LANDSCAPE LOGIC

LINKING LAND AND WATER MANAGEMENT TO RESOURCE CONDITION TARGETS

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Selecting catchments in Tasmania to study the targeting of nutrient and sediment management

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LANDSCAPE LOGIC is a research hub under the Commonwealth Environmental Research Facilities scheme, managed by the Department of Environment, Water Heritage and the Arts. It is a partnership between:

- **six regional organisations** – the North Central, North East & Goulburn–Broken Catchment Management Authorities in Victoria and the North, South and Cradle Coast Natural Resource Management organisations in Tasmania;
- **five research institutions** – University of Tasmania, Australian National University, RMIT University, Charles Sturt University and CSIRO; and
- **state land management agencies in Tasmania and Victoria** – the Tasmanian Department of Primary Industries & Water, Forestry Tasmania and the Victorian Department of Sustainability & Environment.

The purpose of Landscape Logic is to work in partnership with regional natural resource managers to develop decision-making approaches that improve the effectiveness of environmental management.

Landscape Logic aims to:

1. Develop better ways to organise existing knowledge and assumptions about links between land and water management and environmental outcomes.
2. Improve our understanding of the links between land management and environmental outcomes through historical studies of private and public investment into water quality and native vegetation condition.

Selecting catchments in Tasmania to study the targeting of nutrient and sediment management

By Dr Hamish Creswell, CSIRO and Prof Ted Lefroy, UTAS

Summary

This document describes the process undertaken to select the primary study catchment for Landscape Logic Project 5 – Catchment nutrient and sediment management.

Various other Tasmanian catchments are the subject of research in other Landscape Logic projects. Project 5 required a catchment with a significant concentration of nitrogen and/or phosphorous. Many Tasmanian catchments have nutrient levels below the detection limits of available high-frequency monitoring equipment. Effectively the only suitable catchments were those with intensive agriculture. Other important selection criteria included: the presence of significant nutrient and/or sediment related downstream impacts; suitability for estuarine research (Landscape Logic Project 4), free of major 'perturbations' (industrial developments, major engineering works, mining etc); frequent flow events (not low rainfall); being hydrologically discrete; the existence of good supporting data; and being of interest to local catchment management organisations.

The selection process had three steps:

1. initial consultation with the three Tasmanian Natural Resource Management (NRM) regions
2. a catchment screening process completed by a group with representatives from related Landscape Logic projects, and
3. a detailed assessment (desktop and field) of the preferred catchment to go through a shortlist if the first choice proved unsuitable.

The screening process started with all Tasmanian catchments and consisted of various exclusion passes. The process identified a short list of 13 catchments – Duck, George, Huon, Little Swanport, Don, Ansons, Pitt Water-Coal, Rubicon, Great Forester-Brid, Inglis, Montagu, Pipers, and Prosser - and then subsequently identified the Duck and the Inglis as the catchments with the highest suitability against the selection criteria. The Duck catchment was then assessed in more detail and was considered suitable for Project 5 and supported by other Landscape Logic project teams as a location suitable for a collaborative 'mountains to the sea' type research project.

Acronyms

CFEV	Conservation of Freshwater Ecosystems Values
CSE	CSIRO Sustainable Ecosystems
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEM	Digital Elevation Model
DPIW	Department of Primary Industries and Water (Tasmania)
TAFI	Tasmanian Aquaculture and Fisheries Institute
TIAR	Tasmanian Institute for Agricultural Research

Background

Within the Landscape Logic there is clear intent to connect varied areas of research being undertaken in its projects and sub-projects. This provides an opportunity to investigate often missing linkages between estuarine, freshwater, and terrestrial water quality research, seeking a mountains-to-the-sea type understanding of the mobilisation, transport, downstream attenuation and impacts of nutrients and sediment.

One of the key enablers of achieving strong research integration is having teams building a collective understanding of the same catchments. A prerequisite is the selection of catchments suitable for the different types of research and acceptable (e.g. travel distances) to the relevant research teams.

Ideally the catchment selection process is consensus-based involving all research teams. The catchment selection process documented here had the objective of selecting a single catchment as the main focus for Project 5. Various other catchments will be used by other Landscape Logic projects in Tasmania.

Implicit in the assessment of catchment suitability for Project 5, is suitability for other complementary and collaborative research activities to be undertaken in the same catchment by other CERF projects, particularly Projects 4 (Tasmanian Retrospctive Study) Project 1 (Spatial and Database) and Project 6 (Integration).

Methodology

This was a three-step process:

1. initial consultation with Tasmanian NRM regions and state agency staff
2. screening to select a short list of catchments suitable for closer consideration, and
3. a close examination of short-listed catchments, starting from the top of the shortlist and ending once a suitable catchment was identified.

Initial consultations

The initial screening followed a consultation process of meeting with each of the three Tasmanian NRM regions and some state agency staff. Each of the NRM regions were asked if they could nominate preferred catchments in their regions for Project 5's research.

NRM north nominated the South Esk catchment whilst the NRM South and Cradle Coast didn't nominate clear priorities but discussed the pros and cons of various catchments. Project 5 staff subsequently completed a brief field reconnaissance of the South Esk area.

Project 5 staff also visited DPIW and talked to their water monitoring team there (Kate Wilson et al) to explore whether there were particular catchments in which they would like this research to take place in order to maximise synergy with their work. They had no particular preferences at that time. Since then engagement has continued with a range of DPIW staff, including meeting in the field to discuss water-quality monitoring implementation.

Initial catchment screening

This catchment screening process followed a workshop format with representatives from Landscape Logic projects 1, 4, and 5 including: Ted Lefroy, Tony Norton, James Shaddick, Bill Cotching, Peter Davies, Steve Read, Christine Crawford, Jeff Ross, Phil Smethurst, Hamish Cresswell (Chair), Ulrike Bende-Michl, and Jennifer Hemer.

First we proposed, discussed and agreed criteria against which to assess each catchment for its suitability for this research (primarily for the needs of Project 5, but considering suitability for Project 4 and, to a lesser extent Projects 1, 2, and 6). Each project or sub-project team was asked to propose and explain selection criteria relevant to their research so all workshop participants could understanding of each others research needs. The full list of selection criteria is given in Table 1 below.

An exclusion process was seen as the most fair and objective approach; starting with all Tasmanian catchments and progressively excluding unsuitable or less-suitable ones, as opposed to trying to 'pick winners' which could lead to otherwise suitable catchments being not considered.

The first exclusion pass was based on the ''Exclusion factors'' listed in Table 1. This exclusion pass was based on local knowledge of these catchments around the workshop table. Catchments were only excluded if the decision was supported by the whole workshop group. If there was doubt, the catchment was 'retained' for further discussion.

Subsequent exclusion passes considered more selection criteria starting with the ones seen as critical (e.g. suitability for estuarine and freshwater ecology research, nutrient impacts evident and of significance leading to recognised environmental issues or assets under threat). More quantitative data was progressively drawn upon. Available to the meeting was:

- Catchment area
- Rainfall
- Land use distribution
- Observed PO_4-P, NO_3-N, total P, total N concentration ranges catchment-bycatchment
- Estuarine nutrient concentration observations
- Stream network maps
- Location of monitoring sites for streamflow and water quality.

Again, catchments were only excluded in this second (and subsequent) pass(es) if the decision was supported by the whole workshop group (or in a small number of instances if there was a clear majority).

Once a shortlist was established then a matrix of catchment name by selection criteria was established and each catchment was individually assessed against the listed criteria using the available data and collective knowledge of the group. Each catchment was discussed by the group and an assessment agreed (majority basis was accepted).

A final short list was then agreed. A check-back was then undertaken to ensure that everyone in the workshop group was satisfied with the process and results.

Detailed catchment examination

This stage of the catchment selection included the following steps:

- Collation and detailed examination of available data (climate, soils, geology, land-use, water quality etc.)
- Desktop assessment of the catchment
- A field assessment of the catchment
- Consultation with the relevant NRM staff
- Field meeting with DPIW hydrographers to discuss the catchment, current monitoring, and design of new high temporal resolution monitoring
- Collating information on people relevant to the catchment - key contacts, key networks etc.
- Further consultation with LL CERF participants.

Table 1. Catchment selection criteria

Rationale	• Land-use related nutrient impacts evident and of significance i.e. demonstrated downstream impact, recognised environmental issue and/or asset (e.g RAMSAR wetlands, estuaries with aquaculture industries, high conservation value estuaries). • Significant and measurable concentrations of nitrogen and/or phosphorus (inferring a substantial area of the catchment under intensive agriculture. • There needs to be existing DPIW monitoring sites; sites with established flow rating and preferably a long-term record of solutes as well as continuous monitoring of turbidity, DO, temperature, EC which might support our interpretation of high-frequency monitoring data. • Catchment must also meet the criteria of the TAFI estuarine research team and the freshwater ecologists in Project 4. e.g. catchment must have an estuary of interest and some relevant data. • We want our methodology to be transferable; best to avoid unusual or unrepresentative processes or biophysical features.
Exclusion factors	• Catchment should not contain major relevant 'perturbations' such as: industrial developments, hydro electric, major dams, reservoirs at the top of catchments mining, other excavations, channel diversions, highways, major urban development etc. • 'Uncomplicated' geology (i.e. excluding regions with karst) and soils, minimum number of land use by geology and soils combinations.
Environmental	• Catchment must be hydrologically discrete. • River geomorphology should not be extensively modified (e.g. by excavation) • Groundwater needs to be understood (infers good piezometric monitoring) and should not be dominating the hydrology (Landscape Logic does not include research on groundwater, hydrology or hydrogeology). • High enough rainfall to maximise likelihood of flow events, perennial stream flow. • Major land-use change or industrial development should not be likely in the short-medium term. • For retrospective experiments, there needs to be documented land-use and land-management change data to enable tracking the impacts of that change.
Operational	• Catchment not prone to extensive flooding (good hydrographs, minimise likelihood of monitoring equipment being washed away). • Good access to the catchment and monitoring sites – distance from major airports, road travel times, mobile phone reception, cooperative landholders etc.
Support	• Catchment of interest to local NRM region so that they will be active collaborators in our work. • Local community is interested in and likely to cooperate with this project. • Adequate supporting data must be available – climate, land use, land management, DEM, soil mapping, geology, hydrological and water quality time series, groundwater understanding etc. • Relevant previous research studies and current projects being undertaken by others in the same catchment.

Results

Initial catchment screening

The catchment selection process started with a list of 49 catchments as listed in Table 2.

Table 2. Starting list of Tasmanian catchments

Arthur	Huon	Pieman
Black-Detention	Inglis	Pipers
Blythe	Jordon	Pitt Water-Coal
Boobyalla-Tomahawk	King Island	Port Davey
Brumbys-Lake	King-Henty	Prosser
Cam	Leven	Ringarooma
Clyde	Little Forester	Rubicon
Derwent Estuary-Bruny	Little Swanport	Scamander-Douglas
Don	Lower Derwent	South Esk
Duck	Macquarie	Swan-Apsley
Emu	Meander	Tamar Estuary
Forth-Wilmot	Mersey	Tasman
Furneaux	Montagu	Upper Derwent
George	Musselroe–Ansons	Wanderer–Giblin
Gordon–Franklin	Nelson Bay	Welcome
Great Forester-Brid	North Esk	
Great Lake	Ouse	

The first exclusion pass was one of obvious unsuitability following the exclusion criteria in Table 1. The reasons for exclusion are listed in Table 3. It was not practical to record all the discussion on each catchment; the exclusion reason(s) given are a brief summary.

The second pass through the remaining 21 catchments emphasised data availability for estuarine research, nutrient concentration levels, availability of historical catchment flow gauging and water-quality monitoring, and other considerations that warranted more group discussion as compared with the first pass. Catchments excluded and a summary of the reasons are included in Table 4.

Table 3. Catchments excluded on the first pass with brief justification

Catchment	Reason for exclusion
Arthur	Modified due to mining activity
Brumbys	Lake–catchment doesn't have an estuary of interest
Clyde	Catchment doesn't have an estuary of interest
Derwent/ Bruny	Water quality dominated by multiple industrial point sources
Forth-Wilmot	Modified for hydro-electric power generation
Furneaux	Islands present unsuitable topography and difficult (expensive) access
Gordon-Franklin	Modified for hydro-electric power generation
Great Lake	Is a lake rather than a catchment and estuary
Jordon	Catchment doesn't have an estuary of interest
King Islands	Islands present unsuitable topography and difficult (expensive) access
King-Henty	Modified due to mining activity
Lower Derwent	Water quality dominated by multiple urban and industrial point sources
Macquarie	Catchment doesn't have an estuary of interest
Meander	Catchment doesn't have an estuary of interest
Mersey	Modified for hydro-electric power generation
Nelson Bay	Multiple rivers that would have to be monitored to attribute estuarine response. Little or no agriculture in the catchment.
North Esk	Catchment is not directly connected to an estuary
Ouse	Catchment doesn't have an estuary of interest
Pieman	Too remote; lacks a recognised water quality related problem or issue
Port Davey	Too remote; lacks a recognised water quality related problem or issue
Scamander–Douglas	Multiple rivers that would have to be monitored to attribute estuarine response
South Esk	Complicated by dams, inflows, and multiple rivers into the one estuary.
Swan-Apsley	Multiple rivers that would have to be monitored to attribute estuarine response
Tamar Estuary	Multiple catchments contribute, highly regulated
Tasman	Not a single estuary
Upper Derwent	Catchment doesn't have an estuary of interest
Wanderer-Giblin	Too remote; lacks a recognised water quality problem or issue
Welcome	Modified estuary; no estuarine data; distance adds to cost; drainage and channel works.

Table 4. Catchments excluded on the second pass with brief justification

Catchment	Reason for exclusion
Black-Detention	Observed stream nutrient concentrations too low for Project 5
Blythe	No estuarine data available
Boobyalla–Tomahawk	Multiple rivers; has a wetland rather than an estuary (Ringarooma); dams for irrigation; channel alteration on Ringarooma.
Cam	Hard to distinguish an estuary of interest, no estuarine data available
Emu	No estuarine data; likely dominated by point source pollution
Leven	Very limited estuarine and other data
Little Forester	No estuarine data
Musselroe	Lack of flow/water quality monitoring (note Ansons not excluded)
Ringarooma	Complicated by mining disturbance (sediments in the water) and related point source pollution

That left 13 catchments for more detailed analysis – Duck, George, Huon, Little Swanport, Don, Ansons, Pitt Water-Coal, Rubicon, Great Forester-Brid, Inglis, Montagu, Pipers, and Prosser.

The group then proceeded to assess each catchment against multiple selection criteria (Table 5). The workshop considered the data in the matrix and proceeded to discuss each catchment against multiple selection criteria (a change in approach from the earlier exclusion steps). This resulted in further exclusions based on reassessment of data availability and whether there exists a recognized and significant water quality related environmental issue to solve. Catchments excluded in this pass are listed in Table 6.

Table 6. Catchments excluded on the third pass with brief justification

Catchment	Reason for exclusion
Don	Limited estuarine data, lack of flow and water quality monitoring
Musselroe–Ansons	No gauging station and little water-quality monitoring in Musselroe. Ansons has mining impacts. Catchments lack a significant, recognised water-quality related problem
Pipers	No estuarine data; some alluvial gold mining; lacks a significant recognised water-quality related problem
Prosser	No estuarine data; lacks a significant recognised water quality related problem. Dam downstream of monitoring point but above estuary. Access around military area uncertain.
George	Concern that proposed Project 5 research can't address pesticide levels which was considered the primary community concern (See note on this below). Some goldmining activity.
Great Forester-Brid	Major channel alterations. Lacks a significant recognised water-quality related problem.
Huon	Lacks a significant recognised water-quality related problem.

That left a shortlist of 6 catchments for further consideration:

- Duck
- Inglis
- Little Swanport
- Montagu
- Pitt Water-Coal
- Rubicon.

Table 5. The catchment selection spreadsheet matrix

Catchment	Environmental issue	Water-quality monitoring	Stream nutrient concentration	Estuarine nutrient concentration	State of Rivers reports	Waterways reports
Duck	yes	yes	N&P high	N, P high	yes	yes
George	no	yes	no data	no data	no	yes
Huon	no	yes	N, P?	?	yes	yes
Little Swanport	yes	yes (2)	NO_3	low	yes	yes
Don	yes	no	high	high N and P	no	no
Ansons	no	no	no data/low	high P	no	yes
Pitt Water – Coal	yes	yes (2)	elevated TN	high N and P	yes	yes
Rubicon	yes	yes (1)	elevated TN	high P, low N	no	yes
Great Forester–Brid	no	yes	no data	?	yes	yes
Inglis	yes	yes	elevated TN	?	yes	yes
Montagu	yes	yes	N&P high	high N and P	yes	yes
Pipers	no	yes	elevated TN	?	yes	yes
Prosser	no	yes	elevated TN	?	no	yes

Each was discussed in detail, and supporting data evaluated. The supporting data available included: spatial coverages of land-use, stream networks, observed nutrient concentrations in rivers, and observed nutrient concentrations in estuaries. Catchments excluded in this fourth exclusion stage are as listed in Table 7.

Table 7. Catchments excluded on the fourth pass with brief justification

Catchment	Reason for exclusion
Montagu	Main channel extensively modified - unsuitable for complementary fresh-water ecology research. Fractured rock geology might mean not hydrologically discrete. Groundwater-surface water interactions might be significant but little groundwater monitoring data.
Little Swanport	Large area of native vegetation. Large tract of land under management by the military. Potential access issues on military land. Lacks intensive agriculture and high nutrient loads. Risk of few surface water runoff events due to low rainfall.
Rubicon	Multiple rivers entering the estuary. Multiple river monitoring needed to attribute estuarine response.

That then left a final short-list of three catchments for further evaluation subsequent to the workshop:

- Duck
- Inglis
- Pitt Water-Coal (with Pitt Water-Coal the least preferred, the other two hard to separate).

Possible issues that were identified for these three catchments for further investigation were:

- Duck – Complexity due to number of different geology's? Groundwater-surface water interactions could be significant? Some drainage works on flats. Level of local council interest and involvement uncertain.
- Inglis – Divided nature of the streamflow network.
- Pitt Water-Coal – Reservoir at the top of the catchment is problematic and probably justified earlier exclusion. Lower rainfall than the other two meaning less frequent run-off and streamflow events.

Post catchment screening workshop

Post-workshop discussions and re-evaluation resulted in the following:

- If the realization of the presence of a reservoir at the top of Pitt Water-Coal had been made earlier, Pitt Water-Coal would have been excluded.
- It became apparent (after the workshop) that the assertion of pesticide levels being the primary community concern in the George was not uniformly supported by people with local knowledge. Whilst the real situation is hard to ascertain, the George was still viewed as a possibility for further evaluation. Nevertheless this catchment was not regarded as meeting the Project 5 selection criteria as well as the Duck.
- Reinforcement that in many Tasmanian catchments the nutrient levels are so low that they are below the detection limits of the available monitoring technology. Technical constraints and aspects of suitability specific to the project severely limit the choice of suitable catchments (i.e. there is not much room to move in response to second order selection factors).

It was decided to progress with more comprehensive evaluation of the Duck and only revisit other short listed catchments (now regarded as the Inglis, then George) if the Duck proved unsuitable.

Assessment of the Duck catchment

Collation and detailed examination of available data (climate, soils, geology, land use, water quality etc.) indicated:

- Significant concentrations of N and P in the river; concentrations that far exceed the ANZECC trigger guidelines. These concentrations are well within the range of the instrumentation and representing some of the highest nutrient concentrations in Tasmania.
- Good complementary DPIW and Cradle Coast NRM monitoring.
- Favourable rainfall and event frequency.
- Forestry and dairying located such that comparative analysis is possible.
- Significant aquaculture industry in the Duck estuary potentially impacted by forestry and agriculture.
- Suitability for contrasting nutrient delivery processes off the slopes and from the flat areas in the catchment.
- While there is varying geology, the spatial correlation with land-use and soil types is high and so possible to accommodate in experimental design.
- The estuary is subject to greater tidal amplitude than other parts of Tasmania and might be

'well flushed' as a consequence. It is noted that the nutrient input is very high compared with most other Tasmanian catchments; it is a daily occurrence; the estuary is more 'enclosed' than the Montague, there is considerable scope for nutrient exchange with the estuarine sediments (nutrient build-up in the estuary). There have been previous occurrences of death of oysters within the bay. Also, there are various possible environmental consequences of high nutrient loads reaching the near shore marine (past off-shore algal blooms?).

Discussions took place with other Landscape Logic participant's in mid-2007 on the suitability of the Duck catchment for integrated research. Those discussions supported selection of this catchment.

Project 5 staff undertook a field visit to the Duck River (11–13 September 2007) to further assess the catchment. The results of this field trip were:

- Existing flow gauging and water-quality monitoring points were viewed
- Land use, rivers and streams, topographical variation, access, and potential monitoring points were all observed
- Sub-catchments of interest were identified
- Water quality samples were taken
- Suitability of the Duck catchment for Project 5 was discussed with NRM Cradle Coast and endorsed by them (Sue Botting).
- Monitoring was discussed with DPIW field hydrography staff (Chris Dalgleish)
- Information was collated on people relevant to the catchment – key contacts, key networks etc. and are being followed up.

The field visit reinforced our view that the Duck catchment is suitable for Project 5 research. The catchment selection criteria are met to a high degree.

Discussion and conclusions

Detailed evaluation of the Duck Catchment

As described above, further evaluation of the Duck reinforced our view that the catchment is suitable for Project 5 research and was supported by other LL CERF project teams as a location suitable for collaborative 'mountains to the sea' type R&D. The (objective) catchment selection criteria are met to a high degree.

No catchment is a perfect match: groundwater-surface water interactions will have to be assessed; water quality contributions from Smithton may need to be quantified as part of the overall design; access to north-west Tasmania is more expensive compared to some other parts; and likely levels of local council and community involvement are uncertain. However the pros far outweigh the cons which we believe can be worked through.

Subsequent steps

Subsequent to the steps described above, other processes have occurred relevant to the selection:

- An early working draft of this document was widely circulated and discussed
- Project 6 have decided to undertake work in the George River
- Project 4 have selected a number of catchments for their integrated research effort.

It is now more widely understood that Landscape Logic will be working in catchments in each of the Tasmanian NRM regions. Significant Project 5 effort in the Cradle Coast region helps to balance the presence of other Landscape Logic projects around Tasmania.

Recommendation

It is now recommended by the Project 5 team that the proposal to work in the Duck catchment be endorsed by the Landscape Logic management committee (confirming broad acceptance and reinforcing the intent that elements of research from other projects will be undertaken collaboratively in the Duck) and communicated to the Advisory Board.