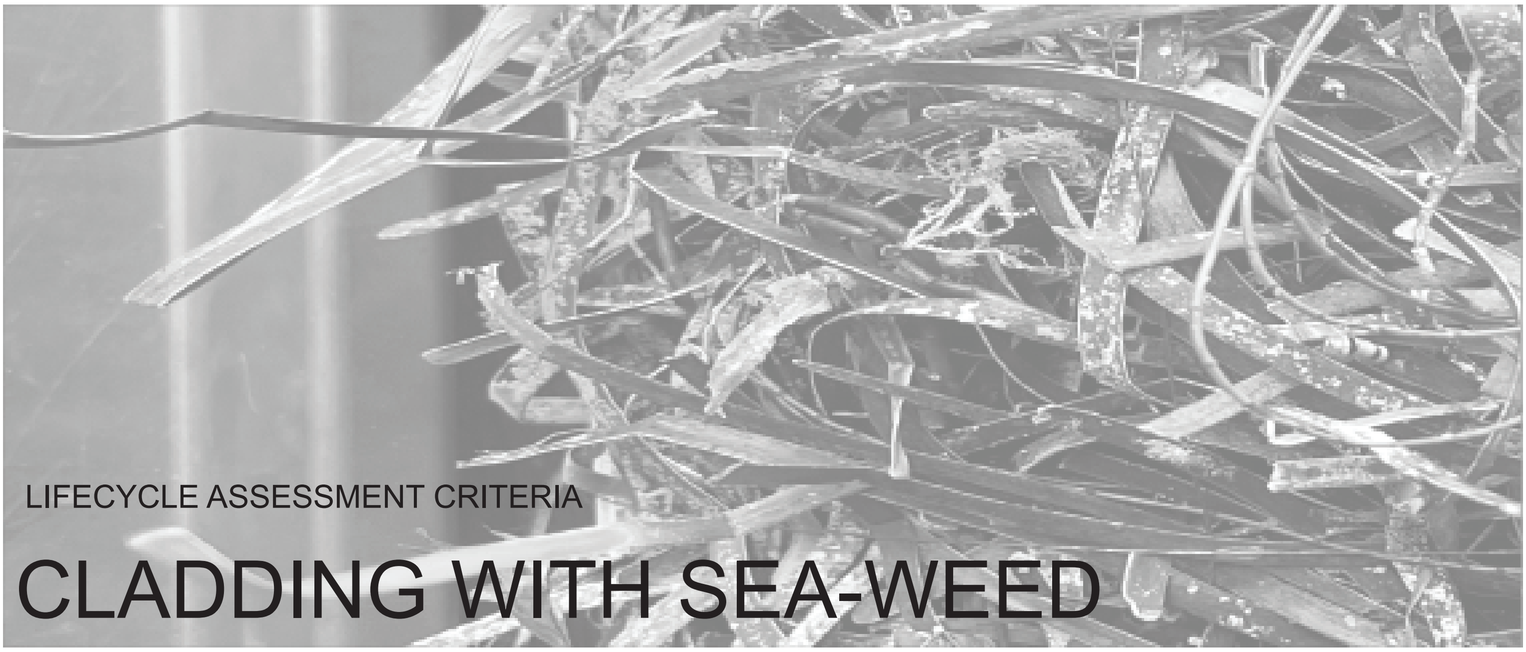

LIFECYCLE ASSESSMENT CRITERIA

CLADDING WITH SEA-WEED

REASONING AUTHENTICALLY CYCLICAL MATERIALS TO EMBED ARCHITECTURE IN PLACE, ECOLOGY AND SYSTEMS.

Table of Contents

Definitions

Sea-weed: Predominantly sea grasses with seaweed specie fragments un-sortable during processing stage of cladding panel construction.

Sea-grass: A grass like plant that lives in the sea, of specific reference to species Posidonia australis.

Wracking: Accumulation of organic material including sea-grass and seaweed that is washed up onto the beach by the tides, wind and waves.

1 Abstract

The aim of the paper is to present the process of life cycle assessment for the application of Sea-weed as an architectural roof and wall cladding solution and assess its connectivity to place and to life.

Seaweeds; in particularly sea grasses have been documented as a traditional construction material in the Nordic regions, China and Japan for hundred of years (Wang, 2023). This material source, through craftsmanship (traditionally women lead) has a life expectancy of more than 150 years (Reynolds, 2018). Its naturally non-toxic, fire-resistant and acts as a thermal insulator but beyond this it offsets carbon throughout the entirety of its life cycle from life under water to life in soil (Short, 2003). The application of Sea-weed as a wall and roof cladding is a potent resource for reconnecting human to life through the embodiment of place.

The use and focus on this material is an extension of exploring Architecture as a foundation for water as an act of reinforcing and reminding users of the greater ecological system that exist and that they are apart of. This notion is in line with the Architects declare statement 5: Evaluate all new projects against the aspiration to contribute positively to mitigating climate breakdown, and encourage our clients to adopt this approach. Alike water in architecture, sea-weed; a bi-product of water can be seen as a visceral force in manifesting a piece of architecture that not only connects but celebrates the function of its application. In working with and celebrating life cycle through Architecture with specific consideration to site, material use and integrated systems will allow Architecture to perform as a beneficiary to the ecosystem it exists within and in turn influence humans connectivity to life. It is shifting attention towards a building being apart of place rather than being on place - and thus evolving the collectives notions towards being on country.

Definitions: sea-weed, sea-grass

AND

~~MATERIAL~~ EMBEDDED IN ~~- PROJECT -~~ EMBEDDED IN ~~PLACE~~

RESOURCE LIFE SYSTEM

LIVING ECOLOGY

Figure 1: Inscription of approach to life cycle assessment. Author

2 Goal of Study

The goal of this study is to provide profile and improve the environmental performance of the construction works for the residential amenity building. The life cycle performance of the project and application of sea-weed cladding is assessed against the living building petals; Place, Water, Health and Happiness, Material, and Beauty and Biophilic Design (see section 3.2 Standardising Living Buildings) in order to exemplify the implications of using a material that is of its integral nature and of place from cradle-to-cradle. This analysis aims to set premise for looking beyond industry standards and technological measures to find reason with architecture and material selection that is integrally apart of the system.

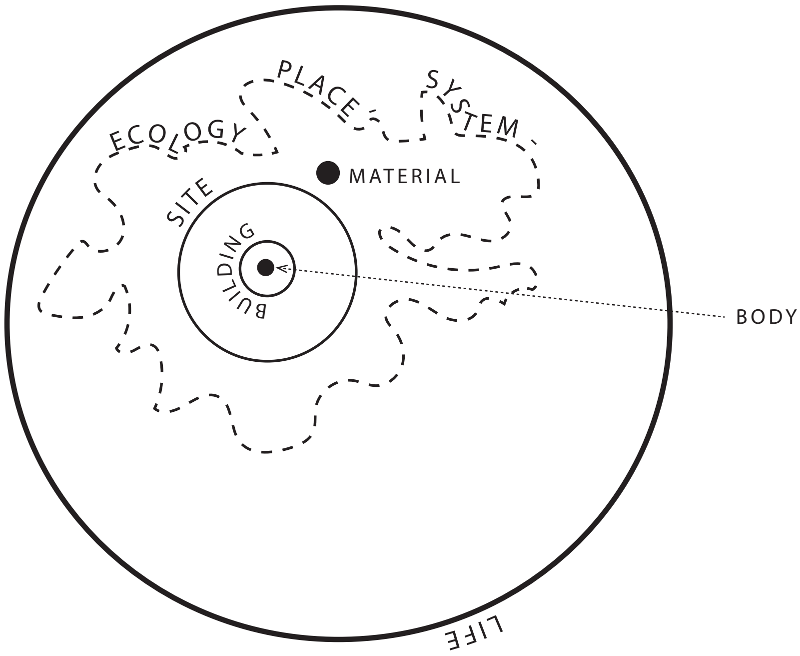

Figure 2: Context of exchange between human, building, place and life. Author.

3 Scope of Study

This assessment will illustrate each stage of life for the application of Sea-weed as a roof and wall cladding and process the ecological centric approach to site, water and architecture that a material of nature entails. This critical analysis will be applied to the class 10a building typology, The Kayak Store on the Swan River; a project that is bound to water due to its purpose, site placement and geographical location. The kayak shed was designed to store recreational equipment and act as an amenity to the river, adjacent Pavilion and the main residential dwelling behind. It is located at the base of a large sloping site and limestone embankment on the edge of the Swan River, Perth, Western Australia. The close relationship to the river means this project has influence on the entire Swan River; ecology and recreational community. While this water centric project upholds statue for future water responsive design as it addresses many perspectives on the site from river, land, underground and sky, of primary focus is the application of Sea-weed as material for both wall and roof cladding.

CRITERIA ORIENTATED
STATIC
FIXED OUTCOMES
PARTICIPATORY DESIGN
DYNAMIC
CHANGING WITH-TIME

~~COST~~ → VALUE
~~SOCIAL IMPACT~~ → BEHAVIOUR
~~ENVIRONMEN~~T → LIFE (THRIVING)

Figure 3: Transforming measures of intention for scope of assessment from terminologies that encourage individual thought to collective action. Author.

3.1 Measuring Life

Due to life cycle being assessed against the projects connectivity to place and to life it is therefore difficult to set bench marks at this stage instead an intuitive approach of evaluation has been employed to conduct this study as a holistic assessment. Transforming measures (see figure 3) shifts perspective away from individual endeavour and intrinsically instructs a sense of reciprocity as a function unit.

Material of life: The function of the Building must reflect the core purpose of connection to life and be demonstrated through the material selection operating beyond its primary function as a cladding system in order to showcase both physical and metaphorical the building being apart of place. This includes the manner of the material being one that expresses time through changing naturally over time and revealing age authentically.

Humane Lifetime: The estimated life of the design is 80 years which has been adopted from research that suggest the application of seaweed thatch has been seen to endure 300 years of occupancy with an average nominal thickness of 1000mm (Widera, 2014). This takes into consideration that the cladding panels are 0.2 of the traditional thickness, devised compaction procedures, additional advanced copper securing methods and the structural capacity of the Kit-built structural support panels that allow for effective serviceability and maintenance throughout occupancy.

Participatory Craftsmanship: Behavioural change is encouraged not only through the occupancy stage of design but from throughout all stage of the life of the building. Using ones hands (Pallasmaa, 1994) and physically engaging in the creation, maintenance and deconstruction of a building is in this study seen to further a sense of identity with place. The material selected must also be of the hands, requiring craftsmanship to be created.

3.2 Standardising Living Buildings

The study has been conducted in accordance with the following legislation, per-formative standards and acts:

THE NATIONAL CONSTRUCTION CODE (NCC)

This performance-based code classifies buildings and sets out requirements for the construction of buildings, including plumbing and drainage. Under this act it is deemed that the Kayak Shed is a Class 10a building typology which includes all buildings or structures that are non-habitable; sheds, carports, and private garages. Of particular importance within the NCC is Volume 3: Section B Water services and Section C Sanitary plumbing and drainage systems.

AS STANDARDS

The classification of class 10 will direct and determine the standards applicable beyond design development. There are no construction standards (or similar international standards) that are specific to the use of Seaweed or specifically sea-grass as a building material.
HOW DOES IT RELATE TO CLASS 10A

DEPARTMENT OF PLANNING, LOCAL GOVERNMENTS AND REDEVELOPMENT AUTHORITIES (DCA)

SWAN RIVER TRUST ACT 1988 and associating acts:

(a)State Planning Policy 2.10 Swan-Canning River system; clause 8.2 Melville
(b) the Health Act 1911 (community and social health impacts regarding
(c) the Environmental Protection Act 1986 (conservation and preservation of wildlife and natural environments
(d) Biodiversity Conservation Act 2016 and Biodiversity Conservation Regulations 2018

LIVING BUILDING CHALLENGE (ILFI)

Of particular allegiance is the Place Petal, Water Petal, Material Petal and Biophilia and beauty Petal.

“The Living Building Challenge envisions a future whereby all developments are configured based on the carrying capacity of the site: harvesting sufficient water to meet the needs of a given population while respecting the natural hydrology of the land, the water needs of the ecosystem the site inhabits, and the ecosystem of the community.” (ILFI, 2023). The intent of the ILFI’s Petals are to realign the humanities connection to the facets of life in order to address the contamination, consumption and disconnection involved construction, occupancy and deconstruction of a building. The petals address both the individuals role in action whilst also recognising the benefits of connecting to community for municipal facilities.
Buildings that give back to the people that inhabit them, to the land they’re on and the resources they draw from.

Building that operates within the water balance of a given place and climate
The use of materials that are healthy for all species throughout time
Design that uplift the human spirit and articulates relationships within the ecological system in order to improve wellbeing and expedite healing (reference).

Whilst codes and standards have been assessed at all stages of the project, the modeling of the life cycle assessment has been conducted using alternative methods that find solution through performance based approaches seeking to focus on the immediate context and altering behavioural attitudes towards life that in some cases of determination can not be standardised.

4 Life Cycle Assessment

Grounded in research, and adapted specifically to the application of Seaweed as a building cladding, the life cycle assessment is conducted across five stages; life before application, material sourcing, construction, life during, life after and embodiment beyond immediate application. Where stages 1-5 are all assessed against their connectivity to place, water and biophilia, the performance of stages 1-4 are evaluated against principles that exist within stage 5, sectioned as connected appearance and physical experience. Connected appearance and physical experience as further broken down for assessment in Figure 5 as dials of assessment and show direct correlation to the 'shifting of perspective and behaviour' as a measure for connectivity to place and life. This has been informed by the inscription of approach to life cycle assessment in Figure 1.

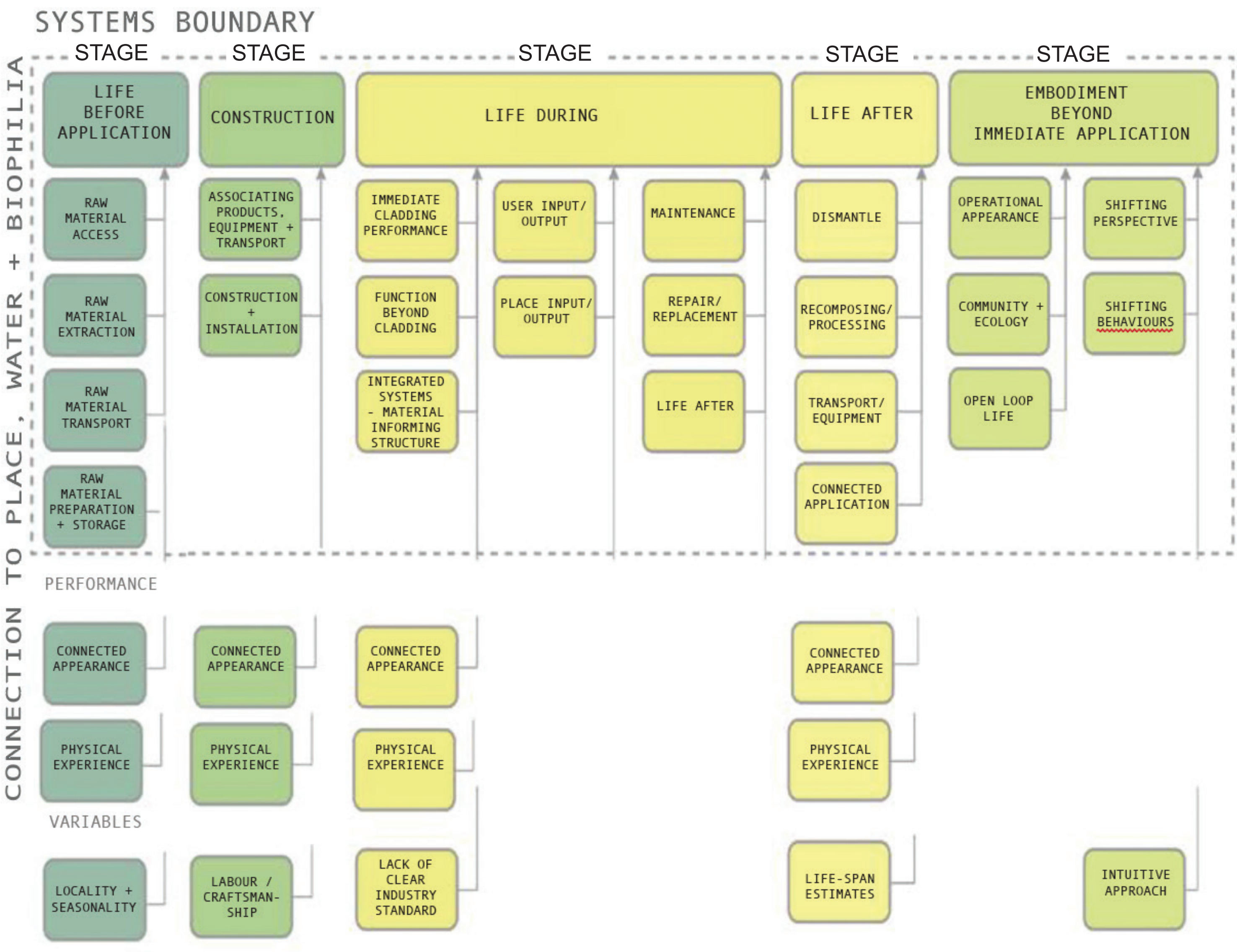

Figure 4: Life cycle assessment criteria adapted from (LCA, 2013), extrapolated by Author.

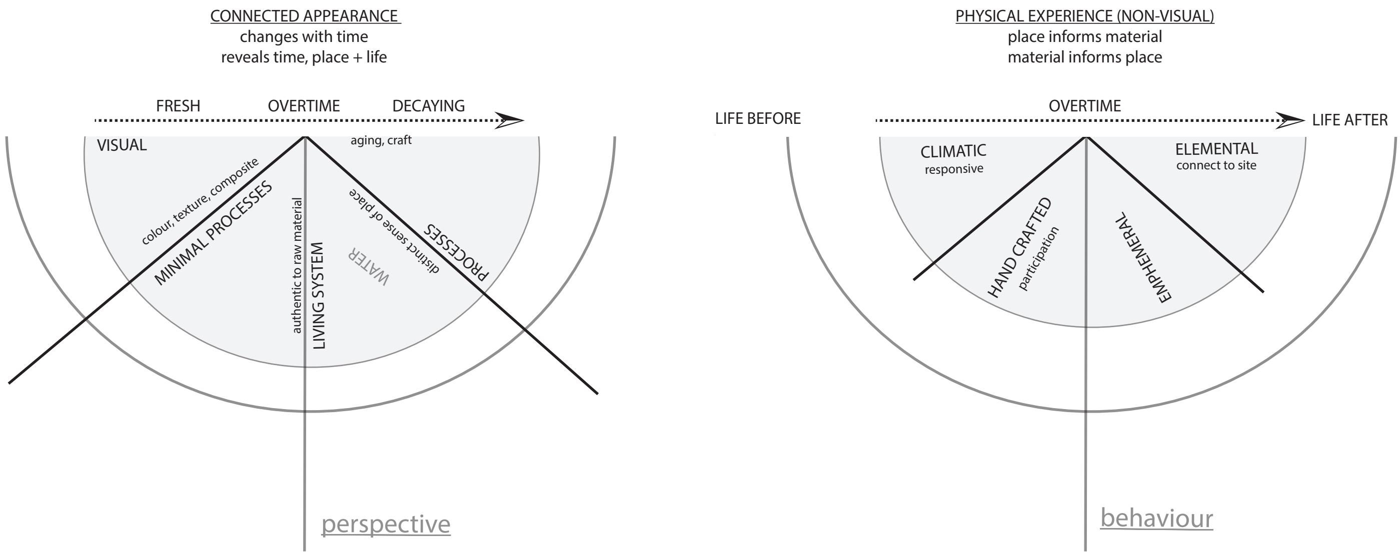

Figure 5:Dial for assessing connected appearance and physical experience as a measure from life before to life after. Author.

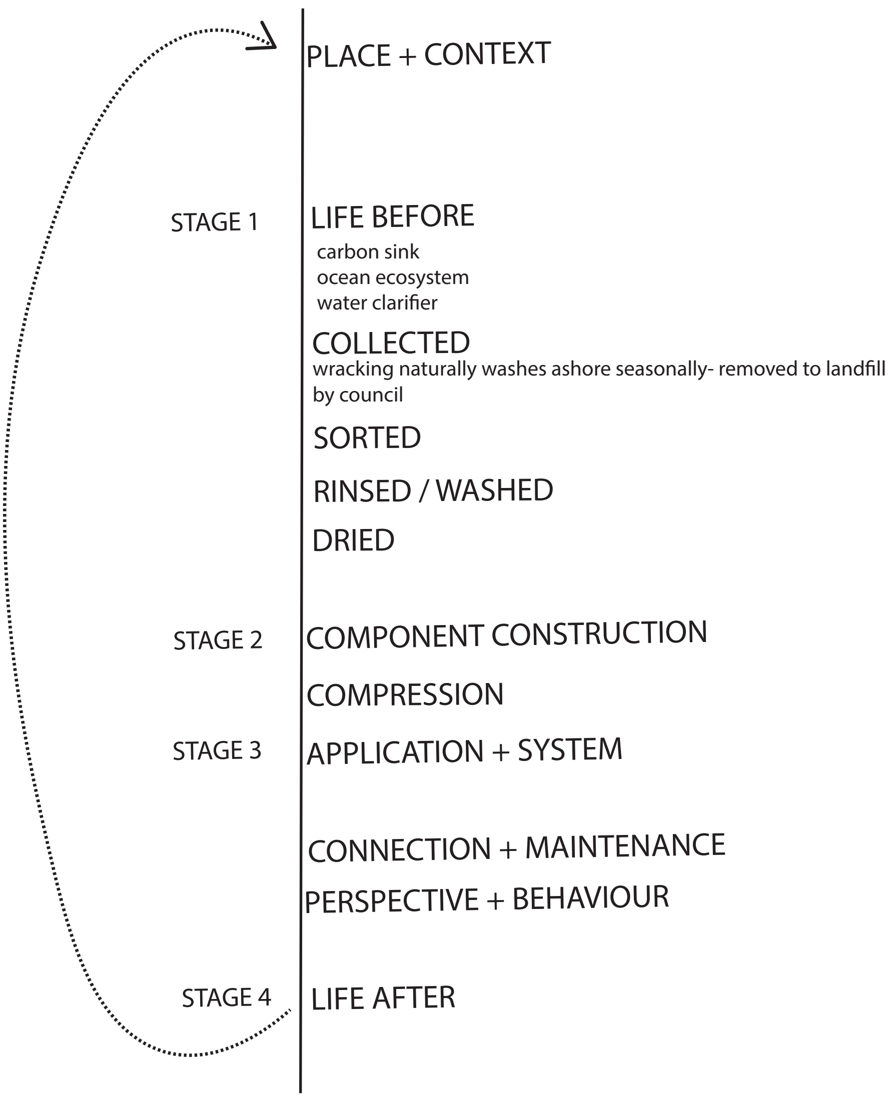

Figure 6: Line of stages of life in process for Sea-weed clading. Author.

5 Life Cycle Interpretation

As this method of assessing life for a building from cradle to cradle is an experiential model that requires both human and ecological feedback to be conducted - assessment is only assumptive and supported by associating gathered research.

5.1 LIFE BEFORE APPLICATION (SEA-GRASS WRACKING) EXEMPLAR ASSESSMENT

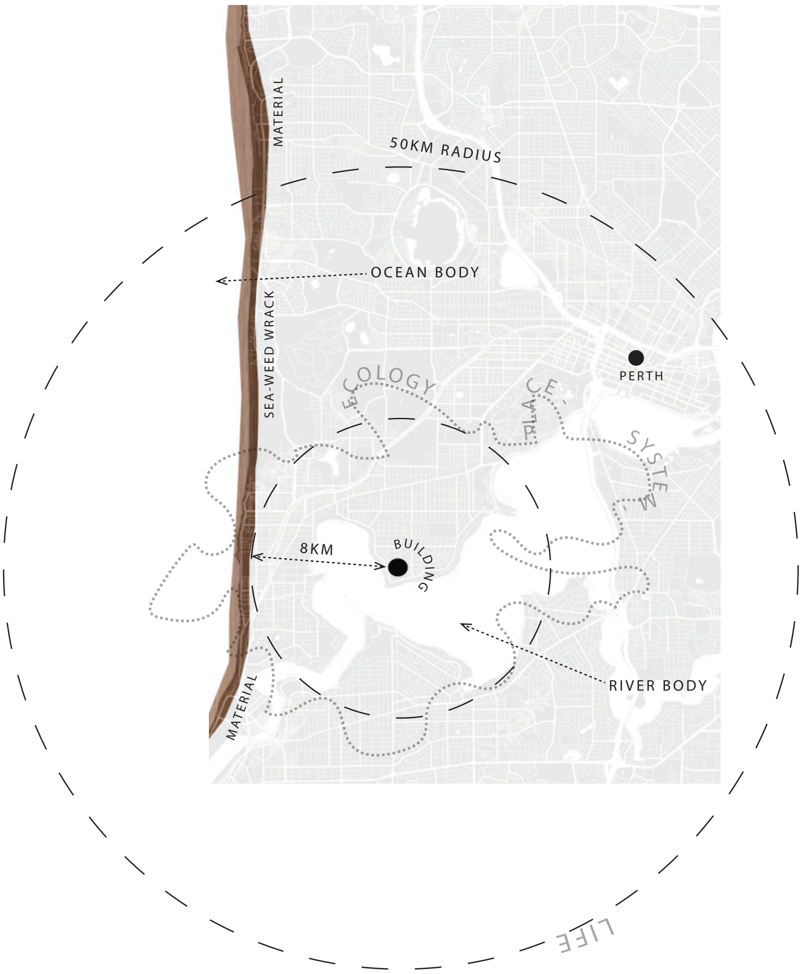

Figure 7: Locality of site to material source.
Place and Context. Author.

PROXIMITY:
5 mile radius to material source to "reflect its specific place, its specific landscape and its specific people" (fivemileradius, 2023).

SEASON:
Wracking gathers on the shore during storm season (winter months) which can extended from May - October each year (Ince, 2007).

QUANTITY:
Due to 'wracking' being a natural process quantities may vary season to season and time frames between the wracking washing ashore and harvesting taking place can affect the quality of the seagrass.

SPECIES:
Posidonia Australis - Seagrass
Meadows are prevalent offshore and in the Swan River. Known to be able to clone itself, P. australis can sequester carbon 35 times more efficiently than rainforest's (Glasby, 2015).

WRACKING:
While wracking is crucial for ecosystems preventing erosion and as a vital bacterial exchange for organisms within the food chain, it is seen as a public health item and as 'waste' by council meaning yearly wrack is collected and taken to land fill if not washed back out to sea. In advocating for use beyond waste this could reduce the build-up on shore lines meaning a sustainable amount is left for decomposition maintaining natural system function.

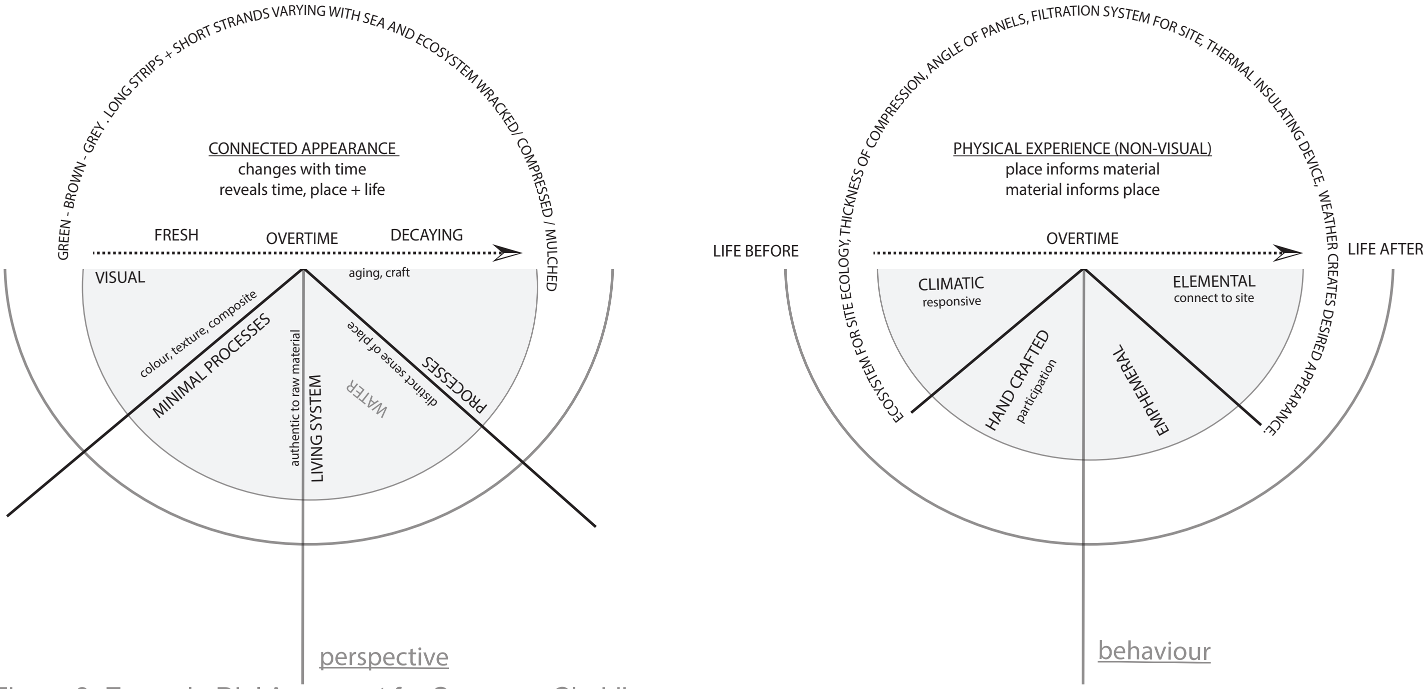

Figure 8: Exempla Dial Assement for Seagrass Cladding

IMMEDIATE PERFORMANCE:
see abstract

VISUAL:
Colour and texture remains authentic to it as a raw aging material and the compression of wrack is symbolic of its composite form on the shore line.

MINIMAL PROCESSES:
Compressed in its natural state

LIVING SYSTEM:
platform for landspecies - such as grasses to grow upon and filter for water moving across building body (Gwóźdź, 2022).

PROCESS:
Changes colour state with time.
Visible unique hand crafted nature.

CLIMATIC:
due to the seagrasses biomass fibers and salt content the material *(Olacia, 2020)*.
- acts as an insulator
- is tensile resistant absorbing and giving off mositure.
- is respondsive to weather by changing colour

HAND CRAFTED:
requires hand crafted labour to be collected, constructed and maintained. users connected to process and to nature.

EMPEMERAL:
Construction that shocases passing time, fragility and reveberates our own existence in such a way has the potential to change perspective not only to our impact on the planet but our vision of self in relation to place. This showcasing of life through materiality and modeular systems transcends typical knowlege and processes of bulding materials and generates deeper thinking of value and impact (Mora, 2007).

ELEMENTAL:
exchanges and interacts with sun, water and air daily aswell extends upon and protects the rivers ecology which is connected to the site acting as both a filter and transporter of water from roof to wall to constructed wetland and back to enviornment.

6 Low Impact Strategies and Concerns

WATER USEAGE IN PROCESSING RAW MATERIAL
Water required to rinse gathered wracking in order to remove potential bacterias and microbes that could influence decay overtime has potential associated wastages. Salt water will be used to rinse the material in order to preserve the high salt density of the material which will need to be sourced or made for use. Water used in rinsing the material will be able to be filtered and reused reducing the amount required for purpose. This offset during extraction or production and the waste water is an aspect of consideration in evaluating assessment of life expense.

TRANSPORTING COSTS:
Collection of the material and transporting it to required place of processing would produce emissions. The locality of the project would be upheld meaning the processing facility would be within the 8km radius ensuring reduction of transporting costs from shoreline to workshop and finally to site.

LACK OF RELEVANT INDUSTRY STANDARDS:
Whilst codes and standards have been assessed at all stages of the project, the modeling of the life cycle assessment has been conducted using alternative methods that find solution through performance based approaches seeking to focus on the immediate context and altering behavioural attitudes towards life that in some cases of determination can not be standardised.

COSTS AND DEMANDS:
The application of Sea-weed as a building material is innately a custom and .... product. If using the wracking as the source supply is dependent on seasonal conditions, and maintaining balance of the existing shoreline ecosystem thus supply can vary. Figure 9 below showcases the future growth and demand for use of seaweed in the construction industry. What it reveals is the long-term viability of it’s use in application which would demand systems of farming to supply the material to the industry whilst simultaneously supporting the planet by sinking carbon emissions and restoring water quality in revitalizing ecosystems (Bjerregaard, 2023.) .

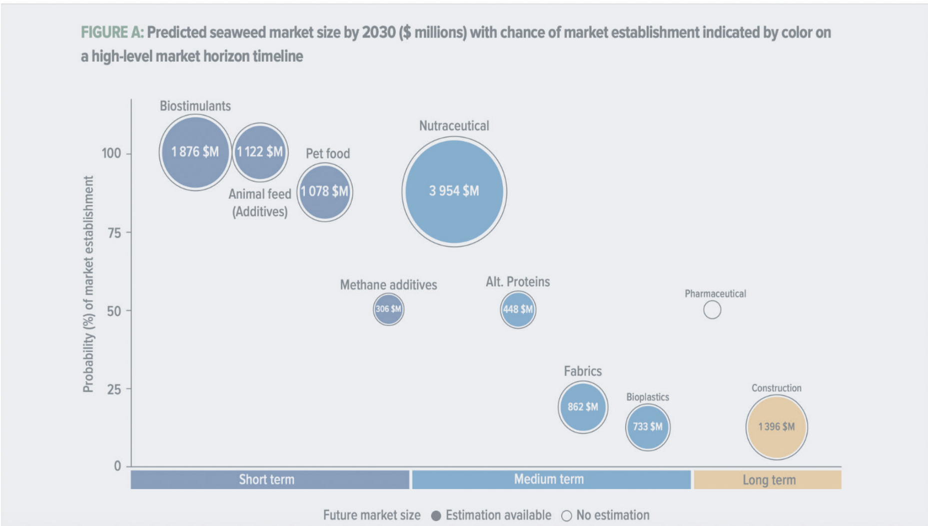

Figure 9: Diagram of future growth of seaweed in the construction industry. Feasibility of growing demand for standards in industry for natural material applications. Author: The World Bank (Bjerregaard, 2023.)

7 Conclusions

The process of life cycle assessment for the application of Sea-weed as an architectural roof and wall cladding solution through evaluating its impact against the notions; Material of Life, Humane Lifetime and Participatory craftsmanship anticipates an application of a raw, local material that is of place and of life. The application of Sea-weed as a wall and roof cladding is a potent resource for reconnecting human to life through the embodiment of place and performance of beneficial ecosystems, life cycle is celebrated. This shift in attention towards assessing a buildings sustainability based on ecosystem experience rather than data influences a building to be apart of place rather than being on place which for future and prolonged interacting aims to also shift the collectives notions towards being on country.

This analysis looks beyond industry standards and technological measures to find reason with architecture and material selection that is integrally apart of the system. While this modeling of life cycle assessment uses local and national standards, using sea-weed as a wall and roof cladding is not standardised in Australia. This alternative method directed from the Institute of living futures petals; water, place and biophilia look at performance through metaphorical and physical objectives which is endorses focus on the immediate context rather than generalisation beyond the material itself. This altering of behavioural attitudes towards life through buildings is in through craftsmanship, connection to place and the revealing of life through authentic materiality.

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