CURL CURL LAGOON

FLOATING WETLANDS PILOT PROJECT

23 July 2021

northern beaches council

Australian Government
Department of Industry, Science, Energy and Resources

Curl Curl Lagoon Friends Inc.

EXECUTIVE SUMMARY

Since 1980 Greendale Creek and Curl Curl Lagoon in John Fisher Park at Curl Curl NSW have been the subject of an extensive programme of environmental restoration and rehabilitation led by Sydney's Northern Beaches Council and assisted by community groups including Curl Curl Lagoon Friends Inc.

In recent years Council's Coasts & Catchments team has been interested in proving the concept of using floating beds of wetlands plants anchored in the main water body to help improve water quality.

In November 2019 Council and Lagoon Friends received a $20,000 grant under the Commonwealth Department of Science, Industry, Environment & Resource's *Communities Environment Program* (*CEP*) to conduct a pilot project to establish whether the floating wetlands concept could help achieve the desired outcome of improving water quality.

Council staff led the scientific and technical elements of the project while Lagoon Friends took responsibility for community participation, project management, and administration of the CEP grant.

A controlled growing environment comprising an above-ground 5000L poly water tank, suspended platform holding a growing medium , crane, winch, air lift aeration pump, water transfer pump and associated equipment and services was established on a site within the grounds of the Council operated Curl Curl Community Nursery adjacent to the Lagoon. CEP grant funds assisted in the establishment of this facility.

In October 2020 water was pumped from the Lagoon into the tank and the first test cycle commenced. By May 2021 it was demonstrated that species *Carex appressa* could both survive and thrive on nothing more than air and the nutrients present in the water sourced from the Lagoon.

Scientific testing of water samples taken daily over a 14 day period in March 2021 revealed an encouraging general net decrease in nutrient concentration.

While this pilot project had originally intended to compare the growth and nutrient reduction performance of a number of species, ultimately one test cycle only could be completed during the grant period. But with the necessary infrastructure now fully operational, further testing can continue into the future.

During the course of the project, progress updates were published on Council's and Lagoon Friends' websites and social media channels and on-site open days were attended by local school children and the general public. The purchase of a working model of the production air lift water pump constructed from transparent Perspex pipe proved to be an excellent educational aid and an object of interest to all those who attended the public demonstrations.

The first growing trial has demonstrated that a garden of wetland plants floating in water drawn from Curl Curl lagoon can survive and improve the water quality. As a closing step, the project purchased a mini wetland pontoon to see whether the same result can be replicated in a section of Greendale Creek.

In conclusion, the combination of CEP grant funds, physical resources and manpower from Council, volunteer effort from Lagoon Friends, and the support of Warringah and Manly's MPs produced what the team considers a good outcome against the project's original objectives and a solid platform on which improvements to the water quality of Curl Curl Lagoon will continue to be developed.

Paula Cowan
on behalf of the Executive Committee
Curl Curl Lagoon Friends Inc

CONTENTS

OBJECTIVES

Concept

To prove the concept of using a floating bed of wetland plants to improve the quality of water in Curl Curl Lagoon and Greendale Creek.

Anticipated benefits

A permanent floating bed of wetland plants in Curl Curl Lagoon could provide bird habitat and a safe nesting area as well as filter and clean the currently heavily polluted water.

Working to restore the degraded natural environmental ecosystem would involve members of the local community and instil pride in place. The community would see a future in which restoration is possible and that innovative solutions that include native vegetation play a part in regeneration.

PROJECT MANAGEMENT

Participants and roles

This project was a collaboration between Sydney's Northern Beaches Council and Curl Curl Lagoon Friends Inc.

Council made out the original value proposition for the project, provided technical solution design, oversaw facilities construction, and managed on-ground operations including water sampling, arranging testing, and the collation of test results. Lagoon Friends managed the project, organised community participation, provided volunteer labour, reported progress and administered grant funds. Coasts and Catchments officers led several on-site community presentations.

Funding

This project was supported by $20,000 in grant funds provided under the Commonwealth Department of Science, Industry, Environment and Resource's Community Environment Program (CEP). For this grant, Council and Lagoon Friends were joint applicants with Lagoon Friends being the lead applicant responsible for project delivery.

APPROACH

This pilot program would trial various saltmarsh band wetland plants to determine those that would survive best as they break down contaminants through biological processes (bioremediation).

The first aim was to determine the most suitable aquatic plant species for vegetating a floating reed bed. The second aim was to measure any water quality improvement gains made by installing a floating reed bed in lagoon water.

By determining the right plant species that would thrive in the lagoon, monitoring and comparing the water quality of control lagoon water and plant-filtered lagoon water, a larger-scale project located in the lagoon itself could be developed.

CONTROLLED GROWING FACILITY

An aquaculture tank holding water taken from Curl Curl Lagoon was used to provide a controlled growing environment for wetlands plants. This facility allows the survivability and water filtration characteristics of different plant species to be readily observed and measured.

Northern Beaches Council manages a parcel of land adjacent to Curl Curl Lagoon and John Fisher Park that is currently used by a community centre, community garden and council native nursery. The site selected for installation of the aquaculture tank and pump is ideal for security, sharing facilities and for access to the lagoon.

Council's Coast and Catchment unit established the site and organised construction of the facility.

Figure 1 - Aquaculture tank secure facility showing plant bed on suspended growing platform, root growth descending from platform base, crane and winch, enclosures for electrical equipment including air pump, and air lift pump and plumbing.

TEST CYCLES

Nutrient Uptake/Removal Tests

A test cycle comprised setting up certain predefined conditions in the tank, selecting a plant species, monitoring plant development, taking water samples for a defined period, having those samples analysed, then planning the next test cycle.

While this pilot project had intended to conduct and compare the results from more than one cycle, one trial only was able to be completed during the grant period.

For Trial #1 the objective was to illustrate and assess the effectiveness of the wetland unit comprising selected plants (sedge *Carex*), their root system and the microbial biofilm on the surface of the root system.

A time series of water sampling was undertaken. The wetland platform was removed from the tank using the jib crane and the water sampled for nutrients. The tank was then filled with water pumped from the lagoon. This “fresh” volume of lagoon water was sampled for nutrient concentration. The wetland was then lowered into the tank and water sampled for nutrients. From this point onwards, water from the tank was sampled roughly every 24 hours or when practical, for the following 14 days.

Samples were filtered through 45um syringe filters and frozen. On completion of the 14 days of sampling, frozen samples were packed on dry ice and shipped over night to the designated laboratory for processing and analysis. Nutrient analysis was conducted at the Ecochemistry laboratory at Australian National University and urea was analysed at the Laboratory for Inorganic Chemistry (Nutrients), Forensic and Scientific Services at Queensland Health.

Please refer to Appendix 1 for detailed results of test cycles.

Conclusions

Results were encouraging in that a general net decrease in nutrient concentration can be seen over time.

Not only did the plants survive the water exchange process but also the doubling in water salinity that accompanied that exchange.

With the assumption that a newly filled lagoon is enriched in nutrients, the plants also tolerated this change of environment, from nutrient depleted water, (6 month old lagoon water sitting in the tank supported growth) to a more nutrient rich and saltier environment.

These are the environmental and physical challenges a full scale wetland would experience in Curl Curl Lagoon.

Figure 2 - A young dragonfly attached to the root system of plants growing in the controlled wetland environment

Next Steps

The results of this pilot project justify proceeding with further survival and efficacy test cycles. The next stage of nutrient sampling will assess the observed reduction rate during the summer months where metabolic rates are higher and plant growth faster. Nutrient reduction rates will also be studied in a controlled environment where no plants are present to further tease out the observed appetite of the plants to uptake nutrient.

Additionally, as a final step in the pilot project, a small scale pontoon garden bed has been installed in the waterway to trial *Carex* survivability in the field. Please refer to Testing in the Natural Environment below.

COMMUNITY PARTICIPATION

During the course of the project the community has been kept informed of progress via news articles posted on Lagoon Friend's and Council's website, on social media channels, on noticeboards in John Fisher Park, and at open days held on site in April and June 2021. The following report of the open day in March was prepared for and printed in Council's April Newsletter.

School Open Day

On 26 March 2021 over 120 students took part in the first Tank Talk designed to help the community better understand their natural environment.

Year 2 students from Curl Curl North Public School joined Council staff and volunteers from Curl Curl Lagoon Friends to take a close look at the floating wetland.

Students first learned about the kinds of plants and animals that live in the lagoon ecosystem and the importance of ensuring enough native plants are in place to feed and shelter wildlife.

Council's Coast team were able to show students the recently revegetated north bank of the lagoon where endemic plant species are replacing problematic invasive weeds.

Getting up close to the tank, students were then able to see more than just the leaves of the Carex sedge plant used in the floating wetland. An ingenious hoist designed to winch the wetland up out of the water enabled the young scientists to also see the root system developed underneath the wetland.

The Catchments team were thrilled to be able to show students dragonfly nymphs using the roots as underwater habitat.

The wetland pilot system includes an air pump to keep water circulating and students were given the challenge of building a mini version using four PVC components and testing in a bucket of water. Hands-on learning rounded off the experience with a whoosh and the odd splash.

Curl Curl Lagoon Friends President Paula Cowan was excited to be able to share this pioneering experiment with the students. "Young people need to hear that we've learned from the past and are doing everything we can to improve the environment.

"By involving students early in learning about the science of the world around them, it switches on their curiosity and develops a life-long appreciation of where they live.

"We know there's a long way to go to solve chemical and litter pollution issues in Curl Curl Lagoon and we're pleased that all levels of government are contributing to setting things right here.

"Together with Council, we're responsibly trying improvements on a small scale to get them right before testing in the lagoon itself. Early signs are really encouraging!"

Figure 3 – Inside the project's controlled environment enclosure at Curl Curl Lagoon Council's Coasts & Catchment team give a hands-on lesson to pupils of North Curl Curl Public School on how the floating wetlands work – 26 March 2021

Figure 4 - Members of the public visit the controlled growing enclosure on World Environment Day – 5 June 2021

EDUCATION MODEL OF AIR LIFT PUMP

The role of the air lift pump is to aerate and circulate the water in which wetlands plants are growing. It is an optional but valuable inclusion in the system to assist and improve the water filtration and purification action of the growing plants. By design, an air lift pump is low energy input (e.g. solar).

An air lift pump uses slightly compressed air from a small, low power electric air pump to generate bubbles at the base of a cylinder immersed in a body of water. The rising movement of the bubbles aerates the water and transfers it vertically then horizontally to a target area elsewhere in the water body.

To demonstrate the operating principles of the air lift pump the project commissioned a working scale model made from transparent Perspex piping. This dynamic model proved to be an excellent educational aid and an object of interest to both adults and children who have attended the public demonstrations.

Unfortunately, an initial attempt to economise by constructing the model from materials purchased for this purpose proved too difficult, leading the project to then commission construction of a model by specialists.

Figure 5 Education model of air lift pump in operation

FIELD TRIAL

The final activity in the pilot project has been the purchase of a small floating wetlands module to see if the results achieved in the controlled growing environment can now be replicated in a section of Greendale Creek.

Figure 6 – Site for first field trial of mini floating wetlands bed

The target location for the bed is adjacent to the main pedestrian bridge at the boundary between the Creek and Lagoon where the water depth is relatively constant and the interest of Park users will be readily attracted.

The installation, which is currently in progress, will include an air lift pump powered by an enclosed air pump connected to mains power from the duck pond viewing platform.

Once established, it may be possible to monitor the biodiversity effect around the root structure with the aid of a small underwater camera.

Also, it will be interesting to see the response of the bird population to the introduction of a floating garden: will they try to occupy the bed and what would that mean for the garden's viability?

FINANCIAL REPORT

		Contributed by		
Item	Value	NB Council	CEP Grant	CCLF
CONTROLLED GROWING ENVIRONMENT FACILITY				
5000l poly water tank	-	-		
concrete slab	-	-		
security fence	-	-		
equipment enclosures	1,392.05		1,392.05	
crane	-	-		
pontoon	-	-		
plant stock & growing medium	-	-		
air lift water pump	515.55		515.55	
electrical services	1,430.00		1,430.00	
plumbing & drainage services	2,830.00		2,830.00	
water transfer pump, hoses & fittings	1,282.37		1,282.37	
AIR LIFT DEMONSTRATION MODEL				
Air Lift 1.0 materials	1,977.03		1,977.03	
Air Lift 2.0 custom build	2,114.31		2,114.31	
Air Lift 2.0 air pump	320.00		320.00	
WATER ANALYSIS				
Trial #1				
Nutrients (ACT)	3,281.05		3,281.05	
Urea (QLD)	1,647.13		1,647.13	
FIELD TRIAL FACILITY				
Fyto pontoon	2,365.00		2,365.00	
Air pump enclosure (allowance)*	1,392.05		845.51	546.54
COMMUNITY PARTICIPATION				
Year 2 excursion, 26/3/2021,vol educator 4hrs @ $50 p/h x 2	400.00			400.00
Marketing collateral: Community update posters x 2 @ $150 ea	300.00			300.00
Social med comms, community mgmt 4 hrs @ $50 p/h	200.00			200.00
World Env Day 5/6/2021 vol educator 4hrs @ $50 p/h x 2	400.00			400.00
PROJECT MANAGEMENT				
Proj mgmt 20 mths, supplier & Council liaison, reporting 80hrs @$50 p/h	4,000.00			4,000.00
SUB TOTALS		**-**	**20,000.00**	**5,846.54**
TOTAL PROJECT VALUE				**25,846.54**

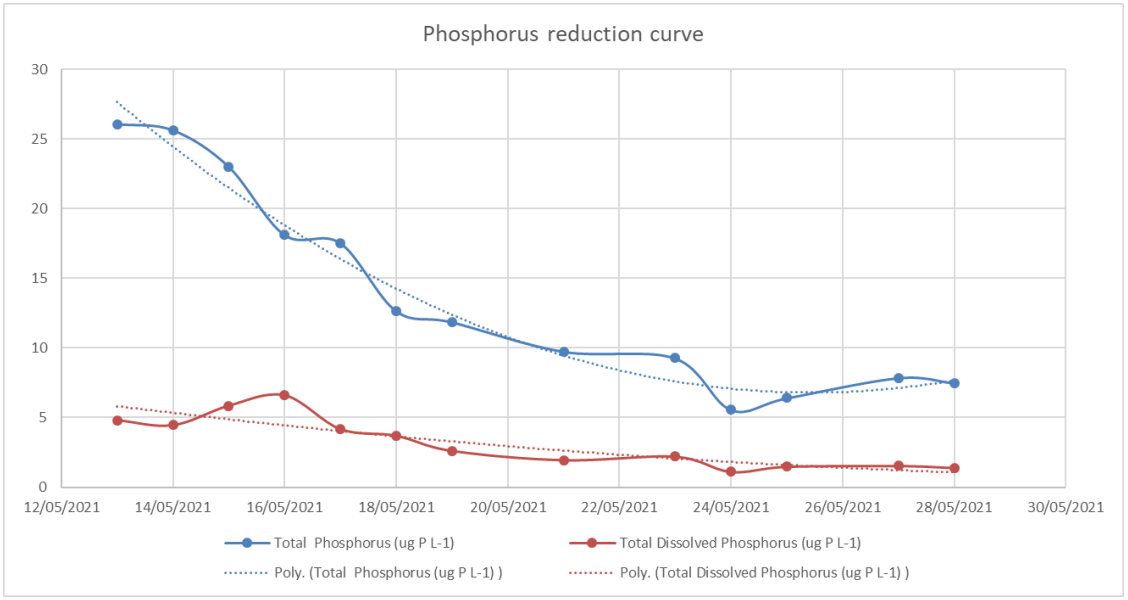
Notes:

1. 'Contributed by CEP Grant' shows actual spending of grant monies.
2. 'Contributed by CCLF' shows value of CCLF volunteer / cash contributions
3. *Field trial air pump enclosure allowance is split between CEP & CCLF.
4. Value of goods and services provided by Council is not included.

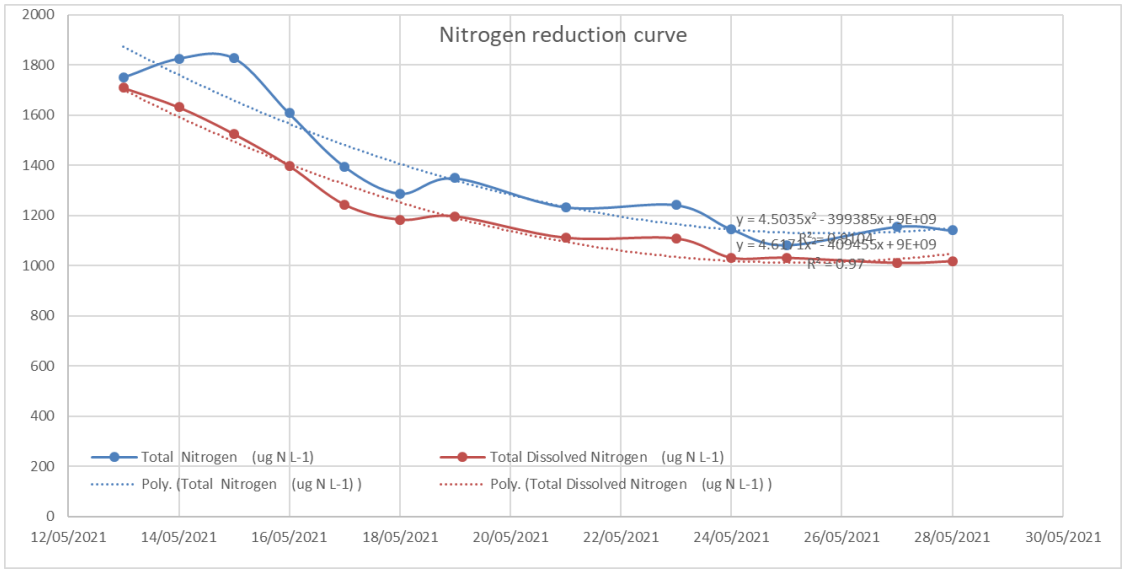
APPENDIX – TEST CYCLE RESULTS

Cycle No	1
Preconditions	Plants were placed in a mix of natural Lagoon water diluted with fresh water in Oct 2020 and left to grow until May 2021 to assist establishment. The tank was then drained and refilled with water pumped directly from the Lagoon.
Test commencement date	19 October 2020
Test conclusion date	30 May 2021
Metrics	Plant viability, nutrient reduction efficacy
Plant species	Sedge *Carex appressa*

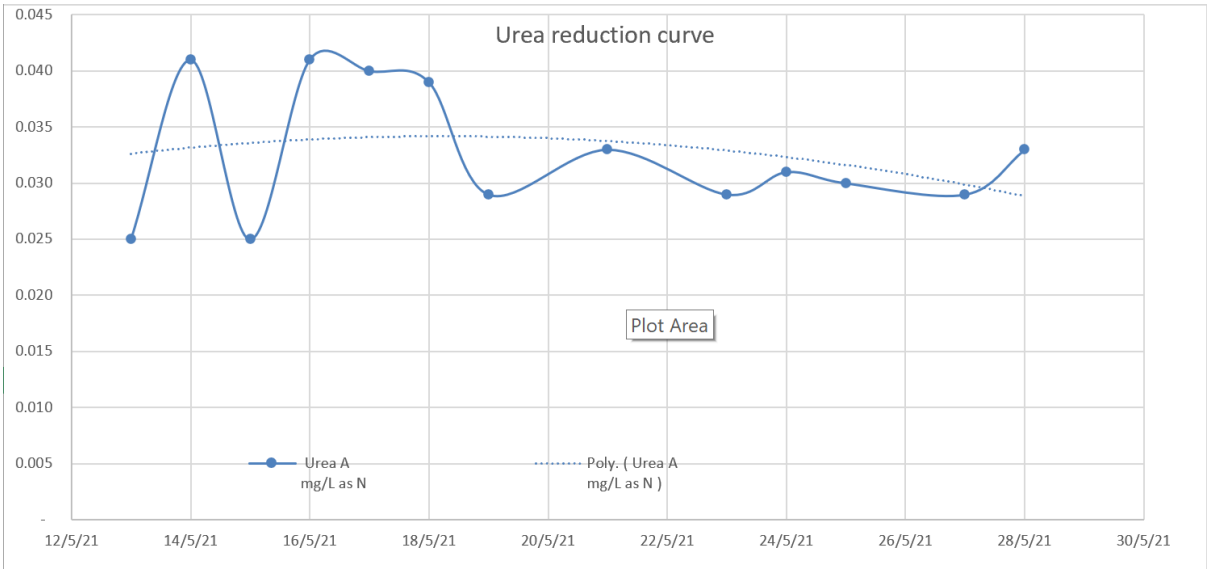
Total Phosphorus Reduction



Total Nitrogen Reduction



Urea Reduction Curve



Laboratory Data

Curl Curl Wetlands Project

Nutrient Samples recieved 01/06/2021 — Jason Ruszczyk Northern Beaches Coast and Catchments

Re-issued REPORT DATE : 9th June 2021

Zone	Sampling date	Run	Location	Lab ID.	Ammonia (ug N L^{-1})	Phosphate (ug P L^{-1})	NOx (ug N L-1)	Lab ID.	Total Dissolved Phosphorus (ug P L-1)	Total Dissolved Nitrogen (ug N L-1)	Lab ID.	Total Phosphorus (ug P L-1)	Total Nitrogen (ug N L-1)	Urea mg/L as N
	13/5/21	Salt water/Lagoon	FW 1A 1200	ES2120 1606	1	<0.1	10	ES210 1634	3	732	ES210 1662	6	739	0.015
	13/5/21	Salt water/Lagoon	FW 1A 1615	ES2120 1607	735	2	267	ES210 1635	5	1709	ES210 1663	26	1751	0.025
	14/5/21	Salt water/Lagoon	FW 1A 1600	ES2120 1608	634	2	284	ES210 1636	4	1632	ES210 1664	26	1826	0.041
	15/5/21	Salt water/Lagoon	FW 1A 0720	ES2120 1609	591	2	289	ES210 1637	6	1525	ES210 1665	23	1828	0.025
	16/5/21	Salt water/Lagoon	FW 1A 0315	ES2120 1610	437	<0.1	279	ES210 1638	7	1398	ES210 1666	18	1608	0.041
	17/5/21	Salt water/Lagoon	NUT 1A	ES2120 1626	390	<0.1	267	ES210 1654	4	1244	ES210 1682	18	1396	0.040
	18/5/21	Salt water/Lagoon	NUT 1A	ES2120 1627	346	<0.1	270	ES210 1655	4	1184	ES210 1683	13	1288	0.039
	19/5/21	Salt water/Lagoon	FW 1A 1610	ES2120 1611	307	1	285	ES210 1639	3	1197	ES210 1667	12	1349	0.029
	21/5/21	Salt water/Lagoon	FW 1A 1630	ES2120 1612	261	<0.1	273	ES210 1640	2	1112	ES210 1668	10	1234	0.033
	23/5/21	Salt water/Lagoon	NUT 1A 0930	ES2120 1628	238	1	267	ES210 1656	2	1109	ES210 1684	9	1243	0.029
	24/5/21	Salt water/Lagoon	FW 1A 1130	ES2120 1613	227	<0.1	273	ES210 1641	1	1032	ES210 1669	6	1146	0.031
	25/5/21	Salt water/Lagoon	NUT 1A	ES2120 1629	220	<0.1	271	ES210 1657	1	1031	ES210 1685	6	1083	0.030
	27/5/21	Salt water/Lagoon	FW 1A 1020	ES2120 1614	191	<0.1	279	ES210 1642	2	1011	ES210 1670	8	1156	0.029
	28/5/21	Salt water/Lagoon	FW 1A 1000	ES2120 1615	176	<0.1	281	ES210 1643	1	1018	ES210 1671	7	1141	0.033
	13/5/21	Salt water/Lagoon	FW 1B 1200	ES2120 1616	2	<0.1	10	ES210 1644	4	675	ES210 1672	9	704	0.014
	13/5/21	Salt water/Lagoon	FW 1B 1615	ES2120 1617	745	<0.1	258	ES210 1645	4	1468	ES210 1673	27	1592	0.025
	14/5/21	Salt water/Lagoon	FW 1B 1600	ES2120 1618	641	8	268	ES210 1646	9	1620	ES210 1674	29	1863	0.048
	15/5/21	Salt water/Lagoon	FW 1B 0720	ES2120 1619	598	<0.1	279	ES210 1647	4	1470	ES210 1675	22	1626	0.025
	16/5/21	Salt water/Lagoon	FW 1B 0315	ES2120 1620	374	<0.1	273	ES210 1648	3	1303	ES210 1676	18	1507	0.048
	17/5/21	Salt water/Lagoon	NUT 1B	ES2120 1630	389	<0.1	267	ES210 1658	3	1208	ES210 1686	18	1447	0.037
	18/5/21	Salt water/Lagoon	NUT 1B	ES2120 1631	346	1	270	ES210 1659	3	1232	ES210 1687	13	1331	0.040
	19/5/21	Salt water/Lagoon	FW 1B 1610	ES2120 1621	311	<0.1	278	ES210 1649	6	1153	ES210 1677	11	1250	0.034
	21/5/21	Salt water/Lagoon	FW 1B 1630	ES2120 1622	260	<0.1	272	ES210 1650	3	1124	ES210 1678	9	1179	0.032
	23/5/21	Salt water/Lagoon	NUT 1B 0930	ES2120 1632	239	<0.1	269	ES210 1660	1	1089	ES210 1688	11	1180	0.034
	24/5/21	Salt water/Lagoon	FW 1B 1130	ES2120 1623	227	<0.1	273	ES210 1651	1	1031	ES210 1679	6	1074	0.031
	25/5/21	Salt water/Lagoon	NUT 1B	ES2120 1633	219	<0.1	272	ES210 1661	2	1018	ES210 1689	6	1099	0.029
	27/5/21	Salt water/Lagoon	FW 1B 1020	ES2120 1624	190	<0.1	275	ES210 1652	1	1024	ES210 1680	8	1093	0.028
	28/5/21	Salt water/Lagoon	FW 1B 1000	ES2120 1625	185	<0.1	277	ES210 1653	5	1069	ES210 1681	9	1085	0.036

Figure 7 – Carex development after seven months (Oct 20 – May21) in controlled growing environment.