# An assessment of Quality Assurance and Quality Control Measures for the Index of Wetland Condition

P. Papas and K. Morris

**January 2014**

Arthur Rylah Institute for Environmental Research

Technical Report Series No. 254

Arthur Rylah Institute for environmental research

Department of Environment and Primary Industries

State Government Victoria

# An assessment of quality assurance and quality control measures for the Index of Wetland Condition

Phil Papas and Kay Morris

Arthur Rylah Institute for Environmental Research
123 Brown Street, Heidelberg, Victoria 3084

January 2014

Arthur Rylah Institute for Environmental Research
Department of Environment and Primary Industries
Heidelberg, Victoria

**Report produced by:** Arthur Rylah Institute for Environmental Research
Department of Sustainability and Environment
PO Box 137
Heidelberg, Victoria 3084
Phone (03) 9450 8600
Website: www.depi.vic.gov.au/ari



**Citation:** Papas, P. and Morris, K. (2014) An assessment of quality assurance and quality control measures for the Index of Wetland Condition. Arthur Rylah Institute for Environmental Research Technical Report Series No.254. Department of Environment and Primary Industries , Heidelberg, Victoria

**ISSN 1835-3835 (pdf)**

**ISBN 978-1-74326-731-8 (pdf)**



**Front cover photo:** Index of Wetland Condition training at Lake Colac, Victoria (Phil Papas).

# Contents

## Acknowledgements

Angela Robb (Department of Environment and Primary Industries) provided information on quality assurance and quality control measures for the Vegetation Quality Assessment. Doug Frood (Pathways Bushland) provided input into the botanical skill level expected of IWC assessors. Janet Holmes and Andrea White (Department of Environment and Primary Industries) provided input to the quality assurance and quality control recommendations and provided comments on the draft. Annette Muir (Department of Environment and Primary Industries) provided comments on the draft.

## Summary

The Index of Wetland Condition (IWC) is a method for assessing the condition of natural wetlands in Victoria which do not have a marine hydrological influence. The method is used in several programs including Wetland Tender which is implemented by Catchment Management Authorities and state-wide condition assessments implemented by the Department of Environment and Primary Industries. Wetland Tender is a market based approach for protection and improved management of wetlands on private land (~ 400 wetlands have been assessed to date). State-wide wetland condition assessments have been performed on ~ 800 wetlands to inform policy, assess risks to wetland values, determine management priorities, set targets and monitor the longer-term trends in condition.

These programs require IWC data of high quality and consistency. The implementation and maintenance of a quality assurance and quality control plan will ensure IWC data meets the standards necessary for these applications. Quality assurance and quality control measures (QA QC) are designed to assure and test, respectively, that a set standard of quality is achieved. This report identifies risks to IWC data quality and consistency, examines existing QA QC procedures to reduce these risks and provides recommendations for improvement.

Five risks to the quality and consistency of IWC data were identified.

1. IWC assessment training program is inadequate.
2. IWC assessor skill level is inadequate.
3. IWC material resources are inadequate.
4. Data curation within the IWC Data Management System is inadequate.
5. Level of engagement for IWC users and support for users by the IWC project team is inadequate or untimely.

Based on the assessment of risks, a QA QC system was developed. The system includes measures to assure IWC assessors are competent in performing assessments through mandatory training, required wetland vegetation skills, regular use of the method, supporting materials, resources and data management. Quality control measures that test assessor competency, the standard of IWC assessments and the level of satisfaction experienced by users of the IWC method are documented. Additional measures to further improve quality assurance and quality control are also provided.

# 1 Project aims

The Index of Wetland Condition (IWC) is a method for assessing the condition of natural wetlands in Victoria which do not have a marine hydrological influence (DSE 2005**,** Box 1). It is used in several programs including Wetland Tender implemented by Catchment Management Authorities (CMAs), state-wide condition assessments implemented by the Department of Environment and Primary Industries (DEPI) and monitoring responses to management interventions on public land, usually implemented by CMAs. Wetland Tender is a market-based incentive approach for protection and improved management of wetlands on private land (~ 400 wetlands assessed to date). State-wide wetland condition assessments have been performed on approximately 800 wetlands to inform policy, assess risks to wetland values, determine management priorities, set targets and monitor the longer-term trends in condition.

These applications require IWC data of high quality and consistency. The implementation and maintenance of a quality assurance system will assure IWC data meets the standards necessary for these applications. This includes quality assurance (QA) and quality control (QC) measures that are designed to assure and test, respectively, that a set standard of quality is achieved in the production of a product, or in the delivery of a service. Quality assurance (QA) refers to the processes that are used to assure the quality of a product or service during its production or development. Quality control (QC) refers to activities designed to evaluate the quality of a product or service that is delivered.

This project had two principal aims.

1. Identify procedures that will assure and test the accuracy of IWC assessments and reporting.
2. Test the accuracy of data entered on IWC field sheets and the IWC data management system (IWC DMS) for assessments undertaken for Wetland Tender projects in 2009/10 and 2010/11.

**Box 1** The IWC measures and its application. The IWC has six subindices based on components critical to the function of wetlands: physical form, hydrology, water properties, soils, biota, and wetland catchment. For these subindices there are 13 measures as shown below.

| Sub-index | Measure |
|---|---|
| Wetland catchment | • Percentage of land in different land use intensity classes adjacent to the wetland<br>• Average width of the buffer<br>• Percentage of wetland perimeter with a buffer |
| Physical form | • Percentage reduction in wetland area<br>• Percentage of wetland where activities (excavation and landforming) have resulted in a change in bathymetry |
| Hydrology | • Severity of change in water regime |
| Water properties | • Severity of nutrient enrichment<br>• Severity of change in salinity |
| Soils | • Percentage and severity of wetland soil disturbance |
| Biota | Wetland vegetation quality assessment based on:<br>• critical lifeforms<br>• presence of weeds<br>• indicators of altered processes<br>• vegetation structure and health |

Application of the IWC method involves a small desktop component and data collection at the wetland. The desktop component involves generating maps and aerial photos of the wetland using an on-line IWC wetland mapping tool. At the wetland, one or two assessors assess the hydrologic phase of the wetland, take photos of the wetland, obtain location coordinates and collect data that correspond to the IWC measures. This is done with the aid of several resources: a manual that describes the IWC assessment procedure (DEPI 2013a), aerial photo(s), wetland map(s) and wetland Ecological Vegetation Class benchmarks (DEPI 2013b) and field guide (DSE 2012). Assessment data is scribed on field assessment sheets. IWC assessment data, maps and photos are entered and uploaded to the IWC Data Management System (IWCDMS) (DEPI 2013c). The IWCDMS calculates the scores for each measure, subindex and the whole wetland (see Papas et al. 2009 for further information).

# 2 Quality assurance and quality control risks and improvements

The following steps were carried out to inform an assessment of IWC Quality Assurance and Quality Control and recommendations for improvement.

1. Risks to the accuracy and consistency of IWC data were identified.
2. Existing *quality assurance* procedures, activities and products that reduce these risks were identified.
3. Additional measures to further assure IWC data accuracy were identified.
4. Existing *quality control* measures that deliver accurate and consistent IWC data were identified.
5. Additional measures to improve IWC quality control were identified.
6. A desktop auditing check list was developed to test the accuracy of data entries to field sheets (DEPI 2013a) and the IWC Data Management System (IWCDMS) (DEPI 2013c).
7. A desktop audit of Wetland Tender assessments was done to assess data quality and inform recommendations for QA and QC improvement.

## 2.1 Risks to accuracy and consistency of IWC data

Identification of key areas of risk to data quality in the IWC program was informed by an analysis of existing quality assurance and quality control measures in the program and a brief review of the QA and QC systems of similar programs. These programs included Vegetation Quality Assessment (DSE 2004) and the rapid bioassessment methodology for rivers and streams (EPA 2003). QA QC measures in other programs have focused on the following program elements: operational procedures and methods, staff training, validation and reporting of data, and communication. These guided the identification of risks to QAQC developed in this report.

## 2.2 Quality assurance

To identify measures to ensure the quality of IWC data, risks to the quality and consistency of IWC data were identified for each of the key risk areas. For each of these risks, existing QA measures are described and recommendations to enhance these measures are outlined. The following risks were assessed.

1. IWC assessment training program is inadequate.
2. IWC assessor skill level is inadequate.
3. IWC material resources is inadequate.
4. Data curation within the IWCDMS is inadequate.
5. Level of support and communication with IWC users and the IWC project team is inadequate or untimely.

### 2.2.1 Risk 1: IWC assessment training program is inadequate

Training forms an important component of IWC quality assurance as it ensures accuracy and consistency in the application of the method. In total nine training courses have been run between 2006 and 2012. In some years multiple courses were run and participant numbers have varied over time from 6 to 33 (Appendix 1). Early training courses (2006-2008) were provided to staff in the former Department of Sustainability and Environment (DSE) and the former Department of Primary Industries (DPI)[1]and catchment management authorities (CMAs) for their wetland assessment programs. In 2009, courses were provided to government agencies and consultants in preparation for the first state-wide assessment of wetlands. Since 2009, courses have been held in response to requests from CMAs for their Wetland Tender programs.

[1] DSE and DPI are now the Department of Environment and Primary Industries (DEPI)

The training courses have included class room and field components. In the class room, participants were provided with background to the development of the IWC and an explanation of the IWC methods manual. In the field, training was provided in all IWC measures as well as in the identification of wetland plants and ecological vegetation classes (EVCs). Participant practiced applying the IWC in small groups and compared scores obtained for a focal wetland among groups. Usually 0.5-1 day was spent in the classroom and 1 day in the field.

Participant's feedback was obtained at the end of each training course and has informed modifications to the course (Papas et al. 2009). The feedback from the courses was generally positive. Most participants felt the length of training (two days) was sufficient to cover all aspects of the method. Views differed in the amount of time spent explaining wetland EVC identification versus time spent doing a full IWC assessment. Participants found the background presentation helped them understand how the method was developed and provided context for the training. Most participants were confident that they could successfully apply the method in the field after the training.

*Current limitations and areas for improvement*

- All programs that use the IWC should build assessor training into their budgets.
- The competency of an assessor's ability to do an IWC assessment has not been tested.
- There is no single database of assessors training details and not all assessors who have been trained have been documented.

---

*Recommendations*

1. Develop and implement an e-learning module to provide training in the IWC assessment procedure prior to a field training module. This would replace the classroom component of the training. The module should cover most aspects of the IWC assessment and test the level of competency attained by the assessor. If this level of competence is not achieved, assessors will not be able to do the field based training. This will provide all assessors access to basic training and ensure a minimum level of competency is achieved. The duration of the training may be able to be reduced to one day.
2. Review and modify the field based training to include a competency test and to ensure key field components can be covered in a one day program. It is considered essential to continue to provide field based wetland EVC identification and IWC assessment training and practice.
3. Ensure that all IWC assessors successfully completed the e-learning module and field module every five years.
4. Assessors must also have performed IWC assessments within one year of training and at least every 2 years thereafter. If any of these requirements are not met an IWC training course must be completed.
5. Add functionality to the IWCDMS to include training accreditation information for all IWC assessors.
6. Encourage programs that use the IWC to build assessor training into their budgets.

### 2.2.2 Risk 2: IWC assessor skill level is inadequate

The IWC methods manual recommends that IWC assessments are performed by a team of two assessors, both trained in the assessment procedure (as outlined above), one of whom has botanical expertise (DSE 2013). These requirements are to ensure the observations and measurements collected are as accurate as possible. For the state-wide assessments that were coordinated by DEPI, these requirement were met. They have not always been met, however, for CMA based assessments. Frequently CMA assessments are made with only one assessor who does not have botanic expertise (see Section 2.2). The level of botanical expertise required to undertake assessment has not been described in the methods manual.

*Current limitations and areas for improvement*

- IWC assessments have been made by assessors with an insufficient level of botanical expertise. The level of botanical skill required to undertake assessments is not described in the IWC methods manual currently in distribution (DSE 2013) but an update will soon be published (DEPI 2013a)
- Budget constraints have limited IWC assessment personnel and led to assessments by single assessors.

*Recommendations*

1. Include quality assurance criteria for performing assessments in the methods manual and IWC website as follows:
    - Assessments should be performed by two trained assessors where possible. Assessments can be performed by one assessor only if all of the following requirements are able to be met:
        i. the assessor is trained in the IWC assessment procedure
        ii. OH&S risks of there being only one assessor in the field have been adequately controlled
        iii. the assessor has the botanical skills detailed in Table 1.
    - A detailed description of the botanical skill level expected of IWC assessors as outlined in Table 1 should be provided in the methods manual to help assessors gauge if they have the necessary skills. This data was informed by botanical skills required for a Victorian Vegetation Quality Assessment (DSE 2004).
    - A single assessor can only undertake an assessment if they have the required level of botanical expertise and OH&S risks associated with one assessor have been adequately controlled.
    - Ensure that users have access to and use up-to-date IWC resources and tools.

**Table 1** Botanical skill level expected of IWC assessors (modified from Vegetation Quality Assessment, DSE 2004).

| | |
|---|---|
| Recognition of plant species | Can distinguish between all the individual native species present |
| | Can identify native species that are required to discriminate between wetland EVCs |
| | Can identify lifeforms that are characteristic of wetland EVCs |
| | Can identify weed species |
| Recognition of vegetation types | Can identify wetland EVCs using reference material, and recognise any major floristic community variants that occur within these |
| Recognition of condition attributes | Can consistently estimate cover values for lifeforms and weeds |
| | Can identify biological invasions due to altered processes |

2. To test compliance to these standards, assessor should be asked to record on the IWC assessment sheet: (i) when they completed an approved training course and (ii) if they have the required botanical skills specified in the manual.
3. In addition assessors should be asked to provide information on training, botanical experience and assessment history when registering on the IWCDMS as an assessor.

### 2.2.3 Risk 3: IWC material resources are inadequate

The IWC method is supported by material resources including the IWC methods manual, vegetation assessment report, EVC field guide, online mapping tool and a website. IWC assessor feedback indicates these publications have assisted with assessments. Each of these supporting materials is evaluated and recommendations for improvements provided.

### *IWC methods manual and field assessment sheets*

The IWC methods manual (DSE 2013) provides guidelines for applying the IWC method. It explains the steps needed to assess wetland condition both prior to the wetland visit and at the wetland. The manual provides clear guidelines on performing assessments, a check list of resources required for field assessments and instructions on downloading wetland maps and aerial photos. An overview of the IWC structure and scoring is also provided. Field assessment sheets for data collection at the wetland are included. The manual has been updated based on feedback from users and changes to the IWC method. Some of these changes have included better guidance and definitions with problematic aspects of the assessment procedure identified by users. These include assessing wetlands in extremely dry conditions, identifying the wetland buffer, assessing large wetlands and floodplain wetland complexes.

The field assessment sheets have been designed to ensure accurate and complete data entry. Instructions and guidance are provided on the field sheets and assessors are referred to the IWC methods manual for further information.

An electronic data entry form designed for personal digital assistant (PDA) devices has commenced using ArcPad software to enable electronic data entry at the wetland. Advantages of direct recording of assessment results via electronic means over field sheets include:

- automatic data entry for some fields
- inbuilt validation checks while assessor is still on site
- reduce time and resources required for IWC assessment completion (no separate field sheet data transcription phase)
- can verify assessor details as assessor would have to log on before they are able to enter data
- automatic assignment of scores while still in field allowing assessor to judge consistency with wetland appearance and recheck any anomalous measures.

Since the development of the PDA form commenced, the IWC method and wetland spatial inventories have been updated and some of the data entry fields for the field assessment have changed. Also since this time, other devices capable of field data entry (e.g. tablets) have become more prevalent. Because of these developments it is now appropriate to scope several options for electronic data collection at the wetland. These include tablet devices and PDAs.

Both the data field sheets and digital data capture software should be reviewed annually to improve clarity.

*Current limitations and areas for improvement*

- Accessibility to the methods manual is limited as it is not published and available on the IWC website. This can lead to out of date versions of the manual being used for IWC assessments.
- There have been frequent updates to the methods manual which has led to numerous versions that have been circulated to users (the most is version 14). This leads to a heightened risk that an incorrect version will be used for assessments.
- Current QA and QC requirements are not explicit or adequately defined in the methods manual which may have contributed to noncompliance with some assessment standards (e.g. botanical expertise).
- Auditing IWC assessments will identify ambiguity in the manual that lead to assessment errors (see Section 2.3.2).
- Contacts for expert support are not provided in the methods manual or field assessment sheet.
- Data omissions or illegible text can occur on the field assessment sheets.

- Recent increased uptake of new portable data capture technology and changes to the IWC method and wetland spatial inventories necessitate an assessment of several options of electronic data collection at the wetland.
- Inadequate guidance is provided to assist agency in assessing human resources required to undertaken assessments.

---

*Recommendations*

1. Review the methods manual annually based on user feedback and update as required.
2. Publish the methods manual on the IWC website.
3. Request assessors check the website prior to undertaking assessments to ensure they have up to date resource materials.
4. Add quality assurance and quality control requirements to the methods manual.
5. Revise existing and provide further guidance in the methods manual on assessing large wetlands and floodplain wetlands.
6. Provide guidance in the methods manual on size classes of critical lifeforms.
7. Rename the methods manual to the IWC Assessment Procedure including the publication month and year in the title to ensure users identify the manual is the most current version and remove ambiguity associated with previous versions.
8. Use existing IWC data to estimate time needed to complete assessments for wetlands in various sizes/types. Update this guidance in the methods manual. This will help identify IWC assessment resource requirements.
9. Include the DEPI Customer Service Centre contact email address and phone number in the methods manual and on the field assessments sheets so that some queries can be resolved over the phone while assessors are in the field. A list of frequently asked questions (FAQs) provided to the DEPI Customer Service Centre will provide solutions to some queries. If the question is not adequately answered in a FAQ, then the call or email should be forwarded to the IWC support team (see also Section 2.2.5).
10. Review the field assessment sheets annually based on user feedback and update as required.
11. Add guidance to the field assessment sheets that direct assessors to complete all steps and data entry fields.
12. Assess the feasibility of electronic data entry at the wetland using tablet devices or the PDA form. Options include:
    - direct upload of data in the field to the IWCDMS using a web browser on any tablet
    - a data entry app for Android and iOS (the most popular tablet operating systems)
    - continued development of the ArcPad based PDA form.
13. Develop a user manual and training program for the electronic data entry solution.

### *Wetland EVCs and benchmarks*

Vegetation condition in the IWC requires the identification of wetland EVCs and an evaluation of their condition against benchmarks. Wetland vegetation condition assessment are supported by the methods manual (DSE 2013a), the wetland vegetation assessment report (DSE 2012b) and Wetland EVC benchmarks (DEPI 2013b). These documents have been reviewed and updated based on feedback from botanists. Following the most recent review, many benchmarks were modified and some new benchmarks were developed. The recently developed DEPI vegetation information management system may be a more easy to use, secure and accessible way to manage wetland EVC benchmarks.

*Current limitations and areas for improvement*

- The Access database containing EVC benchmarks has not been updated to reflect recent changes to EVC benchmarks (DSE 2013) and consequently the data in this is now out of date.

*Recommendations*

1. Assess the suitability of the recently developed vegetation information management system for managing wetland EVC benchmarks.
2. Update the wetland EVC benchmarks annually based on user feedback.

### *IWC Wetland Mapping Tool*

The online IWC Wetland Mapping Tool is built in DEPIs Mapshare environment. Its functions have recently been upgraded and several problems have been fixed to provide better support to IWC assessors. The updates include:

- addition of updated wetland spatial inventories to the map (Current Wetlands, Pre European Wetlands and Ramsar 25)
- simplified access to aerial imagery and generation of aerial maps
- ability to upload a polygon (e.g. wetland shapefile) or point to the map and generate a wetland base map and landuse map
- ability to generate a wetland map template which contains landscape features and map elements (legend, scale bar, etc.)
- addition of a scale bar on wetland base maps and landuse map
- Improved wetland search function.

DEPI is working through a web mapping strategy (DEPI 2013d). This process may lead to the adoption of new mapping architecture, one that is different to the Mapshare environment which is currently used by the mapping tool. The ongoing management of the IWC Wetland Mapping Tool application needs to take into account future changes to DEPIs web mapping architecture.

*Recommendations*

1. Engage with the DEPI web mapping project to enable timely planning for transition to new web mapping systems.
2. Address critical problems with the IWC Wetland Mapping Tool annually.

### *IWC website*

The IWC website contains the following information:

- a summary of the development and testing of the IWC and related reports
- a link to the IWC wetland mapping tool
- background and results of the two state-wide assessments of wetland condition
- a link to the wetland EVC field guide
- basic information on the use of the IWC and an email address to the IWC project manager.

*Current limitations and areas for improvement*

- The IWC website provides insufficient information on the IWC assessment procedure and the methods manual is not accessible.
- IWC information and resources are presently located in several sections of the website and could be grouped together to improve their accessibility.

*Recommendations*

1. Review, redesign and update the IWC website to improve information on the IWC assessment procedure, support and feedback and accessibility to IWC resources.
2. Publish the methods manual on the IWC website.

3. Review the IWC website annually based on user feedback and update if required.

### 2.2.4 Risk 4: Data curation procedures inadequate

The Index of Wetland Condition Data Management System (IWCDMS) is an online data management tool developed for storing, extracting, analysing, and reporting IWC assessment data, images and maps (DEPI 2013c). The system is accessed through any web browser and has the following functions:

- facilitates new user access
- manages wetland assessment projects
- manages wetland assessment data, images and PDF maps
- generates queries and reports (summary and detailed)
- manages database user information
- manages wetland assessor information
- generates maps displaying wetland condition scores and categories.

The IWCDMS was designed so that data entry from the field assessment sheet was as simple as possible. The order and layout of the screens are similar to the field sheets. The system includes features designed to minimise user error and automate calculations for scoring. There have been several iterations of enhancements and fixes to the IWCDMS in response to user feedback, testing by the IWC support team, audits of IWC data (see Section 2.2) and updates to the IWC method. The recently developed version (4.1) has additional data validation measures and checks in place to maximise the accuracy and completeness of the data (Appendix 1).

Training and support for the IWCDMS has been provided in on-site training sessions, over the phone and via email. A user can be adequately trained in data entry, querying and reporting in approximately 1.5 hours.

*Current limitations and areas for improvement*

- A manual has not been developed to provide users with instructions on use of the current version of the IWCDMS.
- Storage of maps, photo point and wetland EVC images require large data storage capacity. The long-term data storage requirements of the IWC will need to be addressed.
- All programs that use the IWC should build assessor training into their budgets.

---

*Recommendations*

1. Add a support and feedback link to the IWCDMS.
2. Develop additional online resources to for IWCDMS including a user manual and demonstration video.
3. Apply critical updates (e.g. bug fixes) to the IWCDMS annually.
4. Review and evaluate the IWCDMS every five years using user feedback to ensure all possible data checks and alerts are provided and instructions are clear.
5. Add guidance to the methods manual that data should be entered onto the IWCDMS within 4 weeks of collection and field assessment sheets are to be retained for minimum of five years and made available for auditing purposes.
6. Evaluate the value of electronically storing maps and images on the database and examine ways of minimising data storage requirements.
7. Encourage programs that use the IWC should factor training costs into their budget.

### 2.2.5 Risk 5: Level of support and communication with IWC users and the IWC project team is inadequate or untimely

Expert support is provided to IWC users by a small DEPI team based in Heidelberg and East Melbourne. The support provided has included:

- coordinating user feedback workshops
- guidance on the IWC assessment procedure, data entry and report generation
- receipt of feedback (e.g. improvements to the method)
- questions about the wetland spatial inventory (and wetland maps)
- lodging and responding to IWCDMS and/or IWC Wetland Mapping Tool problems
- lodging and responding to requests for IWC assessment or IWCDMS training
- creating IWCDMS user accounts and resetting IWCDMS user passwords.

Presently updates to the IWC method and resources are communicated to IWC users via email. A register of IWC assessors is contained in the IWCDMS and a register of other IWC contacts such as CMA Wetland Tender project staff are maintained by a member of the IWC support team (Phil Papas). Occasionally, upon request, students are given access to the methods manual, however, they are not presently included in a contact register. CMAs and other NRM groups sometimes use consultants for IWC assessments associated with CMA projects. The support team is not always notified about, or involved in, selecting these consultants. Consequently they may not be included in the register of IWC users.

Two workshops have been coordinated by the IWC support team and a team in the Knowledge and Decision Systems Branch (a group in DEPI that is involved in the Wetland Tender process) to solicit feedback from users in the application of the IWC method and Wetland Tender assessments. A large amount of feedback was obtained from these workshops. It has not been possible to implement all changes due to resource constraints. Changes resulting from feedback have included:

- improved nutrient enrichment assessment in the IWC method
- improved salinity assessment in the IWC method
- improved water regime assessment in the IWC method
- improved soils assessment in the IWC method
- improvements to the IWCDMS query builder.

The bulk of feedback has been obtained from individuals by phone and email. An email address for IWC queries (admin.iwc@depi.vic.gov.au ) is provided in the methods manual and on the IWC website. Very few emails have been received from this address however – the vast majority of queries are received by phone and email to one member of the IWC support team (Phil Papas). Presently other members of the support team are not able to access these email or phone enquiries.

*Current limitations and areas for improvement*

- There is a risk of untimely response to enquiries with the current support process (i.e. most queries directed to one support team member).
- Resource constraints may limit the degree of personal support provided. Continued development and improvement of online resource material could reduce the requirement for personal support.
- Administration of the current IWC support email address requires support staff to manually check the email account (there is no automatic forwarding of emails to the support team email accounts).
- Identifying the costs of ongoing IWC support could be assisted by promoting the use of the queries email to generate a record of queries.
- A new web mapping architecture will facilitate a change to the way the tool is currently maintained and developed.

*Recommendations*

1. Collate and assess existing feedback solicited from IWC users on the IWC method and measures and develop a plan to address these.
2. Transition IWC users to an IWC support email address from the existing model (phone calls and emails to Phil Papas) that can be accessed by the entire IWC support team. Change the address to IWC.support@depi.vic.gov.au to better reflect and promote its purpose.
3. Add a link to the support email address to the IWCDMS.
4. Ensure emails to this address are automatically forwarded to the IWC support team (Phil Papas and Kay Morris).
5. From user feedback, compile a list of frequently asked questions (FAQs). These should be added to the IWC website and provided to the DEPI Customer Service Centre. This will provide solutions to some queries. If the question is not adequately answered in a FAQ, then the call or email from the service centre should be forwarded to the IWC support team.
6. From user feedback, compile a list of possible improvements to all IWC components including the training program, methods manual, IWCDMS, IWC Wetland Mapping Tool and other resource publications.
7. Include the DEPI Customer Service Centre contact email address and number in the methods manual and on the field assessment sheets.

## 2.3 Quality control

Quality control measure should be established to evaluate the quality of training and the quality and consistency of IWC assessment data and data curation processes.

### 2.3.1 IWC assessment and IWCDMS training

Previous IWC assessment and IWCDMS training programs have not tested the level of competence achieved following training. It is recommend that competency tests developed for future training programs in both these areas. The e-learning tool should include an online test which must be passed in order to attend field-based training. Competency in performing IWC assessment in the field should also be assessed. To verify that IWC assessments have been performed by trained assessors an IWC training registry should be established.

*Recommendations*

1. Develop and implement a competency test in the e-learning module of the IWC assessment training which must be passed in order to attend field-based training.
2. Develop and implement a field based competency test as part of the field module of the IWC assessment training.

### 2.3.2 IWC assessments and IWCDMS data

To determine confidence in the accuracy of IWC data and to assess the role various quality assurance measures play in data quality, audits on the accuracy and completeness of the IWC data collection process from the wetland to the IWCDMS is required.

*Current limitations and areas for improvement*

- At present there are no quality control criteria or guidelines on assessing the quality of IWC data, although some auditing has been performed previously (see Section 2.2).
- As electronic data entry is implemented at the wetland, the need for a desktop audit should be reviewed.

- Auditing should include an assessment of the accuracy of data collected at the wetland, a check on the field assessment sheets to ensure all fields have been completed where appropriate and a cross check of the accuracy of data entry on the IWCDMS.
- Some variation in wetland vegetation assessment scores among botanists was observed in a training program prior to the first statewide assessment of wetland condition. An acceptable level of variation expected among botanists should be determined to enable the accuracy of the wetland vegetation field audit results to be assessed.
- Costs of auditing IWC assessments must be met by the agency leading the project (for example, included in Wetland Tender project budgets).

---

*Recommendations*

1. IWC projects with more than 20 IWC assessments should be audited. A greater number of audits may be required for projects where a higher level of confidence is required. Audit results should be used to inform improvements in the method, resources and/or training to reduce future errors where possible. Field audit results will also be used to inform the development of criteria for evaluating the accuracy of IWC assessments and assigning a confidence rating to assessments and projects.
2. Two types of audits should be performed:
    - Desktop audits should be performed on 10% of randomly selected IWC assessments. These should include a detailed check of field sheets and corresponding IWCDMS data for omissions and errors.
    - Field based audits should be performed on at least 5% of IWC assessments per project. These audits require the wetland to be reassessed by the IWC team or an experienced independent assessor. Assessments should be randomly selected for auditing, however, where desktop audits have identified errors, a field audit should be performed.
3. Errors identified in audits should be documented, discussed with assessors and corrected.
4. Determine the acceptable level of variation in wetland vegetation scores expected among botanists to enable the accuracy of the wetland vegetation field audit results to be assessed.

### 2.3.3 Audits of IWC assessments

*State-wide wetland assessments*

Approximately 10% of the assessment data (65 assessments) in the IWCDMS associated with the 2010-11 state-wide assessment were checked against the field sheets for errors. These checks were done at the conclusion of the state-wide assessment program. Of the 13 components examined, errors were detected only with wetland water source information for approximately 20% of assessments. This was caused by inadequate guidance on the IWCDMS (Papas and Moloney 2012). The water source fields on the IWCDMS have been modified to minimise the risk of future data entry errors.

*Wetland Tender assessments*

For this project, approximately 10% of assessments (40 assessments) associated with Wetland Tender projects were checked to assess the quality of these data and to identify improvements to quality assurance and quality control (Table 2). Prior to this audit there had been no quality control checks of Wetland Tender data. Audits included checks of each component of the field assessment sheets and corresponding data on the IWCDMS. Results of the field assessment sheet and IWCDMS data audits were used to inform quality assurance measures including IWCDMS validation measures (Tables 3 and 4).

**Table 2** Wetland Tender assessments audit details.

| **Year** | **Lead organisation** | **Number of wetlands assessed** | **Number received for audit** | **Number audited** | **Assessors trained** Always/Sometimes/ Never | **Number of assessors** | **Botanists involved in assessments** Always/Sometimes/Never |
|---|---|---|---|---|---|---|---|
| 2010-11 | Goulburn Broken CMA | 20 | | | Always | 1 | Never |
| 2011-12 | Goulburn Broken CMA | 33 | | | Always | 1 | Never |
| 2009-10 | Glenelg Hopkins CMA | 37 | 4 | 4 | Never | 1, rarely 2 | Sometimes |
| 2010-11 | Glenelg Hopkins CMA | 20 | 7 | 6 | Always | 2 | Always |
| 2011-12 | Glenelg Hopkins CMA | 14 | | | Never | 1 | Sometimes |
| 2009-10 | Wimmera CMA | 44 | | | Always | 1 | Never |
| 2010-11 | Wimmera CMA | 46 | | | Always | 1 | Never |
| 2011-12 | Wimmera CMA | 75 | 43 | 10 | Always | 1 | Never |
| 2009-10 | Corangamite CMA | 39 | 8 | 8 | Always | 1 | Never |
| 2010-11 | Corangamite CMA | 24 | 2 | 2 | Always | 1 | Never |
| 2011-12 | Corangamite CMA | 30 | | | Always | 1 | Never |
| 2009-10 | West Gippsland CMA | 13 | 13 | 10 | Always | 1 | Always |
| 2010-11 | West Gippsland CMA | 13 | | | Always | 2 | Always |

The audit found that in most Wetland Tender assessments, one assessor was used to do the assessment. The assessor was a CMA staffer and may not have had a sufficient level of botanical expertise (Table 2). These results may indicate insufficient resources are allocated to these projects.

Wetland maps (base map, EVC map and land use map) were not generated and used in the assessment for approximately 75% of the assessments audited and photos were not taken in 40% of assessments (Table 3). Date/time was not documented on the field assessment sheet for half of the assessments audited (Table 3), however it was completed for all assessments in the IWCDMS (Table 4). These omissions do not affect the scores generated for an assessment. Reasons why maps were not generated and photos were not taken should be investigated.

Data omissions on the field assessment sheets ranged from 2 to 30% for the IWC measures. The field assessment sheets have been redesigned and the clarity of the data entry fields improved to minimise this risk. There were some instances critical lifeform species were used in the critical lifeform calculation instead of the number of critical lifeform groups. This has been addressed through better guidance in the methods manual and field assessment sheets. High threat weeds were not documented in 17% of assessments. Clearer guidance has been provided in the methods manual and field assessment sheets to address this.

**Table 3** Results from the audit of the field assessment sheets and recommendations/action to minimise/prevent errors.

| Component | Sub-component | Error type | Error rate | Recommendation/action (* denotes completed) |
|---|---|---|---|---|
| **Date and time** | | | 50% | Field assessment sheet redesigned* |
| **Inundation** | **Wetland phase** | Incomplete | 7% | Field assessment sheet redesigned* |
| **Map annotation** | **Wetland buffer** | Not generated | 75% | Solicit feedback from CMAs for reasons why maps were not generated and used in the assessment.<br>Review, modify and necessary add guidance to the IWC training modules, methods manual and IWC website on the use and value of the base map, land use map and EVC map in IWC assessments. |
| | **Wetland EVC map** | Not generated | 77% | |
| | **Land use map** | Not generated | 75% | |
| **Photos** | | Incomplete (no photos taken) | 40% | Solicit feedback from CMAs for reasons why maps photos were not generated and used in the assessment.<br>Review, modify and necessary add guidance to the IWC training modules, methods manual and IWC website on the use and value of wetland photos in IWC assessments. |
| **Wetland catchment** | | Incomplete (land use change question only) | 30% | Field assessment sheet redesigned* |
| | | Scores | 12% | None required (validation present in IWCDMS) |
| **Physical form** | | Incomplete (activities leading to a change in wetland bathymetry) | 12% | Field assessment sheet redesigned* |
| **Hydrology** | | Incomplete (water regime components not selected) | 2% | Field assessment sheet redesigned* |
| **Water properties** | **Nutrient enrichment** | Incomplete (no activities selected when nutrient enrichment present) | 7% | Field assessment sheet redesigned* |
| **Soils** | | Incomplete (activities not selected when soil disturbance present) | 5% | Field assessment sheet redesigned* |
| **Biota** | **EVC** | Scores | 5% | None required (validation present in IWCDMS) |
| | **Critical lifeforms** | Incomplete<br>Incorrect (indicator species counted instead critical lifeforms) | 7%<br>5% | Redesigned critical life form table on the field assessment sheet*<br>Clearer guidance added to field assessment sheets to prevent species from being counted as lifeforms* |
| | **Weeds** | Incomplete (high threat wees not identified) | 17% | Better guidance provided in methods manual and field assessment sheets on documenting high threat weeds, especially those not listed in the EVC benchmark* |

Data entry errors on the IWCDMS identified in the audit ranged from 5% to 22% (Table 4). Data entry fields have been redesigned and validation rules added to reduce the risk of these errors (Appendix 2).

**Table 4** Data entry errors identified in the IWCDMS from the cross-checking with the field assessment sheets and recommendations/actions to minimise/prevent errors. Refer to Appendix 2 for a list of all validation measures in the most current version of the IWCDMS (4.1).

| Component | Sub-component | Error type | Error rate | Recommendation/action (* denotes action completed) |
|---|---|---|---|---|
| **Date and time** | | Incorrect | 3% | None required |
| **Inundation** | **Wetland inundation** | | 0% | None required<br>Note Wetland Phase was not assessed in the audit. A validation rule has been added to the IWCDMS however which ensures that when the wetland is 100% dry, the wetland phase is set to dry and when the wetland is 100% full the wetland phase is set to full (see Table 4) |
| **Map annotation** | **Wetland buffer** | Not generated/uploaded | 75% | See Table 3 |
| | **Wetland EVC map** | Not generated/uploaded | 77% | |
| | **Land use map** | Not generated/uploaded | 75% | |
| **Photos** | | Incomplete (no photos taken) | 75% | See Table 3 |
| **Wetland catchment** | | Incorrect buffer width and % of wetland with buffer values/scores | 7% | Changed default buffer width and % of wetland with a buffer scores to blank values (previously the default was 0-5 m and 0-5% respectively)*<br>Fields have been made mandatory (must be completed to progress with data entry)* |
| **Physical form** | | Incomplete (activities leading to a change in wetland bathymetry) | 22% | Validation rule added to IWCDMS so that it is no longer possible to leave the activities unchecked if some disturbance to bathymetry has been identified* |
| **Hydrology** | | Incomplete (water source data not entered) | 5% | Water source fields in the IWCDMS redesigned to minimise the risk of water source data omission* |
| | | Incorrect activities that change water regime selected | 15% | Hydrology assessment redesigned in IWCDMS*<br>Validation rule added which ensures that if water regime change is evident, then at least one activity that effects the water regime must be selected* |
| **Water properties** | **Nutrient enrichment** | Incorrect assessment of nutrient enrichment | 5% | Nutrient assessment redesigned in IWCDMS*<br>Validation rule added to IWCDMS which ensures that when nutrient enrichment is evident at least one activity that effects nutrient enrichment must be selected* |
| | | Incorrect activities that lead to nutrient enrichment selected | 7% | |
| **Soils** | | Incomplete activities not selected when soil disturbance present | 5% | Validation rule added to IWCDMS which ensures that when soil disturbance is evident at least one soil disturbance activity must be selected* |
| **Biota** | **EVC** | Scores | 5% | None required (validation built in to IWCDMS) |
| | **Critical lifeforms** | Incomplete or incorrect (indicator species counted instead critical lifeforms) | 10% | Redesigned critical life form table on the IWCDMS* |
| | **Weeds** | Incomplete (high threat wees not identified) | 17% | Make it mandatory to select at least one high threat weed species if scoring indicates high threat weeds are presentation (logged as an issue to be addressed in a future release of the IWCDMS*) |

*Recommendations (not already addressed in updates to the field assessment sheets and IWCDMS)*

- Solicit feedback from CMAs for reasons why maps were not generated and photos not taken and used in the assessment.
- Solicit feedback from CMAs for reasons why only one assessor was used and identify the level of botanical skill used.

- Add QA and QC requirements to the methods manual.
- Review, modify and add guidance to the IWC training modules, methods manual and IWC website on the use and value of the base map, land use map, EVC map and photos in IWC assessments.
- Ensure feedback about high threat weeds is used to update the list of high threat weeds in the wetland EVC benchmarks.

# 3 Quality assurance and quality control system and recommendations for further improvements

## 3.1 The IWC quality assurance and quality control system

The outcomes of the quality assurance and quality control evaluation and recommendations made in this report informed the developed of the QA QC system documented below. This system has been added to the IWC methods manual (now the IWC Assessment Procedure). Additional measures that can be addressed to improve QA QC were also identified in this review and are listed in Section 3.2.

In general, costs of meeting the QA QC requirements for the IWC will need to be met by the assessment program.

### 3.1.1 Quality assurance

Quality assurances measures for the IWC program aim to ensure the competence of assessors and the secure and effective management of IWC data.

***Assessment teams and assessor competence*:** The following measures help to assure accurate IWC assessments and that assessors are competent in performing assessments.

- *Number of assessors:* Assessments should be performed by two trained assessors where possible. Assessments can be performed by one staff member only if all of the following requirements are met:
    1. the assessor is trained in the IWC assessment procedure
    2. OH&S risks of there being only one assessor in the field have been adequately controlled
    3. the assessor has the botanical skills detailed in the table below.
- *Mandatory training*: All IWC assessors must have completed an IWC training program provided by DEPI in the last five years. At present training is provided only to CMAs undertaking IWC assessments (and the consultants they engage).
- *Required wetland vegetation assessment skill*: The wetland vegetation assessment component of the IWC requires some specialist skill in wetland plant identification. To complete the plant assessment component of the IWC, assessors must be trained in the IWC assessment procedure and must also have the botanical skills detailed in Table 5 below. Where two trained assessors undertake an assessment, only one assessor is required to have the specified plant identification skills.

| **Table 5** Botanical skill level expected of IWC assessors (modified from Vegetation Quality Assessment, DSE 2004). | |
|---|---|
| Recognition of plant species | Can distinguish between all the individual native species present |
| | Can identify native species that are required to discriminate between wetland EVCs |
| | Can identify lifeforms that are characteristic of wetland EVCs |
| | Can identify weed species |
| Recognition of vegetation types | Can identify wetland EVCs using reference material, and recognise any major floristic community variants that occur within these |
| Recognition of condition attributes | Can consistently estimate cover values for lifeforms and weeds |
| | Can identify biological invasions due to altered processes |

- *Regular use of method to maintain skills*: Assessors must have performed IWC assessments within one year of training, and at least every two years thereafter. If these requirements are not met an IWC training program provided by DEPI must be completed.
- *Supporting materials and resources*: To assist assessors in performing assessments a range of up to date material and resources are accessible through the IWC website (http://ics.water.vic.gov.au/ics ). These include this QA QC plan, the IWC Assessment Procedure (formerly the IWC Methods Manual), vegetation assessment report, IWC Wetland Mapping Tool, IWCDMS and a link to purchase the second edition of the EVC photo guide. In addition, guidance in performing assessments can be sought from the IWC support team by email: IWC.support@depi.vic.gov.au, or phone: 136 186. These details are provided in the IWC Assessment Procedure and on the field assessment sheets.

***Data management***: To reduce the risk that assessment data is lost or that incorrect or incomplete data is entered assessors must enter data for field assessment sheets and upload annotated maps and photo point images onto the IWCDMS within four weeks of data collection. Hard copies of field assessment sheets and annotate maps must be kept for a minimum of five years by the organisation in charge of the project and made available for auditing purposes upon request.

### 3.1.2 Quality control

IWC Quality control measures test: (1) assessor competency, (2) the standard of IWC assessments and (3) the level of satisfaction experienced by users of the IWC method.

***IWC assessor competence***: The IWC training program provided by DEPI evaluates the level of competence achieved by participates in entering data on the IWCDMS and determines if participants have the required level of botanical expertise.

***Quality of IWC assessments***: Desktop and field based audits must be performed to assess the quality of IWC data. Desktop audits assess the completeness and accuracy of data entries on field assessment sheets and the IWCDMS as far as is possible without a site visit.

1. IWC projects with more than 20 IWC assessments should be audited. A greater number of audits may be required for projects where a higher level of confidence is required. Audit results should be used to inform improvements in the method, resources and/or training to reduce future errors where possible. Field audit results will also be used to inform the development of criteria for evaluating the accuracy of IWC assessments and assigning a confidence rating to assessments and projects.

2. Two types of audits should be performed:
    - Desktop audits should be performed on 10% of randomly selected IWC assessments. Desktop audits should include a detailed check of field sheets and corresponding IWCDMS data for omissions and errors.
    - Field based audits should be performed on at least 5% of IWC assessments per project. Field based audits require the wetland to be reassessed by the IWC team or an experienced independent assessor. Assessments should be randomly selected for auditing, however, where desktop audits have identified errors, a field audit should be performed.
3. Errors identified in audits should be documented, discussed with assessors and corrected.
4. Determine the acceptable level of variation in wetland vegetation scores expected among botanists to enable the accuracy of the wetland vegetation field audit results to be assessed.

***Stakeholder expectations***: the following measures are to monitor and evaluate the effectiveness of the IWC method, training and data management system by:

- provision of stakeholder issues and feedback to be lodged through the IWCDMS, email: IWC.support@depi.vic.gov.au, or phone: 136 186
- evaluation workshops to obtain stakeholder feedback.
- formal evaluation and review of the IWC materials, resources and method.

### 3.1.3 Recommendations for further quality assurance and quality control improvement

In addition to the QA QC system described in sections 3.1.1 and 3.1.2, a suite of other measures summarised from the Section 2 of this report should be implemented over time to improve the QA and QC of the IWC (Table 6).

**Table 6** Additional measures to those identified in the QA QC system to improve QA and QC of the IWC.

| **Quality assurance measures (recommendations in italics have been addressed)** |
|---|
| **Risk 1: IWC assessment training program is inadequate** |
| 1. Develop and implement an e-learning module to provide training in the IWC assessment procedure prior to a field training module. This would replace the classroom component of the training. The module should cover most aspects of the IWC 4assessment and test the level of competency attained by the assessor. If this level of competence is not achieved, assessors will not be able to do the field based training. This will provide all assessors access to basic training and ensure a minimum level of competency is achieved. The duration of the training may be able to be reduced to one day.<br>2. Review and modify the field based training to include a competency test and to ensure key field components can be covered in a one day program. It is considered essential to continue to provide field based wetland EVC identification and IWC assessment training and practice.<br>3. Add functionality to the IWCDMS to include training accreditation information for all IWC assessors.<br>4. Encourage programs that use the IWC to build assessor training into their budgets. |
| **Risk 2: IWC assessor skill level inadequate** |
| 1. Require assessors to provide information on training, botanical experience and assessment history when registering on the IWCDMS as an assessor. |
| **Risk 3: IWC material resources are inadequate** |
| **IWC methods manual and field assessment sheets**<br>1. Review the methods manual and field assessment sheets annually based on user feedback and update as required.<br>2. Publish the methods manual on the IWC website.<br>3. Request assessors check the website prior to undertaking assessments to ensure they have up to date resource materials.<br>4. Revise existing and provide further guidance in the methods manual on assessing large wetlands and floodplain wetlands.<br>5. Use existing IWC data to estimate time needed to complete assessments for wetlands in various sizes/types. Update this guidance in the methods manual. This will help identify IWC assessment resource requirements.<br>6. Assess the feasibility of electronic data entry at the wetland using tablet devices or the PDA form. Options include:<br>• Direct upload of data in the field to the IWCDMS using a web browser on any tablet.<br>• A data entry app for Android and iOS (the most popular tablet operating systems).<br>• Continued development of the ArcPad based PDA form.<br>7. Develop a user manual and training program for the electronic data entry solution.<br>*8. Include the DEPI Customer Service Centre contact email address and phone number in the methods manual and on the field assessments sheets so that some queries can be resolved over the phone while assessors are in the field.*<br>*9. Provide guidance in the methods manual on size classes of critical lifeforms.*<br>*10. Rename the methods manual to the IWC Assessment Procedure including the published month and year in the title to ensure users identify the manual is the most current version and remove ambiguity associated with previous versions.*<br>*11. Add guidance to the field assessment sheets that direct assessors to complete all steps and data entry fields.*<br>*12. Add quality assurance and quality control requirements to the methods manual.*<br>**Wetland EVCs and benchmarks**<br>13. Assess the suitability of the recently developed vegetation information management system for managing wetland EVC benchmarks.<br>14. Review wetland EVC benchmarks annually based on user feedback and update if required.<br>**IWC wetland mapping tool**<br>15. Engage with the DEPI web mapping project to enable timely planning for transition to new web mapping systems.<br>16. Address critical problems/bugs with the IWC Wetland Mapping Tool annually.<br>**IWC website**<br>17. Review the IWC website annually based on user feedback and update if required. |

**Table 6 (continued).**

| |
|---|
| **Risk 4: Data curation procedures inadequate** |
| 1. Develop additional online resources to for IWCDMS including a user manual and demonstration video.<br>2. Apply critical updates (e.g. bug fixes) to the IWCDMS annually.<br>3. Review and evaluate the IWCDMS every five years using user feedback to ensure all possible data checks and alerts are provided and instructions are clear.<br>4. Evaluate the value of electronically storing maps and images on the database and examine ways of minimising data storage requirements.<br><br>*5. Add a support and feedback link to in the IWCDMS* |
| **Risk 5: Level of support and communication with IWC users is inadequate or untimely** |
| 1. Collate and assess existing feedback solicited from IWC users on the IWC method and measures and develop a plan to address these.<br>2. Transition IWC users to a an IWC support email address from the existing model (phone calls and emails to Phil Papas) that can be accessed by the entire IWC support team.<br>3. Ensure emails to the IWC support email address are automatically forwarded to the IWC support team (Phil Papas and Kay Morris).<br>4. From user feedback, compile a list of frequently asked questions (FAQs). These should be added to the IWC website and provided to the DEPI Customer Service Centre. This will provide solutions to some queries. If the question is not adequately answered in a FAQ, then the call or email from the service centre should be forwarded to the IWC support team.<br>5. From user feedback, compile a list of possible improvements to all IWC components including the training program, methods manual, IWCDMS, IWC Wetland Mapping Tool and other resource publications.<br><br>*6. Change the IWC support email address to IWC.support@depi.vic.gov.au to better reflect and promote its purpose.*<br>*7. Add a link to the support email address to the IWCDMS.*<br>8. *Include the DEPI Customer Service Centre contact email address and number in the methods manual and on the field assessment sheets.* |
| **Quality control measures** |
| **IWC assessment and IWCDMS training** |
| 1. Develop and implement an assessment in the e-learning module of the IWC assessment training which must be passed in order to attend field-based training.<br>2. Develop and implement an assessment in the field module of the IWC assessment training. |
| **IWC assessments and IWCDMS data** |
| 1. Errors identify in audits should be documented and discussed with assessors. A level of confidence in the quality of data should be assigned based on the type and number of errors found. Audit results should be used to inform improvements in the methods, resources and/or training to reduce further errors where possible.<br>2. Solicit feedback from CMAs for reasons why maps were not generated and photos not taken and used in the assessment.<br>3. Solicit feedback from CMAs for reasons why only one assessor was used and identify the level of botanical skill used. |

# 4 References

DSE (2004) Vegetation Quality Assessment Manual–Guidelines for applying the habitat hectares scoring method. Version 1.3. Victorian Government Department of Sustainability and Environment, Melbourne

DSE (2005) Index of Wetland Condition: conceptual framework and selection of measures. Department of Sustainability and Environment, East Melbourne

DSE (2010) Wetland Tender: Field Officer Manual. State of Victoria, Department of Sustainability and Environment, East Melbourne (Unpublished)

DSE (2012a) Index of Wetland Condition: Assessment of wetland vegetation Update – December 2012. Department of Sustainability and Environment, East Melbourne, Victoria

DSE (2012b) A field guide to Victorian wetland Ecological Vegetation Classes – for the Index of Wetland Condition, 2nd Edition. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Heidelberg, Victoria

DSE (2013) Index of Wetland Condition methods manual Version 14. Unpublished report. Department of Sustainability and Environment, Heidelberg, Victoria

DEPI (2013a) Index of Wetland Condition assessment procedure – July 2013. Department of Sustainability and Environment, East Melbourne, Victoria

DEPI (2013b) Benchmarks for wetland ecological vegetation classes in Victoria. Department of Environment and Primary Industries, East Melbourne, Victoria

DEPI (2013c) Index of Wetland Condition Data Management System v4.1. Department of Environment and Primary Industries, East Melbourne, Victoria

DEPI (2013d) DEPI Web mapping strategy. Volume 4 – future state. Unpublished report. Department of Environment and Primary Industries, East Melbourne, Victoria

EPA (2004) Guidelines for environmental management: rapid bioassessment of rivers and streams. EPA Victoria, South Bank, Victoria

Papas, P., LyonS., Holmes, J and Ramsey, D (2009) Index of Wetland Condition: training, information for management and testing. Department of Sustainability and Environment (2009) Wetland Tender: Field Officer Manual. State of Victoria, Department of Sustainability and Environment, East Melbourne

Papas, P. and Moloney, P. (2012) Victoria's wetlands 2009–2011: statewide assessments and condition modelling. Arthur Rylah Institute for Environmental Research Technical Report Series No. 229. Department of Sustainability and Environment, Heidelberg

# Appendix 1

**IWC assessment training courses run since development of the IWC in 2005**

| Month/Year | Location(s) | Participants | | Duration (days) | Components |
|---|---|---|---|---|---|
| | | Number | Affiliation | | |
| June 2006 | Lanigans Swamp | 11 | DSE, North East CMA, Goulburn Broken CMA, consultants | 1 | • Wetland EVC identification<br>• Wetland EVC assessment<br>• IWC assessment demonstration |
| June 2006 | Barmah Forest | 13 | DSE,<br>North Central CMA | 1 | • Wetland EVC identification<br>• Wetland EVC assessment<br>• IWC assessment demonstration |
| October 2006 | Colac | 16 | West Gippsland CMA, Corangamite CMA, Glenelg Hopkins CMA | 2 | • IWC background<br>• IWC assessment procedure explanation<br>• IWC assessment demonstration<br>• IWC assessment by participants in groups |
| October 2006 | Kerang | 16 | DPI, Parks Victoria, North Central CMA, Mallee CMA, consultants | 2 | • IWC background<br>• IWC assessment procedure explanation<br>• IWC assessment demonstration<br>• IWC assessment by participants in groups |
| August 2008 | Point Cook/Laverton | 6 | Port Phillip and Westernport CMA staff, Consultants | 2 | • IWC background<br>• IWC assessment procedure explanation<br>• IWC assessment demonstration<br>• IWC assessment by participants |
| September 2009 | Heidelberg/Point Cook | 33 | DSE, Corangamite CM, Glenelg Hopkins CMA, Goulburn Broken CMA, Mallee CMA, North Central CMA, North East CMA, | 2 | • IWC background<br>• IWC assessment procedure explanation<br>• IWC assessment demonstration<br>• IWC assessment by participants in groups |
| October 2009 | Heidelberg/Point Cook | 15 | Consultants (botanists) | 2 | • Wetland EVC identification<br>• Wetland EVC assessment |
| November 2010 | Shepparton | 6 | Goulburn Broken CMA, consultants | 2 | • IWC background<br>• IWC assessment procedure explanation<br>• IWC assessment demonstration<br>IWC assessment by participants in groups |
| November 2012 | Hamilton | 11 | Glenelg Hopkins CMA, consultants | 2 | • Wetland EVC identification<br>• Wetland EVC assessment |

# Appendix 2

**Validation measures in the IWCDMS to minimise/prevent data entry errors and data omissions**

| Data sheet component | IWCDMS validation/data control measures |
|---|---|
| **General Information** | **Coordinates:**<br>• Wetlands on the Wetland_Current spatial inventory: coordinates for the centre of the wetland are automatically generated.<br>• User created wetlands: only wetland coordinates within Victorian boundary are accepted |
| | **Date and time:**<br>• Finish time must be later than start time |
| **Inundation status of wetland** | **Wetness/wetland phase:**<br>• Wetness values must be between 0% and 100% and the total must equal 100% in order to save the assessment or proceed to the next page<br>• When the wetland is 100% dry, the wetland phase is set to dry and when the wetland is 100% full the wetland phase is set to full |
| | **Number of years dry:**<br>• This can only can only be selected if Wetland phase is set to dry |
| **Attachments (photos)** | **Maps:**<br>• File names are automatically assigned using the specified naming convention when the photo is uploaded |
| | **Photo point photo:**<br>• only coordinates within Victorian boundary are accepted<br>• Only direction values between 0 and 360 degrees are accepted<br>• File names are automatically assigned using the specified naming convention when the photo is uploaded |
| | **EVC photo:**<br>• File names are automatically assigned using the specified naming convention when the photo is uploaded |
| **Wetland catchment** | **Wetland buffer assessment:**<br>• Completion of all measures and questions is mandatory<br>• Default for average buffer width and % perimeter with a buffer is set to blank (previously this was 0-5 for both measures) |
| | **Land use intensity:**<br>• Values must be between 0% and 100% and the total must equal 100% in order to save the assessment or proceed to the next page |
| **Physical form** | **Reduction in wetland area:**<br>• If the current wetland area is manually entered, then the change in wetland area is automatically calculated/set |
| | **Activities that change the wetland bathymetry:**<br>• At least activity that changes wetland bathymetry option must be selected in order to save the assessment or proceed to the next page<br>• If no evidence of activities that change the wetland bathymetry is selected, none of the other activities can be selected |
| | **Severity of wetland bathymetry change:**<br>• Severity of wetland bathymetry change values must be between 0% and 100% and the total must equal 100% in order to save the assessment or proceed to the next page<br>• If no evidence of activities that change in wetland bathymetry is selected, the severity of wetland bathymetry change is set to 0%<br>• If an activity that changes the wetland bathymetry is selected, the severity of wetland bathymetry change cannot equal 0% |
| **Hydrology** | **Water source:**<br>Mandatory to select at least one water source and to assign a level of confidence and data source |
| | **Activities that change the water regime:**<br>• At least one option must be selected in order to save assessment or proceed to the next page<br>• If no activities is selected, none of the other activities can be selected |
| | **Severity of change to water regime component:**<br>• If no activities that change the water regime are selected, then the severity of change to the water regime timing and category are both set to low-very low |

**Appendix 2 continued**

| Data sheet component | IWCDMS validation / data control measures |
|---|---|
| **Water properties** | **Nutrient enrichment activities:**<br>• At least one of the activities leading to nutrient enrichment options must be selected in order to save the assessment or proceed to the next page<br>• If no activities leading to nutrient enrichment is selected, then none of the other activities can be selected |
| | **Nutrient enrichment severity:**<br>• If no activities leading to nutrient enrichment is selected, then the severity of nutrient enrichment is set to no enrichment<br>• If one or more activities leading to nutrient enrichment are selected, then the severity of nutrient enrichment cannot be none |
| | **Change in salinity options:**<br>• At least one of the change in salinity options must be selected in order to save the assessment or proceed to the next page<br>• If no change in salinity is selected, none of the other options can be selected |
| | **Change in salinity severity:**<br>• If no change in salinity is selected, then the severity of change in salinity is set to no change<br>• If one or more change in salinity options are selected, then the severity of change in salinity cannot be none |
| **Soils** | **Activity causing soil disturbance:**<br>• At least activity that causes soil disturbance option must be selected in order to save the assessment or proceed to the next page<br>• If no activities that cause soil disturbance is selected, then none of the other activities can be selected |
| | **Severity of soil disturbance:**<br>• Severity of soil disturbance values must be between 0% and 100% and the total must equal 100% in order to save data or proceed to the next page<br>• If none of the activities that cause soil disturbance is selected, the severity of soil disturbance is set to 0%<br>• If an activity that causes soil disturbance is selected, the severity of soil disturbance cannot equal 0% |
| **Biota** | **EVC name and number:**<br>• EVC names and numbers are a table in the IWCDMS and are selected via a drop down menu<br>• The percentage of wetland areas covered by all EVCs must equal 100% in order to save the assessment or proceed to the next page |
| | **Critical lifeform groups:**<br>• Mandatory to enter number of lifeforms in the benchmark, number of modified and number of unmodified lifeforms |
| | **Indicators of altered processes:**<br>• Mandatory to select an option in order to save the assessment or proceed to the next page |
| **Scores and condition category** | • Automatically generated |

**ISSN 1835-3835 (pdf)**
**ISBN 978-1-74326-731-8 (pdf)**