Adapting the MER framework for assessment and communication of river, lake and estuary health on the NSW central coast
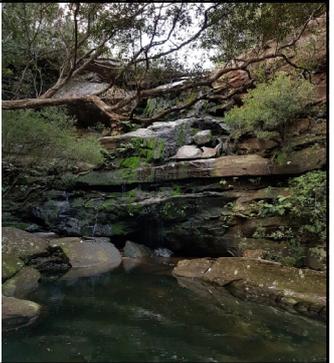
A. Dickson[1], J. Potts[1], V. McCann[2], N. McGaharan[2] and P. Scanes[1]

1 Department of Planning, Industry and Environment, Lidcombe NSW
2 Central Coast Council, Wyong NSW

8/11/2019

Acknowledgement of Country

- I'd like to begin by acknowledging the Traditional Owners of the land on which we meet today.
- I would also like to pay my respects to Elders past and present.

Catchment: Kariong Brook
SiteID: CCC86
Name: Kariong Brook to Mullet Creek
Latitude: -33.47457388
Longitude: 151.2693703
Access: Kariong Brook Falls walking track

Outline of Presentation

Summary of project

- Monitoring
  - Estuaries, lakes and coastal lagoons
  - Freshwater riverine habitats
- Evaluation
  - Catchment adjustment/derivation
  - Land use analysis
  - Water Quality Analysis
    - Deriving Scores and using Guidelines and Worst Expected Values (WEV's)
  - Freshwater biological and habitat assessment
- Reporting
  - Scoring sites
  - Summarising scores
  - Presenting results

Central Coast Council MER

- **Project Summary**

Monitoring, evaluation and reporting of estuarine and riverine ecosystems in the Central Coast Council LGA

- The aims of the monitoring program are to assess the ecological health of waterbodies and waterways using methods that are scientifically valid and standardised, and to report the information generated in an accessible way to a number of potential users in a report card style format.

- Estuarine MER - Continuation of an annual monitoring program that commenced in 2010 within Tuggerah Lakes system, now expanded to:
  - Brisbane Water
  - Hawkesbury River
  - Coastal Lakes and Lagoons
  - Lake Macquarie

- Freshwater MER - Biannual monitoring in Tuggerah Lake Catchment in 2016 (Aut16 & Spr16) expanded and continued in 2018 including:
  - Additional sampling sites in Brisbane Water catchment (Aut18 & Spr18)
  - Repeat sampling of Tuggerah Lake catchment (Spr18 & Aut19)

Estuarine MER

- The NSW Natural Resources Monitoring, Evaluation and Reporting (MER) Program outlines standard sampling, data analysis and reporting protocols to assess estuary ecological health (OEH, 2016).
  - Turbidity, chlorophyll-a and change in seagrass extent are considered to be appropriate measures of estuary ecological health as they are indicators of ecosystem performance in response to catchment pressure.
  - The concentration of chlorophyll-a in the water column is a biological indicator reflecting phytoplankton biomass, and typically reflects the nutrient load into the system.
- Water Quality
  - Trigger values calculated based on methodology recommended by ANZECC (2000) calculating the 80th percentile of all data for reference estuaries in each estuary type
  - Reference estuaries were defined as those minimally impacted with respect to chlorophyll a and turbidity; the ratio of increase in TN loading was adopted as the measure of disturbance
  - Level of compliance against Derivation of Worst Expected Values (WEVs) – 98th Percentile from state-wide monitoring data

Office of Environment & Heritage

Assessing estuary ecosystem health: Sampling, data analysis and reporting protocols

NSW Natural Resources Monitoring, Evaluation and Reporting Program

Riverine MER

- Technical report series – Riverine Ecosystems (Office of Water, 2010)
- Technical background report providing methods used to make a preliminary assessment as a baseline for future reporting with indicators including:
  - Water Quality – Turbidity and Total Phosphorus
  - Macroinvertebrates – Coastal catchments methods
    - AUSRIVAS sampling protocols
    - Observed/Expected Scores
  - Fish and Hydrologic condition
    - **not yet** completed for the Central Coast Council MER

NSW MONITORING, EVALUATION AND REPORTING PROGRAM

Technical report series
Riverine ecosystems

Leading policy and reform in sustainable water management
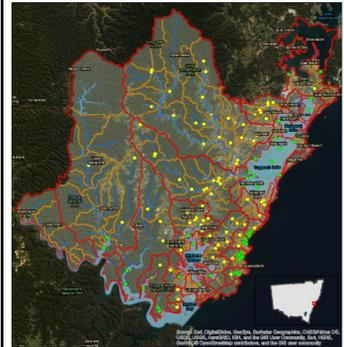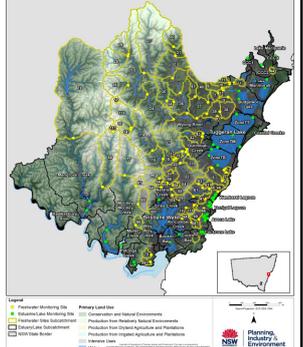
Adapting the Framework

- Estuarine MER: Sampling methods and analysis - no adaptation needed
- Riverine MER: Some adaptation needed
  - Analysis of land use - ALUMv8 - NSW Land Use dataset (2017)
  - Additional water quality parameters
    - Nutrients: TN, NOx, P, Ammonia
    - Electrical Conductivity
    - Chlorophyll-a
  - Additional macroinvertebrate indices
    - Taxa Richness
    - EPT Richness
    - SIGNAL 2-Family
  - Assessment of Reach, Riparian and Instream condition
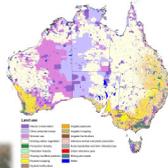
Urban & Coastal Rapid Reach Assessment

Draft October 2013

Prepared by Waters Wetlands and Coastal Science
NSW Office of Environment and Heritage

Slide 1: Land Use

Land Use

- Australian Land Use and Management Classification Version 8 (October 2016)
- NSW Land Use dataset (2017)
- Primary, secondary and tertiary land use classification
  - Minimum attribution level = Secondary

Pie chart labels:
- Water, 8.76%
- Intensive Uses, 18.81%
- Production from Irrigated Agriculture and Plantations, 0.06%
- Production from Dryland Agriculture and Plantations, 5.04%
- Production from Relatively Natural Environments, 23.32%
- Conservation and Natural Environments, 44.01%

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Slide 2: Estuaries, Lakes and Coastal Lagoons

Estuaries, Lakes and Coastal Lagoons

- MER spatial scale whole-of-estuary condition
  - Targets the assumed chlorophyll-a and turbidity maxima
    - For lakes and lagoons this is the central basin, for rivers, the mid to upper sections.
- To allow representative spatial coverage, estuaries are divided into zones
- For lakes and lagoons, a zone is an area of approximately 500–700 m in diameter.
  - Sufficient zones (up to four with a minimum of two) are designated within the central basin so that the majority of the lake or lagoon is represented
  - Small systems may have only one zone at least two integrated samples are collected from a transect within the zone
- *In situ* water quality via multiprobe sonde, sample collection, sea grass depth range, observation

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Slide 3: Calculating Water Quality Condition Scores

Calculating Water Quality Condition Scores

As described in Section 7.9, the process for calculating a condition score for chlorophyll a or turbidity for an estuary or zone within an estuary involves six steps. The Excel formulae that can be used for these calculations are provided in the following table.

Step	Formulae
1. Calculating the non-compliance (NC) score	=IF(Sample>Trigger Value,1,0)
2. Use relevant WEV	WEV values for NSW are provided in Table 2.
3. Calculating the distance from the trigger value (DS)	=IF(NC=1,((Sample- Trigger Value)/WEV Trigger Value),0)
	=IF(DS>1,1, DS)
4. Calculating an indicator score (IS) for each zone	=SQRT(NC x DS)
5. Calculating the zone score (ZS)	=AVERAGE(IS₁, IS₂) where IS₁ is indicator score for chlorophyll a and IS₂ is indicator score for turbidity.
6. Grading the zone	=IF(ZS<0.07,"A",IF(ZS<0.23,"B",IF(ZS<0.44,"C", IF(ZS<0.6,"D",IF(ZS<1,"E","E"))))

Table 1: MER Program trigger values for chlorophyll a and turbidity

Estuary class	Trigger values (Roper et al. 2011)	
	Chlorophyll a (µg/L)	Turbidity (NTU)
Lake	5.0	4.7
River – lower (sal sp >35 ppt)	7.3	7.97*
River – mid (sal sp >0 to <35 ppt)	2.9	8.0*
River – upper (sal sp <13 sp)	5.4	8.07
Lagoon	9.0	3.3

*Trigger values have been revised from those in Roper et al. (2011).

Table 2: Worst Projected values from the MER Program

Estuary class	Worst Expected Value	
	Chlorophyll a (µg/L)	Turbidity (NTU)
Lake	45	35
Lagoon	80	25
River (lower)	80	35
River (mid)	45	55
River (upper)	50	50

Table 3: Percentile values which define cut-offs for grade scores

Percentile	Cut-off zone score
95	0.60
80	0.44
50	0.23
20	0.07

Note: higher scores (those approaching 1) represent a worse condition than lower scores (those approaching 0).

Figure 3: Relationship between distribution of NSW scores, grades and zone scores

Percentage of NSW scores in each grade: 20%, 30%, 30%, 15%, 5%

A	B	C	D	E
0	0.07	0.23	0.44	0.6	1

Zone score

Table 4: Report card grades, definitions and descriptions

Grade	Result	Definition (example)	Description
A	Very good	The indicators measured meet all of the benchmark values for almost all of the time period.	Equivalent to the best 20% of scores in the state
B	Good	The indicators measured meet all of the benchmark values for most of the time period.	Equivalent to the next 30% of good scores
C	Fair	The indicators measured meet some of the benchmark values for most of the time period.	Equivalent to the middle 30% of scores
D	Poor	The indicators measured meet few of the benchmark values for some of the time period.	Equivalent to the next 15% of poorer scores
E	Very poor	The indicators measured meet none of the benchmark values for almost all of the time period.	Equivalent to the worst 5% of scores in the state

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Slide 4: Riverine monitoring

Riverine monitoring

- NSW AUSRIVAS Protocols for sampling water quality, macroinvertebrate and aquatic habitat assessment
- *In situ* water quality (Temp, DO, EC, pH, Turbidity)
- Water sample collection
  - Nutrients
  - Chlorophyll-a
  - Total Suspended Solids
- Edge sampling for macroinvertebrates
- AUSRIVAS assessment of disturbance related to human activities
- Additional aquatic habitat observations

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Riverine Water Quality WEV's

- Following the approach used in the Estuarine MER water quality compared against ANZECC Guideline default trigger values for lowland coastal rivers of NSW
  - Except three upland sites
- Assigning grades: WEV - Worst Expected Values
  - 98th Percentile for each water quality indicator, calculated from all sampling in Central Coat Council LGA and available data from other historic river health programs including;
    - Murray River Health Initiative (1994 to 2000); Coastal SRA (2006 to 2011); Coastal MER - Northern Rivers (2012); MER - Hunter-Central Rivers (2012) & Hawkesbury-Nepean (2013); Shoalhaven (2014-2015)

|	Spatial and temporal coverage of data	Tuggerah (2016)	Tuggerah & Brisbane Water (2018-2019)	Tuggerah & Brisbane Water (2016-2019)	All current and historic for NSW Coastal Catchments (1994-2019)
Report Card Index	Chl-a (µg/L)	40.78	36.67	44.05	47.12
	EC (µS/cm)	1560.80	1291.20	1298.40	2573.52
	NH3 (µg/L)	646.58	739.81	728.98	729.40
	NOx (µg/L)	1535.19	2274.44	2062.14	1079.12
	P (µg/L)	52.55	52.05	52.17	52.23
	TN (µg/L)	2033.22	2887.64	2674.58	2005.96
	TP (µg/L)	328.82	364.75	367.30	342.07
	Turb (NTU)	63.82	101.45	95.45	201.96

## Macroinvertebrate Scoring

- Macroinvertebrate Indices
  - AUSRIVAS NSW Combined Season Edge Model
  - O/E 50 (Observed/Expected > 50% occurrence)
  - Combined Season
    - Brisbane Water catchment (Aut18 + Spr18)
    - Tuggerah Lake catchment (Spr18 + Aut19)

- Other Indices will be used in future including;
  - Taxa Richness
  - EPT Richness (Ephemeroptera, Plecoptera, Trichoptera)
 - SIGNAL 2-Family (Pollution sensitivity)

Scoring Freshwater Sites

		Indicator	Report Card Index (Score)	N Samples	ANZECC Guideline, DSi	20th	50th	80th	95th
Stressors	Water Quality	Ammonia	NH3 (µg/L)	270	20	13.1	36.8	100.4	429.6
			NH3 ISi	188	0	0.109	0.202	0.428	0.703
		Nitrogen Oxides	NOx (µg/L)	1030	40	10.0	20.0	90.0	339.0
			NOx ISi	335	0	0.099	0.255	0.454	0.873
		Total Nitrogen	TN (µg/L)	270	350	313.5	500.2	881.2	1533.1
			TN ISi	196	0	0.241	0.407	0.573	0.836
		Phosphate	P (µg/L)	270	20	1.0	2.8	8.3	30.3
			P ISi	16	0	0.222	0.363	0.657	0.889
		Total Phosphorus	TP (µg/L)	1029	25	12	20	60	160
			TP ISi	393	0	0.122	0.306	0.494	0.758
		Electrical Conductivity	EC (µS/cm)	1819	300	101.0	207.0	570.4	1456.5
			EC ISi	617	0	0.138	0.230	0.400	0.549
		Turbidity	Turb (NTU)	1753	6	0.5	5.5	23.66	92.2
			Turb ISi	808	0	0.092	0.200	0.335	0.459
Response	Bugs	Chlorophyll-a	Chl-a (µg/L)	263	3	0.29	0.86	4.84	20.15
			Chl-a ISi	66	0	0.119	0.285	0.434	0.613
		AUSRIVAS Combined Season Edge	O/E50	78	0.82	0.57	0.37	0.15	0.06
			O/E ISi	49	0	0.103	0.221	0.459	0.691
		Grade				A	B	C	D	E
		Result				Very good	Good	Fair	Poor	Very poor

Ammonia ISi

Ammonia - Grade
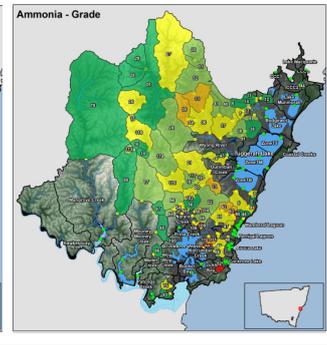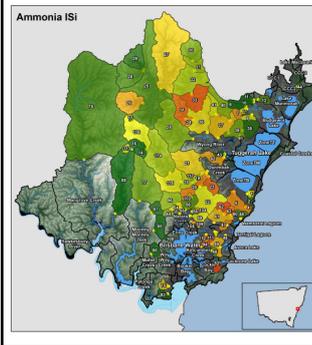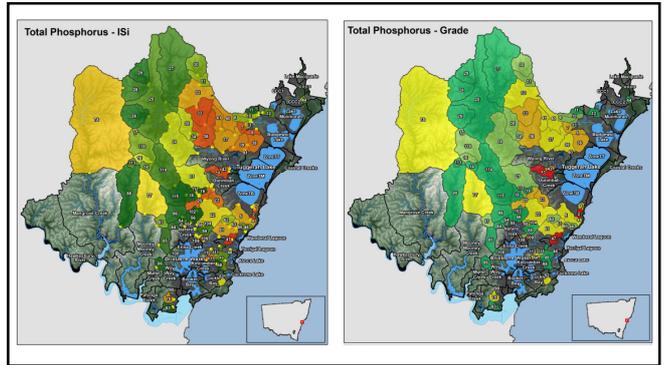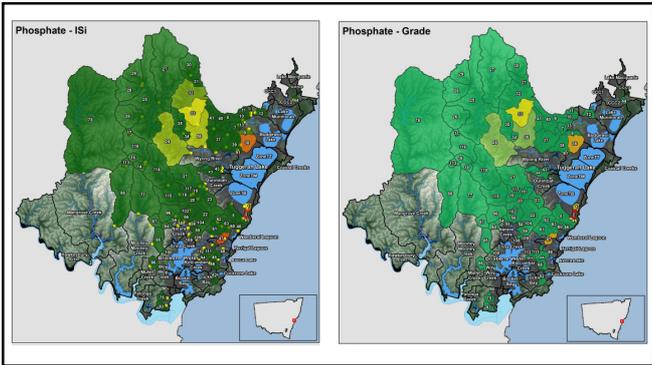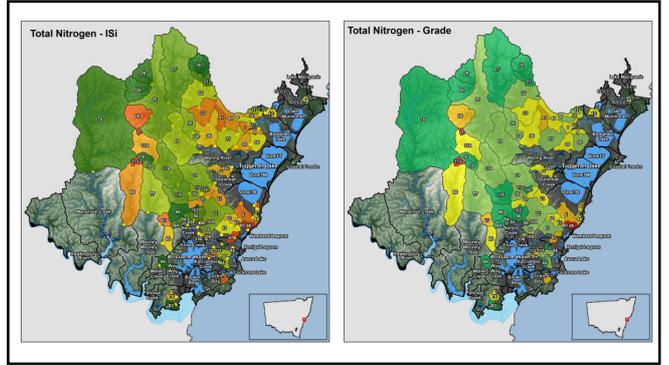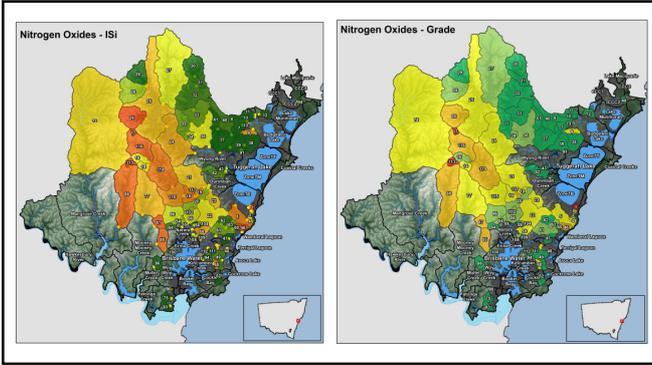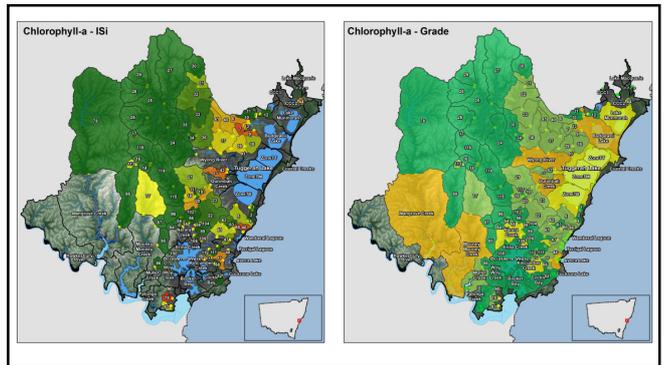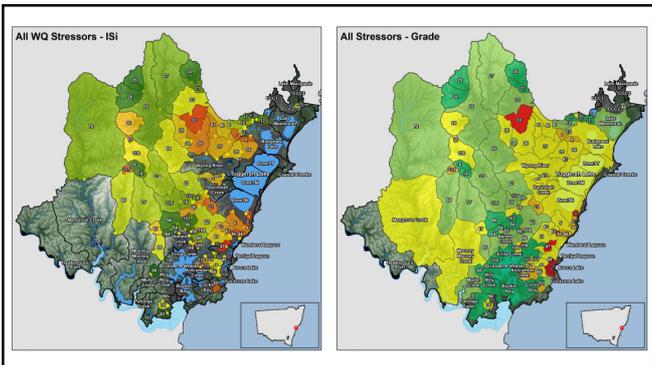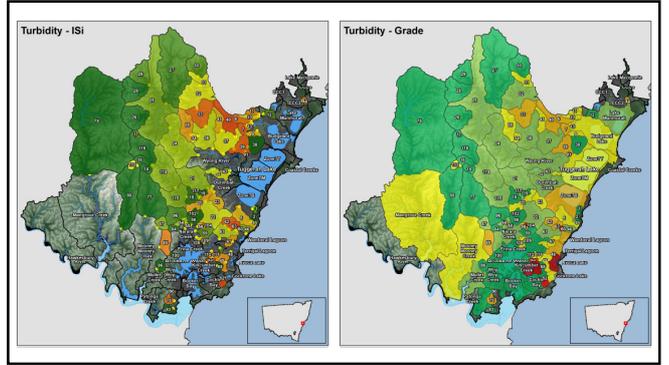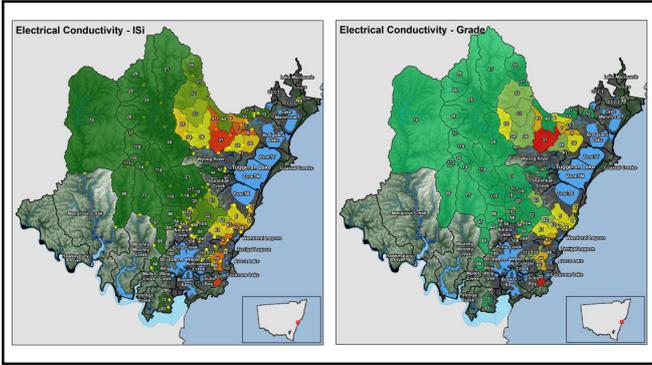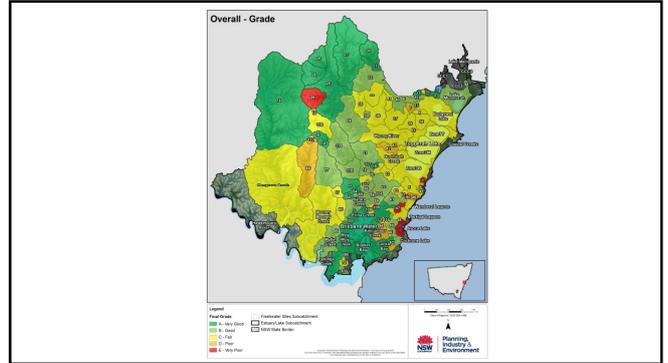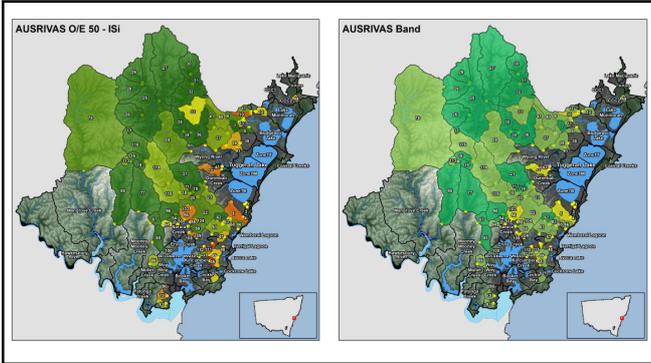
Ongoing Monitoring

- Estuarine MER
  - Summer 2019-20 planned
  - Annual reporting

- Riverine MER
  - Autumn 2018 results for Brisbane Water to be completed
  - Spring 2019 currently underway
  - Autumn 2020 planned

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