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North-east rivers environmental review

A review of Tasmanian environmental quality data to 2001

Lois Koehnken

Natural Heritage Trust
Helping Communities Helping Australia
A Commonwealth Government Initiative

supervising scientist

Tasmania

Environment Australia
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- to undertake a series of capital works projects designed to reduce or remove significant historical sources of pollution;
- to invest in mechanisms that will provide for sustainable environmental improvement, beyond the completion of the capital works program;
- to develop proactical and innovative mechanisms for improving environmental conditions which can be transferred to other areas of Tasmania and other Australian States;
- to produce public education/information materials.

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Executive summary

The north-east of Tasmania encompasses the South Esk River basin, rivers draining into Bass Strait east of the Tamar, and rivers discharging to the east coast of Tasmania north of Scamander. The area incorporates a wide range of riverine environments, ranging from small streams draining high plateau regions, to large rivers that are highly regulated and impacted by land use activities. This report provides a summary of the environmental status of waterways in the north-east region based on published information. Current water quality issues and current water management activities are presented on a catchment basis.

Overall there is a lack of long-term water quality information available for north-east waterways. The recent 'State of the River' reports (Bobbi et al 1996, 1999a,b,c,d) have greatly improved the understanding of water quality and riverine health in a number of waterways, but more information is required to assist catchment managers and the community in identifying issues and priorities.

Riverine water quality issues identified in this review include run-off from agricultural and forestry land, high levels of bacteriological indicators due to stock access to rivers, leaching from septic tanks, poorly performing sewage treatment facilities, and acidic discharges from historic mining centres. Generally, industrial wastewater discharges were not identified as a significant water quality issue except where occasional accidental releases occurred.

The region is characterised by a dispersed population, with the largest towns having fewer than 5000 residents. The low population density has limited local Councils' ability to provide adequate sewage treatment to all residents. Septic tank usage is high outside of the major population centres and although not quantified, it is believed they are impacting downstream water quality.

Impacts from land use practices are a major issue in north-east Tasmania. Turbidity and elevated nutrient and bacteriological loads have been documented during and following rainfall events in many rivers in the north-east. These impacts are most pronounced in agricultural areas where riparian vegetation has been damaged or lost and stock has direct access to waterways. Habitat destruction threatens several aquatic species, such as the giant freshwater lobster and freshwater snails. NHT (Natural Heritage Trust) funded projects are beginning to address these issues in most catchments through the implementation of Rivercare plans.

Many of the sewage lagoon systems in the north-east have been upgraded in the past few years through the NHT Clean Quality Water Program. Notable exceptions are the Longford sewage lagoon system and Scottsdale sewage treatment plant. The Longford facility discharges into Back Creek which is also severely impacted by intensive agricultural practices in the catchment. The Scottsdale STP discharges to Cox's Creek, which is impacted by dairying, forestry and direct stock access.

Storys Creek, tributaries of the Ringarooma/Boobyalla system, and the George River catchment receive acid drainage from historic tin mining sites. Some remediation work has been completed at these sites, but elevated metal concentrations and low pH values continue in parts of the catchments. Near Gladstone, acid drainage affects waterways used for recreation.

Coastal areas in the north-east are used extensively for recreation. An analysis of the estuaries has indicated that most are impacted to moderately impacted, and except for the Boobyalla and Tamar, are of little conservation value. The presence of introduced marine pests in Henderson Lagoon and elevated levels of Tributyl-tin in sediments in Georges Bay are newly recognised additional stresses on these estuarine waterways.

Summary table of activities and impacts in north-east Tasmania

Category of activity	Municipality	Site	Issue(s)	Affected river(s)	Suspected pollutants/impacts
Septic tanks	All	Widespread	Seepage contaminating waterways	Believed to be widespread with coastal areas of particular concern	Bacteria, pathogens, nutrients, BOD
Agricultural activities	All	Widespread impact on riparian zones	Run-off from agricultural land and unrestricted stock access to rivers	Widespread	Damage/loss of riparian communities; loss of habitat for aquatic species including rare and vulnerable giant freshwater crayfish, freshwater snails and frogs, bacteria, pathogens, nutrients, BOD, TSS
Sewage treatment plant	Northern Midlands	Longford STP	Inadequate sewage treatment	Back Creek	Bacteria, pathogens, nutrients, BOD
Sewage treatment plant	Dorset	Scottsdale	Large loading to small waterway	Cox's Creek	
Old mine site	Northern Midlands	Storys Creek	Acid mine drainage	Storys Creek, South Esk	Metals, acidity
Old mine site	Break O'Day	Anchor Mine	Acid mine drainage	George River	Metals, acidity
Old mine site	Dorset	Arba, Briseis, Pioneer, Endurance, Blue Lake	Acid mind drainage	Ringarooma/Boobyalla	Metals, acidity
TBT-paints	Break O'Day and possibly others	Georges Bay	Tributyl-tin entering and damaging ecosystem and marine farms	Georges Bay, possibly other estuaries	Tributyl-tin
Introduction of marine pests	Break O'Day	Henderson Lagoon	Introduced North Pacific sea star (*Asterias amurensis*)		Impact native shellfish populations and aquaculture
Introduction of marine pests	All	Estuaries	Introduced European green crab (*Carcinus maenas)*		Impact native crab and bivalve populations, impact on marine farming operations
Waste disposal sites	Potentially all	Numerous	Seepage from waste disposal sites is contaminating groundwater; coastal areas are of particular concern	MRT finalising report identifying areas	Various organic and inorganic pollutants
Dams, weirs	Northern Midlands	Various	Physical structures impeded fish and eel passage	Various	Migration of eels and native fish disrupted

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Tony Walker	Break O'Day Council
Todd Walsh	Giant freshwater lobster
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Acronyms

ANZECC	Australia and New Zealand Environment and Conservation Council
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CWR	Commissional Water Right
DELM	Department of Environment & Land Management (now DPIWE)
DPIF	Department of Primary Industries and Fisheries
DPIWE	Department of Primary Industries, Water and Environment
GIS	Geographic Information System
HEC	Hydro Electric Corporation
ML	Megalitre
MRT	Mineral Resources Tasmania
NFR	Non-filterable Residue
NHT	Natural Heritage Trust
P&WS	Parks and Wildlife Service
PCB	Polychlorinated Biphenyl
PEV	Protected Environmental Value
SPWQM	State Policy on Water Quality Management
STP	Sewage Treatment Plant
TBT	Tributyl-tin
TSS	Total Suspended Solids
UV	Ultraviolet
WQO	Water Quality Objective

1 Introduction

RiverWorks Tasmania is a Natural Heritage Trust (NHT) program aimed at assisting the community with remediating sources of water pollution. The initial phase of RiverWorks focused on the Tamar, Derwent, Huon and King River catchments. The program is now expanding to encompass all Tasmanian waterways.

During the first stage of RiverWorks (1997–1999), 'State of the Derwent Estuary' (Coughanowr 1997) and 'State of the Tamar Estuary' (Pirzl & Coughanowr 1997) reports were compiled to assist the community and the RiverWorks Program Committees in the identification and prioritisation of water quality issues in these waterways. Because RiverWorks has been expanded to include all waterways in Tasmania, a need has been identified for similar broad background reports summarising the environmental status of the north-east and north-west river catchments.

This report focuses on rivers in the north-east of Tasmania and draws on existing water quality and environmental information in published reports and papers, databases held by the Department of Primary Industries, Water and Environment (DPIWE), and information held by local councils and community groups.

In addition to assisting with the identification of appropriated RiverWorks projects, this report is intended to serve as a ready reference for the community as to the state of the waterway, and as a benchmark for future water quality improvements and monitoring.

During the past few years there has been a focus on waterway and land use issues throughout Tasmania, largely due to the resources available through the Natural Heritage Trust to address these issues. There is a high level of concern in the community about ambient water quality, and community groups recognise that many water quality issues are directly related to land use issues, such as degraded riparian zones.

In contrast to the level of community interest and concern, there is very little water quality data available for waterways that would allow an objective assessment of water quality issues. DPIWE's 'State of the River' reports have recently provided some greatly needed baseline and 'snapshot' information on water quality and catchment health, but additional on-going monitoring at the catchment scale is warranted for the north-east.

1.1 Waterways included in this report

The region defined as 'North-east Tasmania' for this report is shown in figure 1.

The river catchments and estuaries included in this region are:

- South Esk Basin, including:
  - Macquarie River
  - Lake River–Brumbys Creek
  - Meander River
- North Esk
- Pipers
- Little Forester
- Great Forester

- Boobyalla–Tomahawk
- Ringarooma
- Great Musselroe–Little Musselroe
- Ansons
- George
- Scamander

The river catchments bordering the Tamar Estuary and the estuary itself are not addressed in this report, as they have been previously summarised in the *State of the Tamar estuary* (Pirzl & Coughanowr 1997). The catchments on the Central Plateau that have been diverted by Hydro Tasmania into the South Esk Basin via the Poatina Power station are also excluded from this overview, although the effects on water quality from the diverted water are discussed.

1.2 Overview and structure of this report

This report summarises available information relating to water quality in the river catchments in north-east Tasmania. There is a large disparity in the amount of information available for the various catchments, which is reflected in this report. 'State of the River' reports (Bobbi et al 1996, 1999a,b,c,d) have been completed for the rivers in the South Esk Basin (South Esk, Macquarie, Meander), Pipers River, Ringarooma River, Brid River and Great Forester River, so more information is available for these catchments. There is little information available for rivers such as the Little and Great Musselroe, however, these undocumented catchments are likely to have similar water quality issues as the neighbouring, more investigated waterways.

In this report, chapter 2 provides an overview of the physical and hydrological setting of the north-east of Tasmania. Chapter 3 outlines known inputs into the river systems from point and non-point source discharges, including industrial premises licensed by DPIWE, sewage treatment plants, and historic mine sites drainage. Subsequent chapters summarise additional information for each of the individual river catchments. Also presented is a summary of on-going or recently completed NHT environmental projects within the catchment.

Figure 1 Region of Tasmania included in this report

2 Natural environment

The north-east river catchments shown in figure 1 cover an area of approximately 24 000 km^2, or about 35% of the landmass of Tasmania. The areas of the catchments including their estuaries are shown, along with the areas of major sub-catchments. The South Esk and North Esk Rivers discharge to the Tamar Estuary, with all other rivers discharging via the north or east coast of Tasmania.

The river catchments can be broadly separated into three groups: the South Esk River Basin, those discharging to the north coast, and those discharging to the east coast.

Table 1 Catchment areas of north-east rivers as determined by GIS analysis by Edgar et al 1999

Catchment	Area (km^2)	Group
Curries	84	N
Pipers	465	N
Little Forester	347	N
Brid/Great Forester	777	N
Brid	149	N
Great Forester	517	N
Tomahawk	145	N
Boobyalla Inlet	1 187	N
Ringarooma	912	N
Boobyalla	250	N
Little Musselroe	80	N
Great Musselroe	432	N
Georges Bay	557	E
Henderson Lagoon	50	E
Scamander	381	E
Ansons Bay	259	E
Apsley	231	E
Douglas	74	E
South Esk/Tamar	11 589	SE
North Esk	1 065	SE
South Esk	9 543	SE
Meander	1 334	SE
Liffey	234	SE
Nile	323	SE
Break O'Day	230	SE
Macquarie	1 557	SE
Lake	813	SE
Elizabeth	399	SE

N = discharges to north coast; E = discharges to east coast; SE = part of South Esk Basin

2.1 Geology of north-east Tasmania

In north-east Tasmania, doleritic peaks and plateaus form the highest points in the catchments, with elevations of between 1300 and 1500 m (eg Ben Lomond, the Blue Tiers, Central Plateau). The majority of dolerite occurs in the South Esk Basin, with granite and sedimentary sequences comprising the great majority of the other catchments (see table 2).

Table 2 Percentage of major geologic classes occurring in each river (Edgar et al 1999)

Catchment	Cambrian ore deposits	Carbon-aceous	Dolerite	Granite	Lake	Sedimentary	Basalt
Curries		61%				38%	
Pipers			14%			81%	6%
Little Forester		1%		1%		98%	1%
Brid/Great Forester				31%		65%	5%
Tomahawk				38%		63%	
Ringarooma/Boobyalla			1%	44%		47%	9%
Little Musselroe			24%	1%		75%	
Great Musselroe			1%	40%		59%	
Georges Bay				67%		30%	3%
Henderson Lagoon				52%		48%	
Scamander				14%		85%	
Ansons Bay				55%		45%	
Apsley							
Douglas		22%	70%			8%	
South Esk/Tamar	1%		40%	4%	2%	50%	3%

2.2 Hydrology

2.2.1 Climate and rainfall

The climatic conditions in north-east Tasmania have been described by Bobbi et al (1999a,b,c,d). Generally, temperatures in the north-east are influenced by distance from the coast, rather than topographic variation, with inland areas experiencing greater extremes than those nearer the coast. Rainfall, in contrast, is controlled by topographic change, with highest rainfall (≈1200 mm) occurring around the higher peaks in the area. Nearer the coast, rainfall is lower, at about 750–800 mm per annum.

Mean annual rainfall for three sites in the north coast catchments and two sites in the South Esk catchment are shown in figure 2. The north coast catchment sites vary in elevation, with Bridport on the coast, Scottsdale at about 200 m above sea level, and Diddleum Plains located at greater than 600 m. In the South Esk catchment, Fingal and Trevallyn have rainfall patterns similar to Bridport. All sites show a seasonal rainfall pattern, with the highest monthly totals recorded between May and August. Rainfall at Diddleum is more than twice that at Bridport during the wet winter months.

Edgar et al (1999) determined minimum, maximum and average rainfall for all coastal catchments in Tasmania, and derived run-off coefficients for each waterway (table 3). Average precipitation ranges from 700 mm per annum to 1100 mm per annum, with most catchments receiving about 750 mm of rain per year.

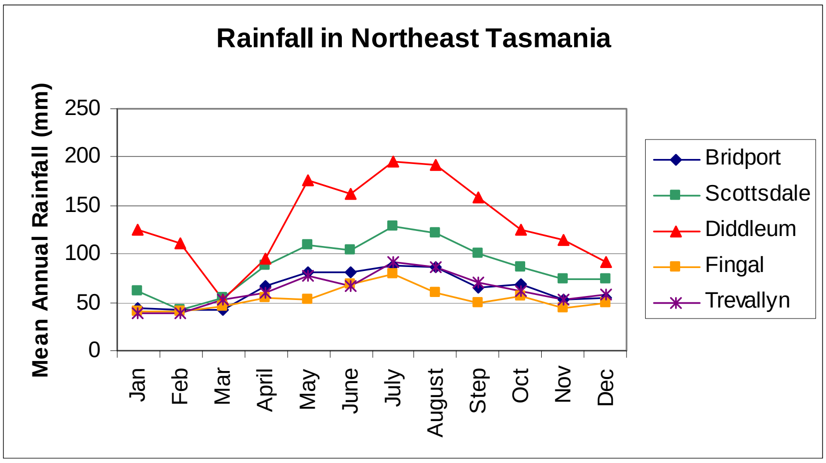

Figure 2 Mean annual rainfall at three sites in north-east Tasmania

Table 3 Average, minimum and maximum rainfall and run off coefficients (from Edgar et al 1999)

Catchment	Average rainfall	Min rainfall (mm)	Max rainfall (mm)	Runoff coefficient
Curries	814	726	1 122	0.26
Pipers	896	744	1 545	0.32
Little Forester	891	758	1 578	0.32
Brid/Great Forester	874	732	1 635	0.3
Brid	1 108			
Great Forester	1 010			
Tomahawk	725	569	1 423	0.19
Boobyalla Inlet	936	651	1 832	0.34
Ringarooma	1 278			
Boobyalla	1 003			
Little Musselroe	733	658	895	0.19
Great Musselroe	919	711	1 819	0.33
Georges Bay	1 097	748	1 832	0.42
Henderson Lagoon	1 091	741	1 444	0.42
Scamander	969	736	1 659	0.36
Ansons Bay	997	834	1 727	0.38
Apsley	824			
Douglas	992	739	1 326	0.37
South Esk/Tamar	944	524	2 126	0.35
North Esk	1 158			
South Esk	893			
Meander	1 128			
Liffey	1 129			
Nile	984			
Break O'Day	958			
Macquarie	646			
Lake	914			
Elizabeth	718			

2.2.2 River flows

Bobbi et al (1996, 1999a,b,c,d) in the 'State of the River' report series have recently completed hydrological analyses of flow in the South Esk, Brid, Great Forester, Ringarooma and Pipers Rivers. Monthly flow analysis plots from these reports are shown in figure 3.

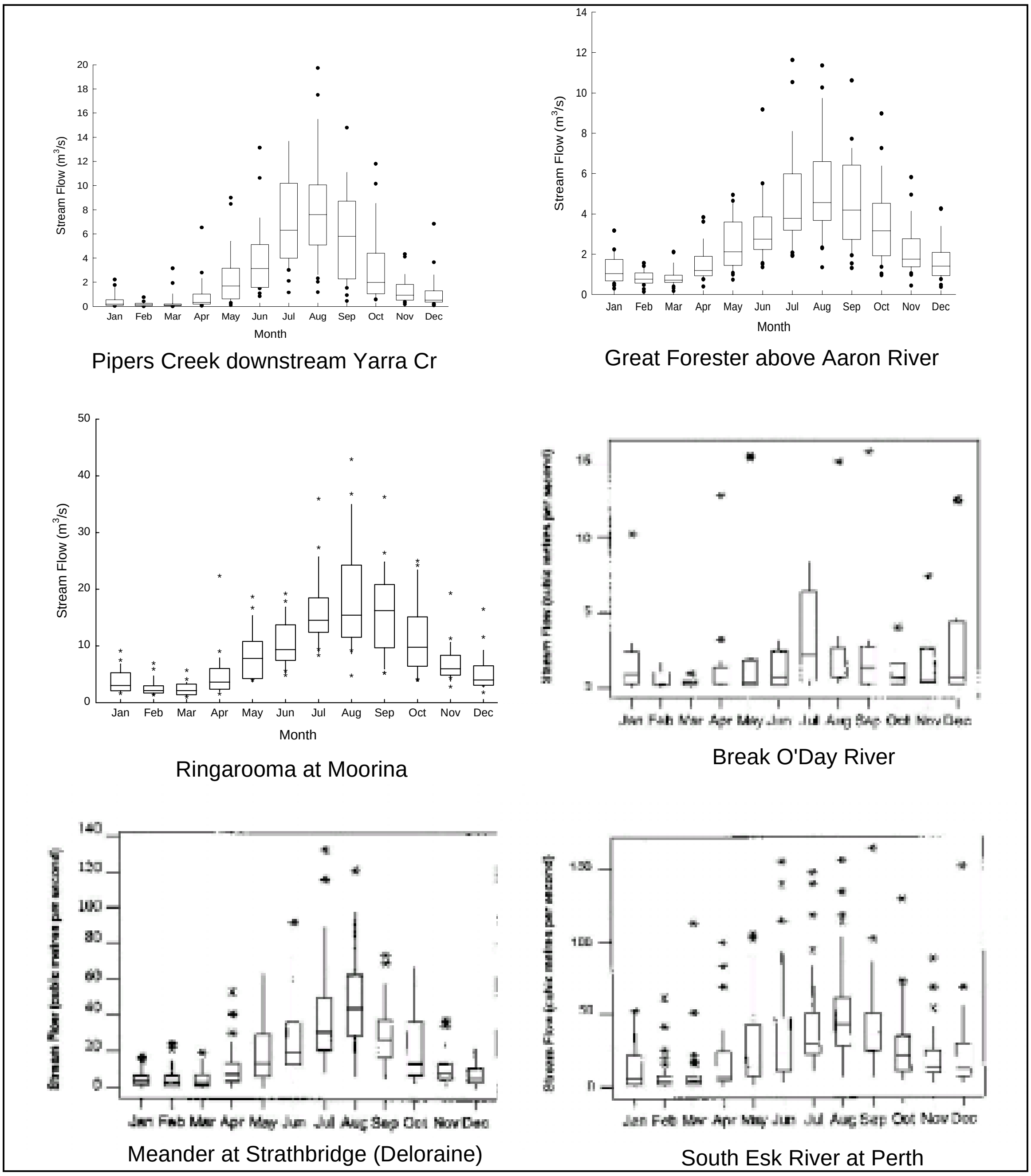

Figure 3 River flows in catchments in north-east Tasmania. The 'box' in these plots encompasses the 20th to 80th percentile flows, and the crossbar denotes median values. The data points outside the boxes show individual events outside the 20th and 80th percentiles (Pipers, Forester, Ringarooma from Bobbi et al 1999a,b,c; Meander, Break O'Day and South Esk at Perth from Bobbi et al 1996).

For most rivers in the catchment, peak flows occur between July and September, with low flows corresponding to the dry summer months.

With the exception of the South Esk Basin, the river catchments in north-eastern Tasmania are generally freely flowing, without major dams, although extraction for irrigation is common during the summer. The Break O'Day catchment is characterised by more extreme flood events than the other rivers.

The natural flow of rivers in the South Esk River has been altered in several ways: irrigation dams are located in the headwaters of two tributaries (Lake Leake and Tooms Lake); water is diverted out of the Lake River into the Great Lake/Poatina hydro-electric scheme; and large volumes of water are diverted from the Great Lake and Central Plateau area into Brumbys Creek via the Poatina Power Station. The flow of the South Esk River into the Tamar Estuary is also regulated at Trevallyn by the Trevallyn hydro-electric power scheme.

The Land and Water Management Section of DPIWE has identified environmental water requirements for many of the rivers in north-east Tasmania. The environmental water requirement is based on a conservative evaluation of ecosystem needs within the catchment, including habitat for rare and vulnerable aquatic species, migration and stocks of native fish and maintenance of the in-stream habitat for macroinvertebrate populations in the river. Rivers for which flows have been developed include: the Brid, Little Forester, Great Forester, Lower Ringarooma, Ansons, George, Little Musselroe, Tomahawk, Pipers, Boobyalla, Great Musselroe, North Esk, St Patricks, Liffey, parts of the Meander, South Esk and Macquarie Rivers.

2.3 Biogeography

The north-east and midlands of Tasmania have been divided into three regions, Flinders, Ben Lomond and Tasmanian Midlands (fig 4), under the 'Interim biogeographic regionalisation for Australia' ((IBRA), v6 LIST 2001). Previous versions of IBRA have divided the north-east into only two zones, without subdividing Ben Lomond and Flinders. Because the Ben Lomond/Flinders refinement has not been finalised, the accepted description of the combined area is presented below (Environment Australia 2001a) along with the Tasmanian Midlands. A description of the Central Highlands is also presented because although it is not immediately in the region discussed in this report, it is the catchment for much of the water in the Macquarie and South Esk Rivers.

- Ben Lomond and Flinders: Moist and dry subhumid warm coastal plains mantled in siliceous gravels, and humid cool/cold mountain ranges comprised of Devonian granites and Silurian-Devonian siltstones and mudstones, covered with sandy loams and siliceous gravels. Lowland vegetation comprising mainly open sclerophyll woodlands and heath while the upper slopes consist of wet sclerophyll forests, some rainforest and alpine vegetation in the highest regions. Land use primarily forestry, mining and agriculture (grazing).
- Tasmanian Midlands: Dry-moist subhumid cool inland lowland plain underlain by Tertiary basalts, Jurassic dolerite, Permo-Triassic sandstones, and recent alluvium. Heavily modified vegetation comprising grasslands and grassy woodlands on deep loams and alluvium. Land use primarily agriculture with some forestry.
- Central Highlands: Perhumid cool to cold high plateau surface underlain by Jurassic dolerite and Tertiary basalts, with skeletal soils to alluvium in valleys, and humid cool to cold lower plateau surface underlain by Jurassic dolerite, Permo-Triassic sediments and

Tertiary basalts, with sandy to clay load soils. Vegetation ranging from dry sclerophyll woodlands and wet sclerophyll forest on the lower plateau to alpine complexes and coniferous forest patches on the higher plateau. Land use a combination of conservation, forestry, agriculture (grazing) and water catchment.

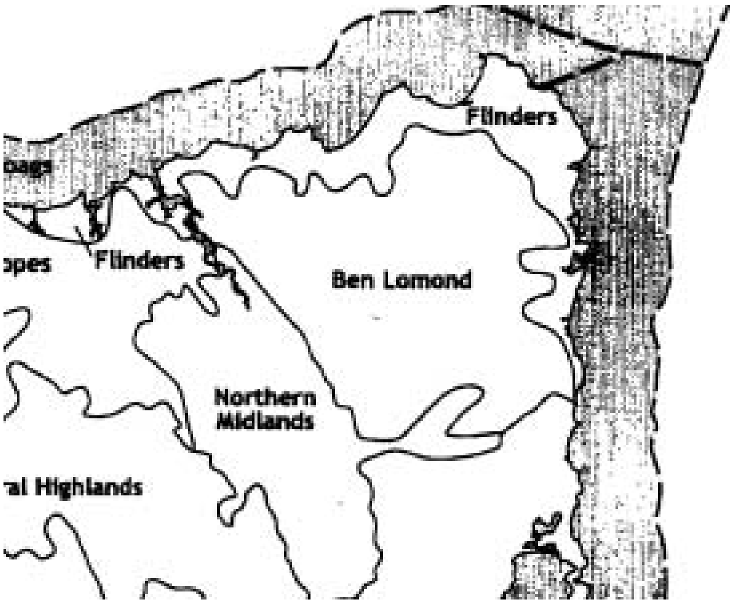

Figure 4 Interim bioregions (version 6) in north-east Tasmania (LIST 2001)

2.4 River fauna

The freshwater fauna of north-eastern Tasmania is characterised by native, endemic and introduced species. A description of the aquatic ecosystem of the entire north-east of Tasmania is beyond the scope of this review, and more detailed information can be found in the 'Biogeography of North-east Tasmania' (Mesibov 1996). The following sections provide general information about the aquatic fauna present in the region, and focuses on endangered, threatened and introduced species.

2.4.1 Fish

Chilcott and Humphries (1996) have compiled a list of freshwater fish species found in the rivers along the north and east coast of Tasmania, which is shown in table 4. In addition to the list in table 4, blackfish (*Gadopsis marmoratus)* and pygmy perch (*Nannoperca australis*) are found in the South Esk River catchment. None of these fish are endemic to the region.

The dwarf galaxias (*Galaxiella pusilla)* has a conservation status of 'rare' in Tasmania, and is considered vulnerable on the mainland. The Australian grayling (*Prototroctes maraena)* is considered vulnerable. Fulton (1990) identified the Tasmanian mudfish (*Galaxias cleaveri)* and the Tasmanian whitebait (*Lovettia sealli)* as being subjected to pressures that may limit their abundance on a local scale.

In the South Esk, two native fish species, the saddled galaxias (*Galaxias tanycephalus*) and the Arthurs paragalaxias (*Paragalaxias mesotes*) occur only in Arthurs and Woods Lakes

(Hydro Tasmania 1999). The saddled galaxias is listed as vulnerable under threatened species legislation, and the Arthurs paragalaxias is currently nominated for listing. Predation by brown trout and possibly turbidity are believed to be the greatest threats to the galaxias. Swan galaxias (*Galaxias fontanus*), a native fish which occurs in the upper South Esk catchment is listed as endangered, with the primary threat to the species being predation by brown trout (Hydro Tasmania 1999). The non-native redfin perch are also present in most of the larger rivers in the South Esk basin. Carp are not present in the South Esk, however, they are present in Lake Crescent and Lake Sorell that are located near the headwaters of the Macquarie River.

Table 4 Freshwater fish of north-east Tasmania (Chilcott & Humphries 1996)

Common name	Scientific name	Life history	Habitat
Native fish			
Short-headed lamprey	*Mordacia mordax*	M	R
Pouched lamprey	*Geotria australis*	M	R
Short-finned eel	*Anguilla australis*	M	R/L/W
Long-finned eel	*Anguilla reinhardtii*	M	R/L/W
Jollytail	*Galaxias maculatus*	M	R/L
Spotted galaxias	*Galaxias truttaceus*	M	R/L
Climbing galaxias	*Galaxias brevipinnus*	M	R
Tasmanian mudfish	*Galaxias cleaveri*	M	R/W
Dwarf galaxias	*Galaxiella pusilla*	NM	R/W
Tasmanian whitebait	*Lovettia sealii*	M	R
Australia grayling	*Prototroctes maraena*	M	R
Tasmanian smelt	*Retropinna tasmanica*	M	R
River blackfish	*Gadopsis marmoratus*	NM	R/L
Southern pygmy perch	*Nannoperca australis*	NM	R/W
Sandy flathead	*Pseudaphritis urvillii*	M	R
Introduced fish			
Brown trout	*Salmo trutta*	M	R/L
Atlantic salmon	*Salmo salar*	M	R/L
Rainbow trout	*Oncorhynchus mykiss*	M	R/L

Life history: M = migrates to and from sea or estuary, NM = freshwater only
Habitat: R = river; L = lake; W = wetlands

The migration of Australian grayling and eels and other diadromous fish in the South Esk River is impeded by the presence of the Trevallyn dam at the mouth of the river. In 1996, Hydro Tasmania installed an eel ladder on the Trevallyn Dam to provide passage for elvers. Structures such as weirs and dams may also prevent the migration of land locked fish species within the drainage system (Hydro Tasmania 1999).

2.4.2 Other freshwater species: frogs, lobster, snails, mussels

Table 5 lists rare waterway animals other than fish present in the north-east (Dorset & Break O'Day) of Tasmania based on information in the Tasmanian Parks and Wildlife GT SPOT database (DPIWE 2001c).

Ten species of freshwater lobster are found in the north-east region, comprising two major genuses *Astacopsis* and *Engaeus (*Horwitz 1996*)*. *Astrogopsis gouldi*, the giant freshwater lobster, is only found in the rivers of northern Tasmania, populating cool waters up to elevations of about 400 m (T Walsh pers comm) The lobster can grow to over 200 mm in length and achieve weights of greater than 4 kg. Specimens weighing up to 8 kg have been observed. The lobster is listed as vulnerable under both the Tasmanian and Commonwealth threatened species legislation. Recreational fishing and habitat destruction (vegetation clearing, de-snagging, sedimentation, water pollution) are cited as the major causes for the decline of the species (Bryant & Jackson 1999). Since 1998, fishing of the species has been prohibited. Important habitat for other lobster include the Great Forester River and Surveyors Creek for the Scottsdale burrowing lobster, and waterways near Lilydale for the Mt Arthur burrowing lobster.

The coastal wetlands in these northern river catchments have been identified as excellent frog habitat, and up to six species are present (Brown 1996). One species, *Litoria raniformis*, is classified as *vulnerable*, and the preservation of the wetlands is considered vital to long-term frog species diversity in the north-east (Brown 1996).

Freshwater snails are associated with streams that maintain permanent water flow over long periods of time (Ponder 1996). They have been found in localised populations and most species are only known from a few sites. Although investigations are limited, evidence suggests the snails are dependent on a healthy riparian zone and are threatened by land use practices that impact on the streamside zone (Ponder 1996).

Two freshwater mussels are found in Tasmania. One (*Velesunio moretonicus)* is endemic to the South Esk River, and the other (*Hyrdella narracanensis)* is only found in the South Esk in Tasmania.

Table 5 Rare waterway animals (DPIWE 2000c, from Tasmanian Parks & Wildlife GT SPOT database)

Kingdom	**Class**	**Name**
Invertebrates	Crustacea	*Astacopsis gouldi* giant freshwater lobster
	Crustacea	*Engaeus spinicaudarus* Scottsdale burrowing lobster
	Gastropoda	*Beddomeia briansmithi* freshwater snail
	Gastropoda	*Beddomeia fromensis'* freshwater snail
	Gastropoda	*Beddomeia minima* freshwater snail
	Gastropoda	*Beddomeia tasmanica* freshwater snail
	Insecta	*Hydrobiosella sagitta* caddisfly
	Insecta	*Hydroptila scamandra* caddisfly
Vertebrates	Amphibia	*Litoria raniformis* green and golden frog

3 Land and water uses

3.1 Population distribution

With the exception of Pipers River, all of the catchments described in this report are located within Break O'Day, Dorset, Meander Valley and Northern Midlands Councils. The combined population of these councils is approximately 42 600, with the breakdown by council shown in table 6. The Pipers River catchment is located within the Georgetown and Launceston City Councils as well as Dorset, so a small portion of the population from these councils must also be included in the north-east.

Table 6 Population of local councils in north-east Tasmania (Australian Bureau of Statistics 2000)

Council	Population
Break O'Day	5 744
Dorset	7 450
Meander Valley	17 560
Northern Midlands	11 813
Launceston City*	62 830
Georgetown*	6 738

*Most of population is located within Tamar Estuary catchment

The largest towns in the region have populations between 1000 and 5000. As shown in figure 5, Longford, Deloraine, Westbury, Hadspen and Perth are situated in the Meander or South Esk catchment. Scottsdale is located between the Brid and Great Forester catchments, Bridport is situated at the mouth of the Brid River and St Helens is the western side of Georges Bay on the east coast.

Edgar et al (1999) determined population densities of both riverine and estuarine catchment areas (table 7). The results show that overall the river catchments are sparsely populated. Comparing the estuarine population densities with the river catchment densities indicates that a large proportion of the total population resides near the coast.

Table 7 Population density of river catchments and estuary (Edgar et al 1999)

Catchment	Population density of river catchment	Population density (estuarine area only)
Curries	3.27	65.87
Pipers	3.56	2.85
Little Forester	2.36	7.79
Brid/Great Forester	11.45	28.71
Tomahawk	0.17	1.08
Boobyalla Inlet	1.63	0.69
Little Musselroe	0.31	0.47
Great Musselroe	0.33	0.58
Georges Bay	3.18	32.31
Henderson Lagoon	1.33	0.75
Scamander	1.79	19.06
Ansons Bay	0.58	5.07
South Esk/Tamar (incl N Esk)	9.52	70.02

river catchments = above estuary; estuary catchments = river + estuary

3.2 Land tenure

Figure 5 shows land tenure in north-eastern Tasmania and table 8 provides a breakdown of land usage as determined by Edgar et al (1999). Most of the land in the north-east is either privately owned, or exploited Crown land, with agriculture and forestry being prominent activities. In the north coast and South Esk River catchments, about one-third of the land area has been cleared, with the Little Musselroe having undergone much greater clearing (70%). The east coast catchments have undergone far less clearing activity.

National parks in the region include Ben Lomond in the South Esk and North Esk catchments, Mount William in the far north-east of the State, and Douglas Apsley in the North Esk catchment and on the east coast. State reserves in the region include St Columba Falls near Pyengana; St Marys Pass, St Patricks Head east of St Marys and Little Beach east of St Marys on the coast.

Coastal conservation areas include Double Sandy Point, Granite Point, Waterhouse, Little Boobyalla River, Cape Portland, Musselroe Bay, Parnella, Humbug Point, Ansons Bay, Bay of Fires, Medeas Cove, St Helens Point, Scamander, Little Beach and Seymour (DPIWE 2000c).

Three wetlands in the north-east have been recognised under the 1971 Convention on Wetlands of International Importance (Ramsar) as having significance for their ecology, botany, zoology, limnology or hydrology. These are Little Waterhouse Lake (56.3 ha) on the north coast, Jocks Lagoon (18.6 ha) near St Helens, and the floodplain of the lower Ringarooma River (3701 ha) (DPIWE 2000c). Additionally, the following wetlands have been listed in Tasmania's *Directory of Important Wetlands in Australia* (DPIWE 2000c):

- Blackmans Lagoon south-west of Waterhouse Point
- A section of Surveyors Creek 8 km north-east of Scottsdale
- Tregaron Lagoons south-east of Cape Portland
- Unnamed wetland 4 km west of Cape Naturaliste
- Unnamed wetlands on the peninsula of Cape Portland and 1.5 km and 2 km south-east of Cape Portland
- Unnamed wetland 500 m inland of Little Musselroe Bay
- Unnamed wetlands 2 km and 4.5 km south of Waterhouse Point

Forest reserves are located in the South Esk (Mt Puzzler Forest Reserve), and Great Forester/Brid (Mt Victoria Forest Reserve, Mt Maurice Forest Reserve) catchments. Coastal protected areas include the Bay of Fires, Musselroe Bay and Ringarooma, as well as the Waterhouse Protected Area on the coast east of Bridport.

Figure 5 Land tenure and population centres in north-east Tasmania

Table 8 Land tenure in north-east river catchments and naturalness index (NI) for estuarine catchment areas and estuarine drainage areas (Edgar et al 1999)

Catchment	Nat. Park	Private	Crown Res.	Crown Expoit.	Cleared	Urban	NI ECA	NI EDA
Curries		32%	27%	41%	17%	1%	1.8	3.18
Pipers		69%	2%	29%	37%	<1%	2.57	1.74
Little Forester		56%	0%	44%	27%	<1%	2.14	3.98
Brid/Great Forester		51%	3%	46%	31%	<1%	2.31	3.59
Tomahawk		49%	2%	49%	36%	<%	2.47	3.67
Boobyalla Inlet		34%	4%	62%	24%	<1%	2.01	3.29
Little Musselroe		99%	1%	0%	70%	<1%	3.81	3.99
Great Musselroe	6%	53%	2%	39%	30%	<1%	2.25	2.49
Georges Bay		31%	8%	61%	14%	<1%	1.64	2.15
Henderson Lagoon		62%	8%	29%	26%	<1%	2.02	2.02
Scamander		5%	5%	79%	3%	<1%	1.19	1.92
Ansons Bay		26%	8%	66%	6%	<1%	1.33	1.59
Douglas	91%	8%		1%	4%	<1%	1.16	3.83
South Esk/Tamar	1%	67%	4%	27%	36%	<1%	2.5	2.81

ECA = whole catchment, EDA = area draining to estuary only
NI ratings: 1 = Pristine; 1–1.5 = Natural; 1.5–2 = Low impact; 2–3 = Moderate impact; 3–4 = High impact; >4 = Severe impact

The ‘naturalness’ of river catchments and estuaries in Tasmania was evaluated by Edgar et al (1999). The Index increases from a base of 1 in pristine areas, and is weighted by a factor of 5 for cleared areas and a factor of 20 for urban areas. Categories based on the naturalness index (NI) are presented in the caption of table 8. The north coast and South Esk River catchments are rated as being moderately impacted, with the east coast catchments having ‘natural’ to ‘low impact’ scores.

The areas draining directly to estuaries generally have a higher degree of impact than the catchments as a whole, with most of the north coast catchments rated as ‘highly impacted’. Again, the east coast catchments display a lower degree of impact.

3.3 Primary land uses

The primary land uses in north-east Tasmania are agriculture and forestry. Farming activities include cropping, grazing and dairies, with activities considered intensive in some areas. Crops include poppies, potatoes, peas and onions. As discussed in Section 3.4.2, these agricultural activities are dependent upon direct water withdrawal from rivers and irrigation schemes.

Forestry activities in the north-east include the logging of both native forests and plantations. Since the finalisation of the Regional Forest Agreement (RFA) in 1997, there has been an expansion of plantations in the north-east under the Intensive Forest Management Program, which includes establishing plantations on cleared land and through the conversion of native forests (Forestry Tasmania 2001).

Other more minor land uses include mining, which includes coal and small base metal operations, urban development and recreation. The north and east coasts are renowned for their natural beauty and are popular summer holiday destinations.

3.4 Water uses

Uses of water in the north-east river catchments include irrigation and stock watering, domestic water supply and aquaculture.

3.4.1 Domestic water supply

There are a number of water supply schemes in north-east Tasmania. Figure 6 indicates water extraction points.

Esk Water supplies treated water to the Launceston, Georgetown, West Tamar Councils and the eastern part of the Meander Council. The Councils are responsible for reticulation to residents. Esk Water has 5 water off-take sites in the South Esk/North Esk catchment: South Esk River at Lake Trevallyn, Distillery Creek, St Patricks River near Nunamara, the North Esk River at Chimney Saddle and Curries River Dam in the Curries River catchment.

Approximate volumes drawn from the catchments are: Trevallyn Dam (4000 ML); St Patricks River (7000 ML); and the North Esk (7000 ML). Turbidity of the intake water is generally low (1–2 NTU), but increases substantially following rain events to 15–30 NTU.

Meander Council also has water off-takes on the Meander River at Deloraine (512 ML), Westbury/Hagley (352 ML), Exton (15 ML), and on the Liffey River at Carrick (80 ML) and Bracknell (73 ML). The Deloraine water supply receives full treatment, with primary treatment completed at the other off-takes.

Dorset Council obtains water for consumptive uses from rivers, bores and irrigation schemes. With the exception of Bridport and part of the Scottsdale supply, the water is not fully treated. Rainwater is also an important water source of drinking water in many parts of the municipality (Gutteridge, Haskins & Davey 1996).

Water supply to the towns of St Helens and Scamander in Break O'Day Council is drawn from the George River and Scamander River respectively, and is fully treated. Supply to Fingal receives chlorination only. Many areas are dependent on rainwater for supply.

Northern Midlands Council maintains 10 drinking water plants that provide chlorination of the water for residents. Under the NHT funded Clean Quality Water Program, the Campbelltown, Perth, Cressy and Evandale drinking water supply systems have attracted funding for upgrading.

3.4.2 Irrigation and stock watering

Two irrigation schemes are operated in the north-east by the Rivers and Water Supply Commission — the Cressy–Longford Irrigation Scheme, and the Winneleah Irrigation Scheme.

The Cressy–Longford Irrigation Scheme is fed by Great Lake derived water, diverted after passage through the Poatina Power Station. The irrigation scheme drains into Back Creek, a tributary of the South Esk River entering west of Longford. The Cressy–Longford Irrigation Scheme has the capacity to deliver 8235 ML on an annual basis (RWSC 2000). In the 1999–2000 irrigation season (October–May) the scheme delivered 7505 ML of water to 70 properties which was used over 3531 ha — primarily for pasture, poppies, potatoes and peas.

Figure 6 Map of industrial operations, water off-takes and sewage treatment plants in north-east Tasmania

The Winnaleah Irrigation Scheme is located in the Ringarooma catchment. During the 1999–2000 irrigation season, the scheme delivered 3546 ML of water to 35 users, which is below the 5-year average of 3793 ML. The reduction in water usage is attributed to the wet summer experienced in the Ringarooma catchment (RWSC 2000). A total of 1301 ha were irrigated from the scheme, with the primary uses of the water being pasture, potatoes, stock and domestic and town water supply (RWSC 2000).

In addition to the irrigation schemes, there is significant direct withdrawal and storage of water for irrigation purposes from many rivers in the region, as summarised in tables 9 and 10.

Table 9 Commissional water right allocations

Catchment	Direct annual ML	Storage annual ML	Total annual ml
Meander	1 465	383	1 848
Tributaries of Meander River	553	7 441	7 994
Liffey River	324	165	489
Quamby Brook	66	1 497	1 563
Western Creek	49	603	652
Elizabeth River	245		245
Macquarie River	2 175	11 577	13 752
Brumbys Creek	1 044	776	1 820
South Esk	6 000	250	6 250
South Esk Tributaries	516	6 203	6 719
St Pauls River	220	356	576
Break O'Day River		1 010	1 010

Table 10 Farm dam storage capacities (Bobbi et al 1996)

Catchment	Number	Capacity (ML)
Meander	161	8 570
Liffey	23	343
Quamby Brook	47	1 789
Western Creek	22	667
Macquarie	83	14 536
Brumbys Creek	13	818
South Esk (above Fingal)	6	565
South Esk Tributaries below Fingal	68	7 175

There are also two artificial lakes (Lake Leake and Tooms Lake) in the headwaters of the Macquarie catchment that are used as a source of irrigation water. The storage capacity of Lake Leake is 18 900 ML, while that of Tooms Lake is 24 800 ML. Both are managed for recreational activities such as fishing, as well as irrigation supply (Bobbi et al 1996).

3.4.3 Aquaculture

Aquaculture in the catchments includes four fish hatcheries on rivers and marine farming leases in Georges Bay.

Fish hatcheries in the region are located on Brumbys Creek (Sevrup Fisheries Pty Ltd), near Targa on the St Patricks River (Mountain Stream Fisheries); near Springfield in the upper Great Forester River (Springfield Fisheries Pty Ltd), and on the lower Brid River in Bridport (Springfield Fisheries Pty Ltd). The hatcheries are flow-through systems that extract and return water to the same waterway. Both trout and salmon are produced at the sites for supply to the marine-based aquaculture industry.

Under the Marine Farming Development Plan established for Georges Bay in 1998 (DPIWE), the farming of shellfish (Pacific oyster, native oyster, mussels and clams) and seaweed is permitted in five zones within the bay (fig 7). The total leaseable area in the bay is approximately 102 hectares, encompassing both intertidal and subtidal areas. The plan does not consider Georges Bay as suitable for the farming of finfish.

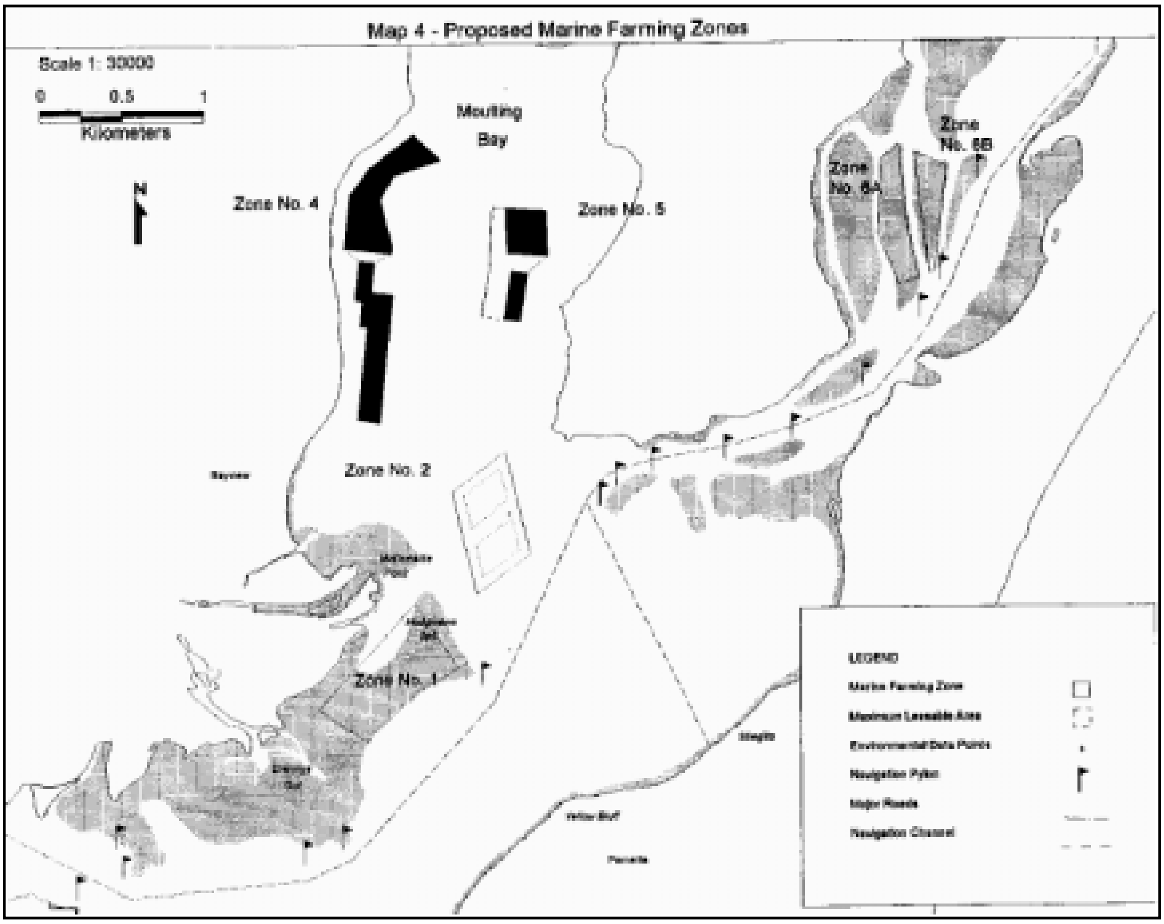

Figure 7 Map of Georges Bay showing allocated marine farming leases (DPIWE 1998)

3.4.4 Hydro electric energy production

The South Esk River, via Brumbys Creek and the Macquarie River, receives water derived from the Great Lake reservoir and discharged from the Poatina Power Station. The Poatina Power Station is comprised of 6 turbines capable of producing 300 MW of electricity, making it one of the largest stations in the state. A second Hydro Tasmania Power Scheme, Trevallyn, is located near the mouth of the South Esk. Trevallyn was created by damming the South Esk and has an installed capacity of 80 MW. The discharge from Trevallyn Power Station enters the Tamar Estuary (HEC 1995).

A privately owned power station is located at Moorina on the Frome River, a tributary of the Ringarooma. The plant was originally constructed in 1907 to provide power for tin-mining operations. A dam on the Frome River supplies water to three small turbines that produce approximately 0.6 MW of electricity which is added to Hydro Tasmania's transmission network (HEC 1995).

3.4.5 Recreational fishing

A significant recreational trout fishery exists in north-east Tasmania. In the South Esk Basin, fishing is popular in Lake Leake and Tooms Lake (Inland Fisheries Commission 2000), as well as in Brumbys Creek and the Macquarie and South Esk Rivers downstream of Brumbys Creek (Davies & Cook 2001).

Along the north and east coast, lagoons (Big Waterhouse Lagoon, Little Waterhouse Lagoon, Big Lagoon) and dams (Curries River Dam, Pioneer Mine Hole) are regularly stocked with trout by the Inland Fisheries Commission (IFC 2000).

3.4.6 Derby River Derby

The Derby River Derby is a high profile river race held every year around the end of October in Derby. Up to 10 races are held on a 6 km portion of the Ringarooma River with most crafts hand constructed by the participants. Up to 8000 participants and spectators attend the event.

4 Catchment inputs — Point source

Waterways in north-east Tasmania are affected by industrial, municipal, and agricultural inputs. Point source activities that are licensed by DPIWE under the *Environmental Management and Pollution Control Act 1994* are identified in figure 6.

4.1 Sewage treatment plants

Twenty-two wastewater treatment premises with flows in excess of 100 kilolitres (kl) per day are licensed by DPIWE in north-east Tasmania (table 11). Smaller treatment facilities in the region are under the jurisdiction of local council or other Government departments, such as the Parks and Wildlife Service. In table 11, the largest volumes are associated with the Launceston City area and are generally discharged into estuarine waters. The Longford and Scottsdale wastewater treatment plants are the largest facilities discharging to inland waters.

DPIWE (2001b) has developed emission limit guidelines for new and upgraded sewage treatment plants, which are based on protecting the environmental values of the receiving water (table 12). The emission limits apply to plants discharging less than 500 kl/day of effluent and entering receiving waters with a flow rate of 80 times the effluent flow rate. Larger plants warrant the site-specific establishment of emission limits.

Table 11 Wastewater treatment premises in north-east Tasmania (list supplied by DPIWE)

Wastewater treatment premises	Receiving waters	Municipality	Permit flow (kL/day)	Receiving environment
Bridport	Andersons Bay	Dorset	500	Coastal
Scottsdale	Cox's Creek	Dorset	2 000	Inland
St Helens	Georges Bay	Break O' Day	690	Estuarine
Carrick	Meander – Liffey River	Meander Valley	500	Inland
Westbury	Meander – Quamby Brook	Meander Valley	600	Inland
Deloraine	Meander River	Meander Valley	568	Inland
Hoblers Bridge	North Esk River	Launceston	4 500	Estuarine
Lilydale	Rocky Creek Pipers River	Launceston	135	Inland
Cressy	South Esk – Back Creek	Northern Midlands	240	Inland
Longford	South Esk – Back Creek	Northern Midlands	2 700	Inland
Evandale	South Esk – Boyes Creek	Northern Midlands	375	Inland
St Marys	South Esk – Break O' Day River	Break O' Day	190	Inland
Prospect Vale	South Esk – Dalrymple Creek	Meander Valley	1 400	Inland
Campbell Town	South Esk – Elizabeth River	Northern Midlands	325	Inland
Perth	South Esk River	Northern Midlands	450	Inland
Fingal	South Esk River	Break O' Day	125	Inland
Norwood	South Esk River	Launceston	4 050	Estuarine
George Town	Tamar River	George Town	3 600	Estuarine
Newnham Drive	Tamar River	Launceston	3 920	Estuarine
Ti-Tree Bend	Tamar River	Launceston	25 000	Estuarine
Scamander	N/A	Break O’ Day	240	Irrigation
Stieglitz	N/A	Break O' Day	110	Irrigation

Table 12 Emission limits based on Accepted Modern Technology, applicable to new and upgraded sewage treatment plants discharging up to 500 kL/day (DPIWE 2001b)

Percentile	BOD mg/L	NFR mg/L	Thermotol. Coliforms cts/100 ml	Ammonia mg/L	Total N mg/L	Total P mg/L	Oil & Grease mg/L
50%ile	5 (10)	10	200	1	7	0.5 (1)	2
90%ile	10 (15)	15 (20)	(500)	2	10	1 (3)	5
Max	15 (20)	20 (30)	200 (750)	5	15	3 (5)	10

Emission limits from marine waters are the same as for freshwaters except where alternative values are specified.

A summary of discharge water quality from wastewater treatment plants in north-east Tasmania between 1999 and 2001 is shown in table 13 (data supplied by DPIWE). Many of the parameters listed in table 13 exceed the emission limit guidelines.

Over the past two years, the Tasmanian Strategic NHT Clean Quality Water Program has provided funding for the upgrading of sewage lagoon systems in the region. The aim of the program is to implement the findings of the Sewage Lagoon Improvement Program which identified best practice management procedures for sewage lagoon systems. Premises that have attracted funding for upgrades under this collaborative program include: Carrick, Prospect and Deloraine in the Meander catchment; Cressy (upgrade and re-use), Campbell Town, Evandale and Perth in the South Esk catchment; and Lilydale in the Pipers River. Upgrade funding applications are pending for the St Marys and Westbury wastewater treatment plants.

The Longford lagoon system is one of the largest in the State and discharges into Back Creek — a waterway known to have significant water quality issues. Although treatment provided by the plant is considered inadequate, the Longford system has not been included under the Clean Quality Water Program to date because the costs of upgrading such a large system are beyond the present funding ability of the program.

Scottsdale wastewater treatment plant is a mechanical system rather than a sewage lagoon system, and therefore does not qualify for consideration under the present Clean Quality Water Program.

4.2 Industrial discharges

Industrial sites licensed by the Department of Primary Industries, Water and Environment are shown in figure 6. These sites include sawmills and timber preservation plants, vegetable washing and processing, pyrethrum and hops extraction, and coal and base metal mining. Generally, these activities have limited water discharges. The use of settling ponds in the timber and coal industries to reduce suspended solid levels in storm water run-off is common and largely effective. Mining sites are small, and settling ponds retain solids. Vegetable processors either treat wastewater on site or discharge to municipal wastewater treatment plants. The pyrethrum extraction plant has a double-bund containment system around the process area, and a closed circuit cooling water system to prevent spills of contaminated water.

Few industrial sites in the region emit discharges directly to waterways. On the National Pollutant Inventory database (NPI 2001), the following companies in table 14 reported discharges to water.

Table 13 Discharge quality from wastewater treatment plants

Premises	Percentile	BOD mg/L	NFR mg/L	Faecal coliforms cts/100 ml	Ammonia mg/L	Total N mg/L	Total P mg/L	Oil & grease mg/L
Bridport	50%ile	39	67	19 000	na	37	11	na
	90%ile	57	98.4	74 400		44	14	
Scottsdale	50%ile	11	18	10	0.41	32.4	11	3
	90%ile	38	35.8	850	8.45	43.28	16	7.6
St Helens	50%ile	45	110	3 950	0.59	19	9.2	
	90%ile	70.4	161	35 500	2.96	24.16	13.2	
Carrick	50%ile	38	64	38 000	28	34	11	na
	90%ile	60.4	124	130 000	35.4	49.6	13	
Westbury	50%ile	23	50	580	3	17.5	5.9	na
	90%ile	33.4	158	3 980	12	29.5	8.425	
Deloraine	50%ile	20	34	1 750	13	25.5	8.15	na
	90%ile	33.8	75.6	17 600	24.5	34.5	10	
Hoblers Bridge	50%ile	12	14	60	30	na	12	na
	90%ile	19.6	30.2	936	44.6		13.2	
Lilydale	50%ile	22	57	500	na	na	4.8	na
	90%ile	41.4	126	2 660			6.56	
Cressy	50%ile	32	71.5	1 950	8.5	24	5.74	na
	90%ile	66.4	130	14 800	18.6	31.6	9.104	
Longford	50%ile	16	32	210	5.19	15.5	13	9
	90%ile	83.9	147.6	3 120	16.8	40	20	11.5
Evandale	50%ile	41	70	675	3.65	19	10.485	na
	90%ile	84.6	148	4 950	15.9	34.2	14.4	
St Marys	50%ile	35	90	6 400	6.21	23	7.65	
	90%ile	58.4	260	24 500	12	26	10.532	
Prospect Vale	50%ile	51	82	2 700	13	25.5	9.3	na
	90%ile	120	120	12 200	19.1	38.5	11.2	
Campbell Town	50%ile	30	87.5	100	1	11	3.3	na
	90%ile	49.5	115	700	6.944	19.2	8.24	
Perth	50%ile	44	97	2 250	8.87	28	11	na
	90%ile	73.4	176	14 100	19.8	39	15.2	
Fingal	50%ile	30	69	580	4.6	16	7	
	90%ile	58.8	100	6 560	17	25	8.36	
Norwood	50%ile	13	18	20	32.5	na	9.35	na
	90%ile	43.1	67	444	40.6		19.4	
George Town	50%ile	20	23.5	na	2.35	na	6.45	na
	90%ile	28.7	45.6		15.22		7.19	
Newnham Drive	50%ile	13.5	18	40	19	na	7.7	na
	90%ile	18	24	595	24.6		8.76	
Ti-Tree Bend	50%ile	5	10	10	0.605	na	4.5	na
	90%ile	11	19.1	568.2	6.14		6.12	
Scamander	50%ile	13.5	44	30	0.19	5.2	8.2	
	90%ile	24.9	78	204	1	9.79	12.6	
Steiglitz	50%ile	31.5	90	350	0.05	12	9.06	
	90%ile	46.4	192	4 040	0.143	20.18	13.19	

Table 14 Industrial sites listed on the National Pollutant Inventory (NPI database)

Company	Activity	Estimated discharge per annum
Tas Alkaloids	Pharmaceutical processing	Acetic acid 130 kg Ammonia 140 kg Total Phosphorous 14 000 kg Total Volatile Organic Carbon 9800 kg
TasFuel Scottsdale		Benzene <1 kg Cumene <1 kg Ethylbenzene <1 kg n-hexane <1 kg toluene <1 kg Total Volatile Organic Carbon 11 kg Xylene 0.5 kg
Koppers Timber Preservation	Timber preservation	Arsenic and arsenic compounds 0.00065 kg Chromium IV and compounds 0.0019 kg Copper and related compounds 0.0008 kg

4.3 Historic mining inputs

There are three general areas where historic mining activities have impacted, and continue to impact on water quality in the north-east of Tasmania. One area is located within the Ringarooma catchment, in the area between Derby and Gladstone, where tin fields were active over the past century (1900s). In the South Esk catchment, the area of Storys Creek and Aberfoyle Creek near the town of Rossarden was another tin mining centre. A third tin mining centre was located in the George River catchment, on and near the Blue Tier. All of these areas have undergone some remediation in the past few years, although water quality concerns remain.

The primary water quality concern with historic mining operations is the continued generation of acidic drainage from the exposed sulphide-rich rock. Acid drainage is the result of the oxidation of sulphur when exposed to air and water. The resulting sulphuric acid liberates metals from the surrounding strata. Acid drainage is characterised by low pH values and high sulphate and metal concentrations.

4.3.1 North-east tin fields

Alluvial tin mining was one of the principal activities in the north-east of the State between 1875 and the 1980s (SDAC 1996). Large volumes of tailings were discharged into the waterways, which remain in transit in the rivers. The old port of Boobyalla is presently land-locked due to tailings deposition from the Ringarooma River, and a large delta of gravel is pushing out of George River into Georges Bay due to mining inputs (Bird 2000). In the mining districts, land degradation is widespread, and revegetation has been slow, with about 2500 ha remaining exposed despite revegetation efforts in the 1980s (SDAC 1996).

In 1998 and 1999, works were undertaken at the Monarch mine site with the aim of diverting clean water away from the acid water in Ruby Creek, which is highly contaminated as shown in table 15. These erosion control works are maintained by Mineral Resources Tasmania (DIER 2000).

Table 15 Snapshot of water quality from Blue Lake, Ruby Creek Endurance Mine area during March 2000 (Gurung 2001a)

Date	Site	pH	Cond. uS/cm	AlK mg/L	Acidity mg/L	Sulphate- mg/L	Al_D mg/L	Al_T mg/L	Iron_D mg/L	Iron_T mg/L	Mn_D mg/L	Mn_T mg/L	Zn_D mg/L	Zn_T mg/L
24/03/00	Monarch pond	3.07	1061	<1.00	212	1100	28.3	28.3	5.22	5.31	1.40	1.39	2.75	2.74
14/03/00	Blue Lake NE	3.05	680	<1.00	180	690	14.8	15.1	9.40	62.2	0.043	0.044	0.081	0.060
16/03/00	Blue Lake outflow	3.96	198	<1.00	18	69	1.21	1.23	0.696	2.98	0.028	0.028	0.008	0.009
16/03/00	Blue Lake west @ picnic site	3.65	263	<1.00	24	130	1.89	1.74	0.715	0.992	0.018	0.016	0.005	0.007
14/03/00	Eastern Blue Lake	3.66	250	<1.00	24	110	1.74	1.90	0.465	1.17	0.015	0.016	0.016	0.008
16/03/00	Endurance tin mine	2.92	845	<1.00	298	800	31.1	30.9	14.1	29.8	0.068	0.068	0.037	0.041
16/03/00	Endurance tin mine	3.18	600	<1.00	195	640	15.9	15.9	10.8	53.6	0.066	0.066	0.033	0.039
16/03/00	Endurance tin mine	3.42	364	<1.00	67	210	5.19	5.26	0.938	15.3	0.021	0.022	0.026	0.030
14/03/00	South Endurance flat	2.57	935	<1.00	296	630	19.2	19.4	27.8	67.6	0.075	0.077	0.063	0.066
14/03/00	South Endurance flat	2.87	1214	<1.00	520	2300	43.6	44.2	42.5	100	0.150	0.152	0.104	0.112
16/03/00	Ruby Ck	3.05	650	<1.00	179	160	17.0	17.1	5.39	23.1	0.069	0.070	0.043	0.047
16/03/00	Ruby Ck	3.09	652	<1.00	177	540	17.0	16.9	5.14	21.3	0.069	0.069	0.043	0.044
16/03/00	Ruby Ck	3.06	656	<1.00	182	530	17.2	17.0	5.88	28.1	0.068	0.068	0.045	0.044
24/03/00	Ruby Ck at Bridge	3.17	533	<1.00	118	780	11.2	11.2	3.58	17.3	0.057	0.058	0.024	0.026
16/03/00	Ruby lagoon	3.21	435	<1.00	51	150	5.54	5.45	1.74	1.83	0.032	0.033	0.020	0.021

Al = Aluminium; Mn = Manganese; Zn = Zinc

D = Dissolved; T= Total (not filtered)

The exposure of sulphide rich rock has also resulted in the generation of acid drainage. Gurung (2001a) has investigated surface waters throughout Tasmania and has documented high sulphate and metal levels and low pH values in the waterways near the former Endurance and Monarch mines. Table 15 contains water quality results from a 'snapshot' of water quality in the region completed in March 2000 (Gurung 2001a). The results show that Ruby Creek and the Blue Lake have very poor water quality due to acid drainage discharge. No flow data was collected during this sampling, so no mass-loading of metals into the Ringarooma catchment can be determined.

4.3.2 Storys Creek

Storys Creek area is another historic tin mining district in the South Esk basin. Acid drainage discharge from mine sites and metalliferous tailings resident in Storys Creek have resulted in elevated concentrations of metals and sulphate in the river. Historically, the influx of metals was blamed for the degradation of the South Esk River downstream of Storys Creek (Norris 1979). More recent analysis and interpretation of historic invertebrate data, combined with new information obtained through the Monitoring River Health Initiative, have indicated that although the metal concentrations are undoubtedly related to environmental degradation immediately downstream, other factors must be contributing to the environmental degradation further downstream. Sites upstream of Storys Creek also demonstrate some degree of catchment degradation, and land use practices have been suggested as a major impact on river health in the catchment (Bobbi et al 1996, Davies 1998).

Since 1998, significant remediation works have been completed at Storys Creek, funded by the Rehabilitation of Mining Lands Trust, and RiverWorks Tasmania. Work to date includes:

- relocation and capping of the acid producing precipitate dam away from Storys Creek;
- implementation of an anoxic limestone drain such that water entering the acid drainage producing underground workings has higher neutralising capacity; and
- placement of limestone gravels on riverbanks blanketed by historic tailings to reduce the release of zinc and cadmium from the underlying material.

Results from water quality monitoring in the catchment are shown in table 16. Overall, John Miedecke and Partners (2001a) identified changes since the remediation works as follows:

- general trend of increasing pH and decreasing acidity near the precipitate dam;
- general trend of decreasing metal aluminium, cadmium, copper, zinc;
- general trend of decreasing pH downstream of Side Creek.

The water quality data indicate that between the precipitate dam site and downstream of Side Creek there is an increase in the metal concentrations in Storys Creek, with zinc increased from 0.4 mg/L to about 7 mg/L. The present remediation investigations have determined that much of this untreated pollutant load is derived from tailings deposits situated on the bank of the river.

4.4 Waste disposal sites

Waste disposal sites in north-east Tasmania are shown in figure 6. Mineral Resources Tasmania is completing an assessment of the effects of waste disposal on groundwater quality, which is scheduled for completion in November 2001 (A Ezzy pers comm). Although the results for the north-east are not finalised, there are indications that several waste disposal sites are located in inappropriate areas with respect to potential to pollute groundwater.

Table 16 Water quality results from Storys Creek following remediation works in September 1998 (John Miedecke & Partners 2001a)

Parameter (mg/L or as stated)	**ANZECC Protection of Ecosystem**	**Storys above mine**	**Storys above mine**	**Storys below PPT Dam**	**Storys below PPT Dam**	**Storys below PPT Dam**	**Storys below Side Cr**	**Storys below Side Cr**	**Storys below Side Cr**	**Storys at Rossar-den**	**Storys at Rossar-den**	**South Esk at Avoca**
		1-Oct-98	14-May-99	14-May-99	6-Jan-01	16-May-01	14-May-99	6-Jan-01	18-May-01	29-Jun-00	30-Aug-00	7 Jul 99
pH		7.1	6.4	6.5	7.2	6.9	6.4	4.0	7.0	5.7	6.5	
Cond (mS/cm)		55	20	20	68	34	23	532.0	35.0	104	63	
TDS		51	26	19	48	37	22	410	30		13	
Susp.sol.		553	8	8	1	2	9	14	1		6	
Alkalinity		14	1	1	1	6	2	1	6		2	
Acidity		1	2	2	4	1	2	74	1	6	3	<1
SO4		0.3	0.3	0	6.3	2.8	1	270	4	33	14	
Ca					8.4	2.14		60.5	2.8	8.9	4	
Mg					1.92	0.79		18.3	0.8	2.6	1.5	
Na					2.4	1.36		4.7	1.4		3.4	
Metals (mg/L)												
Al F	0.1	<0.050	0.068	0.06	0.04	0.02	0.08	3.88	0.07	0.2	0.12	
Al T		0.055	0.187	0.20	0.05	0.07	0.27	4.14	0.16	0.4	0.45	0.1
Cd F	0.0002	<0.001		0.001	0.014	0.002	0.004	0.350	0.003	.034	0.034	
Cd T		<0.001		0.001	0.014	0.003	0.004	0.355	0.005	.037	0.037	0.001
Cu F	0.005	0.009		0.005	0.005	0.001	0.013	0.233	0.005	0.1	0.052	
Cu T		0.005		0.005	0.005	0.001	0.019	0.255	0.007	0.119	0.11	0.003
Fe F	1	<0.02	0.034	0.5	0.02	0.0	0.0	7.17	0.02	ND	0.19	
Fe T		0.028	0.159	0.2	0.06	0.0	0.2	20.0	0.05	0.9	0.38	0.2
Mn F		<0.005	0.006	0.01	0.08	0.0	0.0	2.99	0.01	0.3	0.16	
Mn T		<0.005	0.011	0.0	0.1	0.0	0.0	3.0	0.0	0.3	0.2	ND
Zn F	0.05	<0.001	0.014	0.051	0.431	0.077	0.107	6.87	0.105	1.26	1.26	
Zn T		0.005	0.012	0.058	0.428	0.105	0.127	6.92	0.154	1.37	1.37	0.049

F= Filtrable (<0.45 µm); T=Total; WQO = Water Quality Objective as determined under the *State Policy on Water Quality Management 1997;* ND=Not detectable;
ANZECC (2001) Guidelines for the Protection of Aquatic Ecosystems

5 Catchment inputs — Diffuse

Diffuse inputs to waterways in the north-east include run-off and groundwater inflow from agriculture and forestry activities, stormwater run-off, and septic inputs. Little data exist that quantify the impacts of these activities.

5.1 Agricultural diffuse inputs

Agriculture in the north-east includes cropping and pasture. In many areas, there is no riparian buffer between rivers and agricultural land, and river bank erosion or infestation with weed species is common. Direct stock access to rivers is a common occurrence, and 'State of the River' reports' (Bobbi et al 1999a,b,c,d) have commonly documented increased turbidity and bacteriological indicators in these areas.

Run-off from dairy sheds, especially during high rainfall events, has also been suggested as a potential source of nutrients to waterways in the region (Gutteridge, Haskins & Davey 1996).

5.2 Forestry

Most catchments included in this report contain significant forestry activities. Since the finalisation of the Regional Forestry Agreement in 1997, there has been an increase in the conversion of native forests to plantations in the region. All forestry activities are governed by the Forest Practices Code, which mandates riparian buffer zones be maintained along all waterways. Mandatory buffer zones range from 10 m for the smallest waterways up to 30 m for a major river. The aim of these zones is to conserve soil and water quality, maintain biodiversity and long-term site productivity and reduce visual impact (Forest Practices Board 2000). Water sampling above and below coups is required before and after the use of broadcast herbicides, and turbidity sampling is also completed as part of normal operating procedures.

Concerns about increased sediment input, contamination of waterways by pesticides, damage to riparian zones and decreased water availability due to forestry developments have been expressed at the community public meetings held during the setting of Protected Environmental Values for waterways in the area.

5.3 Septic inputs

Reticulated sewerage service is common in the larger towns of north-east Tasmania, but the smaller towns generally rely on septic tanks, and a few still use 'night carts' for waste management. Seepage from septic tanks has been identified as an issue in several of the councils, especially where water supply off-takes are located downstream of other towns. Because of the low number and dispersed nature of the population in the region, it is not feasible to install sewer systems. Coastal areas, which rely on septic tanks and where summer populations increase significantly, have also been identified as areas with potential problems.

Water quality impacts on riverine and estuarine waters due to seepage from septic tanks have not been quantified to-date. However, it is a concern that is frequently expressed by Councils and in public forums by the community.

6 Summary of catchment information

There are no long-term, catchment-wide water quality monitoring programs in the waterways investigated for this report. For most of the catchments in the South Esk Basin and north-east Tasmania, however, short-term (1–3 year) systematic investigations have been completed concerning the water quality, aquatic ecology and river condition through DPIWE's 'State of the River' report series. The aims of the reports are to provide the information necessary for the development of catchment management and water management plans, and provide information for future comparison when the investigations are repeated. 'State of the River' reports have been completed for:

- South Esk Basin (1996)
- Brid River Catchment (1999)
- Pipers River Catchment (1999)
- Great Forester Catchment (1999)
- Ringarooma Catchment (1999)

The North Esk River 'State of the River' report is in the process of being finalised.

The following sections summarise information from the State of the River reports, and other sources where available.

6.1 South Esk Basin

The *South Esk Basin State of Rivers Report* (Bobbi et al 1996) contains water quality information collected between 1992 and 1995, and provides a good overview of the water quality status of the catchment. The authors documented physical parameters, nutrient concentrations, nutrient fluxes, general ionic characteristics and microbiological data for the three major rivers in the basin: the South Esk, Macquarie and Meander.

In 1999, the Macquarie South Esk Natural Resource Management Action Group developed an Action Plan for the Macquarie/South Esk Catchment following extensive community consultation. Water quality issues identified in the plan include:

- Water quality problems are present where surfaces are paved, animals have direct access to waterways, and/or there are inputs from sewage treatment plants, such as at Longford.
- Water quality problems change with stream flow. Sediment and nutrient transport increase with increased flow, and bacteriological and algal problems increase during periods of drought.
- Heavy metals from mining around Rossarden/Storys Creek have killed riparian vegetation to Evandale.
- High salinity levels are present in the Blackman and Isis catchments, which both have naturally saline lagoons.

Catchment management activities are described at the end of the section.

6.1.1 South Esk River

The largest sub-catchment in the basin is the South Esk River, which comprises much of the ‘midlands’ agricultural region of Tasmania. The headwaters of the South Esk lie north of Ben Lomond, and the river sweeps south before flowing northward to the Tamar Estuary. Land tenure in the catchment is dominated by private property, with state forests fringing much of the catchment boundary. The South Esk River contributes 37% of the freshwater outflow at Launceston, excluding diversions from Great Lake, and its flow is significantly affected during the summer months due to extraction for irrigation (Bobbi et al 1996). ‘Typical’ water quality in the catchment above the confluence with the Macquarie and Meander Rivers has been documented by Bobbi et al (1996), as follows:

- Low conductivity values (generally <100 µS/cm)
- Low turbidity values (generally <5 NTU and <3 mg/L suspended solids)
- Low alkalinity (<10 mg/L $CaCO_3$)
- Low nitrate and total phosphorous concentrations (lower end of ANZECC values)

A water quality ‘blackspot’ in the catchment is related to historic mining operations in the Rossarden/Storeys Creek area. Norris (1979) and others have attributed the degradation of the South Esk catchment to the presence of these mining sites. Elevated concentrations of metals, zinc and cadmium in particular, have been recognised as having a deleterious impact on the downstream environment, and Mineral Resources Tasmania has completed one phase of remediation in the area (see Section 4.3.2).

More recent analysis and interpretation of historic invertebrate data, combined with new information obtained through Monitoring River Health Initiative have indicated that although the metal concentrations are undoubtedly related to environmental degradation immediately downstream, other factors must be contributing to the environmental degradation further downstream. Sites upstream of Storys Creek also demonstrate some degree of catchment degradation, and land use practices have been suggested as a major impact on river health in the catchment (Bobbi et al 1996, Davies 1998). In terms of ecological health, this catchment wide degradation has resulted in four resident invertebrates being identified as endangered or threatened.

Drought breaking rains and associated erosional episodes have been identified by Bobbi et al (1996) as the times of highest nutrient and suspended sediment concentrations in the catchment. Suspended sediment concentrations of up to 420 mg/l have been recorded by the ‘State of the River’ study, compared with a median value of 3 mg/l for the duration of the investigations.

6.1.2 Macquarie River

Of the three rivers in the South Esk Basin, the Macquarie River is the one most affected by Hydro Tasmania operations. Lake River, with its source in Woods Lake, and Brumbys Creek, which receives the discharge from the Poatina Power Station are both tributaries of the Macquarie River. Other flow regulations in the catchment include the diversion of water from the Poatina tailrace to the Cressy irrigation scheme, and the management of Lake Leake and Tooms Lake for irrigation purposes.

Similar to the South Esk River, the Macquarie River catchment is generally used for agriculture and forestry. The DPIWE investigations documented the following water quality characteristics for the Macquarie River (Bobbi et al 1996):

- Highest electrical conductivity of the three rivers in the basin (142–230 μS/cm). EC is dominated by the release of dilute (low conductivity) Great Lake water through Poatina with great fluctuations occurring over short time periods.
- Turbidity is generally low (<5 NTU) except for the Lake and Elizabeth Rivers.
- Low nitrate and total nitrogen values.
- Low total phosphorous concentrations (<0.002 mg/l) except in the Elizabeth River.
- Large flood events are responsible for the majority of nutrient export from the catchment
- No evidence of metal contamination was detected during the survey work.

In general, few water quality 'hotspots' were identified, although there were some elevated nutrient concentrations associated with the Ross and Campbell Town sewage treatment plants (STPs). The inputs from the STPs accounted for a significant portion of the total phosphorous and dissolved inorganic nitrogen inputs into the river during the study period. Since the investigations were completed, Northern Midlands Council with assistance from the NHT Clean Quality Water Program has upgraded the Campbell Town sewage lagoon.

A brief microbiological contamination indicator survey was completed as part of the DPIF study, in both the mainstream of the Macquarie River and its major tributaries. Generally, the upper Macquarie was found to contain unacceptable levels of the indicators in areas where stock had direct access to the river. One site in the lower river also had high levels of faecal indicators, although most of the catchment does not appear to be heavily contaminated (Bobbi et al 1996).

Of the tributaries sampled for bacteriological contamination, the Blackman, Elizabeth and Lake Rivers and Brumby's Creek all had faecal coliform counts above the guideline for primary contact, and disturbed sediment sampling revealed long-term contamination by animal waste at Brumby's Creek.

6.1.3 Lake River

Lake River had the highest median turbidity value of all sites monitored in the Macquarie River (13.5 NTU) with values up to 48 NTU associated with higher flows. Nutrients in Lake River were found to directly reflect conditions in Woods Lake, though were not significantly higher than other sites in the Macquarie River catchment (Bobbi et al 1996). The temperature of the Lake River was found to be lower than other tributaries due to the highland, colder source of water.

The ionic characteristics of the Lake River were found to be more dilute than for the other tributaries of the Macquarie, except for the Elizabeth River. Median alkalinity and hardness values for the Lake River of 12.5 and 32 mg/L were reported, respectively, compared with 25 and 75 mg/L for the Macquarie River at Ross. This is attributable to the doleritic geology underlying these tributaries (Bobbi et al 1996).

6.1.4 Back Creek

Although not directly a tributary of the Macquarie River, Back Creek is greatly affected by the discharge of water from Poatina, and its diversion into Back Creek and the Cressy/Longford irrigation scheme. Back Creek enters the South Esk below the confluence of the South Esk and the Macquarie and therefore represents water diverted out of the Macquarie Catchment. The area serviced by the irrigation scheme is affected by high salinity and land use degradation, and this is reflected in the electrical conductivity of Back Creek when the irrigation diversion is not operating (Bobbi et al 1996). The presence of a sewage treatment plant in the catchment also contributes significant nutrient loads, and the dilution provided by the irrigation scheme is the overwhelming factor controlling downstream water quality concentrations. An extract from the DPIF report demonstrates the dominance the Poatina releases have on determining water quality characteristics (table 17).

Table 17 Water quality in Back Creek

	Nitrate-N	Ammonia-N	Nitrite-N	Total N
Irrigation ON	0.043	0.49	0.009	1.06
Irrigation OFF	1.02	6.2	0.034	13.18

Source: Extract from table 2 (Bobbi et al 1996).
All units in mg/L

The water quality in Back Creek was found to be the most degraded of any of the tributaries sampled by the State of the River investigators.

6.1.5 Brumby's Creek

Electrical conductivity in Brumby's Creek and the lower Macquarie River is also controlled by releases from the Poatina Power Station. Because the water exiting the power station is derived from the higher and generally colder Great Lake, water temperatures in Brumby's Creek are colder than other tributaries and reflect Poatina Power Station operations. Bank erosion has been identified as a significant issue in Brumby's Creek (Abernethy & Bresnehan 2001), and salt scald is evident on the banks of the creek during periods of low power station discharge (Thompson & Chilvers 2001).

Catchment management activities in the South Esk Basin (excluding the Meander)

A large number of NHT funded projects are in progress in the South Esk catchment. A Macquarie/South Esk Catchment Action Plan was completed in April 1999 by the Macquarie South Esk Natural Resource Management Action Group that established long-term objectives, including the rehabilitation and protection of river systems.

Rivercare and/or rehabilitation plans have been developed for many regions within the basin, including the South Esk near Longford, Perth and Evandale, Back Creek, Elizabeth River, Lake River, and Upper Brumby's Creek. Most of these plans focus on restoring a healthy riparian zone to rivers, through fencing, removal of weed species, and re-establishment of native vegetation.

6.1.6 Meander River

The Meander River catchment has more intensive irrigation activity, a greater population density, and more stream bank erosion and willow infestation than the Macquarie or South Esk Rivers (Bobbi et al 1996). There are 65 dairies in the catchment, 323 farm dams, and 60 irrigators draw water directly from the Meander River (MCCG 1998).

Within the Meander catchment, only the Liffey River is directly affected by Hydro Tasmania operations. This is through the introduction of irrigation water via Main Channel from the Poatina tailrace during the summer months, and accounts for a downstream decrease in electrical conductivity in the Liffey River during this period.

The DPIWE investigations found the following ‘typical’ water quality characteristics:

- Electrical conductivity ranged between 29 and 86 μS/cm except for lower Quamby Brook.
- Nutrient concentrations in the Meander catchment were the highest in the South Esk Basin.
- Quamby Brook showed evidence of eutrophication based on total phosphorous concentrations, and had low dissolved oxygen values.
- Median pH values in the catchment ranged between 6.5 and 7.5.
- Metal concentrations for cadmium, copper, lead, zinc and arsenic were generally below detection limits.

In addition, Western Creek has been identified by the Meander Catchment Coordinating Group (MCCG 1998) to be a ‘hotspot’ due to elevated levels of bacteriological indicators.

The State of the River investigations found that similar to the other major rivers, the major transport of sediment and nutrients occurred during large flood events, when suspended solid concentrations frequently increased by greater than 100 fold.

Macroinvertebrate investigations indicated degradation of the communities between Cubits Sugarloaf and Deloraine, and accompanies a degradation of the riparian zone. Similar to the South Esk River, microbiological sampling indicated elevated faecal coliform counts throughout the lower reaches of the catchment.

Catchment management activities in the Meander Catchment

The Meander Valley Council has developed a Natural Resource Management Strategy which aims to ‘give context and meaning to the natural resources of the area so that priorities for their protection and management can be determined’ (Inspiring Place Pty Ltd 2000).

There are a large number of NHT projects that are developing or have developed Rivercare Plans to improve riverine conditions through addressing land use issues. These plans largely focus on better management of the riparian zones (stabilisation, elimination of stock access, weed eradication, revegetation, establishment of Dung beetles), monitor salinity in groundwater and community education.

6.2 North Esk River

The North Esk River catchment is about 10% of the size of the South Esk, and flows from North of Ben Lomond directly west to the Tamar. The catchment is generally used for forestry and agriculture. The major tributary of the North Esk is St Pauls River which serves as a water supply source for Esk Water and for a fish hatchery. DPIWE is in the process of finalising a ‘State of the River’ report for the catchment (Berry pers comm), from which the following water quality information is drawn.

Pirzl and Coughanowr (1997) identified the lower catchment in the vicinity of Launceston as degraded due to past industrial and municipal activities. Many of these point source industrial and sewage emissions have been upgraded, and it is anticipated that diffuse sources of pollution will be the major source of contamination in the catchment (DPIWE 2001b).

6.2.1 North Esk water quality

The DPIWE investigations have established that the water quality in the North Esk catchment is generally good, with high turbidity levels associated with storm events. Table 18 contains a summary of monthly water quality data collected between February 2000 and November 2000, and ANZECC (2000) trigger values for comparison.

Median values are within trigger values for all parameters. Maximum and minimum pH values are beyond the recommended range, as are maximum turbidity and total phosphorous and total nitrogen. Generally, these parameters increased in a downstream direction. Nitrate was found to have a strong seasonal pattern, with levels increasing during winter (Berry 1999b).

Table 18 Summary of water quality in North Esk River (Berry 1999b)

Parameter	Median	Maximum	Minimum	ANZECC* (2000)
pH	7.00	8.36	4.50	6.5–8.0
Conductivity (µS/cm)	66	139	47	PJ
Turbidity (NTU)	3.63	38.4	1.26	10
Dissolved Oxygen (mg/L)	10.8	12.6	5.0	85–110% sat.
[TP] (µg/L)	12	71	<2	13
[Nitrate/N] (µg/L)	203	385	<2	700
[TN] (µg/L)	402	1080	102	480

*ANZECC trigger values for Tasmania lowland rivers. Trigger values indicate levels at which site specific investigations are warranted.
PJ = professional judgement

Turbidity in the North Esk Catchment has been found to be more variable and increase with distance downstream, as shown in figure 8, which shows monitoring sites in the North Esk River in a downstream direction. Nutrient levels were found to follow the same trend.

Table 19 summarised water quality data from the St Pauls River, the largest tributary of the North Esk. Berry (1999b) characterises the St Pauls River as having low turbidity and low nutrient status. Extended dissolved oxygen time series collected from the river show diurnal variations typical of a healthy aquatic environment (Berry 1999b). In table 19, median nutrient concentrations are within trigger value ranges for all parameters, with total phosphorous and total nitrate maximums above the trigger values.

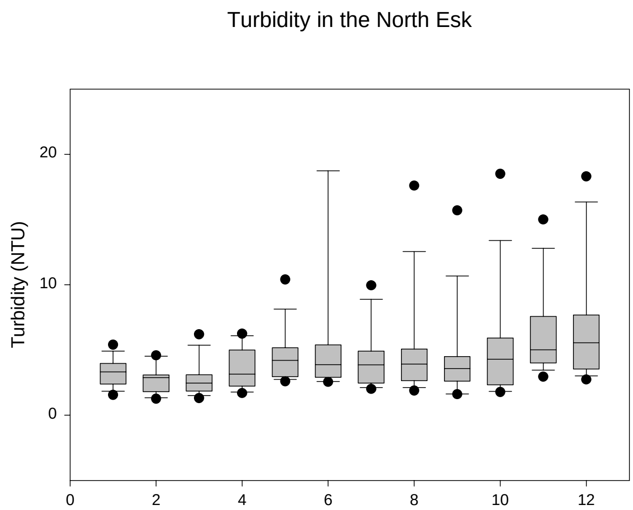

Figure 8 Turbidity in the North Esk River Catchment. Monitoring sites are shown in a downstream direction (Berry 1999b)

Table 19 Summary of water quality in St Pauls River (Berry 1999b)

Parameter	Median	Maximum	Minimum	ANZECC* (2000)
pH	6.74	7.65	5.3	6.5–8.0
Conductivity (µS/cm)	49	67	39	PJ
Turbidity (NTU)	2.45	8.52	0.85	10
Dissolved Oxygen (mg/L)	10.8	12.1	6.7	85–110% sat.
[TP] (µg/L)	10	75	3	13
[Nitrate/N] (µg/L)	204	346	3	700
[TN] (µg/L)	416	523	178	480

*ANZECC trigger values for Tasmania lowland rivers. Trigger values indicate levels at which site specific investigations are warranted.
PJ = professional judgement

Of the smaller tributaries in the North Esk catchment, Berry (1999a,b) found that high levels of dissolved salt are consistently measured in the Rose and Kings Meadows Rivulets, with Rose Rivulet also having high levels of turbidity following rain storms. Elevated turbidity was consistently recorded at Old Mill Creek.

6.2.3 Water quality issues identified by the community

During the development of the *Tamar Region Natural Resource Management Strategy 1999* (Rowlands 1999), the community identified declining water quality as the highest priority issue affecting the region. Community consultation associated with the setting Protected Environmental Values (PEVs) for waterways in the North Esk Catchment also identified signficant water quality issues in the catchment, as described below:

- Declining water quality through industrial, historic, domestic, stormwater, agricultural, urban septic and forestry activities (Rowland 1999).
- Sedimentation of the lower North Esk River and Tamar Estuary which has been linked to the clearance of land for agriculture and forestry operation in the North Esk catchment (DPIWE 2001c).
- Lack of reticulated sewage in developed residential areas and problems with septic tanks.
- Stormwater run-off.

6.2.4 Water related projects in North Esk Catchment

Through the NHT, several water related projects have been implemented in the North Esk Catchment. A brief description of the projects as listed on the NHT website follows:

- Ribbons of Blue North Esk River Restoration Project: Restoration of the North Esk River between the St Leonards picnic ground and the Tamar River. The project will improve water quality and develop a major natural asset in Launceston for community use.
- Regional Waterwatch Co-ordination: to support a community-based water quality monitoring network, to develop water quality awareness projects and to facilitate communication between stakeholders.

6.3 Cox's Rivulet

Cox's Rivulet is a small catchment located between the Brid and Great Forester River catchments along the north coast of Tasmania. Its headwaters extend to Scottsdale and its mouth discharges to the inlet near Bridport (fig 1). One of the headwater creeks in the catchment, Cox's Creek, receives treated wastewater from the Scottsdale Wastewater Treatment Plant. The small tributary also receives catchment run-off from dairy farming, forestry, cropping, grazing and urban activities (Hunter Water 2000). During the 1950s a vegetable processing plant was established at Scottsdale that significantly impacted the water quality in the catchment (Hunter Water 2000). Treatment facilities at the processing plant and the Council owned sewage treatment plant have reduced organic and suspended solid loads to the catchment.

Since 1993, Dorset Council has undertaken environmental monitoring of the catchment between the Scottsdale sewage treatment plant and Moore's Dam (an online dam on Cox's Rivulet below the confluence with Cox's Creek that supplies irrigation water for the area). Since its construction in the 1970s, the dam has gradually silted up. In about 1992, the dam wall was increased in height to increase the storage of the dam. Sediment removal has also been completed on several occasions to also increase the stored volume of irrigation water (Hunter Water 2000).

In 1999, the following observations were made during the annual inspection of Cox's Creek, Cox's Rivulet and Moore's Dam by Hunter Water (2000).

- Moore's Dam was eutrophic with extensive aquatic weed, algal and macrophyte growth in the water body. In the past, blue green algal blooms have occurred within the storage.
- A pine plantation adjacent to Moore's Dam was contributing sediment load to the catchment.
- It is likely that dairy shed wastes enter Cox's Creek during periods of high rainfall.
- At the junction of Cox's Rivulet and Cox's Creek, Cox's Rivulet had relatively high colour and low turbidity compared with Cox's Creek.
- Below the junction of the two waterways, Cox's Creek flowed through an area where stock have unimpeded access to the creek and there is little riparian vegetation.
- Carcasses of beef cattle were present in the creek.
- Streambank erosion was common in areas devoid of riparian vegetation.

The most recent environmental monitoring report concludes that:

- The wastewater treatment plant is not a significant source of suspended solids in the river system; that erosion of banks and run-off from other catchment activities provide the vast majority of sediment in the creek (forestry, urban run-off, bank erosion).
- The wastewater treatement plant is a major source of nitrogen and phosphorus in the creek, particularly during periods of low flow.
- There are a number of sources of bacteriological contamination to Cox's Creek: the wastewater treatment plant, urban stormwater, dairy and agricultural run-off, direct stock access and animal carcasses in the creek. During the 1989–99 monitoring period, the median level of *E. coli* discharged from the plant was 10 organisms/100 ml, which is well below the discharge limit of 200 *E. coli* per 100 ml.

Cox's Creek is routinely monitored by Dorset Waterwatch. Biological oxygen demand (BOD) and conductivity were two of the parameters measured by the group at locations downstream of Cox's Creek, as shown in table 20. Conductivity results are presented in figure 9. Waterwatch monitoring has shown that below the sewage treatment plant there is a large increase in conductivity and BOD. With distance downstream, these parameters decrease.

Table 20 Cox's Creek STP Impact Study* — site locations (in Bobbi et al 1999a)

Site	Code	Easting	Northing
Cox's Creek u/s waste outfall	COX 002	543500	5445000
Cox's Creek at waste outfall	COX 004	543500	5445100
Cox's Creek 500 m d/s waste outfall	COX 006	543500	5445200
Cox's Rivulet at Burnside Rd	COX 010	543400	5446600
Moore's Dam on Cox's Rivulet	COX 020	542700	5447400
Cox's Rvt 500 m d/s Moore's Dam	COX 021	542700	5447500
Cox's Rivulet at irrigation pump inlet	COX 030	541800	5450000
Cox's Rivulet at Boddington's Rd	COX 070	538100	5456500

* Courtesy of Dorset Waterwatch

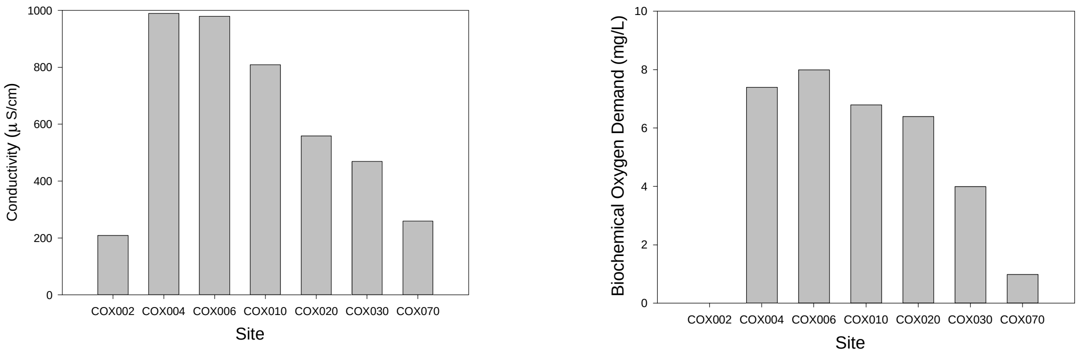

Figure 9 Conductivity (left) and BOD (right) variations in Cox's Creek as measured by Dorset Waterwatch (in Bobbi et al 1999a)

6.3.1 Catchment management activities related to Cox's Creek

Dorset Council has developed a Sustainable Management Strategy that aims to address catchment water quality issues. Within this context, the Council is investigating suitable methods of addressing the degraded water quality in Cox's Creek.

6.4 Pipers River Catchment

The Pipers River is approximately 50 km long, and flows from Mt Arthur to Bass Strait at Weymouth. Other towns in the catchment include Lilydale and Pipers River. The catchment is used primarily for agriculture and forestry.

Bobbi et al (1999d) completed a 'State of the River' report for the Pipers River catchment that includes an analysis of water quality, hydrology, river condition and aquatic ecology based on investigations conducted in 1998.

Water quality in Pipers River was characterised by moderate levels of dissolved salts, and a moderate to low buffering capacity (fig 10). Conductivity readings indicated that salt levels are low in the upper catchment, and increase with distance downstream. Some of the salts in the lower catchment are likely to be attributable to marine aerosols.

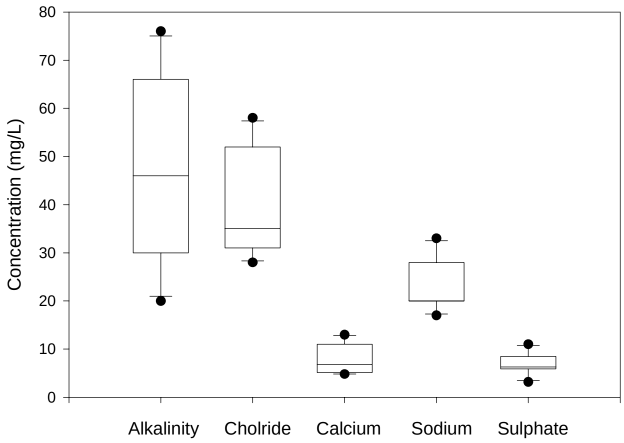

Figure 10 Boxplot showing statistics of bi-monthly monitoring of selected ionic parameters in lower Pipers River during 1998 (Bobbi et al 1999d)

Water quality was found to be moderately impacted across the catchment, and vary with flow and season. Generally, water quality in the headwaters was good, with nutrient and sediment input most pronounced in the middle and lower reaches. During the dry summer months, nutrient concentrations, turbidity and dissolved oxygen levels were low. The low dissolved oxygen suggests the ecosystem is under significant stress.

Nitrite concentrations showed strong seasonal changes related to river flows. Bobbi et al (1999d) suggest that this trend may reflect flushing of nitrite from the soil profile during autumn and winter. Nitrite is compared to flow in figure 11.

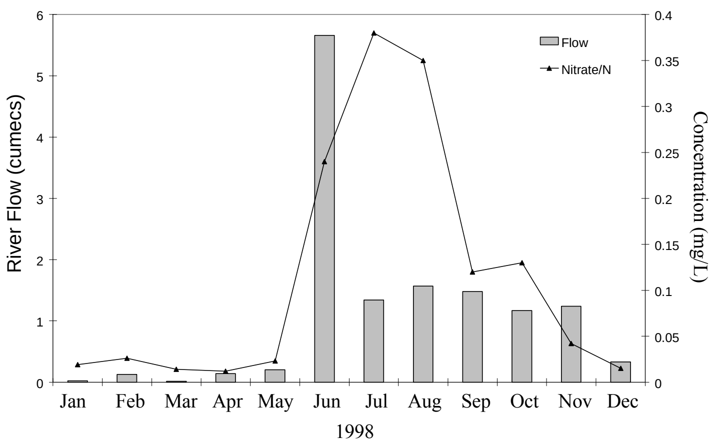

Figure 11 Nitrite and flow in Pipers River during 1998 (Bobbi et al 1999d)

During flood sampling, turbidity levels and total phosphorous concentrations increased (fig 12) indicative of riverbank erosion. This process is exacerbated in some sections of the river by unrestricted cattle access and soil disturbance due to land clearing and cultivation (Bobbi et al 1999d). The input of sediments and nutrients to the river encourages high productivity, leading to the large fluctuations observed in dissolved oxygen levels (Bobbi et al 1999d).

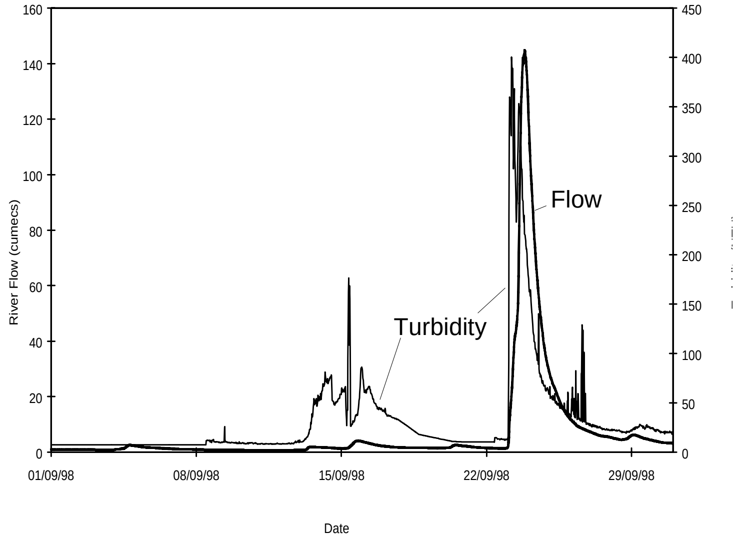

Figure 12 Flow and turbidity in Pipers River (Bobbi et al 1999d)

The nutrient load exiting the river was high compared to other Tasmanian rivers, and the investigators recommended that it be minimised in order to decrease siltation in the estuary, which is a recreational fishing and holiday area. Reducing sediment and nutrient inputs would also reduce the risk of algal blooms and benthic fouling (Bobbi et al 1999d).

An assessment of the aquatic ecology of Pipers River (Bobbi et al 1999d) found that similar to water quality, the headwaters generally had higher health ratings than the middle river, although all sites fluctuated significantly through the study year. The investigation concluded that riverine impacts are sporadic in nature and mostly attributable to physical habitat degradation rather than water quality. Habitat degradation was likely to be associated with agricultural land use in the middle and lower catchment exacerbated by periods of low flow and elevated nutrient inputs from run-off and stock access.

An assessment of river condition as part of the same study also documented degradation of the middle reaches of Pipers River, although the overall condition of the catchment was good.

6.4.1 Water management activities in the Pipers River

Pipers River is included in the Dorset Sustainable Management Strategy.

6.5 Brid River Catchment

The Brid River catchment is a narrow catchment situated between the Little Forester River and Cox's Rivulet. It covers an area of about 145 km^2. Its headwaters originate at Mt Scott, and the river flows for approximately 60 km before discharging to Anderson Bay on the north coast at Bridport. The upper and lower catchment has been cleared for agricultural purposes, while the middle catchment is heavily forested (Bobbi et al 1999a, fig 5). Tributary streams are heavily impacted by on-stream storages, and direct extraction from the Brid for irrigation is common (Bobbi et al 1999a).

Brid River water quality is characterised by near neutral pH values, and moderate to low levels of dissolved ions, with conductivity increasing in value and variation in a downstream direction (Bobbi et al 1999a). Shantys Creek, in the bottom of the catchment, was found to have high salinity, of the order of 5000 µS/cm. This creek drains an area identified by Gurung

(2001) as being composed of potentially acid sulphate soils. Whether this contributes to the high conductivity is unknown.

Both nutrient and turbidity values suggest that the upper catchment is moderately impacted and has a significant impact on water quality downstream. The area contains intensive agriculture and dairies, and run-off from these activities along with a highly degraded riparian zone are suggested as contributing to the water quality impacts. Downstream, where the Brid passes through substantial tracts of state forests, there appears to be some recovery of the Brid during low summer base flows, as shown in fig 13 (Bobbi et al 1999a). During winter, turbidity increases the entire length of the catchment.

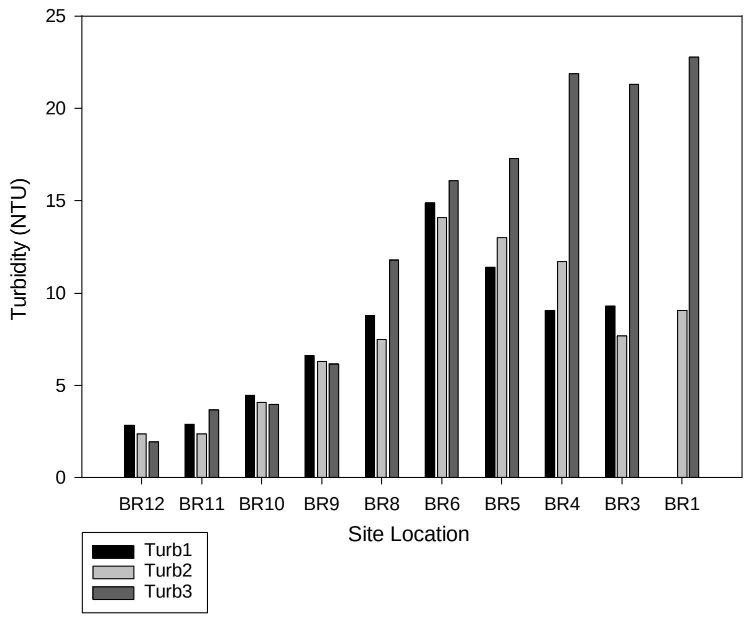

Figure 13 Longitudinal changes in turbidity in the Brid River during two summer surveys (Turb 1 & Turb 2) and one winter baseflow survey (Turb 3). BR 12 is located in the headwaters; BR 1 is located near the mouth of the Brid (from Bobbi et al 1999a).

'Snap-shot' bacteriological sampling was similar to the nutrient data, with the highest values associated with the upper catchment where beef and dairy activities are most intense.

An analysis of river condition in the Brid was consistent with the water quality findings, in that much of the upper and middle catchment was found to have a high degree of streamside modification. In spite of major degradation in the riparian zone, the overall condition of the Brid and its tributaries was generally good, although no reaches were found to be 'essentially natural' and all areas rated as 'near natural' were located in the lower catchment (Bobbi et al 1999a).

Riverine health as assessed using macroinvertebrates as bio-indicators found that the Brid was in good condition with the tributaries in fair condition. Where impacted, it is suggested that factors other than water quality are responsible for degradation of the aquatic community (Bobbi et al 1999a). In spite of the overall fair to good rating, concerns were expressed by the investigators about the vulnerable and threatened species in the catchment, namely the giant freshwater lobster and a hydrobiid snail. Habitat degradation (riparian weeds, un-vegetated riparian zones, stock access, water extraction), deterioration in water quality during flood events and competition with introduced species were suggested as having the greatest impact on these threatened species (Bobbi et al 1999a).

6.5.1 Catchment management activities

The following catchment management activities have been funded through the NHT in the Brid catchment:

- Re-use of effluent and water conservation at Bridport: This project aims to reduce the rate and improve the quality of wastewater discharge from Bridport township to Anderson Bay and reduce the demand on the town water supply by providing an additional sewerage settling pond, using wind-generated power to aerate and pump treated wastewater and using treated water to irrigate the Bridport Golf Course.
- Brid: Forester Catchment Resource inventory and community consultation: This project aims to conduct a resource inventory of the Brid–Forester catchments to collate information already collected by Landcare, Waterwatch, State Government and local focus groups, and to coordinate efforts of these groups to form a catchment management group and develop an intergrated catchment management plan for the catchments.

6.6 Great Forester Catchment

The Great Forester is situated between the Brid and Ringarooma catchments on the north coast of Tasmania. Its headwaters originate at Mt Maurice, and it enters the sea at the estuary near Bridport. Forestry, including pine plantations, and agriculture are the main catchment activities, with small scale tin mining occurring on the Aaron River near Mt Stronach. A pyrethrum extraction plant is located on Hogarth Rivulet in the upper catchment.

6.6.1 Environmental incidents in the Great Forester

In April 1994, a large spill from a holding dam at the pyrethrum extraction plant caused a major fish kill in Hogarth Rivulet and the main channel of the Great Forester River. Anecdotal and physical evidence provided by locals and fisheries officers suggested that there was little life left in a large portion of the main channel (Maxwell et al 1997).

Maxwell et al (1997) documented the rate of recovery of the waterway. The investigation found that recovery varied by species. Invertebrate diversity was initially low, but by the end of the first summer, the number of taxa and community structure was similar to control sites. Generally, fish also recovered over the same time frame, although blackfish (*Gadopsis marmoratus)* continued to have lower population densities after 2 years. The population of giant freshwater lobster (*Astacopsis gouldi)* known to have existed in the river prior to the spill is believed to have been severely impacted by the spill. The investigators noted that documenting the recovery of the ecosystem was hampered by a lack of pre-spill baseline information.

The fish kill occurred at a time when there was community concern about the use of pesticides and herbicides by forestry operations and the potential impact they could have on drinking water supplies. Following the pyrethrum spill, Dorset Waterwatch was formed which monitors the Great Forester and other rivers in the district.

A second more limited fish kill occurred in Hogarth Rivulet downstream of the pyrethrum extraction plant in January 1999. Fish and water samples were collected and analysed, however, the cause of the kill could not be ascertained (DPIWE 1999).

6.6.2 Present status of the Great Forester

A 'State of the River Report' for the Great Forester was completed by Bobbi et al (1999c) which included surveys of water quality, hydrology, river condition and aquatic ecology.

Overall, water quality in the Great Forester is dilute and slightly acidic (pH≈6.5). Nutrients (nitrogen and phosphorous) were found to be entering the river in the upper catchment in the vicinity of Tonganah, and are likely related to agricultural activities in the area. Bobbi et al (1999c) suggest that the nutrient input is probably from groundwater movement rather than direct run-off, although more investigations would be required to accurately identify the pathway. Dorset Waterwatch has also found elevated nutrient concentrations in the upper catchment.

The 'State of the Rivers' investigation included snapshot sampling during winter and summer for bacteriological indicators. Although the results cannot be directly compared with water quality guidelines due to the low number of replicates, the spot sampling highlighted that summer coliform levels exceeded winter levels, and that elevated levels were present in the upper catchment and in Tuckers Creek, with counts of over 600 *E. coli* per 100 mL recorded near Tonganah, (ANZECC 2000 guidelines for primary/secondary recreational contact indicate median values should not exceed 35/230 organisms/100 ml over the bathing season).

Turbidity levels were low in the Great Forester during the summer months, when several sites recorded levels of less than 5 NTU. Tributaries, especially Tuckers Creek, had higher readings. During the winter, turbidity increased markedly downstream of agricultural areas.

Aluminium concentrations in the Great Forester were elevated at all sites in the catchment, except the most upstream sites in summer. Levels of up to 400 µg/L aluminium were recorded, and unlike other rivers in the area, the high aluminium readings did not correlate with turbidity (Bobbi et al 1999c). It is possible that the aluminium is associated with dissolved organic substances in the water which complex the metal, thus reducing its toxicity (Bobbi et al 1999c).

An analysis of river conditions found that for most of the Great Forester and its tributaries the overall condition was rated as 'near natural or 'some modification'. The greatest impacts were associated with the stream side zones which have been degraded through weed infestation, unrestricted stock access and erosion (Bobbi et al 1999c).

Invertebrate health in the middle and upper reaches of the Great Forester and its tributaries was found to be good. The investigators suggest that habitat degradation rather than water quality is likely to be the greatest impact on the sites, although periodic episodes of impairment due to temporary decreases in water quality were also suggested to occur. Besides the major fish kill in 1994, the authors note that low levels of simazine (triazine herbicide) were detected in two water samples from the Great Forester upstream and downstream of Hogarth Rivulet during the Monitoring River Health Investigation. Although the levels were below those known to affect Tasmanian aquatic fauna, its presence in one-off grab samples leaves questions about what peak concentrations may have occurred, and where (Bobbi et al 1999c).

Threats to endangered species in the catchment are largely associated with habitat degradation. The maintenance of good riparian vegetation is identified as an important management consideration for the giant freshwater lobster, hydrobiid snails and dwarf galaxiid which are all present in the catchment.

6.6.3 Water quality issues identified by the community

Community consultation associated the Dorset Sustainable Development Strategy and with the setting of Protected Environmental Values (PEVs) for the Great Forester catchment identified the following water quality issues in the catchment:

- Agricultural practices resulting in run-off of phosphates and other nutrients to waterways.
- Forest practices leading to sediment run-off and chemical contamination.
- Bacteriological contamination due to stock access to rivers.

6.6.4 Water related projects in Great Forester Catchment

Through the NHT, several water related projects have been implemented in the Great Forester Catchment. A brief description of the projects as listed on the NHT website follows:

- Brid–Forester Catchment Resource inventory and community consultation: This project aims to conduct a resource inventory of the Brid-Forester catchments to collate information already collected by Landcare, Waterwatch, State Government and local focus groups, and to coordinate efforts of these groups to form a catchment management group and develop intergrated catchment management plans for the catchments.
- Forester River Catchment Strategy–Springfield Catchment Strategy: This project aims to reduce river bank erosion, reduce stock access to rivers, eradicate weeds and formulate a Rivercare Plan.

6.7 Ringarooma Catchment

The Ringarooma Catchment is located east of the Great Forester and Boobyalla Rivers, and west of the Great Musselroe. It is a relatively large catchment (≈900 km^2) in the north-east, with its headwaters beginning near Ben Nevis and Mt Maurice, and its mouth at the Boobyalla Estuary on Bass Strait. The lower floodplain is listed as a Ramsar site.

Several dams have been built in the catchment. Early in the 1900s, the Frome Dam was constructed on the Frome River to supply the power station associated with the Endurance Tin Mining Company. The dam also supplied water to Pioneer via a race (Bobbi et al 1999b). The Cascade River, which enters the Ringarooma in the middle catchment, has had two in-stream water storages built on it, originally constructed to supply water to mining activities in the region. The most upstream dam, Mount Paris, is no longer operational and the storage has been drained. The downstream Cascade Dam was also originally constructed and used to supply water to mining activities. After a period of disuse between the 1950s and 1970s, the storage was incorporated into the Winnaleah Irrigation Scheme and now services about 45 irrigators (Bobbi et al 1999b).

The abundant mining history in the region has left a legacy of acid drainage at some sites, which are discussed in Section 4.3 of this report. As discussed below, the 'State of the Rivers' investigation completed by Bobbi et al (1999b) in the Ringarooma found no catchment wide impact from these acid drainage inputs.

It is estimated that 40 million cubic metres of mining sediments were discharged into the Ringarooma River from four main mining centres (Arba, Briseis, Pioneer and Endurance) between 1875 and 1984 (Knighton 1987). The sediment wave has moved through the upper catchment, and is presently altering the lower catchment, where increases in river bed height of over 10 m have been recorded (Knighton 1991). In 1989 it was estimated that at least another 50 years would be required for the mining debris to move through the river (Knighton 1989).

Water quality in the Ringarooma is characterised by slightly acidic water, low conductivity and low turbidity during base flow conditions. Dissolved oxygen concentrations generally reflected a healthy river system.

Nutrient input was found to be greatest in tributary streams, especially Legerwood Rivulet. The inputs reflect catchment activities, with ammonia nitrogen highest in areas having intensive animal industries. Bacteriological indicators showed similar trends, with highest levels in the upper and middle section of the catchment.

Storm events increased turbidity in the Ringarooma by up to 100 times baseflow levels, and nutrient concentrations by 10-fold (Bobbi et al 1999b).

With the exception of aluminium, metal concentrations were found to be low and where higher, are likely to be associated with sediments, thus limiting the availability of the metals to the ecosystem (Bobbi et al 1999b). Aluminium concentrations of up to 280 µg/L were recorded in tributaries of the Ringarooma (Wyniford, Weld and Legerwood). It is likely that most of the aluminium is associated with suspended sediments in the Weld and Legerwood Rivulet, as there is a good correlation between metal levels and turbidity. This correlation is not evident in the Wyniford River and the investigators suggest that additional investigations are warranted (Bobbi et al 1999b).

In the 'State of the River' report, riverine health in the Ringarooma was found to be generally good as assessed by macroinvertebrate communities and river condition. Similar to other rivers in the region, the streamside zone was identified as the area most disturbed in the Ringarooma and its tributaries. Land use practices in the Dorset, New and Legerwood Rivers are responsible for much of the impact in the area.

Habitat degradation was found to be the greatest threat to the endangered species resident in the Ringarooma. The establishment and maintenance of riparian vegetation, reduction in sediment input from roads and the drainage of swamps and maintenance of good water quality were all cited as required in order to protect the giant freshwater lobster, hydrobiid snails and dwarf Galaxiids.

6.7.1 Water related NHT programs in the Ringarooma Catchment

The following project related to Ringarooma water quality is listed on the NHT web site:

- Ringarooma Catchment Restoration: This program will address river bank erosion issues, and promote the natural regeneration of riparian vegetation. Objectives include: excluding stock from unstable river banks, limit erosion, clear the river of willows that are blocking flows, re-establish riparian zone vegetation and improve water quality, particularly in flood situations.

6.8 George River Catchment

The George River originates in the Blue Tier and Rattler Range and flows eastward into Georges Bay at St Helens. The catchment is composed of state forest, forest reserves and agricultural lands used for cropping and dairy and beef farming. No 'State of the River' report has been completed for the George River. A Waterwatch group is active in the catchment.

Water quality in the headwaters of the catchment, which are largely managed as State Forest, is considered to be of a high quality (Rattray 2001a).

Historically tin mining occurred in the upper catchment at the Anchor Mine near the township of Lottah, with over 1 million cubic metres of mining waste discharged between 1875 and 1984 (Knighton 1991). Much of the sediment has been deposited behind the Groom River Dam in the Groom River flats where the river slope decreases considerably, and near the mouth of the George River (Bird 2000). Bird (2000) concluded that the impact on the Groom and George Rivers has been relatively minor, due to the small size of the tailings and steep slope of the river. By contrast, sluice mining in the Golden Fleece Rivulet only a few kilometres upstream of Georges Bay has caused considerable sedimentation in the creek and where it enters Georges Bay at Medeas Cove (Bird 2000).

The local Waterwatch group has measured low pH values and elevated levels of aluminium and iron in seeps around the Anchor Mine. Remediation works are continuing at the site.

Discharges from piggeries and dairies have contributed to the decline of water quality in the region. Since the early 1990s effluent has largely ceased being directly discharged to waterways under the 'Dairy Effluent Program', although some run-off is still affecting water quality.

In 1994, herbicides associated with forestry operations were detected in the George River. Following this incident, Forestry Tasmania altered operations and ceased the routine use of pre-emergent herbicides during plantation establishment (Rattray 2001a). Forestry operations in the Groom catchment have also been linked to increased sediment run-off during storm events as compared to neighbouring catchments (C Williams pers comm).

Various groups have completed water quality testing over the past few years. Generally, nutrient concentrations are found to be low, but bacteriological indicators are elevated at many sites in the catchment (Rattray 2001a).

During the development of a Rivercare Plan, the community identified the following water quality issues in the catchment:

- Weeds in riparian zones
- Too much alteration of river channels
- Inadequate protection of streams
- Uncontrolled stock access
- Concerns regarding potential mining activities at the Anchor Mines site
- Erosion of river banks
- Septic tanks too close to river
- Dairy effluent entering riverways.

6.8.1 Water related projects in the George River Catchment

- River Management Planning for the Upper and Lower George River: This project aims to secure sustainable management of the George River in perpetuity through strategic management, including regeneration of flora and fauna breeding grounds, wildlife corridors, etc.

- George River Catchment Rivercare Plan Implementation: With the assistance of Local Council, this project aims to implement the Upper George and Lower George Rivercare Plans.
- A Coastwise project to increase community awareness and involvement in Medeas Cove: This project aims to maintain and preserve the Medeas Cove estuary as a habitat for shorebirds.

6.9 Other rivers: Little Musselroe, Great Musselroe, Curries, Ansons

Little water quality information is available for these waterways. It is generally believed that they are affected by land use practices similar to neighbouring river catchments, but there is no data to substantiate this view.

Land clearing has been extensive (70%) in the Little Musselroe River where 99% of the land is held privately (Edgar et al 1999). The catchment is the most highly impacted of all rivers in the north-east based on the Naturalness Index used by Edgar et al (1999). Bushcare activities are aiming to restore the health of seasonal creeks, improve water retention in soil, stabilise eroding areas and increase biodiversity (NHT website).

The Great Musselroe has also undergone considerable clearing (30%), and there is extensive forestry activity in the upper catchment (Edgar et al 1999).

Forestry is a major land use in both the Curries River and Ansons River catchments. Run-off from forestry and agricultural lands and degradation of riparian zones are common observations made by the community regarding these rivers. Seepage from septic tanks into Ansons Bay at the mouth of the river has also been raised as a water quality issue.

Catchment management activities in these catchments are largely related to the management of the coastal zone and recreational activities, which are described in the following section.

7 Estuaries in north-east Tasmania

7.1 Classification and conservation status of estuaries

The estuaries situated along the north-east coastlines of Tasmania are extensively used for recreation, and have a relatively high population density compared with the river catchments, especially during the summer holiday season.

Coastal conservation areas include Double Sandy Point, Granite Point, Waterhouse, Little Boobyalla River, Cape Portland, Musselroe Bay, Parnella, Humbug Point, Ansons Bay, Bay of Fires, Medeas Cove, St Helens Point, Scamander, Little Beach and Seymour (DPIWE 2000).

Edgar et al (1999) investigated estuaries around Tasmania with the aim of identifying the estuaries and associated catchments with the highest conservation significance. The investigations found a high correlation between human population density, the silt/clay fraction of sediments and faunal composition. It is hypothesised that human activity in catchments and around estuaries results in a large input of fine sediment which are deposited in the estuary. This leads to the conversion of sand flats into mudflats, which alters faunal assemblages.

Threats identified by Edgar et al (1999) to estuaries include: increased sedimentation from land clearing and urban developments, stormwater run-off, increased nutrient inputs from agricultural and municipal discharges, marine farms, mining run-off, introduced species, and altered flow regimes.

The investigators classified estuaries into groups with similar physical, geomorphological and hydrological attributes, and then determined through field investigations whether the groups also reflected biological attributes. Once this was completed, the estuaries within each group were ranked in terms of current human impacts. A conservation significance rating was assigned based on the following criteria (Edgar et al 1999):

- Class A: Critical conservation significance — Estuary and associated catchment area show minimal effects of human activity.
- Class B: High conservation significance — Estuary and associated catchment area remain relatively pristine or contain an unusual range of species. Population density less than 0.5 km^{-2} and agricultural and cleared land covering less than 10% of the catchment.
- Class C: Moderate conservation significance — Estuary and associated catchment area are affected by human habitation and land clearance, but have not been badly degraded. Population densities less than 10 km^2 in estuarine catchment and drainage areas.
- Class D: Low conservation significance — Estuary and associated catchment have been moderately degraded by human impacts. Population densities between 10 and 100 km^{-2}.
- Class E: Low conservation significance — Estuary and associated catchment have been badly degraded by human impacts. Population densities greater than 100 km^{-2}.

Table 21 lists the estuaries in north-east Tasmania, what type they are, and their conservation significance as determined by Edgar et al (1999). With the exception of the Tamar and Boobyalla, all estuaries were found to have moderate or low conservation significance, having been slightly or moderately affected by human habitation and land clearing in the catchment.

The Tamar, to which the North and South Esk Rivers drain, was singled out as having a high conservation significance because it is the only estuary of its type in Tasmania, it possesses extremely high plant, invertebrate and fish diversity, and supports a large component of species not collected elsewhere in the state. The investigators also recognised that it badly degraded largely from the presence of a urban population in its drainage area, land clearing in the catchment, and the presence of introduced species (oysters and rice grass).

The conservation significance of the Boobyalla Estuary was rated a ‘B’ rather than an ‘A’ because it has a greater proportion of agricultural land in its catchment as compared to other high quality mesotidal river estuaries in the state, and because of the presence of acid drainage in the catchment.

Table 21 Description of north-east estuaries and conservation significance (as determined by Edgar et al 1999)

Estuary	Type	Conservation significance
Curries	Small open estuary	D
Pipers	Mesotidal river estuary	C
Little Forester	Mesotidal river estuary	C
Brid/Great Forester	Mesotidal river estuary	D
Tomahawk	Marine inlet or bay	C
Boobyalla/Ringarooma	Mesotidal river estuary	B
Little Musselroe	Marine inlet or bay	C
Great Musselroe	Small open estuary	C
Georges Bay	Marine inlet or bay	D
Henderson Lagoon	Marine inlet or bay	C
Scamander	Barred, low salinity	D
Ansons Bay	Small open estuary	C
Douglas	Small open estuary	C
South Esk/Tamar	Mesotidal drowned river valley	A

All other north-eastern estuaries are considered to have low conservation status due to higher catchment population densities.

7.2 NHT projects in coastal areas

A number of Coast and Clean Seas projects are active in the north-east of Tasmania. These include:

- Implementing the marine and coastal management strategy for the north-east and east coasts of Tasmania (Break O’Day Council).
- Falmouth foreshore rehabilitation and Coastcare project (Falmouth Community Centre Inc).
- Strategic action plan for sustainable coastal camping in the NE region (Bay of Fires Landcare Group).
- Environmentally controlled public use of wetlands and beach (Ansons Bay Coastcare Group).

- State-wide surf site rehabilitation project (Surfing Tasmania Inc).
- Rehabilitation of Beerbarrell Beach surfsite, St Helens Point.
- Defining, rehabilitating and maintenance of campsites in Waterhouse Conservation Area (Waterhouse Coastcare Group).
- Implementation of the north-east sustainable coastal camping strategy (East Coast Regional Development Organisation).

7.3 Emerging environmental issues in north-east estuaries

In addition to the threats and pressures identified by Edgar et al (1999), the following specific environmental issues have been identified as being relevant to estuaries in the north-east of Tasmania:

- Under Australia's Ocean Policy, a commitment has been made to eliminate the use of tributyl-tin (TBT) anti-fouling paint over the next 5 years. TBT paints are used to stop sea creatures from attaching themselves to ship hulls, which can damage the ship and effect performance. TBT paints slowly dissolve off hulls and accumulate around harbours and shipping lanes, where it is ingested by marine creatures and enters the food-chain (Environment Australia 2001b).

  DPIWE has collected and analysed sediment and native oyster samples from ports and slipways in the state, and has documented elevated levels of TBT in several locations, including Georges Bay in the north-east. There is concern about the elevated levels in the sediments and native oysters, and that TBT could impact the shellfish aquaculture industry in the bay.

- The introduced North Pacific sea star (*Asterias amurensis*) was discovered in May 2001 in Henderson Lagoon, south of Scamander. The sea star is considered a pest because it can have a major effect on the recruitment of native shellfish populations (CRIMP 2000a). The sea star has been present in the Derwent Estuary since the mid-1980s, and has in the last few years been documented at other sites along the east coast. It is suggested that the sea star is already having an impact on shellfish aquaculture in the southeast of Tasmania (CRIMP 2000a). Community volunteers, CRIMP and DPIWE have organised and conducted two eradication efforts that have collected 401 and 283 individuals, respectively. It is unknown if the sea star has successfully spawned in the lagoon.

  The European green crab (*Carcinus maenas)* is another introduced marine pest present along the north and east coasts of Tasmania. Its presence is believed to be a major cause of native crab and bivalve mortality, and it could impact on marine farming operations (CRIMP 2000b).

- Mineral Resources Tasmania has been investigating the effects of waste disposal on ground water quality in Tasmania. They have identified some sewage treatment systems that may be directly leaking to estuarine waters in northern Tasmania (A Ezzy pers comm). A detailed report is in the process of being finished.

8 State water management planning

The State Policy on Water Quality Management (1997), and the *Water Management Act 1999* require the identification of water values pertaining to both quantity and quality in all catchments in Tasmania, and the development of Water Management Plans. These processes are actively occurring, with the Protected Environmental Values (PEV), related to water quality, finalised or almost finalised for most of the rivers in north-east Tasmania.

Levels of protection provided for under the State Policy include:

- Protection of Aquatic Ecosystems
- Recreational Water Quality and Aesthetics
- Raw Water for Drinking Supply
- Agricultural Water Uses
- Industrial Water Supply.

Virtually all waterways in the north-east have been identified as warranting the highest level of protection (Protection of Aquatic Ecosystems) due to their high natural values. Following the finalisation of PEVs, Water Quality Objectives, or numerical guidelines designed to ensure the maintenance of the PEV will be developed.

The establishment of Water Management Plans, which will address water quantity and quality issues as well as establish flow requirements for ecosystem needs, is in progress. Environmental Water Requirements (EWR) have been established for the Brid, Little Forester, Great Forester, Lower Ringarooma, Ansons, George, Little Musselroe, Tomahawk, Pipers, Boobyalla, Great Musselroe, North Esk, St Patricks, Liffey, parts of the Meander, South Esk and Macquarie Rivers.

Water Management Plans are in the process of being developed for the Great Forester and Ringarooma catchments. Hydro Tasmania are currently working on Water Management Plans for the lower South Esk, Lake River and middle Macquarie River.

In addition to these water related plans, the State Government released an issues and options paper in July 2001 entitled *Tasmanian Natural Resource Management Strategy*. This Strategy is being developed to co-ordinate planning and management of natural resources on a regional basis and develop an overall framework for the management of natural resources across the State (DPIWE 2001). In the discussion paper, water quantity and quality are recognised as immensely important both socially and economically to the state. The aim of the discussion paper is to obtain input from the community as to the best way to move forward in managing natural resources.

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