Final Report – Hyacinth Recovery and Reuse Pilot

Fitzroy Basin Association Hyacinth Report

Date: 3 January 2025

FBA works for our central Queensland community to grow a sustainable, productive and profitable Fitzroy region.

FBA acknowledges the First Nations of the lands and waters within the Fitzroy region where we learn and live, and pay our respects to them, their culture and Elders past and present.

FBA acknowledge the financial support of the Cooperative Research Centre for Developing Northern Australia (CRCNA) which is part of the Australian Government's Cooperative Research Centre Program (CRCP).

CRCNA DEVELOPING NORTHERN AUSTRALIA

Australian Government Department of Industry, Science and Resources | Cooperative Research Centres Program

This report is an output of the CRCNA project "**Making Water Work: Integrating nutrient, waste and energy streams in agriculture development through hyacinth harvest and processing**" a collaboration between the Fitzroy Basin Association, the Rockhampton Regional Council and Queensland Department of Agriculture and Fisheries. The CRCNA also acknowledges the financial and in-kind support of the project participants.

Suggested citation for this report:
Fitzroy Basin Association. (2025). FInal Report – Hyacinth Recovery and Reuse Pilot. Final Report CRCNA project A.7.2122009. Fitzroy Basin Association. Rockhampton. 24 pages.

ISBN 978-1-922437-57-0

Contents

Introduction

Water hyacinth is an invasive aquatic weed that was introduced as an ornamental plant but once it entered waterways has a long-term impact due to the rate of growth, density of biomass and seed life. The Fitzroy River has seen rafts of weed up to 1km long that block recreational use, impact on irrigators and result in poor water quality when it enters the estuarine reach and dies. The continual supply of nutrient and ideal growing conditions provides an almost year-round growing season for the weed.

Figure 1: Hyacinth in the Alton Down area close to Deep Creek

The weed is likely "here to stay" however the use of the weed as a vector for the removal of nutrient from the waterway and reuse of this nutrient in lieu of imported nutrient for cropping and grazing will contribute to improved water quality flowing to the Great Barrier Reef.

Aim

Identify and evaluate methods for the beneficial reuse of water hyacinth in the Fitzroy River including effective removal, dewatering, utilisation as a nutrient and/or carbon source, understanding of the risks associated with a declared weed and estimation of potential scale up challenges. Answer longer term questions including, Is there potential for the extraction of the weed to become a cost-neutral exercise, will the harvesting reduce the impacts of the weed on native flora and fauna, what are the factors that contribute to the regrowth of the weed / the location of the weed and modelling of the benefits to water quality.

Short Term

- Identification of extraction and handling methods that are cost-effective and limit the spread of the weed to non-impacted areas
- Develop the collective knowledge on the weed and its life cycle within a Northern Australian waterway
- Bring together skilled local parties with an interest in the program
- Harvest and test reuse options for aquatic weed
- Clarify any risk management strategies required to reduce potential impacts on native aquatic flora and fauna (including liaison with the relevant government agencies)

Medium Term

- Determine the reuse benefits (or disadvantages) of water hyacinth for land repair, or nutrient removal
- Determine the economic value of weed removal for water quality improvement, reduced impacts to native flora and fauna or as a product
- Mapping harvest zones including restricted access and unloading areas

Long Term

- Provide the basis for a reduction in the use of herbicides for the management of water hyacinth in the Fitzroy River
- Reduce the likelihood of large weed mats accumulating in the lower reaches that impact on recreational use, water quality and fish habitat
- Provide users of the Fitzroy Basin a locally beneficial option to offset nutrient releases from their environmental relevant activities or land developments
- Reduce the cost of weed management through the development of saleable products that offset the high cost of weed removal from waterways

Key Deliverables

a. Removal of approximately 500 tonnes of water hyacinth from the Lower Fitzroy River system via a mechanical harvesting process
b. Trial of water content reduction of the weed
c. Trial of processing methods of the weed to produce beneficial products
d. Sampling and analysis of the harvested weed and products for key parameters
e. A preliminary understanding of the biomechanics of water hyacinth in a Northern Australian River system

Hypothesis

Can hyacinth be removed from the Fitzroy River system and be repurposed into a valuable product?

Through our initial research there are many options for repurposing hyacinth. We hypothesize that water hyacinth as a mulch will improve soil health by helping to regulate soil temperature, reduce water evaporation, and minimize erosion by providing a protective cover over the soil surface. We expect that hyacinth mulch will supply nutrients such as nitrogen, phosphorus, and potassium in plant-available forms, boosting fertility while reducing reliance on synthetic fertilizers. We presume hyacinth mulch will also enhance microbial activity and biodiversity, which can help support processes like nutrient cycling, organic matter decomposition, and disease suppression. Hyacinth could also increase soil organic carbon, which not only improves soil structure but also contributes to long-term carbon sequestration.

We expect hyacinth could be used as a viable stockfeed via palletising the water hyacinth. It would potentially provide a cheap feedlot food option that is high in nutrient and palatable to beef cattle.
Lastly, considering biochar requires a high initial startup investment and current availability lacks in Central Queensland, we assume hyacinth biochar will be a carbon rich product that is beneficial to soil performance and will improve the retention of water and diffusion of nutrients.

Figure 2: Hyacinth matt in the lower Fitzroy River adjacent to the Macadamia Farm

Methodology

Harvesting Methodology

1. The originally planned harvesting location needed to be updated due to unplanned variability in weed availability and contractors were engaged to harvest the trial in Murray Lagoon. A site visit was required to be undertaken with the harvesting operator to ensure logistical suitability of the newly chosen site. There was concern with the depth of the lagoon and the ability for the harvester to manoeuvre. FBA staff identified several shallow areas and mapped the depths to ensure the harvester had appropriate access to the larger hyacinth clusters.

Figure 3: FBA employees measuring depths in Murray Lagoon for the harvester.

The minimum depth measured was 600mm, with the remainder of the lagoon coming in around 900mm or deeper. All access points, albeit being in public areas, were appropriately distanced from high traffic areas and posed minimal impact on the public day visitors access and could be easily cordoned off to ensure safety requirements were met.

2. Another 'Species Management Plan' (SMP) was developed utilising the Rockhampton Regional Council (RRC) monitoring programme for nesting avifauna in the primary harvesting locations and significantly streamlined the preparation process of the SMP. Relevant information from Ecosure Environmental Consultancy were incorporated into the SMP which indicated minimal risk to any species and the harvesting process to remove hyacinth out of the system would positively impact the fauna and flora.

3. Landholder contracts were developed between Fitzroy Basin Association (FBA) and the participating landowners. This process required more time than anticipated and had a follow-on affect in ability to commence planned harvesting timelines. Thankfully, through collaboration with Rockhampton Regional Council (RRC), a timely resolution was able to be achieved and signed trial could commence.

4. Harvest programme was devised to plan access routes, travel times and harvest quantities and agreed upon by contractors and funders.

5. Product testing programme plan was refined during the harvest phase.
   At each site, there would be 30 plots composed of:
   - Five with mulch and no nitrate applied
   - Five with compost and no nitrate applied
   - Five with tarped mulch (for heat treatment) and no nitrate applied
   - Five with mulch and nitrate applied
   - Five with compost and nitrate applied
   - Five with tarped mulch (for heat treatment) and nitrate applied

6. Harvesting process - the most cost-effective method for extraction and handling of hyacinth was adopted. This included selecting the largest blanket of hyacinth in Murray lagoon and setting up an extraction offloading site there. Hyacinth was collected by the harvester which travelled between the compact truck and hyacinth matt. The harvester unloaded around 1-1.5 tonnes of hyacinth per load into the compactor parked at the offloading site on the edge of the lagoon. After about 10-14 loads the compactor would be full of (the compressed equivalent of) 16 tonnes of hyacinth. The compactor would then fully enclose for safe weed transport. Hyacinth was delivered to the test plot locations at South Yaamba via the most direct route. Hyacinth was dumped in long tall piles awaiting decomposition, mulching and baking.

7. Distribution - around 100-150 tonnes was left with the council for mulching trees, 300-350 was transported to landholders for their macadamia and lychee plantations and around 60 tonnes was used for the trial plots.

8. Total harvesting volume - with a total of over 33 x 16-tonne compactor loads, 528 tonnes of hyacinth was removed from Murray Lagoon. The process was slower than expected due to the travel distances to the Macadamia and Lychee farms for the first few days. Towards the end, all the hyacinth was disposed off at site and meant the crew could do double the volumes. See Figure 3 and Table 1 for details.

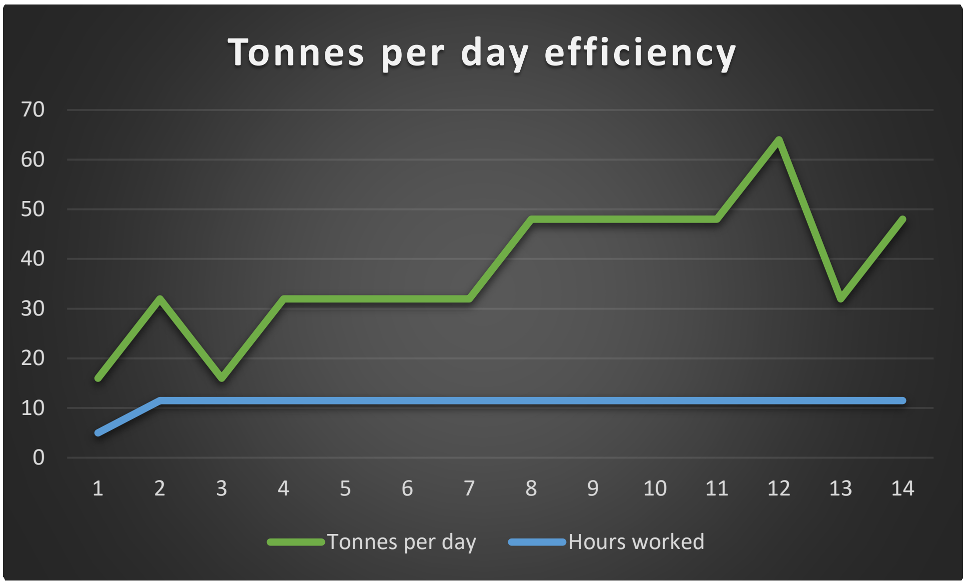

Figure 3: Tonnes per day efficiency


Figure 4: Harvester and compactor truck

Table 1: Hyacinth Harvesting Hours

Day	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday
Date	12/3/24	13/3/24	14/3/24	15/3/24	16/3/24	17/3/24	18/3/24	19/3/24	20/3/24	21/3/24	22/3/24	23/3/24	24/3/24	25/3/24
Days	0.5	1	1	1	1	1	1	1	1	1	1	1	1	1
Hours charged	8	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Hours worked	5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Loads complete	1	2	1	2	2	2	2	3	3	3	3	4	2	3
	Agremeent sign delay													
Tonnes per day	16	32	16	32	32	32	32	48	48	48	48	64	32	48

Summary		
Days worked	13.5	
Hours charged	157.5	120hrs in contract
Hours worked	154.5	
Loads complete	33	
Average Loads per day	2.44	16
Loads per hour	0.21	
Tonnes complete	528	
Tonnes remaining	-28	
Tonnes per day	39.11	
Days remaining	-0.72	

9. Site remediation - the extraction location was then tidied, and the harvest contractor demobilised.

10. Piled hyacinth was then mulched using a wood-grade mulcher and left to dehydrate for 1-3 weeks.

Hyacinth Mulch Sampling Methodology

The study was conducted at three chosen sites in Rockhampton, Queensland: a macadamia orchard, a lychee orchard, and grazing pasture. The semi decomposed hyacinth material were distributed to multiple test plots at each site. Hyacinth was mulched with industrial mulchers from the macadamia farm, and then finely layered between top and bottom tarps to bake the hyacinth. Hyacinth was then transported from the baking location to the treatment plots. Treatments included water hyacinth mulch, woody mulch, and no-mulch control, with and without urea application. Initial sampling of soil was taken before hyacinth was placed in each plot and then 6 weeks later a second round of sampling took place. Soil samples were analysed for microbial diversity, community composition, and functional traits. Once the sampling results were returned a literature review and report with recommendations was drafted.

Figure 5: Decomposing hyacinth piles


Figure 6: Mulched hyacinth set out between black tarps


Figure 7: Plot layout at the macadamia farm

Figure 8: Plot layout at the lychee farm

Stockfeed Assessment

A sample was also taken to Blue Ribbon Stock Feeds in May and July of 2024. The sample was sent to the Department of Primary Industries and Regional Development. Results were returned late November for review.

Harvesting Outcomes

Once a harvest location was selected the relevant landholder agreements were developed for each landholder where harvesting or stockpiling or sampling of hyacinth occurred.

Contractors were engaged for harvesting on an agricultural landholder's property in the lower Fitzroy. However, with a lack of hyacinth due to recent high flows flushing the hyacinth into the estuary, other sites were considered. All potential sites on the Fitzroy were considered, however, there was either challenges with river access or the required distance to be travelled from the boat ramp to hyacinth was prohibitive or significantly lowered the amount of hyacinth able to be harvested.

FBA investigated several alternative options to source hyacinth from surrounding landscapes. Murray lagoon was selected as the best candidate with both a large amount of hyacinth available, ease of access and perceived public and private benefit for removal of the weed. This shift initiated further logistical effort required to incorporate additional transport distance, circumvent extensive roadworks coinciding with trials and revisit council and government/environmental approvals. This resulted in delaying commencement and was compounded by the harvester speed, which was slow moving. Even with the ample access points on Murray lagoon, there was still considerable time lost in travel and harvesting process of the hyacinth clusters.

A final tally of 528 tonnes of hyacinth was removed from Murray Lagoon, which resulted in a considerable opening of the lagoon which had been choked with hyacinth for an extended period. Extra hours were required to reach the desired tonnages as efficiency was reduced with extended travel routes and slowed progress due to roadworks. We reached the updated target of 500 tonnes. Yet, with extended travel times, between hyacinth loads, and a completely different source of hyacinth (much less dense than originally expected for on the Fitzroy) this is a very commendable outcome. Around 100 -150 tonnes was piled at the council land to be later used as mulch for lagoon tree planting mulch. Around 60 tonnes was used for the sampling/testing program. The remaining 300-350 tonnes was delivered to landholders as a mulch product for their fruit trees.

The key limitation was a lack of hyacinth during the proposed harvest period. This was due to large freshwater flows and sub-optimal growing conditions, resulting in scarcity in the Fitzroy River. The tributaries and anabranches that did contain considerable amounts of hyacinth either did not have suitable access or required excessive travel times to a fit-for-purpose entry point, making hyacinth extraction inefficient and ineffective. The team did consider 2024 to be a very unusual season and certainly not an expected variable.

Hyacinth typically is too far from entry locations to consider harvesting feasible. Cost per tonne grows rapidly with increased travel distance between entry points and hyacinth cluster. The harvesters are designed for small ponds, lagoons and lakes where there are multiple entry points from many edges of the gentle sloping banks. The Fitzroy is characterised with very steep/vertical banks and means harvesting is limited to few access options.

Boat ramps on the Fitzroy are few and predominantly servicing recreation/personal boat users and restrictive for a large compactor truck to reverse to collect harvester's hyacinth. Even after moving harvest locations to Murray lagoon, with better accessibility, the efficiency of hyacinth removal was underwhelming. Harvesters are usually powered by paddle wheels (like a paddle steamer). This design helps avoid getting weed tangled around the propeller, but also results very slow travel speeds. Even when not harvesting and moving to and from the boat ramp, the harvester travels only at walking pace.

What Worked

We relocated to Murray Lagoon, which borders the Rockhampton Zoo due to the scarcity of hyacinth during the proposed harvest period in the Fitzroy River. There were considerations of other locations along the Fitzroy, however, they were all either too far from suitable boat ramps, plot locations, or the river was too shallow.

Due to the change in location, trucking the hyacinth from Murray Lagoon to the plot sites was significantly further. This meant most of the contractor cost was spent trucking the hyacinth rather than operating the harvester. Therefore, even fulfilling the reduced 500 tonne target was a challenge. To meet the planned target more resources were diverted from landholder activity and towards additional harvesting.

Learnings – Opportunity for Improvement

Improving the speed of the harvester, when the harvester is transporting hyacinth (rather than harvesting) would be very beneficial. Transporting hyacinth from the harvest site, back to the offloading location was a large time constraint as the harvester's maximum speed is only a brisk walking pace. Faster boats, even a second (faster) motor for quickly travelling between hyacinth and the offloading location would decrease travel time and improve cost per tonne of harvest.

The Fitzroy River does lack usable public boat ramps for hyacinth extraction. By adding more boat ramps in key locations for hyacinth extraction, there is also a double benefit of improving community access to the Fitzroy River for fishers, boaties and locals. These would need to be concrete boat ramps with relatively low gradients.

James Cook University Testing Programme

The adjunct study examined the effects of mulch type, nitrogen addition, and vegetation type on soil microbial communities and their functional traits across macadamia, lychee, and grazing systems. The analysis focused on microbial diversity, community composition, and functional traits associated with ecosystem services, including nutrient cycling, decomposition, and pathogen suppression.

Land-use type was a major driver of microbial diversity and functional traits, reflecting the influence of plant inputs and root-microbe interactions. For example, macadamia vegetation strongly supported traits such as leaf/fruit decomposition and soil saprotrophy, likely due to the high-quality organic inputs and specific root-associated communities in these systems. In contrast, lychee vegetation was associated with declines in ectomycorrhizal diversity and shifts in decomposition traits. This was likely due to the unique practices used to grow lychees (e.g. soil mounding).

Executive Summary Excerpt from JCU Testing Programme

Water hyacinth (WH) mulch increased the diversity of arbuscular mycorrhizal fungi, chitinolytic microbes, and other traits related to rapid nutrient cycling and decomposition. However, this effect was context dependent. For example, arbuscular mycorrhizal diversity decreased under WH mulch in lychee orchards, potentially due to specific interactions between WH mulch inputs and lychee root exudates or lychee agricultural practices. Woody mulch, in contrast, favoured traits associated with longer-term organic matter stabilization and soil structure, such as soil saprotrophy and nematophagous activity.

Nitrogen addition had notable interactions with mulch and vegetation treatments effecting microbial traits. Urea increased the diversity of arbuscular mycorrhizal fungi, suggesting that added nitrogen may alleviate nutrient limitations for these mutualists, thereby enhancing their ability to support plant nutrient uptake. Similarly, chitinolytic diversity was elevated under macadamia vegetation and WH mulch with urea addition. However, the negative interactions observed between urea addition and specific mulch treatments, such as reductions in methanotrophic and nematophagous diversity under WH mulch, highlight the potential trade-offs of nitrogen inputs. Excess nitrogen may shift microbial community composition, favouring taxa adapted to high nitrogen environments at the expense of others, potentially disrupting ecosystem functions.

Nitrogen addition via urea had notable effects on microbial traits, often interacting with mulch and vegetation treatments. For example, urea increased the diversity of arbuscular mycorrhizal fungi, suggesting that added nitrogen may alleviate nutrient limitations for these mutualists, thereby enhancing their ability to support plant nutrient uptake. Similarly, chitinolytic diversity was elevated under macadamia vegetation and WH mulch with urea addition, indicating potential synergies between nitrogen availability, labile carbon inputs, and pathogen suppression traits. However, the negative interactions observed between urea addition and specific mulch treatments, such as reductions in methanotrophic and nematophagous diversity under WH mulch, highlight the potential trade-offs of nitrogen inputs. Excess nitrogen may shift microbial community composition, favouring taxa adapted to high nitrogen environments at the expense of others, potentially disrupting ecosystem functions.

The diversity of specific microbial traits provides insights into the functional resilience and ecosystem services of agricultural soils. For example, the increase in chitinolytic and saprotrophic diversity under WH mulch suggests enhanced decomposition and nutrient cycling, which could improve soil fertility and crop productivity. Conversely, the reduced diversity of ectomycorrhizal fungi in lychee orchards highlights potential challenges in maintaining symbiotic relationships critical for phosphorus uptake and plant resilience. The observed increases in nematophagous diversity under woody mulch suggest potential for biological control of nematode pests, reducing the need for chemical nematicides. However, the elevated *diversity of opportunistic human pathogens under certain treatments emphasizes the need for careful management to balance soil health benefits with biosecurity concerns.*

Limitations of the Testing Programme

This study has several limitations that should be considered. First, the experimental duration was relatively short to match funding availability, limiting the ability to observe long-term effects of mulch and urea treatments on soil microbial communities and functional traits. The use of a single application of urea and mulch may not capture the cumulative effects of repeated treatments often used in agricultural practices. Testing did not account for metabolic activity and cannot be generalised to other soil types/climate conditions. Future research is required to address these limitations by conducting long-term experiments to evaluate the persistence of treatment effects and their potential cumulative impacts. More land use types, soil conditions, and climatic regions would improve generalisation of findings.

Discussion & Recommendations

Return on Investment / Circular Economy Assessment

Potential reduction in weed control cost for Rockhampton
The currently reported cost to Rockhampton Regional Council for spraying water hyacinth exceeds $230,000 annually. This will not necessarily be eliminated, but likely reduced if harvesting hyacinth as well. Transferring some of the costs associated with spraying hyacinth into harvesting and processing hyacinth has the environmental benefit of removing hyacinth (nutrient reduction) and improving farms/land by incorporating that into soil. Harvesting hyacinth at scale could mean that hyacinth quantities are reduced faster that the population can reproduce. To make certain solutions viable, a constant source of hyacinth is needed. This could mean that hyacinth population could be maintain on a selected water body and harvested without depleting it. If the water quality and quality of the hyacinth doesn't have an impact on the end of life for example pyrolysis, the option of growing it on nutrient rich waste water settling ponds could be viable.

Identify hyacinth hotspots
Hotspots have been identified for water hyacinth in the Fitzroy River. Alligator Creek is a location where hyacinth builds and rarely flushes out, even staying locked in during larger floods. Fitzroy River offshoot opposite Long Island bend is also a location where hyacinth is commonly present year-round and is rarely flushed. Fitzroy river bend immediately upstream of Alligator creek chokes during large hyacinth events and is a great location for harvesting. Fitzroy Barrage builds up with a large matt of hyacinth during thick hyacinth years. The section in Alton Downs between Alligator Creek and Deep Creek is a seasonal hyacinth hot spot.

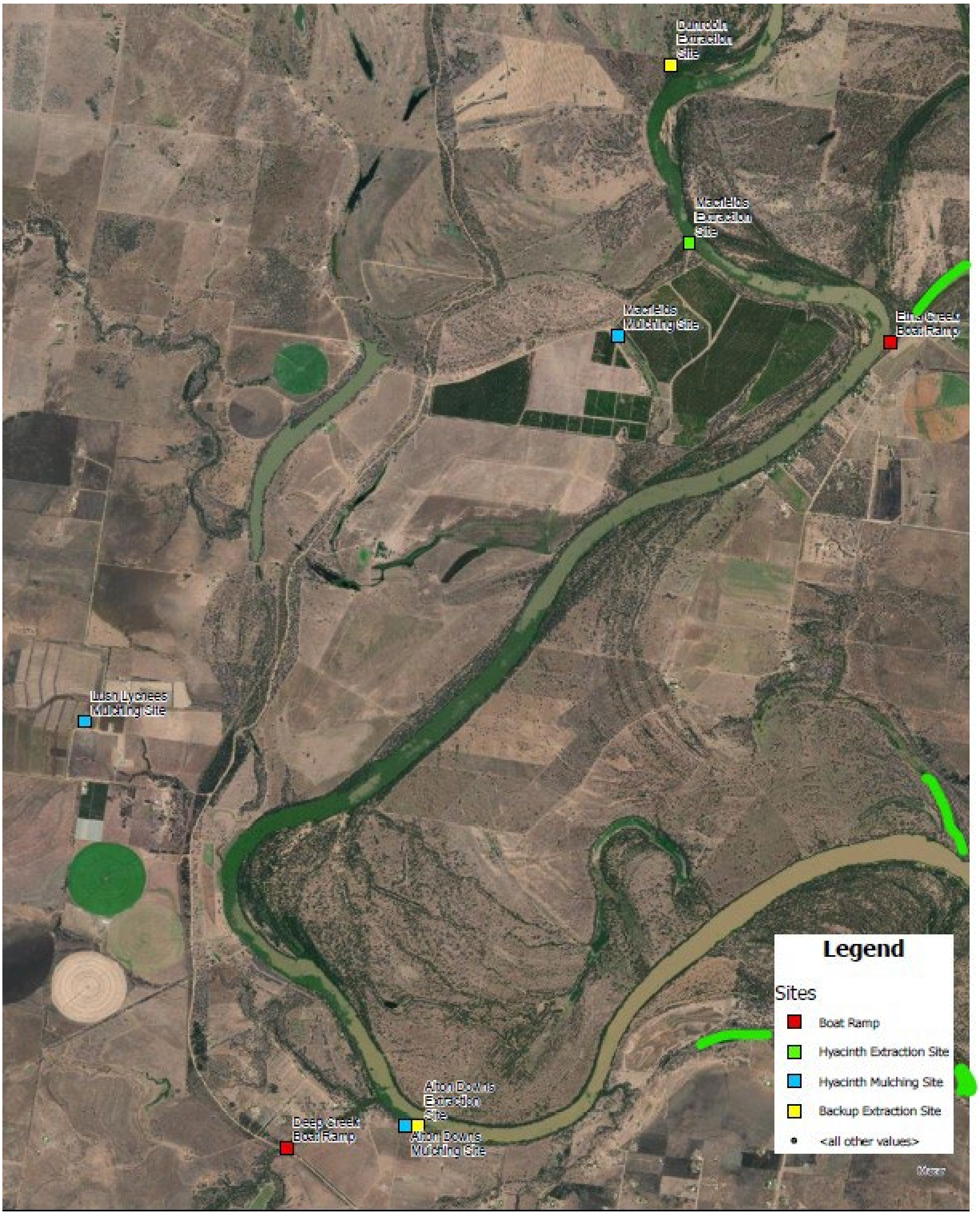

Figure 5: Hyacinth hot spots

Alternative locations

Rookwood weir is farther away, but likely to have consistent hyacinth. Murray lagoon has large amounts of hyacinth even in flood years. Sheep wash lagoons have large amounts of hyacinth even in smaller flood years. Gracemere lagoon is another alternative location for times when the Fitzroy Hyacinth is low.

Combination of effort – upskill spray team to operate harvester

There is opportunity to upskill the spray team to operate the harvester. This results in likely little to no cost savings. However, in upskilling staff, there is benefit in more options in reducing hyacinth in the river and in reducing nitrogen inputs into the Fitzroy and therefore the Great Barrier Reef. Moreover, the hyacinth can be relocated to nearby landholders, fruit growers, biochar facilities and stockfeed producers to re-purpose the hyacinth. If a solution is found that offsets the cost of harvesting, then less spraying can be done and more harvesting.

Incentivised projects

Landholders can be offered reduced cost for hyacinth removal. Landholders are required to manage pests and weeds on their properties. If they opted to remove hyacinth manually, and an RRC hired/purchased harvester were to be used, and some expenses can be covered by the landholder. This could save landholder cost by opting to undertake the work on their own cost.

Offsetting funding opportunities

In the building of the Rookwood weir, Sunwater was required to offset nitrogen due to inundating forests for water storage. Removing water hyacinth from the Fitzroy could be a real option for nitrogen reduction. Also, if other corporations are funding this work in the future, there is cost savings for council and opportunity for landholders/cattle farmer to benefit from cheaper livestock feed, mulch or soil ameliorant.

Stockfeed Assessment Outcomes

Blue Ribbon Stockfeed lab results (DPI&RD)

Blue Ribbon Stock Feeds sent a sample of hyacinth to the Department of Primary Industries Research and Development's AgEnviro Labs South for testing. The results were great with wet and dry chemistry of the hyacinth sample sharing similar results to that of the '2018 Season Hay Nutritional data based on analysis at NSW DPI Feed Quality Service' hay results. This includes wheaten, oaten, cereal, lucerne, pasture, vetch, and canola hays, as well as various silage. These results are promising, as this indicates that hyacinth could be used as an effective feed alternative for cattle. The Mort & Co feedlot development will create a major demand in the industry for feed and this could become a primary solution for them.

The water quality of the water body does impact the quality of the hyacinth. It is important to maintain a monitoring and testing regime of both water and hyacinth for pollutants, metals, chemicals and pathogens prior to utilising it for animal feed production.

2018 Season Hay Nutritional data based on analysis at NSW DPI Feed Quality Service

HAY TYPE		DM	NDF	ADF	CP	ASH	OM	DMD	DOMD	ME	WSC	FAT
WHEATEN HAY	AVE	91.1	51.9	26.9	9.9	6.2	93.8	67.6	64.0	10.0	21.6	
	MIN/MAX	69.9 / 97.0	38.3 / 82.9	17.7 / 51.4	2.9 / 17.1	2.1 / 11.1	88.9 / 97.9	39.7 / 77.3	40.4 / 72.3	5.2 / 11.7	1.0 / 36.4	
	SD	5.7	6.0	4.3	2.2	1.7	1.7	5.1	4.3	0.9	6.3	
OATEN HAY	AVE	90.2	56.6	31.1	8.5	6.6	93.4	63.3	60.4	9.3	14.4	
	MIN/MAX	87.0 / 94.3	38.4 / 75.9	18.8 / 48.5	3.1 / 17.2	4.0 / 12.5	87.5 / 96.0	43.7 / 78.9	43.9 / 73.6	5.9 / 11.9	1.0 / 27.9	
	SD	1.7	7.7	5.9	2.5	1.6	1.6	7.9	6.7	1.4	7.5	
CEREAL HAY	AVE	92.1	53.9	28.7	10.0	6.6	93.4	66.2	62.9	9.8	18.3	
	MIN/MAX	76.7 / 96.6	41.6 / 67.4	19.5 / 39.8	4.6 / 16.5	3.2 / 10.1	89.9 / 96.8	53.6 / 79.2	52.2 / 73.9	7.6 / 12.0	6.8 / 28.2	
	SD	5.5	7.0	5.7	2.7	1.9	1.9	7.1	6.0	1.2	6.9	
LUCERNE HAY	AVE	91.1	47.6	33.8	19.1	12.3	87.7	57.0	55.2	8.2	2.0	
	MIN/MAX	79.1 / 98.3	28.9 / 65.6	20.4 / 47.4	6.5 / 34.6	6.0 / 22.1	77.9 / 94.0	39.2 / 40.1	40.1 / 72.9	5.1 / 11.8	1.0 / 14.1	
	SD	4.6	6.0	4.4	4.1	3.9	3.9	7.8	7.8	1.6	4.8	
PASTURE HAY	AVE	93.0	59.3	35.0	11.0	8.3	91.7	62.8	60.0	9.2	13.1	
	MIN/MAX	73.5 / 98.2	39.6 / 83.3	21.2 / 50.2	1.0 / 24.4	2.8 / 20.9	79.1 / 97.2	33.0 / 87.7	34.8 / 81.1	4.1 / 13.5	1.0 / 29.9	
	SD	4.3	11.4	6.1	6.1	3.5	3.5	13.7	11.6	2.4	6.6	
VETCH HAY	AVE	92.4	46.0	31.5	17.2	9.1	90.9	66.3	63.0	9.8	9.5	
	MIN/MAX	88.0 / 95.4	35.7 / 58.8	24.5 / 42.9	8.2 / 22.6	5.6 / 12.4	87.6 / 94.4	47.8 / 78.4	47.3 / 73.2	6.6 / 11.9	0.6 / 15.0	
	SD	2.9	8.3	6.3	4.7	2.3	2.3	10.9	9.2	1.9	4.8	
CANOLA HAY	AVE	89.6	48.3	34.7	14.0	8.9	91.1	59.5	57.2	8.6	11.0	
	MIN/MAX	69.5 / 97.1	33.4 / 82.3	24.3 / 59.2	2.5 / 24.9	0.7 / 20.0	80.0 / 99.3	31.8 / 78.2	33.8 / 73.0	3.9 / 11.8	1.0 / 19.0	
	SD	4.3	6.2	4.7	3.3	1.9	1.9	5.7	4.8	1.0	3.7	
LUCERNE SILAGE	AVE	51.8	46.4	32.9	18.6	9.2	90.8	61.6	59.2	9.5		
	MIN/MAX	16.1 / 79.8	41.3 / 52.8	28.8 / 40.3	13.5 / 21.0	5.6 / 18.6	81.4 / 94.4	11.0 / 72.4	17.6 / 68.1	2.8 / 10.9		
	SD	20.2	3.2	3.1	2.0	3.2	3.2	16.3	13.5	2.2		
CEREAL SILAGE	AVE	53.9	52.2	26.2	10.6	11.7	88.3	68.4	65.0	10.4		
	MIN/MAX	25.9 / 79.9	41.2 / 66.4	18.9 / 36.9	7.1 / 14.4	6.1 / 26.8	73.2 / 93.9	57.7 / 75.9	55.7 / 71.8	8.9 / 11.5		
	SD	8.5	7.4	5.8	2.7	5.2	5.2	5.5	4.7	0.8		
WHEATEN SILAGE	AVE	71.5	48.5	24.3	11.9	10.0	90.0	68.5	64.9	10.6		
	MIN/MAX	40.4 / 88.1	39.8 / 63.0	17.7 / 38.6	7.4 / 17.1	7.4 / 17.1	84.1 / 93.1	55.9 / 76.5	54.1 / 71.6	8.7 / 11.5		
	SD	16.9	8.7	6.9	3.2	3.2	2.2	6.7	5.7	0.9		
CANOLA SILAGE	AVE	56.4	43.5	29.5	17.2	8.2	91.8	61.4	59.1	9.5	9.5	
	MIN/MAX	28.1 / 85.3	27.5 / 60.8	18.7 / 40.1	18.7 / 40.1	5.3 / 15.7	84.3 / 94.7	49.5 / 73.4	49.0 / 69.4	7.8 / 11.1	7.8 / 11.1	
	SD	13.9	6.6	4.3	4.3	1.6	1.6	4.2	3.6	0.6	0.6	
WHEAT	AVE	92.0	9.1	3.1	14.7	3.1	96.9	86.7	85.5	13.0		1.4
	MIN/MAX	90.6 / 93.4	4.2 / 11.7	2.2 / 5.0	11.7 / 18.1	1.8 / 5.0	95.0 / 98.2	85.5 / 88.2	84.3 / 86.9	12.5 / 13.3		0.2 / 2.8
	SD	0.8	1.8	0.6	1.8	0.9	0.9	0.8	0.8	0.2		0.6
BARLEY	AVE	91.5	15.4	7.1	12.4	4.5	95.5	83.2	82.1	12.6		1.5
	MIN/MAX	89.4 / 95.2	2.5 / 21.7	5.0 / 11.5	9.9 / 15.5	2.5 / 8.1	91.9 / 97.5	80.0 / 85.4	79.0 / 84.2	11.6 / 12.9		0.8 / 34.6
	SD	1.0	3.3	1.2	1.4	1.2	1.2	1.1	1.0	0.2		5.4
OATS	AVE	93.6	27.4	14.4	12.5	3.9	96.1	75.3	74.5	12.5		4.9
	MIN/MAX	92.0 / 69.9	13.7 / 34.5	6.7 / 17.8	8.5 / 14.9	2.4 / 6.2	93.8 / 97.6	70.3 / 85.0	69.7 / 83.8	11.5 / 12.8		1.3 / 6.1
	SD	1.3	4.6	2.3	1.9	1.0	1.0	3.0	2.9	0.4		1.1

= Hay Types which have a largely increased level of submissions based on Frosted crop mitigation.

*Data based on submissions from OCT-NOV 2017

Figure 6: Feed hay nutritional data (NSW DPI&RD)

Department of Primary Industries and Regional Development

DATE OF ISSUE: 4/11/24 REPORT NO: R24-01448-[R00]

ANALYSIS RESULTS

Dry & Grind inc Dry Matter & Moisture	LOR	UNITS	1 Sample 1 - Hyacinth
Dry Matter (DM)	0.5	%	87.0
Moisture	0.5	%	13.0

Approved by:

Richard Meyer
Richard Meyer
Feed Chemist
Feed Quality Service

Feed Package - Wet Chemistry	LOR	UNITS	1 Sample 1 - Hyacinth
Neutral Detergent Fibre (NDF)	10	%	51.0
Acid Detergent Fibre (ADF)	4.0	%	26.3
Crude Protein (CP) by Dumas Combustion Method	0.6	%	10.9
Crude Fat (EE)	0.5	%	1.3
Water Soluble Carbohydrates (WSC)	0.5	%	2.3
Dry Matter Digestibility (DMD)	39	%	41.4
DOMD	38	%	41.9
Inorganic Ash	0.5	%	18.0
Organic Matter (OM)	0.5	%	82.0

NATA

2 of 4

Figure 7: Hyacinth nutritional data (NSW DPI&RD)

Biochar Pyrolysis Assessment Options

Biochar pyrolysis is a process in which organic material (in this case water hyacinth) is heated at high temperatures with limited oxygen to chemically decompose those organic materials to produce biochar – a charcoal like substance, rich in carbon and can improve soil health, fertility, water retention and can help neutralize soil acidity.

Establish a Stanwell Power Station pyrolysis plant

In Coal fueled energy production there is a byproduct or a leftover fly ash, furnace bottom ash and char. This Loss of Ignition (LOI) material at the power stations is generally less than 5 per cent of coal combustion products produced annually. This LOI material is what has the potential to be used to heat a furnace to power a biochar plant at Stanwell. Coal combustion products are typically made up of Fly Ash (90-95% of volume), and Furnace Bottom Ash and Char (5-10% of volume). Stored Ash (combination of the above) materials are suitable for biochar feedstock and are mainly found in the char, but smaller particles can be extracted from the Fly Ash. This new biochar plant could be used to produce a nutrient and carbon-rich biochar out of a range of products, including hyacinth.

Anergy Yarwun

Anergy Yarwun High Temperature Pyrolysis Plant is a pyrolysis plant developed by a waste-to-energy company (Anergy). Pyrolysis plants have the potential to double as a biochar plant. Located in Yarwun near Gladstone, there is potential to transport the hyacinth down to Yarwun (100km) to be treated into biochar.

Establish a Rockhampton pyrolysis plant

Like GreenTec Consulting (the first pyrolysis plant in Queensland), which thermally treats tyres and plastics to produce products like steel, oil, and carbon black. Rockhampton could develop a pyrolysis plant to service the mines in converting plastic, mining truck tyres and other industry waste products into usable products such as oil, carbon black, naphtha, diesel, unleaded. This pyrolysis plant could double as a biochar plant and help create a valuable biochar product for Rockhampton and surrounds.

Biofuel as briquettes

Dried hyacinth has a calorific value of around 14.46 MJ/kg. A study undertaken by Okia *et al* in Kenya on the *Physical and Chemical Properties of Water Hyacinth Based Composite Briquettes* indicates that it is a suitable material to be compacted into briquettes as an alternative fuel source. The outcome of the study is captured below.

For quality control, the water hyacinth composite briquette gave good indications on physical parameters that were measured e.g. durability index, densities, relaxation ratio. The water hyacinth briquettes possess high material strength (durability index) as well as high value combustible fuel as can be seen from the experiment. Based on the findings of this study and the above conclusions, the production of water hyacinth composite briquettes and its utilization could be advocated since its usage as solid biofuel, will alleviate the menace caused by this aquatic plant. Utilization of water hyacinth as a composite briquette could also enhance rural economic development, farm income, and market diversification, reduction in agricultural surplus, reduced negative environmental impact and creation of employment opportunities in the area of production, harvesting and utilization.

Environmental Benefit Analysis

Reduction in herbicide

Reducing herbicide in waterways is always a benefit. One benefit is that the hyacinth is less likely to build up a tolerance to the herbicide and that herbicides are not limited to killing hyacinth alone. Destroying plants at the toe of the riverbanks is a large risk for starting or speeding up the erosion process.

Reduction in increased nutrient loads – thus healthier fish, animals, coral and less algal blooms

Spraying weeds causes hyacinth to die, and once dead it stays in the river and becomes anoxic reducing water oxygen and increasing nitrogen. This increased nitrogen reduces water quality, clarity and promotes weed and algal blooming. Moreover, it provides a disadvantaged environment for coral to survive.

Less barrier to fish and animal migration

Many animals, fish and reptiles require connectivity of waterways to migrate. In shallow areas hyacinth completely chokes the entire water column thus halting migration through water. But also in deep water, many fish and animals use the upper water column of the river to travel and when this is choked by hyacinth migration can be reduced. All it takes is a hyacinth matt in front of one of the very few turtle/crocodile nesting sites to completely stop nesting for that year.

Increased volume of natives – less hyacinth smothering toe of bank

By reducing the prevalence of hyacinth, it gives natives the chance to proliferate and reclaim. This will increase diversity and reduce the monoculture that is hyacinth and other water weeds. Because the non-root-bounding hyacinth smothers the toe of banks, it can outcompete important erosion mitigating grasses and sedges, thus promoting accelerated erosion and sediment loss.

Social Benefit Analysis

Reduced visual pollution impact

Hyacinth is an eyesore and by spraying and harvesting it at the same time, it is more likely that the hyacinth is beaten or regulated before it gets too large and grows faster than it can be removed.

Saving irrigation/household pump replacement costs

Many landholders living along the Fitzroy often have to repair and replace pumps because they become blocked by hyacinth and/or burnout. Fitzroy Basin Association have had streambank projects suffer from lack of irrigation to riparian restoration projects because the expensive pumps fail due to hyacinth blocking and destroying pumps.

Increase use of Fitzroy waterways by fishers, kayak, rowing, boating, commercial business, croc tours

With a reduction in hyacinth, there will be an increase in fishing, kayaking, rowing, boating, commercial business use and even croc tours. The Fitzroy River is an underutilised resource within Rockhampton and if it can be kept fresh and healthy, this may promote a healthy abundance of water activities in Rockhampton.

Financial Benefit Analysis

Reduced pest spray cost

With hyacinth spray costs totalling $230,000 annually, there is the option for reducing that cost annually or even maintaining a similar annual sum but adding environmentally beneficial and socially beneficial outcomes such as reduced hyacinth left in the system and potential stockfeed/mulch/biochar benefits to farmers.

Increased cost (harvester operation, purchase, maintenance)

Aquatic weed harvesters are around $100,000 or more to purchase new and are labour intensive to operate. There are similar risks to hyacinth spraying. Trading chemical risk for mechanical. Maintenance of a harvesting vessel will likely be larger than a spray boat and spray equipment. Upskilling staff is a cost too, however, this has added benefits for staff (empowerment, confidence, value increase). The viability of the solution is based on the repurposing and demand. If it has commercial value and could be profitable, then the cost of the investment will make sense.

Saving irrigation/household pump replacement costs

Irrigation and household pumps are often destroyed by one of:

- Pump being clogged with water hyacinth, prevents water intake causing the pump to run dry and burn out.
- During flood events, hyacinth is swept downstream in large masses, entangling pumps and ripping them from banks.

Saving on sporting events

Any costs associated with removing hyacinth for water sports could be reduced by utilising a mix of harvesting and spraying the hyacinth. In 2018 the Australian Olympic rowing team trained on the Fitzroy River in Rockhampton to prepare for the world championships. There were costs associated with controlling and bunding hyacinth to open the area for training. Other common events on the Fitzroy are the Queensland school rowing championships, Rockhampton City Rowing Regatta, and Central Queensland Schools Rowing Championships Regatta. Efforts could be focused upstream of the lower reaches of the Fitzroy, particularly in the anabranches and creeks where hyacinth continues to exist during floods or 'hyacinth cleanout periods', and later exponentially multiplies from this location. This could stop hyacinth at some of the sources and greatly reduce the volume of hyacinth matts accumulating in the lower reaches of the Fitzroy.

Summary

- Harvester will spend a portion of time in the Fitzroy River
- Float lines placed out during period of low hyacinth will help aggregate hyacinth to make harvest effective
- Harvesters must have capacity for harvesting in lagoons, dams and ponds in low hyacinth times
- Multi-use approach of cattle feed, biochar and mulch is the best option for success
- Further research is required for cattle feed opportunity
- It may not necessarily be a profit producing exercise or large cost saving rather than using pesticides, but there is a large social and environmental benefit.

@fitzroybasinassociation
07 4999 2800
@fitzroybasin
admin@fba.org.au
fitzroy-basin-association
fba.org.au

fba.org.au

PEOPLE. ENVIRONMENT. FUTURE.