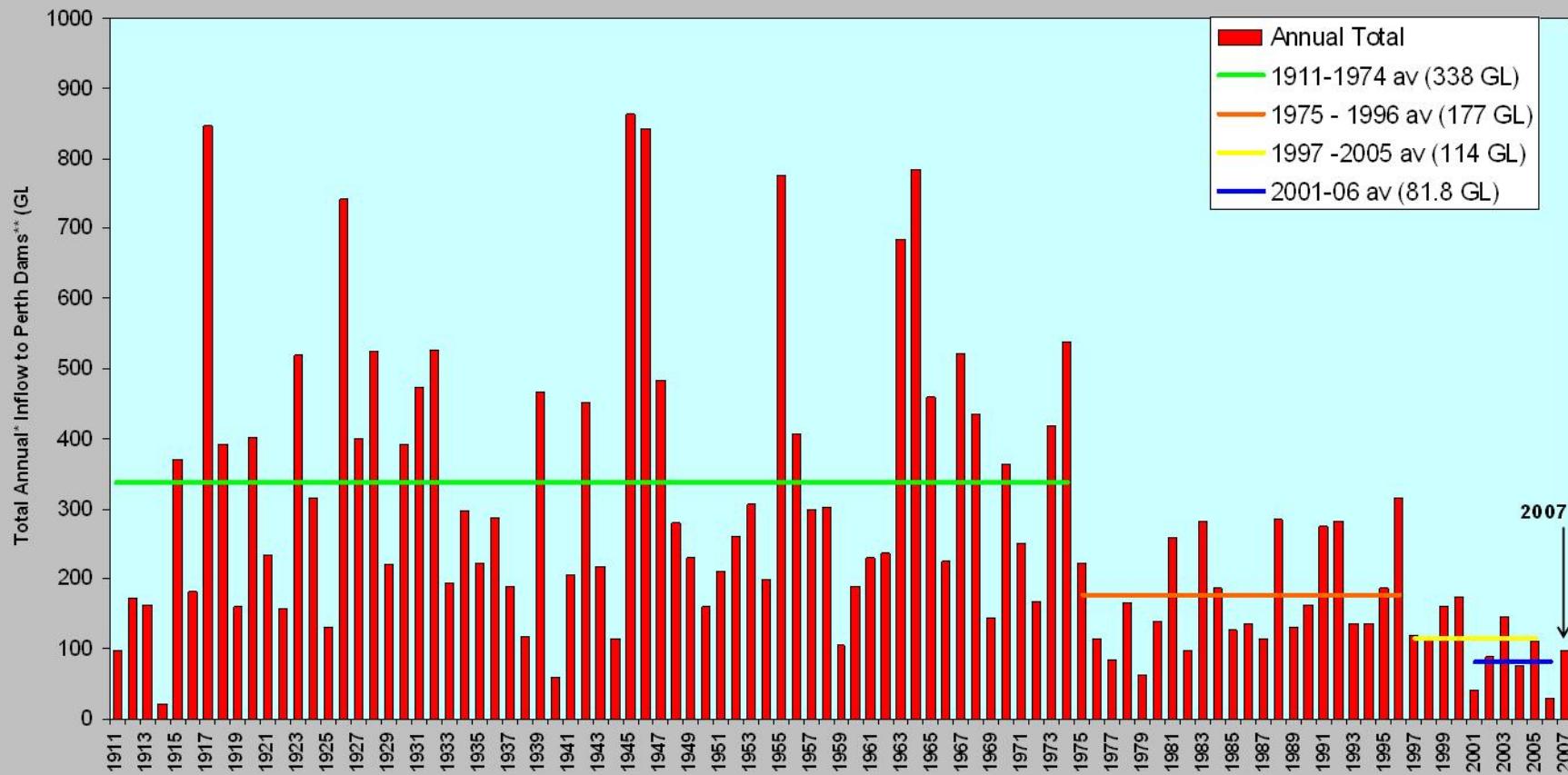


Whole Effluent Toxicity Testing for Desalination Plant Discharges: Application for Plant Design and Ecosystem Protection

Jill Woodworth, Michelle Rhodes,
David Luketina and Gordon Groth





Notes: - A year is taken as May to April
 - 2007/08 inflow to 7th November 2007





Introduction

- Ecotoxicology testing was conducted to confirm that the RO brine from the PSDP would not disrupt the integrity of the receiving ecosystem
- This presentation will discuss the methodology used to determine species protection trigger values for Cockburn Sound



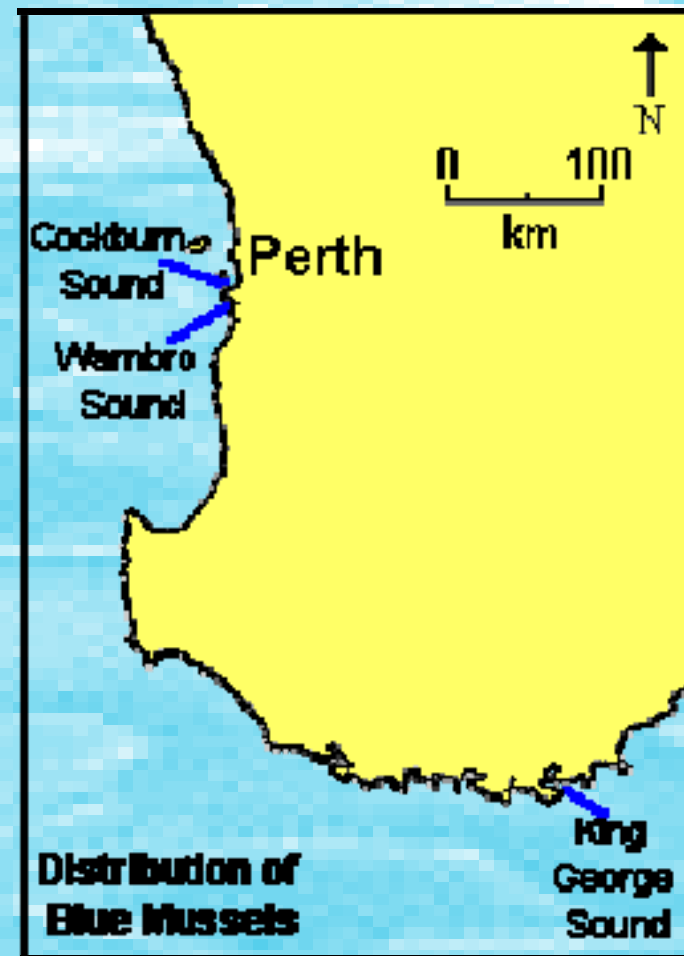
Whole Effluent Toxicity Testing



- Little information on the effects of RO brine on marine ecosystems
- WET Testing
- Species Protection Trigger Values
- ANZECC and ARMCANZ (2000)

Bioassays

- WET testing uses single species bioassays
- Species indigenous to, or representative of, the local ecosystem
- Controlled conditions
- NATA accredited



Bioassays

- End points
 - **Acute** (Not Performed)
 - Survival
 - **Short Term**
 - **Chronic** (sub-lethal)
 - Reproduction
 - Growth
 - Embryo/larval development
 - Fertilization



Bioassays



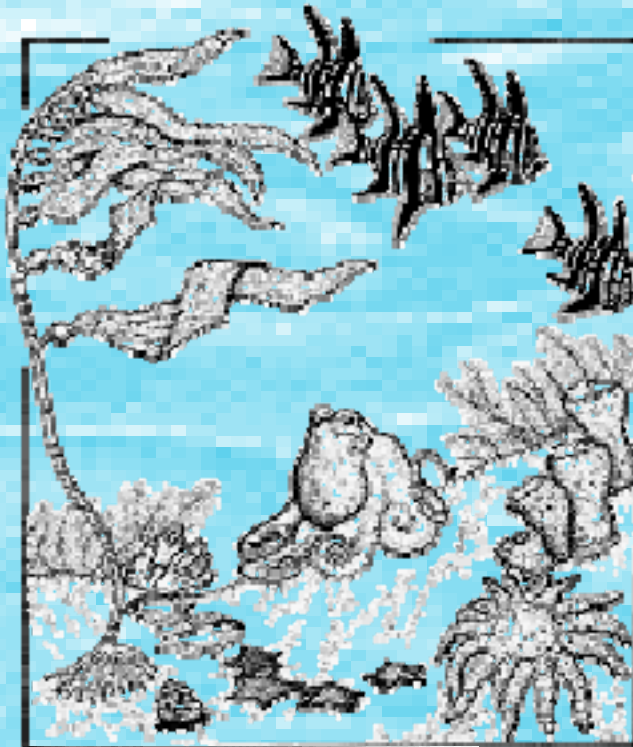
- Several concentrations of RO brine and a Cockburn Sound control
- Cockburn Sound dilution water
- Concentrations of RO brine tested: 0, 0.65, 1.6, 3.125, 6.25, 12.5, 25, 50 and 100%

BIOASSAYS

- **Chronic EC50** – Concentration that causes an effect on 50% of the test population
- **EC10s** - Concentration that causes an effect on 10% of the test population
 - Accurate - Calculated statistically
- **LOEC** – Lowest concentration showing effects
- **NOEC** – Concentration showing no effects
 - LOEC and NOEC are functions of the concentrations tested
- **EC10** results from bioassays with five different species used to calculate the Species Protection Trigger Value

Species Protection Trigger Values

- These values are the maximum concentrations of RO brine that should permit the integrity and function of the Cockburn Sound aquatic ecosystem to be maintained



Trigger Values

- Derived from the EC10 of a minimum of 5 toxicity tests
- Using a statistical distribution approach
- Protects a predetermined % of species
- Cockburn Sound:
 - MEPA = 90%
 - LEPA = 80%
- Using local species with short-term chronic tests will minimize use of safety factors

Rev: 02/16/07



DATUM: GDA94 (MGA ZONE 50)

0584D_F01.dgn



Water Corporation
 PERTH SEAWATER DESALINATION PLANT
INLET AND OUTLET LOCATIONS
 as built co-ordinates shown from drawing HHS0-3-20.3

Figure
 1

Report No.: 0584D Author: P. Short Drawn: Environmental GIS Date: Sep 2006

Trigger Values

- Derived from single species chronic toxicity tests
- Range of test species
- Representative of ecosystem
- Minimum 5 data sets
- Minimum 4 different taxonomic groups



Trigger Values

- HC₅ (95% protection level)
- Uses ETX approach by dividing geometric mean of EC10 values for m species by an extrapolation factor K (OECD 1995)

Where

$$K = \exp(S_m \times k)$$

Where

S_m = sample standard deviation of natural logarithm of EC10 values for m species

K = one-sided tolerance limit factor for a logistical or normal distribution

Tests Performed

- 2005 – Simulated RO brine and pilot-scale RO Brine Prior to plant construction
- 2006 – RO Brine from PSDP at start-up
- 2007 – RO brine from PSDP 12 months post commissioning

Tests used for RO Brine WET Testing: 2005, 2006 and 2007

- **Local Species: Indigenous to, or representative of, Cockburn Sound**
 - Microalga (*Isochrysis* sp.) growth
 - Macroalga (*Ecklonia radiata*) germination
 - Copepod (*Gladioferens imparipes*) reproduction
 - Mussel (*Mytilis edulis*) larval development
 - Fish: Pink Snapper (*Pagrus auratus*) larval growth

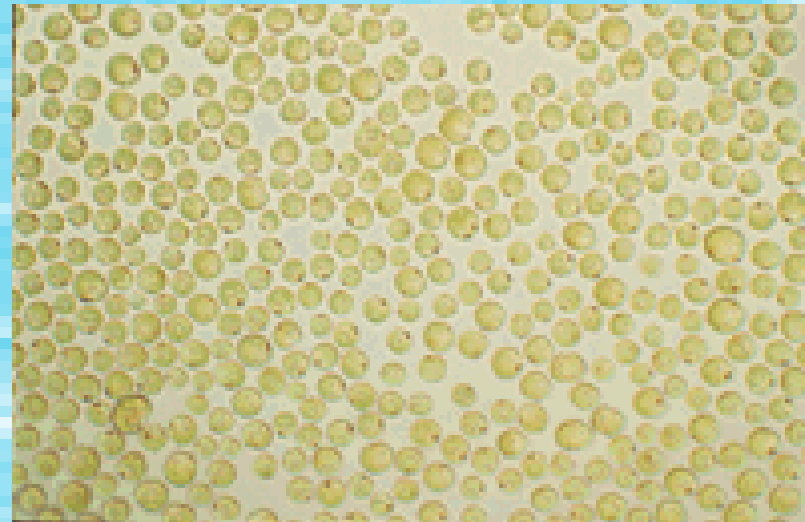
All Bioassays



- Temp: 22 degrees
- Photo period: 12 / 12
- Volume: 3 – 400 mL
- Diluent: Cockburn
Sound sea water filtered
to 0.45 microns
- Exchange: Nil (copepods
100% exchange every 24 hr)
- Replicates: 3 – 4
- Reference toxicants:
chromium and copper

Algal Bioassay

- 72 Hour EC50 algal growth
- *Isochrysis sp.* Common
- End point – Number of algae after 72 hours
- Static
- 8 concentrations and control



Macroalgal Bioassay



- *Ecklonia radiata*, common, temperate
- 72 Hour EC50 germination
- End point – Number of germinated zoospores after 72 hours
- Static
- 8 concentrations and control

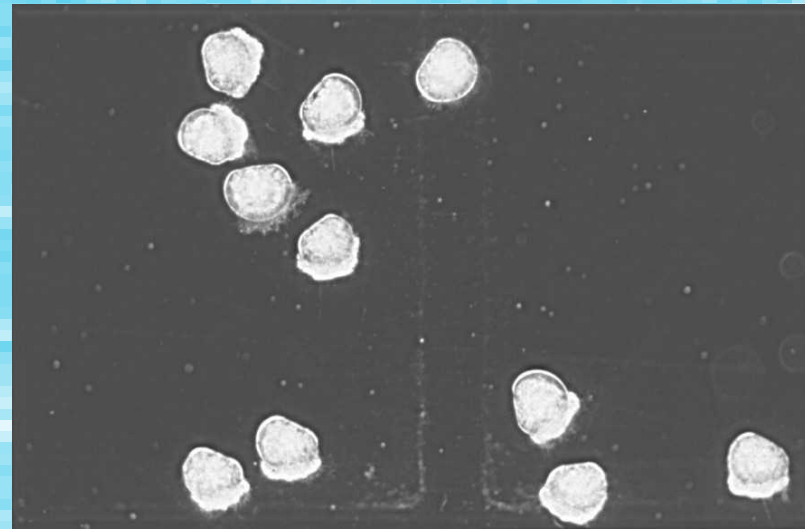
Copepod Bioassay

- *Gladioferens imparipes*, Swan River
- 21 - 28 Day EC50 reproduction
- End point – number of neonates produced
- 24 hour pulse exposure



Mussel Bioassay

- *Mytilus edulis*, common, temperate
- 48 Hour EC50 larval development
- End point – Number of normal and abnormal larvae after 48 hours
- Static
- 8 concentrations and control



Fish Bioassay

- Pink snapper, common, temperate
- 7 Day EC50 Larval Growth
- End point – Length of larvae in mm at day 7 after hatch
- 8 concentrations and control



2007 WET Testing Results

Species	Test	EC50 % RO Brine	EC10 % RO Brine
Microalga	72 hr Growth	81.3	13.7
Macroalga	72 hr Germination	>100	92.9
Copepod 24 hr pulse	28 day Reproduction	29.8	5.9
Mussel	48 hr Larval Development	17.9	12.5
Fish	7 day Larval Growth	19.9	9.6

Species Protection Trigger Values

- Using the EC10 values:
- Exposure to **95%** Species Protection Trigger Value results in a
- **10%** decrease in a chronic factor (growth, reproduction, larval development, etc.)
- in **5%** of exposed species.

2007 BurrliOZ Species Protection Trigger Values (EC10 Values)

Protection Level %	Protection Value % RO Brine	Dilution Factor
99	6.6	15
95	8.2	12
90	9.2	11
80	10.9	9



Conclusions

- Wet testing results show that target dilutions are being met with the 40 port diffuser in Cockburn Sound
- The diffuser has always delivered >45 fold dilution 50 m from the diffuser at all flow rates
- Species protection trigger values are met with a safety margin
- RO Brine from the PSDP poses no significant risks to the Cockburn Sound Ecosystem

Acknowledgements

- I would like to acknowledge the Aquaculture Development Unit at Challenger TAFE, Fremantle for providing the pink snapper eggs.





Thank You