Index of Stream Condition

The Third Benchmark of Victorian River Condition

ISC3

Department of
Environment and
Primary Industries

State Government Victoria

Ministerial Foreword

The Hon Peter Walsh MLA   **The Hon Ryan Smith MP**

Healthy rivers are important to all Victorians and communities are always keen to know more about the condition of their local waterways.

Comprehensive and up-to-date information about the condition of Victoria's rivers also is vital to support the development of state policy and regional waterway management programs and to assess progress against targets for improving river health.

The Index of Stream Condition (ISC) report reveals that waterway health has remained stable and there have been no substantial changes in condition since the second benchmark in 2004.

Across Victoria, 23 per cent of stream length assessed was in good or excellent condition. This is an encouraging finding because data for the 2010 benchmark was collected over a six-year period that coincided with the prolonged drought, from 1997 to 2009.

This third ISC benchmark report is another valuable addition to Victoria's waterway reporting. The ISC provides a state-wide snapshot of river condition and data, providing a good understanding of ongoing river health.

A major advancement for the third benchmark report has been to use remote sensing technology to cover 29,000 km of rivers and streams across Victoria. This exercise has been the largest operational demonstration of this type anywhere in Australia.

This approach has delivered an unprecedented amount of data on the condition of our major rivers and streams. In addition, the remote sensing data is being used to improve flood risk mapping and flood warning systems, which will significantly cut the cost of floods to the community and the government.

Advancing the use of remote sensing technology for the ISC continues to improve Victoria's approach to collecting river condition data and management of regional waterways.

Condition monitoring is just one part of the broader Victorian Waterway Management Program, which aims to improve the environmental condition of waterways to support environmental, social, cultural and economic values. Other elements of the program include:

- a state policy framework with an evidence-based, adaptive management approach;

- new regional Waterway Strategies being prepared to identify priority management activities in each region for the next eight years;

- more than 600 GL of environmental water held by the Victorian Environmental Water Holder; and

- significant Victorian Government commitment and investment to improve waterway condition since 2011.

All of these activities play a vital role in maintaining the health and resilience of our waterways. The next step is to work with local communities to build on this result, particularly through the ten regional Waterway Strategies, which are now being developed to guide the Victorian Government's continuing investment in priority waterway health programs.

This report is an important source of information for the future management of Victoria's rivers and we congratulate everyone who has contributed to its compilation. We encourage you to read this report and learn more about the health of your local rivers.

The Hon Peter Walsh MLA
Minister for Water

The Hon Ryan Smith MP
Minister for Environment and Climate Change

Contents

Cover Images:
LiDAR image, lower Ovens River. Courtesy Christina Ratcliff.
Genoa River. Courtesy Sean Phillipson.

Goulburn River. Courtesy Alison Pouliot

Introduction and history

In 1999 the Victorian government in conjunction with the Catchment Management Authorities (CMAs) undertook the first statewide benchmark of the environmental condition of Victoria's major rivers and streams.

This was an important milestone as it was the first complete and comprehensive assessment of the environmental condition of rivers anywhere in Australia.

The benchmarking process was undertaken using the first integrated measure of river condition – the Index of Stream Condition (ISC). The ISC provides information on five key aspects (see Figure 1) of river condition: hydrology, streamside zone, physical form, water quality and aquatic life. This information is then combined to give an overall measure of environmental condition.

To date, the ISC benchmarking process remains the only ongoing statewide assessment of river condition in Australia. A second ISC benchmark was undertaken in 2004 and this, the third ISC benchmark, in 2010.

Over the past 15 years, the ISC benchmarking process has provided:

- a consistent statewide picture of river condition

- a consistent approach to the identification of river values and threats

- statewide data that has been incorporated into the CMA regional Waterway Health Strategies

- a standardised interpretation of river health that has allowed communities to understand and get involved in regional river health discussions

- a way to assess the long-term effectiveness of river management programs.

The ISC is much more than just a monitoring program that benchmarks the condition of the State's major rivers and streams. It is a vital component in the adaptive management framework for waterway management in Victoria. The ISC provides data and information that feeds into the CMA regional Waterway Strategies and is used to help prioritise CMA work programs. Over the longer term the ISC program will be able to assess changes due to management intervention (such as revegetation, weed control, delivery of environmental water). To achieve this, the ISC benchmarking process will need to continue to evolve and move away from only reporting at the reach scale to also report at smaller scales and to change from assessing the environmental condition of rivers and streams against reference river condition to assessing against management targets.

The results of this third ISC benchmarking exercise – the 2010 ISC - are summarised in this report and are available at the Department of Environment and Primary Industries web site **http://www.depi.vic.gov.au/water/ water-resource-reporting** and follow the link to the Index of Condition site.

Bemm River in East Gippsland. Courtesy of Graeme Dear

The ISC Concept

This report presents the results from the third statewide benchmark of the condition of Victoria's major rivers and streams using the Index of Stream Condition. The first two ISC benchmarks were in 1999 and 2004.

The ISC brings together data from a variety of sources to give a detailed overview picture of river and stream condition across the State. The ISC is made up of five sub-indices – hydrology, streamside zone, physical form, water quality and aquatic life.

A number of metrics are combined to characterise each sub-index (see Figure 1 and Appendix 1). A total of 23 metrics are used and each of these is considered important from a statewide perspective. The ISC is evaluated for sections of a river known as a 'reach'. Reaches are typically between 10-30 km in length and with a similar flow regime, vegetation and landscape characteristics.
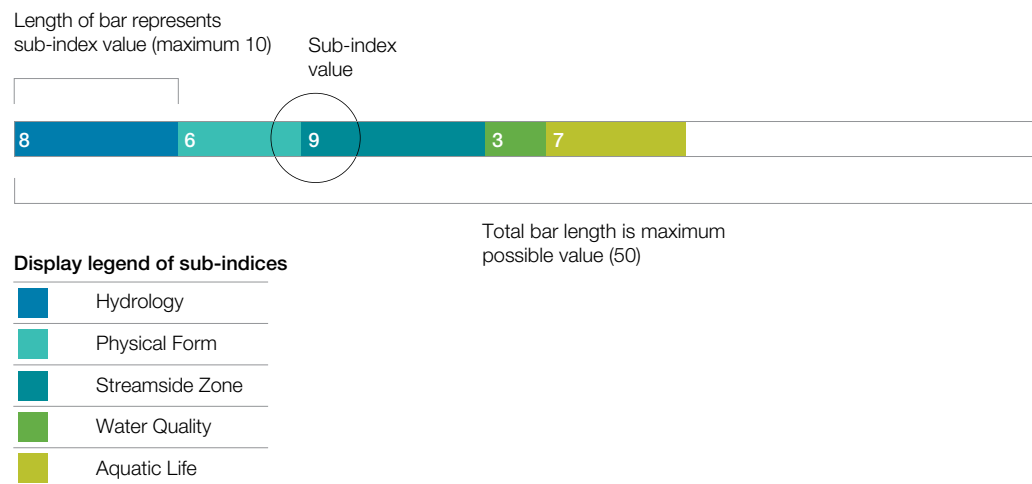
Figure 1: The 2010 Index of Stream Condition sub-indices and metrics

Hydrology	Physical Form	Streamside zone	Water Quality	Aquatic Life
Hydrology refers to the amount of water that is within the river channel at a particular point in time at a particular location. A minimum of 15 years of monthly flow data is used.	Physical form takes into account the river bank condition as well as instream habitat (logs or 'snags') and major barriers to fish migration, such as dams and artificial weirs.	Streamside zone measures characteristics of the woody vegetation within 40 metres of the river's edge.	Water quality is the quality of water in the river.	Aquatic life is based on the number and type of aquatic macroinvertebrates found within the river.
• Low flows • High flows • Zero flows • Seasonality • Variability	• Bank condition • Artificial barriers • Instream woody habitat	• Width • Fragmentation • Overhang • Cover of trees and shrubs • Structure • Large Trees • Weeds	• Total Phosphorus • Turbidity • Salinity (EC) • pH	• AUSRIVAS • SIGNAL • EPT • Number of Families

The ISC score for each river reach is presented as a bar graph of the five sub-indices, as shown in Figure 2.

Each river reach assessed is given an overall ISC score of between 0-50. This score is then categorised into one of five broad condition bands – excellent, good, moderate, poor or very poor. It is important to emphasise that while the condition band is useful in summarising the overall condition of a river reach, it is the details (sub-index and metric scores) that are used to better understand the issues affecting the condition of a reach and are used in river planning and management.

Figure 2: The ISC bar showing the 5 sub-indices

Length of bar represents sub-index value (maximum 10)

Sub-index value

| 8 | 6 | 9 | 3 | 7 | |

Total bar length is maximum possible value (50)

Display legend of sub-indices

- Hydrology
- Physical Form
- Streamside Zone
- Water Quality
- Aquatic Life

Reference condition

The majority of river condition assessment techniques adopt what is termed a 'referential approach'. This is where the current river condition is compared against its reference condition. This reference condition is generally accepted to be what a river would have looked like in its undisturbed or unmodified form (i.e. before European settlement). The reference condition is used as a convenient point of comparison for the current river condition. The change over time represents the environmental condition of the river, for example, if a river is close to its reference condition it is assumed to be in good environmental condition (as it has changed little), while a river that is very different to its reference condition is assumed to be in poor environmental condition. Essentially the use of a reference condition is a standardisation method to allow sensible comparisons across the State, allowing the condition of a river reach to be compared with any other river reach.

The reference condition of a river or river reach can be determined through a variety of sources, including collecting data from minimally disturbed sites, using historical data, modelling or using expert opinion. The aim of using a reference condition is to allow comparison of the environmental condition of river reaches, even if they have very different characteristics.

The reference condition approach has matured considerably since its first application in the 1999 benchmark. In this third benchmark of river condition, the Hydrology sub-index has used both a reference and a management target approach (see Box 1 for an explanation of how the current reference condition approach differs from the management targets approach).

For the 66 ISC river reaches that had priority watering actions listed in the *2011 – 2012 Seasonal Watering Plan* (Victorian Environmental Water Holder 2011), the agreed priority watering actions were used as the management targets. These reaches have environmental entitlements that have been allocated through detailed consultative water planning processes (e.g. Sustainable Water Strategies and Government water recovery programs). The hydrology sub-index scores for these 66 river reaches are based on the number of the priority watering actions that were fully met for 2011-12. For the river reaches that do not have priority watering actions, the standard hydrology reference condition approach has been used (i.e. based on the flow characteristics prior to any dams, diversions or other modifications).

It is intended, that wherever possible, the next statewide benchmark of river condition, (due in 2018), will report against management targets (such as the priority watering actions) and not reference condition. The reference condition approach can only account for how altered (from reference) a river reach is. This approach takes no account of what can be done to improve the condition of the river (if at all). This change from the reference condition approach to assessing condition against management targets will be challenging. However, it will deliver a more meaningful interpretation of river condition and will allow an assessment to be made of how management works are contributing towards meeting management targets.

Box 1 / Reference condition and management target condition

Reference condition is not the same as a management target. The reference condition is what a river would have looked like in its undisturbed or unmodified form. In determining reference condition it is important to allow for regional variations in climate, landform and topology etc. These variations will differ depending on the variable of interest. Typically, for each variable of interest (such as water quality or vegetation) there will be more than one reference condition for the State. For example, there are 15 water quality reference regions for Victoria and streamside vegetation is classified into 66 reference types (known as Ecological Vegetation Classes or EVCs). A reference condition can be derived from a number of sources, including collecting data at minimally disturbed sites, historical data, modelling or expert opinion.

Using reference condition is useful in describing how much of the landscape has been modified since European settlement. This approach assists in understanding how a river has changed, what has caused the change and what are the threats to river condition. However, the reference condition is usually not the target for management actions, as in many parts of the State it is unrealistic (and expensive) to expect all rivers to be returned to their pre-European condition.

Therefore, it makes sense to move away from comparing current condition with reference condition and instead comparing the current condition with its management target condition.

River condition defined by a *management target* is the environmental condition that is the objective of a river management program. In Victoria, this is set through the regional waterway planning process, co-ordinated by CMAs, together with community input, which aims to achieve the environmental condition required to maintain or improve agreed key waterway values.

The development of a management target is the result of careful consideration of the current environmental condition of the river, community values, the use of the river and the feasibility, costs and benefits of improving its condition. For some rivers in good condition, the management target may be to improve its condition to its reference condition or simply to maintain its current condition. For a 'working river', such as the Goulburn River, the management target could be aimed at conserving the river's current condition (largely in moderate condition) and its associated values for the benefit of the community.

Evolution of the ISC benchmarking process

The primary aim of the ISC is to assess the environmental condition of Victoria's major rivers and streams and to provide statewide data for CMA regional waterway action planning and priority setting. Three statewide benchmarks have been undertaken – in 1999, 2004 and 2010.

The ISC is an essential component of the adaptive management framework for waterway management in Victoria. The first ISC benchmark in 1999 demonstrated that rivers in many parts of the state were in poor environmental condition. This data then allowed the development of a case to Government for investment to halt the decline and improve the condition of Victoria's rivers. The information from the first ISC benchmark was a key building block that helped the CMAs to create their priorities for action in the first round of regional River Health Strategies.

The ISC methodology is reviewed before every statewide benchmark. This is to ensure that the ISC remains up to date, incorporates recent advances in science and research and provides the best possible information for waterway planning and management. A panel of independent scientific experts oversaw each review. The panel aimed to strike a balance between incorporating new scientific advances while maintaining comparability of results with the previous benchmark. A series of principles were developed to guide any changes made to the ISC data collection methods. It was agreed that changes to the methodology would only be made if:

- it was demonstrated that the new method was an improvement on the old method

- there was a strong reason to integrate new methods with existing methods and improve them along the way

- the new method had been tested

- the new method conformed to the original ISC criteria (transparent, intuitive and an appropriate balance of cost, speed, accuracy and scientific rigour).

The ISC in 2004

For the 2004 benchmark, 1,040 river reaches representing approximately 26,000 km of Victoria's major rivers and streams were assessed. This was an increase of 90 reaches and 18,000 km of stream length compared with the 1999 benchmark.

The 2004 ISC methodology evolved significantly from that used in the first benchmark in 1999. The major advance was in the refinement of the hydrology sub-index. For hydrology, the approach moved from a very simple approach (taking 12 months of gauged flow records and manually adding back in the licenced diversions) to a modelling approach that extracted five key metrics of ecological significance and used a minimum of 15 years of monthly flow data.

Improvements in the ISC since 2004

The 2004 ISC used a field sampling approach which had some limitations (i.e. limited number of randomly selected sampling sites). With a limited number of random sites there is always a risk that the random site selection will not lead to results that accurately reflect the overall environmental condition of the reach. The most efficient way to improve this was to move to some form of remote sensing technology that does not rely on a limited number of field samples. However, the traditional field sampling approach could not be changed until it was demonstrated that remote sensing technology offered a viable alternative.

A number of trials were undertaken to assess a range of remote sensing technologies for use in the 2010 ISC benchmark. The result was that a combination of two remote sensing technologies, aerial photography and LiDAR (see Box 2) was recommended. The adoption of these two remote sensing technologies meant that there would be a change to how the Streamside Zone and Physical Form metrics would be collected and assessed. Instead of collecting field data from a limited number of randomly selected field sites for each reach, field data would now be collected remotely. This meant that data could be continuously collected from both sides of the river (what is termed a 'census' approach). This approach gives a very accurate assessment of the condition of the Streamside Zone and Physical Form metrics, as the entire river is assessed.

However, as with all assessment methods there are some trade-offs. This is also the case with the use of LiDAR. There are some things that LiDAR can not measure, including understory diversity and detailed floristics (the identification of plant species). This trade-off was accepted, as LiDAR would provide a very accurate baseline, which would provide a more accurate and comprehensive data set.

The improvements made to the 2010 ISC methodology are summarised in Appendix 2.

Other uses of the remote sensing data

The third ISC benchmark was the first time that LiDAR and aerial photography was collected over such an extensive river network (29,000 km of rivers and streams) anywhere in Australia.

While producing data for the ISC benchmark, the LiDAR and aerial photography has a number of much wider applications and benefits, including:

- *Flood risk mapping*. Many small towns and rural areas in Victoria have very poor information on flood risk. Typically, where flood information is poor, insurance companies will increase premiums as the flood risk is unknown. The LiDAR data will enable flood risk mapping for many of these areas to be undertaken. The value of this data has been recognised by the insurance industry with some insurance companies already purchasing the LiDAR data. The Insurance Council of Australia is extremely interested in ensuring that this information is available to the broader industry. Having high quality information about flood risk will enable land-use planners and the community to make decisions on the level of development appropriate to the flood risks.

- *Flood warning*. The Government is also using the LiDAR data to develop 'Floodzoom' which is an online tool that will provide forward warning to the public of areas that will be inundated during floods. The completion of the flood risk mapping and 'Floodzoom' will mean that there will be a significant reduction in the cost of future floods to the community and the Government.

- *Modelling applications*. The LiDAR data has been used by a Victorian water authority to improve its level of certainty in the volume of water that could flow into a dam and whether the existing spill way was capable of handling the volume of water. Computer modelling using the LiDAR data meant that the water authority saved $6 million as it did not need to increase the capacity of its spill way.

- *Day to day CMA works planning*. The mapping of metrics derived from the LiDAR will provide detailed information that will allow CMAs to determine where they need to undertake river management activities and how much work is required to meet management targets or to improve the environmental condition of a river.

Box 2 / What is LiDAR?

LiDAR stands for Light Detection And Ranging. It is a form of optical remote sensing technology. The LiDAR sensor is attached to a light plane and works by emitting a laser beam of light that detects the light that is reflected back from objects in the landscape. This information is then processed and the light returns are seperated into bare ground/ buildings/ vegetation. This allows the creation of a range of very accurate three dimensional (3D) images of the terrain and landscape features.
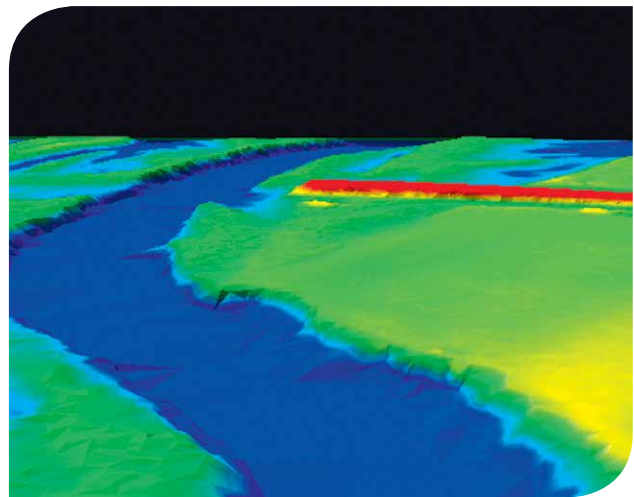
A 3D LiDAR image of the ground surface with the vegetation and built structures (such as bridges) removed. The image is coloured by elevation. The blue is the river channel, the green the surrounding land and the red is an elevated road (the bridge across the river has been removed from this image)

A 3D image of the ground surface showing vegetation generated using LiDAR technology. The different colours are due to the different height of the vegetation (red is taller). This image has not had the road and the bridge across the river removed.

Snapshot vs trend

The ISC was not designed to asses trend. Trend is concerned with measuring a change over time that is outside the natural variation. However, the ISC can be used to make general comparisons of river condition. For the ISC to measure trend would require its methodology to remain constant across many benchmarks. To date, the emphasis has been on improving the data collection and analysis methods, so that the results are accurate and comprehensive. The ISC is being used to provide a 'snapshot' of condition across the State at a point in time.

The design of ecological condition assessment programs to measure trend requires very intensive data collection over a long period of time (typically 10 – 20 years). This ensures that, statistically, there is sufficient data to be able to accurately identify a directional (positive or negative) change (or absence of a directional change) in condition and to be confident that the directional change is outside the expected natural variability.

Changing components of the ISC methodology every benchmark requires significant consideration. The primary emphasis has been to ensure that the results are accurate and comprehensive. This has led to significant advances in how data is collected and analysed.

The disadvantage is that it is very difficult to compare the results of one ISC benchmark with another. Therefore, it is almost impossible to determine trend. It is important that the ISC delivers accurate results, as they are used by CMAs in their regional Waterway Strategies as one of the major inputs to prioritise work programs. These work programs are the basis on which the Government invests in waterway management activities to maintain and improve river condition in Victoria.

The 2010 ISC should be seen as a snapshot of river condition that has been taken at the end of the Millennium drought (1997-2009), rather than as a means to assess trends since 1999 or 2004. Since 2009, Victoria experienced two years of above average rainfall resulting in widespread floods. Weather conditions are always variable from drought to flood and this can influence many of the metrics assessed in the ISC. Such changes in weather conditions influence the natural variability which needs to be understood when interpreting trends.

2010 ISC Benchmark Results

The 2010 ISC benchmark assessed approximately 29,000 km of rivers and streams. Figure 3 shows that 12% of river length was in excellent condition, 11% in good condition, 43% in moderate condition, 19% in poor condition and 13% in very poor condition (2% of stream length had insufficient data to allow its condition to be determined).

The basins in the east of the State had more river length in good or excellent condition compared with basins in the west (see Figure 4). Three basins had at least 70% of their river length in good or excellent condition and include the East Gippsland (basin 21), Snowy (basin 22) and Mitchell (basin 24) basins. This is not surprising as these basins are largely inside National Parks. Another three basins had at least 50% of their river length in good or excellent condition including the Tambo (basin 23), Thomson (basin 25) and the Upper Murray (basin 1) basins. Another two basins have one third of their river length in good or excellent condition (Latrobe (basin 26) and Otway (basin 35)). The largest number of basins (14 basins) had less than 10% of their river length in good or excellent condition and these represent a broad band of basins in the mid-west of Victoria. Typically these basins have been extensively cleared for agriculture.

The additional modelling done for the Hydrology sub-index allowed the impact of drought to be quantified for the first time. The analysis looked at flow before and after 1997 (1997 was the year that the Millennium drought officially started). This analysis showed that virtually all reaches were adversely affected by the drought and that the south-west of Victoria was the most severely affected. Drought had a major impact on flow regimes across the entire State, with rivers in the Wimmera (basin 15), Portland (basin 35) and Glenelg (basin 38) basins being the most drought affected in Victoria.

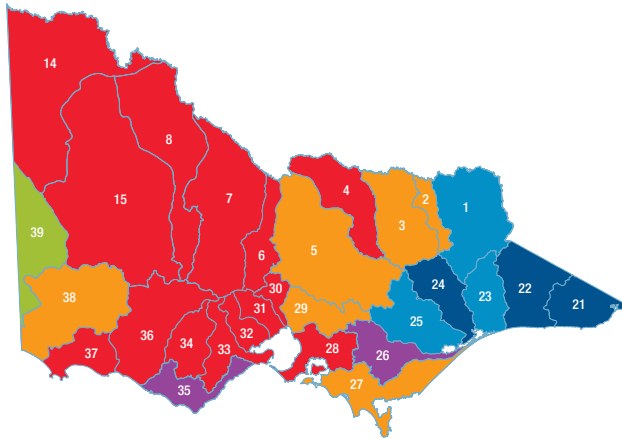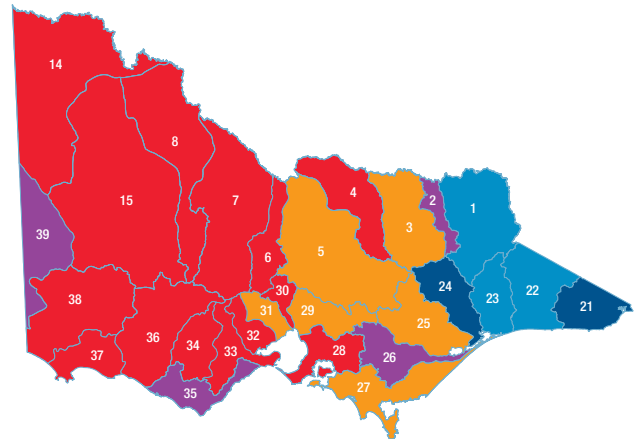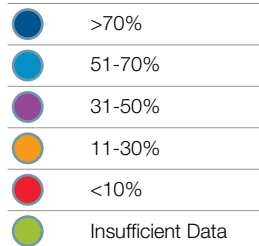## Figure 4: 2010 ISC – Percentage river length in good or excellent condition

## Figure 5: 2004 ISC – Percentage river length in good or excellent condition

Environmental Condition

- ● >70%
- ● 51-70%
- ● 31-50%
- ● 11-30%
- ● <10%
- ● Insufficient Data

Basin Names

1	Upper Murray	14	Mallee	27	South Gippsland	35	Otway
2	Kiewa	15	Wimmera	28	Bunyip	36	Hopkins
3	Ovens	21	East Gippsland	29	Yarra	37	Portland
4	Broken	22	Snowy	30	Maribyrnong	38	Glenelg
5	Goulburn	23	Tambo	31	Werribee	39	Millicent Coast
6	Campaspe	24	Mitchell	32	Moorabool		
7	Loddon	25	Thomson	33	Barwon		
8	Avoca	26	LaTrobe	34	Corangamite		

Figure 3: 2010 state wide river condition (histogram)

Stream condition % length
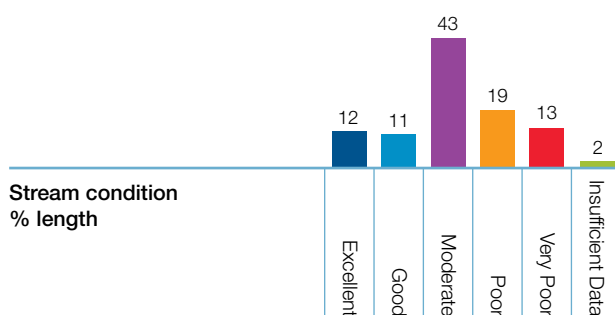
Comparing the 2004 and ISC 2010 results

Due to the changes made to the methods for all five sub-indices, it is difficult to make direct comparisons using the sub-index scores. However, it is possible to make comparisons using the reach condition scores. This is in line with the *Framework for the Assessment of River and Wetland Health* (AWR 2005) which acknowledges that there are many valid ways to assess river condition. If the primary purpose of the method is to assess river condition and assign condition scores, then the condition scores should be comparable, even if the data collection methods are very different.

Comparisons can be done at a two levels – the basin and the reach. Figures 4 and 5 show the basin results for the 2010 and 2004 ISC benchmarks. The two maps compare the percentage of river length in good or excellent condition for each basin. The results are very similar. There was no substantial difference between the 2004 and 2010 results, despite the fact that data for the 2010 benchmark was collected over six years that coincided with the severe Millennium drought (from 1997-2009). It is likely that rivers and streams that are in good or excellent condition are fairly resilient and able to withstand prolonged periods of drought.

Before

After

East Gippsland CMA case study

The above two photos show the Genoa River before the East Gippsland CMA installed fences and undertook a revegetation program. The two photographs were taken 20 years apart. In East Gippsland, substantial changes in streamside vegetation can be seen in around 5-7 years. In other parts of the state, where rainfall is lower and soils are not as productive, these sort of changes could take 10-15 years or even longer to occur. The photo below shows revegetation of native vegetation after 18 months on the Snowy river.

CMAs have played an important role in maintaining and improving river condition by undertaking management activities such as fencing, revegetation, weed control etc. and the Environmental Water Holder has released environmental flows. These activities should help rivers to become more resilient in the future and better able to respond when weather conditions improve. Many of the changes as a result of these management activities are not yet obvious in the ISC results. The improvements due to management works and increased environmental flows will take a number of years to detect and be reflected in increased ISC metrics and condition scores.

Basin comparisons

Whilst the two statewide maps (Figures 4 and 5) appear similar, they are not the same. There are changes in six basins. These changes are due to four broad reasons:

- changes in the Werribee basin (basin 31) were due to the 2010 score being within 1% of a condition band boundary. In the 2010 benchmark, 10% of stream length was in good or excellent condition which meant the basin was coloured red. If 11% of stream length had been in good or excellent condition, then the basin would be coloured orange, the same result for the 2004 benchmark.

- the Thomson (basin 25) and Glenelg (basin 38) basins improved due to the way the Hydrology sub-index was assessed. Both basins had reaches with priority watering actions. This meant that the Hydrology sub-index scores are a mix of comparisons against management targets and reference condition.

- four reaches (reaches 1,2,4 and 5) in the Kiewa basin (basin 2) on the Kiewa River (totalling 25% of the river length in the basin) changed condition from good to moderate. This change in condition was due to the condition band boundary issue mentioned above and their poorer hydrology scores due to increases in the duration of low flows and changes in flow seasonality.

- Millicent Coast basin (basin 39) did not have sufficient data to allow the condition bands to be calculated in 2010.

Reach comparisons

Comparing the reach condition results for the 2004 and 2010 benchmarks indicates that river condition did not change for approximately 50% of reaches, while approximately 20% of reaches recorded an increase in condition, and other 30% of reaches, recorded a decrease in condition. However, it should be stressed that this does not mean that their condition necessarily changed between the 2004 and 2010 ISC benchmarks. These differences are caused by three main factors:

- The move from a limited number of random sites assessed to a full census approach for the Streamside Zone and Physical Form metrics. The location of the random sites in the 2004 ISC benchmark may not have accurately characterised the reach condition. As the 2010 ISC benchmark used a census approach, the 2010 ISC benchmark results are more accurate than the 2004 ISC benchmark results.

- The large number of reaches that had Aquatic Life scores in the 2010 ISC benchmark compared with 2004 ISC benchmark. Approximately sixty per cent reaches did not have an Aquatic Life sub-index score for 2004 ISC benchmark and this directly influenced how their final ISC scores were calculated. For the 2010 benchmark, 70% of reaches had an Aquatic Life score. Final ISC scores are calculated using a method known as the inverse ranking method, which requires all five sub-indices to have scores. To achieve this where one or two sub-indices have no scores, scores are estimated based on the average of those sub-indices with scores. If more than two sub-indices do not have scores, then the overall ISC condition can not be determined. The actual 2010 Aquatic Life scores are more accurate than the estimated average scores used in the 2004 benchmark.

- It is likely that past bushfires continue to have an influence on river condition. These fires include the 2003 Great Divide fire, 2006 Grampians fire, 2007 Victorian Alps fire and the 2009 Black Saturday fires.

The reach results for both the Aquatic Life and Water Quality sub-indices are more suitable for a direct comparison between the 2004 and 2010 results. It should be noted that for the Water Quality sub-index scores, the 2004 ISC results are based on water quality results for a single year, while the 2010 ISC results are based on the average of six years of data. To allow a direct comparison to be made between the 2004 and 2010 scores for the Aquatic Life sub-index, the two metrics that were added for the 2010 ISC benchmark have been removed, so that the same two metrics (SIGNAL and AUSRIVAS) could be used for a direct comparison.

There were a number of significant changes in Water Quality scores for 15 reaches between the 2004 to 2010 ISC benchmarks. Seven reaches had significant improvements to water quality, while in eight reaches water quality deteriorated. Reaches with improved water quality included the Ovens River reaches 1 and 5 (basin 3), Snowy River reach 9 (basin 22), Buchan River reach 11 (basin 22), Tambo River reach 9 (basin 23), Bunyip main drain reach 16 (basin 28) and the Glenelg River reach 2 (basin 38). Typically these reaches had improvements (i.e. decreases) in their levels of Total Phosphorus and Turbidity.

Reaches where water quality deteriorated between the 2004 and 2010 benchmarks included the Goulburn River reach 15 (basin 5), Avoca River reach 5 (basin 8), Macalister River reach 11 (basin 25), Bunyip River reach 17 (basin 28), Yarra River reach 3 (basin 29), Maribyrnong River reach 1 (basin 30) and the Moorabool River reach 6 (basin 32). Typically these reaches were in cleared areas and typically saw a deterioration (i.e. increase) in the levels of Total Phosphorus and Turbidity.

Water quality is strongly influenced by local conditions and events, such as rainfall, runoff, floods and bushfires. As a result, water quality is inherently variable but is only of concern when results are consistently outside the expected natural variability. Events such as bushfires and floods can push water quality values outside their natural range, but this is usually short-term and levels return to normal fairly quickly. Drought conditions and the lack of runoff in the catchment after rain can lead to improvements in some water quality results, as nutrients and sediment are not washed into the river.

Between the 2004 and 2010 ISC benchmarks, there were slight increases or decreases in the Aquatic Life scores across nearly all basins. The Ovens basin (basin 3, reaches 2, 6, 9, 10, 22, 23 and 39) and the Latrobe basin (basin 26 reaches 8, 19, 20 and 22) recorded a number of significant improvements in the Aquatic Life scores.

The value of the ISC is not just its ability to summarise river condition data for Victoria at the reach level. Its true value lies in the underlying data. The LiDAR derived metrics for the Streamside Zone and Physical Form sub-indices were assessed at very fine scales (1-2 metre) and were summarised every 100 metres for both the left and right banks over 29,000 km of river length. Figure 6 shows a sample of the vegetation width data generated using the LiDAR and aerial photography.

Figure 6: Width of vegetation on both river banks

The length of the line indicates the width of vegetation along the river. Vegetation width was assessed every 25 metres along the river (therefore the lines in the diagram are 25 meters apart). The longest lines represent a vegetation width of 200 metres. This illustrates the level of variability of streamside vegetation width along a stretch of river and the difference that can be encountered on opposite river banks.
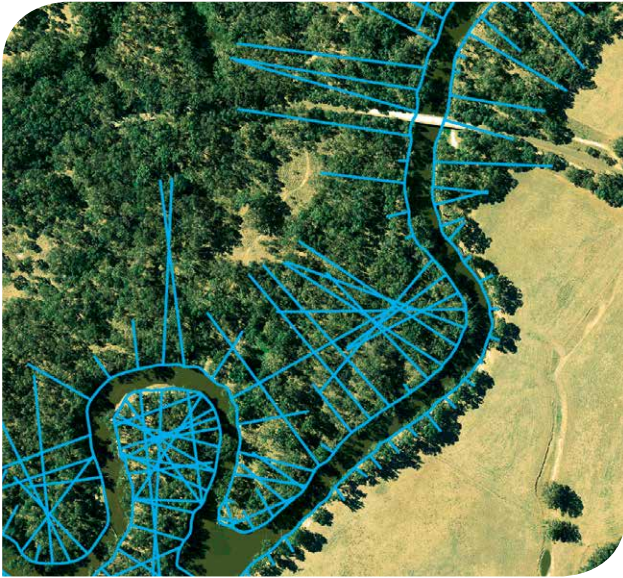
Conclusion and next steps

The three ISC benchmarks have provided an hugely valuable information resource about the condition of Victoria's major rivers and streams which has been critical in providing data and information to the CMAs to allow them to determine their priorities and work programs.

The 1999 ISC benchmark demonstrated that rivers and streams in many parts of the State were in poor environmental condition. This data then allowed the development of a case to Government for investment to halt the decline and improve the condition of Victoria's rivers and streams. The ISC was a key building block that helped to create the priorities for action in the first round of regional River Health Strategies.

The 2004 ISC benchmark saw refinements to the data collection methods which continued for the 2010 ISC benchmark with the incorporation of data collected through remote sensing technologies (LiDAR and aerial photography). This large investment by the Victorian government in the remote sensing technologies has provided a very accurate baseline that can be used to assess changes in river condition at the site scale. This data also provides an unprecedented level of information to allow CMAs to better identify and undertake priority management actions to improve the river condition.

Goulburn River. Courtesy Alison Pouliot

The three ISC benchmarks have provided an hugely valuable information resource about the condition of Victoria's major rivers and streams

The results from the 2004 and 2010 benchmarks are very similar. For rivers and streams that were in good or excellent condition, there was no substantial difference between the 2004 and 2010 results, despite the fact that data for the 2010 benchmark was collected over six years that coincided with the severe Millennium drought (from 1997-2009). It is likely that rivers and streams that are in good or excellent condition are fairly resilient and able to withstand prolonged periods of drought. CMAs have played an important role in maintaining and improving river condition by undertaking management activities such as fencing, revegetation, weed control etc. and the Environmental Water Holder has released environmental flows. These activities should help rivers to become more resilient in the future and better able to respond when weather conditions improve. Many of the changes as a result of these management activities are not yet obvious in the ISC results. The improvements due to management works and increased environmental flows will take a number of years to detect and be reflected in increased ISC metrics and condition scores.

Over the past 15 years, there has been considerable refinement to river condition data collection and regional waterway management so that there is now a mature adaptive management framework, new regional Waterway Strategies are being prepared to identify priority management actions over the next eight years, over 600 GL of environmental water is available and there is significant government investment to improve waterway condition. The combination of these efforts means that the focus for monitoring river condition will change to be more concerned with assessing the outcomes from Government investment in river management and environmental watering programs.

The next phase of the ISC program will see two major changes:

- A move away from comparing the existing river condition against a reference condition. Instead, the fourth ISC benchmark will compare the existing river condition against management targets. The traditional referential approach is limited as it measures how altered (from reference) the condition of a river reach is. It takes no account of what can be done to improve the condition (if at all). This change will be challenging. However, it will deliver is a more meaningful interpretation of river condition and will allow an assessment to be made of how management works are contributing towards meeting management targets.

- A move away from reporting at the reach scale, to allow reporting at smaller spatial scales. This will then allow two types of condition to be assessed – (a) background condition at the reach scale – useful in detecting gross changes in river condition due to climate change and natural variability and (b) condition at sites that have had active management intervention. Such sites have previously been 'lost' within the reach scores as CMA on-ground works are usually carried out at scales smaller than a typical reach.

References

Australian Water Resources (2005) Assessment of River and Wetland Health: a framework for comparative assessment of the ecological condition of Australian rivers and wetlands.

Victorian Environmental Water Holder (2011) Seasonal watering Plan 2011 – 12.

Genoa River. Courtesy Sean Phillipson

Over the past 15 years, there has been considerable refinement to river condition data collection and regional waterway management