Report 2008: Loan of AATAMS VR2W receivers

Movement patterns, habitat use and species interactions of key shark and finfish species in coastal systems

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Summary:

Acoustic methods are being used to measure movement patterns of a range of shark and finfish (Teleost) species in coastal habitats of south east Tasmania. This project is a collaboration between two studies within the same region, effectively permiting a multispecies approach by merging resources to increase possible output. The sharing of field and equipment expenses increases data collection capabilities by allowing a much larger VR2 array system to be established than would be possible for individual studies. Moreover, the combination of the two projects permits data to be collected for multiple species, producing information on both individual species and species interactions, effectively studying a component of the coastal ecosystem.

The first study, examining the movement of sevengill sharks (*Notorynchus cepedianus*) and their prey is a significant component of a larger project on the role of apex predators in coastal ecosystems and their interaction with fisheries. The movement component of this study will be accomplished by utilising a range of tracking and monitoring techniques to examine spatial and temporal population dynamics such as movement patterns, seasonality, and site fidelity. The combination of trophic and movement data will indicate habitat usage, predator prey interactions and food web dynamics. Significant prey items such as gummy (*Mustelus antarcticus)* and school sharks (*Galeorhinus galeus*) will also be tagged to allow the comparison of movement patterns of predator and prey and examine any interactions.

The second project is examining the movement of important inshore recreational species, including sand flathead (*Platycephalus bassensis*), black bream (*Acanthopagrus butcheri*) and, in conjunction with the Inland Fisheries Service (IFS), sea-run brown trout (*Salmo trutta*). These species are, by numbers, amongst the most commonly caught fish by recreational anglers in Tasmania. An understanding of their movement and behaviours in response to environmental factors and seasonality will provide useful information for the ongoing sustainable development of the recreational fishery that target these particular species. In addition information gained from these acoustic telemetry studies will provide interesting and useful information on the ecological role these species play in their given habitats.

Aims:

Objectives – In relation to IMOS (AATAMS)
To study the spatial dynamics and habitat use of seven gill sharks their prey and key recreational fishery species in coastal habitats

Aims-
1. Determine seasonal movement patterns
2. Determine habitat usage, including residence times in different habitat types
3. Determine movement patterns in relation to life history stages
4. Determine the use of coastal habitats (critical habitats)
5. Investigate species interactions and predator prey relationships

Receiver deployment:

Seventy two VR2 receivers were deployed between late November 2007 and January 2008. The majority of receivers including 12 AATAMS VR2W's were deployed by early December. All receivers were covered in duct tape to prevent fouling, making battery changes and maintenance easier. Divers attached receivers to a steel pole set in a concrete mooring approximately 1.5-2.0 m above the substrate using a split pin system (Figure 1), with the hydrophone pointing upwards.

Receivers were deployed in depths ranging from 4 m to 35 m throughout Norfolk and Fredrick Henry Bays and the Derwent Estuary (Figure 2). Receivers were either placed in curtain arrays, with individual receivers 800 m apart (based on range testing), or as single receivers in bottle necks where there was less than 800 m between two shorelines. The VRAP system was also deployed in Norfolk Bay between January 25th and April 21st. The buoys were set 400 m apart in an area with a consistent depth of approximately 14 m.

Figure 1. Picture of the mooring used for VR2 receivers.

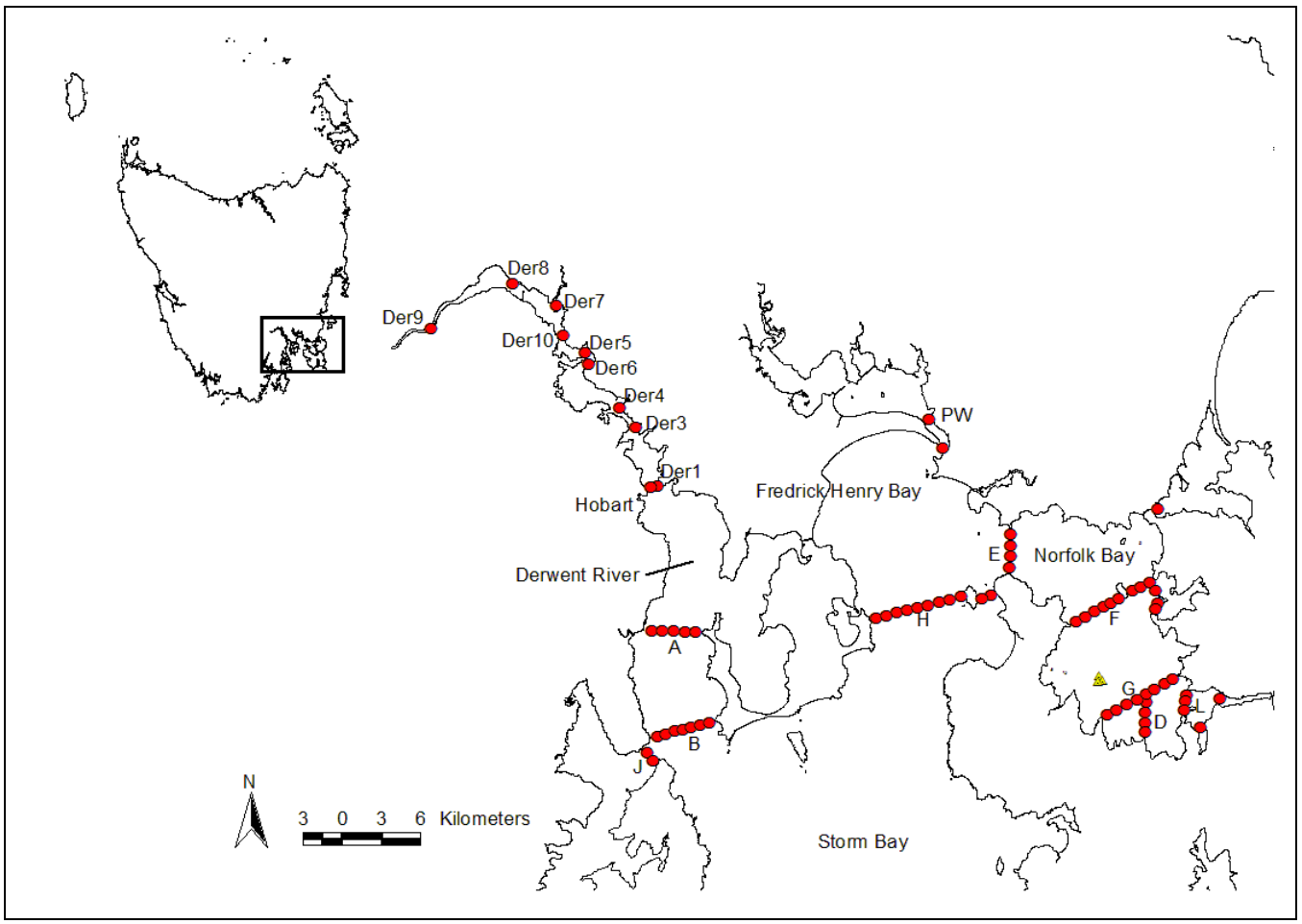

Figure 2. Receiver locations: Note that curtains are labelled by letters and individual receivers up the estuary are individually numbered. Curtain H represents the receivers on loan from AATAMS. Triangles represent VRAP location.

Animals tagged

Sharks were tagged from the 4th December to the 7th March. Thirty-three sevengills (24 females and 9 males) coving a range of sizes (153 to 277cm) were tagged. 10 gummy sharks (*Mustelus antarcticus)* (6 male, 4 female) and 8 School sharks (*Galeorhinus galeus*) (3 male, 5 female) were also tagged (see Appendix 1 for details). To examine the use of suspected nursery areas all school and gummy sharks tagged were juveniles. Twenty nine bream, 14 trout (to date) and 25 sand flathead have been tagged (see Appendix 2 for details). Tagging was conducted in two areas; Norfolk Bay where 20 sevengill, all gummy and school sharks and 12 flathead were tagged, and the Derwent Estuary where 13 sevengill sharks, 13 flathead, 14 trout and 20 Bream were tagged. Nine Bream were also tagged in Browns River, a small tributary flowing into the southern reaches of the Derwent Estuary. Additionally, as Norfolk Bay has a relatively consistent bottom depth in relation to each receiver (Figure 3), 9 sevengill and 5 gummy sharks captured in this area were implanted with tags with pressure sensors to record depth (see Appendix 1). All tags were surgically implanted in the body cavity of all animals (see below for details).

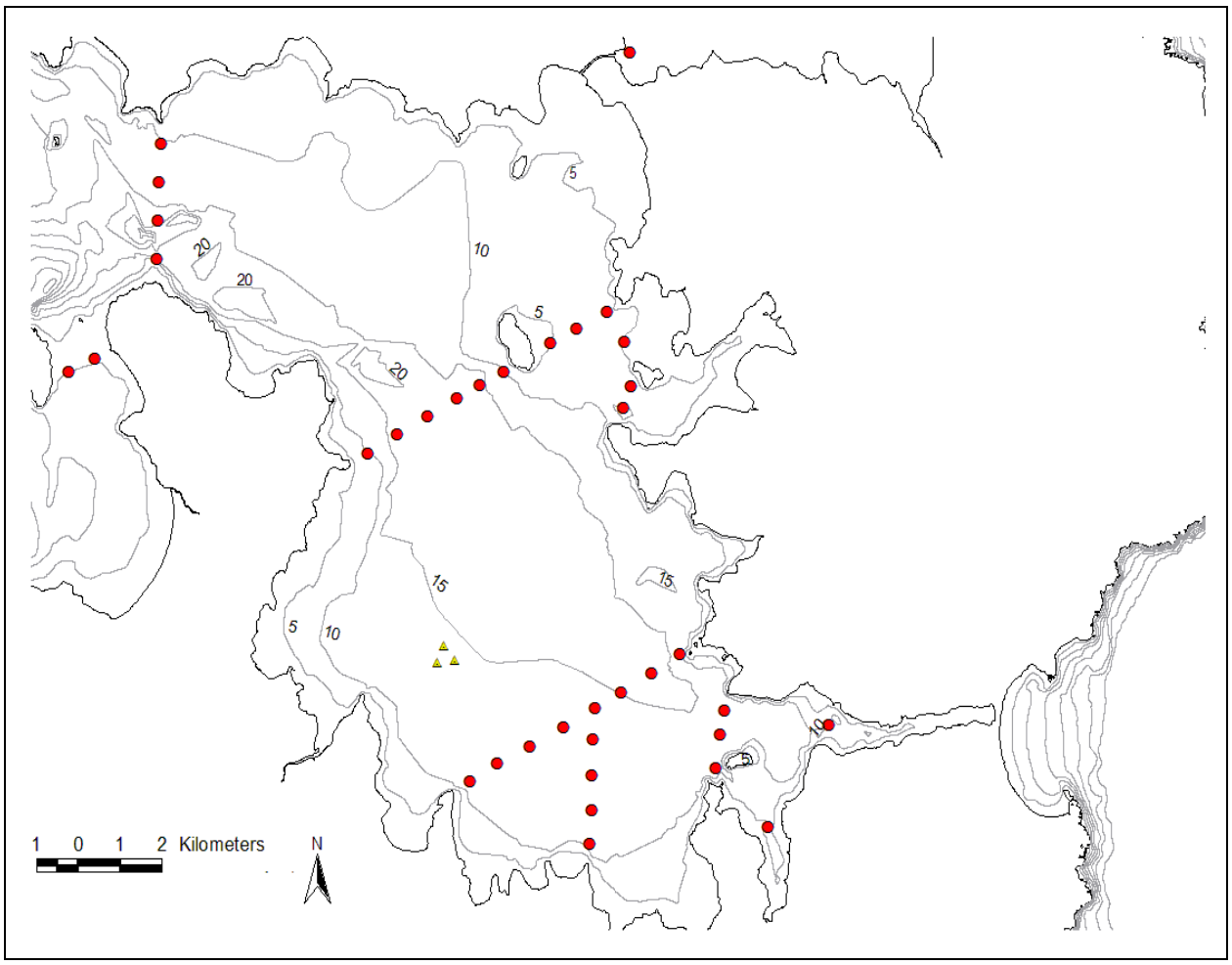

Figure 3. Norfolk bay depth profiles in relation to VR2 Array and VRAP (Triangles).

Surgical procedures

Sharks

Sharks caught on bottom set longlines were brought on board and the acoustic transmitters were internally implanted. Surgery involved disinfecting surgical equipment, the tag and the 'surgeons' hands when gloves were not used (gloves proved not to be practical) before making a 1 to 3cm incision (depending on the size of the shark and the tag utilized) in the abdominal region, inserting the tag into the body cavity and closing, the incision with sutures. The surgical procedure was normally accomplished in 3 minutes. Running water was pumped over the shark's gills throughout the procedure to keep them wet. The sharks were also tagged with conventional fishery (roto tags) tags in the dorsal fin for recapture identification and then released.

Figure 4. Surgery on a sevengill shark: a) shark being brought on board with cradle, b) shark placed on foam mat to begin surgery, c) incision to implant tag, d) suturing the incision after the tag has been implanted.

Fish

Fish were caught using baited hook and line, once a fish was brought on board its condition was assessed and, if healthy, it was prepared for surgical implantation of an acoustic tag into its gut cavity. The fish were anesthetised using an appropriate dose of clove oil based on the fish's weight, it was determined that fish recovered better if they went under anaesthesia quickly. All surgical equipment, the tag and the 'surgeons' hands were sterilised using betadine and all surfaces that the fish came in contact with were treated with Nycex (anti-fungal) and vidalife (reduces mucus loss). A 1cm incision was made along the ventral side of the fish, slightly anterior to the pectoral fins, into which the acoustic tag was inserted; the incision was then closed with sutures. The surgical procedure was normally completed in 1 to 2 minutes. Gently running water with a dilute amount of clove oil was pumped in the fish's mouth and over the fish's gills throughout the procedure. An external t-bar tag was also inserted below the dorsal fin to assist recreational anglers in identifying a fish that may have an internal tag.

Figure 5. Surgery on recreational fish species: a) closing the incision on a flathead after tag insertion, b) implanting a tag into a Bream, c) releasing a tagged Bream.

Receiver Downloads

Forty one receivers were downloaded during July 2008; all receivers in the Derwent Estuary have been downloaded. From Norfolk Bay the majority of receivers in curtains G, D and L have been downloaded, plus three receivers from the right hand side (east) of curtain F (Figure 2). Receivers from curtain D and PW (6 receivers) will be downloaded over the next month (Figure 2). Curtain H (Figure 2) containing the AATAMS receivers will be downloaded when the receivers are retrieved in October to be returned to AATAMS. The remaining receivers will be downloaded in April 2009. Initial results indicate that by the end of the study we will have a very substantial data set. To date a number of receivers have had over 10 000 detections with one receiver recording 160 000 hits.

Initial results (December 2007 to July 2009)

Fishing data from the previous year indicated that the majority of sevengill sharks exited Norfolk Bay and the upper Derwent Estuary by April (mid autumn). From these results we hypothesised that sevengill sharks left coastal areas over winter, returning gradually throughout spring. However early tracking results indicate that many of the tagged sevengill sharks utilise Norfolk Bay and the Derwent Estuary for longer periods than expected i.e. some sharks were still being detected at the time of downloading receivers in July. The majority of sharks detected in winter were in the lower region of the Estuary (ie between curtains A & B Figure 2.). Sevengill sharks appear to range throughout the estuary including moving up as far as receiver Der 05 over summer into autumn (Figure 2). However as the season moves on they restrict their movements to the mid to lower sections of the Estuary (curtains A & B Figure 2.). In Norfolk Bay sevengill, gummy and school sharks appear to have exited the bay by the end of April, with the exception of a solitary sevengill shark being detected in late June and a gummy detected in late May. All the sevengill sharks tagged in the Derwent Estuary were only detected within the Estuary. In contrast a number of the sevengill sharks tagged in Norfolk Bay moved into the Derwent Estuary later in autumn or into winter indicating that the lower Derwent Estuary may have some significance at this time of year. No gummy or school sharks have moved between sites thus far. These initial movement patterns indicate that curtain H (Figure 2) which is supplied by AATAMS will be critical in determining the timing of movements between the study sites and when sharks exited the coastal regions into the deeper waters of Storm Bay (Figure 2). This may verify a theory by Stevens and West (1997) that juvenile school and gummy sharks moved into deeper waters over winter.

Preliminary data retrieved at battery changes indicate that we are collecting a significant quantity of data on the movement of all three recreational species, particularly within the Derwent Estuary. Bream and trout have been recorded moving up and down the upper reaches of the Derwent estuary and the Bream tagged within Browns River are moving frequently within the tributary, we suspect they are responding to environmental fluxes.

V**RAP**

The VRAP system was deployed in Norfolk Bay for three months (January 25th to April 22nd) resulting in some interesting fine scale movement results. We managed to obtain movement rates for all three shark species including burst speeds for sevengill sharks. Depth data indicated that sevengill sharks appeared to spend the majority of daylight hours associated closely with the substrate. However during the night the sharks increased their activity, displaying yo-yo type behaviour were they appeared to be oscillating throughout the water column. In contrast gummy sharks remained close to the substrate almost all the time. Initial VR2 results show that similar patterns of water column use are being detected in Norfolk Bay where a consistent bottom depth is known.

Twelve sand flathead were also released into the VRAP array and a preliminary examination of the data reveals interesting information on diurnal movement and residency times.

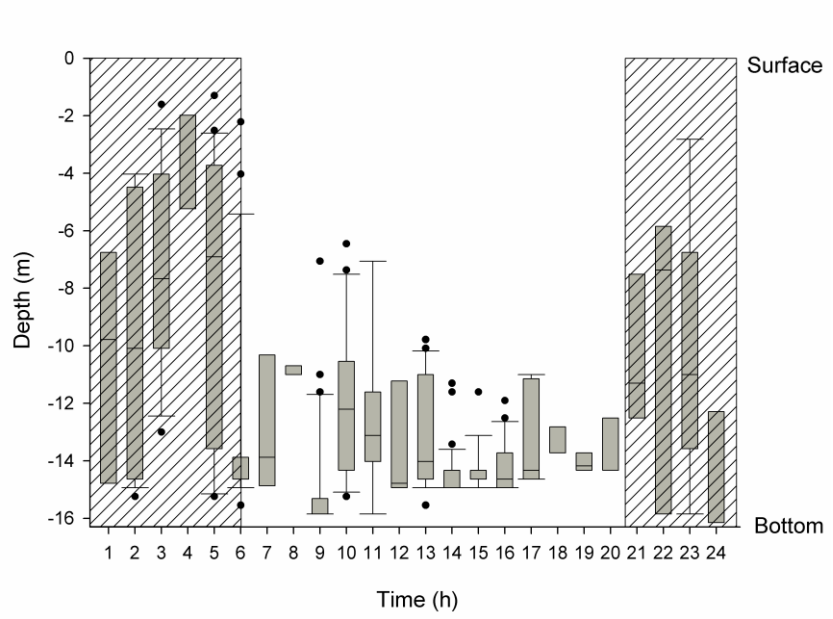

Figure 6. Box plots showing the median (line within the boxes), interquartile ranges (boxes), 10th and 90th percentiles (whiskers) and outliers (•) of depths recorded. Diagonal line pattern indicates nocturnal period. Total depth data for all sevengills was pooled by the hour for the entire study period.

Continued work

September to December 2008

This spring will see the continuation of shark tagging. The aim is to tag a minimum of 14 sevengill sharks and 18 prey species. Dietary analysis has indicated that dogsharks (*Squalus acanthias*) are an important prey species, particularly within the Derwent Estuary, so we are planning to increase tagging within the Derwent to include dogsharks. Elephant fish (*Callorhinchus milii*) have also been prominent in stomach analysis, and as such they will also be included in prey items tagged this season. During this period we are attempting to employ business card tags on sevengill sharks to investigate interactions between other tagged sharks.

Proposed species to be tagged are:
Sevengill sharks (*Notorynchus cepedianus)*
Gummy sharks (*Mustelus antarcticus*)
School sharks (*Galeorhinus galeus*)
Elephant Fish (*Callorhinchus milii)*
Dogshark (*Squalus acanthias*)

November 2008 to January 2009

Thus far we have managed to actively track two sevengill sharks; this summer season should see an increase in work on active tracking with at least three continuous tags to be used. Active tracks will complement the data already gained from the VRAP on fine scale movements over short time frames.

Reference

Stevens JD and West GJ (1997) Investigation of school and gummy shark nursery areas in south eastern Australia. FRDC report 93/061

Appendix 1. Tagging details of sharks

species	date	sex	T L(cm)	release location	tag type
gummy	30/1/08	m	93	Norfolk Bay	V13P-1H
gummy	30/1/08	f	90	Norfolk Bay	V13P-1H
gummy	30/1/08	m	108	Norfolk Bay	V13P-1H
gummy	30/1/08	m	87	Norfolk Bay	V13P-1H
gummy	30/1/08	m	127	Norfolk Bay	V13P-1H
7gill	9/2/08	f	255	Norfolk Bay	V16P-5H
7gill	9/2/08	f	262	Norfolk Bay	V16P-5H
7gill	1/2/08	f	188	Norfolk Bay	V16P-5H
7gill	9/2/08	f	249	Norfolk Bay	V16P-5H
7gill	30/1/08	f	200	Norfolk Bay	V16P-5H
7gill	9/2/08	f	284	Norfolk Bay	V16P-5H
7gill	17/2/08	m	215	Norfolk Bay	V16P-5H
7gill	21/2/08	m	204	Norfolk Bay	V16P-5H
7gill	22/2/08	m	219	Norfolk Bay	V16P-5H
7gill	12/4/07	f	234	Norfolk Bay	V16 - 6H
7gill	12/4/07	f	226	Norfolk Bay	V16 - 6H
7gill	2/1/08	f	157	Norfolk Bay	V16 - 6H
7gill	2/1/08	f	153	Norfolk Bay	V16 - 6H
7gill	2/1/08	f	208	Norfolk Bay	V16 - 6H
7gill	2/1/08	f	200	Norfolk Bay	V16 - 6H
7gill	2/1/08	f	196	Norfolk Bay	V16 - 6H
7gill	2/1/08	m	204	Norfolk Bay	V16 - 6H
7gill	2/1/08	f	198	Norfolk Bay	V16 - 6H
7gill	7/3/08	m	222	Norfolk Bay	V16 - 6H
7gill	7/3/08	m	224	Norfolk Bay	V16 - 6H
gummy	14/2/08	f	81	Norfolk Bay	V13- 1H
school	14/2/08	f	87	Norfolk Bay	V13- 1H
school	17/2/08	f	68	Norfolk Bay	V13- 1H
school	17/2/08	f	85	Norfolk Bay	V13- 1H
gummy	14/2/08	f	58	Norfolk Bay	V9 -2H
school	9/2/08	f	68	Norfolk Bay	V9 -2H
school	5/2/08	m	39	Norfolk Bay	V9 -2H
gummy	30/1/08	f	70	Norfolk Bay	V9 -2H
gummy	1/2/08	m	90	Norfolk Bay	V9 -2H
gummy	30/1/08	m	71	Norfolk Bay	V9 -2H
school	22/2/08	f	65	Norfolk Bay	V9 -2H
school	18/2/08	m	68	Norfolk Bay	V9 -2H
school	22/2/08	m	73	Norfolk Bay	V9 -2H
7gill	22/1/08	m	212	Derwent Estuary	V16 - 6H
7gill	22/1/08	f	224	Derwent Estuary	V16 - 6H
7gill	26/1/08	f	243	Derwent Estuary	V16 - 6H
7gill	26/1/08	f	247	Derwent Estuary	V16 - 6H

7gill	26/1/08	f	217	Derwent Estuary	V16 - 6H
7gill	26/1/08	f	257	Derwent Estuary	V16 - 6H
7gill	2/2/08	f	256	Derwent Estuary	V16 - 6H
7gill	2/2/08	f	262	Derwent Estuary	V16 - 6H
7gill	2/2/08	f	260	Derwent Estuary	V16 - 6H
7gill	2/2/08	f	277	Derwent Estuary	V16 - 6H
7gill	2/2/08	f	246	Derwent Estuary	V16 - 6H
7gill	26/2/08	m	232	Derwent Estuary	V16 - 6H
7gill	6/3/08	m	246	Derwent Estuary	V16 - 6H

Appendix 2. Tagging details of recreational fish species

species	date	TL (mm)	release location	tag type
Bream	01-Mar-08	380	Derwent - Cadburys	V9 - 2L
Bream	01-Mar-08	428	Derwent - Cadburys	V9 - 2L
Bream	01-Mar-08	360	Derwent - Cadburys	V9 - 2L
Bream	01-Mar-08	380	Derwent - Cadburys	V9 - 2L
Bream	01-Mar-08	345	Derwent - Cadburys	V9 - 2L
Bream	01-Mar-08	355	Derwent - Bridgewater	V9 - 2L
Bream	01-Mar-08	355	Derwent - Bridgewater	V9 - 2L
Bream	01-Mar-08	365	Derwent - Bridgewater	V9 - 2L
Bream	01-Mar-08	390	Derwent - Bridgewater	V9 - 2L
Bream	01-Mar-08	350	Derwent - Bridgewater	V9 - 2L
Bream	02-Mar-08	360	Derwent - Cadburys	V9 - 2L
Bream	02-Mar-08	365	Derwent - Cadburys	V9 - 2L
Bream	02-Mar-08	375	Derwent - Cadburys	V9 - 2L
Bream	02-Mar-08	385	Derwent - Cadburys	V9 - 2L
Bream	02-Mar-08	360	Derwent - Cadburys	V9 - 2L
Bream	02-Mar-08	360	Derwent - EZ	V9 - 2L
Bream	02-Mar-08	365	Derwent - EZ	V9 - 2L
Bream	02-Mar-08	295	Derwent - EZ	V9 - 2L
Bream	02-Mar-08	390	Derwent - EZ	V9 - 2L
Bream	02-Mar-08	310	Derwent - EZ	V9 - 2L
Flathead	21-Feb-08	340	Norfolk Bay - VRAP	V9 - 2H
Flathead	21-Feb-08	315	Norfolk Bay - VRAP	V9 - 2H
Flathead	21-Feb-08	320	Norfolk Bay - VRAP	V9 - 2H
Flathead	21-Feb-08	295	Norfolk Bay - VRAP	V9 - 2H
Flathead	21-Feb-08	300	Norfolk Bay - VRAP	V9 - 2H
Flathead	21-Feb-08	335	Norfolk Bay - VRAP	V9 - 2H
Flathead	21-Feb-08	360	Norfolk Bay - VRAP	V9 - 2H
Flathead	21-Feb-08	360	Norfolk Bay - VRAP	V9 - 2H
Flathead	21-Feb-08	275	Norfolk Bay - VRAP	V9 - 2H
Flathead	21-Feb-08	355	Norfolk Bay - VRAP	V9 - 2H
Flathead	21-Feb-08	270	Norfolk Bay - VRAP	V9 - 2H
Flathead	21-Feb-08	355	Norfolk Bay - VRAP	V9 - 2H
Flathead	27-Feb-08	325	Derwent - EZ	V9 - 2L
Flathead	27-Feb-08	295	Derwent - EZ	V9 - 2L

Flathead	27-Feb-08	290	Derwent - EZ	V9 - 2L
Flathead	27-Feb-08	270	Derwent - EZ	V9 - 2L
Flathead	27-Feb-08	305	Derwent - EZ	V9 - 2L
Flathead	27-Feb-08	285	Derwent - Cadburys	V9 - 2L
Flathead	27-Feb-08	335	Derwent - Cadburys	V9 - 2L
Flathead	27-Feb-08	355	Derwent - Cadburys	V9 - 2L
Flathead	02-Mar-08	300	Derwent - Cadburys	V9 - 2L
Flathead	02-Mar-08	280	Derwent - Cadburys	V9 - 2L
Flathead	12-Mar-08	410	Norfolk Bay - Cascade Bay	V9 - 2L
Flathead	12-Mar-08	400	Norfolk Bay - Cascade Bay	V9 - 2L
Flathead	12-Mar-08	370	Norfolk Bay - Cascade Bay	V9 - 2L
Flathead	12-Mar-08	360	Norfolk Bay - Cascade Bay	V9 - 2L
Flathead	12-Mar-08	310	Norfolk Bay - Cascade Bay	V9 - 2L
Flathead	12-Mar-08	275	Norfolk Bay - Cascade Bay	V9 - 2L
Flathead	12-Mar-08	315	Norfolk Bay - Cascade Bay	V9 - 2L
Flathead	12-Mar-08	290	Norfolk Bay - Cascade Bay	V9 - 2L
Flathead	12-Mar-08	330	Norfolk Bay - Cascade Bay	V9 - 2L
Bream	31-Mar-08	190	Browns River	V7 – 4L
Bream	31-Mar-08	240	Browns River	V7 – 4L
Bream	31-Mar-08	335	Browns River	V7 – 4L
Bream	31-Mar-08	365	Browns River	V7 – 4L
Bream	31-Mar-08	225	Browns River	V7 – 4L
Bream	31-Mar-08	260	Browns River	V7 – 4L
Bream	31-Mar-08	265	Browns River	V7 – 4L
Bream	31-Mar-08	260	Browns River	V7 – 4L
Bream	31-Mar-08	190	Browns River	V7 – 4L
Trout	17-Jun-08	420	Derwent - Cadburys	V9 - 2L
Trout	17-Jun-08	300	Derwent - Cadburys	V9 - 2L
Trout	17-Jun-08	255	Derwent - Cadburys	V9 - 2L
Trout	17-Jun-08	320	Derwent - Cadburys	V9 - 2L
Trout	17-Jun-08	430	Derwent - Cadburys	V9 - 2L
Trout	17-Jun-08	285	Derwent - Austins Ferry	V9 - 2L
Trout	24-Jul-08	285	Derwent - Cadburys	V9 - 2L
Trout	24-Jul-08	545	Derwent - Cadburys	V9 - 2L
Trout	24-Jul-08	330	Derwent - Austins Ferry	V9 - 2L
Trout	24-Jul-08	520	Derwent - Austins Ferry	V9 - 2L
Trout	24-Jul-08	430	Derwent - Austins Ferry	V9 - 2L
Trout	24-Jul-08	540	Derwent - Cadburys	V9 - 2L
Trout	24-Jul-08	335	Derwent - Cadburys	V9 - 2L
Trout	24-Jul-08	435	Derwent - Cadburys	V9 - 2L