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Monitoring Your Estuary
A Methods Manual for Communities
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The manual may be distributed to other interested individuals and organisations. Readers are warned against relying solely on the information contained herein. Further professional advice should be sought before acting on the information supplied in this manual.

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1. Introduction

How to use this manual
The EstuaryWatch Estuary Monitoring Methods Manual is a guide for individuals and groups to the community monitoring component of EstuaryWatch (see Section 3 for explanation of EstuaryWatch). It provides you with all the necessary information you will need to start monitoring your local estuary. The Manual explains the relevance of each parameter monitored, the procedure for each test and the order in which the monitoring tests should be taken. Sampling procedures, equipment maintenance, safety considerations and quality control procedures are also explained.

The Manual is presented in a ring binder folder to enable updates and local adaptations to methods to be inserted or removed as needed.

The information presented in this Manual follows the procedures as recommended by instrument and test kit manufacturers, as well as by experts in the estuarine monitoring field. The information should be used to supplement the training and information provided by the EstuaryWatch Coordinator.

In addition to the use of this Manual, a monitoring plan should be developed for your estuary of interest with the EstuaryWatch Coordinator. The monitoring plan will provide guidance for where and when monitoring should take place giving consideration to the particular estuary and community involved in monitoring.

If you have any questions regarding the contents of this Manual, or would like further information about the EstuaryWatch Program, please contact:

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2. Estuaries

What is an estuary?

Estuaries are the places where rivers and the sea meet. They are typically semi-enclosed coastal bodies of water with a connection with the open sea and within which sea water is measurably diluted with fresh water from land drainage\(^1\).

Unlike many features of the landscape that are easily described, estuaries are transitional zones that encompass a wide variety of environments. Located as they are at the interface between the ocean and freshwater streams, they include different habitats along their length and act as a transition zone from freshwater to marine habitat. They are dynamic and highly productive ecosystems.

How do estuaries function?

Habitats in estuaries include shallow wetlands, saltmarshes, mangroves, seagrass beds, sandy and muddy sediments as well as the water column itself. These habitats support a range of waterbirds, fish and invertebrates. The survival, health and distribution of these plants and animals are dependent on various physical and chemical processes operating in each estuary.

The most important of these processes is the movement and mixing of fresh and salt water. The degree of tidal influence and amount of freshwater determine how long and often different areas of an estuary are under water.

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Figure 1: Estuaries within the Corangamite CMA Region
3. What is EstuaryWatch?

EstuaryWatch is a new program initiated by the Corangamite Catchment Management Authority (Corangamite CMA) and the Western Coastal Board in 2006 to address the growing interest and need for local communities in the Corangamite region to learn more about their local estuary and contribute positively to its management. Funding was secured through the National Action Plan for Salinity and Water Quality, the Victorian Government’s Our Water Our Future Action Plan funding and Alcoa Australia.

The EstuaryWatch program is guided by a Steering Committee consisting of representatives from the Corangamite CMA, the Western Coastal Board, CoastAction/Coastcare, Parks Victoria and Corangamite Waterwatch. In consultation with community members and other government organisations in the Corangamite Region, the following vision for EstuaryWatch was developed:

Raise awareness and provide educational opportunities to the community in estuarine environments. Enable communities and stakeholders to better inform decision making on estuarine health.

An important part of achieving this vision is through a framework for community monitoring and assessment of estuary health. This Manual outlines how to undertake this monitoring.

The EstuaryWatch Program will also undertake liaison, promotional and educational activities aiming to:

- raise community awareness of estuaries and their links to catchment and coast;
- provide opportunities for community engagement; and
- facilitate better communication between communities and government on estuarine health issues.

As EstuaryWatch is a new program it will grow and develop according to the desires of the community in the Corangamite region. If you have any ideas, concerns or queries please pass this on to the EstuaryWatch Coordinator or any representative of the Steering Committee. Contact details for the Steering Committee are:

**Corangamite CMA (Chair):**
Greg Peters, Team Leader, River Health Operations
ph: 03 5232 9100

**Western Coastal Board:**
Steve Blackley, Executive Officer
ph: 03 5226 4925

**CoastAction/Coastcare:**
Dianne Moore, Facilitator
ph: 03 5226 4669

**Parks Victoria:**
Mark Rodrigue, Marine Coasts and Catchments Officer
ph: 03 8627 4845

**Corangamite Waterwatch:**
Michelle Anderson, Scientific Coordinator
ph: 03 5226 9268
4. EstuaryWatch
Community Monitoring

What is monitoring?
Monitoring can be defined as the continuous or repeated observation, measurement, and evaluation of health, environmental or technical data for defined purposes, according to prearranged schedules in space and time, using comparable methods for sensing and data collection.

Confused? In a nutshell, monitoring means observing what is happening to different aspects of the environment over time in a coordinated and scientific manner.

Why monitor?
There are many things we do not know about our estuaries here in the Corangamite region. There has never been a long-term collection of estuarine data in any of our estuaries through a monitoring program.

Monitoring an estuary over time provides vital information for maintenance of estuary health. It also provides a baseline to compare future measurements of the estuary against. Estuaries change naturally over time scales from hours to decades. Understanding when and how these changes happen and which changes are caused by human impacts is crucial for managing estuaries for the future.

Estuaries are highly valued ecosystems, but rising populations and human use are placing increasing pressure upon them, causing many changes. Some changes are visible, for example, destruction of habitat, but many are long term, gradual or not visible to the human eye.

By monitoring an estuary over the long term, the status of indicators can be determined (i.e. whether they are stable, improving or declining) and early changes can be detected. Without monitoring it would be very difficult to prove or gauge the amount of change.

EstuaryWatch Monitoring Arrangements
EstuaryWatch community estuary monitoring will be a means of gathering information about the condition or ‘health’ of an estuary and to understand changes that may be occurring. It will consist of a combination of observations or measurements of the characteristics of the water itself, of the shoreline and bed of the estuary, and also of the animal and plant life in and around the water.

When undertaking EstuaryWatch Estuary Monitoring, a core set of parameters is measured on a regular basis. These are estuary mouth state, water levels, the upper extent of the estuary, turbidity, water colour and depth profiling of temperature, salinity and dissolved oxygen. These parameters, once measured, provide a basis for understanding how your estuary functions, that is, the natural processes that occur in the estuary.

This information is not currently available for estuaries in the Corangamite Region and your monitoring will provide unique, interesting and very useful data on your estuary’s natural processes. An understanding of these processes underpins and provides meaning to all
other monitoring and observations that can be made about the estuary.

If so desired, additional parameters can be measured through EstuaryWatch on top of the core parameters. This will provide a greater understanding of the processes, ecology and/or human interaction with the estuary.

Core Monitoring

Estuary Mouth State/Water Levels
As most Corangamite estuaries are strongly influenced by sandbars at their mouths, photopoint monitoring of the mouth of the estuary at regular intervals will tell us a lot about the processes which are going on in the estuary. These observations combined with flow gauge and depth level readings will be very helpful when managing estuary mouth openings.

Water quality: Physico-chemical Water Parameters
Monitoring for physical/chemical parameters within the estuary will provide a useful indication of the health of the estuary through telling us what is going on at different depths.

Corangamite Waterwatch monitors collect surface water samples and test for a range of physical and chemical parameters. Due to the dynamic nature of estuaries, with influences of fresh and salt water often varying with depth, EstuaryWatch monitoring will require the collection of water samples from different water depths and will only test for a smaller range of parameters which provide information on estuarine processes.

EstuaryWatch water quality monitoring will consist of monitoring temperature, salinity, dissolved oxygen, turbidity and water colour at different depth levels at several different sites along the estuary. Your monitoring plan will determine the location of monitoring sites and regularity of monitoring.

Core monitoring also includes the determination of the upper extent of the estuary. This is achieved through testing for salinity.

Additional Monitoring
In addition to core monitoring, there are many other aspects of estuaries that can be monitored. The importance of monitoring any of these aspects depends on the nature of any particular estuary. These parameters typically do not need to be monitored as regularly as the core estuary process orientated monitoring. Additional monitoring is encouraged, as long as you are also monitoring the core parameters. The EstuaryWatch Coordinator will provide you with advice and assistance on developing methodology for additional monitoring.

A monitoring plan will be tailored for each estuary, identifying the components of monitoring to be included and frequencies of sampling required. These plans will also be reviewed periodically.

Additional monitoring possibilities fall into three main groups:

- **Estuarine Processes** (including pH, phosphorus, land inundation/bathymetric measurements and mapping upper extents of marine influence);
- **Estuarine Ecology** (including habitat mapping and wetland, seagrass, fish, bird and macroinvertebrate monitoring); and
• Community Use, History and Values (including human use surveys, oral histories, fishing surveys and landscape status monitoring).

If there are other aspects of your estuary that you think are important and would like to monitor please contact the EstuaryWatch coordinator.

How will EstuaryWatch Monitoring Data be Used?
Data collected will enable us to build an understanding of what the natural processes, ecology and community values of an estuary are. It will form a database for estuaries of the Corangamite Region that will act as a baseline and allow changes in the estuaries through time to be analysed. This will be a valuable long-term source of information that can be used to support any other estuary health information being gathered by management agencies or more intensive but shorter term estuary studies.

Data will be regularly evaluated by the EstuaryWatch Coordinator using comparison with appropriate reference values. If at any stage, monitoring results indicate a possible threat to estuarine health the appropriate authorities will be notified immediately and action taken to investigate the issue. EstuaryWatch monitors will be kept fully informed of any actions taken in this instance.

The data will be public information and as such may be utilized by a number of individuals, groups and organizations including but not restricted to:

• Community members and school groups involved in EstuaryWatch;
• The general community, who will gain access to community monitoring information through public distribution;
• Waterwatch and the Corangamite CMA;
• Researchers;
• Government and community bodies involved in different aspects of estuarine management including the Corangamite CMA, the Environment Protection Authority, Parks Victoria, local governments and Committees of Management.

Monitors will receive a report of their monitoring data on an annual basis, including a discussion of the data collected and any inferences that can be made from the data.
5. Safety and operating procedures

Risk Management and Safety

The most important thing in doing any environmental monitoring is your safety. The Corangamite Catchment Management Authority is committed to the health, safety and welfare of all EstuaryWatch volunteers.

At the beginning of any EstuaryWatch Monitoring Program, the EstuaryWatch Coordinator will:

- Register the contact details, personal health details of relevance to monitoring tasks and the emergency contact details of all EstuaryWatch volunteers;
- Undertake a risk assessment of all monitoring sites to inform volunteer induction; and
- Induct all EstuaryWatch volunteers in safe monitoring procedures and risk management when traveling to, and when at monitoring sites.

It is essential that all volunteers undertake this induction and register with the EstuaryWatch Coordinator before undertaking any EstuaryWatch community estuarine monitoring.

Once you have undertaken the Induction, it is your responsibility to ensure you are familiar with your monitoring site, understand your monitoring tasks and any safety procedures you need to undertake. It is also important to follow recommendations contained within the induction process on managing health and safety incidents whilst undertaking EstuaryWatch monitoring.

If at any point you are unsure of safe operating procedures to undertake whilst conducting EstuaryWatch monitoring, do not hesitate to contact the EstuaryWatch Coordinator.

Below are some tips for improving safety and identifying risks. These are only general tips and do not replace the EstuaryWatch Volunteer Induction:

- Always work in pairs;
- Always let somebody know where you are going and what time you expect to complete your monitoring;
- Due to the dynamic nature of estuaries, situations may arise where it is unsafe to access monitoring sites, e.g. during flood conditions. If this is the case, DO NOT attempt to access the sites;
- Always wear footwear and clothing suited to the monitoring sites you are visiting;
- If possible, carry a mobile phone and a first aid kit;
- Take food and water with you;
- When sampling from a canoe or boat make sure you have and use all required safety equipment;
- If sampling from a road bridge wear bright reflective clothing to ensure you are easily seen and be very wary of road traffic;
- Check tide timetables before going monitoring to avoid being trapped by rising or falling tides;
- Keep a prepared list of emergency contact numbers (e.g. police, ambulance, EstuaryWatch Coordinator, EPA).

If at any point you feel uncomfortable about the
conditions of the monitoring site or your surroundings, immediately stop monitoring and leave the site. Your safety is more important than the data!

Being a good EstuaryWatch Ambassador

Most likely you have become involved in EstuaryWatch as you live near an estuary that you value and care about. It is also important to respect other people who value and use estuaries in different ways.

When you are out in the field undertaking EstuaryWatch monitoring you will be representing the EstuaryWatch Program. Take this opportunity to be a good ambassador for EstuaryWatch and the estuary itself! The following are some general tips on ethics and courtesy for EstuaryWatch:

- Be considerate with data use. Do not use results to single out individuals or a business that may be contributing to a perceived problem, as they may be unaware that they are doing so. Always report data to the EstuaryWatch Coordinator in the agreed manner. If you have any concerns regarding the implications of the data please first discuss this with the EstuaryWatch Coordinator.

- Do not rush out and make comments about ecosystem health to the media or local community based on just a few monitoring tests. This is a quick way to discredit your EstuaryWatch Monitoring Program. Remember, it may require several years of data to paint an accurate picture of what you are monitoring.

- Let local landholders, authorities and businesses know why, when, where and how you are monitoring – even better, involve them.

- Never enter private property without the prior permission of the landowner.

- Always remove your rubbish.

- Always leave any gates as you found them – open or closed.
6. Inventory of EstuaryWatch Monitoring Equipment

- This manual
- Data sheets
- Digital camera
- Meter (see below)
- Distilled water
- Conductivity standard solutions – 0.1M KCl & 0.4M KCl
- Tissues
- Sample bottles
- Remote sampler
- Turbidity tube
- Ule Scale, Sea State, Freshwater Inflow and Beaufort Wind Strength Scale Sheet
- White laminated paper
- Equipment for additional monitoring as applicable

The EstuaryWatch Community Estuarine Monitoring Kit your EstuaryWatch group will be supplied with will contain one of the following types of meters:

**YSI meter**
- Model 85 Oxygen, Conductivity, Salinity and Temperature meter and probe
- Spare membranes for dissolved oxygen probe
- KCl solution for dissolved oxygen probe
- 6 spare AA alkaline or nickel metal hydride batteries for meter
- YSI manual

**Hach meter**
- HQ40d meter
- Conductivity probe
- LDO (luminescent dissolved oxygen) probe
- Duct or electrical tape for DO calibration
- 4 spare AA alkaline or nickel metal hydride batteries for meter
- Hach manual

OR
7. EstuaryWatch Monitoring Methods

Overview
This section of the Manual outlines how to undertake EstuaryWatch community estuarine monitoring. Monitoring methodology for the core set of parameters for EstuaryWatch is detailed and a short explanation given for the reasoning behind monitoring each parameter. There are three main components of the core monitoring: mouth State, water levels and physico-chemical parameters. Combined, these provide a record of mouth dynamics, the degree of current marine influence in the estuary, likely inundation of habitat types and environmental conditions in the waters of an estuary.

Timing of Monitoring
An EstuaryWatch Monitoring Plan for each estuary will be developed by the EstuaryWatch Coordinator in conjunction with each EstuaryWatch Monitoring Group. This plan will detail when, where and what the group will monitor. This monitoring plan will be developed giving consideration to the interests, capabilities and skills of each group. The plan will be developed in consideration of the following general guidelines for timing of monitoring.

EstuaryWatch monitoring aims to develop a dataset that will help us understand the processes which are going on in an estuary. Therefore, it is important that monitoring occurs regularly, at the minimum monthly.

If possible, it is also important that monitoring occurs during an irregular event such as a high rainfall period or before, during and after an estuary opens, or when an algal bloom or fish kill is noticed. For example, if dissolved oxygen levels and photopoint monitoring were taken over the short time period in which an estuary mouth was artificially opened, we would be able to obtain some very useful information about what is happening within the estuary during this time frame.

Monitoring methods outlined in this manual are appropriate for regular monitoring and for monitoring during irregular events. More care should be taken when monitoring during irregular events as unusual weather conditions may compromise access or safety at a monitoring site. If at any point, safety is not assured whilst undertaking monitoring, the EstuaryWatch monitor should cease monitoring immediately and leave the site in a safe manner.
8. Estuary Mouth State

Why do we monitor the estuary mouth?

An important aspect of estuary health is the flow of the water itself. Many estuaries in the Corangamite region are river dominated estuaries with intermittently opening connections to the sea. Therefore, the hydrology of estuaries can be very changeable - freshwater and saltwater are both present in differing amounts dependent on a variety of factors including whether the mouth is opened or closed (see Appendix A and B) as well as the degree of mixing, water levels and the immediate history of conditions in the estuary. The dynamics between fresh and saltwater and the depth of water within the estuary are important factors in determining the health of the estuary and the species found within it.

For a number of reasons management agencies sometimes have to open estuary mouths artificially, the decision to open the mouth requires good data on estuarine processes. This data has not been available in the past and EstuaryWatch will provide valuable data for this through photopoint monitoring in conjunction with measurements of water level.

Methods

Location & Timing

- At set points at the estuary mouth as determined by EstuaryWatch Monitoring Plan.
- If possible, take photos and record water levels near high and low tide or estimate the amount of change in water level with the tide.

Equipment

- Digital camera
  - Always use the same camera if possible. If different cameras are to be used, make sure you determine how to align their settings to ensure similar photographs are taken. Most importantly they must have the same field of view. Each camera should be given an ID code to record on the data sheet.
  - Understanding the features and functions of your camera is always a good starting point! Check if a tripod will add clarity to your photos. A tripod (or something to lean your camera on) may be especially helpful if you take any photos in low light conditions. If you have one, a polarizing lense may be especially helpful for removing reflection (from the water) from your photos. However, be wary of vignetting (darkening of corners due to occlusion of the image by the polarizer ring);

- Estuary Mouth Condition Data Sheet (Yellow).

Procedure

a. Record your name, the estuary, mouth state, date and time on the data sheet;
b. Observe and record if there is any flow in the estuary and its direction;
c. Take photo(s);
d. Write which photopoint you are taking pictures from, the
number of pictures and the time pictures were taken;
e. Estimate and record the berm height above sea level and estuary water level.

Techniques used

Photopoint Monitoring

The concept of Photopoint Monitoring is very simple – it is about taking a photograph of the same location at specific time intervals. It gives a good general overview or inventory of a situation, landscape or environment and allows you to gauge temporal and spatial trends in a more objective way than through memory or written notes.

It is important that photopoint monitoring can be easily replicated by different people over time, hence consistent data collection is crucial. That’s where you come in!!

Through photopoint monitoring we are aiming to show the estuary mouth and its relationship to the surrounding area. We aim to document changes on or around the estuary entrance over time, whether long term or short-term over the course of an ‘opening’ or storm event. The photopoint monitoring will help interpret other data collected.

The Photo Point: Establishing Position of Photographer

1. The EstuaryWatch Coordinator will help you set up the photo point for monitoring. This is a set place where the photographer will always stand to take the photo. In your monitoring plan the photo-point position will be marked on a map and the position described in words in relation to the set landmarks you are using. A photo of a photographer standing in the photo point location will also be included.

Photopoint Monitoring: Taking The Shots

- Always take each photo from the same position (photo point), and at the same compass bearing and photo angle, i.e. stand at the same level when taking photo. Refer to copies of previous photos when arriving at the photo point.
- Try to maintain a level (horizontal) camera view.
- Always place the landscape reference point (such as a fence post, building, large tree) in the same place within the picture frame (in the case of Figure 1 it is the lighthouse in the top left-hand corner).
- If for some reason an important feature in the landscape relative to the estuary mouth at that point in time is not included in the normal photopoint shot, take a second photo of this feature along with the normal photopoint shot.
- Remember that you are photographing to provide information – not to show artistic flair!

Figure 1
9. Water Levels and Tidal Changes

Why do we monitor water levels and tidal changes?
The depth of water within an estuary changes over time. These changes can be due to a number of different reasons such as changes in flows coming from upstream, changes in flows through the entrance channel (including the amount of tidal influence) and loss of water from the estuary to the ocean through estuary mouth openings.

Depth data, when linked with other parameters monitored can provide an important link in the information about the processes that are going on in the estuary such as the length of time that water is resident in the estuary and relative amounts of fresh and salt water entering and leaving the estuary. These processes in turn affect other parameters being measured such as dissolved oxygen and salinity as well as determining which habitats are wet and for how long.

Daily changes in water levels in Corangamite estuaries can vary from zero, when a mouth is fully closed, to around 1.4m, with near-full tidal influence. Over time, changes in water level have reached at least 1.6m.

Methods

Location and Timing
- Monitoring will take place at depth indicators or at sites set in EstuaryWatch Monitoring Plan for depth measurement.

- Water levels should be measured at the same time that estuary mouth state is monitored, as well as before and after depth profiling of physico-chemical parameters. If possible, regular (ideally daily) measurements of water height and records from high and low tide heights will build up a picture of how the estuary is functioning over time.

Equipment
- Tide tables
- Meter rule or measuring tape (if no gauge installed)

Procedure
a) Record date and time;
b) Record the nearest two tide heights and times for the closest location in tide charts;
c) Record water level on fixed gauge visually.
10. Weather and Conditions

Why do we monitor weather and conditions?
Weather patterns and other changeable conditions such as sea state and freshwater inflow provide valuable information about an estuary. These conditions have great influence over the state of an estuary and provide valuable data for interpretation of other parameters monitored through EstuaryWatch.

Methods

Location and Timing
- All physical conditions are to be reported as close as possible to the same time as estuary mouth condition monitoring.
- Monitoring will take place at the monitoring site closest to the mouth of the estuary for wind direction and wind strength observations.
- Sea State is to be monitored at a point where a good view of the ocean can be achieved.
- Freshwater inflow is to be taken at a point above the upper extent of the estuary as set out in your Estuary Monitoring Plan.
- Record all current parameters.
- If you know what the conditions have generally been like for the last 2 weeks enter them also (assuming your EstuaryWatch group has not monitored in the last 2 weeks). If you do not know what conditions have been like, DO NOT guess, leave this section blank.

Equipment
- Beaufort Wind Strength Scale (see Table 1)
- Sea State Table (see Table 2)
- Freshwater inflow explanatory table (see Table 3)
- A stick to throw in for freshwater inflow testing

Procedure
- a) Record the wind direction, i.e. N, NE, E, SE, S, SW, W or NW;
- b) Observe the wind strength and record according to the Beaufort Wind Strength Scale;
- c) Observe the sea and record the sea state according to the Sea State Table;
- d) Throw stick or object into the water at freshwater inflow monitoring site and record movement (or lack thereof) accordingly.

Note: Many estuaries in the Corangamite region have a flow gauge on them which will provide freshwater flow information. In these cases freshwater flow will not need to be determined and recorded.
This scale gauges wind speed through the use of observations of the winds effects on trees and other objects. It is often used in monitoring projects because it is simple to understand and does not require specialized equipment.

Example: A "light breeze" is recorded as 2 on the Beaufort Scale.

<table>
<thead>
<tr>
<th>B. No</th>
<th>Approx Speed</th>
<th>Classification and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&lt; 2 km/h</td>
<td>Calm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Still, smoke will rise vertically.</td>
</tr>
<tr>
<td>1</td>
<td>2 to 5 km/h</td>
<td>Light Air</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rising smoke drifts, weather vane is inactive.</td>
</tr>
<tr>
<td>2</td>
<td>5 to 12 km/h</td>
<td>Light Breeze</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaves rustle, can feel wind on your face, weather vane is active.</td>
</tr>
<tr>
<td>3</td>
<td>12 to 20 km/h</td>
<td>Gentle Breeze</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaves and twigs move around. Light weight flags extend.</td>
</tr>
<tr>
<td>4</td>
<td>20 to 30 km/h</td>
<td>Moderate Breeze</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thin branches move around, raises dust and paper.</td>
</tr>
<tr>
<td>5</td>
<td>30 to 40 km/h</td>
<td>Fresh Breeze</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trees move and sway.</td>
</tr>
</tbody>
</table>
**Table 2: Sea State Table**

The Sea State Scale is a standard method of observation and recording of sea waves. These are waves generated by the wind blowing at the time, and in the recent past, in the area of observation. The Australian Bureau of Meteorology utilizes this scale.

<table>
<thead>
<tr>
<th>SEA [in open sea]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Calm (glassy)</td>
</tr>
<tr>
<td>Calm (rippled)</td>
</tr>
<tr>
<td>Smooth</td>
</tr>
<tr>
<td>Slight</td>
</tr>
<tr>
<td>Moderate</td>
</tr>
<tr>
<td>Rough</td>
</tr>
<tr>
<td>Very rough</td>
</tr>
<tr>
<td>High</td>
</tr>
<tr>
<td>Very high</td>
</tr>
<tr>
<td>Phenomenal</td>
</tr>
</tbody>
</table>

**Table 3: Freshwater Inflow Analysis**

<table>
<thead>
<tr>
<th>Dry</th>
<th>No water present.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pool</td>
<td>Water present but no flow.</td>
</tr>
<tr>
<td>Slow</td>
<td>Pool-like but flowing.</td>
</tr>
<tr>
<td>Med</td>
<td>Turbulent non-broken water.</td>
</tr>
<tr>
<td>Fast</td>
<td>Turbulent broken water.</td>
</tr>
</tbody>
</table>

To test for flow throw a stick or small biodegradable object into the centre of the waterway at the freshwater inflow site as set out in your EstuaryWatch Monitoring Plan. If the object moves in a constant direction this indicates flow.
11. Physico-chemical Parameters: Depth Profiling

Three water quality parameters are measured at differing depths within the estuary: temperature, salinity and dissolved oxygen.

Why monitor temperature, salinity and dissolved oxygen?

Estuaries are dynamic systems. The ratio of freshwater to saltwater is dependent on tide, freshwater flows, season and how recently the mouth of the estuary has opened. The vertical profile of each of these types of water, the amount of dissolved oxygen available in the different layers of water and the temperature also changes within and along the estuary.

By monitoring the physical and chemical components of the water within the estuary regularly, EstuaryWatch monitors can develop a dataset which indicates what processes may be occurring in that particular estuary at different times of year. This in turn will tell us about the nature and changeability of the environment that the estuary provides for animals that visit it. It will also go some way to explaining the habitat types found within the estuary. More information on specific parameters is included below.

Temperature

Water temperature is a key factor controlling the rate of biological processes, for example algal growth. For every 10°C increase in temperature, the rate of biological processes almost doubles. This is why algal blooms and deoxygenation are much more likely in summer than in winter.

Temperature is a key influence of the physical environment on aquatic plants and animals. It also affects other physico-chemical variables, such as the density of water, rates of electrical conductivity and the maximum amount of oxygen that can be dissolved in a water body. As water temperature increases, its capacity to hold oxygen decreases, which in turn can affect aquatic organisms.

Temperature changes can occur naturally as part of normal daily and seasonal cycles, or as a consequence of human activities. For example, loss of riparian vegetation can lead to temperature increases in streams or estuaries.

While artificially warm or cold waters are not common in estuaries of the Corangamite region, accurate measurement of temperature is important for:

- determining the range of temperatures that estuarine plants and animals experience;
- understanding hydrodynamic processes of your estuary; and
- accurately recording salinity and dissolved oxygen.
The temperature of an estuary can vary depending on air temperature, time of day, water depth and the relative influences of fresh and salt water in any given time or place. In the Corangamite region, river inflows typically are warmer than marine waters in summer and cooler than marine waters in winter. Estuaries thus tend to have intermediate temperatures while open. When estuaries are stratified, it is common for each layer of water to have a different temperature.

Expected Results
Temperature is measured in degrees celsius. There are currently no guidelines for acceptable temperature levels in estuaries as there is insufficient data to establish a guideline. By gathering temperature information through EstuaryWatch we will be able to build up some reference data. This will enable us to develop an understanding of temperature fluctuations within estuaries in the Corangamite region.

Salinity
Salinity is a measure of the amount of dissolved salts that are in a water sample. It is measured in parts per thousand (ppt). Fresh water has a salinity of less than 5ppt, while sea water has a salinity between 35ppt and 38ppt. Patterns of salinity distribution are a crucial part of estuaries, which are defined as places where fresh and salt water mix.

Salinity is also very important to aquatic plants and animals, which are adapted to live in particular ranges of salinity. Salinity patterns in estuaries depend on factors such as the size and shape of an estuary, how much fresh and salt water is entering and leaving an estuary and wind.

In estuaries, salinity largely depends on the interaction between marine and freshwater inflows. Thus, the salinity range may vary greatly between 35ppt when the tide is high to less than 5ppt in areas of low tide and freshwater inflow. Salinity is normally highest at the mouth and decreases gradually as the water moves upstream to the freshwater reaches. However, in some estuaries of the Corangamite region, when freshwater flows are low, or non-existent, evaporation in the mid reaches of an estuary can cause water to become even more saline than seawater (hypersaline) by as much as 60%.

In Corangamite estuaries, it is common for a layer of fresh water to be ‘floating’ on top of a layer of salt water (see Appendix B). This is termed ‘stratification’. The boundary between the two layers (known as the halocline) may be sharp, occurring over a small depth range, or may be blurry, over a larger depth range. At times, waters in the estuaries may also mix, leading to an essentially homogeneous water body. The occurrence and timing of these patterns is an important part of what kinds of plants and animals are able to use the estuary.

The meters used for EstuaryWatch do not directly measure salinity. They measure the electro-conductivity (EC) of the water sample. The EC is then automatically temperature-corrected by the meter to result in a number that compares the amount of salt present in your sample to an international standard ‘seawater’ sample. An increase in salts and/or temperature in turn increases the electro-conductivity. The meter then converts this EC measure to salinity in ppt.
Expected Results
Each estuary has a relatively consistent range of salinity values, which once known can act as baseline data against which to compare regular measurements of these variables.

<table>
<thead>
<tr>
<th>Units Measured</th>
<th>Expected Range</th>
<th>Results to note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts Per Thousand</td>
<td>5 to 38</td>
<td>&lt;5 freshwater &gt; 38 the estuary is hypersaline.</td>
</tr>
</tbody>
</table>

Dissolved Oxygen
Dissolved oxygen is essential for a healthy and diverse water body. It enters estuarine waters by mixing in from air at the surface and from estuarine plants photosynthesizing during the day.

Dissolved oxygen is used by animals and most microbes and by plants during the night. Without enough dissolved oxygen, estuarine animals will die or move elsewhere. Examples of this have been seen in fish kills throughout western Victoria.

At times in Corangamite estuaries, it is possible for the fresh water layer in a stratified estuary to ‘blanket’ the salt water layer. If this occurs for long enough animals and microbes living in the lower waters and sediments can use all the oxygen in the bottom layer. At such times there is a particularly high risk of fish kills from sudden draining of the surface layer, such as in an artificial mouth opening. During algal blooms it is common to observe very high levels of dissolved oxygen during the day, followed by low levels through the night.

Dissolved oxygen can be recorded in two ways. The first, mg/L represents the number of milligrams of oxygen per litre of water. Most animals and plants can grow and reproduce unimpaired when dissolved oxygen levels exceed 5mg/L. When levels drop to 3-5mg/L living organisms become stressed.

The second way of recording dissolved oxygen is as percent saturation and is more biologically relevant than mg/L. Percent saturation refers to the highest dissolved oxygen concentration possible in a water sample under the limits of temperature, salinity and atmospheric pressure. As salinity increases, the amount of oxygen that water can hold decreases substantially. For example, at 20°C, 100% dissolved oxygen saturation for freshwater is 9.09mg/L. At the same temperature, 100% saturation for seawater is 7.34mg/L.

Measurements of percent saturation of dissolved oxygen will typically range from 0% to 100%, but can exceed 100% at times when large amounts of oxygen are being produced by plants and algae. When levels greatly exceed 100% saturation this can indicate an unhealthy imbalance in the estuarine system and potentially an algal bloom. Most animals and plants can grow and reproduce unimpaired when dissolved oxygen levels exceed 80%. When levels drop to less than 80% living organisms can become stressed.

Percentage saturation values should be used for estuaries because the solubility of oxygen is affected by both the temperature and the salinity of the water.
**Expected Results**

<table>
<thead>
<tr>
<th>Units Measured</th>
<th>Expected Range</th>
<th>Results to note</th>
</tr>
</thead>
<tbody>
<tr>
<td>% saturation</td>
<td>0 to 200 %</td>
<td>&lt;80% not optimal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;110% not optimal</td>
</tr>
<tr>
<td>mg/L</td>
<td>5mg/L and greater.</td>
<td>&lt; 5mg/L not optimal</td>
</tr>
</tbody>
</table>

**Methods**

**Location and Timing**
- 5 set monitoring sites within the estuary which are representative of the entire estuary will be detailed in your EstuaryWatch monitoring plan. Testing is to take place at each of these sites.
- Take profiles in the deepest part of the estuary at each monitoring site.
- Mouth state should be recorded on the same day as depth profiling and water level should be recorded before and after sampling.

**Equipment**
- Multi-parameter meter. This meter measures for temperature, salinity and dissolved oxygen. The meter is attached to a lead on the end of which is a probe. The lead is 15 metres in length which allows the probe to be lowered to a certain depth at which measurements can be taken.
- Extension pole. This is to be used to extend the meter probe out from the bank of an estuary or from a jetty over the water. This will enable you to sample deeper water away from the bank.
- Weight and cable tie. A fishing ‘sinker’ should be attached to the end of the probe when sampling in stronger currents. The weight enables the probe to hang vertical. This allows for more accurate depth measurements. It is not necessary to use the weight in low flow conditions.
- Depth-profiling data sheet (Green).

**Procedure**
- a. Measure oxygen, salinity and temperature at different depths.
- b. Record details in data sheet.

**Techniques used**
- a. Replace oxygen membrane and calibrate meter if required – parts of this can be done at home before the sampling trip. See Appendix C or D as appropriate for calibration methods.
- b. Record calibration on EstuaryWatch Calibration Record Sheet.
- c. Rinse the probe with distilled water.
- d. Paddle boat (or walk over structure such as bridge) until you are approximately mid-stream or at the known deepest point, such as the channel.
- e. Be sure to measure the depth from the surface of the water, not from the bridge or boat you are on.
- f. Lower the probe into the water to a selected depth. Take measurements (according to instrument instructions – see Appendix C or D depending on your meter type) at 10cm below surface level and record in EstuaryWatch data sheet, then take readings at 50 cm, 100cm, then 150cm and so on in 50cm intervals until the bottom of the water column is reached.
- g. For the last reading at the bottom, raise the probe 10cm above the
bottom and record the depth in the last row on the datasheet.

h. Allow 1 minute for readings to stabilize at each depth and gently bounce the probe (~1cm) as you measure. Try not to disturb sediments on the bottom of the estuary.

i. Once you have recorded measurements for the bottom of the water column, look at the measurements you have recorded for the depth intervals before you reached the bottom. Try and determine the degree of stratification and, if stratified, the depth range of the freshwater/saltwater interface. This can be estimated from measurements already recorded or, if the halocline is sharp, further measurements can be taken to more closely define the depth of this interface. Checking measurements while lifting the probes up is a good check on the original measurements.

j. When you have finished measuring rinse the meter in distilled water and replace probe in storage chamber. This is important as the oxygen membrane must remain moist. Then move on to the next monitoring site.

k. After you have sampled all sites, wash the probe and lead in tap water making sure to remove all mud. Wipe excess water off the meter itself with a soft wet cloth.

Two further measures of water quality complete the core monitoring program, turbidity and water colour. These are measured in water samples from the top and bottom of the water body at each monitoring site.

Why do we monitor turbidity?

Turbidity is an indirect measure of the suspended solids in the water. As the amount of suspended solids in the water increases, the turbidity increases, i.e. the depth that light can penetrate is reduced.

The suspended solids may consist of sediments or of plankton, including both algae and animals. Turbidity is affected by numerous factors including rainfall and catchment run-off, soil erosion, riparian vegetation, salinity, tidal flow, stormwater and algal growth.

Large variations generally occur in turbidity in the Corangamite region’s estuaries depending on chemical, physical and biological factors. Therefore interpreting turbidity readings requires measurements to be made over a long period of time to determine the natural turbidity in your estuary.

Unnaturally high turbidity can be an indication that the amount of light reaching plants on the bottom of the estuary is limited. It can also be a sign of high sediment loads that can stress filter-feeding animals like pipis and other shellfish.

Apart from making the water look muddy, unnaturally high levels of turbidity can have other negative effects. The reduced light reaching the estuary floor can affect plant growth, and has been recorded as reducing the extent, range depth of seagrass beds. Fine particles can clog the gills of fish, or hinder their ability to spot prey. Nutrients, heavy metals and other pollutants can attach themselves to the fine particles, resulting in increased nutrient and pollutant levels.

Methods

Location and Timing

At 5 set points within the estuary as per depth profiling.

Both parameters are measured from two water samples, one from the surface and one from bottom waters. Locations for these samples should be the same as for depth profiling.

Equipment

- EstuaryWatch Physico-chemical data sheet
- Remote sampler (extendable pole)
- Sample bottle
- Turbidity tube

Procedure

a. Collect a sample of water from 10 cm below the surface.
b. Stand with your back to the sun and the turbidity tube at arms length and at right angles to the ground.
c. Gradually pour the water sample into the turbidity tube. Stop pouring when the wiggly black lines become barely visible.
d. Note the N.T.U. reading on the tube. If you fill the tube to the top and the lines are still visible the reading is taken as <10. If the reading is greater than 200, dilute the sample 1:1 with distilled water and repeat testing procedure. If the sample has not been diluted it can also be used for water colour testing.
e. Collect a sample from 10 cm above the bottom and repeat above procedure.
f. Wash tube in tap water at the end of sampling.

Why do we monitor water colour?
In conjunction with other information, the colour of the water in an estuary can tell us a number of things about the processes going on within the estuary and has the potential to indicate estuarine health. Building up a long-term database of water colour will provide information on colour changes and potentially enable us to develop links between threats to estuaries and colour changes over time.

The colour of water in estuaries can be affected by organic substances flowing in to the estuary (especially from trees), by algal blooms within the estuary, by sediments carried into the estuary and, very occasionally, by chemical reactions at the fresh/salt water interface. At times when there is strong tidal exchange and flow, the location of the salt wedge can be seen as a colour discontinuity.

Methods

Location
At 5 set points within the estuary as per depth profiling.

Equipment
- EstuaryWatch Physico-chemical data sheet
- Pole, or other, remote sampler
- Sample bottle
- Ule colour scale card (Figure 2). The Ule colour scale consists of a series of standard coloured strips encased in a plastic card. The 6 “U” Ule Scale are estuarine colours. Water colour is best determined when viewed against a white background;
- Clear container or turbidity tube;
- White sheet of paper.

Procedure
a. Collect a sample of water from 10 cm below the surface of the water approximately mid-stream, or reuse an undiluted turbidity sample;
b. Hold this sample against the white paper as background.
c. Using the Ule colour scale card (Table 3), find the colour which most closely matches the colour of the water and record the corresponding U Scale number. If the water colour does not match any of the codes but seems to lie somewhere in between, then record the intermediate number, e.g. U6.
d. Collect a sample from 10 cm above the bottom (or re-use the undiluted turbidity sample) and repeat above procedure.
Figure 2: Ule Scale – Estuarine Water

![Ule Scale - Estuarine Water](image)

Table 3: Ule Colour Codes based on comparison with colour card

<table>
<thead>
<tr>
<th>Code</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>Green</td>
</tr>
<tr>
<td>U3</td>
<td>Yellowish Green</td>
</tr>
<tr>
<td>U5</td>
<td>Khaki</td>
</tr>
<tr>
<td>U7</td>
<td>Olive</td>
</tr>
<tr>
<td>U9</td>
<td>Greenish Brown</td>
</tr>
<tr>
<td>U11</td>
<td>Brown</td>
</tr>
</tbody>
</table>
13. Reporting Data
All data and notes should be recorded on EstuaryWatch data sheets. You will be provided with carbon paper which will enable you to make copies of all your data sheets for you to retain for your own records.

Photos
You will need access to email in order to download and send photos to the EstuaryWatch Coordinator. Photos should be emailed in as high a resolution format as possible. Associated data sheets can be filled in electronically and emailed; or printed, written on and posted. All data and photos will be placed on the EstuaryWatch database.

If you are emailing more than one photo and datasheet from a different photopoint monitoring event in the same email, be sure that it is clear which photo links to which data sheet.

If you do not have access to email you will be provided with CDs for you to place photos onto and you can mail these in to the Corangamite CMA at the address below.

Data Sheets
Data sheets must be sent to:

Corangamite CMA
PO Box 159
Colac VIC 3250

You will be provided with a set of postage paid envelopes for this purpose.
14. **Data Confidence:** Ensuring your information is credible

The quality of data is important – it must be of a certain standard if it is to be useful. The EstuaryWatch Program achieves this through employing Quality Assurance and Quality Control.

**Quality Assurance (QA)** is an integrated system of activities to ensure that data meets defined standards. These activities include quality planning, control, assessment, reporting and improvement.

The aspects of QA already covered in this manual are monitoring procedures for each parameter, calibration procedures (including collection of metadata), some equipment maintenance and documentation requirements.

**Quality Control (QC)** is the system of activities whose purpose is to measure and control the quality of data.

QC for EstuaryWatch will be achieved through:
- Initial induction and training of all volunteers;
- Annual refresher training for all volunteers;
- Regular equipment servicing (minimum quarterly) by EstuaryWatch Coordinator; and
- Monitors participate in split-sample analysis or mystery sample program once annually.
Appendix A: Influences on mouth status.

Source: Dr. Helen Arundel, Deakin University, Warnambool.
Appendix B: Generalised seasonal hydrological cycle.

Source: Dr. Helen Arundel, Deakin University, Warrnambool.
Appendix C: Hach meter operation and maintenance

The Hach 40d meter incorporates data logging procedures that assist with ensuring that operators and locations are recorded and that calibration of probes is current. Unless you are very confident of using the automatic data logging features, all data should also be written on the data sheets provided.

Meter Setup and Calibration

To ensure that data collected in EstuaryWatch are credible it is essential to ensure that measurements collected using electronic probes are done using accurately calibrated equipment. Full details of calibration procedures are given in the manual from Hach. The procedures listed below are a summary for quick reference.

Calibration/checks of both salinity and dissolved oxygen for the Hach meter can be done at home immediately before a sampling trip.

Salinity

Attach probes to meter and screw in clockwise. The meter display should be set to single screen mode using the arrow keys before calibration begins.

The standard solution used for EstuaryWatch monitoring is 0.1M KCl (potassium chloride). This standard is harmless and has a salinity consistent with mid-range brackish waters. Should the majority of samples in your estuary/ies be consistently higher or lower than this then please contact the EstuaryWatch coordinator for a more appropriate standard. After use, the probe should be rinsed and stored dry.

Of the two measures used to calculate salinity, only the conductivity calibration needs to be checked. Temperature will not need calibration. To check conductivity calibration:

- Rinse a clean container well with distilled water twice.
- Rinse the container three times with a small amount of standard solution.
- Fill the container enough to cover the sensor on the bottom of the probe.
- Remove the guard from the probe by unscrewing the knurled ring and insert the probe into the standard solution.
- Check the conductivity reading on the probe. The conductivity of the standard should read between 12.494 and 13.266 mS/cm (standard is 12.880mS/cm +/-3%). If the reading is outside this range, the meter will need to be calibrated. Details for this are given on page 63 of the Hach manual.
- Press ‘done’
- Replace the guard, ensuring that it is clipped into the notches on the probe.

Dissolved Oxygen

The Hach dissolved oxygen probe has a replaceable sensor that uses a luminescent method. Once installed, these sensors require little ongoing maintenance or calibration. The sensors have a limited lifespan and must be replaced once a year. A countdown to replacement will be shown on the meter when there are 30 days or less until the replacement date. Between trips the probe should be rinsed and stored dry.

Details for installing new sensor caps are given in the Hach manual and the associated LDO probe instruction sheets. A factory calibration may be sufficient for use but this should be checked.
against 100% saturated air. To check the calibration:

- Set up equipment in a shady spot
- Dry the probe, and ensure that the probe does not get wet during calibration.
- Remove the guard from the probe by unscrewing the knurled ring.
- The probe end should be placed just inside the end of a sample bottle with a small amount of water in the bottom.
- The gap between the probe body and the neck of the bottle should then be sealed using electrical or duct tape.
- Allow 5 minutes in the shade for the air in the bottle to become completely saturated with water.
- Press ‘read’
- Check that the dissolved oxygen is reading 100% (+/-1.5%)
- Press ‘done’
- Replace the guard, ensuring that it is clipped into the notches on the probe

If the factory calibration is not accurate, the sensor should be manually calibrated:

- Prepare probe as per the calibration check above.
- When the reading has stabilised, calibrate the probe as per instructions on page 80 of the Hach manual.

Operator and Sample Ids

When sampling, both operator and sample (location and depth) identification (ID) should be set to be associated with electronically recorded monitoring data. The operator ID is set using the button with a figure of a person on it. Sample ID is set with the button showing a flask (see p25 of the Hach manual).

When you start monitoring you should enter the names of all people likely to use the meter as ‘operators’. This assists quality control by ensuring that specific monitoring records are associated with individuals and can be easily followed up after the sampling event. Instructions for entering new operator ID’s are given on page 27 of the Hach manual.

Sample ID’s are associated with each individual water sample tested. In the case of EstuaryWatch, this means that there will need to be a separate sample ID for each depth at each site monitored. Date and time are automatically recorded. A suggested coding for sample ID’s is shown below.

PAIN S4 050

Translated, the first four letters are a code for estuary, in this case Painkalac; ‘S4’ refers to Site 4 (these should be numbered sequentially from the mouth to the head of the estuary); ‘050’ refers to a sample take at a depth of 50cm, other depths should also be recorded using this code, e.g. 150cm = ‘150’.

Once a full set of Sample ID’s have been entered they can be used for subsequent monitoring, although it may be necessary to add additional ID’s if water levels increase and so more depths are measured at individual sites. Instructions for creating sample ID’s are given on page 25 of the Hach manual.

Recording Monitoring Data

The HQ40d can store up to 500 records of monitoring data and calibrations. When taking readings, before pressing ‘read’. Operator ID should be set before
monitoring commences and whenever the operator changes. The appropriate Sample ID should be selected when the probe is at the correct depth, before any readings are taken.

If the salinity between depths changes by more than 1 or 2 units then it will be necessary to reset the salinity correction factor that the meter uses to calculate dissolved oxygen in % saturation before recording dissolved oxygen. This is done by altering the measurement method as detailed on pages 81 to 85 of the Hach manual.

To record monitoring data make sure that both salinity and dissolved oxygen results are showing on the screen ('multi' mode), then press the green/right button under the 'Read' label on the screen. The meter will then show “Stabilising...” until stable readings are obtained. When the reading is stable a padlock symbol will appear and the measurement is automatically recorded, along with date and time.

**Downloading Sample and Calibration Data**

Following a monitoring trip, sample and calibration data can be downloaded to a PC if you wish. Instructions for this are given on page 34 of the Hach manual.
Appendix D: YSI meter operation and maintenance

Meter Setup and Calibration
To ensure that data collected in EstuaryWatch are credible it is essential to ensure that measurements collected using electronic probes are done using accurately calibrated equipment.

Calibration/checking of salinity for the YSI meter can be done at home immediately before a sampling trip. This calibration & check will not need to be done again for the next 12 hours, no matter how often the meter is turned on and off.

Dissolved oxygen should be calibrated at the first site and after every time the meter is turned off.

Salinity
EstuaryWatch Monitoring requires the measurement of salinity not electrical conductivity (an explanation of the relationship between these two measures can be found on page 23). However, electrical conductivity measurements are used for the calibration of the YSI meter.

The standard solution used for salinity calibration for EstuaryWatch monitoring is 0.1M KCl (potassium chloride with a conductivity of 12.88mS/cm at 25°C). This standard is harmless and has a salinity consistent with mid-range brackish waters. Should the majority of samples in your estuary record consistently higher readings for salinity it may be more appropriate to use the 0.4M KCl (potassium chloride with a conductivity of 47.20mS/cm at 25°C) standard solution you have been supplied with for calibration. If you decide to do this please discuss with the EstuaryWatch Coordinator first. The following table is not necessary information for EstuaryWatch monitoring, but gives you an understanding of the standard solutions we use for calibration.

<table>
<thead>
<tr>
<th>Water type</th>
<th>Expected electrical conductivity readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh water</td>
<td>0 – 1.9 mS/cm</td>
</tr>
<tr>
<td>Brackish</td>
<td>0 - 19.90 mS/cm</td>
</tr>
<tr>
<td>Sea water</td>
<td>~ 50 mS/cm</td>
</tr>
</tbody>
</table>

Of the two measures used to calculate salinity, only the conductivity calibration needs to be checked. Temperature will not need calibration.

To check conductivity calibration:
1. Aim to be at a temperature as close to 25°C as possible. This will minimize any temperature compensation error of the meter. Inside at home before you set out for monitoring is ideal.
2. Rinse a clean container well with distilled water twice.
3. Rinse the container three times with a small amount of 0.1M KCl standard solution.
4. Fill the container with about 3 inches of 0.1MKCl solution.
5. Turn the meter on by pressing the ON/OFF button. Press the MODE button on the meter until the conductivity units mS show on the right hand side of the display.
6. Insert the probe into the jar deep enough that the oval-shaped hole on the side of the probe is completely covered. Do not rest the probe on the bottom of the container – suspend it above the bottom.
7. Check that °C units beside the temperature reading are flashing.
This shows the temperature corrected (to an international 25°C standard) reading for electrical conductivity which is required for calibration for salinity.

8. Move the probe vigorously side to side to dislodge any air bubbles from the probe electrode.

9. Wait approximately 1 minute for the reading to stabilise.

10. Check the conductivity reading on the probe. The temperature-corrected conductivity of the standard should read between 12.494 and 13.266 mS/cm (standard is 12.880 mS/cm +/- 3%).

11. If the reading is outside this range, the meter will need to be calibrated (keep probe in the standard solution in the jar for calibration). Details for this are given below and on page 12 of the YSI manual.

**Salinity Calibration**

1. Undertake a conductivity check (directions listed above). If the conductivity reading is outside the set range proceed with salinity calibration.

2. The meter probe should be in the jar of 0.1M KCl standard solution and the MODE reading of the meter should be showing mS as the units measured on the right hand-side of the display.

3. Using 2 fingers to press and release both the UP ARROW and DOWN ARROW buttons on the meter at the same time. A black box with CAL in it will appear on the bottom left-hand corner of the meter display to indicate the meter is now in calibration mode.

4. Use the UP ARROW and DOWN ARROW to adjust the reading on the display to read 12.88 mS. Then press ENTER.

5. SAVE will flash onto the screen and the meter will return to normal reading mode.

6. Ensure that the °C units are flashing next to the temperature reading. This indicates that the meter is in specific conductance mode. The reading should now read 12.88 mS. The calibration is now complete.

7. If the calibration does not work, repeat steps 3 to 6.

8. Allow at least 60 seconds for the temperature reading to become stable.

**Dissolved Oxygen**

The YSI dissolved oxygen probe has a refillable sensor with an electrode in a KCl solution held in a special membrane. The solution and membrane will need to be replaced every 2 to 4 weeks, or after contact with sediments and waters with extremely low amounts of dissolved oxygen. Instructions for replacement are given on page 7 of the YSI manual. Care should be taken to make sure there are no air bubbles inside the membrane and that there are no wrinkles in the membrane once installed. Between trips the probe should be rinsed and stored with a damp sponge in the purpose-built holder at the top of the meter.

Dissolved oxygen should be calibrated before each monitoring trip, following any breaks in the monitoring and each time the meter is turned off and on again.

**To check dissolved oxygen calibration:**
1. Make sure the meter is in the shade. This is important as you are trying to calibrate at a temperature as close as possible to the estuary water temperature you are about to sample.
2. Ensure that the sponge in the probe-holder is damp, but not dripping. To remoisten the sponge squirt distilled water into the probe-holder cavity and let any excess water drip out.
3. The probe end should be placed into the holder far enough for a good seal around the edge of the probe.
4. Turn the meter on by pressing the ON/OFF button. Press the MODE button on the meter displays dissolved oxygen in %.
5. Wait for the temperature and dissolved oxygen readings to stabilise (usually 5 to 15 minutes is required). Check that the dissolved oxygen is reading within 1.5% of 100.0%, e.g. between 98.5% and 101.5%.
6. If the calibration is not accurate, the sensor should be manually calibrated.

**Dissolved Oxygen Calibration**

Detailed instructions for this procedure are on page 11 of the YSI manual.

1. Follow steps 1 to 5 above
2. Use two fingers to press and release both the UP ARROW and DOWN ARROW on the meter at the same time.
3. An altitude setting ALT will appear on the meter display – make sure this is set to ‘0’ and press ENTER.
4. A black box with CAL written in it will show on the bottom left hand side of the meter display. The calibration value of 100% will be displayed in the lower right of the display and the current % reading (before calibration) will be shown on the main display.
5. Wait until the % oxygen reading (large display) is stable (this may take about 5 minutes) and press ENTER.
6. ‘SAVE’ will appear briefly on the screen before a DO reading of 100.0%
7. The calibration is now complete and the meter will return to normal operation mode.

**Recording Monitoring Data**

There are six distinct types of information provided by the YSI meter. Temperature is always shown on the screen. Pressing the ‘mode’ button scrolls the meter through a series of: dissolved oxygen (%sat), dissolved oxygen (mg/L), actual conductivity, specific conductance (conductivity temperature corrected to that at 25°C), and salinity (see p. 17 of the YSI manual).

For each depth, scroll slowly through these measurements and record values on the data sheet, ensuring that the value has stabilised before recording it. If a recording does not stabilise, but fluctuates by a few decimal places (or by ~3%), record the average reading.
Appendix E: Additional Monitoring Possibilities

Estuarine Processes

pH has been identified as an important parameter in some Corangamite estuaries with acidic freshwater inflows. However it is not usually considered to be a parameter of concern in estuarine water because of the capacity of seawater to quickly bring the pH of freshwaters to a pH similar to that of the sea. Monitoring of pH along with essential depth profiling will provide information to help assess the potential influences of pH on those estuaries with acidic inflows.

Phosphorus is another water quality parameter that could be important in particular estuaries. Along with nitrogen, it is an essential nutrient for plant growth and, in excess, can lead to algal blooms. Unfortunately changes in phosphorus levels large enough to cause blooms in many estuaries are too small to detect using standard testing kits. Because of this, the potential usefulness of phosphorus monitoring in an estuary should be discussed with the EstuaryWatch coordinator.

Land Inundation Measurements will be very helpful in determining what is happening in the estuary and surrounding wetlands at different water depth levels. This will be useful information for the CMA, it will assist in estuary opening decisions and will help ground-truth some of the mapping that has been done of this water movement already.

Mapping the Upper Limits of an Estuary The upper limit of an estuary can be defined by the limit of tidal influence or by the upstream extent of salt water penetration. Sometimes this limit is defined by a structure such as a weir or high culvert, or by a natural feature like a set of rapids or waterfall. Most of the time however, this limit is not immediately apparent, and for most estuaries in the region is unknown. The distance that a salt wedge travels upstream differs according to flow and tidal conditions, as well as the contours of the estuary. Detecting the upper limits therefore requires several dedicated sampling trips to measure bottom water salinities during a range of conditions.

Estuarine Ecology

Habitat Mapping/Monitoring could give us some good information about aquatic, riparian and estuarine wetland vegetation. It need only be undertaken a few times a year.

Fish Monitoring could provide information about some or all fishes in an estuary. Collected over time, patterns of change in the abundance, size and number of species in an estuary can be related to other changes in their habitat.

Bird Monitoring will help us determine what importance an estuary and different water levels/ seasons have for the different sets of birds which visit it. This will contribute to the development of a routine long-term data set of bird visitation for the estuaries within the Corangamite Region.

Macroinvertebrate monitoring tells us about what species of invertebrates live in an estuary and how they change over time. Invertebrates are a very important part of estuarine food webs, often linking plants and algae with bird and fish
populations as well as providing a role in processing detritus from macrophytes.

**Community Use and Value Surveys**

*Human Use of Estuary Surveys* will provide a great base of information on what is happening in and around an estuary throughout the year and the interaction of this usage and the health of the estuary. This data does not currently exist.

*Oral histories of Human Interaction with Estuaries* are a great way of recording information about estuaries that could otherwise be lost. People who have lived near or regularly visited an estuary over many years have a great deal of knowledge about their systems and how they have changed over long time-spans.

*Fishing Data* can be collected using random surveys of the number of people fishing, which parts of the estuary they are fishing in and what species and sizes of fish they are catching. This information is useful both in terms of describing one of the major social and economic values of the estuary and in terms of the biology of the estuary.

*Landscape Status Monitoring* refers to the ‘look’ of an estuary in an aesthetic sense. This aspect of the health of an estuary has been revealed to be very important to some coastal residents through recent discussions on mouth opening protocols. Landscape monitoring will involve photopoint monitoring.