Questions on Notice

AgForce responses to QoN from 11 June 2021 public hearing to Environmental and Other Legislation (Reversal of Great Barrier Reef Protection Measures) Amendment Bill 2020

Key Points

During the public hearing of the Bill on Friday 11 June 2021, AgForce was requested to respond to three (3) Questions on Notice. Responses to be emailed to the Queensland Government Health and Environment Parliamentary Committee Secretariat at HEC@parliament.qld.gov.au.

1. **Provide new Reef science reports from the Australian Government National Environment Science Program, since compilation of the 2017 Reef Scientific Consensus Statement** (pp1-10)**.**

2. **Clarification on current legislation which assumes landholder is guilty and there is reverse onus of proof** (p10)**.**

3. **How proposed penalties compare with other areas of environmental breach** (pp11,12)**.**

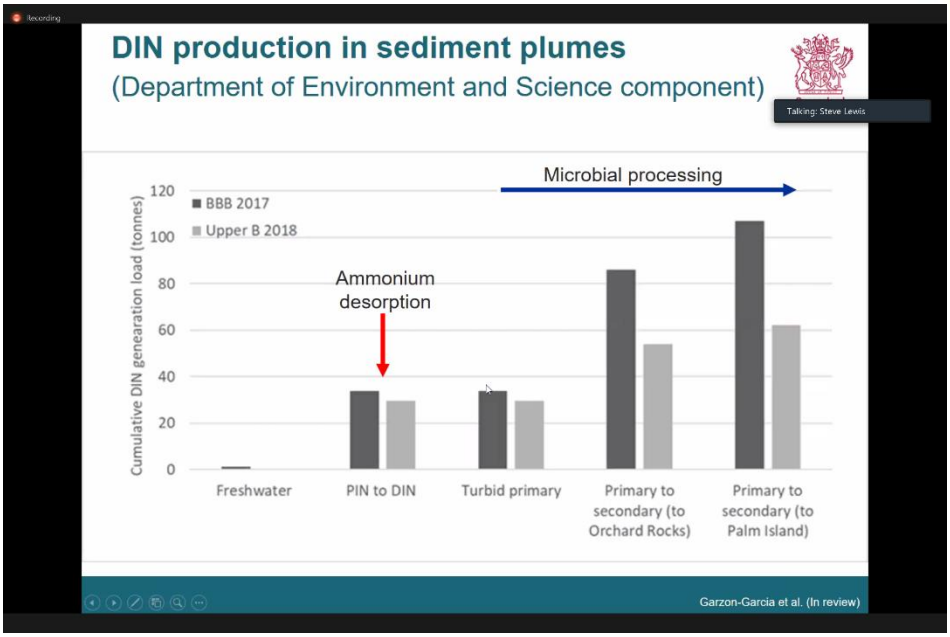
1) [i]Provide new Reef science reports from the Australian Government National Environment Science Program, since compilation of the 2017 Reef Scientific Consensus Statement

1.1 NUTRIENTS

2017 Reef Scientific Consensus Statement[i]

Nutrient run-off, particularly nitrogen fertilisers from cane farms causes crown of thorn starfish outbreaks, lower coral diversity, algal blooms susceptibility to coral bleaching and some coral diseases. Dissolved inorganic nitrogen is immediately available for uptake by marine plants and algae. The main source of DIN is fertiliser runoff from cane farms.

- Five years of cumulative Reef science research has recently been published by the Australian Government National Environmental Science Program – Tropical Water Quality Hub NESP-TWQ. The science is published in peer-reviewed journals, along with final reports and factsheets available on the hub's website https://nesptropical.edu.au/index.php/nesp-twq/# and the interactive Hub synthesis website https://nesptropical.edu.au/ .
- Lewis *et al* (2021)[ii] traced the origin and fate of sediment and bioavailable nutrients in Reef catchments and Great Barrier Reef Lagoon in Project 5.8. There are additional pathways of bioavailable Dissolved Inorganic Nitrogen DIN production such as ammonium desorption from particulate nitrogen (leaf litter, organic matter) and microbial processing of organic matter in river plumes. These alternative pathways can contribute 25 to 100 per cent of DIN load in river plumes (Figure 1 a,b). Queensland Government Reef regulations unfairly regulate fertiliser sources of DIN.



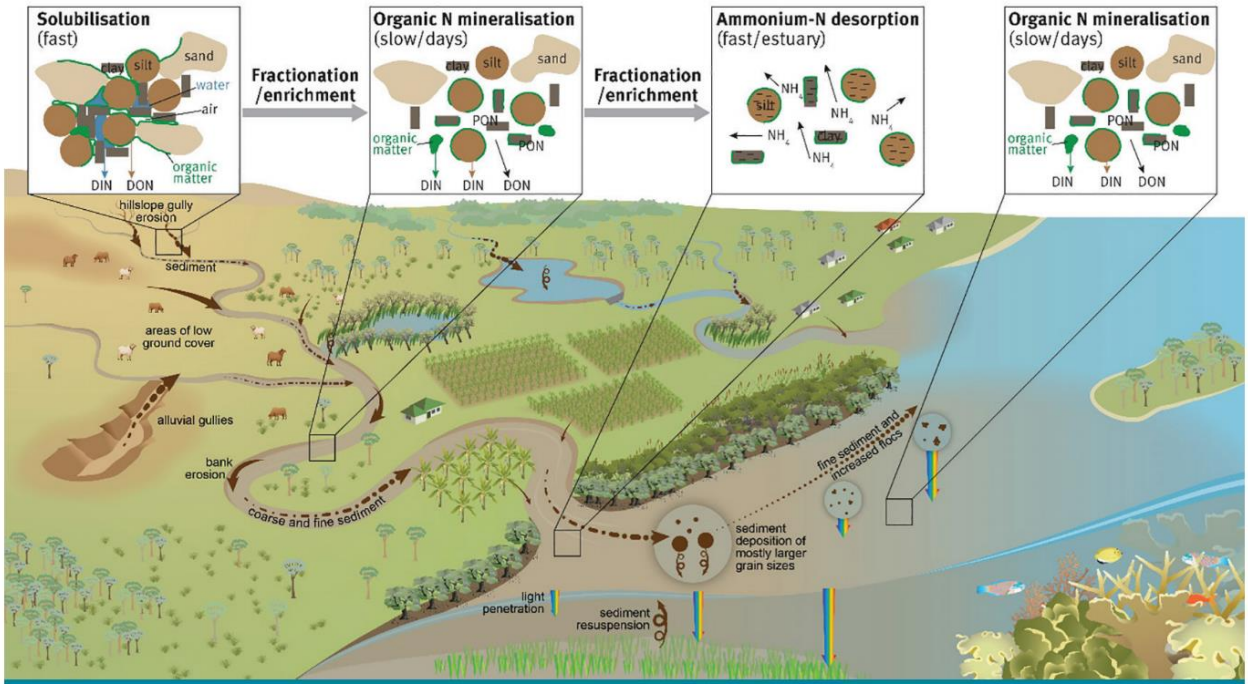


Figure 1 (a) and (b): NESP-TWQ Project 5.8 monitored the three main sources of Dissolved Inorganic Nitrogen DIN in sediment plumes from river discharges. These processes release DIN from particulate and organic nitrogen (PON and DON) associated with sediment, leaf litter and ground cover from the whole landscape, not just farming land. The annual Reef Report Cards cannot distinguish these other major sources of additional DIN from the small amounts reported and regulated as fertiliser runoff. Stephen Lewis TropWATER JCU and Alex Garzon-Garcia DES Outcomes Factsheet 2021: https://nesptropical.edu.au/wp-content/uploads/2021/05/NESP-TWQ-Project-5.8-Outcomes-Factsheet.pdf [iii]

In 2020, scientists, Margaret Johnson and Jessica Hoey, from the Great Barrier Reef Marine Park Authority stated DIN is not the cause of Crown of Thorns starfish COTS outbreaks[iv], as stated in the 2017 Reef Consensus Statement. DIN may exacerbate COTS outbreaks, by increasing phytoplankton growth, which benefits COTS larvae.

2017 Reef Scientific Consensus Statement

Chlorophyll-*a*, a measure of phytoplankton biomass from satellite observations, is used as a proxy for estimating levels of dissolved inorganic nitrogen DIN. This is used for the annual Reef Report Cards.

Water turbidity, cloud cover can affect satellite-based observation. Requires monitoring data for validation. Since 2016, the national research program (NESP-TWQ) trialled a new method (benthic light index) in the 2015/2016 and 2017/2018 Reef Report Cards. The revised method provided an improved water quality score.

The seasonal bioavailability and role of dissolved and particulate nitrogen, phosphorus and carbon in Reef health are poorly understood.

The annual Reef report cards report on "modelled reductions" of DIN, based on assessing farm practices and satellite observations of chlorophyll-a, not on actual DIN in the water. The 2050 ReefPlan target is 60 per cent reduction in anthropogenic end-of-catchment DIN. The 2019 Reef report card indicates a 4.3 per cent reduction across the GBR, due to efforts of canefarmers and banana growers[v]. Other sources of DIN are not reported, only fertiliser use. Methods used for Reef Report Card modelling score DIN estimates very low in qualitative confidence[vi], whereas Reef regulation compliance audits conducted on cane farmers drill down to precise quantities of fertiliser used on-farm and detailed record-keeping.

Why is fertiliser singled out and regulated, when there are many other nutrient sources and their bioavailability are not fully understood? AgForce recommends utilising the new Reef science for improved understanding of the nitrogen and phosphorus cycle before imposing further Reef regulations on fertiliser use by farmers.

1.2 SEAGRASS CONDITION

2017 Reef Scientific Consensus Statement

Fine sediments cause turbidity which reduces the amount of light available to seagrasses and inshore coral reefs, stunting their growth and even smothering them when present for extended periods. Grazing lands are the major contributor of sediment in Reef ecosystems.

Rainfall pattern across different years and flood events impact on inshore seagrass condition, not grazing practices. Farmers do not control the weather. NESP-TWQ research studies by Barbara Robson from the Australian Institute of Marine Science show mid-shore and off-shore seagrass beds are always in good condition (Figure 2).

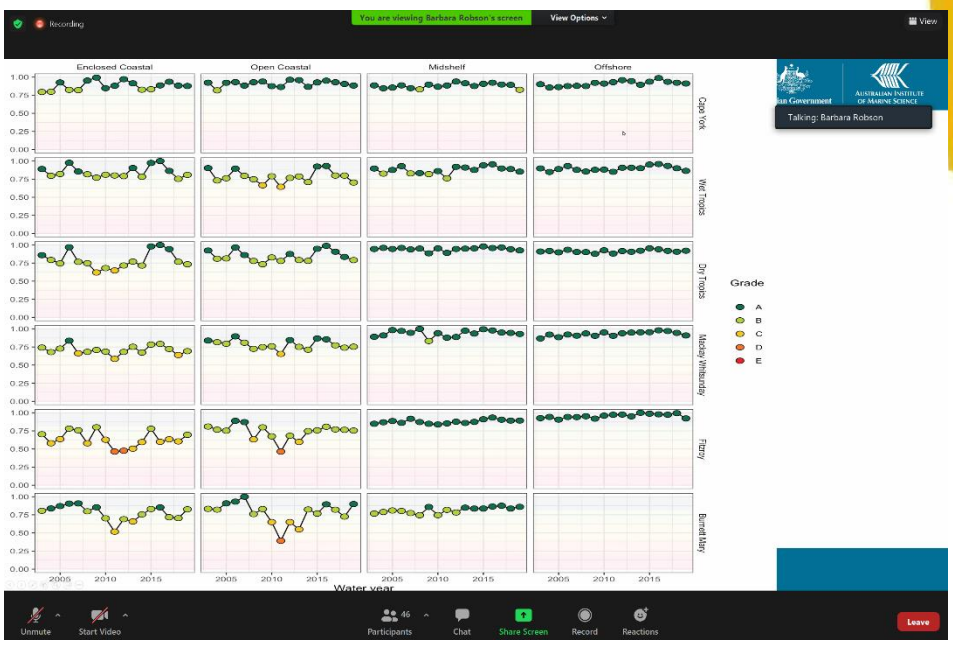


Figure 2: Mid and off-shore seagrass beds are in good condition over the last 20 years. Barbara Robson AIMS.

The decline of in-shore coastal seagrass beds is due to flooding events such as the record floods in 2010 / 2011. The red and blue lines in Figure 3 show recovery and natural resilience of inner-coast seagrass beds over eight years since the flood event. Figure 4 shows the variability in annual river discharge and suspended sediment loads over a 17-year period. Weather patterns are the main influence on inner-shore seagrass condition, not grazing practices.

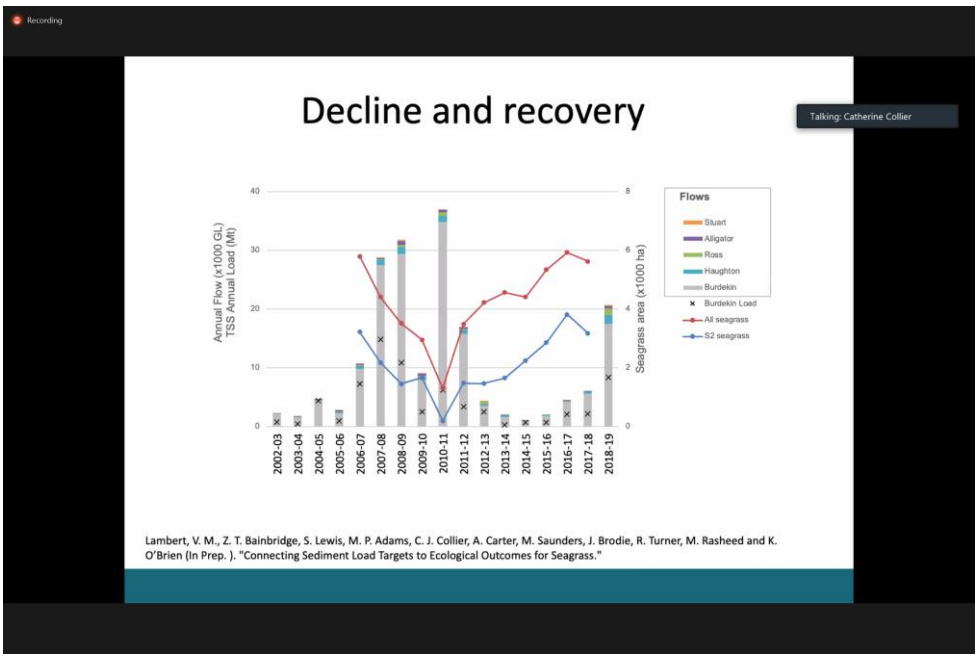


Figure 3: Decline in inshore seagrass condition is due to river flood events such as 2010/2011. Inner-shore seagrass condition recovers after flood events (Lambert et al, 2020 JCU)[vii]

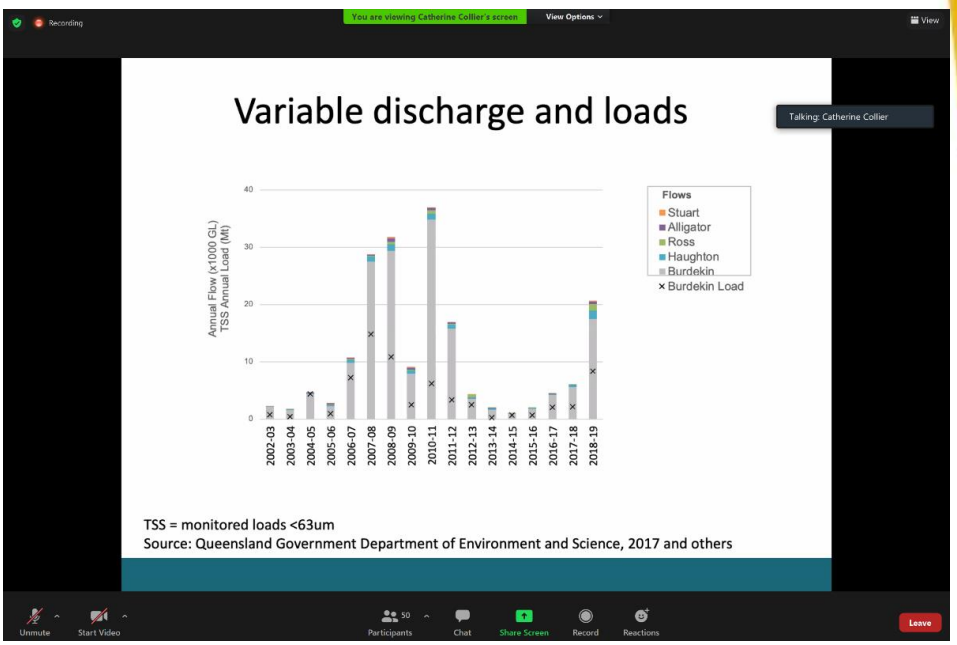


Figure 4: Burdekin River suspended sediment load (marked as "X") follows the trend of annual river discharge (greater in wet years or flood years. For example, in 2006 to 2009, 2010 to 2011, 2018 to 2019) [Catherine Collier, JCU, pers.comm.]. The greatest decline in seagrass condition was during the 2010/2011 flood year, when the suspended sediment load was lower than the previous wet year period from 2006 to 2009.

1.3 SOURCES AND FATE OF SUSPENDED SEDIMENT

2017 Reef Scientific Consensus Statement

Turbidity from high concentrations of suspended sediments and sedimentation are the most widely recognised threats to coral reefs.

Recent Reef research has confirmed zonal, not widespread impact areas of suspended sediments. Land-based run-off may affect inner shore Reefs (mainly seagrass and soft coral zone) and occasional impact on mid-reefs. There is no impact on outer Reefs. Inner-shore Reefs only occupy three per cent of the GBR Lagoon area. The GBR World Heritage Area[viii] spans across 2900 coral reefs, 1050 islands and 46,000 km^2 of seagrass beds within its 348,000 km^2. Onerous Reef regulations on farmers and state government's costly compliance is aimed at protecting only three per cent of the GBR WHA from suspended sediment and fertiliser runoff from agricultural farms.

There are three main pathways for suspended sediment impact on the GBR[ix].

(1) Turbid water in shallow areas (5m depth) after consecutive large flooding periods over two to three years.
(2) Pulsed delivery of sediment and particulate nutrients to inshore Reefs triggers macroalgae growth and deposition of 'marine snow'.
(3) Persistent turbidity due to resuspension and/or new sediment in areas of poor flushing (e.g. Whitsunday inshore islands).

Ninety (90) per cent of fine sediment entering the GBR Lagoon is mainly from sub-surface erosion (gullies, streambank, deep rill erosion). Beef cattle and sugarcane grazing[x] Environmental Relevant Activity ERA Standards require records of agricultural chemical usage, any fertiliser usage and measures to minimise erosion and soil loss. Grazing land must implement measures to maintain ground cover above 50 per cent. Cane farmers must implement measures such as surface cover, drainage structures, recycle pits, vegetated buffers, diversion or contour banks[xi]. These regulated requirements are over the entire agricultural land use area and not where suspended sediment is mainly traced from in gullies and streambanks.

Only up to 15 per cent of suspended sediment reaches beyond the Burdekin River mouth. Sediment cores confirm fine sediment (less than 63 microns μm) settles out within 50km of the Burdekin Delta[xii]. Farmers are burdened with excessive and onerous regulation to benefit such a small portion of the GBR WHA.

1.3.1 GULLY REHABILITATION

Some of the NESP-TWQ Hub projects trialled and costed gully rehabilitation techniques in the Burdekin and Normanby catchments. Research results reiterate that the 2025 Reef Water Quality Plan targets for reduction in fine suspended sediment are not achievable.

Based on results from the gully erosion project area in the Bowen, Broken, Bogie BBB sub-catchment in the Burdekin, an additional 129 gullies would need to be rehabilitated to achieve the water quality target for the BBB catchment (Figure 5). Rehabilitation costs per gully ranged from $3K to $1million[xiii].

Monitoring results indicate only two sites at Strathbogie and Mt Wickham Stations out of seven trial sites reduced sediment and nutrient load concentrations. The two sites costed $44K to protect 41ha and $595K to protect 14ha (Bartley *et al*, 2020[xiv]).
AgForce recommends a review of unrealistic Reef water quality targets, before Queensland Government continues with strengthened Reef regulations.

Sediment Abatement Achieved as of May 2020

	2025 EOS FSS reduction targets kt/yr	Best Estimate verifiable catchment reduction to date (kt/yr) (2013-20)	EOS FSS Abatement achieved from Study Project sites kt/yr	Project outcome % of remaining target	Number of equiv. sites required to achieve remaining 2025 target
Normanby	15	5#	0.165	1.7%	61
Burdekin (total)	890		.		
BBB/Lwr Burdekin (sub-set of Burdekin)	623	50*	4.43	0.8%	129

Figure 5: Gully rehabilitation is costly and potentially not feasible on a large scale to achieve water quality targets. An additional 129 gullies would need to be rehabilitated in the BBB sub-catchment alone.

1.4 PESTICIDE RUNOFF

2017 Reef Scientific Consensus Statement

- Pesticides impact plants and animals in rivers, creeks, coastal inshore areas and can take years to breakdown.
- Pesticides impact plants and animals in rivers, creeks, coastal inshore areas and can take years to breakdown.
- Condition of coastal freshwater wetlands affected by chronic and acute pressures from nutrient, sediment and pesticide loads.
- Many inshore seagrass meadows are exposed to herbicide concentrations year-round.
- Mean-annual loads of prevalent pesticides are estimated (modelled) to be around 12,000kg per year across the GBR.

Firstly, the purpose of the Minister's environmental protection policy in Chapter 4A of the *Environmental Protection Act 1999* is to set an objective to reduce loads of dissolved inorganic nitrogen and suspended sediment to a stated limit and time period (Section 77 of the *EPA Act*[xv]). Pesticides are not mentioned. However the regulated agric ERA Standards require all beef cattle graziers and cane farmers across five Reef catchments to record ALL agricultural chemicals used on agricultural land within three days of use. Records need to be shown to an EPA compliance officer, on request.

This is a duplication of government red tape. There is already a requirement to keep records of agricultural chemical usage under the *Chemical Usage (Agricultural and Veterinary) Control Regulation 2017*, Division 4[xvi], administered by the Queensland Department of Agriculture and Fisheries DAF. DAF inspectors, paid by Queensland Government Reef funding, are currently conducting audits on cane farmers for compliance to this Regulation. Compliance staff are only authorised under their respective Acts.

Secondly and most important – pesticide detection at extremely low concentrations and below water quality trigger values has no effect on aquatic organisms. Corals are not exposed to pesticides. They are further away from where pesticides are detected. In the outer Reef, any concentration of pesticide is below a level having effect. No coral in the GBR has ever been killed by pesticides. Why are there additional Reef regulations for pesticide use?

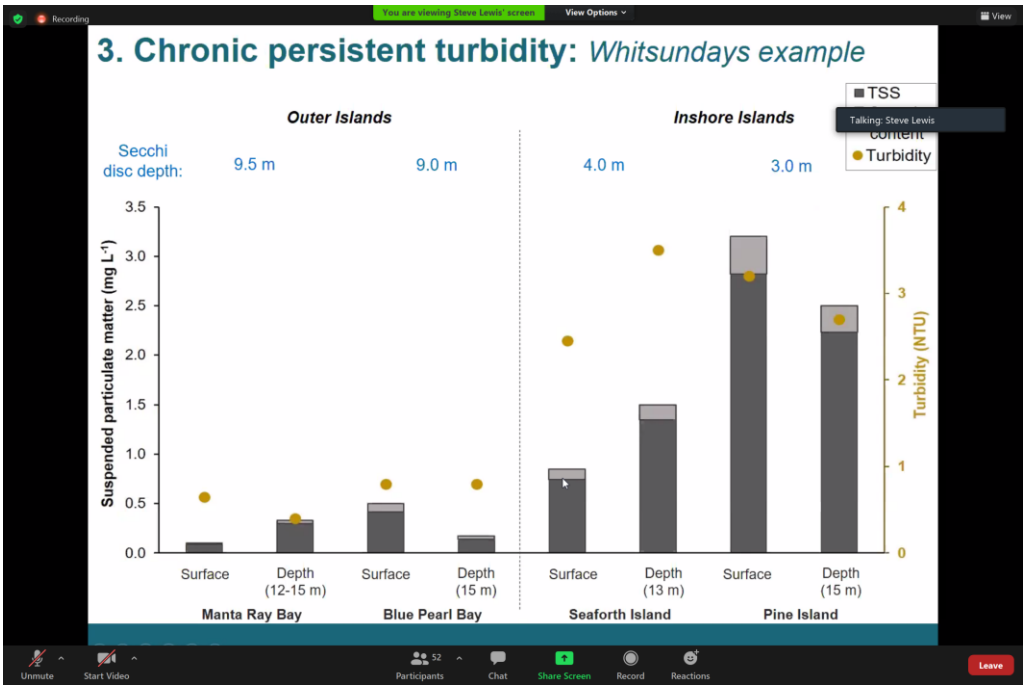
University of Queensland conducts annual marine pesticide monitoring for the Great Barrier Reef Marine Park Authority GBRMPA (Thai *et al*, 2020)[xvii]. Passive and grab samples confirmed no detected pesticides exceeded the current marine water quality trigger values. Reef regulations from 2009 prescribe five residual herbicides which have additional usage and competency training requirements. Detection levels of these five herbicides are below water quality trigger values which ensure 99 per cent of aquatic organisms are safe. The minuscule pesticide levels detected are in nanograms. There are 1000milion nanograms in one gram (10^{-9}ng=1g) and hence there is no biological impact of pesticides at these extremely low detected levels.

According to Thai et al, 2019, the 2018-19 detected pesticide concentrations included:-

- diuron 250 ng/L- Flat Top Island [i.e. *86 per cent <u>below</u> the current wq trigger value*]
- atrazine 176 ng/L - Repulse Bay
- hexazinone 58 ng/L – Repulse Bay
- DE atrazine 19ng/L – Barratta Creek
- 2,4-D 7.7 ng/L - Flat Top Island

- imidacloprid 38 ng/L – Repulse Bay
- metolachlor 6.8 ng/L – Repulse Bay

These pesticide detection levels in Repulse Bay in the Whitsunday inshore island group is possibly due to the shape of the bay. Sediment tracing studies by Lewis et al 2021[xviii], confirmed the chronic persistent turbidity near these Whitsunday inshore islands is due to inherent poor flushing of existing resuspended sediment and new sediment loads.



1.5 METHODOLOGY FOR ASSESSING PESTICIDE RISK BASELINE FOR ANNUAL REEF REPORT CARDS

The methodology for assessing pesticide risk and runoff for the annual Reef Report Cards has changed three times since the first baseline Reef report card in 2009. The method changed from estimating pesticide loads to concentrations to cumulative toxicity of pesticide mixtures. The 2017 Reef Scientific Consensus report still refers to pesticide loads in kilograms.

In February 2021, the Queensland Department of Environment and Science publicly released the latest methodology by Warne et al (2020)[xix] after technical review. This method was previously cited in the 2017/2018[xx] and 2019[xxi] Reef Report Card methods, although only published in 2020.

Both AgForce and CropLife Australia expressed concerns with the latest methodology:-

- The cumulative pesticide mixture theory is based on assumptions and modelled outcomes, with limited monitoring evidence.

- The additive impact of pesticide mixtures is questioned. There is no evidence this occurs in the water column and would require the extremely small amounts of pesticide runoff to be in the same waterway location at the same time, if the pesticide molecules could bind and interact.

- No consideration of biological degradation of pesticides in the water column over time, nor use of the stream flow variable.

- No consideration of existing pesticide runoff risk methodologies and models used by the national pesticide regulator, the Australian Pesticide and Veterinary Medicines Authority APVMA.

- Warne et al (2020) recommend the Reef baseline risk method for Species Sensitivity Distributions SSD and cumulative toxicity of pesticide mixtures for use by Water Quality Australia to derive Default Guideline Values DGV for contaminants in freshwater and marine waters across Australia and New Zealand https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants. Is the SSD and DGV methodology an evidence-based scientific method that is appropriate for Australia and New Zealand water quality guideline values?

As the national peak body for registrants of crop protection products and agchem stewardship programs, CropLife Australia commissioned an independent review of the Warne *et al* (2020) Reef baseline methodology by an internationally renowned pesticide environmental ecotoxicologist. The review by the Australian Environment Agency[xxii] confirmed some technical issues with the Warne *et al's* (2020) Reef pesticide baseline methodology:-

- Average daily pesticide runoff concentrations were estimated from 53 monitoring days and extrapolated out to 182 days. A bias could occur, depending if monitoring days coincided with rainfall events or not.
- An error in the Burr type III equation for calculating species sensitive distributions SSD's.
- Ambiguity in coefficients describing the toxicity of pesticides in the SSD's.
- The methodology for calculating SSD end-points uses EC10 values, whereas the diuron SSD in the report has used a EC05 value (0.14 micrograms/L), which is nearly half of the EC10 value (0.25 micrograms/L). End-point values must be correct and robust, as they determine the trigger value for 99 per cent of aquatic organisms to be safe from the effect of pesticide runoff.
- Validity of EC10 trigger end points and data sources for metolachlor herbicide SSD's are questioned.
- Of the 22 pesticides checked for presence in Reef waterways, the herbicide diuron and insecticide imidacloprid are the main ones detected. Other pesticides are not contributing significantly to calculated effects of total pesticide toxicity.
- The methodology only considers rainfall and runoff and not stream flow variables. The highest risk period for pesticide toxicity runoff would be the initial period of the wet season (October to December) with lower stream flow rates.
- Recommend biomonitoring in unimpacted upstream areas compared to stream areas where there is reported risk to aquatic species to ascertain if risk predictions are realistic.

CropLife Australis is currently discussing these review findings amongst registrant members for further action.

The statements from the 2017 Reef Consensus Statement can clearly be challenged with this emerging new pesticide science and monitoring. Pesticide detection at extremely low levels does not infer impact on off-target aquatic organisms in water ways, nor the Great Barrier Reef Lagoon. There is no substantiation for additional regulation of pesticide use and record-keeping through Reef agric ERA Standards, on top of existing statewide regulations under the *Chemical Usage (Agricultural and Veterinary) Control Act 1988*.

2) CLARIFICATION ON CURRENT LEGISLATION WHICH ASSUMES LANDHOLDER IS GUILTY AND THERE IS REVERSE ONUS OF PROOF

- Unless a farmer facing an audit can provide the required Environmental Risk Activity ERA records and completed all components of required records, there is inference by a compliance officer that the farmer is in breach of the ERA Standard. It is deemed the farmer, through inaccurate or lack of records, is potentially causing runoff of sediment or nutrient or pesticides to the Reef.

- For example, farmers are being assessed as non-compliant because they have not included a column stating "date of entry of record" when all other required information about agricultural chemical and fertiliser use is recorded (Michael Kern, AgForce Cane Manager, *pers.comm*.). Apparently there needs to be evidence that of the recording date, in addition to the usage date. Queensland Government's compliance program for cane farmers has reported 55 per cent non-compliant on the first visit and 34 per cent non-compliant on the follow up visit between March 2016 and June 2020 https://www.qld.gov.au/environment/agriculture/sustainable-farming/reef/reef-regulations/producers/compliance . The main reasons for non-compliance are lack of records, soil tests and applying more than the calculated optimal rate of fertiliser. What is the fate of these non-compliant cane-farmers on the third visit by a departmental compliance officer? Will the farmer be charged with an offence of contravening an agricultural ERA Standard for insufficient records? Section 82 of the *Environmental Protection Act 1994* outlines the penalty fee is 1665 penalty units ($222,194.25) for wilful offence or 600 penalty units ($80,070) otherwise. Failure to comply with an audit notice is 300 penalty units ($40,035).

- Section 504 of the EPA Act requires the court to sentence a person for an offence against the Act and consider the environmental harm caused to the GBR WHA. How will the offence of insufficient records cause environmental harm to the GBR?

3) How proposed penalties compare with other areas of environmental breach

- The penalty units associated with inadequate record-keeping, minimum practices, audits and protection order requirements for meeting agric ERA Standards are higher than penalties from other Acts requiring record-keeping for environmental purposes and far more encompassing with regulatory burden.
- The current Queensland penalty unit value is $133.45, which increases to $137.85 on 1 July 2021.

Environmental Protection Act 1994
Chapter 4A – GBR protection measures
Offence to contravene an agricultural ERA Standard

- A person who carries out the agric ERA must not contravene the agric ERA Standard.
- Maximum penalty. Wilful offence = 1665 penalty units. Otherwise = 600 penalty units[s82] .

In a proceeding for an offence, it is a defence if a person is accredited under a recognised accreditation (BMP) program and the person's conduct does not contravene the accreditation program.

Tailored advice must not be false or misleading

- An adviser must not give tailored advice about carrying out an agric ERA that is false or misleading to a person carrying out the agric ERA. Maximum penalty = 600 penalty units[s85] .

Environmental protection orders

- An environmental protection order may be issued to secure compliance with an agric ERA Standard [s358 (d xii)].
- May require the recipient to not start or stop a stated activity for a stated period until further notice or indefinitely. May require activity only during stated times or subject to stated conditions. Or require an action within a stated period [s360].
- Offence not to comply with an environmental protection order. Wilful contravention = 6,250 penalty units or 5 years jail. Otherwise = 4,500 penalty units.

Order to enter land to conduct investigation or conduct work

- An authorised person may apply to a magistrate for an order to enter land to secure compliance with an agric ERA Standard[s458 (1)(iii)] .
- The magistrate must be satisfied the entry sought is reasonable and necessary to carry out the work or to conduct a site investigation[s458 (5)]

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Environmental audit

- If the administering authority is satisfied a person has contravened a regulation or environmental protection policy or agric ERA standard or unlawfully depositing a prescribed water contaminant into waters [s323].
- Audit notice must state the name of the recipient, the agric ERA standard, the matter for audit. The recipient must commission the environmental audit and provide a report within a stated period [s324].

Failure to comply with audit notice

- A person must comply with an audit notice, unless has a reasonable excuse. Maximum penalty = 300 penalty units.

Chapter 9 – Investigation and enforcement

Failure to produce document

- A person required to produce a document for an agric ERA standard must comply, unless the person has a reasonable excuse. Maximum penalty – 50 penalty units.

False or misleading documents and incomplete documents

- Must not give a false or misleading document or information to an authorised person, if the person knows, or ought reasonable know it is false or misleading. Maximum penalty 4,500 penalty units or 2 years jail[s480 and 481].

- Must not give a document with incomplete information to an authorised person, if the person knows, or ought reasonable know, the document was incomplete. Maximum penalty 4,500 penalty units or 2 years jail[s480A].

Penalties under other Acts and Regulations.

In comparison, the maximum penalty for <u>not</u> keeping a general record or incomplete record of agricultural chemical usage required under the *Chemical Usage (Agricultural and Veterinary) Control Regulation 2017*[xxiii] and *Chemical Usage (Agricultural and Veterinary) Control Act 1988 is* 50 penalty units [S24].

Failure of prescribed record-keeping for fuel manufacturer or imports – 50 penalty units [S440ZY of EPA Act]

Failure to comply with giving information or required documents to an authorised person under the *Vegetation Management Act 1999* is 50 penalty units [S51 and S54 of the VMA Act]

Producing false or misleading statements or documents to an authorised person under the *Vegetation Management Act 1999* is 50 penalty units [S58 and S59 of the VMA Act]

4) FURTHER INFORMATION

Please contact AgForce if you require any further information or clarification on these three Questions on Notice.

On behalf of public hearing witnesses from AgForce – Michael Guerin, Alex Stubbs and Marie Vitelli.

REFERENCES

[i] Reef 2050 WQIP (2019). 10 key facts from the Scientific Consensus Statement https://www.reefplan.qld.gov.au/science-and-research/10-key-facts-from-the-scs.

[ii] Lewis, S., Bainbridge, Z., Stevens, T., Garzon-Garcia, A., Chen, C., Bahadori, M., Burton, J., Rezaei Rashti, M., James, C., Smithers, S., & Olley, J. (2020). *What's really damaging the Reef?: Tracing the origin and fate of the environmentally detrimental sediment and associated bioavailable nutrients. Report to the National Environmental Science Programme.* Reef and Rainforest Research Centre Ltd, Cairns. https://nesptropical.edu.au/index.php/round-5-projects/project-5-8/ https://nesptropical.edu.au/wp-content/uploads/2021/05/NESP-TWQ-Project-5.8-Final-Report.pdf (267pp).

[iii] Schaffelke B. AIMS. NESP-TWQ Project 3.2.5. Testing and implementation of the water quality metric for the 2017 and 2018 reef report cards. Final Report and Factsheet http://nesptropical.edu.au/index.php/round-3-projects/project-3-2-5/.

[iv] Australian Government Rural and Regional Affairs and Transport References Committee. Inquiry into regulation of farm practices that impact water quality outcomes in the GBR. Brisbane public hearing 28/7/20. GBRMPA segment. https://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;db=COMMITTEES;id=committees%2Fcommsen%2F1be7126e-d98c-48d9-8fd7-8aabb96cfcf4%2F0006;query=Id%3A%22committees%2Fcommsen%2F1be7126e-d98c-48d9-8fd7-8aabb96cfcf4%2F0000%22

[v] Reef water quality report card 2019 – Summary https://www.reefplan.qld.gov.au/__data/assets/pdf_file/0025/227068/report-card-2019-summary.pdf

[vi] Australian and Queensland governments, 2020, Catchment load modelling methods, Reef Water Quality Report Card 2019, State of Queensland, Brisbane. Page 10.

[vii] Lambert, V., Collier, C., Brodie, J., Adams, M.P., Baird, M., Bainbridge, Z., Carter, A., Lewis, S., Rasheed, M., Saunders, M., O'Brien, K., (2020) Connecting Sediment Load Targets to Ecological Outcomes for Seagrass. Report to the National Environmental Science Program. Reef and Rainforest Research Centre Limited, Cairns (141pp.). https://nesptropical.edu.au/wp-content/uploads/2020/10/NESP-TWQ-Project-3.2.1-Final-Report.pdf page 58.

[viii] Kroon FJ, Thorburn P, Schaffelke B, Whitten S. 2016. Towards protecting the GBR from land-based pollution. Global Change Biology 22. 1985-2002 https://onlinelibrary.wiley.com/doi/epdf/10.1111/gcb.13262.

[ix] Lewis, S., Bainbridge, Z. Stevens, T., Garzon-Garcia, A., Chen, C., Bahadori, M., Burton, J., Rezaei Rashti, M., James, C., Smithers, S. and Olley, J. (2020). What's really damaging the Reef?: Tracing the origin and fate of the ecologically detrimental sediment and associated bioavailable nutrients. Report to the National Environmental Science Program. Reef and Rainforest Research Centre Limited, Cairns (246pp.) https://nesptropical.edu.au/wp-content/uploads/2021/05/NESP-TWQ-Project-5.8-Final-Report.pdf .

[x] Agricultural ERA standard – Beef cattle grazing in the GBR catchment https://www.qld.gov.au/__data/assets/pdf_file/0014/113144/grazing-agricultural-era-standard.pdf

[xi] Agricultural ERA Standard for sugarcane cultivation – V1 https://www.qld.gov.au/__data/assets/pdf_file/0017/113147/sugarcane-era-standard.pdf

[xii] Lewis SE, Olley J, Furuichi T, Sharma A, Burton J. 2014. Complex sediment deposition history on a wide continental shelf: Implications for the calculation of accumulation rates on the Great Barrier Reef. Earth and Planetary Science Letters, 393. 146–158 https://researchonline.jcu.edu.au/35428/ .

[xiii] Bartley, R., Wilkinson, S., Henderson, A. Hawdon, A. (2018) Cost effectiveness of gully remediation in the Burdekin catchment: preliminary insights based on measured data from NESP monitoring sites and progress with new Lidar methodologies. Report to the National Environmental Science Program. Reef and Rainforest Research Centre Limited, Cairns (28pp.). https://nesptropical.edu.au/wp-content/uploads/2019/01/NESP-TWQ-2.1.4-TECHNICAL-REPORT-3.pdf

[xiv] Bartley, R., Hawdon, A., Henderson, A., Abbott, B., Wilkinson, S., Goodwin, N. and Ahwang, K. (2020) Quantifying the effectiveness of gully rehabilitation on water quality: results from demonstration sites in the Burdekin catchment. Report to the National Environmental Science Program. Reef and Rainforest Research Centre Limited, Cairns (146pp.). https://nesptropical.edu.au/wp-content/uploads/2021/01/NESP-TWQ-Project-5.9-Final-Report.pdf

[xv] *Environment Protection Act 1994*. Section 77
http://classic.austlii.edu.au/au/legis/qld/consol_act/epa1994295/s77.html

[xvi] *Chemical Usage (Agricultural and Veterinary) Control Regulation 2017*. Division 4
https://www.legislation.qld.gov.au/view/html/inforce/current/sl-2017-0136#pt.3-div.4

[xvii] Thai, P., Paxman, C., Prasad, P., Elisei, G., Reeks, T., Eaglesham, G., Yeh, R., Tracey, D., Grant, S. and Mueller, J. 2020, Marine Monitoring Program: Annual Report for inshore pesticide monitoring 2018–19. Report to the Great Barrier Reef Marine Park Authority, Townsville, 69 pp. https://elibrary.gbrmpa.gov.au/jspui/handle/11017/3666

[xviii] Lewis, S., Bainbridge, Z. Stevens, T., Garzon-Garcia, A., Chen, C., Bahadori, M., Burton, J., Rezaei Rashti, M., James, C., Smithers, S. and Olley, J. (2020). What's really damaging the Reef?: Tracing the origin and fate of the ecologically detrimental sediment and associated bioavailable nutrients. Report to the National Environmental Science Program. Reef and Rainforest Research Centre Limited, Cairns (246pp.). https://nesptropical.edu.au/wp-content/uploads/2021/05/NESP-TWQ-Project-5.8-Final-Report.pdf Chapter 4, page 133.

[xix] Warne MStJ, Neelamraju C, Strauss J, Smith RA, Turner RDR, Mann RM. 2020. Development of a method for estimating the toxicity of pesticide mixtures and a Pesticide Risk Baseline for the Reef 2050 Water Quality Improvement Plan. Brisbane: Department of Environment and Science, Queensland Government. 261pp.

[xx] Australian and Queensland Governments 2019. Pesticide Risk Baseline Methods -Reef Water Quality Report Card 2017 and 2018 https://www.reefplan.qld.gov.au/__data/assets/pdf_file/0026/82925/report-card-2017-2018-methods-pesticide-risk-baseline.pdf page 20.

[xxi] Australian and Queensland Governments, 2020, Methods, Reef Water Quality Report Card 2019, State of Queensland, Brisbane. https://www.reefplan.qld.gov.au/__data/assets/pdf_file/0019/211672/report-card-2019-methods-combined.pdf page 51.

[xxii] Australian Environment Agency 2021. Review of the Development of a method for estimating the toxicity of pesticide mixtures and a pesticide risk baseline for the Reef 2050 Water Quality Improvement Plan. Report submitted to CropLife Australia. 17pp.

[xxiii] *Chemical Usage (Agricultural and Veterinary) Control Regulation 2017*
https://www.legislation.qld.gov.au/view/html/inforce/current/sl-2017-0136#pt.3-div.4