Drought impact on fish communities and river health in the Corangamite Region

An isolated pool in Painkalac Creek.

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Executive Summary

This study provides a rapid assessment of river condition and aims to determine the key issues affecting aquatic health including the relative impact of drought. It is designed to help prioritise potential management actions in the drought response plan.

Pre-existing catchment issues, such as water extraction, extensive land clearing and lack of riparian vegetation can directly affect river health and compounds impacts caused directly by drought. Where catchments have been degraded by past management practices, the severity of the drought upon stream health has been the most extreme.

Waters examined in this study have been classified into 3 distinct classes of river health, streams with minor stress, streams with moderate stress and streams that have severe stress. Waterways with minor drought stress had lower streamflows than normal as a result of the drought but were in no immediate threat of becoming severely stressed by the drought.

Waters classified as having moderate stress are ones in which the existing aquatic fauna is expected to be experiencing some stress, however, the stress is unlikely to have caused the loss of species. Streamflow may have ceased in freshwater reaches and water deterioration may have occurred in remaining refuge habitat, however, the duration of the stress upon aquatic fauna has only been for a relatively short period.

Waters with severe stress are those in which there were obvious signs of drought. These waters may have had dying aquatic vegetation or no water remaining in the stream channel. For the Corangamite Region these waters are ones in which the entire aquatic ecosystem could potentially collapse if it has not already or are waters in which threatened fish populations may have been lost.

Natural recruitment of native migratory fish species should recommence in the Otway and Barwon Basins once streamflows re-open the mouth of estuaries that have been closed during the drought. Sources for the re-colonisation of Yarra pygmy perch include populations within remnant pools in the middle reaches of Waurn Ponds, Pennyroyal and Thompsons Creeks. River blackfish populations remaining include those in remnant pools of Moorabool River and smaller populations in the upper Barwon River and Callahan Creek. The only remaining known population of dwarf galaxias in the Corangamite region is being sustained in Gosling Creek.

Management recommendations include:

Drought monitoring in future

- *In drought conditions it is necessary to conduct monthly inspections of systems with important surviving populations of endangered fish species of known drought stressed systems (Curdies River, Callahan Creek, Barwon River West Branch, Gosling Creek, Waurn Ponds Creek, Painkalac Creek, Thompsons Creek, Matthews Creek, Pennyroyal Creek, Moorabool River)*
- *In drought conditions moderately drought stresses sites need to be monitored on a regular basis to ensure that remedial action to protect aquatic fauna can be made if instream conditions deteriorate further*
- *Undertake strategic fish surveys at key locations to assess the streams with more extreme drought impacts and important fish populations in the Corangamite region*

Building ecological resilience to protect threatened species against drought

- *Protect and encourage the recovery of key populations of Yarra pygmy perch, dwarf galaxias and river blackfish by seeking to have greater flow security and habitat diversity and where necessary investigate alternative water supply options to alleviate extreme low water and poor water quality events where necessary*
- *Encourage re-colonisation of important nationally threatened and regionally significant fish populations by improving fish passage and instream habitat complexity*
- *Develop catchment management strategies to alleviate some of the other detrimental influences on drought stress such as a lack of riparian vegetation, excessive stock access and groundwater intrusion*

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

The Corangamite Catchment Management Authority (CCMA) has been requested by the Department of Sustainability and Environment (DSE) to provide regional drought response plans for rivers and lakes of the Corangamite Region.

This study provides a rapid assessment of river condition, key issues affecting aquatic health and categorises waters which had minor stress, were moderately stressed and were severely stressed due to the current drought. It is designed to help prioritise potential management actions in the drought response plan and is a precursor to a survey to determine the status of the threatened fish fauna throughout the Corangamite Region and their survival during the drought.

The report will highlight the importance of maintaining important habitat (that occupied by significant species), detail what habitats have been lost to drought and the potential for future recruitment of fish fauna back into these locations and any other related aspects of the drought (like the positive removal of pest species from a system).

Primary and secondary action that can be taken to protect remaining habitat and the species in these locations will be provided.

Methods

Determination streams for drought assessment was made primarily according to the occurrence of important fish species and the potential for the stream to provide important drought refuge for diverse native fish communities.

The distribution of native fish species was undertaken with particular reference to species of national, state or regional significance. Key habitat features of these populations were therefore assessed as a primary importance to the investigation. The targeted sites would be related to habitats that support threatened species or regionally significant populations that may be lost if the drought continues (where poor connectivity exists and only shallow pools remain).

At each of the survey sites an inspection of the waterway was made. Collected data included assessing visual changes in the riparian vegetation, noting the flow regime relative to the expected flow, measuring several *in-situ* water quality parameters including temperature, pH, electrical conductivity, dissolved oxygen and turbidity, and finally, recording any other noticeable effect that could be attributed to the current drought. A photograph was taken at each survey site. Additional

specific habitat characteristics at each site were noted including the presence of barriers, condition of aquatic vegetation and other relevant issues.

At some shallow water sites, a dip net was used to do a brief check of the fish fauna. A brief fish survey of key sites (which may soon dry out) assisted in the assessment to determine whether fauna recovery and/or potential translocation from these locations should be given immediate priority.

Threatened species occurrence

Table 1 lists threatened fish species and their known occurrence in the waters assessed in this study. There is 4 known threatened fish species in the Corangamite Region; the Yarra pygmy perch (*Nannoperca obsura*), Australian grayling (*Prototroctes maraena*), the dwarf galaxias (*Galaxiella pusilla*) and the Tasmanian mudfish (*Neochanna cleaveri*).

The Yarra pygmy perch, the Australian grayling and the dwarf galaxias are listed for protection at a National level under the Environment Protection and Biodiversity Conservation (EPBC) Act, 1999. These species, plus the Australian mudfish are considered threatened in Victoria (Department of Natural Resources and Environment (NRE 2003) and are listed for protection under the *Victorian Flora and Fauna* (FFG) *Act*, 1988.

Twenty-three sites from 14 different waterways were examined in the Otway Basin. In the Otway Basin, Yarra pygmy perch, Australian grayling and the Tasmanian mudfish have been recorded (DSE 2007). Streams known to support Yarra pygmy perch, including Curdies River and Thompson Creek were assessed at 3 to 5 locations. One site was chosen in streams where Australian grayling have been recorded (the Ford River, Aire River, Gellibrand River, Barham River, Wild Dog Creek, Skenes Creek, Wye River, Cumberland River, St. Georges River and the Erskine River). The Tasmanian mudfish has been recorded in 2 of these waters, the Aire River and the Wye River (DSE 2007). Additional survey sites were chosen in Painkalac Creek, Sheoak Creek and the Anglesea River; waters which are not known to support any threatened species.

In the Barwon Basin 20 sites were examined. The majority of the sites were located in the upper part of the catchment, upstream of Inverleigh. Waters in the area included the upper Barwon River locations such as the Barwon River West Branch and East Branch and smaller tributaries which included Callahan, Dewings, Boundary, Matthews, Pennyroyal and Retreat Creeks. The only known record of threatened species is Yarra pygmy perch in Pennyroyal Creek and the dwarf galaxias in Gosling Creek (DSE 2007). Yarra pygmy perch were suspected to also occur in Deans Marsh Creek and dwarf galaxias in Matthews Creek.

The Leigh River, Waurn Ponds Creek and Reedy Lake were also sampled within the Barwon Basin. Yarra pygmy perch are known to occur in the middle reaches of Waurn Ponds Creek.

Four sites were assessed in the Moorabool River catchment. In the lower margins of the Moorabool River Australian grayling has previously been recorded, while further upstream significantly large population of river blackfish have been recorded. This population of river blackfish is likely to be regionally significant given the current trends in the overall state wide decline of this species.

Table 1: Known distribution of threatened fish species in the Corangamite Region.

Basin	Waterway	Yarra pygmy perch	Australian grayling	dwarf galaxias	Tasmanian mudfish
OTWAYSs	Curdies River	X	suspected		
	Gellibrand River		X		
	Ford River		X		
	Aire River		X		X
	Barham River		X		
	Wild Dog Creek		X		
	Skenes Creek		X		
	Wye River		X		X
	Cumberland River		X		
	St. Georges River		X		
	Sheoak Creek				
	Erskine River		X		
	Painkalac Creek		suspected		
	Anglesea River		suspected		
	Thompson Creek	X	X		
BARWON	Barwon River West Branch				
	Callahan Creek				
	Dewing Creek				
	Barwon River East Branch				
	Boundary Creek				
	Barwon River				
	Gosling Creek			X	
	Matthews Creek			suspected	
	Deans Marsh Creek	X			
	Pennyroyal Creek	X			
	Retreat Creek				
	Reedy Lake		X		
	Leigh River				
	Waurn Ponds Creek	X			
MOORABOOL	Moorabool River		X		

Final Site selection

The selected streams were chosen to represent freshwater and estuarine environments throughout the Corangamite Region. In total of 51 sites were surveyed including eight estuarine sites, one lake site 15 rivers, 16 creeks (Table 2). Site locations are also provided on a map together with the Index of Stream Condition (ISC) for 2004 for the Otways Basin sites in Figure 1, Barwon Basin sites in Figure 2 and Moorabool Basin sites in Figure 3.

Table 2: Sites surveyed in the Corangamite Region.

Site Number	Date visited	Waterway	Reach	Location
1	16/05/2007	Curdies River	freshwater	Maddens Bridge Road, Glenfyne
2	16/05/2007	Curdies River	freshwater	At Limestone Creek junction, north of Timboon
3	16/05/2007	Curdies River	freshwater	At bridge on Nullawarre Road, Bruknell
4	16/05/2007	Curdies River	estuary	Curdie Vale
5	16/05/2007	Gellibrand River	estuary	Great Ocean Road, Lower Gellibrand
6	16/05/2007	Ford River	freshwater	Old Ocean Road, Glenaire
7	16/05/2007	Aire River	estuary	Great Ocean Road, Lower Gellibrand
8	16/05/2007	Barham River	freshwater	Barham Valley Road, Paradise
9	17/05/2007	Wild Dog Creek	freshwater	Wild Dog Road, Apollo Bay
10	17/05/2007	Skenes Creek	freshwater	Upper Skenes Creek Road, Skenes Creek
11	17/05/2007	Wye River	freshwater	At top of caravan park, Wye River
12	17/05/2007	Cumberland River	freshwater	At caravan park, Cumberland River
13	17/05/2007	St. Georges River	freshwater	Allenvale Road, Allenvale
14	17/05/2007	St. Georges River	estuary	Great Ocean Road, near Lorne
15	17/05/2007	Sheoak Creek	freshwater	Allenvale Road, Allenvale
16	17/05/2007	Erskine River	freshwater	At top of caravan park, Lorne
17	17/05/2007	Erskine River	estuary	At Great Ocean Road, Lorne
18	17/05/2007	Painkalac Creek	freshwater	Old Coach Road, Fairhaven
19	17/05/2007	Painkalac Creek	estuary	Great Ocean Road, Fairhaven
20	17/05/2007	Anglesea River	freshwater	Near Coal Mine Road, Anglesea
21	17/05/2007	Anglesea River	estuary	Coal Mine Road, Anglesea
22	30/05/07	Thompsons Creek	freshwater	Pettavel Road, Freshwater Creek
23	10/08/07	Merrigig Creek	freshwater	Blackgate Road, Freshwater Creek
24	30/05/07	Thompsons Creek	freshwater	Ghazeepore Road, Freshwater Creek
25	30/05/07	Thompsons Creek	freshwater	Surf Coast Highway, Mount Duneed
26	30/05/07	Thompsons Creek	estuary	Point Impossible
27	18/05/2007	Barwon River West Branch	freshwater	Kaanglang Road, Forrest
28	18/05/2007	Barwon River West Branch	freshwater	Seven Bridges Road, Barwon Downs
29	18/05/2007	Callahan Creek	freshwater	Birregurra Forrest Road, Barwon Downs
30	18/05/2007	Dewing Creek	freshwater	Griffins Road, Barwon Downs
31	18/05/2007	Barwon River East Branch	freshwater	Birregurra Forrest Road, Yeodene
32	18/05/2007	Boundary Creek	freshwater	McCalls Road, Yeodene
33	18/05/2007	Boundary Creek	freshwater	Colac Forrest Road, Yeodene
34	18/05/2007	Barwon River	freshwater	Deepdene Road, near Yeodene
35	18/05/2007	Gosling Creek	freshwater	Division Road, Maroon
36	18/05/2007	Matthews Creek	freshwater	Birregurra Barwon Downs Road
37	18/05/2007	Deans Marsh Creek	freshwater	Deans Marsh Birregurra Road, Deans Marsh
38	18/05/2007	Pennyroyal Creek	freshwater	Winchelsea Deans Marsh Road, Deans Marsh
39	30/05/2007	Pennyroyal Creek	freshwater	Wurdee Buloc Outlet off Bushes Road, Deans Marsh
40	18/05/2007	Retreat Creek	freshwater	Bambra Boonah Road, Bambra
41	30/05/2007	Waurn Ponds Creek	freshwater	Upstream from Waurn Ponds East Tennis Club
42	30/05/2007	Waurn Ponds Creek	freshwater	Rossack Road, Highton
43	30/05/2007	Waurn Ponds Creek	freshwater	Highmont Drive, Belmont
44	30/05/2007	Waurn Ponds Creek	freshwater	Bailey Street, Belmont
45	31/05/2007	Reedy Lake	freshwater	Whitehorse Road, Moolap
46	29/05/2007	Leigh River	freshwater	Downstream from Shelford
47	24/07/2007	Moorabool River West Branch	freshwater	Elaine – Egerton Road, Ballark
48	24/07/2007	Moorabool River	freshwater	Ballan Meredith Road , Morrisons
49	24/07/2007	Moorabool River	freshwater	Upstream of Coopers Bridge
50	24/07/2007	Sutherland Creek	freshwater	Steiglitz Road, Sutherland Creek
51	20/07/2007	Moorabool River	freshwater	Upstream of Batesford

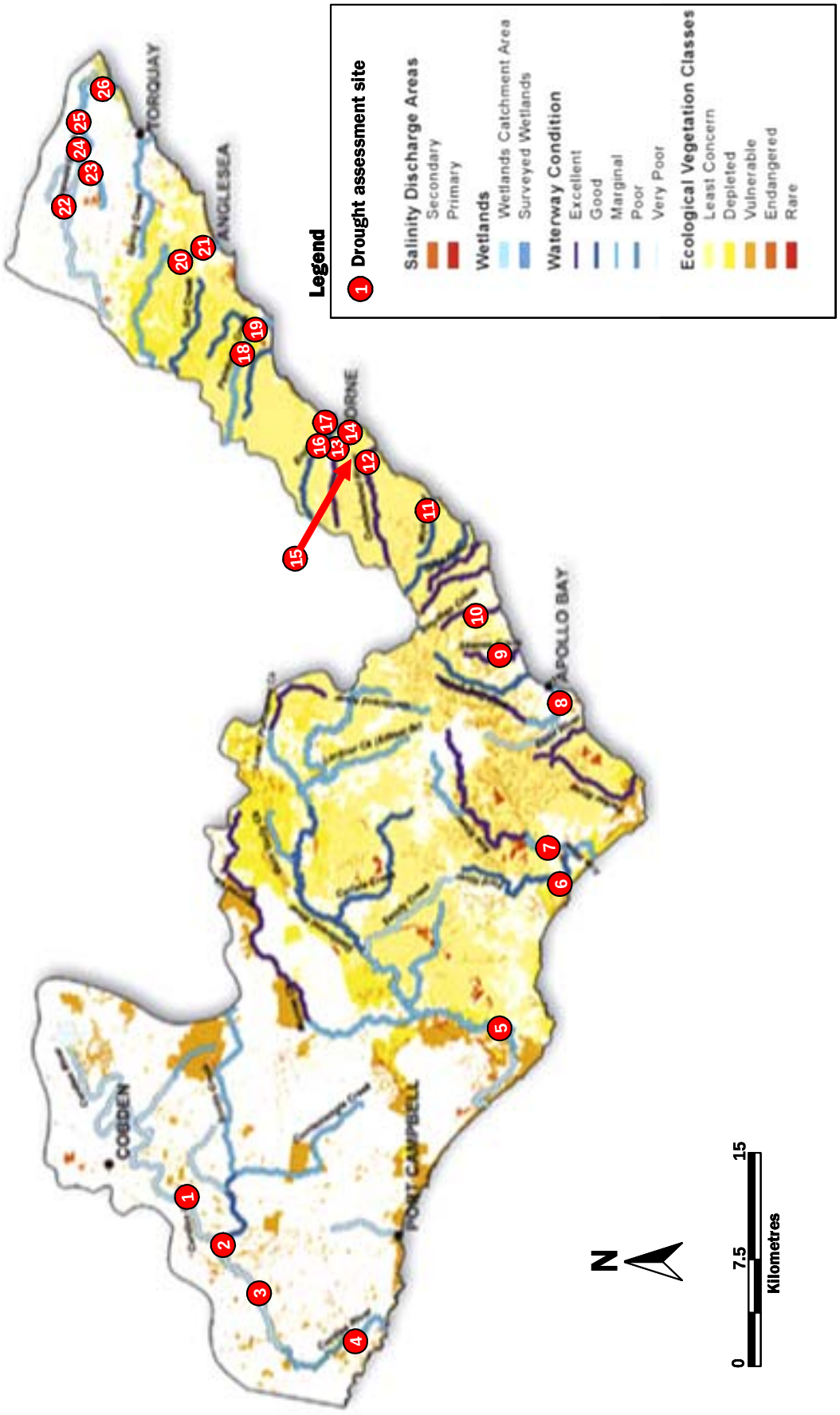

Figure 1: Drought Assessment site surveyed in the Otways Basin.

(Base map includes the catchment condition assessment and Index of Waterway Condition from 2004 from CCMA 2007)

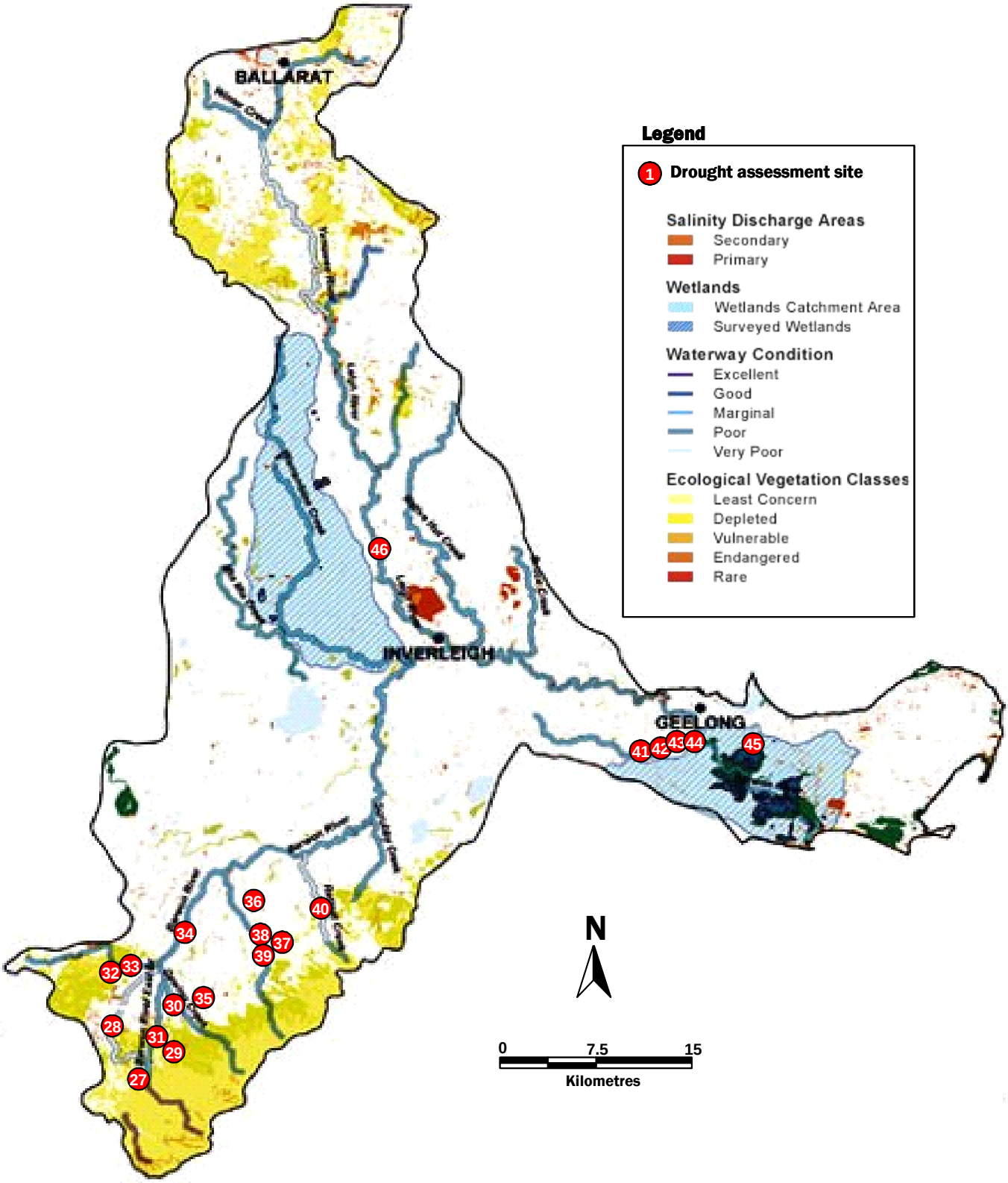

Figure 2: Drought Assessment site surveyed in the Barwon Basin.

(Base map includes the catchment condition assessment and Index of Waterway Condition from 2004 from CCMA 2007)

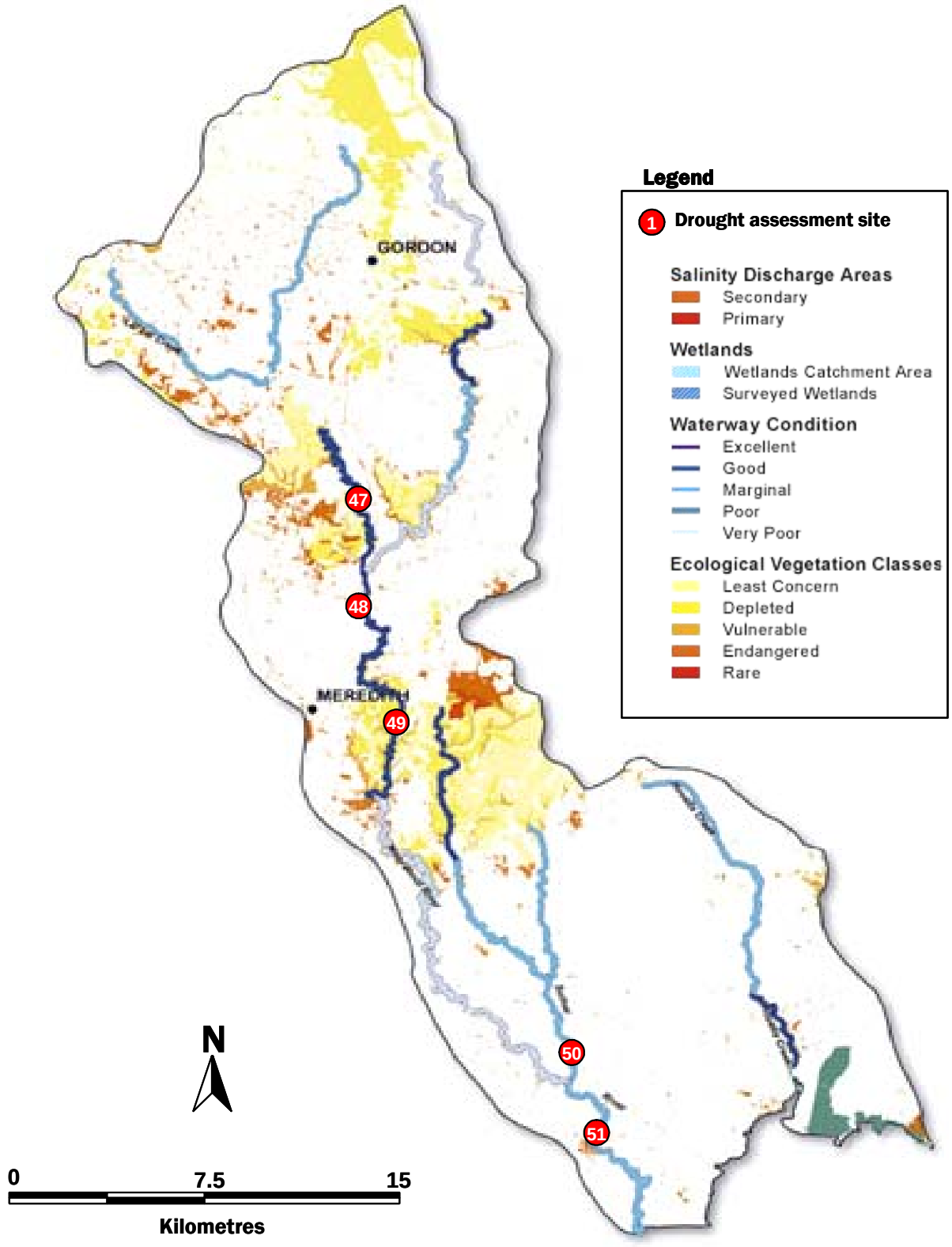

Figure 3: Drought Assessment site surveyed in the Moorabool Basin.

(Base map includes the catchment condition assessment and Index of Waterway Condition from 2004 from CCMA 2007)

Results

It is important to note, that while at least 3 sites were planned to be assessed in each stream, a decision was made in the field to survey only one site if drought had obviously not impacted that stream. Streams that were observed to have sufficient riverine flow and sampled at only one location included Wild Dog Creek, Skenes Creek, Wye River, Aire River, Ford River, Barham River, Gellibrand River Reedy Lake and the Leigh River.

Summary sheets for site in the Otways Basin are provided in Appendix 1 and include four sites on Curdies River, one on Gellibrand River, one on Ford River, one on Aire River, one on Barham River, one on Wild Dog Creek, one on Skenes Creek, one on Wye River, one on Cumberland River, two sites on St. Georges River, one site on Sheoak Creek, two sites on Erskine River, two sites on Painkalac Creek, two sites on Anglesea River and five sites in the Thompsons River catchment.

Summary sheets for site in the Barwon Basin are provided in Appendix 2 and include two sites on the Barwon River West Branch, one site on the Barwon River East Branch, sites on Callahan and Dewings Creeks, two sites on Boundary Creek, one site on Gosling Creek, one site on Matthews Creek, three sites in the Pennyroyal and Dean Marsh catchment, one site on Retreat Creek, one site on Reddy Lake, one site on Leigh River and four sites on Waurn Ponds Creek.

Summary sheets for site in the Moorabool Basin are provided in Appendix 4 and include four sites on the Moorabool River and one site on Sutherland Creek.

Discussion

Pre-existing catchment issues affecting river health

Pre-existing catchment issues, such as water extraction, can directly affect river health, and act as a compounding impact during periods of drought. For example, a reach of waterway downstream of weir or dam may have a modified streamflow which affects stream health. During drought this same waterway may be further impacted by operational changes to the upstream storage when emphasis upon water harvesting becomes a higher priority than the provision of streamflow.

The Index of Stream Condition (ISC) rating, conducted in 2004, provided a rating of pre-existing instream condition for each waterway (DSE 2005). The ISC is a statewide standardised rating of instream condition based upon hydrology (low, high, zero, seasonality and variability of flows), physical form (bank stability, large wood, fish passage), streamside zone (longitudinal continuity, understory diversity, recruitment, large trees, tree canopy, litter, logs, weeds), water quality (total phosphorus, turbidity, salinity (EC), pH) and aquatic life (macroinvertebrate indices - AUSRIVAS and SIGNAL).

The ISC include a number of measurement relevant to this drought impact assessment, including the occurrence of low and zero flows, fish passage and woody debris, water quality and macroinvertebrate population condition. The ISC of each waterway investigated in this drought study is provided in Table 3.

Many Otways Basin streams had near natural flow regimes including many tributaries of the Gellibrand and Aire Rivers and small mountain streams, including the Wye River. The Curdies River and the lower Gellibrand and Barham Rivers demonstrated periods of low flow and summer stress that were attributed to water diversions for small coastal towns. High levels of total phosphorus were recorded in many reaches and were attributed to stock access, dairy effluent and agricultural run-off. Reaches with highly modified streamside zones, are on the upper Curdies and Gellibrand Rivers. Macroinvertebrate population were overall in above average condition with lower scores only in the lower Aire River and in Spring Creek (DSE 2005).

Stream reaches with low ratings in the Barwon Basin included the upper tributaries such as Retreat, Pennyroyal, Deans Marsh, Matthews, Gosling and Callahan Creek and also the upper east and west branches of the Barwon River. The majority of the streams in the Barwon Basin had extremely modified flow regimes including the upper Barwon River and tributaries (where water is diverted to Wurdee Boluc Reservoir) and the Leigh River. The upper Barwon streams, in particular, demonstrated evidence of summer flow stress with extended periods of low flows. Elevated salinity and phosphorus was noted in most reaches, while the middle and lower reaches of the Barwon River also had elevated

turbidity and the Leigh River in general had elevated pH levels. The only reaches considered to have good riparian vegetation cover were the headwater reaches of the east and west branches of the Barwon River and Dewing Creek. Good instream woody debris habitat were noted only in the upper Retreat and Dewing Creek. Numerous weirs and reservoirs were noted to be a major impediment to fish movement in the basin. Macroinvertebrate populations recorded in the lower Leigh River were near natural ecological condition, while in contrast, Waurn Ponds and the Barwon River East Branch were noted to be of low macroinvertebrate condition (DSE 2005).

The ISC rating considered most of the Moorabool River to have heavily modified flow conditions due to artificial water storages, urban demand, intensive farm dam development, summer irrigation and winter storage and pumping. As such system experiences increased periods of low and zero flow, decreased periods of high flow and summer and winter stress (DSE 2005). Despite the lack of flows, water quality was considered to be of relatively high standard, except some evidence of elevated salinity and limited nutrient runoff. Discontinuous stream side vegetation was a serious limiting fact to riverine health throughout the catchment, however, macroinvertebrate health was considered to be overall of a good standard.

Table 3: Instream condition rating of sites surveyed in the Corangamite Region.

(ISC rating from DSE 2005)

Site Number	Waterway	Instream condition rating	Site Number	Waterway	Instream condition rating
1	Curdies River	Moderate	**27**	Barwon River West Branch	Poor
2	Curdies River	Moderate	**28**	Barwon River West Branch	Poor
3	Curdies River	Moderate	**29**	Callahan Creek	Poor
4	Curdies River	Moderate	**30**	Dewing Creek	Moderate
5	Gellibrand River	Moderate	**31**	Barwon River East Branch	Very poor
6	Ford River	Good	**32**	Boundary Creek	Moderate
7	Aire River	Moderate	**33**	Boundary Creek	Moderate
8	Barham River	Poor	**34**	Barwon River	Poor
9	Wild Dog Creek	Good	**35**	Gosling Creek	-
10	Skenes Creek	Excellent	**36**	Matthews Creek	Poor
11	Wye River	Excellent	**37**	Deans Marsh Creek	Poor
12	Cumberland River	Good	**38**	Pennyroyal Creek	Very Poor
13	St. Georges River	Good	**39**	Pennyroyal Creek	Very Poor
14	St. Georges River	Moderate	**40**	Retreat Creek	Poor
15	Sheoak Creek	-	**41**	Waurn Ponds Creek	Moderate
16	Erskine River	Good	**42**	Waurn Ponds Creek	Moderate
17	Erskine River	Good	**43**	Waurn Ponds Creek	Moderate
18	Painkalac Creek	Moderate	**44**	Waurn Ponds Creek	Moderate
19	Painkalac Creek	Moderate	**45**	Reedy Lake	Insufficient Data
20	Anglesea River	Excellent	**46**	Leigh River	Moderate
21	Anglesea River	Excellent	**47**	Moorabool River West Branch	Moderate
22	Thompsons Creek	Moderate	**48**	Moorabool River	Moderate
23	Merrigig Creek	Moderate	**49**	Moorabool River	Moderate
24	Thompsons Creek	Moderate	**50**	Sutherland Creek	Very Poor
25	Thompsons Creek	Moderate	**51**	Moorabool River	Very Poor
26	Thompsons Creek	Moderate			

Issues affecting river health due to the current drought

Drought can have direct impacts upon river health. The severity may be less dramatic for permanent streams that have reduced stream flow, than it is for intermittent and ephemeral streams which may stop flowing or totally dry up.

Under drought conditions, the amount of available instream habitat is reduced in a waterway. Initially, the remaining habitat can provide refuge for fauna but with the absence of freshwater inflows, the water quality conditions in these refuge areas gradually deteriorates. As water levels drop, aquatic biota become more crowded and the importance of acceptable water quality conditions become critical to the survival of the aquatic organisms. High oxygen dependent species are the most stressed and the first to be lost from the aquatic fauna. The longer the drought continues the more water quality deteriorates until it eventually becomes so degraded that it can no longer support resident aquatic life. Loss of aquatic species and communities can, thus occur, without a waterway totally drying out.

Drought can also exacerbate pre-existing river health conditions, adding further stress to aquatic fauna that are already stressed. Waterways with poor pre-existing river health condition are more likely to be adversely affected by drought than those waterways that have excellent pre-existing river health. Preserving high quality river health under normal stream flow conditions therefore provides a buffer against the effects of drought and can, thus, be a useful management tool to lessen the potential effect of drought upon aquatic ecosystems. Efforts to improve the progression of natural flow regimes should therefore continue, particularly within impacted streams such as the upper reaches and tributaries of the Barwon River and the Moorabool River. While the domestic water supply demand on these systems is likely to increase, further guarantees to maintain a minimum flow during drier periods appear necessary, particularly in locations where threatened species occur.

Drought river health categories

Waters examined in this study have been classified into 3 distinct classes of river health, streams with minor stress, streams with moderate stress and streams that have severe stress. Table 4 lists waters placed in each of these 3 classes.

Waterways with minor drought stress have lower streamflows than normal as a result of the drought. These waters may have experienced some loss of streamflow and water quality degradation but the conditions are not expected to have adversely affected aquatic fauna. These waters are in no immediate threat of becoming severely stressed by the drought. The aquatic habitat of these stream reaches have provide refuge for aquatic biota, and in most cases are expected to make a full recovery after the drought.

Waters classified as having moderate stress are ones in which the existing aquatic fauna is expected to be experiencing some stress, however, the stress is unlikely to have caused the loss of species. Streamflow may have ceased in freshwater reaches and water deterioration may have occurred in remaining refuge habitat, however, the duration of the stress upon aquatic fauna has only been for a relatively short period. A full recovery of aquatic fauna is expected if the drought breaks in the near future. In future drought events, these sites need to be monitored on a regular basis to ensure that remedial action to protect aquatic fauna can be made if instream conditions deteriorate further. Water could be added to remnant pools to prevent further stress to aquatic biota and to avoid the possible loss of one or more valued aquatic species.

Waters with severe stress are those in which there were obvious signs of drought. These waters may have had dying aquatic vegetation or no water remaining in the stream channel. For the Corangamite Region these waters are ones in which the entire aquatic ecosystem could potentially collapse if it has not already or are waters in which threatened fish populations may have been lost. Such systems included the lower reaches of Painkalac Creek, Matthews Creek, Pennyroyal Creek, Thompsons Creek, the Moorabool River (particularly the lower reaches) and the upper reaches of Waurn Ponds Creek. The aquatic community in these waters may take a long time to full recovery even when streamflows return, that is, if recovery is possible at all. For some of these systems it may be possible to re-negotiate minimum flows to maintain important habitat and fish populations. Action may also be necessary to re-establish aquatic fauna after the drought is over when continuous streamflows have returned. Numerous instream barriers are likely to impede the re-colonisation of these drought impacted systems and it may therefore, be necessary to construction fish ladders capable of functioning in a range of flows including low flows.

Table 4. Drought priority rating for waters in the Corangamite Region.

Site Number	Waterway	Reach	Drought Priority Rating
2	Curdies River	freshwater	Minor
3	Curdies River	freshwater	Minor
4	Curdies River	estuary	Minor
5	Gellibrand River	estuary	Minor
6	Ford River	freshwater	Minor
7	Aire River	estuary	Minor
11	Wye River	freshwater	Minor
13	St. Georges River	freshwater	Minor
15	Sheoak Creek	freshwater	Minor
17	Erskine River	estuary	Minor
20	Anglesea River	freshwater	Minor
21	Anglesea River	estuary	Minor
27	Barwon River West Branch	freshwater	Minor
28	Barwon River West Branch	freshwater	Minor
29	Callahan Creek	freshwater	Minor
31	Barwon River East Branch	freshwater	Minor
32	Boundary Creek	freshwater	Minor
33	Boundary Creek	freshwater	Minor
34	Barwon River	freshwater	Minor
37	Deans Marsh Creek	freshwater	Minor
40	Retreat Creek	freshwater	Minor
45	Reedy Lake	freshwater	Minor
46	Leigh River	freshwater	Minor
1	Curdies River	freshwater	Moderate
8	Barham River	freshwater	Moderate
9	Wild Dog Creek	freshwater	Moderate
10	Skenes Creek	freshwater	Moderate
12	Cumberland River	freshwater	Moderate
14	St. Georges River	estuary	Moderate
16	Erskine River	freshwater	Moderate
30	Dewing Creek	freshwater	Moderate
35	Gosling Creek	freshwater	Moderate
42	Waurn Ponds Creek	freshwater	Moderate
43	Waurn Ponds Creek	freshwater	Moderate
44	Waurn Ponds Creek	freshwater	Moderate
18	Painkalac Creek	freshwater	Severe
19	Painkalac Creek	estuary	Severe
22	Thompsons Creek	freshwater	Severe
23	Merrigig Creek	freshwater	Severe
24	Thompsons Creek	freshwater	Severe
25	Thompsons Creek	freshwater	Severe
26	Thompsons Creek	estuary	Severe
36	Matthews Creek	freshwater	Severe
38	Pennyroyal Creek	freshwater	Severe
39	Pennyroyal Creek	freshwater	Severe
41	Waurn Ponds Creek	freshwater	Severe
47	Moorabool River West Branch	freshwater	Severe
48	Moorabool River	freshwater	Severe
49	Moorabool River	freshwater	Severe
50	Sutherland Creek	freshwater	Severe
51	Moorabool River	freshwater	Severe

Drought Impacted Stream reaches

Painkalac Creek

The daily average flows in Painkalac Creek below the Painkalac Reservoir demonstrates that flows were non-existent during 2006 and were probably the case until May 2007 (Figure 4). However, this plot also demonstrates that there are large periods of zero flows in this stream including an extended period between 1992 and 1999. The last large flushing flow occurred in 2001 and discharges over 30 ML/day last occurred in February 2005. The long periods of zero flows would have been likely to result in a deterioration of water quality and reduction of suitable aquatic habitat downstream. Water extraction and minimal passing flows have made Painkalac Creek more susceptible to drought conditions.

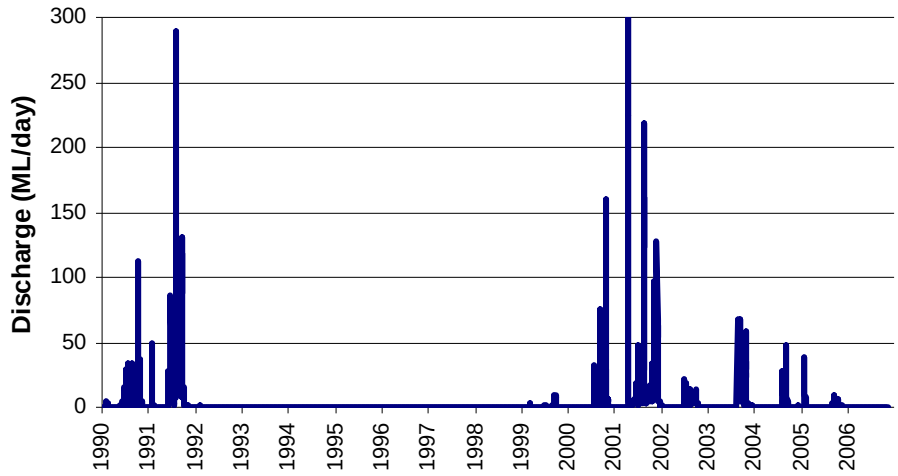

Figure 4: Average daily discharge of Painkalac Creek below Painkalac Reservoir (1990 – 2006)

Fish species previously captured **Last surveyed in 1982** in Painkalac Creek include numerous estuarine species such as black bream (*Acanthopagrus butcheri)*, estuary perch *(Macquaria colonorum),* sea mullet *(Mugil cephalus),* yelloweye mullet *(Aldrichetta forsteri),* longsnout flounder *(Ammotretis rostratus),* salmon species *(Arripis* spp.), small mouth hardyhead (*Atherinosoma microstoma),* Tamar River goby *(Afurcagobius tamarensis),* luderick *(Girella tricuspidate),* soldierfish *(Gymnapistes marmoratus),* and smooth toadfish *(Tetractenos glaber).* Migratory freshwater species captured include short finned eels (*Anguilla australis*), common galaxias (*Galaxias maculatus*), climbing galaxias *(Galaxias brevipinnis),* spotted galaxias *(Galaxias truttaceus),* tupong *(Pseudaphritis urvillii)* and pouched lamprey *(Geotria australis).* Salt tolerant non-migratory species also captured include flat headed gudgeon *(Philypnodon grandiceps)* and Australian smelt *(Retropinna semoni*) (DSE 2007).

The drought conditions would have impacted the suitability of the estuary to recreationally important species such as black bream and estuary perch and made the stream less attractive for migratory species such as the galaxias species and tupong and lamprey.

Thompsons Creek

The daily average flows in Thompsons Creek at Ghazeepore demonstrates that flows were non-existent during 2006 as was probably the case until June 2007 (Figure 5). However, this plot also demonstrates that there are large periods of low flows in this stream including between 1998 and 2005. Larger flushing flows also occurred in the system in February 2005 and flows up to 100 ML/day last occurred in August 2005. The low flow period of 2005 / 06 is considered to be the lowest on record for Thompsons Creek, while the 1999/00 low flow periods represents the 90th percentile of lowest flow periods (GHD 2007).

Low flows throughout 2005 and 2006 would have resulted in deteriorating water quality and a decrease in suitable aquatic habitat.

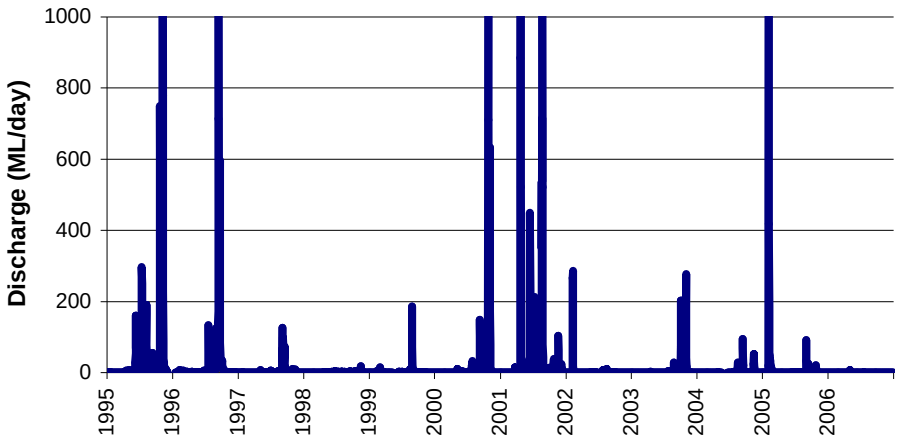

Figure 5: Average daily discharge of Thompsons Creek at Ghazeepore (1995 – 2006)

Fish species recorded in the lower reaches of the Thompsons Creek include small mouth hardyhead, Australian salmon (*Arripis truttacea*), black bream, longsnout flounder, greenback flounder (*Rhombosolea tapirina*), tommy rough (*Arrpis georgianus*), yelloweye mullet, sandy sprat (*Hyperlophus vittatus*) and bluespot goby (*Pseudogobius olorum*) (DSE 2007, Zampatti 2001).

A fish kill was recorded in the lower estuarine reach of Thompsons Creek near Blackgate Road on February 23 and 24, 2007 (N. Bate, Environment protection Authority, personal communication, 2007). This event represents an extreme example of the impact of drought. Resident estuarine fish are likely to have been impacted by a lack of inflows (tidal or freshwater) and resulted in a deterioration of

water quality conditions. High flushing flows are required to re-establish the link with the river and the sea and effectively flush the stagnant estuarine water. Such events further demonstrate the important role that natural flow regimes have on the entire length of a stream.

Native freshwater fish species previously recorded in the Thompsons Creek include short finned eels, common galaxias, spotted galaxias, Australian smelt, southern pygmy perch (*Nannoperca australis*), flat headed gudgeon, tupong and the listed Yarra pygmy perch. Low flow barriers (such as Thompsons Creek weir, Horseshoe Bend and Ghazeepore Road crossings), impact of eastern gambusia, clearing of riparian vegetation and lack of stock exclusion fencing have further compromised the suitability of Thompsons Creek catchment to native fish species. Saline groundwater also has a significant impact on the water quality within the catchment. Without streamflows to dilute the intruding saline groundwater, many pools within the Thompsons Creek catchment could become too saline for fish species, including Yarra pygmy perch.

Upper Waurn Ponds Creek

The vegetation of the upper reaches of Waurn Ponds Creek have been mostly cleared for agricultural purposes, has little riparian vegetation, degraded instream habitats, and is impacted by channel straightening and instream barriers. Very low flow upstream of the Princes Highway was evident in this study. Dip netting in the remaining, unconnected shallow pools, collected only eastern gambusia. A number of native species were recorded in this upper reaches in 2002 including short finned eel, common galaxias, spotted galaxias, southern pygmy perch and Yarra pygmy perch (DSE 2007, Close *et al.* 2002)

An increasing influence of saline groundwater will directly influence the fish fauna found in this upper reach. For example, stream conductivities over 10,000 EC are likely to be limiting for Yarra and southern pygmy perch species.

Pennyroyal Creek

The daily average flows in Pennyroyal Creek at the Railway Bridge (downstream from the Wurdee Buloc Reservoir offtake) demonstrates that there has been a steady decline in larger discharges in the creek since 2003. Flows over 20 ML/day were last recorded in September 2006 flows were non-existent during 2006 as was probably the case until June 2007 (Figure 6). Low flows through 2006 and 2007 are likely to have resulted in a deterioration water quality and a decrease in suitable aquatic habitat. The low flow period from 2005 to 2006 is the lowest on record for this stream (GHD 2007).

Previously recorded native fish species in the catchment include short finned eel, mountain galaxias (*Galaxias olidus*), southern pygmy perch, river blackfish (*Gadopsis marmoratus*) and Yarra pygmy perch (DSE 2007, Raadik 2000). Drought conditions were observed to directly impact the population of southern and Yarra pygmy perch in remnant pool habitat below the Wurdee Boluc offtake. A rapid dip net survey revealed that the abundance of pygmy perch had significantly declined in five months since December 2006, when a brief survey was conducted for the CCMA as part of the Pennyroyal Catchment Restoration Project. Other previously recorded native species, particularly river blackfish and mountain galaxias would also be expected to be impacted by reduced pool volume and water quality further downstream in the system and instream barriers are likely to impede re-colonisation. The survival of these species in the system should be determined with follow-up surveys and development water delivery strategies to prevent the drying out of important refuge pools such as immediately below the Wurdee Boluc offtake.

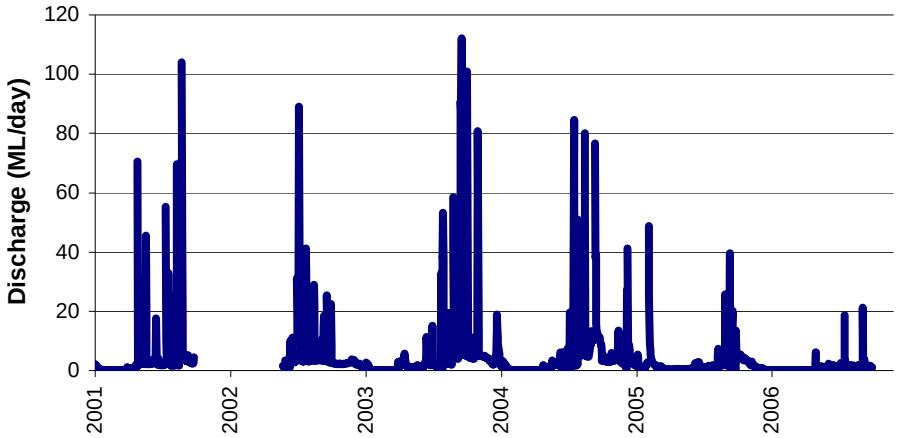

Figure 6: Average daily discharge of Pennyroyal Creek at Railway Bridge (2001 – September 2006)

Matthews Creek

The daily average flows in Matthews Creek at the siphon demonstrates that the last large flushing flow was recorded in April 2001 (Figure 7). Other large flows greater than 100 ML/day occurred in August 2001, August 2003, August and December 2004 and February 2005. The last significant flow peaking at 86 ML/day occurred in July 2006 with very low flows prevailing until at least June 2007. The low flow period of 2005/06 is considered to be the lowest on record for Matthews Creek, while the 2002/03 low flow periods represents the 90th percentile of lowest flow periods (GHD 2007).

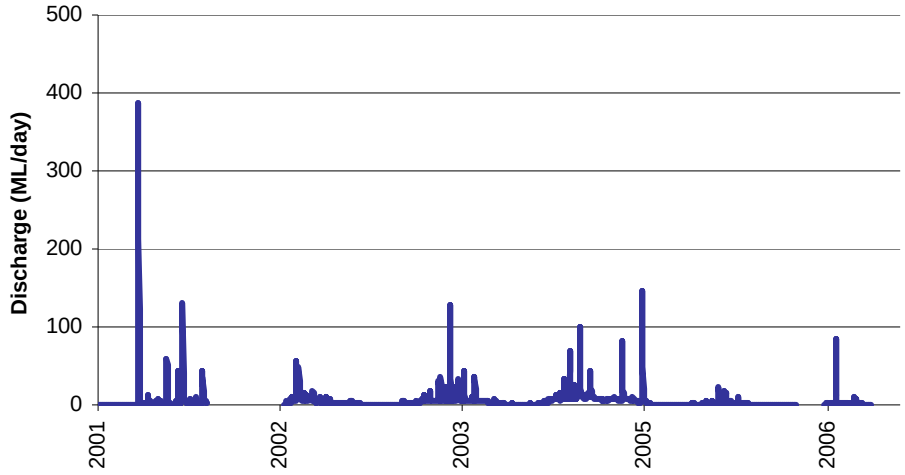

Figure 7:Average daily discharge of Matthews Creek (2001 – November 2006)

Previously recorded native fish species in the catchment include short finned eel, mountain galaxias, common galaxias and southern pygmy perch (DSE 2007, Raadik 2000). The survival of these species in the system should be determined with follow-up surveys and development water delivery strategies to prevent the drying out of important refuge pools such as immediately below the Wurdee Boluc offtake.

Moorabool River

The daily average flows in Moorabool River at Batesford demonstrates that the last large flushing flow peaking at 720 ML/day was recorded in February 2005 (Figure 8). Periods of lower flow included 1994, between 2002 and 2003 and between 1997 and 1998. Since April 2005 streamflows had remained below 10 ML/day which would have resulted in deteriorating water quality and a decrease in suitable aquatic habitat. At Batesford the longest dry period was the 2005/06 period, while the 2002/03 period represented the 99th percentile and 1997/98 represented the 90th percentile of longest low flow periods. At Morrisons, the 1999/00 represents the longest recorded dry period, while the 2005/06 represents the 99th percentile and 1967/68 represents the 90th percentile of longest low flow periods. This variability demonstrates the long term impacts of prolonged low flow periods experienced in the Moorabool catchment.

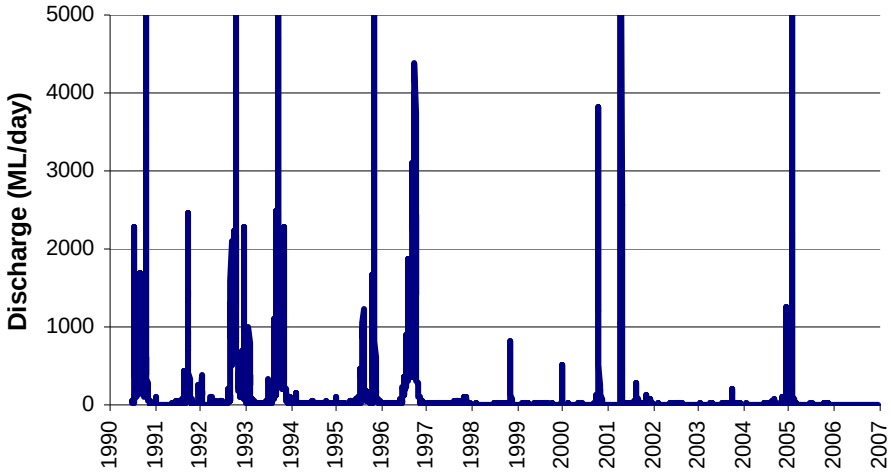

Figure 8: Average daily discharge of Moorabool River at Batesford (1990 – 2006)

Native fish species previously recorded in the lower reaches of the Moorabool River include Australian grayling, tupong, Australian smelt and common galaxias while species found throughout and further upstream include short finned eel, river blackfish, southern pygmy perch, mountain galaxias and flat headed gudgeon (DSE 2007, Raadik and Koster 2000). Previous reference to Australian grayling near Meredith prior to 1976 (DSE 2007) is unlikely to be supported by the current management regime of the Moorabool River. One Australian grayling was captured 100 m upstream from the Barwon River in 1998 (Raadik and Koster 2000), however, this species could be expected to occur up as far as Batesford during sufficient streamflows.

Numerous instream barriers comprising of concrete diversion and stream gauging weirs and natural rock barriers occur throughout the system and large reservoirs (Lal Lal and Bostock Reservoirs) on the upland east and west branches, limit the passing flows.

Contrary to the ISC rating, most of the sites visited for this investigation had above average instream habitat quality with large amount of woody debris and a variety of potential substrate and flow environments (including Sutherland Creek). This habitat could support a greater fish diversity and abundance given additional flow.

The flow regime is heavily modified and was therefore more sensitive to the compounding impacts of drought. Given the heavy demand for water from this system, it is difficult to imagine a more natural flow regime in the near future. However, alternative water resources such as from mining operations, may supplement low flows and provide some relief.

Management considerations after the drought

The status of the aquatic fauna should be evaluated in these systems noted to be more impacted by drought conditions, including Painkalac River, Thompsons Creek, Matthews Creek, Deans Marsh and Pennyroyal Creeks, Waurn Ponds Creek and Moorabool River. These surveys are required to provide a measure of recovery for these waterways and that have been severely stressed by the recent drought. The aquatic fauna of these waters may have been permanently lost. With the return of streamflow these waters needed to be monitored to determine possible re-colonisation, particularly for the nationally threatened dwarf galaxias and Yarra pygmy perch and regionally significant river blackfish.

Australian grayling are considered to be an more elusive species and are therefore a less reliable indicator of catchment health. Fish surveys should be conducted following good spring rains in an attempt to capture juvenile Australian grayling migrating upstream in the Otways streams, Barwon, Moorabool and Leigh Rivers.

Natural recruitment of native migratory fish species should recommence in the Otway and Barwon Basins once streamflows re-open the mouth of estuaries that have been closed during the drought.

Sources for re-colonisation of Yarra pygmy perch include populations in remnant pools in middle reaches of Waurn Ponds, Pennyroyal and Thompsons Creeks. Remnant river blackfish populations remaining include those in remnant pools of Moorabool River and smaller populations in the west branch of the Barwon River and Callahan Creek. The only remaining known population of dwarf galaxias in the Corangamite region is being sustained in Gosling Creek.

Low flow barriers were found in a number of sites during this investigation. Rectifying these barriers will allow the re-establishment of aquatic fauna that may not have had passage during the drought. Most road crossings and stream gauging sites represented low flow barriers. It is recommended that these barriers be further investigated and prioritised for their effect upon fish passage.

Conclusion

The waterways which appear most severely stressed by drought are Painkalac Creek, Thompsons Creek, Matthews Creek, Pennyroyal Creek, and the Moorabool River. While all of these systems stopped flowing for several months, they also had pre-existing catchment issues which would have stressed aquatic fauna even before the commencement of the current drought.

Water harvesting was implicated as a confounding factor in the increasing the impacts of drought on a number of river systems, including Painkalac Creek, Pennyroyal Creek, Matthews Creek and Moorabool River.

Both the Matthews and Pennyroyal Creek catchment have been extensively modified in the past. The removal of native vegetation and more specifically the draining of swampy areas have meant that critical habitat that may formerly have supported the nationally threatened Yarra pygmy perch and dwarf galaxias has been lost.

Where catchments have been degraded by past land practices, the severity of the drought upon stream health has been the most extreme. Land clearing and intensive stock grazing in the Thompsons and Waurn Pond Creek catchments have dramatically reduced available riverine habitat and have exacerbated groundwater intrusion into these systems. The important Yarra pygmy perch populations within these two systems would have been impacted by these changes.

Waterways in which streamflows have not been harvested, which have intact reaches of native riparian vegetation have been less affected by the current drought than those where catchment changes have been made. The lesson is that nature will protect itself from the extremes of drought and flood by having a greater quality of habitat and a variety of niches available.

The closure of estuaries to the ocean during the current drought has temporarily restricted migratory native fish passage. It also prevents the tidal mixing of water in the lower reaches and as occurred in Thompsons Creek earlier this year can lead to a critical deterioration of water quality.

Recovery of these systems following drought will be influenced by the surviving species and their population size, connectivity to other suitable habitat and where possible the development of a more natural flow regime.

Recommendations

Drought monitoring in future

- In drought conditions it is necessary to conduct monthly inspections of systems with important surviving populations of endangered fish species of known drought stressed systems (Curdies River, Callahan Creek, Barwon River West Branch, Gosling Creek, Waurn Ponds Creek, Painkalac Creek, Thompsons Creek, Matthews Creek, Pennyroyal Creek, Moorabool River)
- In drought conditions moderately drought stresses sites need to be monitored on a regular basis to ensure that remedial action to protect aquatic fauna can be made if instream conditions deteriorate further
- Undertake strategic fish surveys at key locations to assess the streams with more extreme drought impacts and important fish populations in the Corangamite region

Building ecological resilience to protect threatened species against drought

- Protect and encourage the recovery of key populations of Yarra pygmy perch, dwarf galaxias and river blackfish by seeking to have greater flow security and habitat diversity and where necessary investigate alternative water supply options to alleviate extreme low water and poor water quality events where necessary
- Encourage re-colonisation of important nationally threatened and regionally significant fish populations by improving fish passage and instream habitat complexity
- Develop catchment management strategies to alleviate some of the other detrimental influences on drought stress such as a lack of riparian vegetation, excessive stock access and groundwater intrusion

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