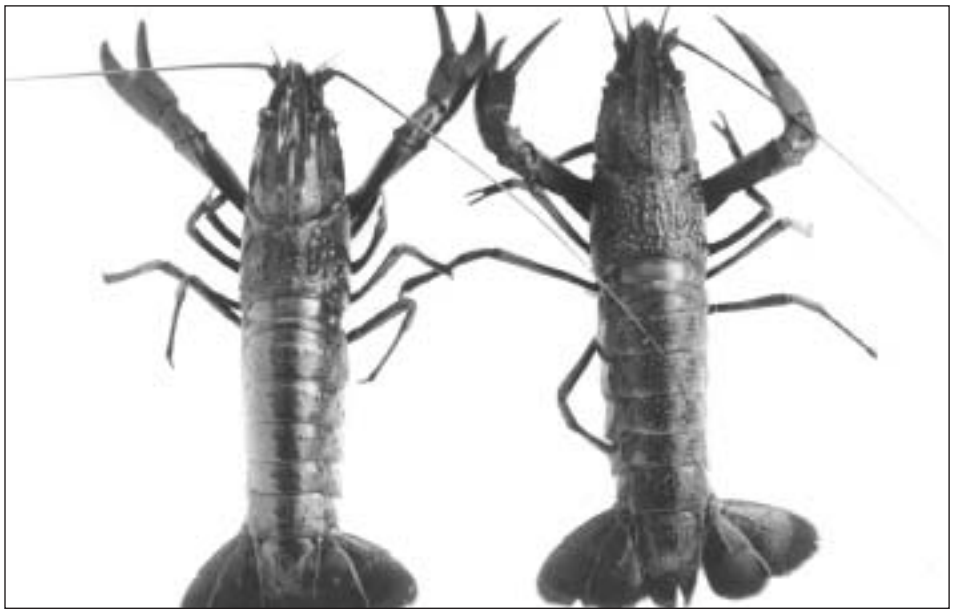
Scientific Workshop on the Margaret River Marron

West Australian Marine Research Laboratories
May 10, 2002

Edited by Brett Molony



Department of **Fisheries**
Government of **Western Australia**

Fish for the future

Cover photo by Dr Craig Lawrence: “Smooth” marron (left), “Hairy” Margaret River marron (right).

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Published by Department of Fisheries, Western Australia.
Fisheries Occasional Publications No. 2, July 2002.
ISSN: 1447 - 2058

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List of Delegates at the Scientific Workshop on the Margaret River Marron May 10, 2002

Delegate	Affiliation
Ms Cathy Anderson	Community Awareness Branch, Department of Fisheries, Western Australia
Dr Chris Austin	School of Ecology and Environment, Deakin University
Mr Chris Bird	Research Division, Department of Fisheries, Western Australia
Mr John Bunn	MSc Student, Centre for Ecosystem Management, Edith Cowan University
Mr Colin Chalmers	Program Leader, Fish and Fish Habitat Protection, Department of Fisheries, Western Australia
Dr Barbara Cook	Centre for Excellence in Natural Resource Management, University of Western Australia
Dr Pierre Horwitz	Consortium for Health and Ecology, Edith Cowan University
Dr Brenton Knott	School of Animal Biology, University of Western Australia
Dr Annette Koenders	Centre for Ecosystem Management, Edith Cowan University
Dr Craig Lawrence	Research Division, Department of Fisheries, Western Australia
Ms. Gaye Looby	Management Officer, Recreational Fisheries Program, Department of Fisheries, Western Australia
Dr Greg Maguire	Research Division, Department of Fisheries, Western Australia
Ms. Harriet Mills	PhD Student, School of Animal Biology, University of Western Australia
Dr Brett Molony	Research Division, Department of Fisheries, Western Australia
Dr Noel Morrissy	Emeritus Researcher, Department of Fisheries, Western Australia
Ms Jodie Oates	Fish and Fish Habitat Protection, Department of Fisheries, Western Australia
Mr Steve Ryan	Research Division, Department of Fisheries, Western Australia
Dr Phil Vercoe	School of Animal Biology, University of Western Australia

Apologies

Delegate	Affiliation
Dr Mike Johnson	School of Animal Biology, University of Western Australia
Dr Glen Whisson	Aquatic Sciences Unit, Curtin University
Mr Greg Paust	Pearling and Aquaculture Program Manager, Department of Fisheries, Western Australia

AGENDA

Chair for the Day – Colin Chalmers

09:00 – 09:15 **Welcome – *Colin Chalmers***

09:15 – 10:00 **Introductions**
All participants introduce themselves with a very short summary of their interest and involvement in MRM, including;
• The participant's name, position and affiliation
• Area of expertise/ current research area and how this relates to MRM

10:00 – 10:30 **Introduction to, and comparison of, genetic techniques available to researchers.** ***Presenter – Phil Vercoe***

10:30 – 10:45 **MORNING TEA**

10:45 – 11:15 **What do we know about the genetic diversity of marron and other *Cherax*?** ***Presenter – Chris Austin***

11:15 – 11:45 **Morphology and Hybrids** ***Presenter – Craig Lawrence***

11:45 – 12:15 **The status of the MRM** ***Presenter – Brett Molony***

12:15 – 13:00 **LUNCH BREAK**

13:00 – 14:45 **Can we influence the genetic population structure of marron in Margaret River?** ***Presenters – Various***
Chair for session – Barbara Cook
• Closures of the River to Fishing? ***Presenter – Gaye Looby***
• Upper versus Lower River management. Should we/can we modify Fisher/ Farmer behaviour ***Presenter – Greg Maguire***
• Breeding programs and restocking for endangered species ***Presenter – Harriet Mills.***
• Active removal of non-endemic strain ***Presenter – Brenton Knott***
• Community awareness programmes - community ownership ***Presenter – Pierre Horwitz***

14:45 – 15:00 **AFTERNOON TEA**

15:00 – 15:30 **Review of today's sessions** ***Presenter – Barbara Cook***

15:30 – 16:00 **What we don't know about MRM - Discussion**
Chair – Annete Koenders

16:00 – 16:30 **Where to from here? -Discussion**
Chair – Colin Chalmers

16:30 – **END OF DAY AND INFORMAL DISCUSSION**

The Scientific Workshop on the Margaret River Marron

Mr Colin Chalmers
Program Leader, Fish and Fish Habitat Protection,
Department of Fisheries, Western Australia

Purpose of the Workshop

- To gather together and review the scientific evidence around genetic and sustainability issues necessary for the management of Margaret River Marron (MRM)

Objectives of the Workshop

- Review current knowledge of genetic issues of MRM
- Examine historical changes in the marron fishery within MR
- Propose way(s) forward and priorities for the MRM

Scope of the Workshop

- Focussed primarily on the MRM and MR watershed
- Although the outcomes may have wider application, the focus will remain on MRM

The outcomes of the day will be to provide scientific advice, options and priorities to the relevant Programs within the Department of Fisheries to promote the sustainability of marron within MR.

Molecular Techniques in Ecology

Dr. Phil E. Vercoe
School of Animal Biology, Faculty of Natural and Agricultural Sciences,
University of Western Australia, 35 Stirling Highway, Crawley, WA, 6009.

There are a number of molecular genetics techniques in ecology. These techniques involve using molecular markers to answer questions about mate selection, parentage, kinship, reproductive strategy, immigration and phylogenetics. In order to answer these questions the molecular markers must reflect variation at the genetic level and be able to detect enough variation to allow valid comparisons to be made among individuals and populations. The two molecules that can be used to reflect genetic variation are proteins and DNA. It is perhaps not surprising then that it is these two molecules that form the basis of the techniques used in molecular analysis of diversity in ecological studies. What can be difficult is deciding on the best technique to use. This decision is influenced by a number of practical factors like cost, time and whether there is a laboratory set up to perform a particular technique. However, perhaps the most important factor that influences the decision is the specific question that is being asked and the level of genetic variation that is required to answer that question.

The most common molecular techniques used are allozyme analyses, random amplified polymorphic DNA (RAPD), restriction fragment length polymorphism (RFLP), microsatellites and sequencing (nuclear and mitochondrial genes and genomes). These techniques can be grouped according to whether they use proteins or DNA as the source of the molecular markers for analysis. Allozyme analysis is based on the use of proteins whereas the others are based on the use of DNA. All of the techniques involve electrophoresis, a technique that enables DNA and protein molecules to be separated according to size. Allozyme analysis was the original technique used by population biologists but more recently analysis using DNA-based techniques has become more popular. The advantage of using the DNA-based techniques is that they are a direct measure of genetic variation whereas allozyme analyses measure genetic diversity indirectly and the amount of variation that can be measured is limited due to the degeneracy of the genetic code. The potential of, and excitement surrounding, the DNA-based techniques are highlighted by the numerous genome projects currently underway around the world and the possibility to perform the ultimate genetic analysis; a comparison of complete genome sequences between individuals and individuals from different species. However the main disadvantage of the DNA-based techniques is cost; the idea of comparing entire genome sequences between numerous individuals, within and between populations, on the scale of an ecological study is unrealistic economically at the present time. The choice of which DNA-based technique to use depends on the scale of genetic detail required. For example, if it is necessary to identify specific individuals, then it is essential to be able to analyse fine scale genetic variation. In this case, DNA sequencing provides the finest scale analysis but microsatellite analysis can also be used (DNA fingerprinting). Where the level of genetic detail required is lower, then RAPDs, RFLPs, microsatellites or allozyme analysis can be used and the ultimate decision on which technique to use might be based on the more practical factors mentioned previously, like cost and convenience.

In summary, there are a number of molecular techniques that can be used in ecological studies. The choice of which molecular technique(s) to use depends on the question(s) being asked and the scale of genetic detail that is required to answer the question(s). In general, the finer the scale of genetic detail required, the fewer the choices of technique and the more expensive it becomes.

Molecular Techniques in Ecology

Dr Phil Vercoe
University Of Western Australia

Main message

The technique chosen for genetic analysis depends on the question being asked and is influenced by costs and the facilities available.

Molecular Techniques in Ecology

- What are we trying to do?
- What types of questions can be asked?
- What are the techniques?
- Comparison of techniques

What are we trying to do?

- Trying to find differences so we can compare individuals/populations
- Identify these differences at the level of the genes or the gene products

What types of questions?

- How diverse, how similar?
- Who are the parents?
- Who is the individual?
- What's the phylogeny?
- What's the population structure?
- What's the allele frequency?
- What's the heterozygosity?
- What's the effective number?

Overall objective?

- How does survivorship, fertility and gene flow contribute to Δ's in allele frequency?
  - Parentage exclusion/assignment
  - Individual identification
  - Population structure
    - Variation within and between individuals, populations, species
- Management

What are the techniques?

- Electrophoresis - size separation
- Protein
  - Allozyme
- DNA
  - RAPD, AFLP, RFLP, Microsatellite, Sequencing
  - Hybridisation, PCR, sequence

Techniques

- Allozymes - different allelic forms of an enzyme from a single locus
- Original electrophoretic methodology
  - Local mating patterns, fine-scale structure within populations, variation across species

Allozymes

- Advantages
  - Cost, codominant, sample processing
  - Fine and broad scale genetic variation
- Disadvantages
  - Lack of variation
  - Selection can act directly on allozymes
  - No good for genealogical studies

DNA technologies

- Some advantages over protein
- Access to fine scale genetic variation
  - identification of individuals
  - more variability
- Physical
  - found in all cells
  - living or dead
  - ng quantities required (PCR)

DNA techniques

- Hybridisation - RFLP
- PCR based - RAPD's, AFLP's, microsatellites, (RFLP)
- Sequencing - genes, mtDNA, regions, genomes

Restriction fragment length polymorphism (RFLP)

- Make use of restriction enzymes
- Cut DNA at very specific sites
- Get specific fragment lengths
- Length variation if mutation has created or destroyed RE sites

Restriction fragment length polymorphism (RFLP)

- Main limitation -can't be analyzed directly
- RFLP of nuclear DNA requires hybridisation
- Identified using a genetic probe
  - Specific gene
  - Repeated sequences
  - Average DNA diversity - random probes

Restriction fragment length polymorphism (RFLP)

- Main use in population studies
  - Survey allelic diversity in mtDNA
- Can answer genetic questions within and among populations

Polymerase Chain Reaction

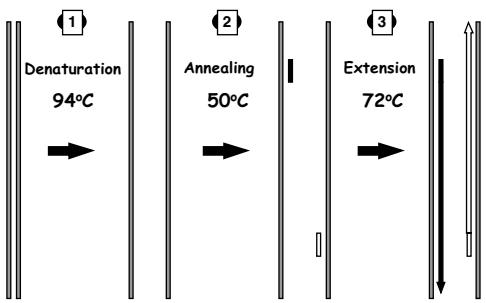
- Used to amplify specific regions of DNA
- 3 steps:
  - denaturation (melting strands apart)
  - annealing - joining primers to template
  - extension - DNA Polymerase used to synthesize new strand

PCR

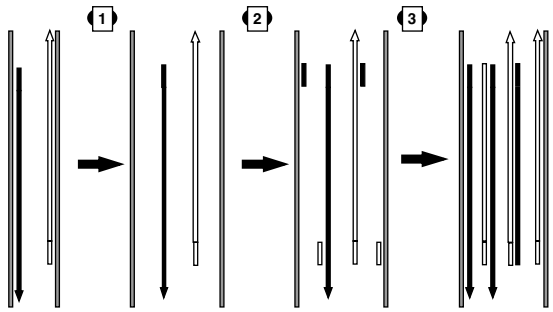
- Three main ingredients:

- template
- primers (synthetic oligonucleotides)
- heat stable DNA Polymerase

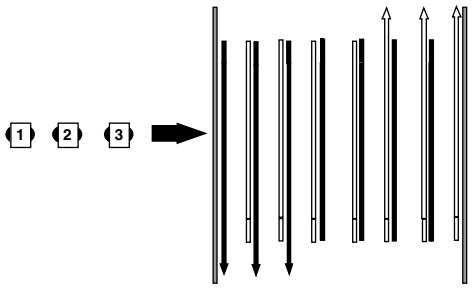
Cycle 1



Cycle 2



Cycle 3



PCR

- After 4 more cycles
  - 256 strands
  - 240 strands will have both ends identical (ie the region defined by the two primers
  - Need 20 to 30 cycles to get effective amplification

RAPD's

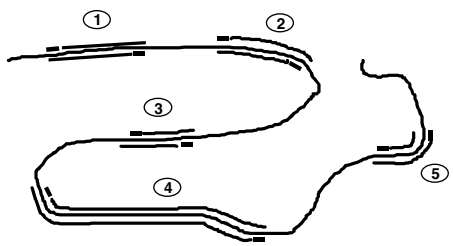
- Random primers/PCR to detect differences
- Dominant markers
- High density genetic maps
- Limited use in pop. Genetics
- Problem - reproducibility

RAPD'S

Random Primers:

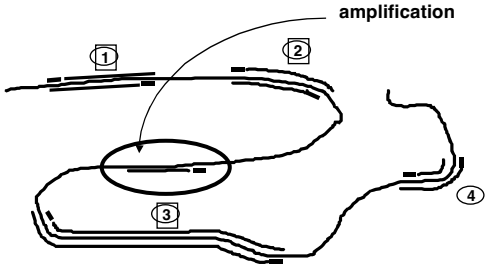
```
5' - GGATCCTGCC - 3'
5' - TCAGGCATTA - 3'
5' - TAGGCCGCGA - 3'
5' - CGATAGCGTA - 3'

etc, etc ...
```

Individual 1

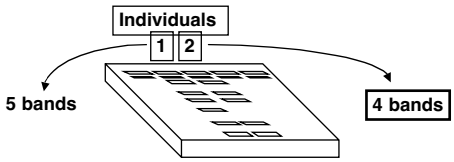


Individual 2

DNA mutation: primer does not anneal: no amplification



Agarose gel electrophoresis of RAPD'S from individuals 1 and 2



RAPD's

- Random primers/PCR to detect differences
- Dominant markers
- High density genetic maps
- Limited use in pop. genetics
- Problem - reproducibility

AFLP

- DNA fingerprinting technique using PCR
- AFLP - stringent reaction conditions
- Detects polymorphisms
  - High resolution mapping (plants/animals)
  - Positional cloning of genes (disease resistance - plants)
  - Determining genetic relationships
  - Epidemiological typing

AFLP

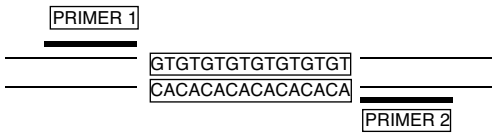
- Dominant
- High density genetic maps
- Similar data to RAPD's but more repeatable
- Used mainly in plants, some bacteria

Microsatellites

- Short repetitive elements (2 - 6 bp)
- Throughout genome of most organisms
- Amplified using PCR
- Highly polymorphic
  - can be >40 alleles/locus
- Codominant

Microsatellites

- Short Tandem Repeats
  - TGTGTGTGTGTGTG . . .
  - bovine >40% repetitive sequences
- Common to get unequal crossing over
- High degree of variation



- Size of amplified product depends on the number of repeats
- Primer pair defines chromosomal location
- #'s of repeats gives differences for genetic analysis

Microsatellites

- Many applications:
  - Population structure, Parentage assignment/exclusion, Phylogenetic relationships
- Development can be costly
- Primer specificity - cross species
- Useful in crustacean pop. studies (Fetzner and Crandall, 2001)

Microsatellites - several advantages

- Provide info from individual loci
  - calculate allele frequencies
- High levels of diversity
  - routinely assay high levels of polymorph^{m}
- No hybridisation

Sequencing

- Provides a direct measure of variation
- Most accurate measure
- Others methods measure indirectly
- Entire genome, individual genes, segments of genes
- Nuclear and mitochondrial

Nuclear DNA

- Genome sequencing !!!
- Alignment of specific gene sequences
- Historical relationships
- Phylogenetic studies

Mitochondrial DNA

- Smaller - combine with RFLP
- Maternally inherited
- Linked - inherited as single locus
- 16S rRNA (crayfish phylogenetics)
- Displacement loop (D- loop)
  - Non-coding region of mtDNA
  - More variable than the rest of mtDNA

Mitochondrial DNA cont^{d}

- Useful for phylogenetic studies and systematics
  - relationship among species, genera and families
- Used for population structure
- Molecular evolution

Disadvantages of using DNA

- Expense (sequencing)
- Development of primers
- Time identifying microsatellites
- Hybridisation

Comparison of techniques

- Pick the technique that best suits the question you're asking
- Depends on degree of resolution required
- Degree of genetic polymorphism directly proportional to level of relatedness addressed

What do we know about the genetic diversity and taxonomy of marron?

Dr Chris Austin
School of Ecology and Environment, Deakin University.

The marron, *Cherax tenuimanus,* was described by Smith in 1912 who gave the type locality as the Margaret River. There have been three subsequent formal taxonomic reviews of the Western Australian *Cherax* species by McCulloch (1914) Clark (1936) and Riek (1967). None of these authors disputed the original delineation of *C. tenuimanus* by Smith. Allozyme surveys of genetic variation in *Cherax* from the south west of WA by Austin (1979, 1986) and Austin and Knott (1996) identified 2 genetically distinct forms of marron; one restricted to the Margaret River; the other widespread throughout the rest of the range of marron. The two forms can be readily distinguished morphologically on the basis of the presence of long setae (hairs) on the carapace, the development of the mid-carina and the degree of tuberculation. While clearly identifiable on the basis of fixed allozyme differences, the extent of these differences overlaps the levels of intraspecific variation seen in other species of *Cherax*.

Based upon morphological characteristics, a small number of specimens of the widespread form of marron were found in the Margaret River in April 1985. Allozyme studies conducted on samples of marron collected in September of the same year confirmed this and also identified a limited number of hybrid individuals. The analysis of samples collected in 1992 and 1998 indicated that the 2 forms of marron were not freely interbreeding and the introduced form was rapidly displacing the endemic Margaret River form. Additional genetic analyses using direct sequencing of mitochondrial DNA gene regions and RFLP analyses confirmed the distinctiveness of the two forms of marron and was entirely consistent with the allozyme data.

Papers presenting the results described above are in press in Fisheries Management and Ecology and Invertebrate Systematics. The latter paper includes a formal taxonomic description of the second species of marron.

Key Reference

Austin, C.M. and Ryan, S.G. 2002. Allozyme evidence for a new species of freshwater crayfish of the genus *Cherax* Erichson (Decapoda: Parastacidae) from the south-west of Western Australia. *Invertebrate Taxonomy.* **16**: 357-367.

Genetic and Taxonomic Studies of the Marron: An Update.

C. M. Austin
School of Ecology and Environment
Deakin University
Warrnambool

Freshwater crayfish - taxonomic complexities

- Isolated and fragmented populations favours genetic divergence
- Morphological variation and conservatism
- Dealing with allopatric populations will often present taxonomic problems
- The case of *Parastacoides*

The case of *Parastacoides:* extensive cryptic speciation

- Small Tasmanian burrowing crayfish
- Riek (1967) identified 7 species
- Sumner (1976) identified 1 species (3 subspecies)
- Hansen and Richardson (in press) identified 14 species belonging to 2 genera (cryptic genera!)
- Type specimen = *Geocharax*! Name *Parastacoides* abandoned for this group.

TAXONOMIC HISTORY OF *Marron - 1*

- Described by Smith (1912)
- Type locality: Margaret River
- Type specimen: WA Museum
- Taxonomic reviews (McCulloch, 1914; Clark, 1936; Riek, 1967)
- All recognise just a single species

TAXONOMIC HISTORY OF *Marron - 2*

- Two subspecies suggested by Austin and Knott (1996) - Australian Journal of Zoology, 4: 223-58.
- Formal taxonomic revision by Austin and Ryan (2002) - Invertebrate Systematics, in press.

HISTORY OF GENETIC STUDIES INVOLVING MR *Marron*

- Austin - 1979 - Honours (UWA)
- Austin - 1981-86 - PhD (UWA)
- Austin - 1992, 1998
- Henryon - 1994 PhD (UWA)
- Imgrund - 1998 PhD (Curtin)
- Austin, Munasinghe, Whisson - 2001
- Bunn - ongoing - (ECU)

Austin - 1979

- Biochemical systematics of *Cherax* in sw -WA
- Examined 8 putative species + *C. destructor*
- Allozyme variation at 15 loci in 17 samples of *Cherax*
- Marron: 2 samples of 20 from Margaret and Inlet Rivers
- Fixed differences at Est, Lp & Lt loci, (GI = 0.80, FD = 20%)
- Used marron as a benchmark for intraspecific variation!
- Noted consistent morphological differences (setation, midcarina & tuberculation).

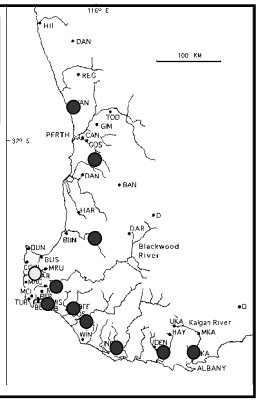
Austin - 1981

- Re-sampled marron from Margaret River and Inlet River plus 9 other locations.
- Allozyme variation at 30 loci in 50 samples of *Cherax*
- Fixed differences between MRM and all other marron sampled
- Est, Lgg & Lt loci variable (GI = 0.90, FD = 10%)
- Comprehensive morphological analysis
- Described marron as 2 subspecies in PhD thesis based on differences in setation and development of midcarina.

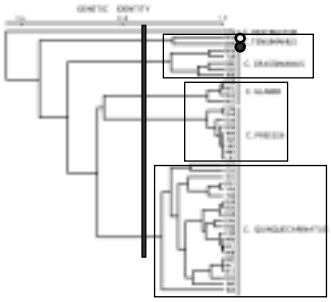
Marron sampling sites (Austin 1979/1986)

○ *Hairy*

● *Bald*



UPGMA phenogram derived from genetic identity coefficients for 42 populations of 6 species of *Cherax*.



Marron Translocation

- The presence of the wide spread form in the Margaret River discovered in 1985
- Genetic data for 1979, 1981, 1985, 1992 & 1998
- "before" and "after" genetic data
- Reproductive interactions and fate of two forms of marron
- Implications for taxonomy & conservation

IF TWO FORMS OF MARRON ARE CONSPECIFIC THEN A MIXED POPULATION SHOULD :

- Show random mating
- Produce viable hybrids
- Each form will lose morphological and genetic individuality over time

WITH FIXED DIFFERENCES AN ALLOZYME ANALYSIS OF A MIXED POPULATION SHOULD:

- Detect F_1 hybrids
- Give expected = observed heterozygotes (H-W test)
- Show segregation of alleles across loci
- Reveal introgression of alleles between gene pools

THE ALLOZYME DATA SET

	1979	1981	1985	1992	1998
Locus	(20)	(5)	(56)	(80)	(104)
Lt-2	*	*	*	* *	* *
Lgg	ns	*	*	* *	* *
Lp	*	ns	*	* *	* *
Est	*	*	*	* *	* *

*** Lower * Upper** Margaret R. 1985 - Blackwood R. (24)

INITIAL MARRON GENOTYPES

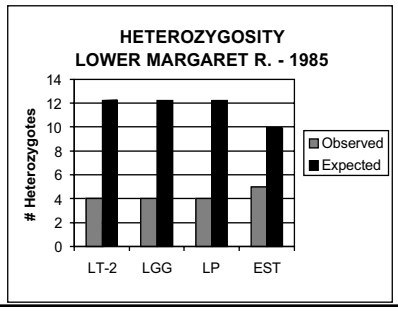
Lt-2	Lgg	Lp	Est	Locat.
SS	SS	SS	SS	M. R.
FF	FF	FF	FF	*, B. R.
FF	FF	FF	FS	B. R.

* = 9 locations from through out southwest

GENOTYPES
LOWER MARGARET R. - 1985

Lt-2	Lgg	Lp	#
SS	SS	SS	47
FF	FF	FF	4
FS	FS	FS	5

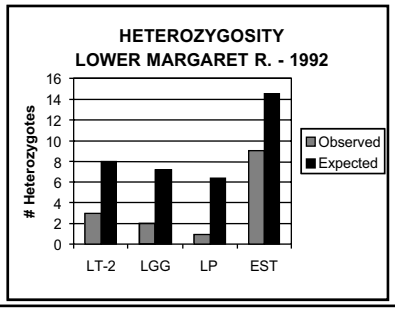
Hardy-Weinberg Equilibrium - 1



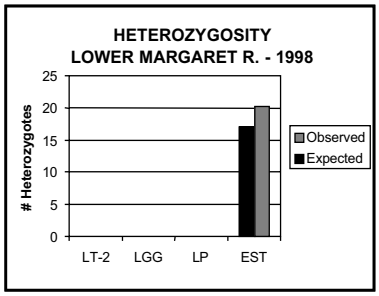
GENOTYPES
LOWER MARGARET R. - 1992

Lt-2	Lgg	Lp	#
SS	SS	SS	3
FF	FF	FF	33
FS	FS	FS	0
FS	FF	FS	1
FS	FS	FF	1
FF	FS	FF	1
FS	FF	FF	1

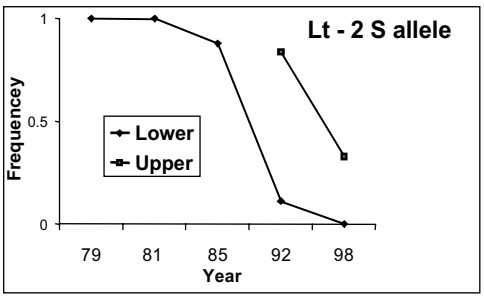
Hardy-Weinberg Equilibrium - 2



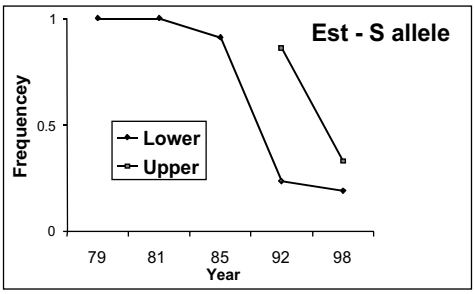
Hardy-Weinberg Equilibrium - 3



Change in allozyme frequencies



Change in allozyme frequencies



CONCLUSIONS - Allozymes

- Evidence for 2 taxonomic forms of marron - separate gene pools in sympatry
- Evidence for rapid extinction of hairy marron
- Potential for significant loss of genetic diversity
- Why???
- Useful to look at other kinds of genetic data

MITOCHONDRIAL NUCLEOTIDE DATA

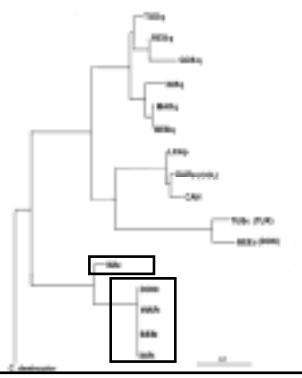
- 16S rRNA *&* 12S rRNA sequences for a range of *Cherax* species
- COI, COII/III & Cyt b for several species including marron and yabbies

COMPARISON OF DIVERGENCE LEVELS

REGION	INTRA (Bald marron)	BETWEEN (Marron spp.)	AVERAGE (*Cherax*)
16S	0	2.76	10.3
12S	0-0.3	3.9-4.2	9.4
COI	0-3.9	5.4-7.5	17.9
CYT b	0-3.6	13.5-14.6	16.9

16S rRNA tree for WA*Cherax*

Allozyme tree for WA*Cherax*



RFLP analysis of 16S fragment in Margaret River

	Lower (60)		Upper (38)	
	Hairy	*Bald*	*Hairy*	*Bald*
Haplotype	1.7%	98.3%	36.8%	63.2%
Pep. Fast Al.	0.0%	99.6%	33.3%	66.7%

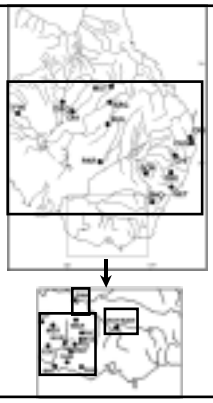
Haplotypes by allozyme genotype

Mt Haplotype	Allozyme genotype: *Hairy*	*Bald*	F1	F2/ Back Cross
Hairy	8	1	1	5
Bald	0	79	1	3

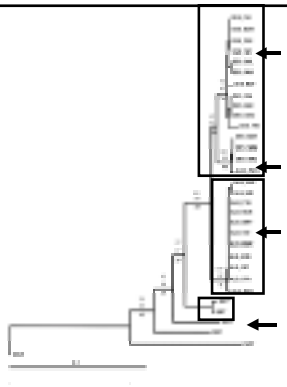
Parallels between yabbies and marron

- Taxonomic uncertainty regarding taxonomic status of *C. destructor destructor* and *C. destructor albidus*
- Allozymes: 4.72% fixed differences
- 16S rRNA: 2.8% divergence
- Mixed population at Tatiara Creek (is for yabbies what the Margaret River is for marron)
- Has both “destructor” and “albidus” haplotypes

Sampling sites for *C. destructor*



16S rRNA tree for *C. destructor*



Tatiara Creek - frequency of most common allele

Locus	1989 (31) (Campbell et. al. 1994)	2000 (60) (Nguyen et al unpub.)
Adh-2	95.2%	92.5%
Got-2	88.7%	88.3%
Gpt	96.6%	95.0%
Pep-D	87.1%	100.0%
Pgm	60.7%	56.7%
Sordh	56.5%	71.7%

TOPICS TO CONSIDER

Is the MRM genetically distinct? YES

Is there more than one genetic type? YES

Identification ? Morpho., Allozymes & mtDNA

Is one endemic? YES: Hairy

When & How? EARLY 1980S — FARM ESCAPEES OR DEL. STOCKING

THANK YOU

ACKNOWLEDGEMENTS

M. HENRYON
G. WHISSON
C. LAWRENCE
D. JERRY

S. RYAN
T. NGUYEN
M. MEEWAN
H. MUNASINGHE

Margaret River Marron : Morphology and hybrids

Dr Craig Lawrence
Senior Research Scientist, Research Division,
Department of Fisheries, Western Australia

Marron from the Margaret River have a number of morphological features that allow them to be distinguished from introduced marron. The two key features used by field biologists to distinguish between marron from the Margaret River and those from other catchments are firstly the median longitudinal carina (which is continuous on the Margaret River marron, but discontinuous on marron from other river systems) and secondly the presence of setae on the carapace of Margaret River marron (marron from other river systems have no carapace setae). The presence of this setae has been used by researchers to commonly refer to animals from the Margaret River as “hairy” marron, in contrast to the “clean” marron. However according to Imgrund the “hairy” and “clean” marron in the Margaret River are hybridizing and these hybrids also have the distinctive setation of the hairy Margaret River marron.

In our studies we have produced hybrids between Margaret River (MR) marron and those from other river systems. We currently have 7 lines of MR hybrids, consisting of 5 river strain males x MR female lines, and 2 MR males x river strain female lines. The age of these marron are 16 months (4 lines) to 4 months (3 lines). Therefore it will require at least an additional 7 – 19 months to determine the fertility of hybrids.

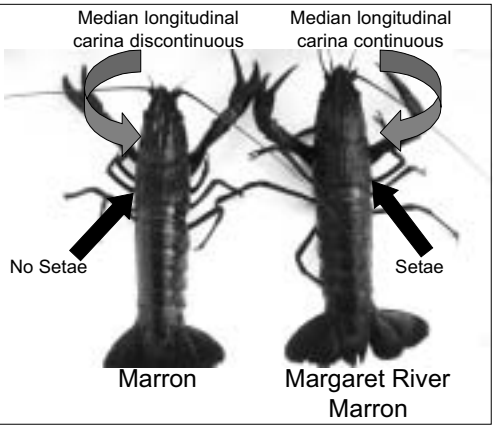
Margaret River Marron : Morphology and hybrids

Dr Craig Lawrence
Senior Research Scientist

Department of Fisheries
Government of Western Australia

Fish for the future

Is the Margaret River type anatomically and/or visually distinct from other types of marron



However - Hybrids are hairy

What size/stage does this occur?

?

12 month old MR marron have not shown distinctive traits (except growth)

- Is our line “pure”
- Are traits affected by environment
- Traits being recorded (this is a growth study)

Do hybrids of different types of marron occur within the Margaret River ?

Yes

- Imgrund (1998)
  - Hybrids in Margaret River

Yes - Hybrids have mated

- Henryon (1996)
  (reciprocal crosses of 4 marron strains including MR)
  - Few MR ♂ x ♀ marron mated
  - No MR ♀ x ♂ marron mated
  - Due to poor breeding success MR marron and hybrids discontinued.

Yes – Hybrid juveniles have been produced

- Current study
  (reciprocal crosses of 6 marron strains including MR)
  - MR ♂ x ♀ marron = **2/5** = ☹
  - MR ♀ x ♂ marron = **5/5** = ☺

Margaret River Hybridisation

♀ \ ♂

	1MR	2	3	4	5	6	7
1MR	Y Y	Y X	Y X	Y -	Y -	Y -	- X
2	Y Y						
3	X Y						
4	Y -						
5	X -						
6	X -						
7	- Y						

X Y- Henryon

X Y- Lawrence

Are hybrids sterile and are hybrids readily identifiable ?

?

Are hybrids sterile ? (fertility)

- Currently have 7 lines of MR hybrids
- 5 river strain males x MR female lines
- 2 MR males x river strain female lines
- Age =
  - 16 months (4 lines)
  - 4 months (3 lines)
  - Require at least an additional 7 – 19 months to determine fertility

Are hybrids readily identifiable ?

Morphology = No

Microsatelites = Yes

Acknowledgements

- Noel Morrissy
- Chris Bird
- Jim Penn & Pemberton staff
- Greg Maguire & Brett Molony

Margaret River Marron Stocks - Effective breeding number

- Fisheries MRM stocks
  - Currently 1000 MR marron in Pemberton & Shenton Park
  - However all are from 10 males x 10 females Ne = 20
- Recommended Ne for restocking
  - Min 10 generations Ne= 680 – 3500 (340M : 340F – 1750M:1750F)
  - 25 generations Ne = 1250 – 4000 (625M:625F – 2000M:2000F)

The Status of the Margaret River Marron – A Fishery Perspective

Dr Brett Molony
Senior Research Scientist, Research Division,
Department of Fisheries, Western Australia

Mr Chris Bird
Senior Technical Officer, Research Division,
Department of Fisheries, Western Australia

The recreational marron fishery (RMF) is an extensive fishery unique to Western Australia. Fishing effort is focused in rivers and irrigation dams across 16 catchments. However, declining catches and catch-per-unit-effort (CPUE) have been recorded since the mid to late 1970s. There are two groups of factors for the decline; factors within the Department of Fisheries jurisdiction (e.g. size and bag limits, closed seasons, gear restrictions), and; factors outside the jurisdiction of the Department of Fisheries (e.g. climate change, rainfall, water management, salinisation, land management etc).

At a whole of fishery scale, the current regulations of the RMF do not appear to be effective and are unlikely to be effective without a control of the total fishing effort (i.e. the total number of recreational fishing days). However, the RMF appears to be driven by the strength of winter rainfall. It appears that the higher the winter rainfall, the higher the catches of marron during the following season. This is likely to be due to increased productivity and therefore growth rate of marron, resulting in more marron growing into legal size before the post-Christmas fishing season. There is also an increase in marron numbers 2 – 3 years later, probably as a result of increased juvenile survival during periods of good rainfall. Poor rainfall (e.g. drought) has the opposite impacts.

During periods of poor rainfall, the demands for water for human consumption, irrigation and private landholders increases and other management agencies respond by allocating water to these users. However, there is no legislation requiring environmental flows or water volumes to be maintained by water management agencies in Western Australia. Further, there are at least ten State government agencies that managed water resources or catchments in Western Australia. With so many agencies and no common goals, there is currently conflict among government agencies in regard to water resources. This results in a high risk to the sustainability of aquatic habitats and species in Western Australia, particularly during drought years.

Margaret River is a sub-set of the RMF and provides an example of the conflicts of water management. The abundance of the endemic “hairy” marron has declined since the mid 1980s and a range of options involving modification to fisheries regulations in this area to preserve the “hairy” marron are presented including stock enhancement of “hairy” marron. However, without the integration of all management agencies, water users and the local community, there is no guarantee that changes in fisheries regulations or stock enhancement would save the “hairy” marron in Margaret River. A way forward, incorporating all management agencies, is presented.

The Status of the Margaret River Marron – A Fishery Perspective

Brett Molony and Chris Bird
Department of Fisheries

Department of Fisheries
Government of Western Australia

Fish for the future

1

The Recreational Fishery

- Extensive area
- Ca. 20 000 valid licences.
- Ca. 45% used in 2001
- Season, bag and size limits, applied over entire fishery
- Total catch – ca. 138 500 ± 12 900 marron
- Total effort – ca. 32 845 ± 2 944 days
- (600 marroners each night of the season)

2

Distribution of Effort - 2001

- Two data sources
- Telephone survey (n = 800)
- Logbooks (n = 130)
- Overall effort to dams = 26 % (16 %)
- Overall effort to rivers = 74 % (84%)

3

Top Dam Sites

- Wellington Dam – 39 % (26%)
- Harvey Weir** – 27 % (4%)
- Waroona Dam* – 14 % (22%)
- Logue Brook Dam – 8% (4 %)

- * = Now drained
- ** = Currently being modified

4

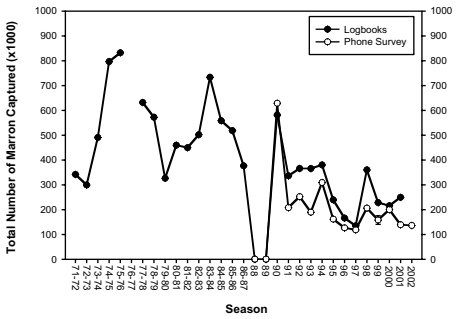
Top River Sites

- Blackwood River – 21% (18%)
- Collie River – 13% (4%)
- **Busselton Coast * – 13 % (19%)(3,160 d)**
- Murray River – 11% (1%)
- Warren River – 7% (15%)
- Harvey River – 6% (2%)
- Donnelly River – 5% (12%)

- *** Includes Margaret River- 9% (2,300 d)**

5

Catch History



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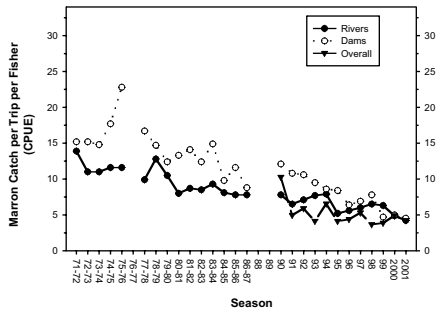
CPUE History



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Reason for Decline of this Type?

- **Two Groups of Reasons**
- **<u>Within</u>** Fisheries Management Jurisdiction
- **<u>Outside</u>** Fisheries Management Jurisdiction

8

Fisheries Management Jurisdiction

- **Season – ! 56 days long- too long?**
  - About 48% of effort in the first fortnight
  - Not possible to manage recreational fisheries on effort levels quotas
- **Size limit – 76 mm RCL – too small?**
  - Well above reproductive "size" for most stocks
  - Margaret River 2000: 3 sites surveyed. Size of smallest berried female was 31.0-70.0 mm RCL
- **Bag limit – 10 per person per day – too High?**
  - Average in 2001 was 4.22 ± 1.09

9

What Drives the Marron Fishery?

- The RMF is sensitive to changes in rainfall and the flow of water into rivers and open dams.
- This is a complex process and works in two ways

10

A. Immediate impacts

- Rain washes plant material etc into rivers and dams.
- This increases the primary productivity, which flows through the food web and increases the growth of marron

= **<u>More legal-size marron in the following season</u>**

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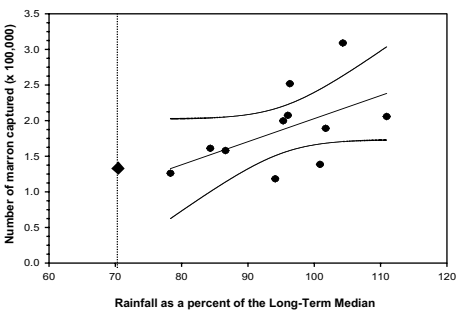
Rainfall and Marron Catches



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B. Long-term Impacts

- Rainfall not only increases the productivity of aquatic systems, but increases space.
- In a typical year, full rivers and dams allow marron to "spread-out".
- During the time of the year of releases of juvenile marron by females (November-December), this extra space leads to an increase in juvenile survival and numbers.

13

Impact on the Fishery

- More Rain
  = More productivity and more space
  = better juvenile growth and survival
- Better survival
  = **More legal size marron in the next 2 - 3 seasons**

14

But…….

- Another reason that high rainfall is good is that the RMF is protected as rivers are difficult to access pre-season (riparian vegetation)
- Low rainfall means that many rivers are reduced to pools well before the RMF season commences. This will result in marron being concentrated.
- Therefore marron will be easy to catch and more than predicted may be captured [c.f. Hyperstablility] (Natural mortality rates are higher too).
- **This will have a very negative impact on following seasons.**

15

Outside Fisheries Management Jurisdiction

- Poor rainfall has more insidious consequences
- Poor rainfall leads to the following responses from other agencies:
- Higher usage of water for irrigation and drinking, plus re-routing of water to other areas (Water Corp)
- Licensing of landholders to pump water from rivers etc to fill farm dams (W&RC)

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State Regulatory Authorities

- Agriculture WA
- CALM
- Dept of Fisheries
- Water Corp.
- Waters & River Comm.

- Dept of Environmental protection
- Conservation Comm. of WA
- LandCorp
- Development Commissions
- Forestry Products

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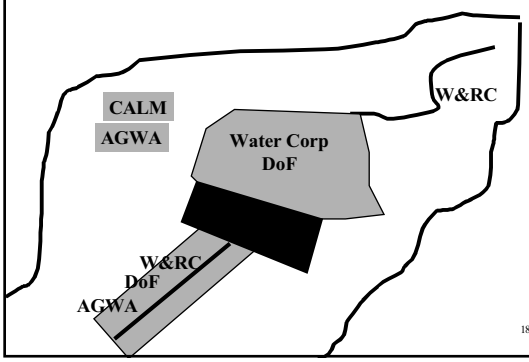
How it works



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Problems

- Overlap of Jurisdictions
- Conflicting Uses
- Conflicting Objectives/Outcomes
- No established baselines/goals
- No overall direction/ guidance,

- Therefore high risk of loss of habitat/species/stocks

19

Result to RMF

- Poor rainfall years have a multiplicative effect on freshwater animals and systems

- [For RMF, also increases vulnerability, exposure to predation, etc, leading to long recovery]

20

Other factors

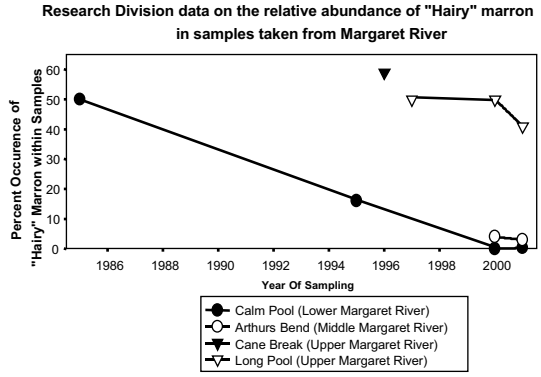
- Illegal fishing
- Change in gears and effort
- Introduced species
- Land management
- Water extraction
- Closure of locations (e.g. Stirling Dam)
- Salinisation
- Habitat loss
- (Climate Change)

21

Margaret River

- Relatively small river – about 30 km long
- Small catchment – approx 325 km ^{2}
- Close bye to town
- Series of weirs along the river – 3 major weirs
- Small dam to one side (town water supply)
- Wine making, tourism, farming (Including aquaculture) light industry.

22



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Fisheries Management Jurisdiction

- Retain only “clean” marron?
  - Even logbook holders were unaware ± unable to tell “hairy” marron from clean marron
  - (What size do “hairy” marron become morphologically/visibly different?)
- Close Margaret River?
- Other?

24

But No Guarantee that we would save the MRM

- Need to include ALL managers of the freshwater resources of the area
- Plus Users

25

What is needed

- Co-ordination of Agencies (WOG)
- Clear directions
- Clear acceptance of responsibilities
- Priorities
- Identification of value of areas by different agencies
- Identification of areas of different/unique habitats

26

How to Achieve this

- Make the problem(s) known
- Set a list of priorities among agencies (areas, threats, etc) = Strategic planning
- Redefine objectives and identify strengths (e.g. engineering)
- Map areas to identify habitats, species, threats
- Identify gaps (e.g. environmental flows)
- Move forward together

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Can we influence the genetic population structure of marron in Margaret River?

Session Chair – Dr Barbara Cook
Department of Agriculture, Western Australia

1. Closures of the River to Fishing?

Ms. Gaye Looby
Management Officer, Recreational Fisheries Program,
Department of Fisheries, Western Australia

The Recreational Marron Fishery (RMF) today;

- Margaret River – approximately 3% of river fishing effort (2001 season)
- Management Controls currently applied:
  Licence ($20); Bag limit (10 per fisher); Size limit (76 mm RCL); Gear Control (either 6 drop nets, or 1 scoop net per fisher or 1 snare per fisher); Closed Season from midday on the last day of February in each year until midday on first Saturday after the following 3 January).

What will a fishing closure in Margaret River achieve?

- Is fishing mortality really the problem?
- If two "strains" of marron exist in Margaret River and "clean" marron are out-competing "hairy" marron, closure to fishing within the River will allow "clean" marron to dominate the system.
- Need for more data to determine various options for a closure to marron fishing in Margaret River, for example;
  - temporal closures – part or whole of season?
  - spatial closures – all of river or upper reaches only?

Why a closure is unlikely to work?

- Management Issues

  For example, the 1988/89 closure to the RMF season resulted in a "gold rush" effect – much greater effort was applied to the RMF in 1990 on re-opening and much higher catches resulted. The subsequent marron season again displayed a similar decline in catch and CPUE to prior to the fishery closure. Thus, the closure did not result in a more sustainable RMF.
- Compliance Issues – there is a need to enforce a closure, especially in regard to "veteran" poachers who do not appear to consider the long-term sustainability of the RMF. Given that the RMF is spread over approximately 100 locations and is nocturnal, adequate enforcement to all areas is virtually impossible.

What are the challenges to management of the RMF?

- From a management point of view RMF is a very complex fishery;
  – Fishing effort occurs in at least 96 waterbodies – little is known about the productivity and carrying capacity of the different waterbodies;

  - Marron in different waters have separate breeding populations and biological parameters (e.g. growth rates, fecundity etc);
  - Marron have been translocated outside their natural range as far north as the Hutt River, as well as east beyond Esperance. Most translocations probably occurred between 1900 & 1960.
- Is a closure sufficient? Size limits protect breeding populations but recruitment is appears to be affected by rainfall.

Further complications to the management of the RMF.

There are a number of impacts on the fishery that are outside the control of the Department. They include:

- Environmental factors;
  - dependence on rainfall;
  - land management practices (e.g. over-clearing leading to salinisation problems; the damming of streams and tributaries which have reduced the amount of run-off into natural water courses of the RMF);
- Poaching – on-going problem;
- Other predators (e.g. exotic and feral redfin perch, birds).

Future Management Initiatives.

A major review of the marron fishery is scheduled to commence in 2002/2003 to consider long-term management options for a sustainable RMF in the future.

Future Management Changes for Recreational Marron Fishery

- Historical catch trends, together with information on this year's (2002) winter rainfall will be used to assess the status of the fishery and to formulate options for the 2003 season.
- One option may include whether to close or reduce the marron season for the whole fishery or part of the fishery, to adjust for increasing vulnerability due to low rainfall.

2. Opportunities for adopting different management strategies for upper and lower marron populations in the Margaret River and for influencing fisher and farmer behaviour

Dr Greg Maguire, Supervising Scientist
Aquaculture Development & Fisheries Environment
Department of Fisheries, Government of Western Australia

Any relative shift in fishing pressure away from "hairy" marron should be helpful in altering the population balance between "smooth" and "hairy" marron, the latter being the strain of marron that is considered to be endemic to the Margaret River. This could be achieved by using trained staff and volunteers in intensive fishing operations and/or getting recreational fishers to routinely release "hairy" marron back into the fishery. Another approach would be to opportunistically release juvenile "hairy" marron, arising from occasional years of higher reproductive success in broodstock/ nursery farming ponds into upper and, at a later time, lower reaches of the Margaret River. Simply closing a fishery, whether upper or lower, without adopting either or both of the fishing/restocking strategies, is likely to simply secure the demise of "hairy" marron.

A key question is whether fishers can distinguish between "smooth" and "hairy" marron in a night fishery? This should be possible if fishers are provided with appropriate advisory material. An analogy is the requirement for amateur fishers to examine breeding status of female rock lobsters. The next issue, assuming it is feasible for fishers to distinguish "smooth" from "hairy" marron, is whether they will be motivated to do so. Given that some of the fishery occurs at isolated sites, compliance activities would not be sufficient by themselves. The Margaret River area is considered to have an environmentally aware population and a well-presented campaign should attract strong local support for protecting "hairy" marron stocks. However, not all marron fishers targeting the Margaret River are "locals"; there is a risk that "outsiders" may not respond to a local campaign. Again, a shift in fishing pressure away from "hairy" marron should be helpful even if it is not applied with 100% efficiency. A similar argument should apply to the risk of fishers returning hybrid "hairy" marron to the fishery.

Do farmed marron represent a threat to "hairy" marron or indeed other genetically distinct marron river lines? The idea that the "smooth" marron came from a farm escape is a presumption, not an established fact (N. Morrissy, pers. comm. 2002). Furthermore marron farming is not a significant activity along the Margaret River itself. Marron will walk out of ponds/dams although not all marron farms are close to a watercourse as they typically just rely on storage of surface runoff. Escape of stock from farms is a financial loss to the farmer and is commercially undesirable. As the industry moves towards use of genetically selected strains, greater emphasis should be placed on avoiding escape of farmed marron into the wild. If farmers follow the Department's latest farm design Aqua Info (No. 4, in review) they should avoid wall collapses (a rare event) and, because we recommend use of electric fences to exclude water rats, both egress and ingress of marron should be much less likely. At present, use of such designs is voluntary. In general, however, aquaculture farms should be required to reduce, by affordable means, the risk of escape of any farmed species that could lead to its colonisation of natural habitats.

Farmers growing marron at low densities in private water storage dams will not have electric fences and typically do not require a licence to hold marron. They may be gully dams that are prone to flooding and overflow into waterways. Risk reduction in such cases will be very difficult but it does not lessen the responsibilities of licensed aquaculturists. I emphasise that these are the opinions of a research staff member and as such do not have no any official status as Department of Fisheries policy.

Upper versus Lower River management. Should we/can we modify Fisher/ Farmer behaviour

Greg Maguire
Aquaculture Development & Fisheries Environment Branch

Close the Upper River?

- **Will it still just allow non-hairy stock to still take over?**
- **Can we be effective with compliance in isolated upper river sites?**

Fish for the future

Can we modify fisher behaviour?

- **Not all marron fishers in the marron river are locals i.e. may not respond to a local campaign?**
- **Can they distinguish hairy and non-hairy marron at night?**
- **Still, any relative shift in fishing pressure away from hairy marron would be helpful.**

Fish for the future

Can we modify farmer behaviour?

- **The idea that the non-hairy stock came from a farm escape is a presumption not established fact (N. Morrissy pers. comm.)**
- **Marron will walk out of ponds/dams.**
- **May not be near a water course**
- **Escape of stock from farms is a financial loss to the farmer**

Fish for the future

Can we modify farmer behaviour?

- **Following latest farm design Aqua Info (in review) should avoid wall collapses and escapes (via e-fences to exclude water rats).**
- **Following the above designs is voluntary.**
- **Farmers growing marron in low density water storage dams will not have e-fences.**

Fish for the future

Can we modify fisher behaviour?

- **The combination of a shift in relative fishing pressure AND restocking of hairy marron could be even more helpful.**

Fish for the future

Status of this information?

- **Merely ideas which have no official status.**
- **Research staff propose suggestions but do not decide policy**

Fish for the future

3. Breeding programmes and restocking for endangered species

Ms. Harriet Mills
PhD Student, School of Animal Biology, University of Western Australia

Assuming that the Margaret River marron has been identified as a separate taxon and that some form of management is required to protect it, the next step should be to establish a 'recovery plan'. Recovery plans have been used in Western Australia to coordinate the recovery of fauna species such as the noisy scrub bird, western swamp tortoise and chuditch, as well as plants and ecological communities, and recovery plans are a requirement for receiving commonwealth funding. Another invertebrate, the Minnivale trapdoor spider, currently has a state approved interim recovery plan.

A recovery plan should outline the specific objectives and proposed actions to manage the threatened species. The benefit of such a document is that the objectives and actions can be prioritised and that the aims and processes are transparent. The recovery plan should identify and, ideally, be written by a recovery team consisting of representatives of all stakeholders. In this case the stakeholders should include government agencies such as the Department of Fisheries, Waters and Rivers Commission, Water Corporation, Department of Conservation and Land Management, research institutions, industry such as marron farmers and recreational fishers and the Margaret River community.

The first objective of the Margaret River marron recovery team should be to assess the status of the species by determining the size and distribution of the population. Has the population declined since the introduction of another species, or has the catchability changed? If the species has declined, it is imperative that the threatening processes be identified (competition, hybridisation, overfishing, water quality etc).

Once these issues are addressed, restocking may be considered as an option. Restocking, however, may require a large investment in time and resources and therefore needs careful planning. Ideally, the threatening processes should be removed to allow a natural recovery of stocks, and restocking should be only considered where a population is locally extinct or where numbers have declined to a point where recovery from a sufficient genetic base is not possible.

If restocking is necessary, the recovery team should consider the release area (i.e. part of the river or a dam?). The release area should be within the former range of the species and provide suitable habitat (i.e. habitat for survival and breeding with the threatening processes absent or ameliorated). The area should be under suitable tenure and sufficient access and resources should be available for the release and subsequent monitoring.

There are several decisions regarding the founder stock that must also be addressed. Should wild or captive-bred founders be released? What is the risk of disease of introducing stocks to an existing population? What is the optimal number, sex ratio, age and/or size at release and season for release? Other strategies, such as an initial period of supplementary feeding, might enhance the survival rate.

It is crucial that the released stocks are monitored. This requires a suitable method of capturing and identifying the stocks (or individuals?). The frequency and duration of monitoring should be sufficient to allow an assessment of survivorship and, if it is the case, to identify the reason for failure. Assessment of the outcome of restocking will be aided by establishing criteria for success and failure at the outset.

Breeding programmes and restocking for endangered species

Harriet Mills
UWA

Recovery planning

- Specify objectives and actions
- Prioritise and coordinate efforts
- Collaboration
  - government agencies
  - research institutions
  - industry
  - community

Objectives

- Clarify taxonomic issues
- Determine population size and distribution
- Identify threats and methods of control
- Restocking?

Is restocking the best option?

Only if other management options will not result in recovery

If 'yes' then consider:
- Release site
- Founder population
- Strategies

Release site

- Threatening processes absent or ameliorated
- Within former range
- Habitat size and structure
- Existing stocks
- Tenure
- Resources

Founders

- Taxonomy
- Wild or captive?
- Number
- Sex ratio
- Age

Strategies

- Time of year
- 'Soft' or 'hard' release
- Monitoring
  - Method
  - Frequency
  - Duration
  - Success criteria

4. Active removal of non-endemic strain: How might the interloper be removed from Margaret River and its tributaries?

Dr Brenton Knott
School of Animal Biology, University of Western Australia

There has been considerable experience in Europe with the introduction and unwelcome spread of alien species of crayfish, namely *Orconectes limosus* (Rafinesque), *Pacifasticus leniusculus* (Dana) and *Procambarus clarkii* (Girard). In response to the widely perceived (in Europe) need to control the spread of alien crayfish Holdich *et al*. (1999) reviewed the approaches that have been used to achieve this control or, where appropriate, eradication of the alien form. Holdich *et al*. (1999) recognise a number of control categories;

- **Legislative** – involving local and national laws aiming to prevent the spread. Clearly this is irrelevant at this juncture: The Margaret River has already been invaded by alternative genetic stock of marron;
- **Mechanical –** such as trapping. Trapping is unlikely to be selective for one genetic stock without first determining the biological attributes which encourage a crayfish to enter a trap;
- **Biological –** Such as the use of fish predators. Predation by fish can reduce crayfish populations, but again, would a predatory fish be selective on the non-Margaret River marron? Also, there are no suitable endemic species in Margaret River and the introduction of another exotic species is likely to be unacceptable;
- **Diseases** – The introduction of diseases is unlikely to be selective for the same reason.
- **Microbial insecticides** – developed for insects but not yet for crayfish, although crayfish are physically similar to insects;
- **Physical** – such as draining a watercourse and removing all non-endemic marron. This is logistically difficult and will impact on other species.
- **Biocides** – the use of;
  - Organophosphate and organochlorine insecticides;
  - Pyrethroids;
  - The anthelminthic ivermectin;
  - Rotenone;
  - Surfactants – emulsifiers which inhibit oxygen uptake;
  - Pheromones – to function as a lure;

None of these are 'of-the-shelf' remedies, all require considerable research before they could be considered for use to control non-endemic marron. Further, using biocides or introducing disease should be considered only as an extreme last course of action due to the potential risks to other biological components of Margaret River. One problem in the present case is the likely similarity in biology between the two genetic stocks (species) of marron, which probably would mean that research to find a solution adopting any of these approaches would be especially protracted and costly. Indeed, the chance of succeeding must be very low.

In view of these discouraging conclusions, the approach much more likely to succeed, and immediately, would be to harness the human resources resident throughout the catchment. Following a careful educational programme explaining the problem, and discussing all possible solutions, the environmental instincts of the people of Margaret River may well be directed towards organising their own 'Eradication Activities'. The success of such an approach will depend on giving ownership to the local residents, not dictating to them.

Reference

Holdich, D. M., Gydemo, R. and W. D. Rogers (1999). A review of possible methods for controlling nuisance populations of alien crayfish. In *Crustacean Issues* **11** *Crayfish in Europe as Alien Species. How to Make the Best of a Bad Situation?* (eds F. Gherardi and D. M. Holdich), pp 245-270. Rotterdam: Balkema.

5. Notes on Community Involvement in the conservation and management of the Margaret River Marron

Dr Pierre Horwitz
Consortium for Health and Ecology, Edith Cowan University

My notes emphasise the imperative that we are faced with, and the opportunity for dealing effectively with the situation in which we find ourselves.

1. A perspective on where we are in the world: Southwestern Australia is one of 25 Global hotspots of biodiversity, where extremely high levels of endemism are threatened by poor environmental practices. In SW Australia, the Leeuwin-Naturaliste ridge has its own special biota, the western-most part of the Warren Bioregion with innumerable endemics itself; and with no fewer than nine species of freshwater crayfish - a remarkable diversity in its own right. As part of this, the Margaret River Region is also special - it has another endemic (and endangered) species of freshwater crayfish (*Engaewa pseudoreducta*) (Horwitz and Adams 2000), two endemic species of frog (*Geocrinia* species*)* occur just south of the catchment. The catchment probably represents some form of faunal break and is significant in biogeographical terms. The region is also on the world's stage as a destination for tourists and an appellation region for wine-lovers. In short, this stage is set and the world is watching. If ever there were a *flagship region* - this would be it!

2. The two species of Marron are the largest, most easily recognised thing in freshwaters in the southern half of the western half of the continent. The "smooth" species of marron has already been recommended as a flagship or icon species for river restoration (see Nickoll and Horwitz 2001). Using the "hairy" species in the Margaret River makes intuitive sense - it gives the Government (all departments, not just Fisheries) an opportunity to accomplish multiple gains and benefits in terms of the improvement in river condition.

   A Flagship species in a flagship region - what an opportunity!

3. Community involvement is essential. I believe that Fisheries authorities too often assume that the public has elements who are either unable to understand anything more than a simple ecological message, or they are devious when it comes to fish stocks. I think we need to avoid this kind of reasoning. When we have an ideal opportunity to capture the local public's imagination and support, issues of enforcement can, with careful planning, be dramatically minimised. The key is to ensure that the community feels a sense of ownership over the fate of the "hairy" endemic marron, and for the community to generate its own goals and objectives for its management and conservation. The Fisheries Department must be prepared to "let go" a little bit here, and to provide its resources wherever possible to the community initiatives when they come.

   Local people already have a sense of the importance of their place. They can be a government department's greatest asset if we are careful about the messages we send out from this forum. Firstly we must change the way we speak of marron - from now on there are two species. Secondly we must diversify our fishing regulations to emphasise the special nature of these

species. Thirdly we need to commence by handing the process of conservation and management of the "hairy" marron over to the local community in Margaret River region. The Fisheries Department is in an ideal situation to facilitate this appropriately, and to provide resources to community members involved in the process.

References

Horwitz, P. and Adams, M. 2000. The systematics, biogeography and conservation status of species in the freshwater crayfish genus *Engaewa* Riek (Decapoda: Parastacidae) from south-western Australia. *Invertebrate Taxonomy.* **14**: 655-680.

Nickoll, R. and Horwitz, P. 2000. Evaluating flagship species for ecosystem restoration; a case study involving freshwater crayfish and a river in southwestern Australia, in *Nature Conservation 5: Nature Conservation in Production Environments: Managing the matrix,* eds. J.L. Craig, N. Mitchell and D.A. Saunders, Surrey Beatty & Sons, pp 557-564.

Review of Today's Sessions – What We Know About the Margaret River Marron

Chair – Dr Barbara Cook
Centre of Excellence in Natural Resource Management, University of Western Australia

Chris Austin: What do we know about the genetic diversity of marron and other *Cherax*?

- Summarised the results of several studies (ranging from 1979-2001) on the genetics and specific status of marron.
- Confirmed the existence of two 'forms' of marron – a widespread "smooth" form, and a "hairy" form (only found in, and endemic to, Margaret River). Both forms are now found sympatrically with in the Margaret River.
- These two forms of marron display fixed allele differences at three allozyme loci and several microsatellite loci, and are characterised by two different haplotypes for the 16S rRNA coding region of the mtDNA gene;. They thus represent two separate, distinct gene pools worthy of recognition as 'evolutionary significant units', or even separate species.
- Repeated sampling from the Margaret River during the period 1979-1998 showed a rapid decline of the "hairy" form genotype from a site along the lower reaches of the river, with the "hairy" form (the only form present in 1979) being completely replaced, by the smooth form by 1998.
- Very little hybridisation occurs between the two genotypes.

Craig Lawrence: Morphology and hybrids.

- Margaret river ("hairy") marron are morphologically distinguishable from the "smooth" widespread form based on three carapace features.
- Unfortunately, hybrids resulting from crosses between the "hairy" MR form and the "smooth" widespread marron can be "hairy" in appearance.
- MRM have not bred well in captivity in the past, and thus their husbandry requires further research.

Brett Molony: The status of the MRM

- There has been a distinct downward trend in catches of marron over the last few years.
- While it is unlikely that this is due to factors such as length of season, size limits, or bag limits, these factors cannot be ruled out entirely.
- The most likely factor driving the marron fishery is rainfall and subsequent water levels, with higher rainfall leading to higher catches.

Various speakers: Can we influence the genetic population structure of marron in Margaret River?

- Closing of the Margaret River probably not a viable alternative due to problems of compliance, gold rush effect, etc (Gaye Looby).

- There is a potential for modifying fisher/farmer behaviour in various parts of the river, and for using fishing as a 'tool' (Greg Maguire).
- If we are to consider breeding programs and restocking (but not always the best option), then we need a recovery plan which would have to include an assessment of present population size and distribution, specific objectives and an assessment of the best release sites, founder populations, timing of release, etc (Harriet Mills).
- Various strategies for removal of the "smooth" form from the river exist, and include legislative, mechanical, physical and biocide options (Brenton Knott).
- The MRM is a very good candidate for involving the community through its recognition as a flagship species, and is distributed in a river which is a known hotspot for biodiversity (Pierre Horwitz).

What We Don't Know About the Margaret River Marron – A Discussion

Chair – Dr Annette Koenders
Centre for Ecosystem, Edith Cowan University

What we don't know was summarised as follows.

Probably the most important thing we don't know is what we need to do to ensure the survival of the MRM.

This is hampered by a lack of basic knowledge about the biology of the MRM., including;

- The relationship between morphology and the underlying genetic make-up of the individual, particularly hybrids;
- The current distribution and population structure of the MRM and if and how these are changing;
- Specific details of the interactions between MRM and 'smooth' marron. We don't know their relative fitness, the extent of crossbreeding and backcrossing, or the characteristics of hybrids and how to recognise them;
- We know very little about the MRM's reproductive biology and its productivity;
- What common names should be attached to the two species?

John Bunn is currently addressing the first four items for his Master's project.

The importance of mapping the river was discussed, particularly of inaccessible areas, to ascertain the status of the MRM.

There was also some discussion of the importance of maintaining and protecting the genetic identity of the MRM. Sources of danger were identified as escapes from marron farms and the potential introduction of new strains in the catchment through unauthorised or authorised stocking of farms.

Measures to prevent escapes from farms including electrified fencing were described. It was suggested that only MRM be farmed within the catchment. One difficulty with this is that currently the Department of Fisheries has no positively identified holding stock of MRM.

The importance of community education and involvement came up again.

After discussion, consensus was reached about the common names. For the time being, we agreed to call the MRM "hairy" and the other species, "smooth".

Where to from here? – A Discussion

Mr Colin Chalmers
Program Leader, Fish and Fish Habitat Protection,
Department of Fisheries, Western Australia

- The workshop has generated a range of complex information regarding the status of marron in Margaret River.
- The likely outcomes for marron in Margaret River and Western Australia is that there are two species of marron, and one is imminently threatened with extinction.
- Ensuring the sustainability of the "hairy" form will be both complex and expensive, and will be a long-term investment and will involve the Margaret River Community and a range of Government Departments.
- A formal recovery plan must be developed through a consultation process for the best chance of a successful outcome.
- The funding for any such project is likely to be from external sources and involve both the community and research institutions.
- Further, the recognition of two species of marron and the threatened status of one species has major implications for many of the Department's Programs, including Fish & Fish Habitat Protection, Recreational Fishing and Aquaculture. Changes in legislation are likely to be involved across the Department.
- The document resulting from today's workshop will be used as a basis for the Department's response to the future management of the Margaret River Marron and issues surrounding the sustainability of Margaret River Marron.

Acknowledgements

Thanks to all workshop participants for their timely and informative presentations. Special thanks to Jodies Oates for administrative support for the workshop and Brett Molony for organising the agenda, venue and topics for various speakers. Thanks also to Sandy Clarke for typesetting the final document.