How Freshwater Flows Enrich Estuaries

The proposal to dramatically reduce the volume of freshwater flowing into Great Sandy Strait by the construction of a Traveston Crossing Dam has raised the question of the importance of maintaining fresh water flows into estuaries. This FIDO backgrounder attempts to explain the impact of such impoundments by discussing just how three criteria — nutrients, salinity and pH — vital for the health and productivity of estuaries influence the marine ecosystems and how freshwater environmental flows are critical to each.

Estuaries: Estuaries are semi-enclosed coastal water bodies with a free connection to the open sea and are fed by one or more rivers or streams. Estuaries are more likely to occur on submerged coasts, where the sea level has risen in relation to the land. This process floods valleys.

In this respect Great Sandy Strait is a most typical estuary being formed in the ancestral bed of the Mary River following the sea level rise which began about 10,000 years ago. With Tin Can Bay, it is the sixth largest enclosed embayment off the Queensland coast and one of the most productive.

Estuaries are often associated with high rates of biological diversity and productivity. Estuaries rely for their productivity on maintaining a regular inflow of freshwater to maintain the brackish conditions that are the basis for the high productivity. Whereas most seawater is of relatively uniform character, there is greater variability of the water quality in estuaries, particularly in respect of nutrients, salinity and pH.

Estuaries are most significant marine nurseries, not only because they provide habitat where juvenile fish and other marine fauna can hide and be better nourished, but because they provide habitats safer from predation. Many larger predators are adjusted to higher levels of salinity and avoid estuaries.

Nutrients: The marine ecosystem relies on an inflow of nutrients. Much food sources in the marine ecosystem such as mangroves, seagrass, algae and phytoplankton on which the marine fauna is ultimately dependent need the nutrients carried into the marine ecosystem from the run-off from the land. These provide the foundation of the marine fauna's food chain in the marine ecosystem.

These photosynthesizers also reduce atmospheric carbon and generate oxygen. Phytoplankton are responsible for the blue or green colour of sea-water. Globally phytoplankton generate more oxygen for the atmosphere than either the forests of the Amazon, Africa or Asia. Estuaries and oceans can only derive nutrients from undersea volcanoes, coastal erosion, atmospheric fallout and freshwater flow but it is the latter which clearly makes the greatest contribution to sustaining the nutrient levels of the estuaries.

Salinity: Salinity indicates how much fresh water has mixed with sea water. As such it is also an indicator of the input of nutrients. Salinity is important in coastal waterways. Most aquatic organisms function optimally within a narrow range of salinity. When salinity changes to above or below this range, an organism may lose the ability to regulate its internal ion concentration. Organisms operating outside their preferred level of salinity may succumb to biotic pressures such as predation, competition, disease or parasitism. Consequently, shifting salinity distributions can affect the distributions of macrobenthos as well as rooted vegetation such as seagrasses and mangroves.

Salinity is also an important control on the types of pathogenic organisms and invasive species that can occur in a coastal waterway, on the types of species that can occur in algal blooms, and on the activity of nitrifying and denitrifying bacteria

Salinity is a dynamic indicator of the nature of the exchange system. It shows the relationship between salinity and other soluble substances including nutrients.Salinity can demonstrate the dynamic or conservative nature of those substances in 'mixing plots'.

pH: pH is a measure of acidity or alkalinity of water on a log scale from 0 (extremely acidic) through 7 (neutral) to 14 (extremely alkaline). The pH of marine waters is close to 8.2, whereas most natural freshwaters have pH values in the range from 6.5 to 8.0. Most waters have some capacity to resist pH extremes.

When seawater (pH 8.2) mixes with typical river water (pH 7-7.5), pH tends to decrease. However, river water has a much higher pH than seawater if it evaporates to the same salinity. Therefore, in evaporative coastal settings, mixtures of seawater and river water with relatively more river water may have higher pH levels than mixtures with relatively less river water, at the same salinity.

It follows then that freshwater deprivation due to the extraction and diversion of riverine water can alter natural pH ranges and gradients in coastal waterways.

Most aquatic organisms and some bacterial processes require that pH be in a specified range. For example, the activity of nitrifying bacteria is optimal over a narrow pH range from 7 to 8.5. If pH changes above or below the preferred range of an organism (including microbes), physiological processes may be adversely affected.

For all of the above reasons it is vital to sustain the flow of freshwater into estuaries to maintain the health of the marine environment.

Water which runs into estuaries and the ocean is not wasted. It isn't a waste to allow the marine ecosystem to be nourished through a healthy environmental flow discharging from rivers and streams.

Freshwater flow into estuaries:

- **enriches the marine environment with nutrients;**
- **increases the range of habitats by providing a more diverse range of pH and**
- **provides lower salinity which benefits a whole range of species which otherwise would not be present.**

The reduction of environmental flows through impoundments or diversions adversely impacts on the health and productivity of estuaries.