Water use across a catchment and effects on estuarine health and productivity

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The issue

Land-based farmers in upper catchment want to expand and diversify ⇒ increased requirement for water for irrigation

Oyster farmers want environmental flows to maintain estuarine health and oyster production

(2 oyster farms and nursery producing 70% of spat for Tas and SA)

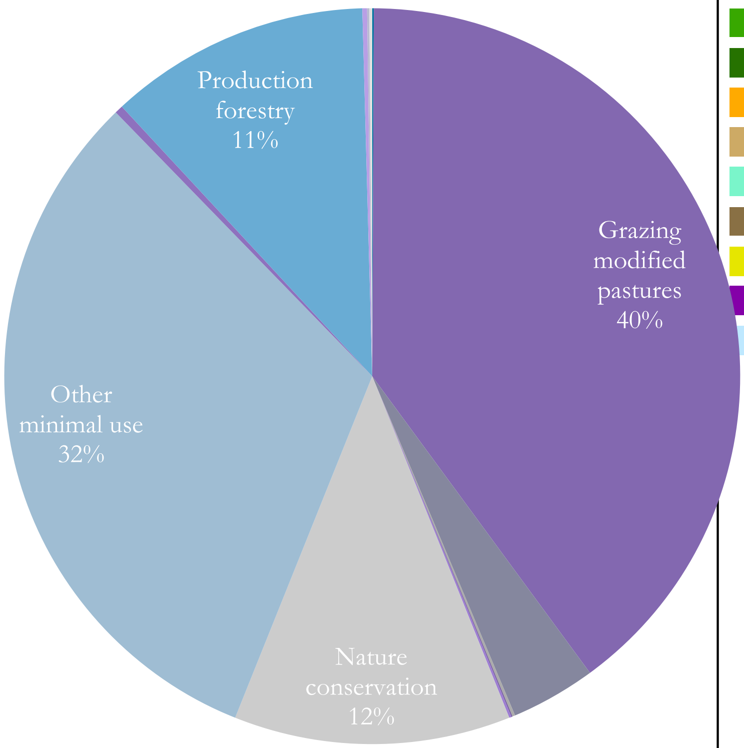
Objectives

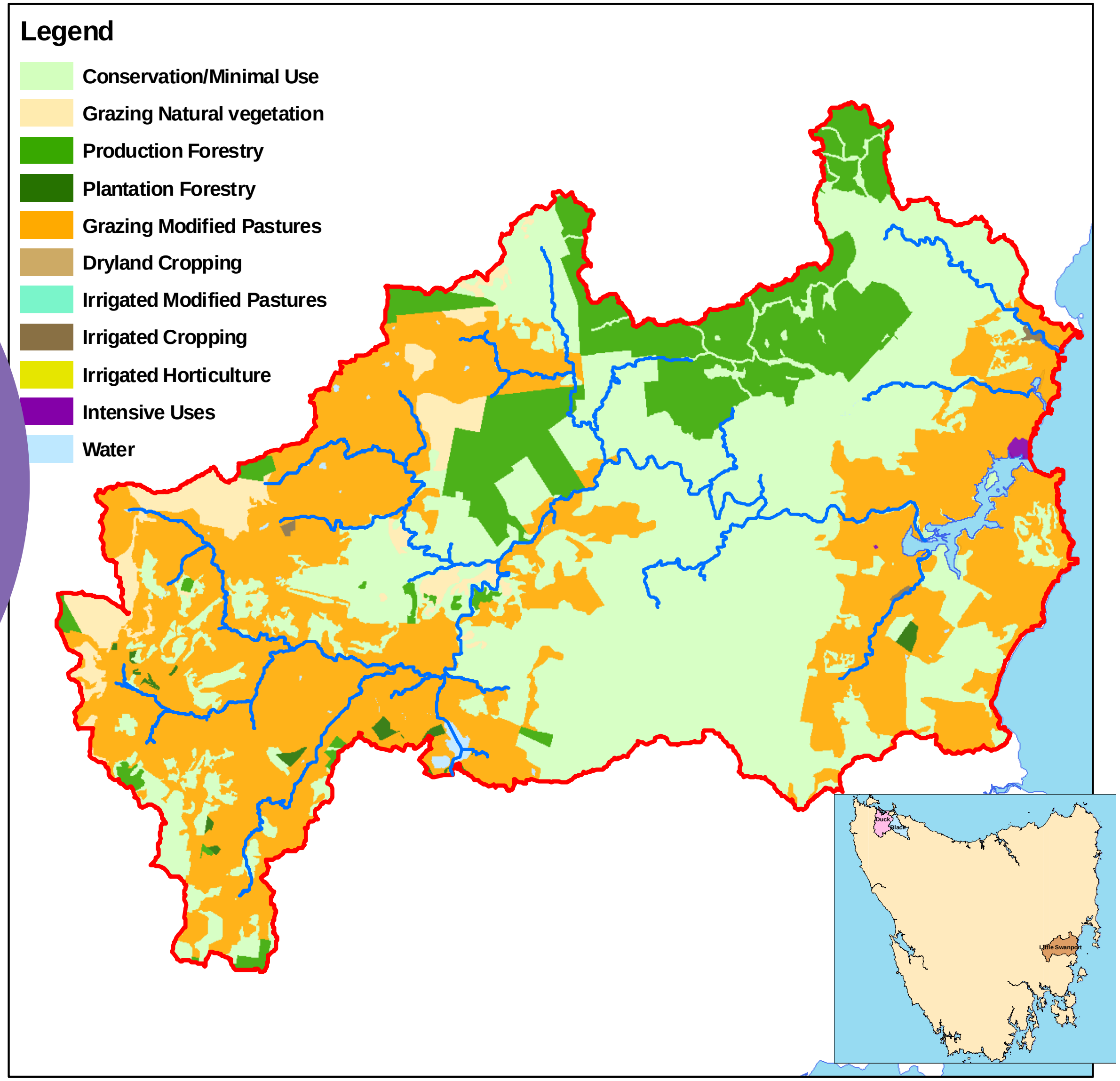
Using the Little Swanport catchment as a case study

1. Complete investigation on environmental flows and develop an estuarine model to predict the effects of different flow regimes.

2. Develop a set of economic accounts and associated tools, to assess the value of water to users across the catchment, including upstream agriculture, shellfish farmers, non-market goods and services.

Length ~ 61 km
Area ~ 609 km2
Rainfall mean ~ 591 mm
Population ~ 600





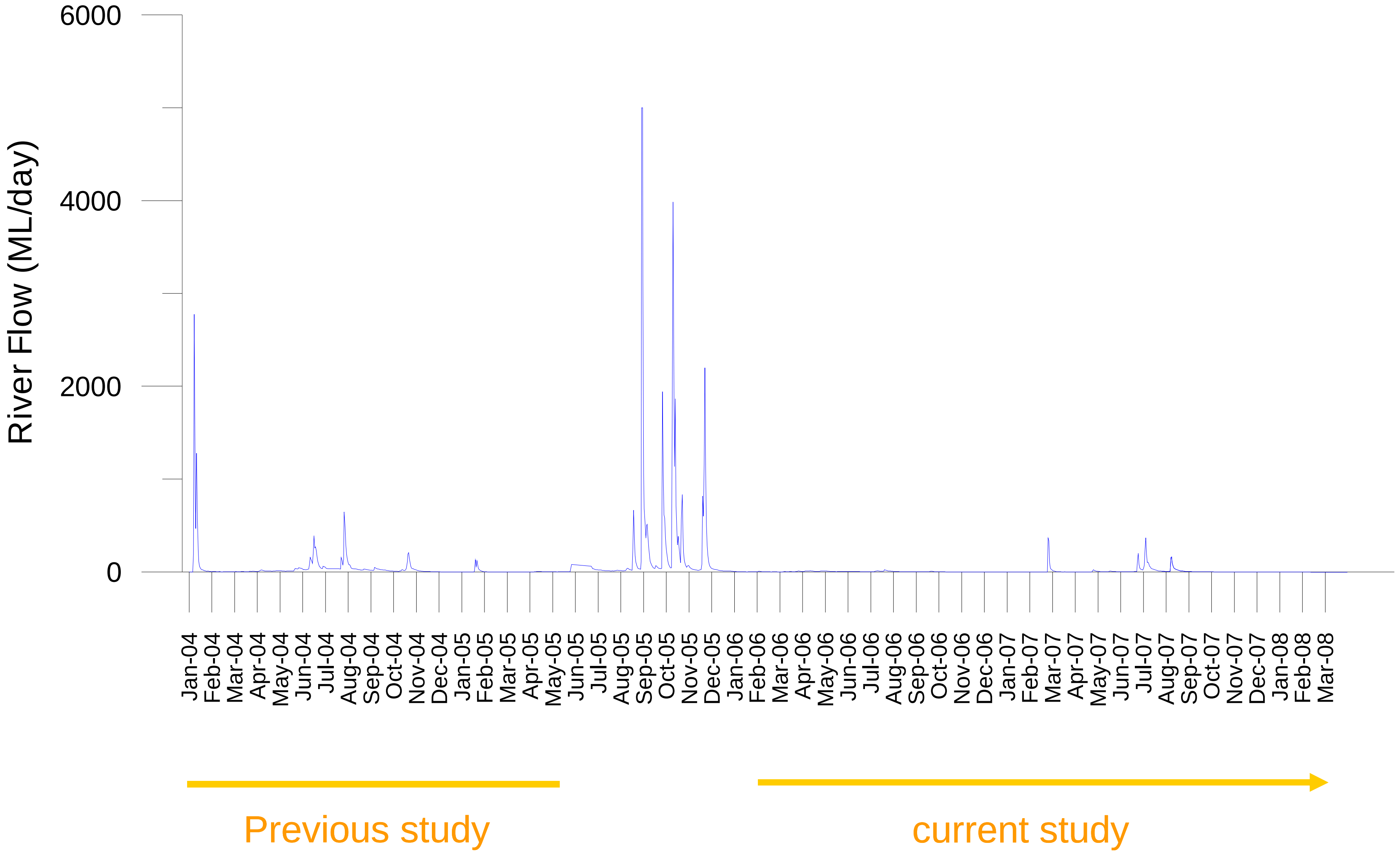
44.38% Human Modified Env.
55.62% Natural Veg /Min Use

Estuary - aims

1. Improved understanding of ecosystem dynamics
2. Role of oyster farming in estuarine dynamics
3. Importance of environmental flows to estuaries

3 approaches

- field observations : e.g. between oyster growth rates and river flow
- nutrient budget: e.g. observations to calculate annual inputs and outputs
- ecosystem box model – predict estuarine response to flows on daily basis



River Flow (ML/day)
6000
4000
2000
0
Jan-04
Feb-04
Mar-04
Apr-04
May-04
Jun-04
Jul-04
Aug-04
Sep-04
Oct-04
Nov-04
Dec-04
Jan-05
Feb-05
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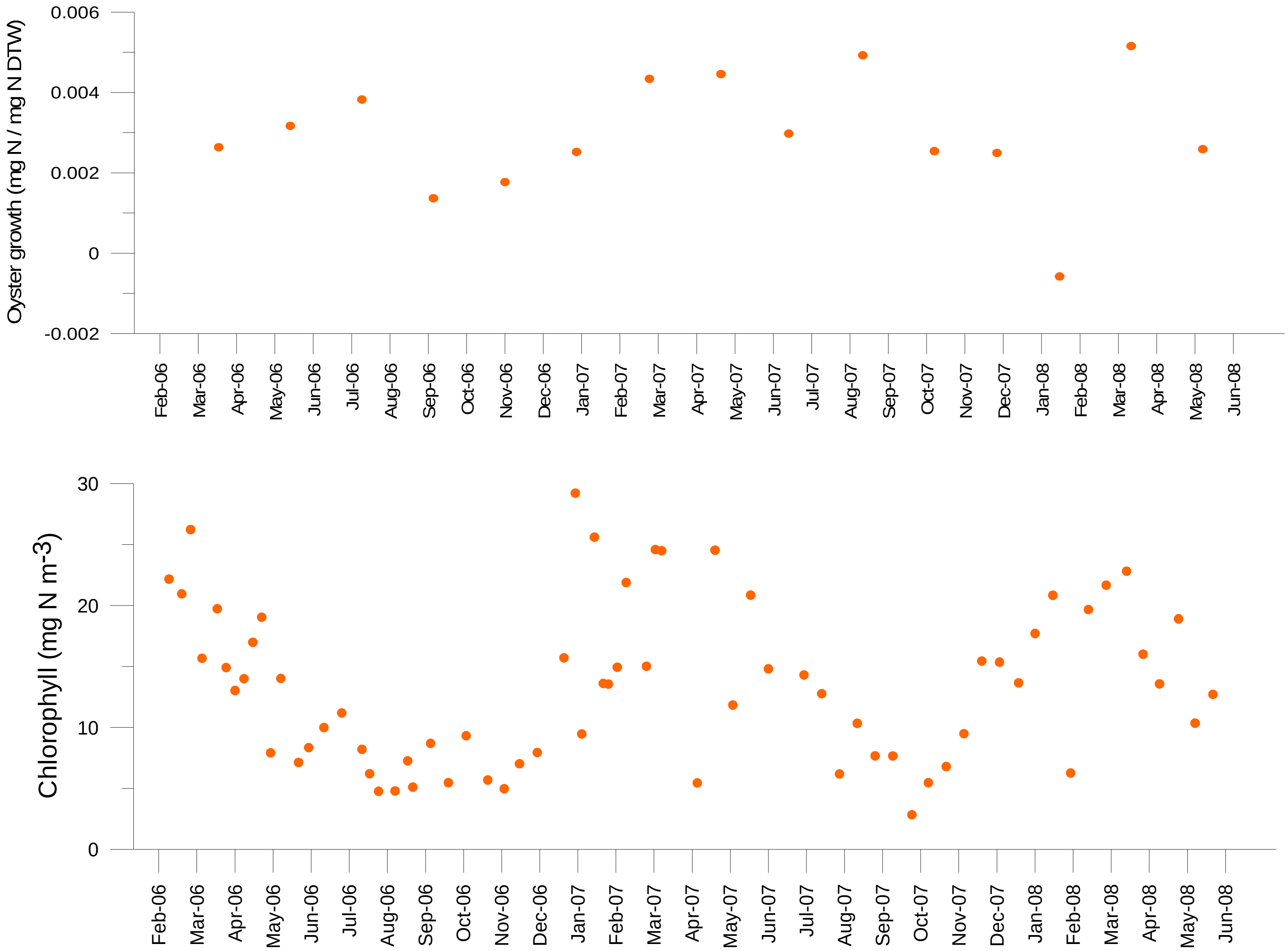
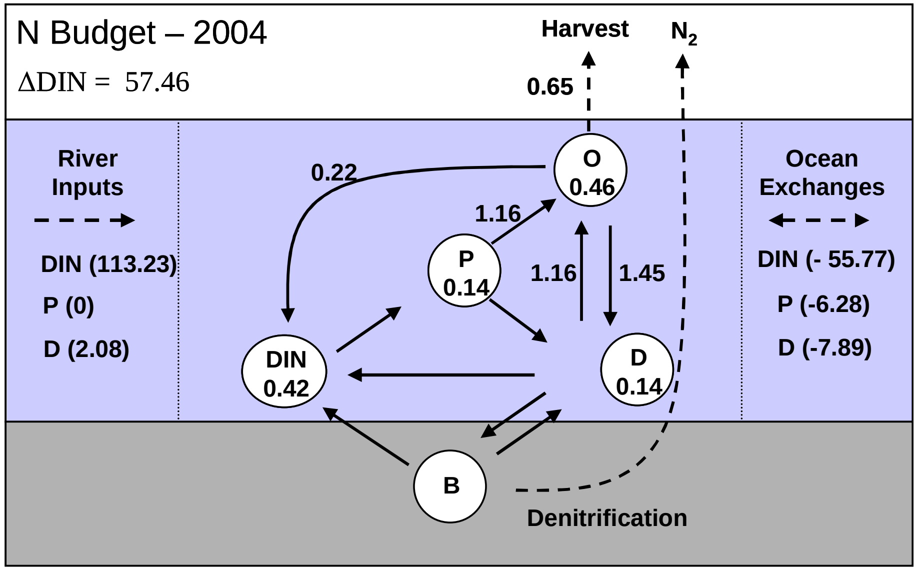
Sep-07
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Previous study
current study

Oyster Growth

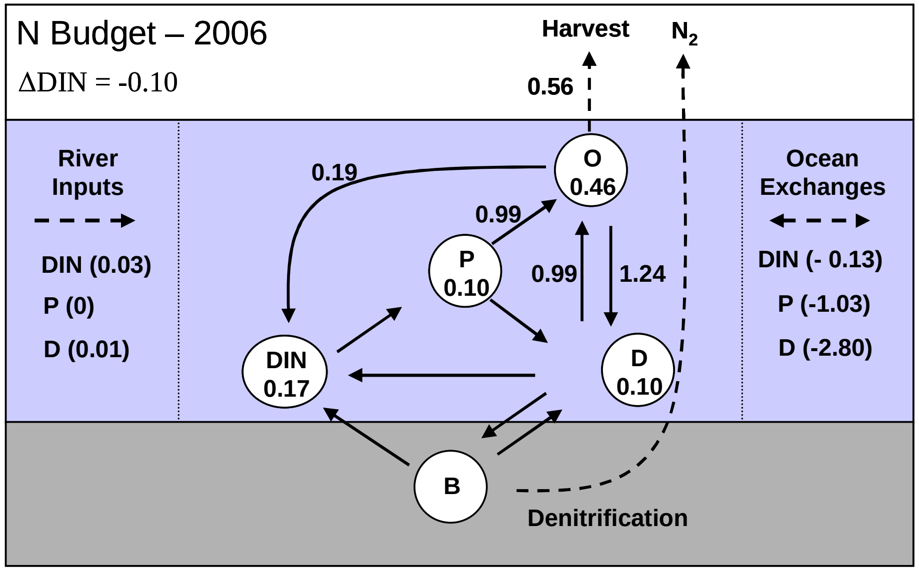


Nutrient budgets

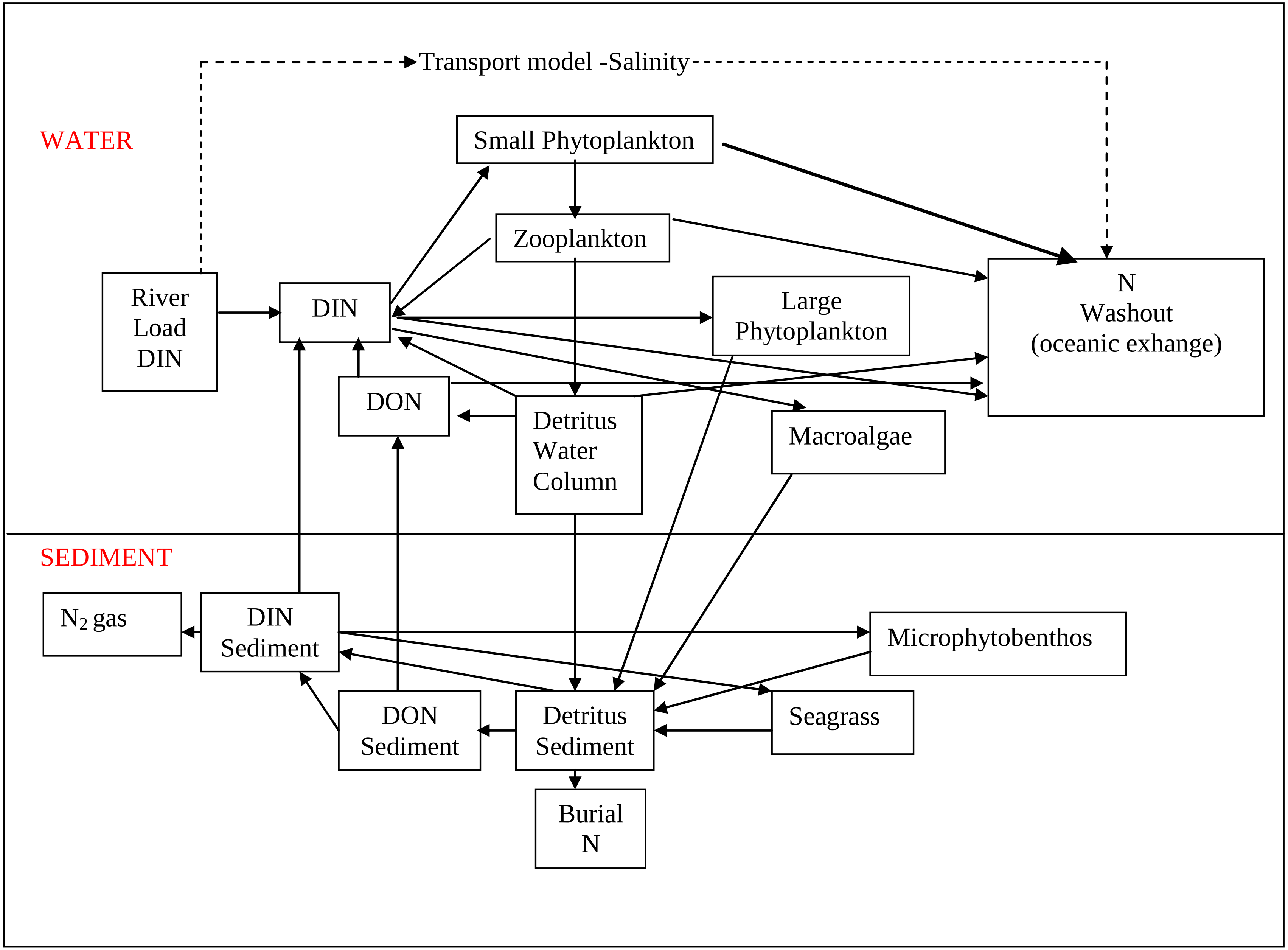
total river flow ~ 31, 251 ML



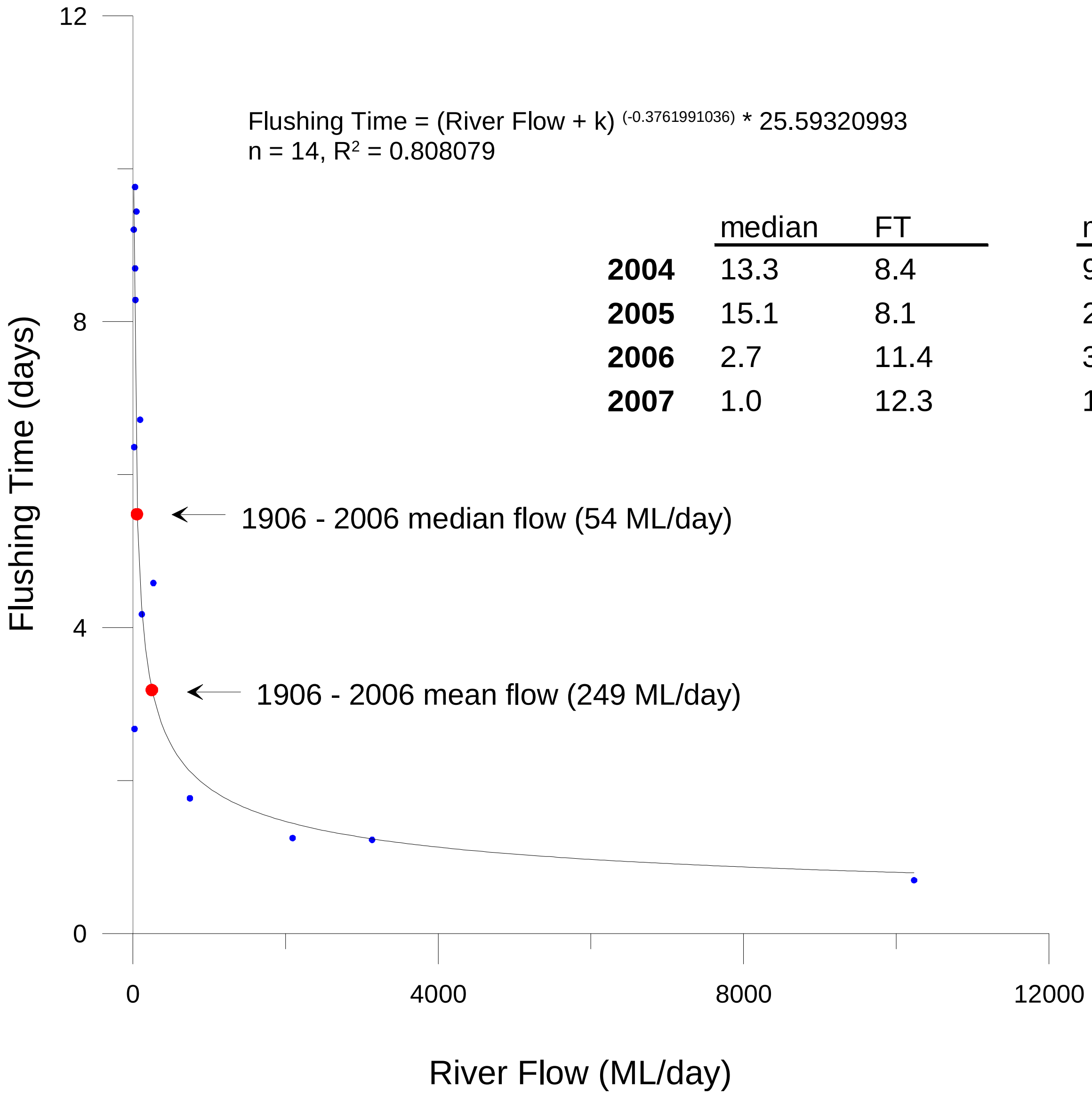
total river flow ~ 1, 234 ML



1D Model Structure of Nitrogen Cycling in Little Swanport Estuary



Transport model

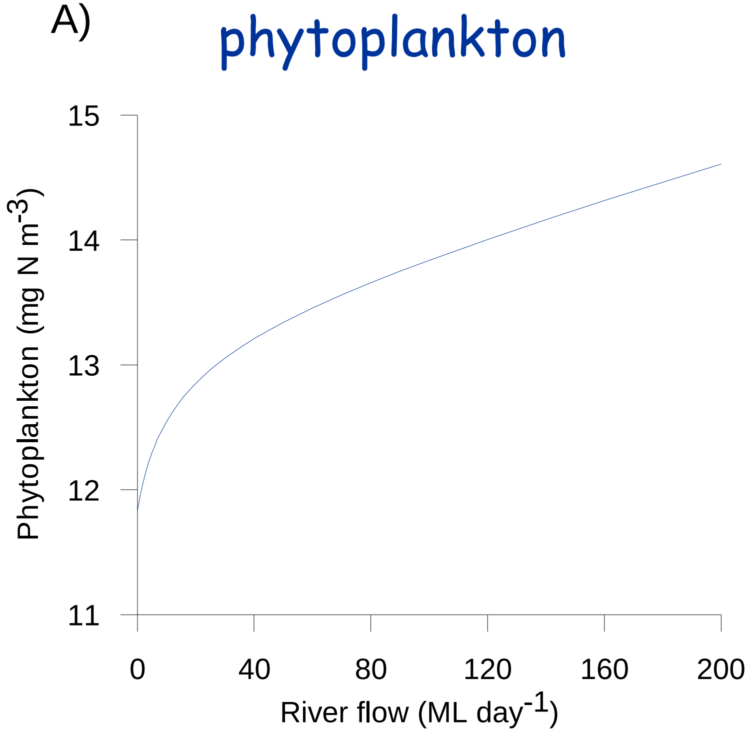


	median	FT	mean	FT	total flow (ML)
2004	13.3	8.4	90.8	4.6	31251
2005	15.1	8.1	206.2	3.4	75258
2006	2.7	11.4	3.4	11.0	1238
2007	1.0	12.3	11.7	8.7	4258

$$C = C_{est}\, e^{\frac{1}{FT}}$$

Model simulation of effect of base flows on estuarine dynamics 0-250 ML day $^{-1}$

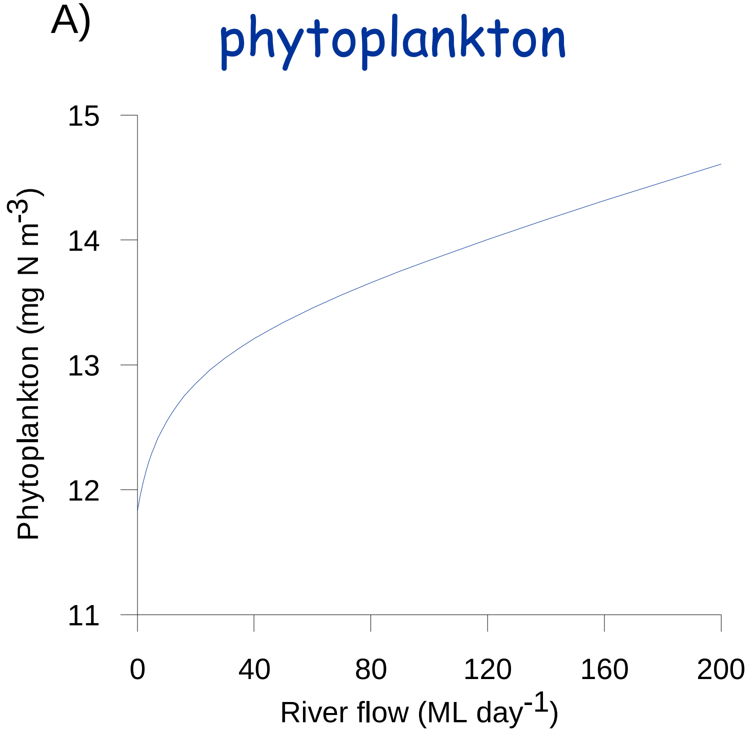
A)



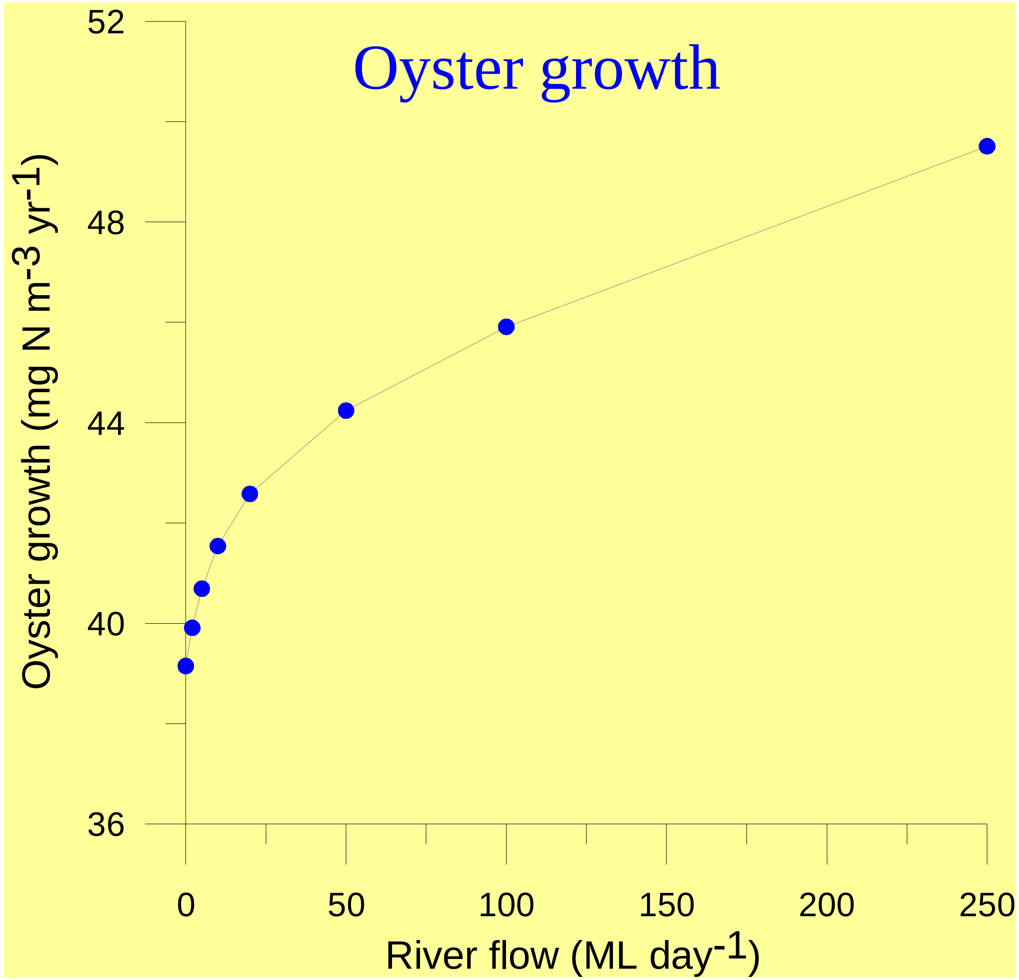
D)

Model simulation of effect of base flows on estuarine dynamics 0-250 ML day $^{-1}$

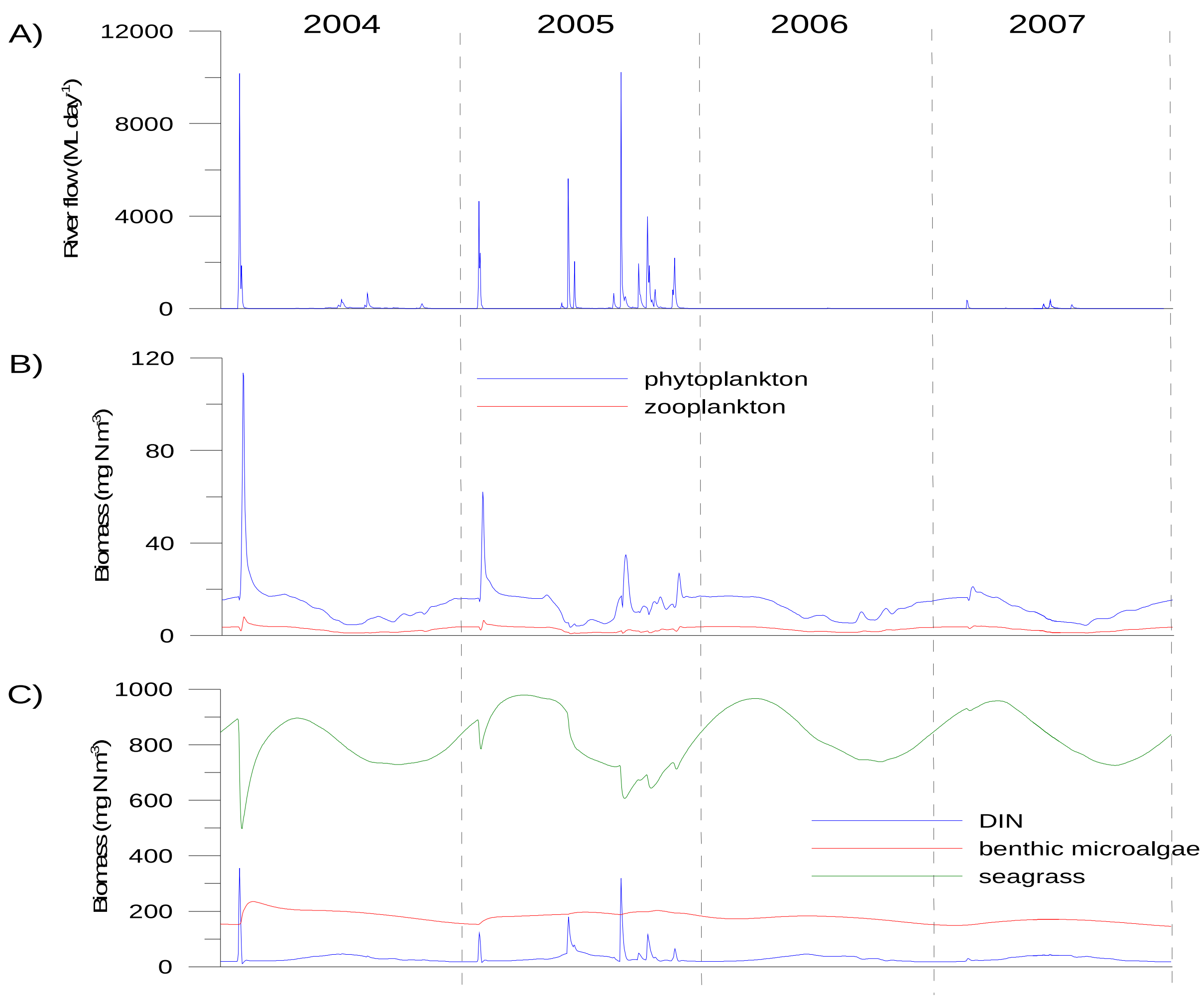
A)



D)



Model simulations for normal vs drought years

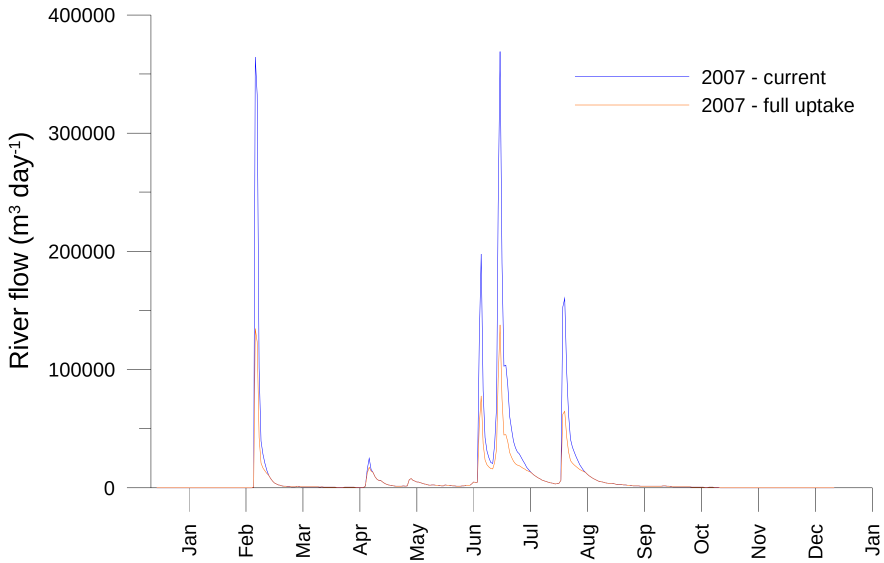


Comparison of total oyster harvest, average biomass of phytoplankton, seagrass, MPB and zooplankton, and the average concentration of DIN in the estuary from 2004-05 to 2006-07.

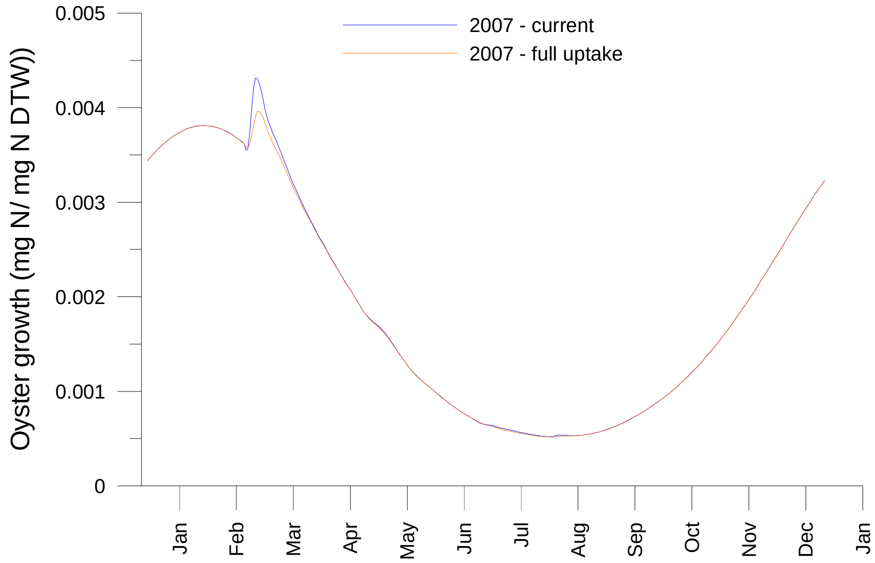
Year	River flow (ML)	Oyster harvest (kg)	Phytoplankton (kg)	DIN (kg)	Zooplankton (kg)	MPB (kg)	Seagrass (kg)
2004	31361	350.9	109.6	251.9	22.0	1034.2	4288.1
2005	75258	362.2	116.1	295.0	22.3	1009.5	4433.3
2006	1238	316.1	97.4	232.9	22.1	948.0	4582.1
2007	4258	310.5	94.9	231.9	21.5	870.2	4549.1
change (04-05 vs. 06-07)	50562	43.3	16.7	41.1	0.3	112.7	-204.9
change as % of 04-05	-95%	-12%	-15%	-15%	-1%	-11%	5%

Model simulations – increased extractions

a)



b)



c)

d)

	Oyster (kg N)	Phytoplankton(kg N)	DIN (kg N)	Zooplankton (kg N)
2007 - current	325.1	101.1	223.5	22.5
2007 - full uptake	320.8	100.3	223.0	22.6
change current to full uptake	1.31%	0.73%	0.20%	-0.18%

Conclusions so far….

- River flow is important for estuarine production
  - 2004 - 2005 vs 2006-2007 drought years
- However, full allocation unlikely to alter estuarine productivity
- Low flows = greater productivity per ML
- Cease to take flows likely to be very important for estuarine EWR's

Socio-Economic study

Aim:

To determine best overall use of resources in the catchment by integrating ecological, economic and social values

- Surveyed all households - landuse, income, expenditure, natural values, social values etc
- Economic structure of catchment
- Value of water
- Water accounts

Linking catchment community to regional economy

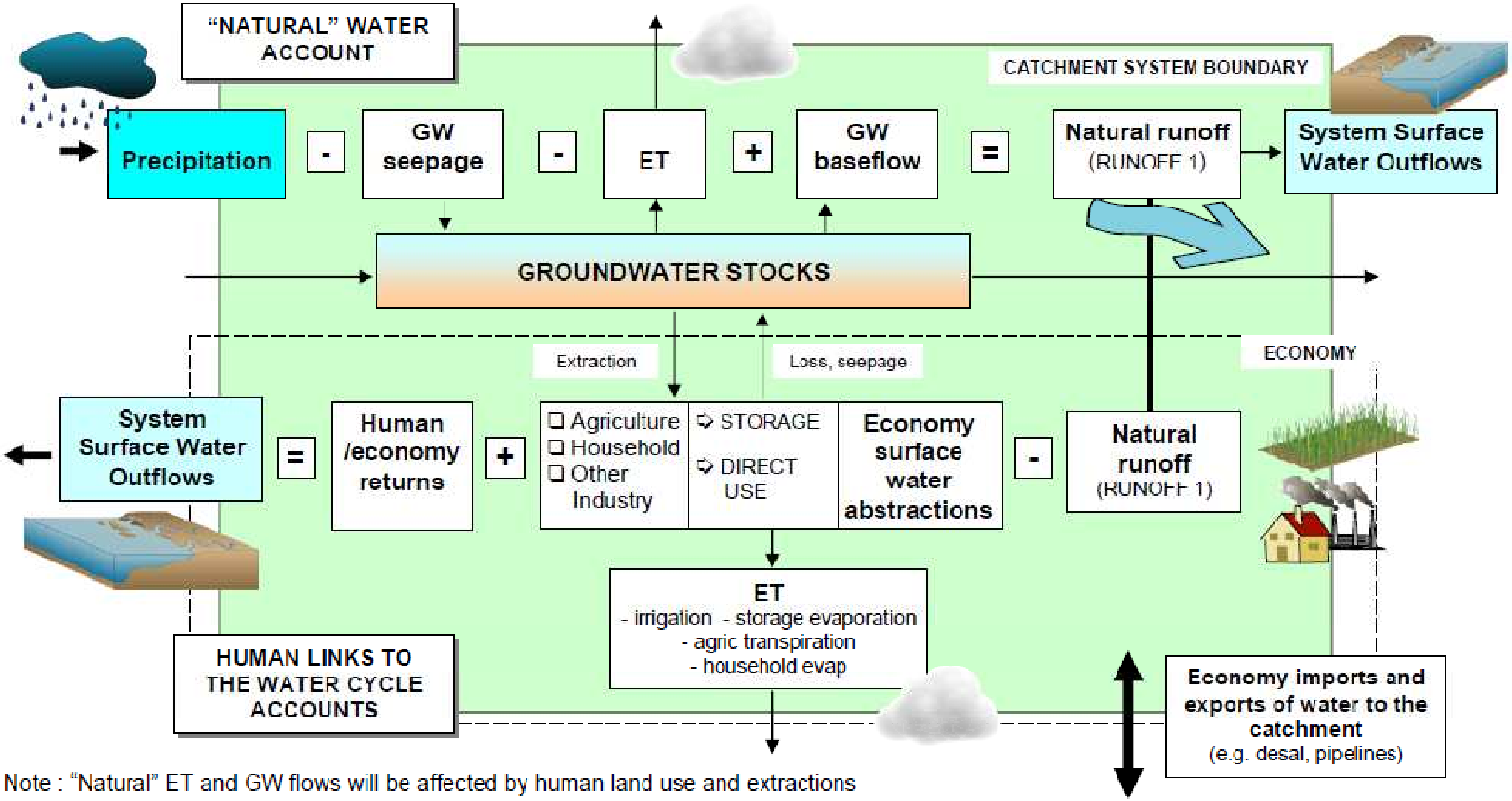
- Developed input-output transaction tables
- No statistically valid relationships between income and water use

  - great variability in farm size and type
  (not enough farms with similar characteristics to develop a representative production function)

  - no data on water used

Figure 16.2 A Simple Water Budget Framework for Catchment Water Accounts

GW = groundwater
ET = evapotranspiration



Note : "Natural" ET and GW flows will be affected by human land use and extractions

Water accounting:

Major components of the water accounts

- Major inflows and outflows to the system (catchment)
- Inflows to surface water
- Inflows to ground water
- Outflows from surface water
- Outflows from groundwater
- Use of water – by supply source and release type

500GL	-	213GL	–	154GL	–	24GL	+	6GL	=	113 GL
(Precip)		(Evaportn)		(Transpiration)		(Recharge to GW)		(GW to baseflow)		(Surface water outflow)

Overall extraction & losses by economic sector

Sector	Surface Water - Volume Extracted	Losses from Evaporation and Transpiration	Losses to Groundwater	Returns to Surface Water
Irrigation	3330 ML	2 429 ML	693 ML	347 ML
Stock and domestic	1 400 ML (1430 – 30 ML to households) + 191 (licensed source extraction)		subtract	
	TOTAL Irrigation and Stock = 4 921 ML			TOTAL water applied to irrigation and stock = 3 469 ML
Dams	Covered in irrigation and stock and domestic above	subtract 960 ML	492 ML	-
Household	30 ML (from dams) 50 ML (rainwater harvesting) TOTAL = 80 ML	64 ML	16 ML	
TOTAL	5 000 ML			

TOTAL FLOWS DIVERTED BY DAMS (excluding households) =
4 921 ML – 3330 (irrigation) + 1400 (stock ; non licensed) + 191 (stock ; licensed)
TOTAL WATER APPLIED FOR IRRIGATION AND STOCK =
3 469 ML = 4921 (dam diverted flows) – 960 ML (dam evap) – 492 (dam seepage)
FATE OF WATER APPLIED FOR IRRIGATION AND STOCK = 3 469 ML
347 ML to surface water (10%) 693 ML to groundwater (20%) 2 429 ML evapotranspiration (balance)
TOTAL SURFACE WATER DIVERSION =
5 000 ML = 4 921 (Dam diverted) + 80 ML (Household)
RETURNS TO SURFACE WATER FROM THE ECONOMY =
347 ML (Irrigation and stock to groundwater)
NET CONSUMPTION OF SURFACE WATER (including losses to groundwater) =
4 653 ML = 5 000 ML – 347 ML (3 452 if loss to groundwater not considered consumption)

Different approach to valuing water

Value of water under drought conditions

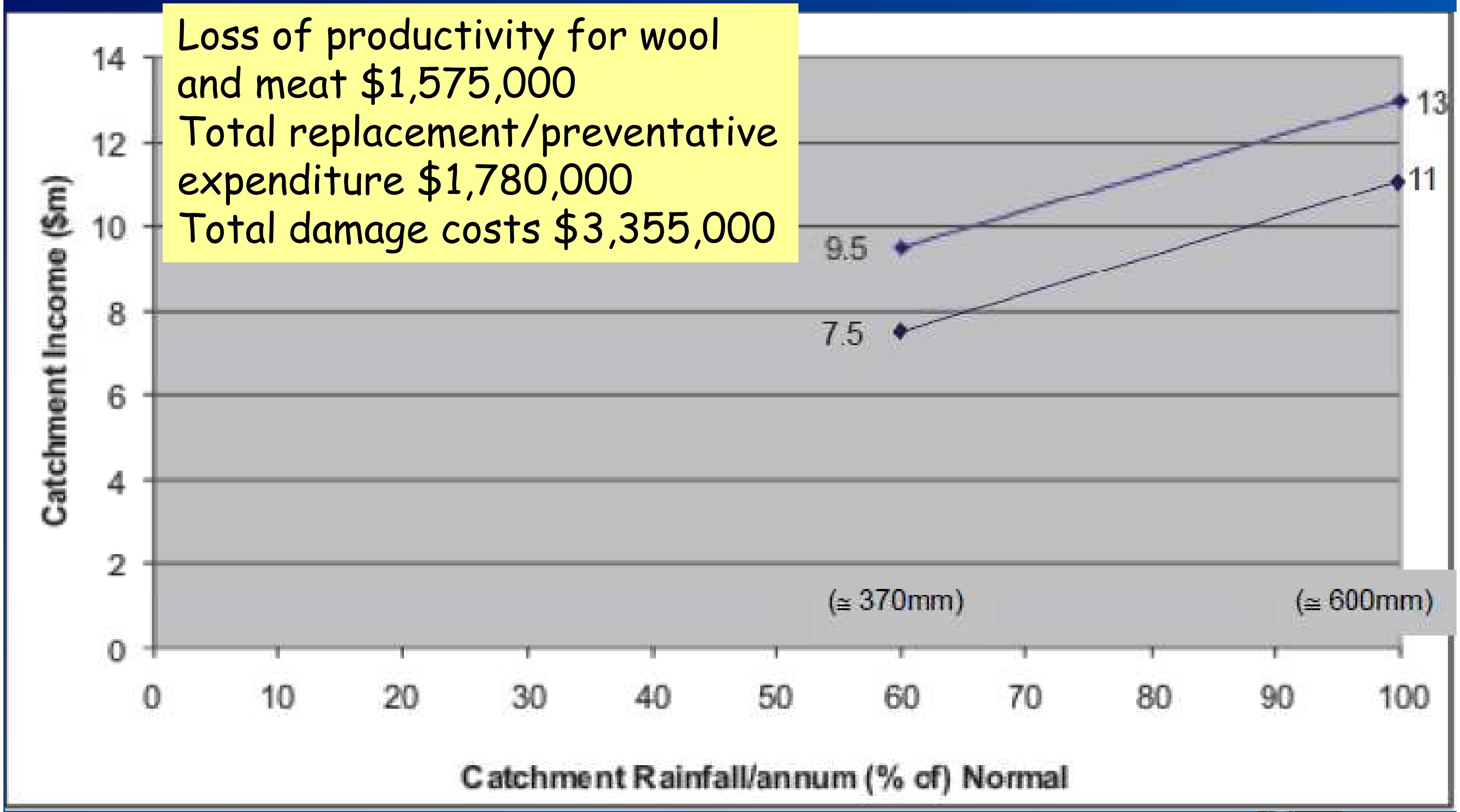
Resurveyed in 2007 and modelled value of changes in water quantity

- Loss of productivity
- Preventative expenditure
- Replacement costs

Preventative Expenditure leading up to 2006-07

Action Taken	Percentage of Farmers Undertaking this Strategy	Average Additional Costs for Those Taking Action
1. Purchase more than normal stock feed	57%	The average ***additional*** purchases in 2005-06 were $7,600
2. Grow more than normal stock feed	43%	The average ***additional*** material costs were in the order of $20,000 in 2005-06
3. Clearing-out existing dams, installing water tanks & troughs, improving irrigation, digging new water holes	36%	The average ***additional*** material costs were in the order of $15,000 in 2005-06
Other (eg. Use more fertilizer, open up new paddocks for grazing)	14%	

Rainfall and Income




Losses (drought) continued in 2008
Winter 2009 hasn't stopped raining