aurecon

Leading. Vibrant. Global.

Relationships Between the Areas of Seagrass, Mangroves and Saltmarshes with Commercial Finfish Catch in various types of NSW Estuaries

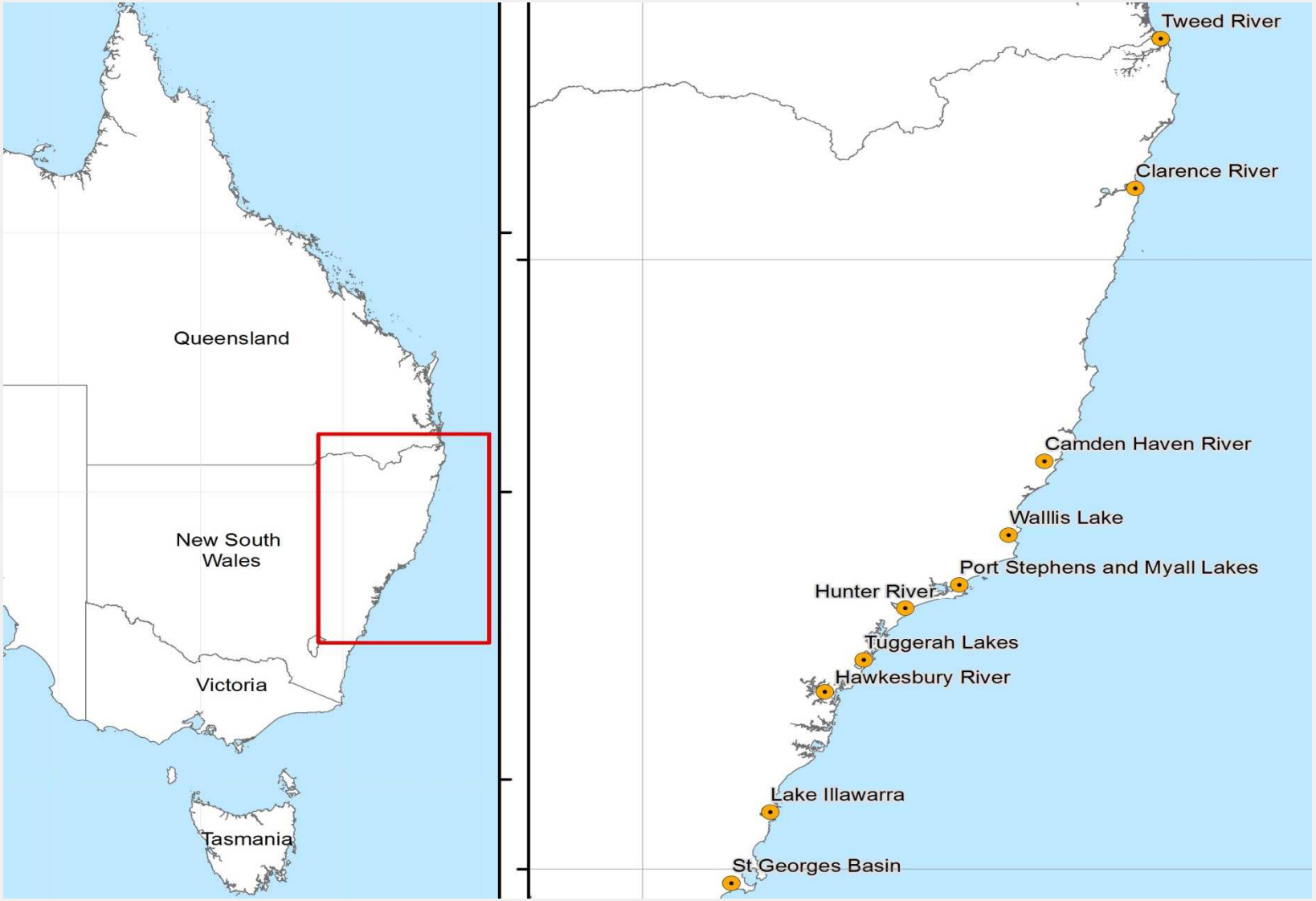
Dr Bruce Hodgson

Image source: Mangrove tree and pneumatophores in Moreton Bay, Qld
Photo taken by BoundaryRider 24/12/11
http://en.wikipedia.org/wiki/File:Mangrove_and_pneumatophores_in_Moreton_Bay,_Qld.JPG (Accessed 11 June 2013).

Background to relationships between Estuarine Wetland Areas and Commercial Finfish Catch

- Seagrass, mangroves and saltmash support juveniles of commercial fish species, so the relationship of the combined influence of these areas, within estuaries, to the commercial finfish catch was examined.
- The data used was taken from the nine New South Wales (Australia) estuaries studies by Gillson et al. (2008).

Study Area


Queensland
New South Wales
Victoria
Tasmania
Tweed River
Clarence River
Camden Haven River
Walllis Lake
Port Stephens and Myall Lakes
Hunter River
Tuggerah Lakes
Hawkesbury River
Lake Illawarra
St Georges Basin

Study Area

NSW estuaries studied:

- Clarence River (CR)
- Hunter River (HR)
- Hawkesbury River (HawR)
- Camden Haven River (CHR)
- Wallis Lake (WL)
- Port Stephens and Myall Lakes (PS+ML)
- Tuggerah Lakes (TL)
- Lake Illawarra (LI)
- St Georges Basin (StGB)
- with Tweed River (Twd) included

Maps of the NSW estuarine wetlands (seagrass, mangrove and saltmarsh) are shown in: http://www.dpi.nsw.gov.au/research/areas/aquatic-ecosystems/estuarine-habitats-maps

Commercial Finfish Catch and Wetland Areas

Location	Finfish*	Seagrass	Mangrove	Saltmarsh	Estuary Area
	t/y	km²	km²	km²	km²
CR	1088.6	0.82	7.65	2.90	132.3
HunR	167.5	0.15	15.00	5.00	47.0
HawR	400.0	0.38	11.00	2.40	114.5
CHR	153.0	10.25	1.40	0.77	32.2
WL	459.5	33.20	0.00	5.29	98.7
PS+ML	580.9	11.14	9.46	5.03	134.4[#]
TL	311.9	17.61	0.00	0.11	80.8
LI	178.3	7.96	0.00	0.32	35.8
StGB	55.4	3.17	0.28	0.15	40.9
Twd^	150^^	0.30	3.10	0.20	22.7

*July 1997 to July 2007 ^^total catch 119 to 197 t/year [#]Port Stephens
^(http://dbforms.ga.gov.au/pls/www/npm.ozcoast2.showmm?pBlobno=8997)

Wetland and Commercial Finfish Catch Relationships Indication of future areas of Research

- The Gillson et al. (2008) estuaries had mostly high and low areas of mangroves, so the Tweed River (Twd) wetland areas and finfish catch was added to provide an intermediate area of mangroves.

- The relationships obtained are estimates for indication of future areas of research into the contributions of seagrass, mangroves and saltmarshes to the commercial (and recreational) finfish catch in NSW estuaries.

Procedure for Estimation of Seagrass, Mangroves and Saltmarsh Area Contributions to Commercial Finfish Catch

The differing contribution of the coastal wetland areas of seagrass, mangroves and saltmarsh to the commercial catch were unravelled step-wise using regression of each wetland area against catch, by using existing knowledge of their importance (eg McArthur et al. 2003, Bloomfield & Gillanders 2005). The literature suggests seagrass > mangrove > saltmarsh in importance to fish catch.

The following steps were undertaken:

1. Initial relationships for dominant wetland areas:
   - Regression of dominant wetland type against fish catch was undertaken first.
2. Final relationships for each wetland area was estimated by iteration, using the initial relationships, to correct for contributions from other wetland areas.
3. The estimated relationships between wetland areas and finfish catch was assumed to apply to all the estuaries

Procedure for Estimation of Seagrass, Mangroves and Saltmarsh Area Contributions to Commercial Finfish Catch

Assumptions:

- Commercial catch represents the maximum number of fish operators can possibly catch, or allowed by NSW Fisheries
- Commercial finfish catch is influenced by:
  - Physical limitation for fishing
  - Management controls by NSW Fisheries
    - Including access to fishing areas
    - Area closures for recreational anglers
    - Protection of wetland areas
- Contribution to the finfish catch by wetland areas of each particular relationship being examined could not be accounted for
- Contributions from non-vegetated areas to the catch are not known and not included

Relative Importance to the Commercial Finfish Catch and Combined Seagrass, Mangrove and Saltmarsh Areas to the Total Catch in all the Estuaries

Relationships for each wetland type:

- Fish Catch $_{seagrass}$ = a_1 x (Seagrass Area) + b_1
- Fish Catch $_{mangrove}$ = a_2 x (Mangrove Area) + b_2
- Fish Catch $_{saltmarsh}$ = a_3 x (Saltmarsh Area) + b_3

where

- a_1 = fish catch (tonnes/years) per Seagrass Area (km^2)
- a_2 = fish catch (tonnes/years) per Mangrove Area (km^2)
- a_3 = fish catch (tonnes/years) per Saltmarsh Area (km^2)
- b_1, b_2, b_3 = fish catch contributed by wetlands or other areas not part of the relationship being examined.

Relative Importance and total catch for each wetland type:

- Rate (fish tonnes/year/ km^2):

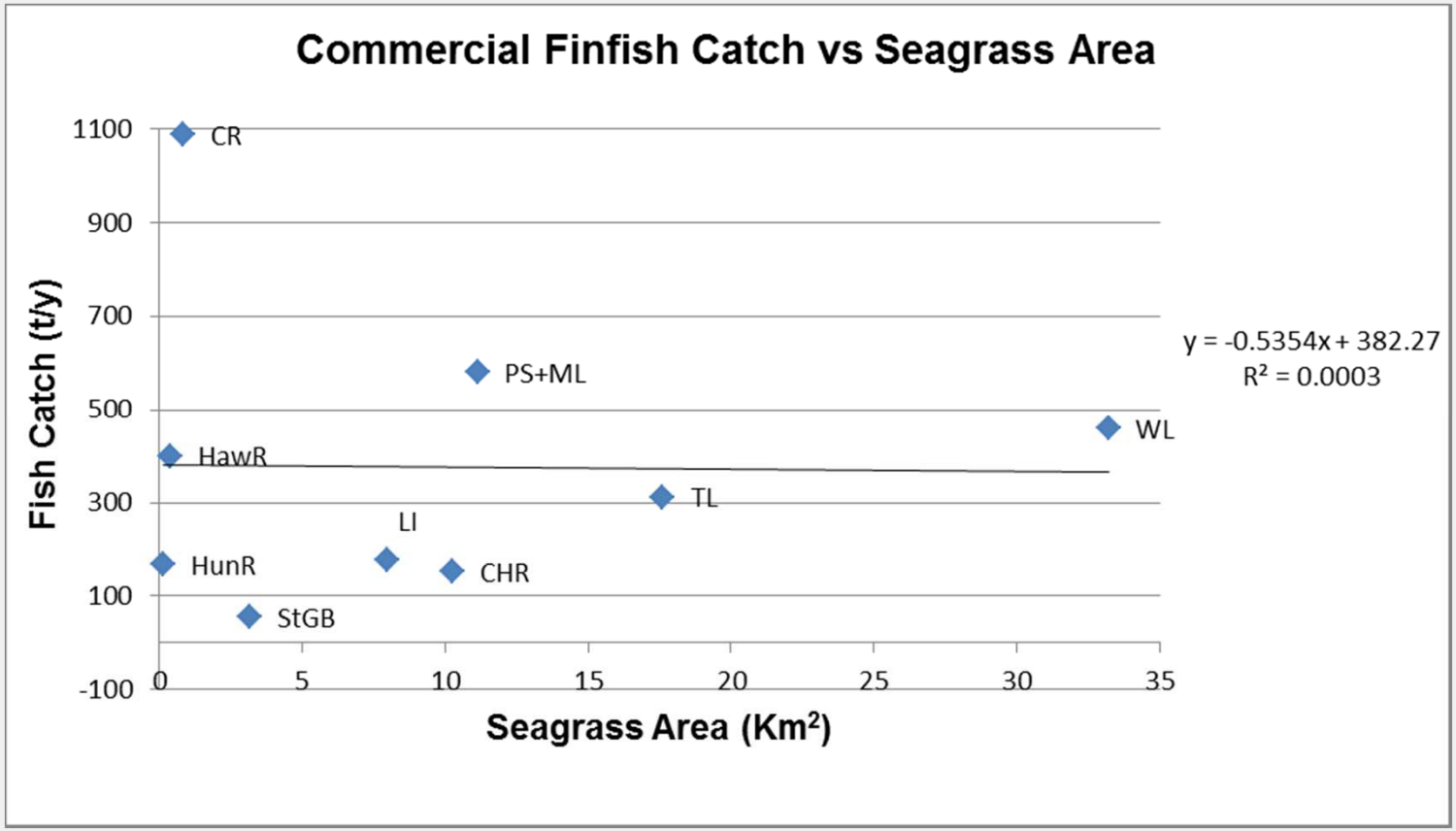
  seagrass a_1 : mangrove a_2 : saltmarsh a_3

- Total fish catch in an Estuary (Tonnes/year):

$\sum a_1$ (Seagrass Area) + a_2 (Mangrove Area) + a_3 (Saltmarsh Area) – [(b_1+ b_2 + b_3)]

Seagrass vs Finfish Catch

If estuaries with high mangrove and / or saltmarsh are not taken into account, there is no relationship between seagrass area and fish catch.



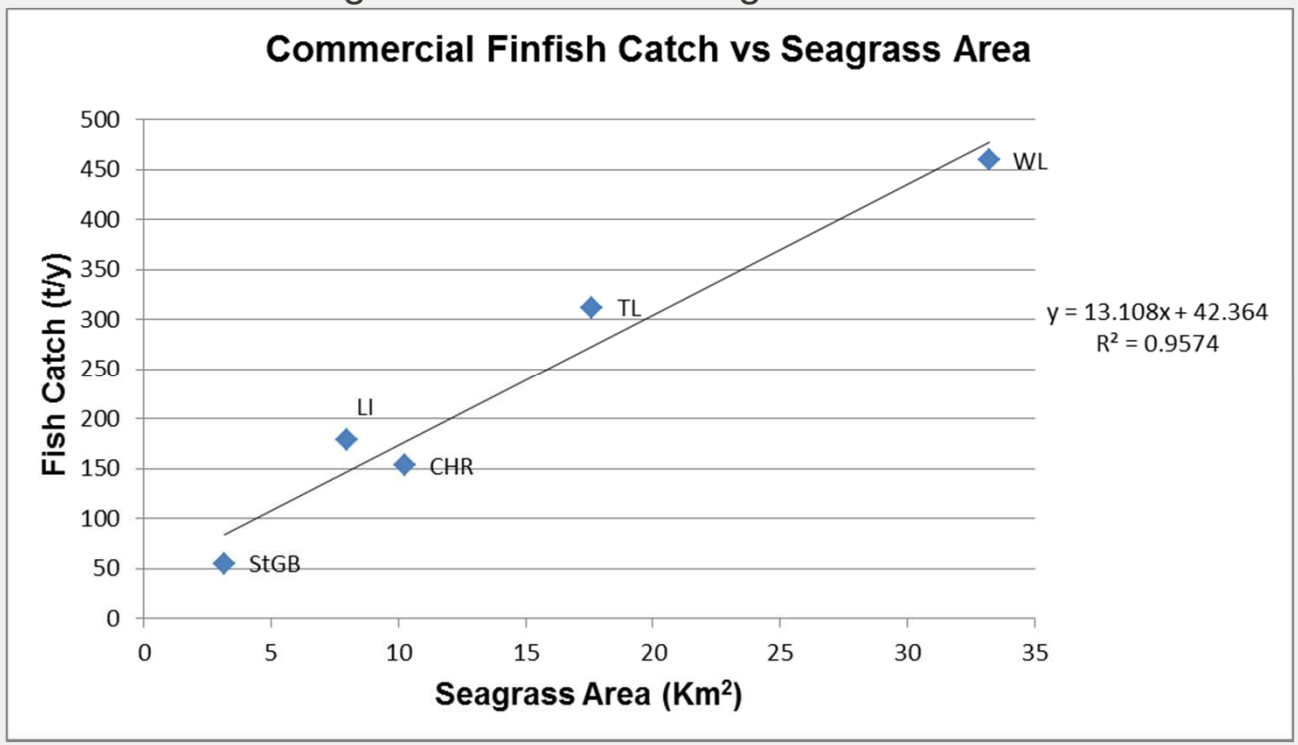
Clarence, Hunter and Hawkesbury Rivers and Port Stephens and Myall Lakes have relatively significant areas of mangroves and saltmarsh, so these were removed in the regression for estuaries dominated by seagrass.

Seagrass vs Fish Catch

The remaining estuaries dominated by seagrass area are **coastal lagoons** and the regression obtained was:

$$\text{Fish Catch}_{\text{seagrass}} = 13.108 \times (\text{Seagrass Area}) + 42.364,\ R^2 = 0.9574\ (p<0.001)$$

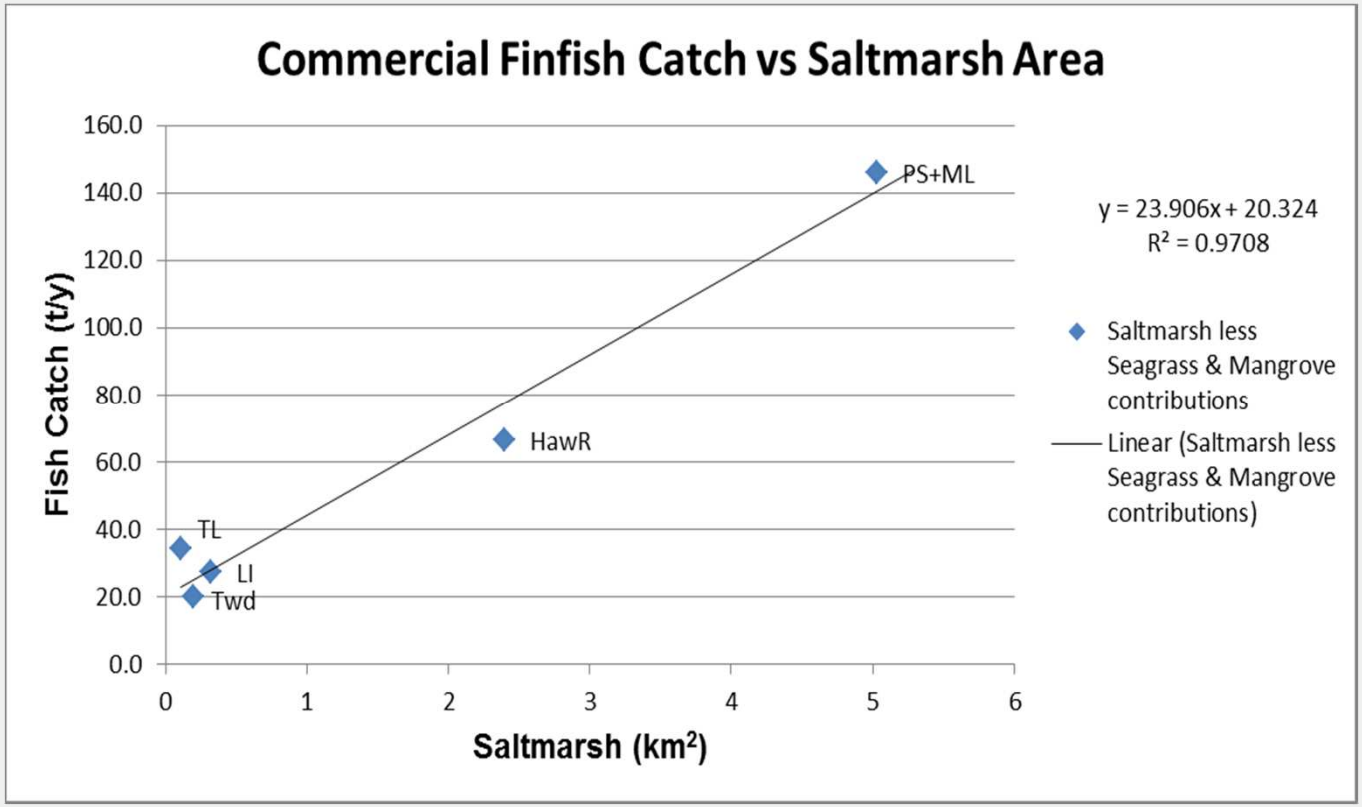
The relationship between seagrass area and fish catch was assumed to apply to all the estuaries and was used to remove seagrass effects on mangrove and saltmarsh areas.



It is noted that the contribution of seagrass area to finfish catch for the highly urbanised Tuggerah Lakes (TL) and Lake Illawarra (LI) estuaries fitted the same relationship as operating in more pristine estuaries.

Commercial Finfish catch vs Saltmarsh Area with Seagrass Contribution to Catch Removed

Saltmarsh contribution to fish catch after seagrass and mangrove contributions were subtracted.



The regression obtained was:

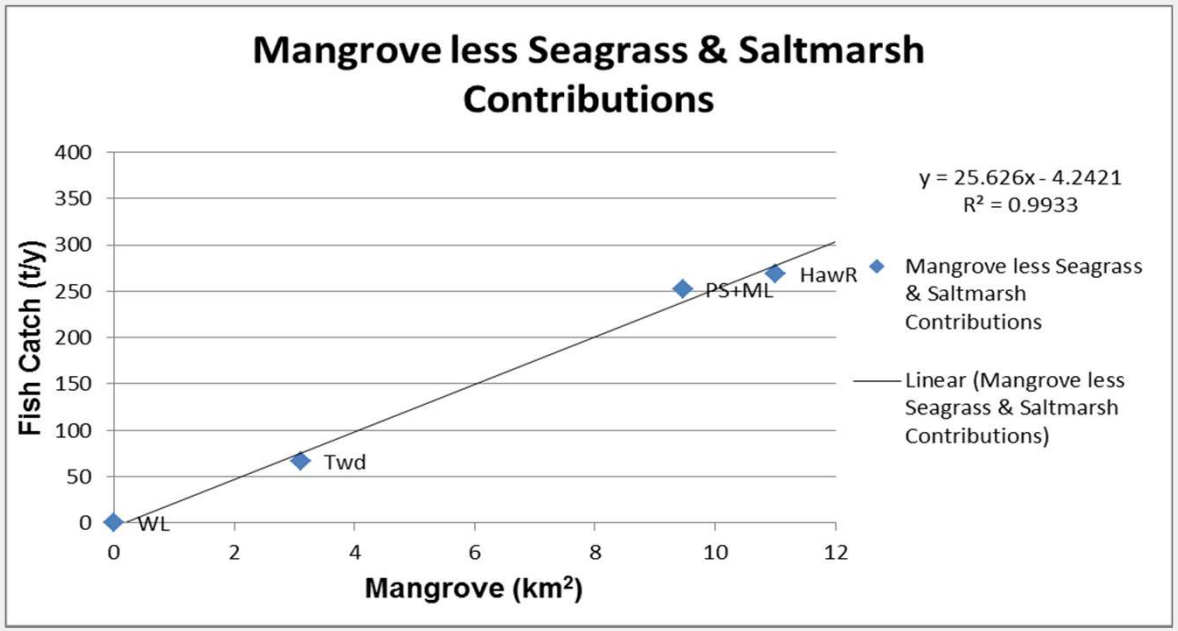
$$\text{Fish Catch}_{\text{saltmarsh}} = 23.906 \times (\text{Saltmarsh Area} + 20.324,\ R^2 = 0.9708\ (p<0.01)$$

This relationship and that for seagrass was used to adjust the estimated finfish catch due to mangrove areas.

Commercial Finfish Catch vs Typical Mangroves Areas

Mangrove contribution to finfish catches was complicated by a very high catch in the Clarence River and a very low catch in the Hunter River. These are treated separately below.

Accounting for contributions due to seagrass and saltmarsh, only four estuaries remained, including the Tweed River, Hawkesbury River, Port Stephens and Myall Lakes, with Wallace Lake used to direct the relationship through zero.



The regression obtained was:

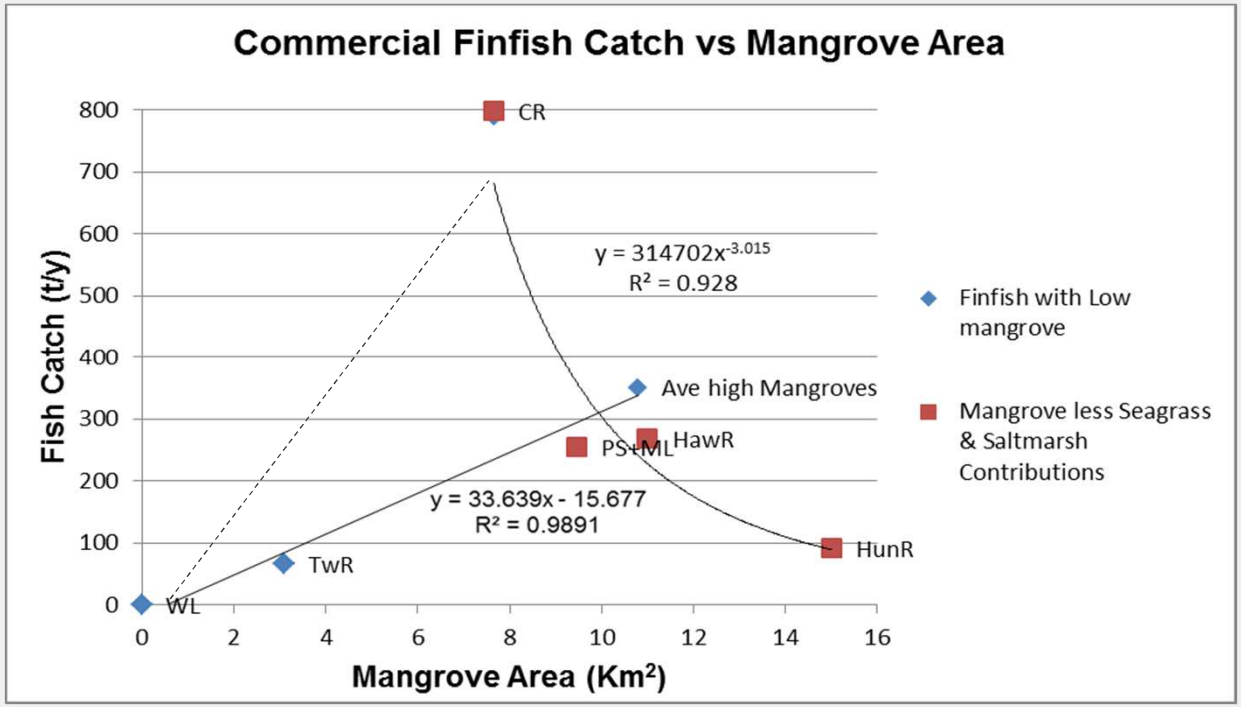
$$\text{Fish Catch}_{\text{mangroves}} = 25.626 \times (\text{Mangrove Area}) - 4.242,\ R^2 = 0.9933\ (p<0.001)$$

This regression is tentative and approximates the average contribution of high mangrove estuaries to finfish catch examined in the next figure.

Commercial Finfish Catch for High and Low Mangrove Area Estuaries

The high Clarence River catch and low catch in the Hunter River with about twice the mangrove area suggests:

- Clarence River represents the potential for mangroves to contribution to the commercial (and recreational) finfish catch
- Commercial fishing in the Hunter River is limited by access to the fish



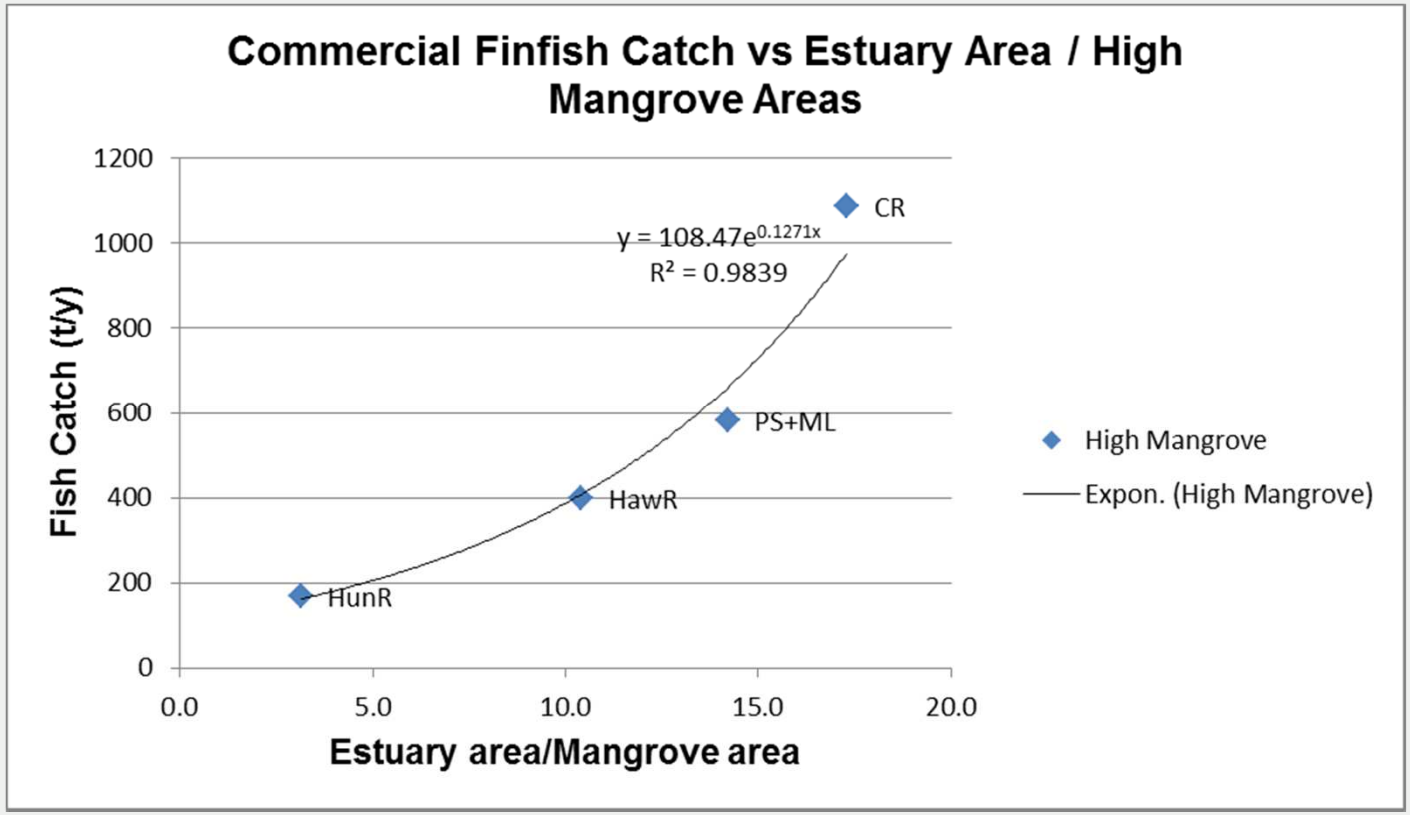
The dotted line indicates a potential link between low and high mangrove areas and contribution to catch.

As fishing access appears to be a factor, the effect of estuary area was investigated.

Commercial Finfish Catch for High Mangrove Area Estuaries with Area of the Estuary taken into account

When the estuary area is taken into account, the importance of a large enough estuary to allow harvesting of the mangrove contribution to the finfish catch, in areas outside the mangrove areas, becomes apparent.

It was also noted that the size of the estuarine area was important to determining the finfish catch in all the estuaries examined (see Table above).



Rate of Finfish Catch per Wetland Area and Total Catch for each Type

Location	Reported Finfish	Estimated Mangrove	Estimated Saltmarsh	Estimated Seagrass	Predicted Total
	t/y	km²	km²	km²	t/y
CR	1088.6	681.8*	69.3	10.7	761.9
HunR	167.5	89.5*	119.5	2.0	211.0
HawR	400	286.1	57.4	5.0	348.5
CHR	153	40.1	18.4	134.3	192.8
WL	459.5	0	126.5	434.9	561.4
PS+ML	580.9	246.7	120.2	145.9	512.8
TL	311.9	0	2.6	230.7	233.3
LI	178.3	0	7.6	104.3	111.9
StGB	55.4	11.4	3.6	41.5	56.5
Twd	150	83.7	4.8	3.9	92.4
Average	354.51	127.0	53.0	111.3	308.3
Rate (Finfish/ km²)		26.5	23.9	13.1	

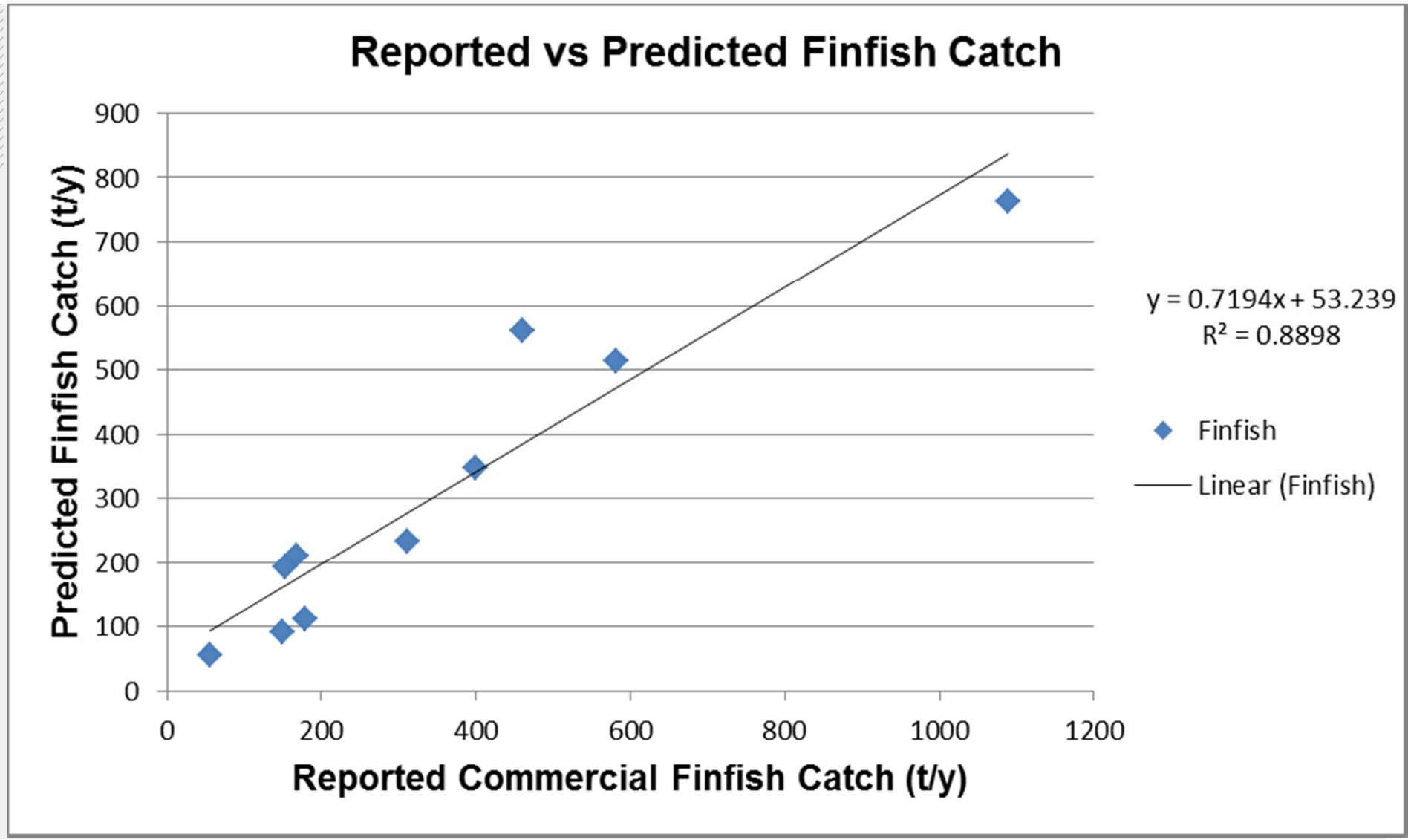
*power relationship of mangrove area with finfish catch

Rate of Finfish Catch per Wetland Area and Total Catch for each Type

The findings were:

- Overall average total predicted finfish catch of 308.3 tonnes was 87% of the reported average of 354.5 tonnes
- Average finfish catch (tonnes) potentially attributable to mangroves areas was about 30% higher than seagrass areas, mainly due to the Clarence River and more than twice that of saltmarsh areas
- Rate of potential catch (finfish/km^2) attributed to mangroves and saltmarsh were similar and about twice that of seagrass areas
- Total finfish catch in seagrass areas attributed to development of large areas of seagrass beds in coastal lagoons

Reported vs Predicted Finfish Catch



Overall Findings

- Mangrove, saltmarsh and seagrass contributions to the commercial (and by association recreational) catches are all important due to fish production rates and areas of each wetland developed within the estuaries examined
- Mangroves are potentially more important to the commercial fish catch than currently understood
- Estuary area is important for access to the fish production by the estuaries with high mangrove areas
- Hunter River is under-utilised in relation to the area of mangroves present apparently due to the physical constraint of the estuary area limiting commercial fishing
- Size of the estuarine area, within all the estuaries examined, is important to the finfish catch
- The relationship of seagrass area to fish catch in the highly urbanised Tuggerah Lakes and Lake Illawarra estuaries was found to be the same as operating in the other more pristine estuaries

Recommendations for Further Research

It is suggested that future research be undertaken to:

- Confirm if similar relationships exist for support of wetland areas to the commercial (and recreational) fish catches in other estuaries
- Confirm that estuarine size, and hence access to areas outside the wetlands producing fish production, is important to the overall commercial finfish catch
- Examine the potential use of such relationships for optimisation of fishery management with regard to commercial (and recreational) catch and protection of appropriate wetland areas
- Determine the contribution of mangrove areas to the commercial (and recreational) fish catch
- Research suggests some interacting relationships between catch and wetland types however further research is required to understand these relationships

References

Bloomfield A.L. and Gillanders B.M. (2005). Fish and invertebrate assemblages in seagrass, mangrove, saltmarsh, and nonvegetated habitats, *Estuaries* 28(1): 63-77.

Gillson, J.P., Scandol, J.P. and Suthers, I.M. (2008). NSW Department of Primary Industries Fisheries Research Report Series: 21, *Impacts of freshwater flow on catch rates of estuarine fisheries resources in New South Wales*, University of NSW October, 2008.

McArthur, L.C., Boland, J.W., Brown, B. and Jones, G.K. (2003). Investigation of the influence of seagrass on fisheries catch level using isotonic regression, *Environmental Modeling and Assessment* 8(4): 285–290.

Williams, R.J, West, G., Morrison, D. and Creese, B. (2006). Estuarine Resources of New South Wales by NSW Department of Primary Industries, *Port Stephens for the Comprehensive Coastal Assessment*, in a 2-part DVD pack published by the NSW Department of Planning. Sydney, NSW, Australia.