs in the area will also suffer (see MTSRF Project 3.7.2: "*Connectivity and risk: tracing materials from the upper catchment to the reef*").

Since the early 2000's, researchers have determined that pesticides from land-based resources are a greater potential threat to the GBR ecosystems than was previously thought. In fact, testing has found pesticide and herbicide residues have been found up to sixty kilometres offshore. Furthermore, it has been shown that even at low concentrations, these chemicals are having measurable negative impacts on the corals and seagrasses.

It is important, therefore, to find a way to pre-empt impacts on the reef by detecting changes upstream *before* they become too large a problem with far-reaching impacts.

THE RESEARCH

Many of the research programs under the Marine and Tropical Science Research Facility (MTSRF) Program 3: Water Quality), are looking at variables that can be used as potential indicators of water quality at all levels – from the waterways of the Wet Tropics, to the catchment areas, to the coastal waters and finally to the reef.

Project 3.7.3, "*Biological Indicators of Ecosystem Health in Wet Tropics Streams*" is part of a larger strategy plan to develop and implement in a fully functional monitoring system for the region. Once appropriate water quality indicators are found, then researchers can continue to develop monitoring protocols for Wet Tropics wetlands. These, in turn, will then be incorporated into water quality guidelines

As the complexity of the connection between rainforest health and coral reefs is better understood, researchers are beginning to delve further into *how* to measure water quality and *which indicators* will give the best 'early-warning' of water quality degradation.

New research has looked at a few potential water quality indicators to analyze their effectiveness:

- Macrophyte assemblages – large aquatic plants
- Fish assemblages
- Macroinvertebrate assemblages –animals without backbones (e.g. insects, mollusks, crustaceans)

WHICH INDICATORS MIGHT WORK?

Macrophytes (Large Plants)

Macrophytes, especially aquatic plants, are already used in Europe to monitor the status of streams and rivers. However, they are not widely used yet, as biomonitoring tools for waterways in Australia.

Different environments support different plant assemblages. If these assemblages change, then it is usually indicative that the conditions of that area have also changed.

Possible changes in macrophyte assemblages could include:

- shift in species dominance (more of one type and less of another),
- variation in overall abundance - either increase or decrease in vegetation cover in an area,
- Changes in species diversity or richness (fewer types of plants)
- The appearance of 'alien' invasive plant species that have never been documented from that area before.

In other words, significant changes to the plant communities living near a specific waterway will usually mean that one or more of the environmental conditions has changed.

The findings in this MTSRF Project 3.7.3 suggest that macrophytes living on the edges of streams and rivers, are potentially the most useful indicator of the health and condition of the 'edge habitats', but their use as indicators for assessing stream and river water quality in the wet tropics region of the northern Queensland is limited.

For Example

Some specific types of plants thrive with increased nutrients. Therefore, if the abundances of these specific plants increase in a particular waterway, it will most likely indicate a decline in water quality (e.g. increased nutrient or sediment load).

Macroinvertebrates ('Large invertebrates')

In this study, macroinvertebrates included a range of animals without backbones, such as aquatic insects, worms, mollusks (clams and snails), crustaceans (shrimp and crabs), spiders and mites.

Ecologically, these animals are important members of the freshwater ecosystem. Not only do they make up the first link in the aquatic food web, but they also play an important in keeping the ecosystem healthy by helping with decomposition, nutrient cycling and energy transfer.

Since these organisms rely on specific water quality conditions to survive, and are generally very sensitive to habitat and water quality deterioration, they have the potential to be good water quality indicators.

Freshwater macroinvertebrates are sensitive to changes in:

- water chemistry (e.g. levels of dissolved oxygen),
- salinity,
- toxic contaminants (e.g. insecticides)
- organic pollution,
- nutrient enrichment, and
- increases in sedimentation.

Because of these sensitivities, changes in a macroinvertebrate community would indicative a changes within the water ecosystem where they live. In fact, Project 3.7.3 found that certain macroinvertebrate assemblages seem to be powerful indicators of stream ecosystem health.

Fish

Fish, just like the plants and macroinvetrebrates, are often used as water quality indicators because they are also sensitive to changes in water quality. However, due to their mobility, they can be used to give an indication of water quality over a larger scale.

This study confirmed that fish assemblages are particularly responsive to the effects of water quality degradation in the waterways of the Wet Tropics.

As environmental conditions change, the established fish diversity and relative abundances will also change. Some species of native fish, which are particularly sensitive to elements in the water, can disappear altogether from a site, while other species will increase in relative abundance. Furthermore, invasive 'alien' fish species often appear and become established waterway with reduced water quality. These alien species can be extremely detrimental to an area, as they tend to be able to out-compete native fish for natural resources.

Not A Nice Fish – Tilapia
"the carp of the north"

The Wet Tropics has one of the highest infestations of exotic, or alien, fish in Australia. Probably the worst of all these pest fish is the African fish called Tilapia, which were first introduced into northern Queensland in the 1970's for weed and mosquito control.

Tilapia are large, fast growing, rapid breeders that can tolerate a wide range of water conditions, including fresh, brackish and salt water. These characteristics allow them to establish quickly and outcompete native fish species.

They also disrupt the native aquatic plant life directly by physically digging the plants up, as well as indirectly by creating so much turbidity (suspended sediment) that sunlight cannot penetrate to the plants life below, thereby killing it.

REFERENCES

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RELEVANT MTSRF RESEARCH

The Marine and Tropical Sciences Research Facility (MTSRF) is part of an Australian Government initiative to "develop collaborative, public benefit research between Australia's best tropical environmental researchers to support the conservation and sustainable use of North Queensland's environmental assets - the Wet Tropics rainforests, the Great Barrier Reef and the connecting coastal regions".

The Reef and Rainforest Research Centre (RRRC) is contracted to administer the MTSRF Research Programme in North Queensland.

There are 5 main themes of study:

Theme 1	Status of ecosystems
Theme 2	Risks and Threats to the Ecosystems
Theme 3	Halting & Reversing decline in water quality
Theme 4	Sustainable use and management of natural resources
Theme 5	Enhancing Delivery