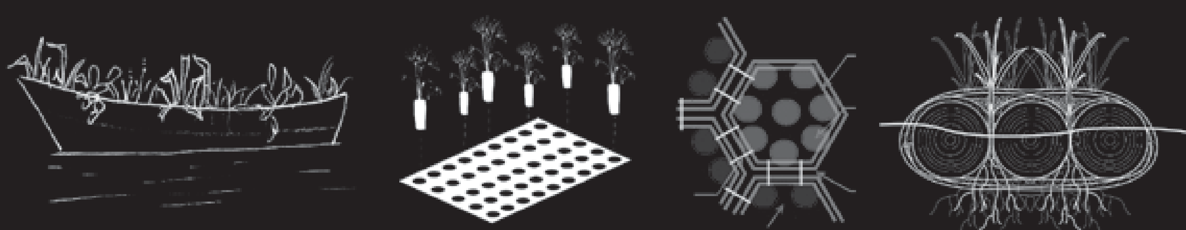
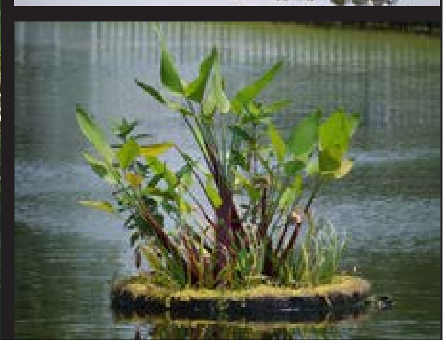
Volume II
Floating Wetlands
Design Investigations

Site Locations for Potential Demonstration Projects // Design Criteria // Conceptual Design Ideas // Schematic Design Workshop // Design Development





Acknowledgements

Seminar Participants

Biruk Belay, Landscape Architecture
Peter Cromwell, Landscape Architecture
Ann Dinthongsai, Landscape Architecture
Kristen Gelino, Urban Design and Planning
Taj Hanson, Landscape Architecture
Tyson Hiffman, Community and Environmental Planning
Vera Hoang, Community and Environmental Planning
Cayce James, Landscape Architecture
Janice Johnson, Restoration Ecology
Elyssa Kerr, Chemical Engineering
Heather Khan, Environmental Horticulture
Kaie Kuldkepp, Architecture and Landscape
George Lee, Landscape Architecture
Matt MacDonald, Landscape Architecture
Autumn Nettey, Landscape Architecture
Jonathan Pagan, Landsape Architecture
Malda Takieddine, Landscape Architecture
Wenny Tsai, Forest Resources
Alyse Wright, Landscape Architecture

Seminar Leadership

Leann Andrews, RLA, SEED, Instructor/Lab Manager, Green Futures Lab, University of Washington
Nancy Rottle, RLA, Professor/Director, Green Futures Lab, University of Washington

Floating Wetlands Advisory Board

Sally Abella, King County
Mason Bowles, King County
Jeff Cordell, PhD, University of Washington School of Aquatic and Fishery Sciences
Laddie Flock, Floating Islands International, Inc.
Linda Krippner, Krippner Consulting, LLC
Bruce Kvam, Kvam Consulting, LLC
Jason Toft, PhD, University of Washington School of Aquatic and Fishery Sciences
Paul Wilcox, Waterfront Construction, Inc.
Zach Wilcox, PhD, Waterfront Construction, Inc.
Rob Zisette, Herrera Environmental Consultants, Inc.
Steve Zuvela, Waterfront Construction, Inc.

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Waterfront Construction, Inc.
205 NE Northlake Way, Suite 230
Seattle, WA 98105
(206) 548-9800
www.waterfrontconstruction.com/

Foreword

Wetlands of many types are now recognized for their multiple high functional values, providing critical habitat, food production for many species of fish and wildlife, cleansing and storing water, and regulating temperatures. Yet our wetlands and waterways continue to degrade due to impacts of urbanization. How might we begin to restore the quality of these important environments, using the natural processes that occur in wetlands? Constructed floating wetlands are promising restoration tools, mimicking the processes that naturally occur in wetlands and nearshore environments while being cost and space effective. Yet while floating wetlands have been employed as useful green technologies around the world, little testing of their application has been done in the Pacific Northwest.

This document is the result of a seminar that investigated the feasibility of deploying floating wetlands in King County, WA, offered through the Green Futures Research and Design Lab at the University of Washington in the Spring of 2013. The seminar drew interest from 17 UW students in numerous disciplines who asked the questions "what can we learn from naturally-occurring, vernacular, and proprietary designed floating wetlands?" and "what research can inform the design of floating wetlands?" They applied this knowledge to explore and design floating wetlands for two distinctly different conditions: one, where shading of a newly constructed shallow freshwater wetland is required to keep temperatures sufficiently low to support fish species, and the other to enrich habitat and potentially improve water quality and cultural / ecological literacy in the Duwamish River mouth where excess shading can be problematic for juvenile salmon.

This document is divided into two volumes: Research and Design. The research volume is a window into a larger body of case studies and literature on floating wetland systems, aimed to inform designers, decision-makers and the general public on the breadth of interest in floating wetlands worldwide. The design volume documents the design process in the ten-week seminar, and highlights new floating wetland design ideas for the Lower Stensland Creek Wetland and South Park Bridge Duwamish River sites. It is our hope that these design ideas will be further developed into constructed demonstration projects in the near future.

We extend our many thanks to King County ecologist Mason Bowles, who initially approached the Green Futures Lab with an invitation to investigate the potential of deploying floating wetlands on the Duwamish River, assisted with fundraising and supported our investigations throughout the project. We are sincerely grateful for the generous financial support of Waterfront Construction, Inc., without which the robust research in the seminar and this document would not have been possible. Paul and Zach Wilcox from Waterfront Construction Inc., also presented their carefully designed prototype solutions, deepening the students' understanding of issues and possibilities for floating wetland applications. We are also indebted to our Advisory Committee who informed and guided the students through this creative and scientific process. Finally, thanks to the team of interdisciplinary UW students who have spent countless hours researching and creating over the past ten weeks. We hope that we will all continue the dialogue in the next phase of testing our designs, and that this document will be useful to all.

Nancy Rottle
Professor/Director Green Futures Lab, University of Washington

Leann Andrews
Instructor/Lab Manager Green Futures Lab, University of Washington

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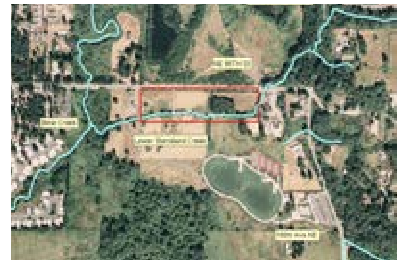
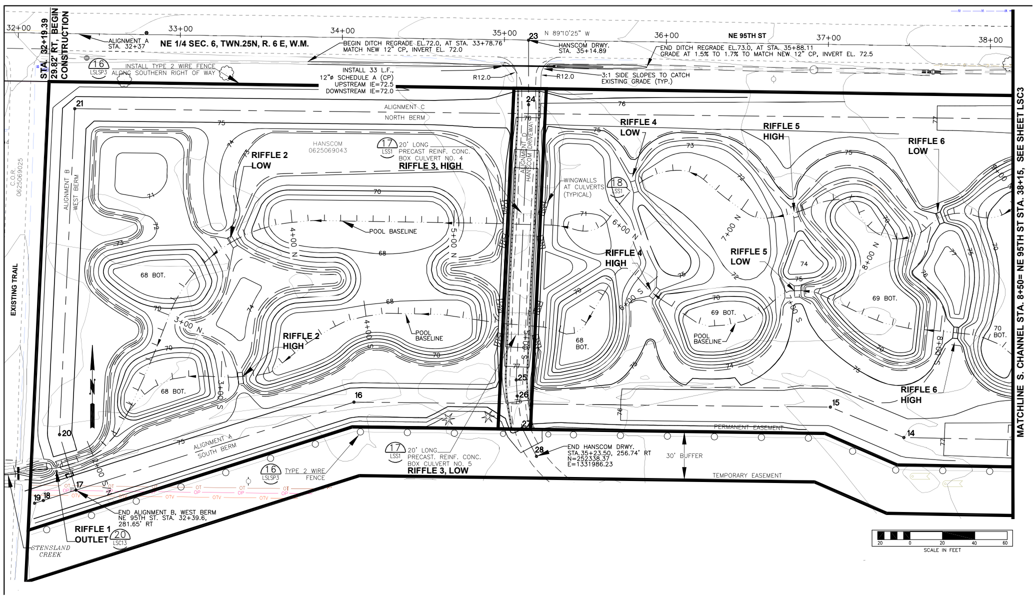
Site Locations for Potential Demonstration Sites

Understanding the Lower Stensland and Duwamish Sites



Above Image:
Aerial view of Lower Stensland Creek Site

[King County Department of Transportation]



Left Image:
100% construction plan of the recently constructed Lower Stensland Wetland Mitigation Site. The floating wetlands could be installed in any of the wetland cells.

[King County Department of Transportation]

1) Lower Stensland Creek Wetland Mitigation

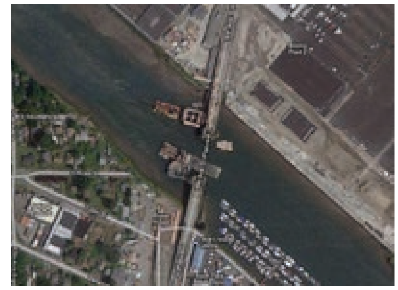
The first potential location for a floating wetland demonstration project is the Lower Stensland Creek Wetland Mitigation site recently installed by King County. While the wetland was designed to provide adequate shade coverage upon maturity, the young trees do not currently provide enough canopy to cool the water to acceptable measures needed to support fish and amphibian life(below 23 degrees C). Currently, shade cloth is being deployed over 25% of the site to meet water temperature requirements. King County would like to explore the potentials for using floating wetlands as an alternative to, or complementary system along with shade cloth to reduce water temperatures. Floating wetland demonstration projects could be installed in any of the 3-5' deep wetland cells.

currently installed design

5 year design
[King County Department of Transportation]

The wetland was designed to provide adequate temperatures to support aquatic habitat, however the young trees do not shade the wetland enough currently and supplementary measures need to be taken.

Image of Lower Stensland Creek Wetland Mitigation Site
[King County Department of Transportation]



Above Image:
Aerial view of South Park Bridge

[King County Department of Transportation]

Left Image:
plan of the recently constructed South Park Bridge, and potential locations for a floating wetland demonstration project

[King County Department of Transportation]

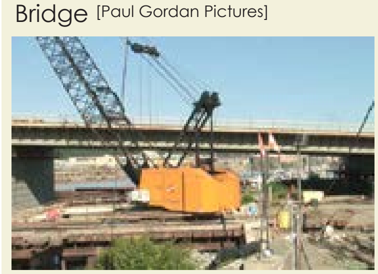
2) South Park Bridge Project, Duwamish River

The 2nd potential site for a demonstration project is the Duwamish River at the location of the recently under-construction South Park Bridge. There is a space between the bumper walls and the abutments that might provide a possible testing area for floating wetlands. The tribes do not fish in this area, and the bridge structure reduces the need for official aquatic habitat assessment. The designs would need to consider salt water conditions, a fluctuating 12 foot tidal range, sturdy anchoring and design complexity from being a highly public and culturally diverse location. Students investigating this site explored this space, as well as potential application elsewhere on the Duwamish.

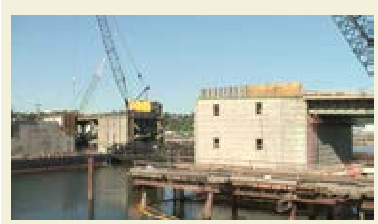
the potential demonstration project would be situated between the bumper walls and the abutments, removed from tribal fishing areas

Rendered image of the South Park Bridge
[King County Department of Transportation]

2010 photo of the South Park Bridge [Paul Gordan Pictures]



June 3, 2013 construction photo
[King County Department of Transportation]



June 3, 2013 construction photo
[King County Department of Transportation]

Design Criteria

Design criteria to guide floating wetlands designs

Above Image:
Brainstorming design criteria

[Matt MacDonald]

Students began the design process by creating design criteria from information provided by King County for each of the potential sites. The Lower Stensland Creek site had a more directed goal to meet mitigation requirements, while the Duwamish River criteria was more open to exploration of the possibilities of floating wetlands applications. Below and the following page outline the criteria that the students came up with to direct their design explorations:

Floating Wetlands Design Criteria at Lower Stensland Creek

and other freshwater mitigation sites in King County

-last for at least 5 years
-decrease water temperature of Lower Stensland Wetland to below 23˚C
    -increase dissolved oxygen and aquatic habitat in the process
    -shade cloth is being deployed over 25% of wetland to achieve this goal
    -hope is that floating wetlands might be able to replace shade cloth over time
-affordable cost (less than the $15-20,000 needed for shade cloth)
-be able to monitor results
-fixed location, but flexible (i.e. anchor)
-buoyant
-explore ways for replicability in other similar situations

[photos by Matt MacDonald of Lower Stensland Creek Wetland Mitigation Area]

Floating Wetlands Design Criteria for the Duwamish River
and other flowing fresh and saltwater sites in King County

<u>explore ways to increase habitat</u>
-decrease water temperature
-increase dissolved oxygen
-create light/shade conditions visible to juvenile salmon
    -mimic dappled light conditions of natural tree cover in nearshore habitat
    -soften harsh light to dark transitions
-increase food source
    -mimic overhanging vegetation conditions in natural shorelines (insect food)
    -maximize edges (opportunity for overhanging vegetation and food)
    -maximize conditions for biofilm to form
    -use native plants
    -locate where does not disturb functional aquatic habitat
-increase shelter for vulnerable aquatic populations
    -diversity of conditions (shelter from aquatic as well as aviary predators)
    -explore resting and spawning conditions (fish, amphibians, birds, small mammals)

<u>explore ways to improve water quality</u>
-maximize conditions for biofilm to form
-explore plants that will cleanse common pollutants (i.e. nitrogen, fecal coliform)
-utilize non-contaminating materials/design (i.e. protected compost, non-leaching frame)

<u>explore ways to increase practicality and sustainability</u>
-minimize cost of construction
-minimize cost and time to maintain
-maximize durability (meet goals without falling apart)
-be able to monitor results (to open permitting dialogue)
-constructible (i.e. reduce need for machinery)
-flexible (i.e. option for relocation)
-replicable (i.e. modular system, floating wetlands'kit')
-utilize local materials that are not harmful to aquatic life

<u>explore cultural considerations</u>
-maximize aesthetics and human experience
-address the needs of tribes and tribal fishing
-harmonize with industrial and recreational boats and sports
-explore how community could be involved (public acceptance and stewardship)
-explore how public awareness/education could be incorporated

<u>components</u>
-strong, buyant frame (able to support birds)
-anchoring system (i.e. fixed pole, rope to shoreline, anchor, free floating)
-nutrients/growing medium (i.e. soil, coir/organic layer, hydroponic)
-appropriate plants (urban tough, native, emergent/wetland plants

<u>options: explore varying Seattle aquatic conditions</u>
-fresh water vs. salt water
-wave attenuation vs. calm waters
-restoration over time (i.e. seed rafts)
-small size (flexible, less impact etc.) vs. larger (larger affect on shade, water quality etc.)

Conceptual Design Ideas

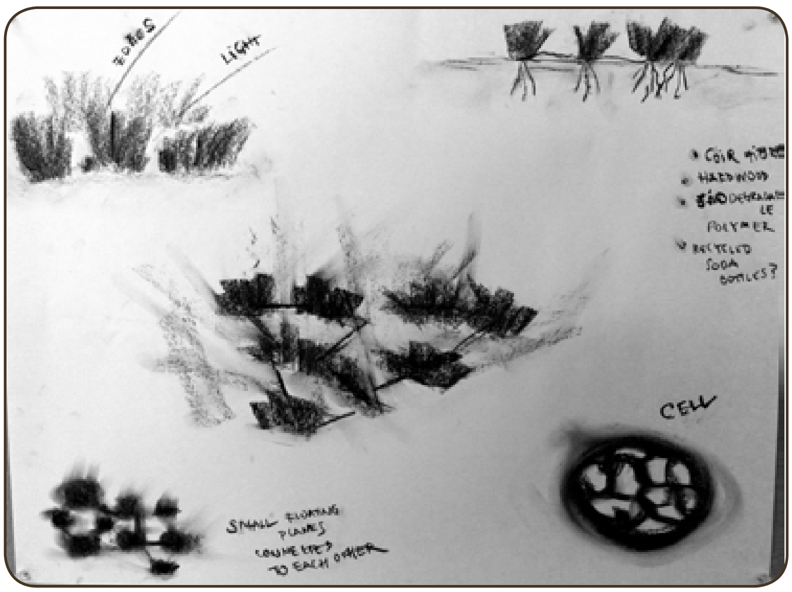
Brainstorming floating wetland designs

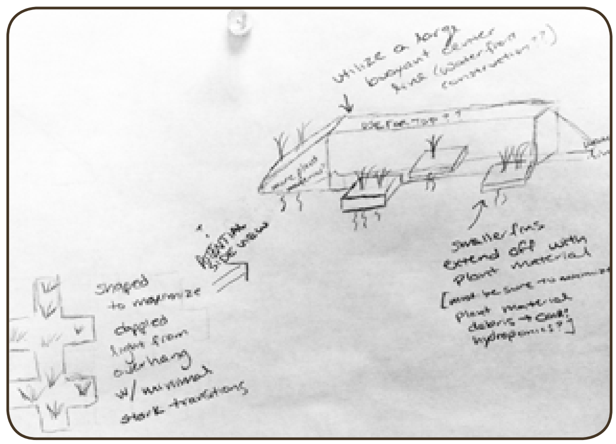
Students synthesized information from the case studies, literature review, and advisory board presentations, and individually crafted conceptual design ideas for a floating wetland system. This initial brainstorming phase was not site specific, however students did carefully consider the design criteria when formulating sketches.

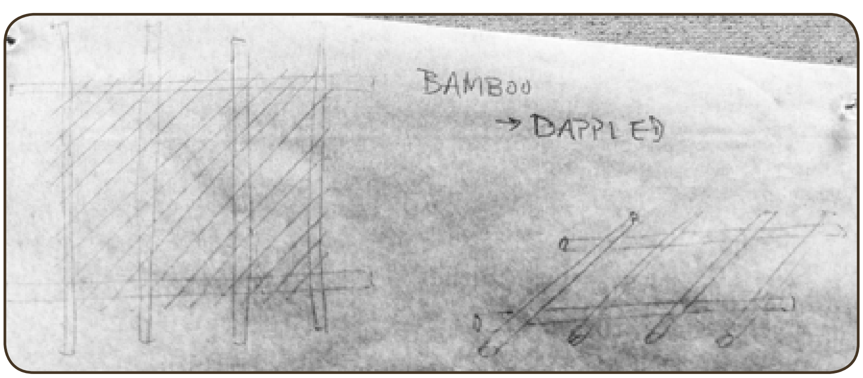
There were several trends in students' designs. Many tackled the varying regulatory shade requirements for each of the sites while also considering habitat needs. Some students investigated the capacity to mimic nearshore habitat conditions through various planting levels, while others examined ways to maximize edges and the potential for overhanging vegetations and insects. Designs explored various structural shapes, with a common emphasis on a modular design solution that addresses efficient constructability and flexibility of adapting to site conditions. This modular exploration often manifested in a 'checkerboard' pattern to allow light. Lastly, students explored ways that the floating wetlands could contribute to the human experience, by being a sculptural and intriguing piece of land art.

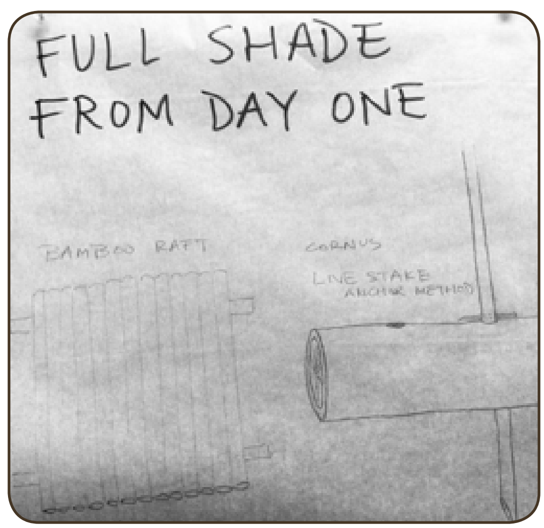
Shade Needs

investigating ways to address the different shade needs of the sites: dappled shade and gentle shade/light transitions for the Duwamish River site, and full shade coverage for the Lower Stensland Creek site



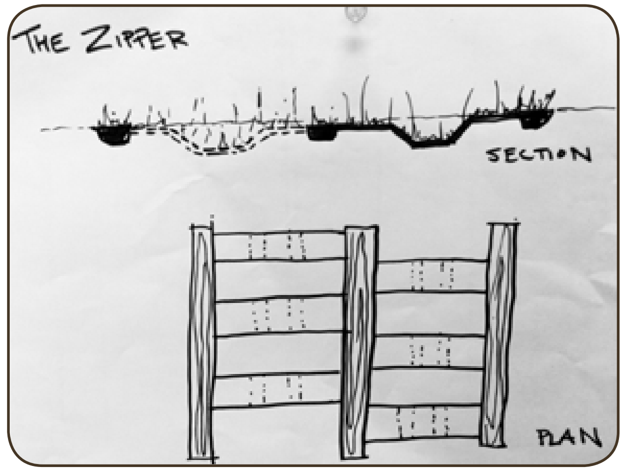


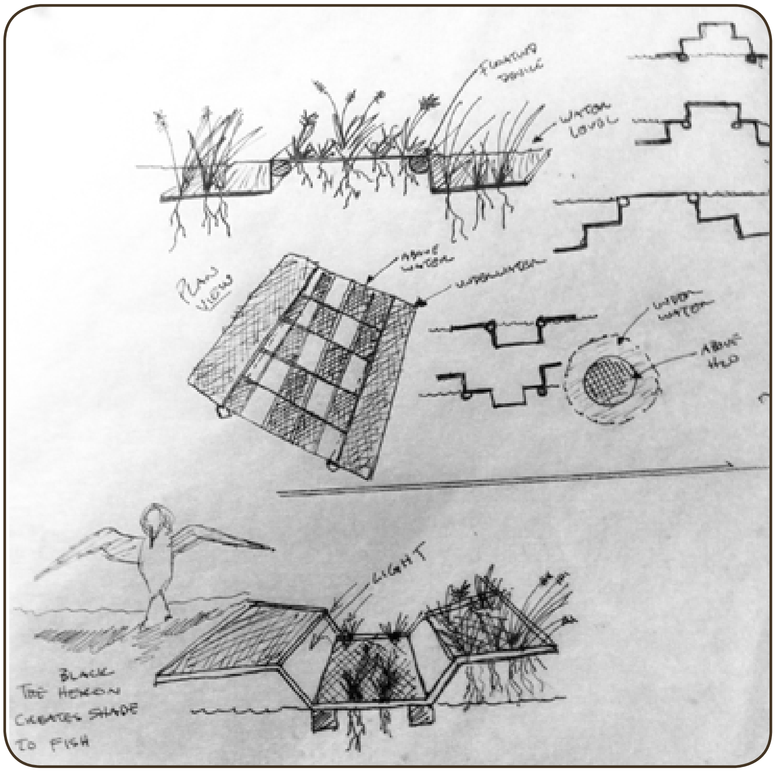


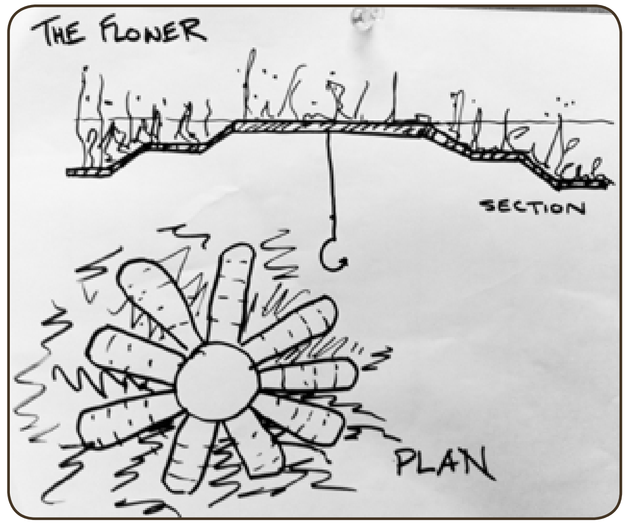


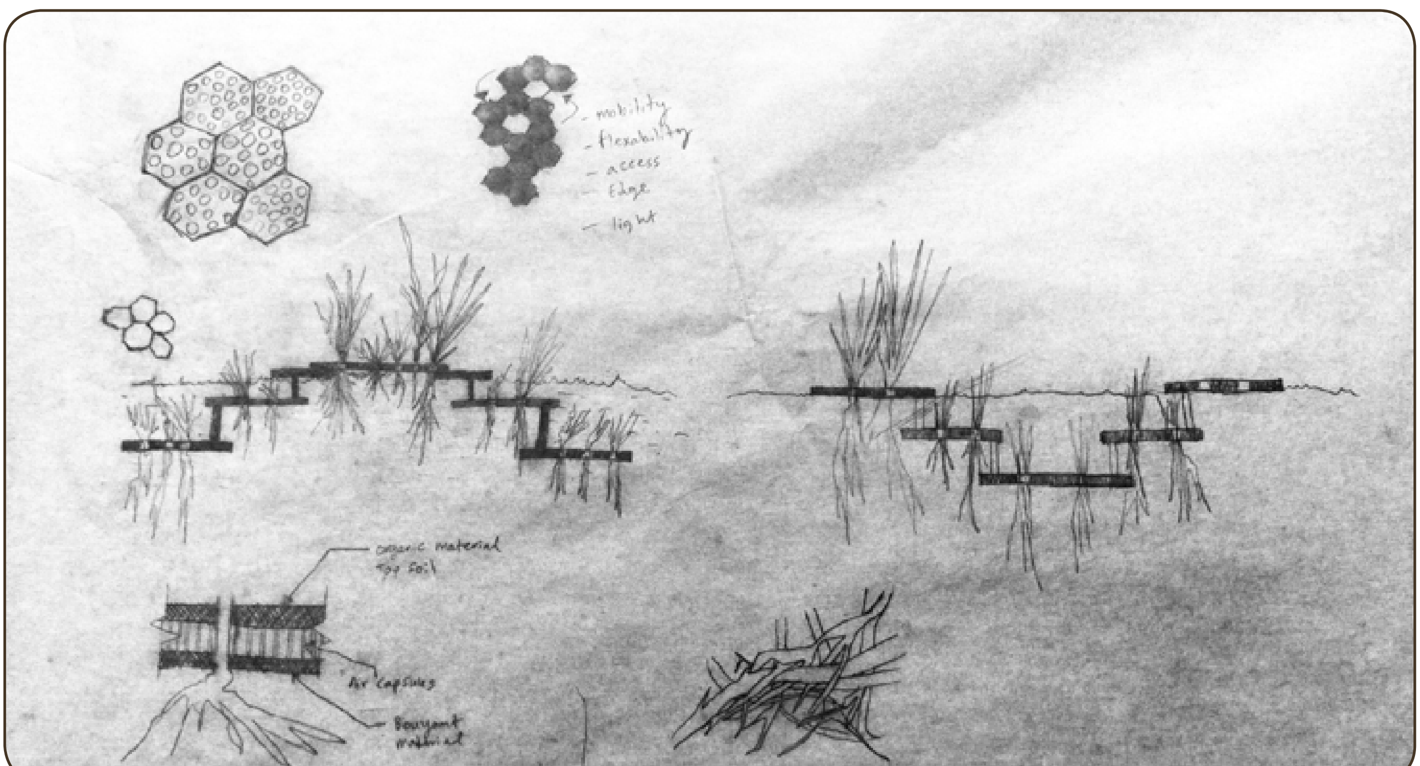
Habitat Levels

exploring ways to mimic nearshore habitat conditions through multiple vegetated levels to create a diversity of shelter and food source options for vulnerable aquatic populations



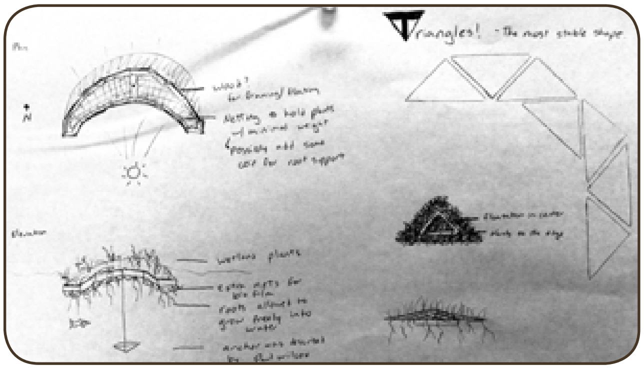


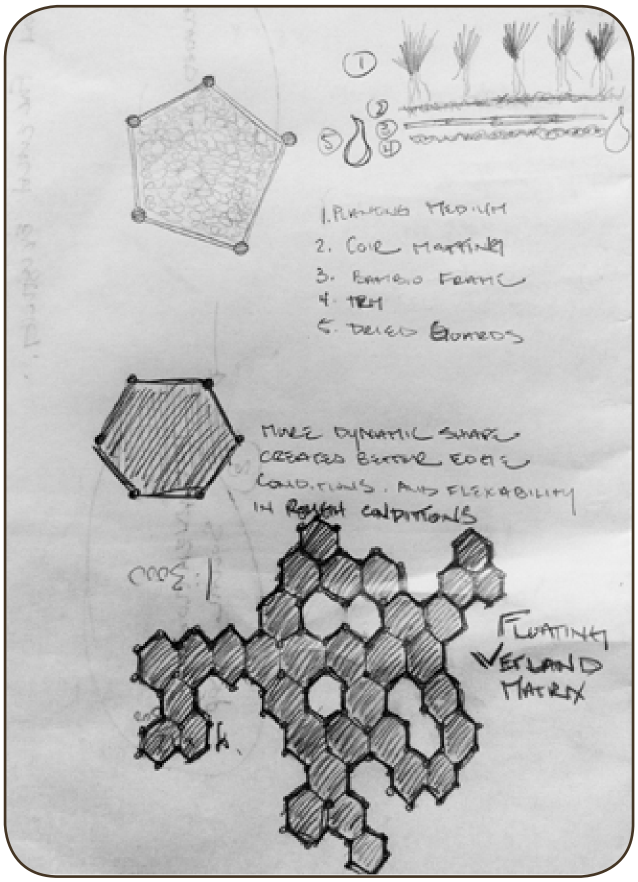


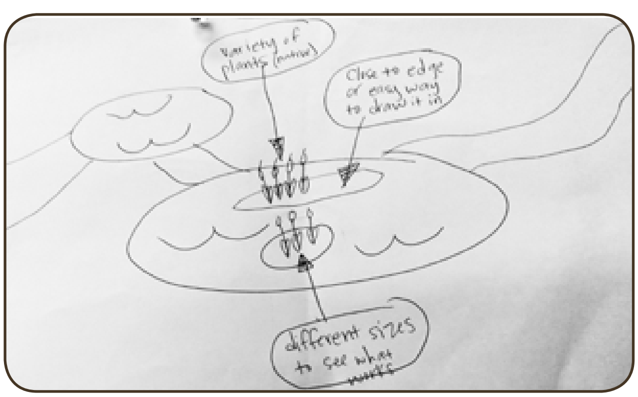


Edges + Structure Capacity

exploring ways to maximize edges (and overhanging vegetation) while playing with structural shapes and durability

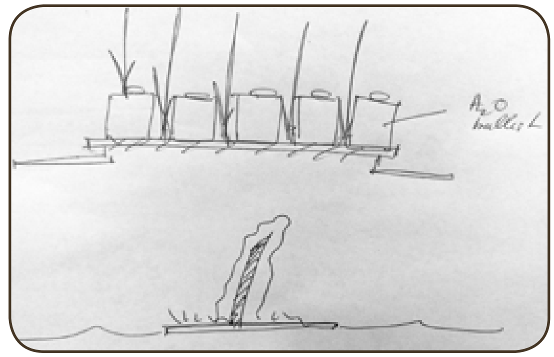


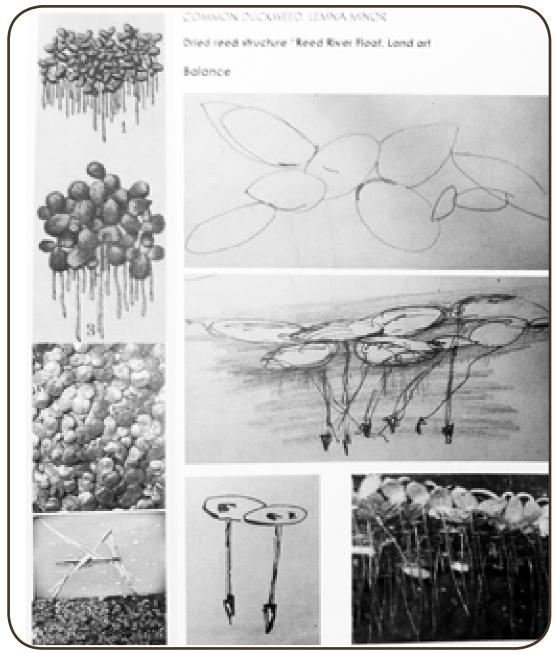


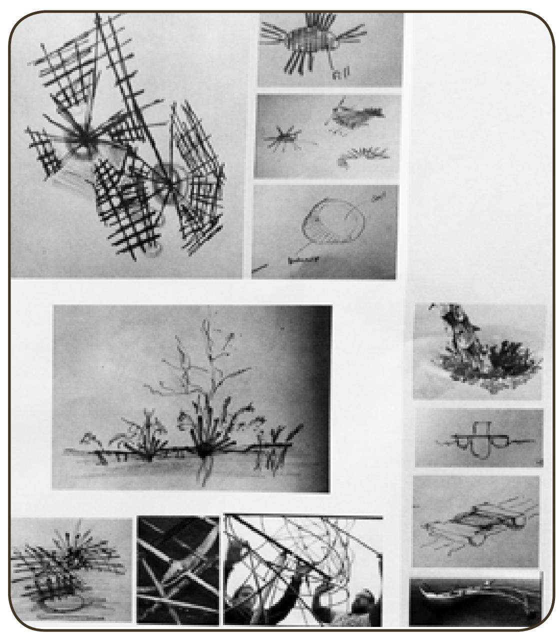


FWs as Land Art

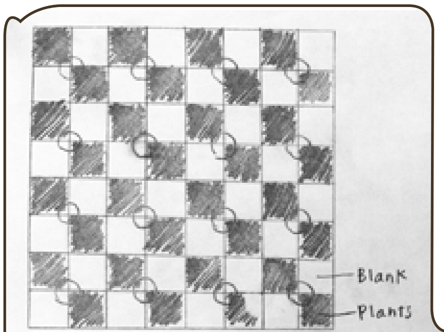
investigating ways that floating wetlands could be artistic pieces of nature that change and morph over time



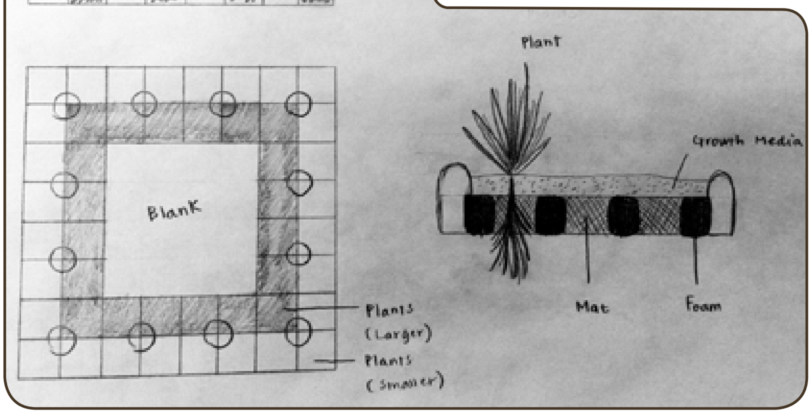


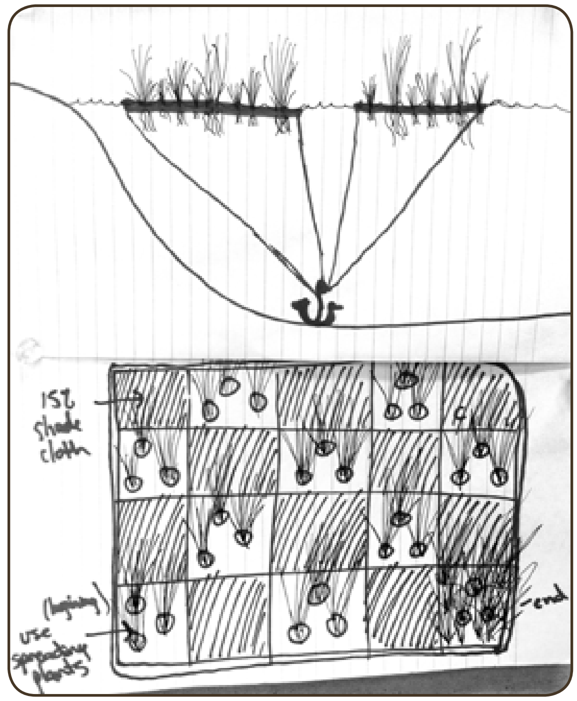


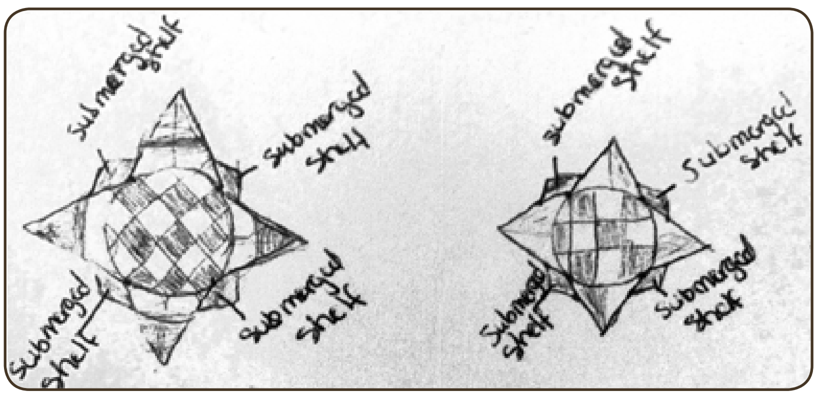
Modular Checkerboards

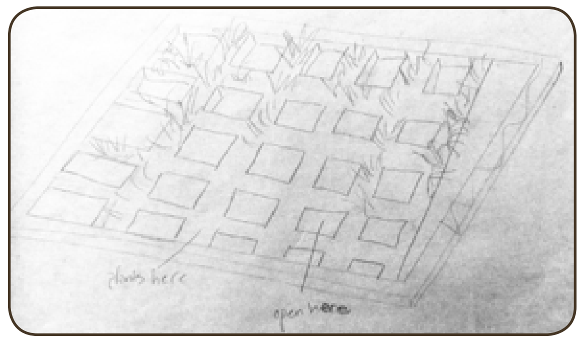


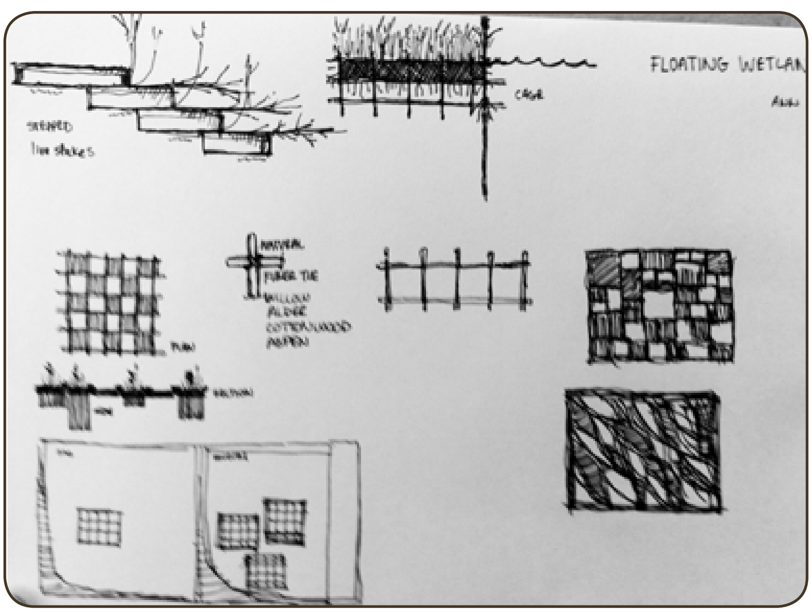
exploring the efficiency and practicality of modular systems while addressing dappled shade requirements and maximized edge conditions

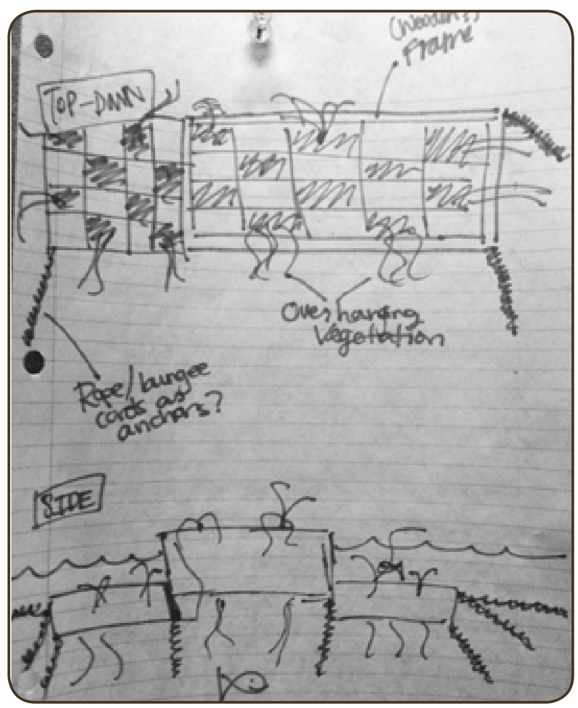






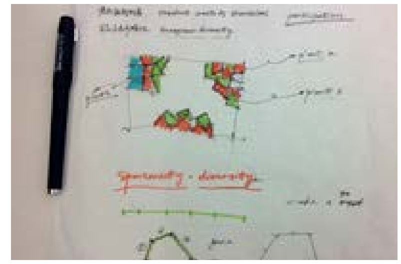






Schematic Design Workshop

A design charrette to discover designs for the various sites



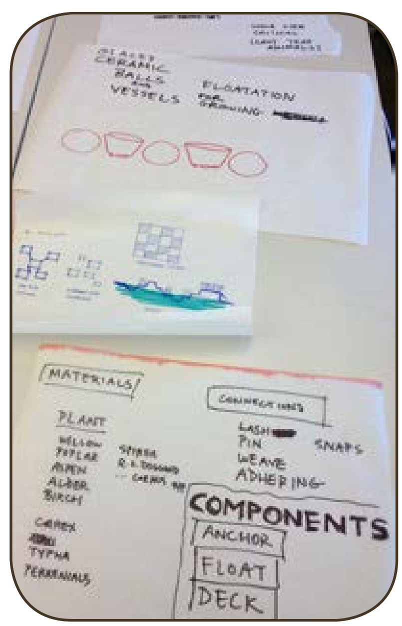
Above Image:
Image from the design workshop

[Photo by Mies]

[photos by Matt MacDonald]

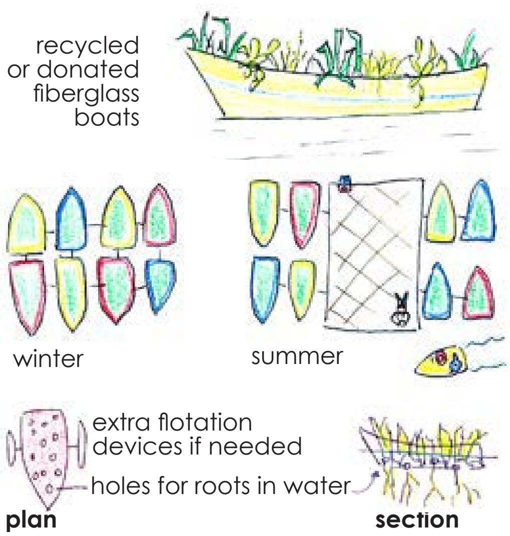
The next design phase began to address specific needs of the Lower Stensland Creek wetland and Duwamish River sites. Using the Design Criteria as guidelines, students broke into groups in the Schematic Design Workshop, sketching design ideas and presenting them for critique in front of their classmates.

The following pages outline the various design ideas that emerged from the Schematic Design Workshop.



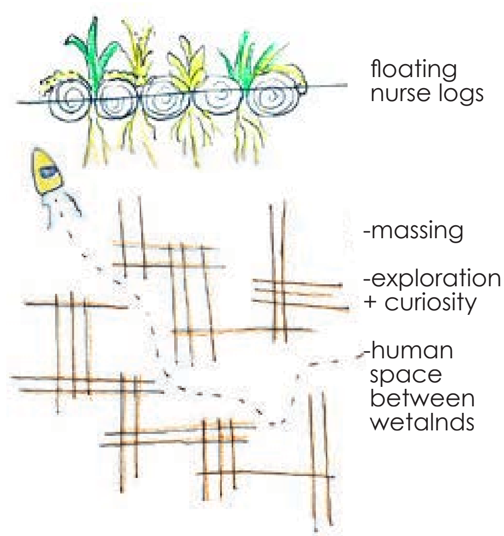
S.S. Wetland

Goal: to explore potential floating wetland application in the Duwamish River, introduce industrial character, provide human interaction, water quality improvement, cultural and artistic appeal



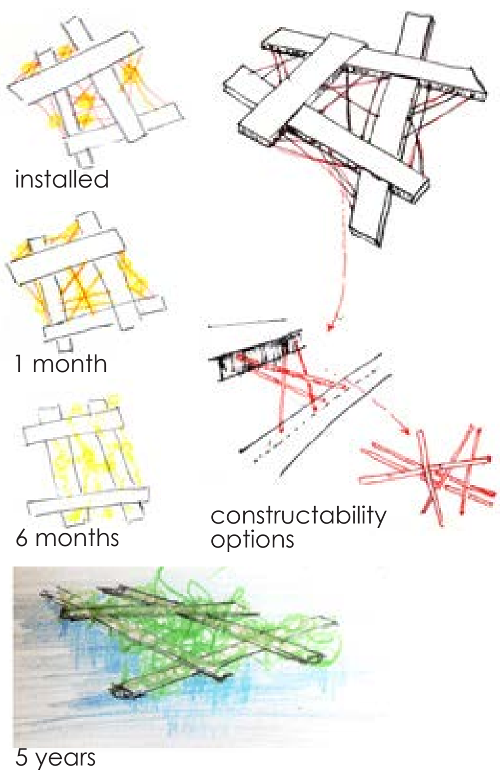
Log Labyrinth

Goal: to utilize natural materials for application in the Duwamish River, provide opportunity for human experience and education, a natural modular design, water quality improvement, low cost solution



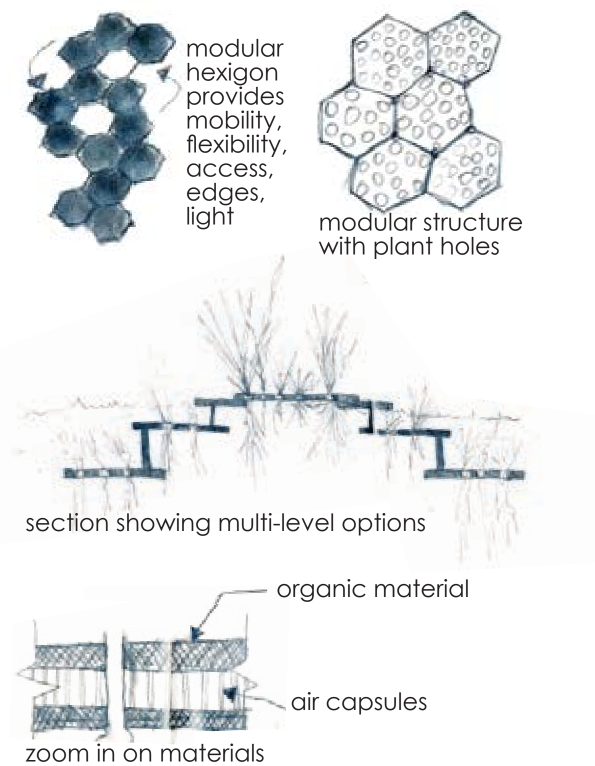
Phased Shade

Goal: a phased solution for Lower Stensland Creek wetland that would begin with full shade to meet the coverage requirements, and as the structure decomposes, plants would grow to dappled shade, becoming part of the wetland over time



Honeycomb

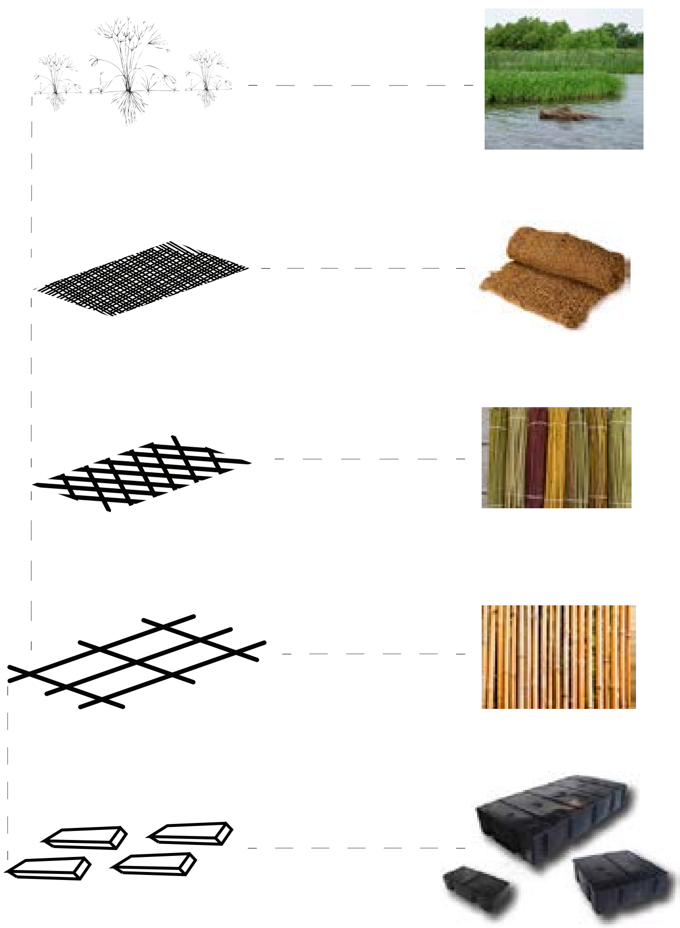
Goal: a modular system for either the Duwamish River or Lower Stensland Creek wetland that maximizes edges and overhanging vegetation, provides diverse habitat conditions, and flexibility in shade requirements



Modular Dock Floats

Goal: to create a easily replicable system for either the Duwamish or Lower Stensland Creek sites that mimics dappled light conditions, increases shelter for vulnerable aquatic populations, uses non-contaminating materials, lasts 5 years, decreases water temperature, affordable cost, buyant but with an anchoring system that allows for a fixed location as well as flexibility in movement.

MATERIALS



Emergent wetland plants

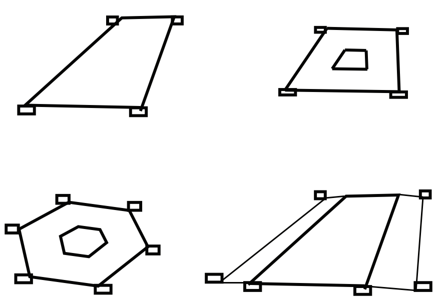
Coconut coir mat

Willow and Dogwood Clippings

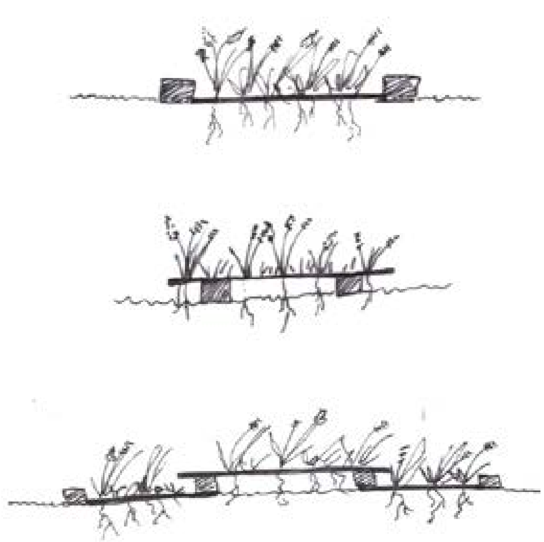
Capped bamboo poles

Dock floats

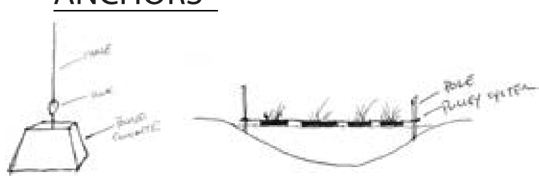
SHAPES



SECTION VIEW



ANCHORS



Components and Possibilities

Goal: to explore various options for floating wetlands components and their constructability for either the Duwamish or Lower Stensland Creek sites; options of structure, connections, modularity, plant material and buoyancy; consider possibilities of human interaction, education, community outreach, sustainability and water quality improvement

COMPONENTS OF A FLOATING WETLAND

DECK
ANCHOR
BUOYANCY

IMPORTANT NOTES
-MODULAR SYSTEM
-ORGANIC MATERIALS
-CULTURAL/COMMUNITY OUTREACH

BUILDING METHODS

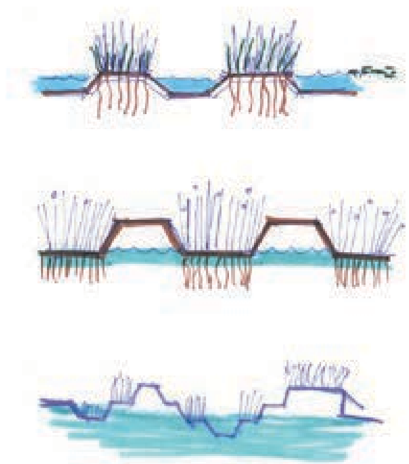
LASH
PIN
WEAVE
ADHERE
SNAPS

BUOYANCY

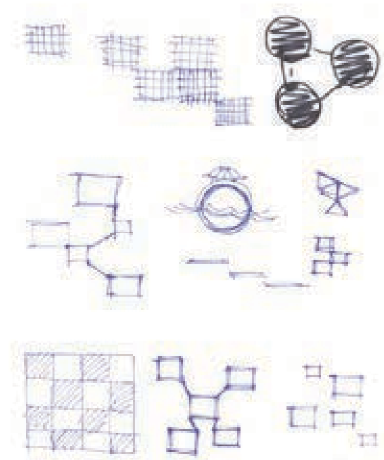
BUOYS
PVC PIPES
FOAM
BAMBOO
PHRAG
WATER HYACINTH
WOOD
RECYCLED PLASTICS
CORN PLASTIC
GOURDS
BLADDERS
CLAY POTS
KNOTWEED
PUMICE

PLANT MATERIAL

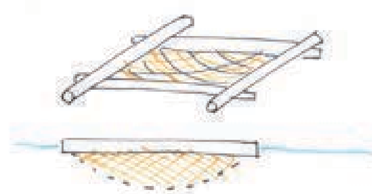
WILLOW
POPLAR
ASPEN
ALDER
BIRCH
CAREX
TYPHA
PERENNIALS
SPIREA
CORNUS SP.
WATER HYACINTH
LILY PADS
CATTAILS



varying levels

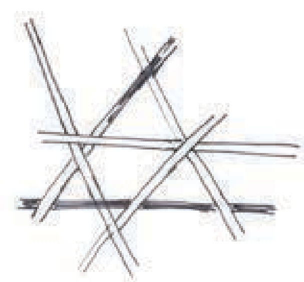


modular system, different sizes
phasing
cultural native volunteers
easy access, replacement
weaving interlocking

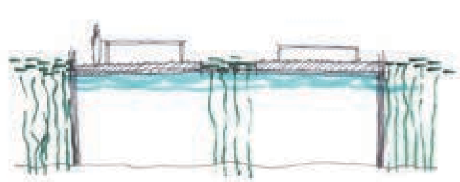


any type of suspended net/fabric
hole size critical (can't trap animals)

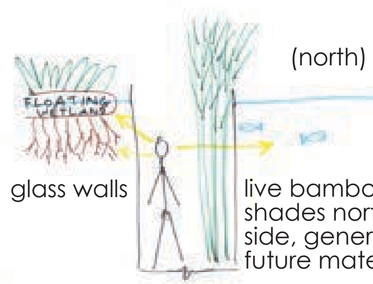
glazed ceramic balls and
vessels for flotation + growing



woven willows as joists



lily pad fence / border



(north)

glass walls

live bamboo
shades north
side, generates
future materials

rehabilitation aquarium
corridor through cell

Design Development

Developing designs for both the Lower Stensland + Duwamish sites

Above and Left Images:
Photos from the final review presentation
[Photo by Leann Andrews]

In the final design phase students delved into design details for floating wetland installations at both the Lower Stensland Creek Wetland and South Park Bridge/Duwamish River sites. Students broke into four groups and one independent study to develop their designs and present their findings to the Floating Wetlands Advisory Board for feedback. The following pages summarize this design development process and include:

- Design 1: Edge and Habitat
- Design 2: Thirteen °C
- Design 3: S.S. Wetland
- Floating Wetland Preliminary Prototype Testing
- Preliminary Plant List for Floating Wetlands

Students will potentially use the feedback from the design review to construct a floating wetland demonstration project in the coming months.

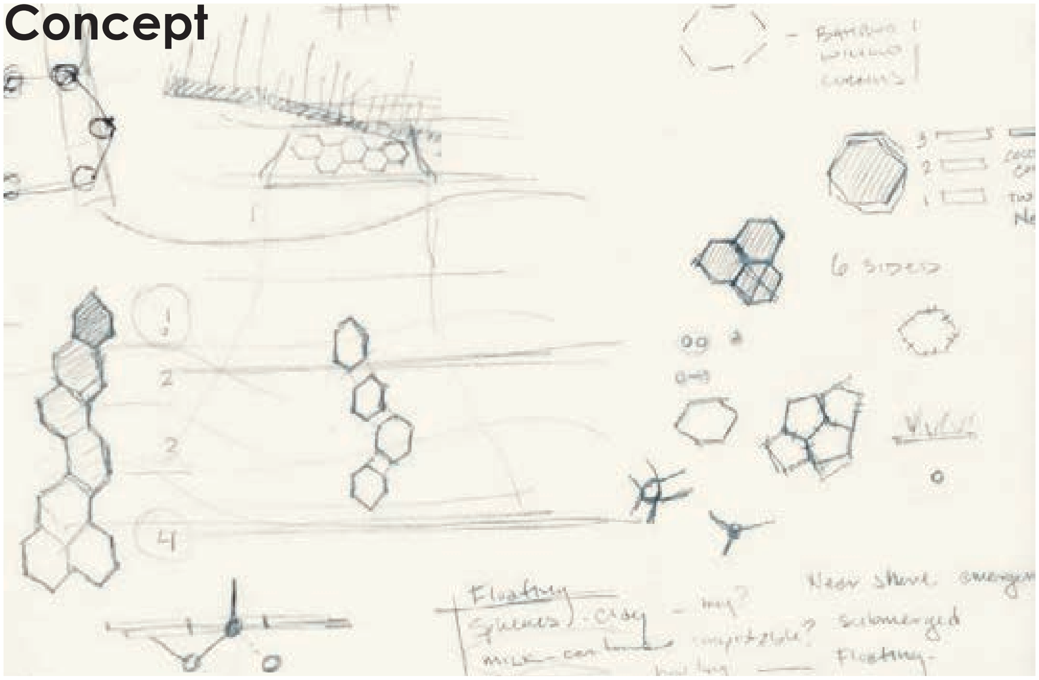
[photos by Leann Andrews]

Design 1: Edge & Habitat

Biruk Belay, Peter Cromwell, Kristen Gelino, Heather Khan

Design for Lower Stensland Creek Site

Concept



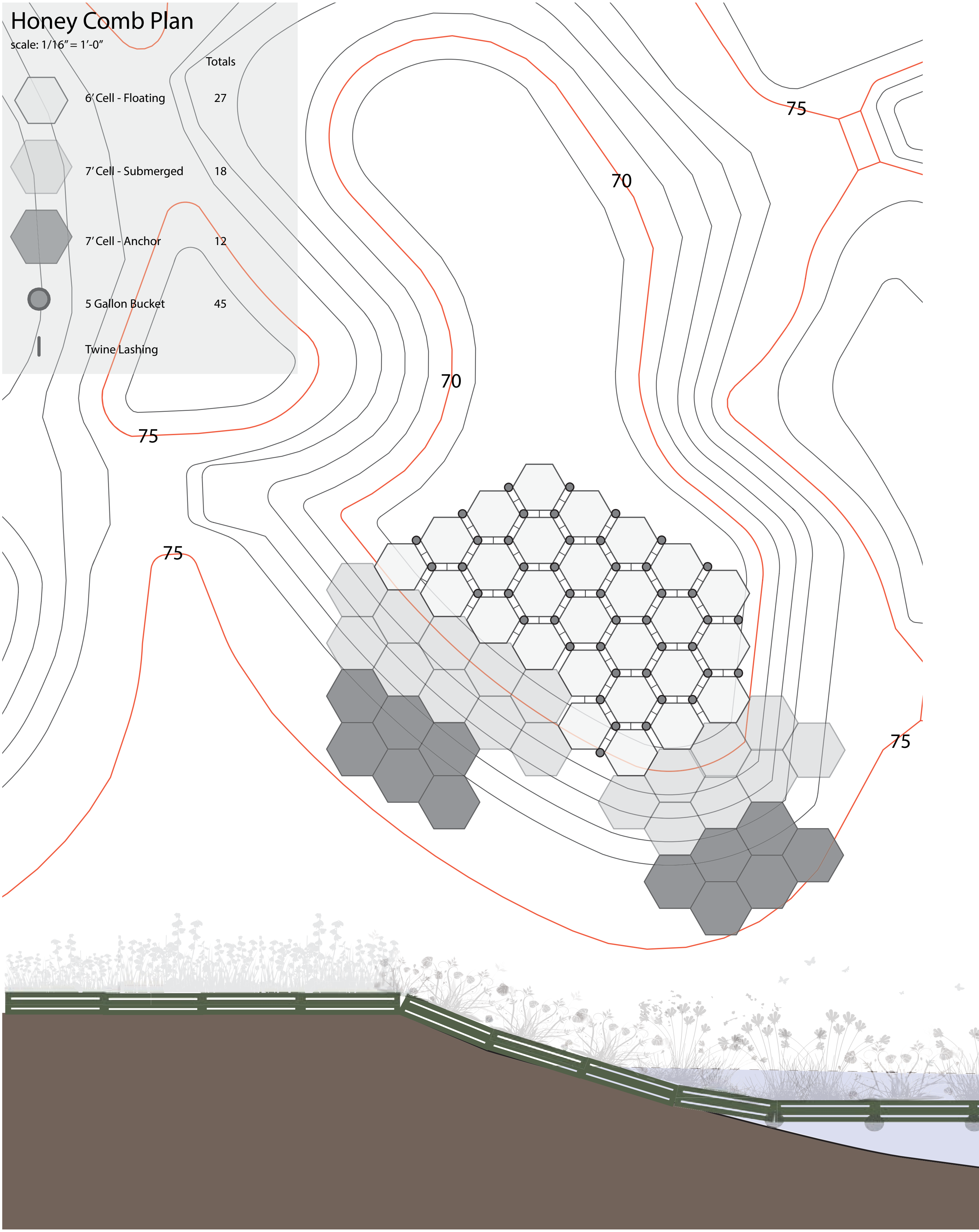
Design Approach:

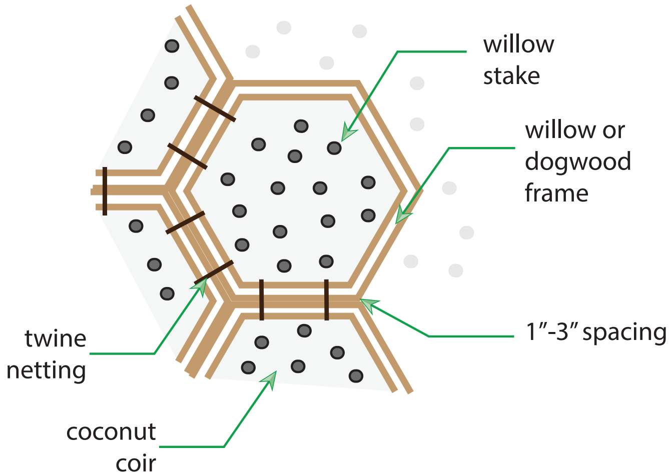
- Basic structure is a collection of six-sided cells
- Provide a structure that will quickly provide the needed shade, but will not have such a big presence in three years after the alders have grown in
- Design a biodegradable or integrate-able structure, so materials and/or plants integrate into the site once the floating wetland is no longer needed
- Key anchors would root into the ground with willow or dogwood stakes. Cells further out will be made of bamboo
- Some cells might be submerged and some might be floating creating the need for different plant pallets

Design Goals:

- Water quality improvement
- Monitoring flexibility
- Phased approach
- Increased edge habitat
- Spectrum of habitat and diverse planting schemes

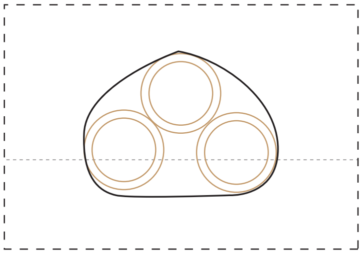
Existing conditions photo
[Matt MacDonald]


Honey Comb Plan
scale: 1/16" = 1'-0"
Totals
6' Cell - Floating 27
7' Cell - Submerged 18
7' Cell - Anchor 12
5 Gallon Bucket 45
Twine Lashing
75
70
70
75
75
75

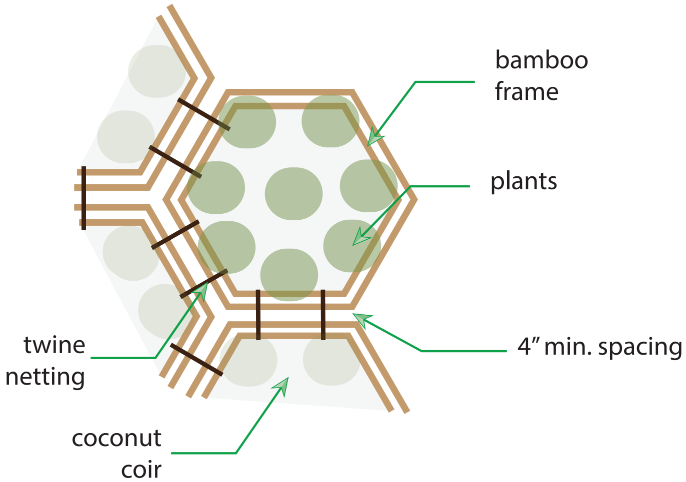


Shoreline Frame:

- willow or dogwood species frame
- allowing it to root over time
-strong anchoring near shoreline
- gradients of plants
- provides rich biodiversity

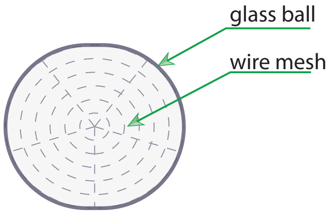


Bamboo frame

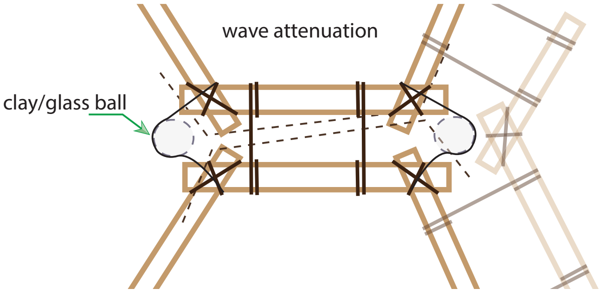


submerged Frame:

- willow or dogwood species frame
- allowing it to root over time
- mix live stakes and plated plants
- providing instant shade for water temp. and fish habitat.
- allowing plants to take root to create a shallow shoreline habitat

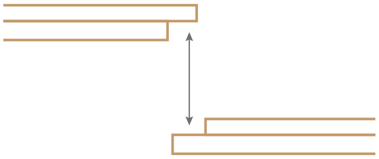


Glass ball

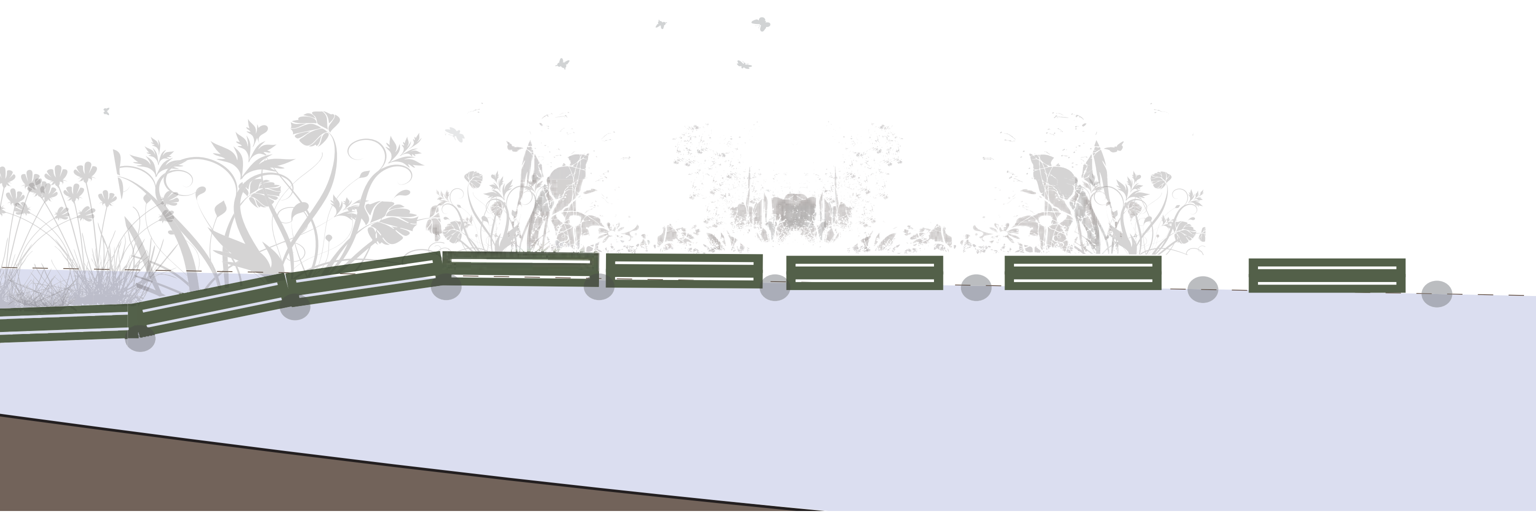


Shoreline Frame:

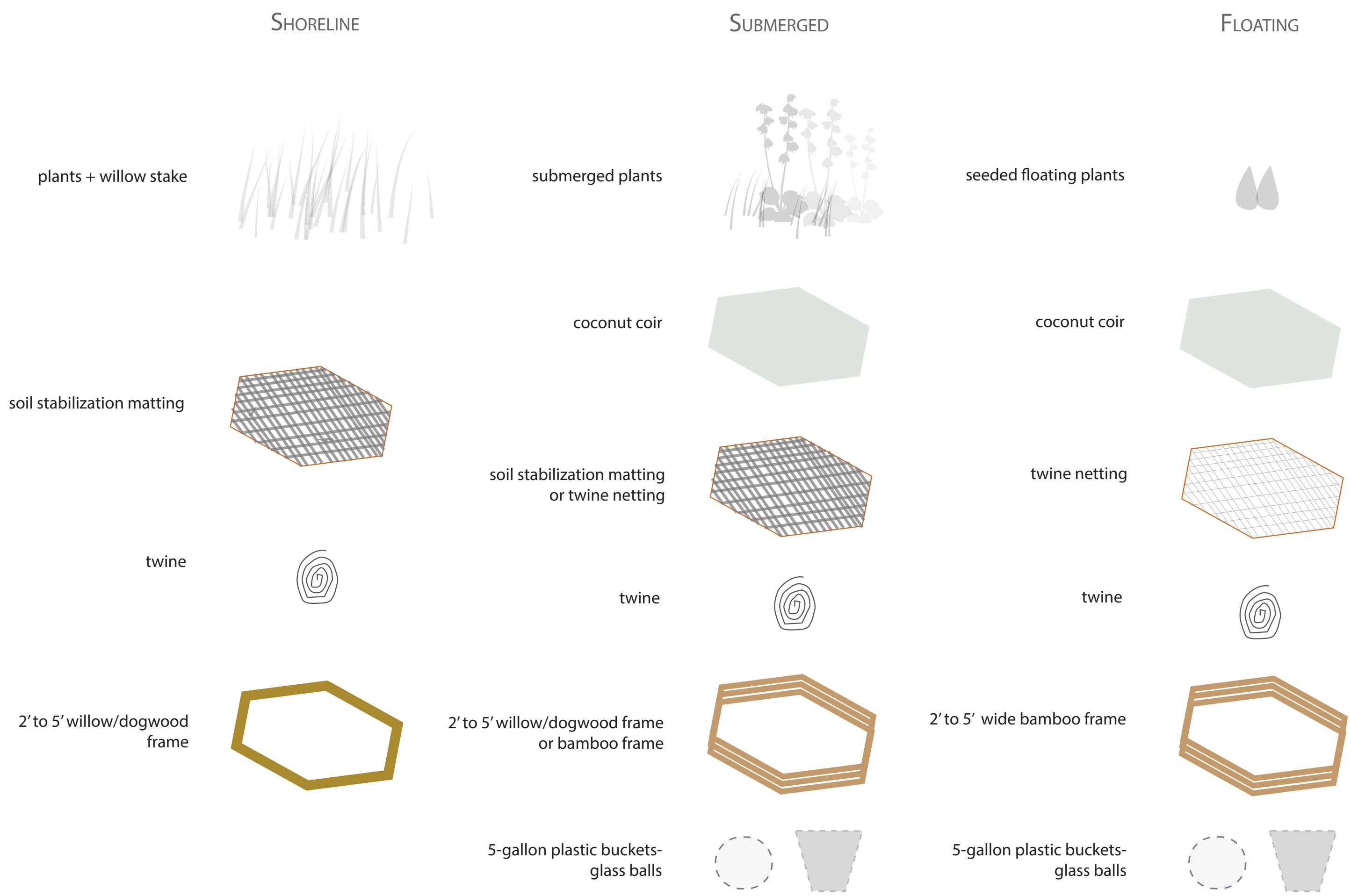
- bamboo frame
-provide shade with matting while plants are being seeded
- floating frames that are flexible



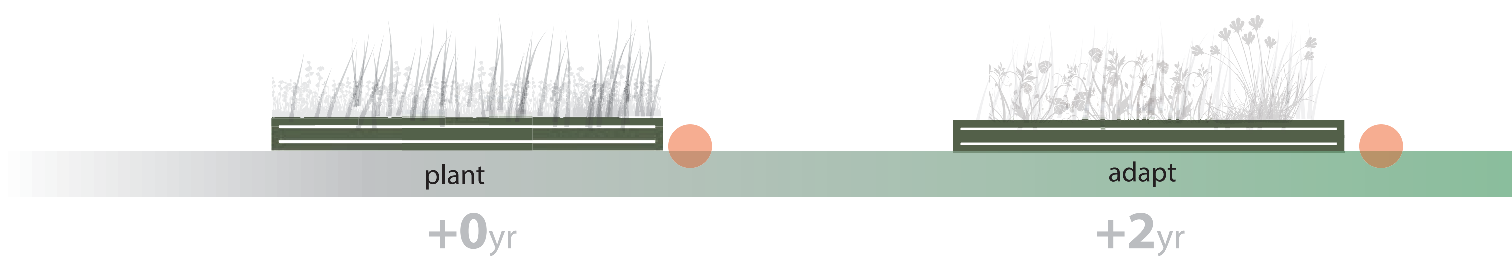
Frame connection



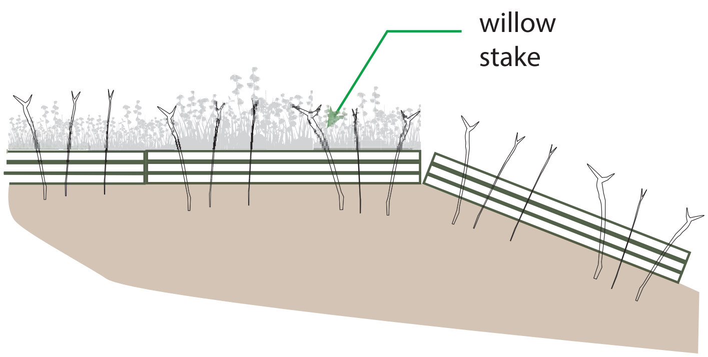
Materials



Phasing

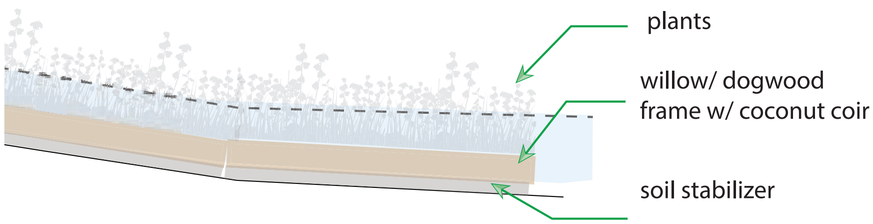


Edge & Habitat Detailed Sections



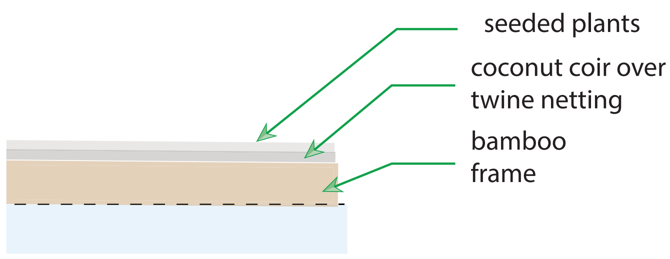
Shoreline: Native willow and dogwood live stakes

- Staking then at an angle to provide additional shading to bring down the water temperature.
- Adding leaf litter (insects that drop into the water).
- Also may include wapato or other plants with ethnobotanical elements for human consumption and educational piece.



Submerged: Native plants that provide shade, fish habitat and lower temperature.

Emergent areas: Native plants, a diverse palette of grasses (sedges, rushes) and flowering plants.



Floating areas: Native plant seed

- Opportunity to experiment with different kinds of planting from seeds.
- Seeding this area also gives the submerged and emergent areas time to establish to help anchor the floating pieces.

Proposed Installation Over Time

current conditions

+ after construction

+5 years

EDGE & HABITAT DESIGN REFLECTIONS

Pros

- Modular + scalable
- Provides needed shade on day 1
- Uses inexpensive materials, most of which are biodegradable
- Creates complex and diverse edges
- Supports numerous plant types for habitat diversity
- Extends nearshore habitat
- Creates dappled light
- Likely resilient in changing water levels and wave attenuation
- Relatively easy to decommission
- May provide benthic habitat after buoyancy is lost

Cons

- May be labor intensive
- Buoyancy requirements need to be calculated
- Uncertain lifespan

Questions

- Could the modules be designed in such a way that they could be decommissioned in phases?
- How can geese habitation be discouraged either through plant choice (i.e. shrubs or tall grasses) or browse management provisions?
- Would it be less cost or more desirable to use a submerged anchor rather than anchor at the shore?
- Are there additional elements that can be added to more readily encourage the growth of biofilm?

Design 2: Thirteen °C

Ann Dinthongsai, Jonathan Pagan, Vera Hoang,
Matt MacDoald, Elyssa Kerr and Autumn Nettey

Applicable for both
Lower Stensland Creek and Duwamish River Sites

Design Criteria:

Lower Stensland Creek Site:

- Decrease water temperature through shading- dappled light for fish
- Fixed location (anchoring system)
- Last for ~5 years
- Organic, available and sustainable construction materials
- Buoyant

Duwamish River Site:

- Improve water quality through uptake of pollutants
- Highly durable
- Maximize biofilm formation
- Scalable and replicable
- Low impact on other water activities (anchoring)

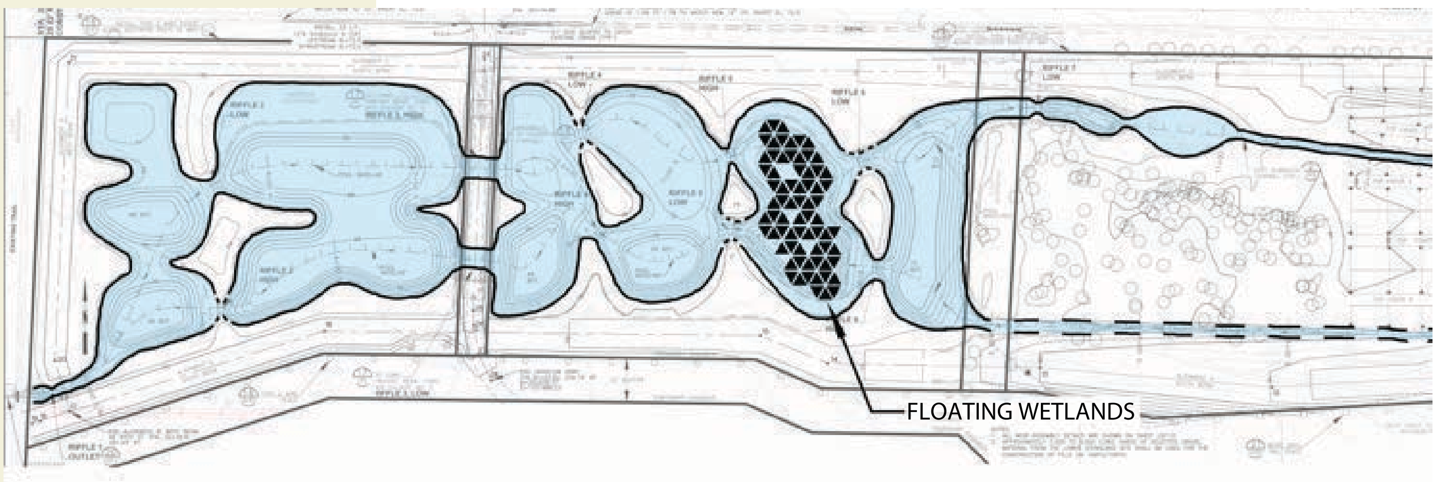
Design Goals:

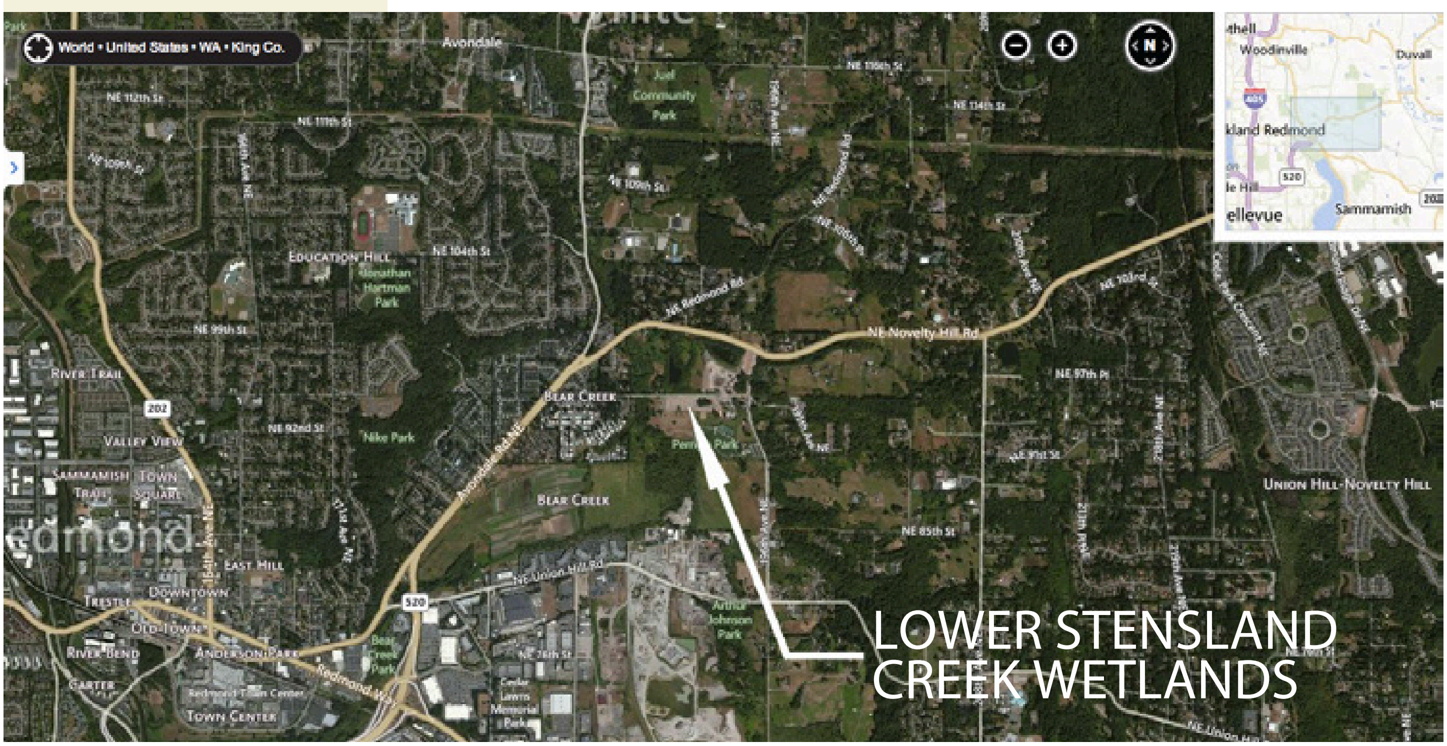
To enhance and expand habitat through water quality improvement and mimicry of natural systems

Explore modular designs flexible enough to be applicable in a variety of local settings

Existing Conditions + Site Context for Lower Stensland Creek Site

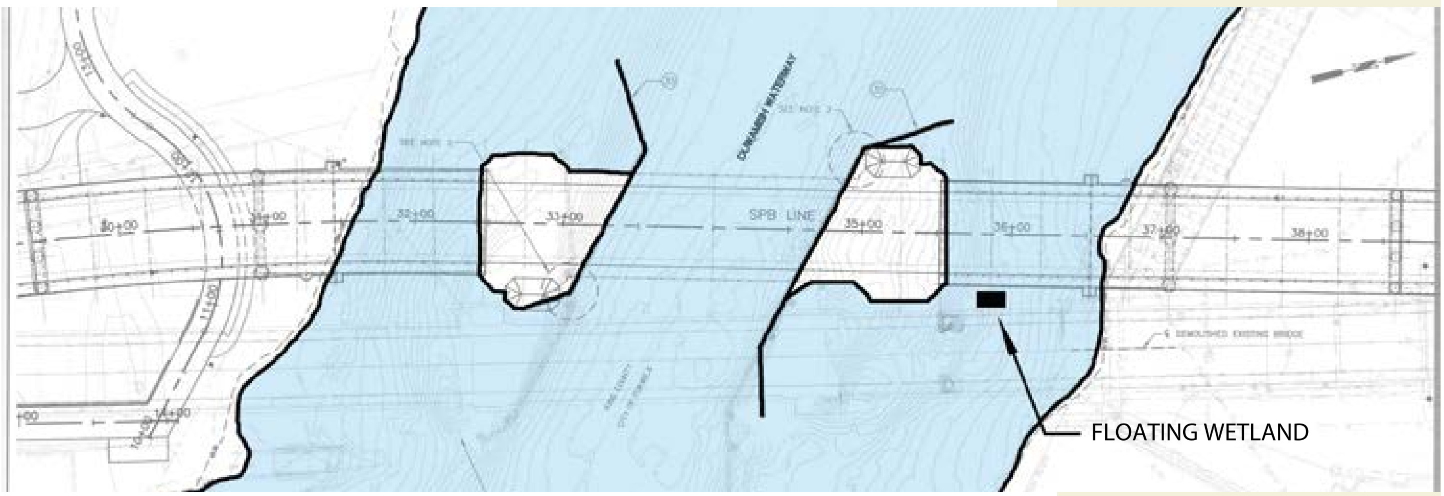
[photo by Matt MacDonald]

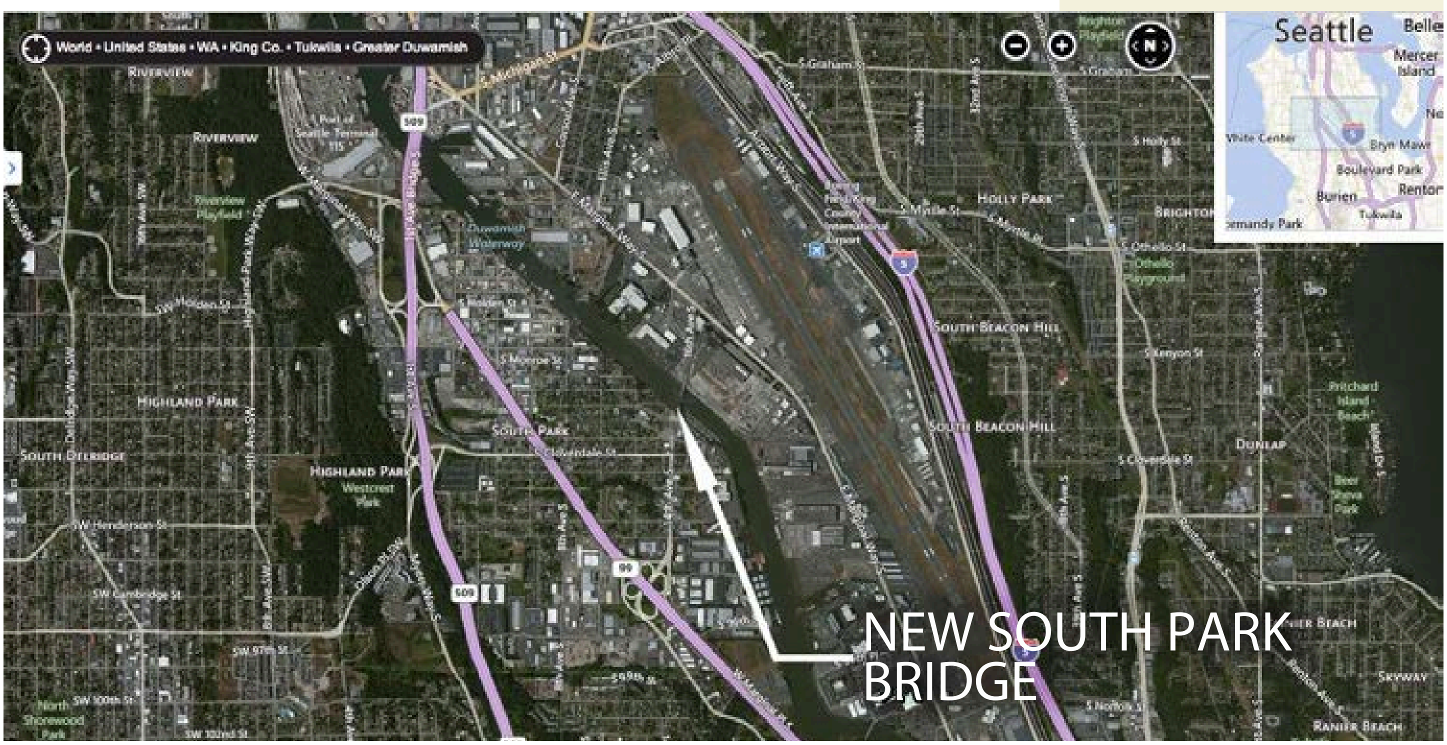




Existing Conditions + Site Context for Duwamish River Site

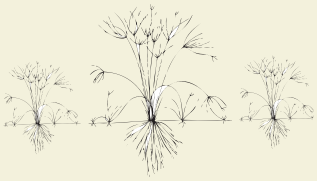
[photo by Paul Gordon Pictures]



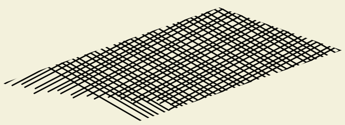


Lower Stensland Floating Wetland System

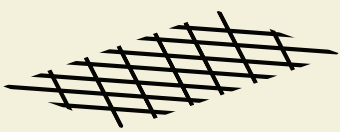
Components



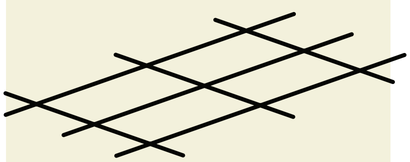
Wetland System



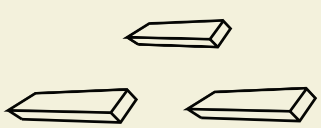
Substrate



Inner structure



Frame

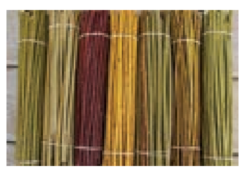


Floatation device

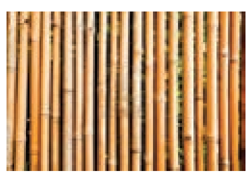
Materials

Emergent wetland plants

Coconut coir mat



Willow/dogwood clippings

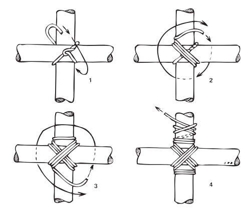


Treated bamboo poles

Buckets/
Recycled bottles

Fastening

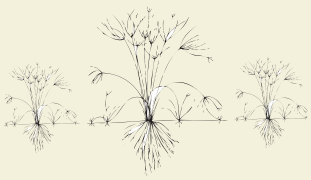
Synthetic twine/
zip ties



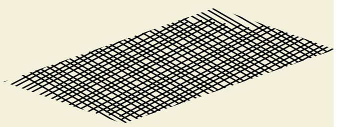
Lashing

Duwamish Floating Wetland System

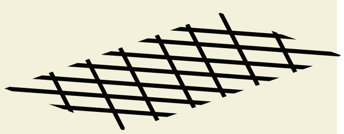
Components



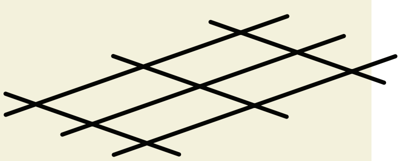
Wetland System



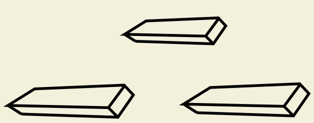
Substrate



Inner structure



Frame



Floatation device

Materials

Emergent wetland plants

Synthetic mat

Geotextile fabric

Aluminum frame

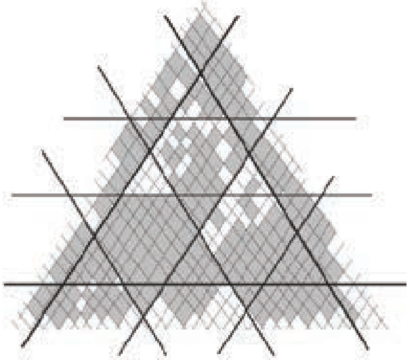
Dock Floats

Fastening

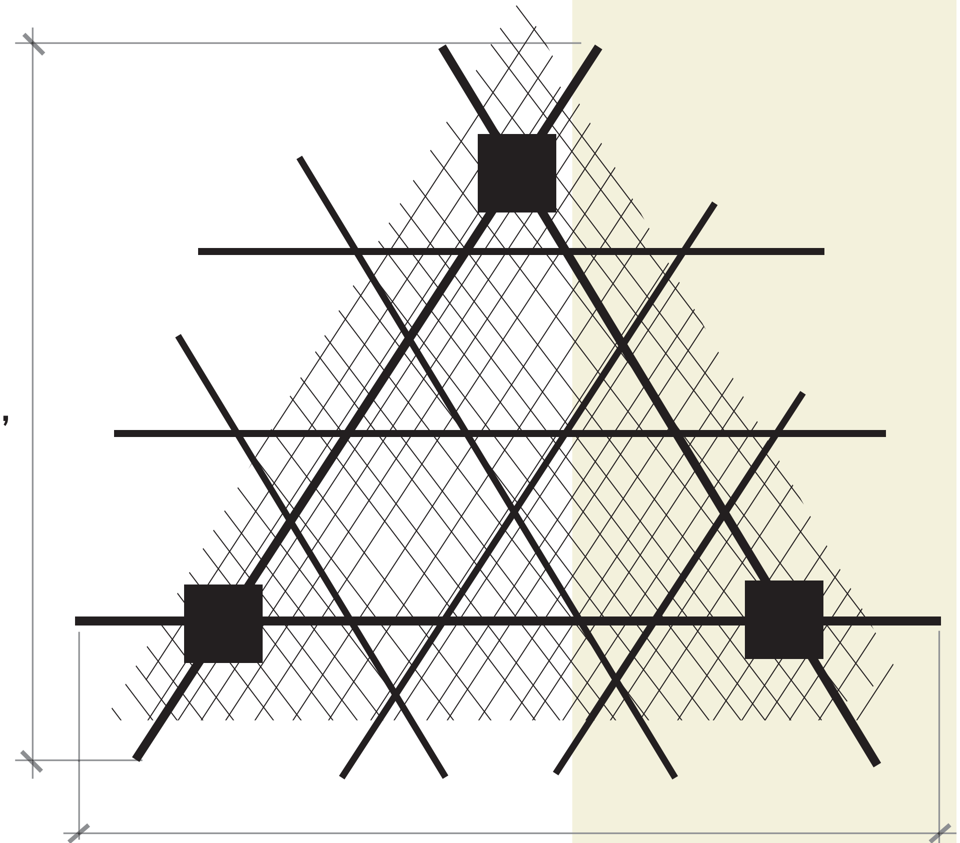
Steel wire/zip ties

Bolts

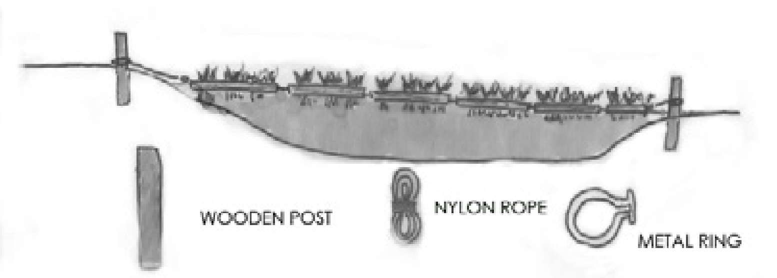
Lower Stensland Floating Wetland Design Details



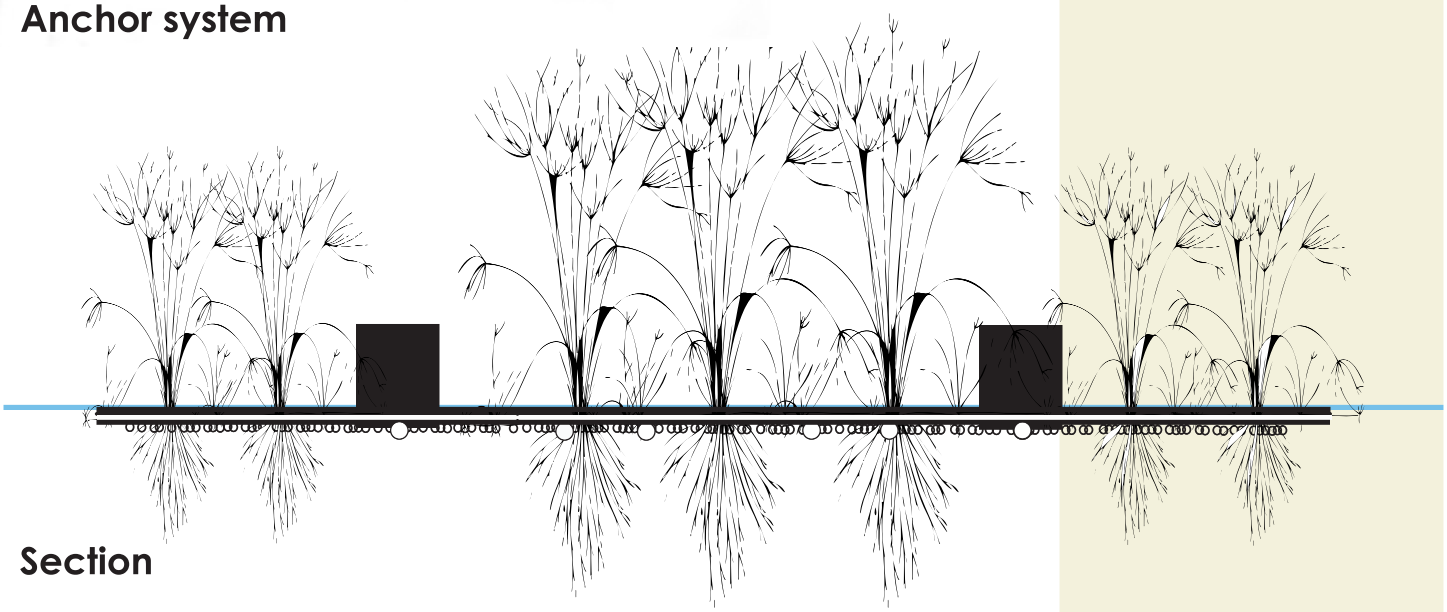
Shade diagram



Plan

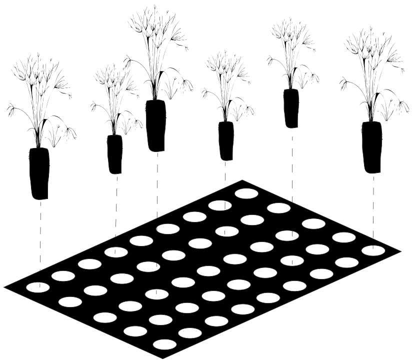


Anchor system

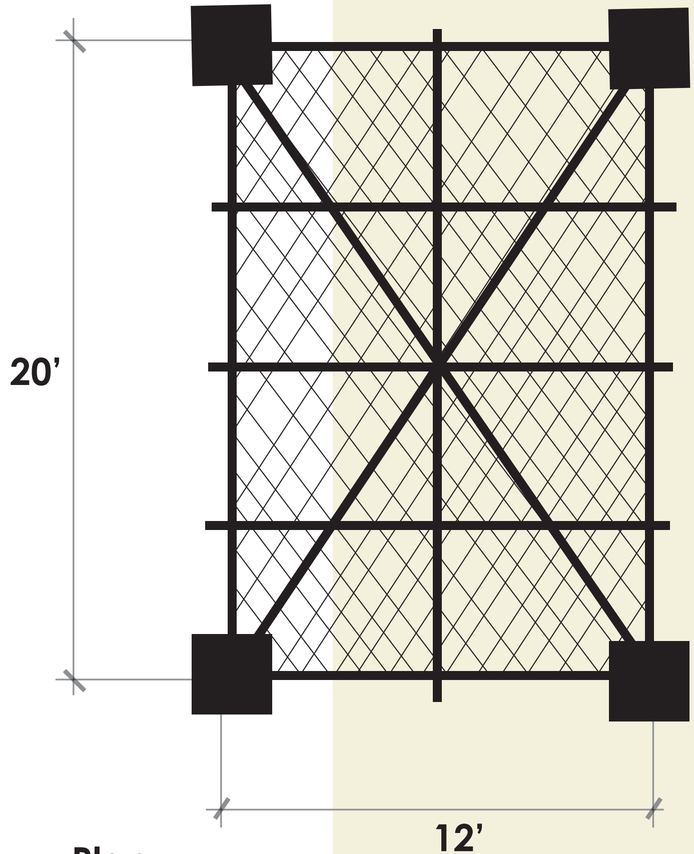


Section

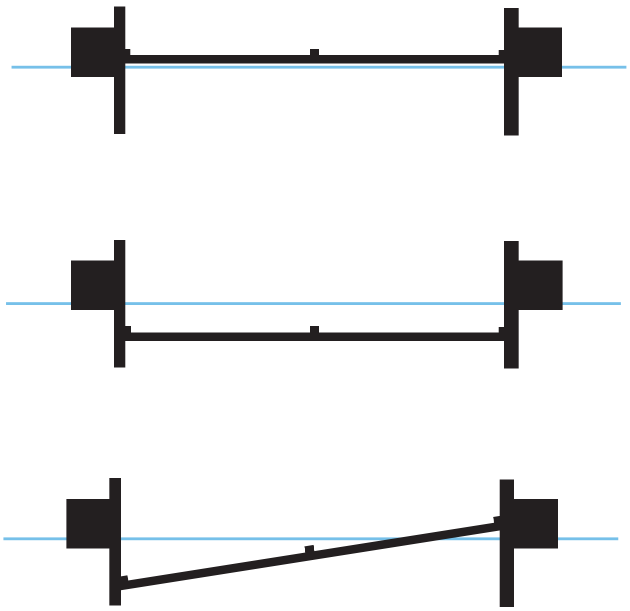
Duwamish Floating Wetland System Design Details



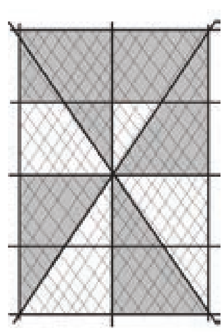
Planting diagram



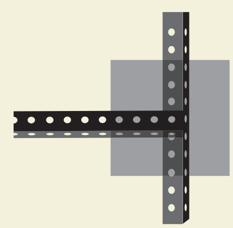
Plan



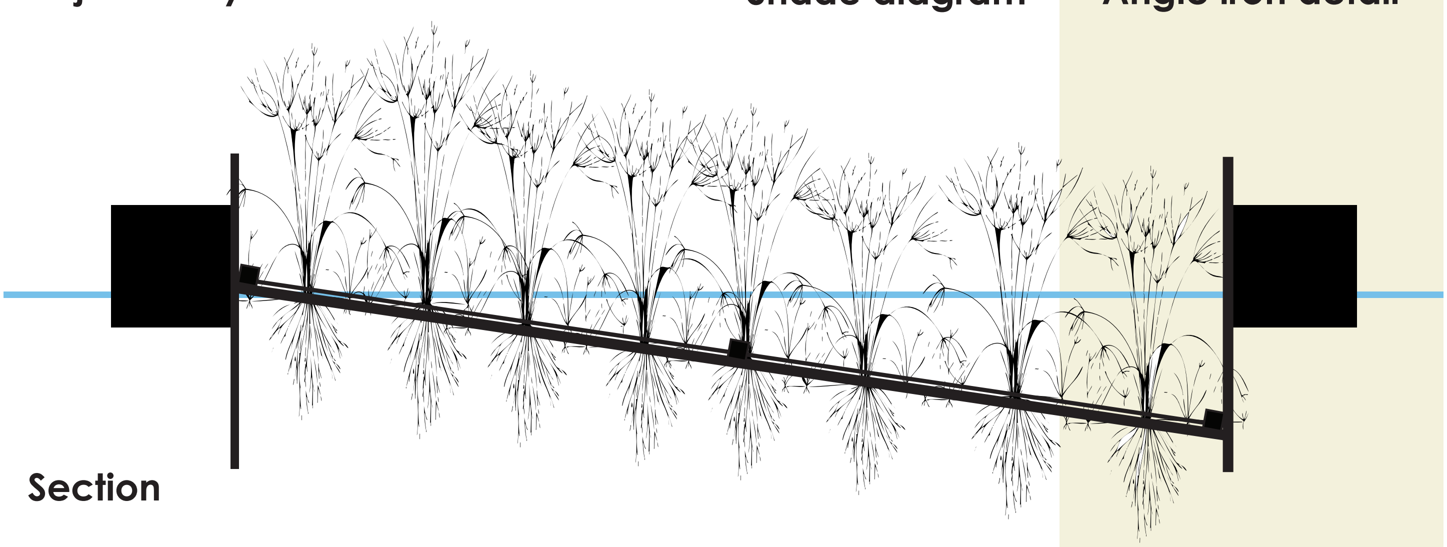
Adjustability



Shade diagram



Angle iron detail



Section

Proposed Lower Stensland Floating Wetland Design

Proposed Duwamish Floating Wetland Design

THIRTEEN °C DESIGN REFLECTIONS

Pros
Stensland Creek:
-Inexpensive
-Simple
-Natural + available materials
-Easy construction
-Movable

Duwamish:
-Durable
-Abundant biofilm surfaces
-Adjustable heights for differing shoreline conditions
-Reusable materials

Cons
Stensland Creek:
-The timeline it would take for plant growth and to fully be a useful means for shading
-Unsure of plant growing capabilities
-Durability
-Bird use

Duwamish:
-Expensive materials
-Construction cost
-Material availability
-Unsure of plant growing capabilities
-Hard to transport out of water
-Maintenance
-Bird use

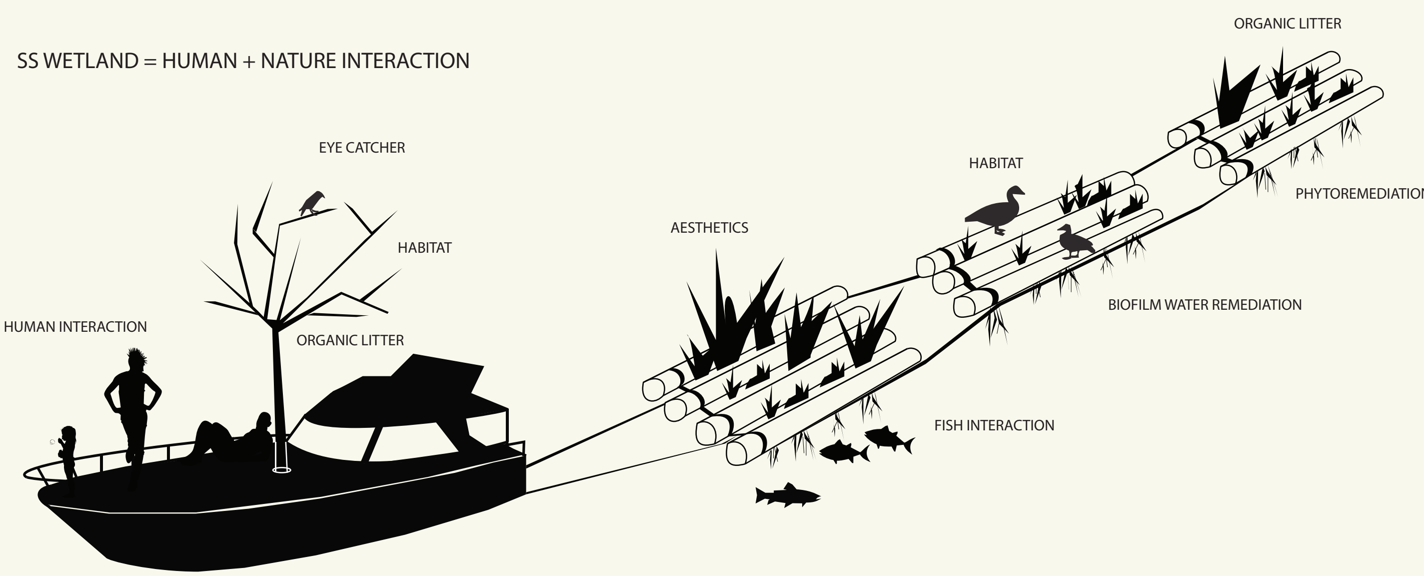
Questions
Stensland Creek:
-Will the willow and dogwood clippings sprout, and if so is the layer of emergent plants or the coir necessary?
-Will the plants thrive?
-How buoyant or stable is the bamboo structure?
-Are the extra floating devices needed?

Duwamish:
-How well can a plant community establish itself in the synthetic planting matrix?
-What about invasive species?
-How can this design be more aesthetically pleasing?
-How can ecological literacy be present in the design, since it will be highly visible by boaters?

Design 3: S.S. Wetland

Tyson Hiffman, Kaie Kuldkepp, George Lee,
Malda Takieddine, Alyse Wright
Design for Duwamish River Site

Concept



Design Goals:

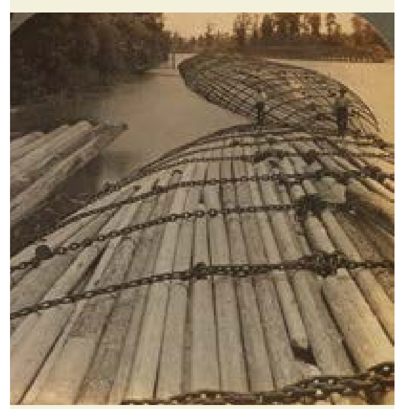
Habitat
Overhanging vegetation
Leaf litter
Native plants
Varying light and shade conditions
Maximized edges
Located to not disturb functional aquatic habitat

Water quality
Maximize biofilm conditions
Use of plants which uptake toxins

Culture
Reference historic timber rafts
Boat to become an icon
Partner with community organizations for upkeep and monitoring
Allow for public interaction

Sustainability
Use non-functional, recycled boat
Use plastic only when benefit outweighs concern; matrix for biofilm

The S.S. Wetland floating wetland design references the historic use of local waterways for timber transport. The design aims to increase aquatic habitat, improve water quality, and engage interaction in a sustainable and culturally iconic way.



Great chained log rafts on the Columbia River, WA

[Robert N. Dennis collection of stereoscopic views]

Timber Rafts: Past and Present

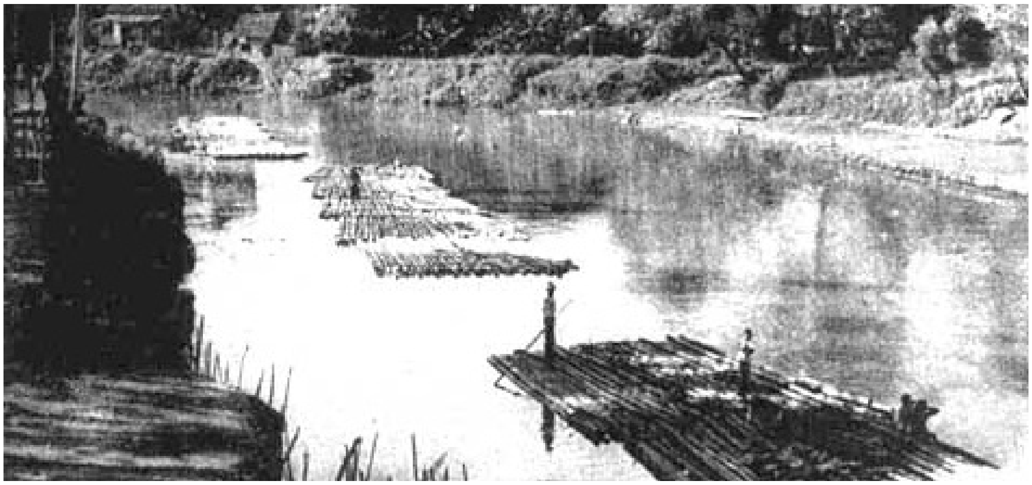
Modern Timber Raft

British Columbia
[flickr.com, Tony Higsett]

Historic Timber Rafts

Yeon & Pelton Raft at Rainier
[Rhinearson Slough Joe Corsiglia collection, www.vannattabros.com]

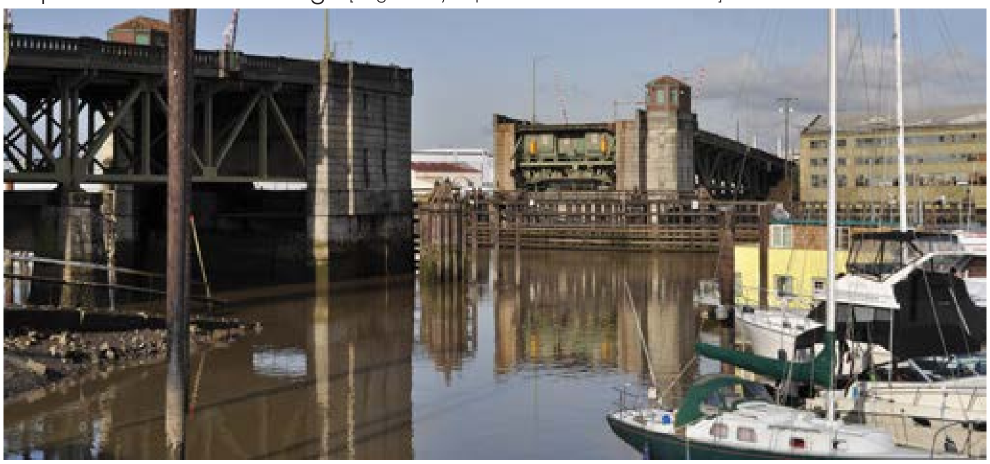
Benson Raft, San Diego Bay
[Maritime Museum of San Diego, www.sandiegoyesterday.com]

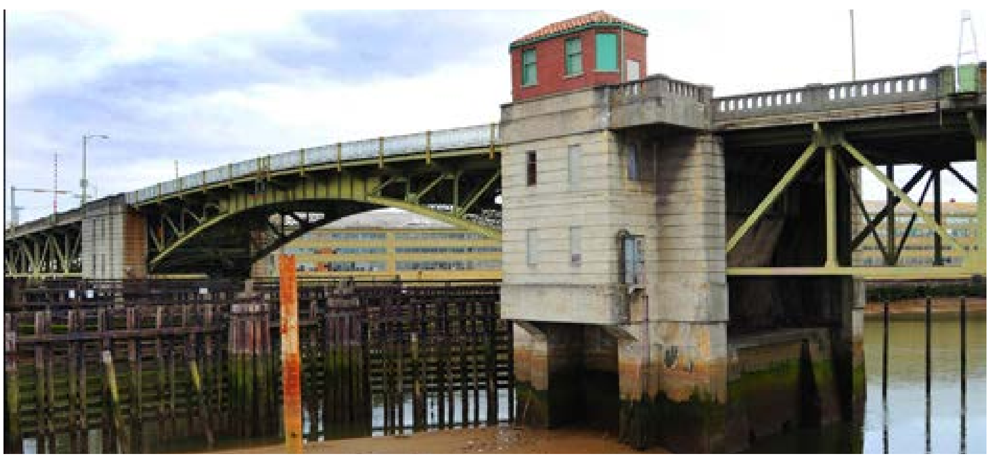


Bamboo rafts, Boliche River, Ecuador
[www.fao.org]

South Park Bridge Site, Duwamish River

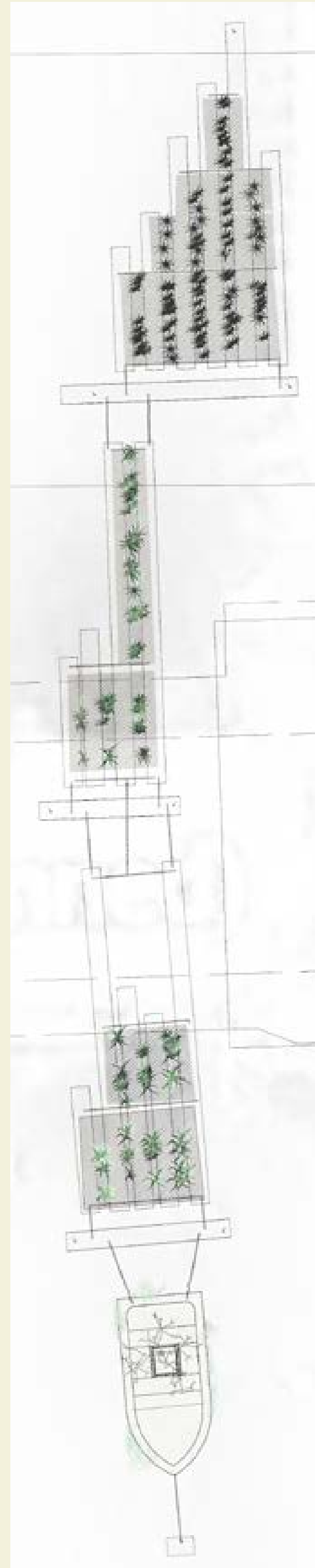
Proposed rennovated bridge [King County Dept. of Natural Resources + Parks]





Existing South Park Bridge Conditions

S.S. WETLAND



Plan of proposed S.S. Wetland

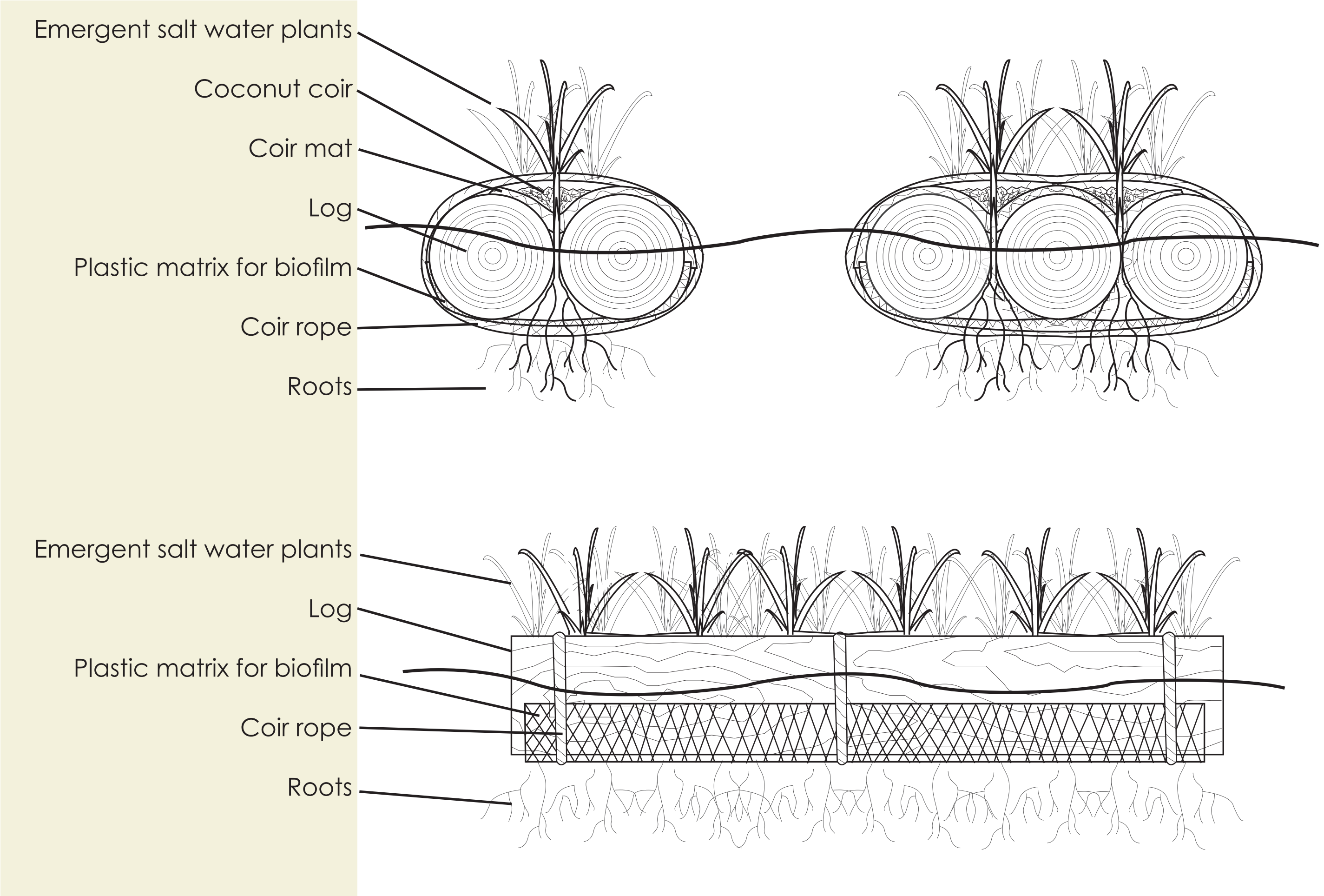
Proposed Installation

Context plan of how proposed S.S. Wetland Installation might fit into the site

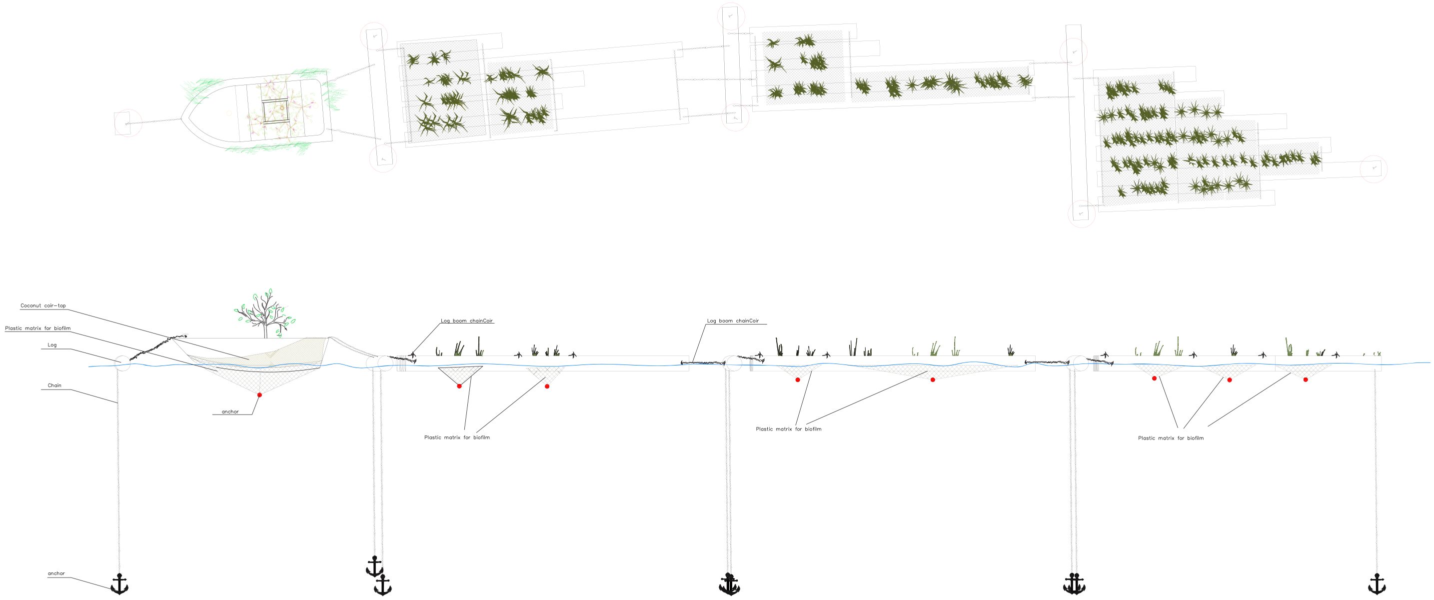
Photo rendering of proposed S.S. Wetland Installation

S.S. Wetland Details

Section Details



Detailed Plan and Section



Materials

BOAT

Free boat

TIMBER RAFT

Free logs

PLANT MEDIA

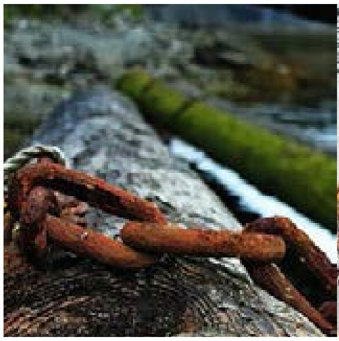
Coconut coir-top of logs, side of boat

Plastic matrix for biofilm under the boat and logs

Coconut coir - between logs

CONNECTORS

Chain to secure logs



Log boom chain

Log boom chain

Anchors to restrict movement

C-clamps

Coir rope

Reflecting questions on design elements:

Logs
How can they be transported?
How big will they be?
Will the bark fall off and create an undesireable condition in the water?

Fish
Will the fish behave as though the floating wetland is a nearshore habitat?
Will the structure create undesirable bass habitat?

Overall
What is the scale of the project?
How much shade will it produce?
How will people interact with it?
Who will maintain it?
How will it be deconstructed when the project is over?

Reviewer Suggestions:
Create a small scale version as an art installation, and apply for a public art grant
Use cameras to monitor the site and/or act as educational elements
Maintain 60% open area in the wetland

Floating Wetland Preliminary Prototype Testing

Matt MacDonald

Independent study of live staking feasibility

Test Site
6x6' concrete pond
14" deep
Vertical walls
Bottom debris
Shaded by vegetation
Mix of rainwater
and municipal water
Closed, circulating system
Aerated by small waterfall

Findings,
Ten Days into Test
No sprouts or roots yet.
Vertical test stakes in muck sprouted new growth, demonstrating viability of stakes used for these rafts.

Summary of Preliminary Prototype Testing:

Design Intent
Simple, inexpensive, easy to build.
Use one living material as structure, growth medium, and vegetation.
Living material will stay alive, not decay, nor be inert.
Structure may graft to itself and become a product with additional uses.

Design Strategy and Concept
A woven grid of floating live stakes.
Stakes will sprout shoots and roots, becoming a floating wetland.

Details and Specifications
Duration of experiment (to date): 10 days
May 25 to June 3, 2013.

Three small rafts, each made from a single species:
red osier dogwood *Cornus sericea*
black cottonwood *Populus balsamifera ssp. trichocarpa*
willow *Salix sp.*

Avg. stake diameter: 1/2".
Avg. stake length: 2'.

Live stakes cut, stripped, wrapped, transported, woven into rafts and deployed within two hours of harvest. Plastic bottles used as floats.

Top Two Hypotheses,
re: Sprout Deterrence
Not enough air/air exchange for bark.
No direct sun.

Next Steps
Continue current raft monitoring.
Test new dome-shaped rafts in sunny location.
Test larger emergent design.

Vertical "Test Stake", sprouting
[Matt MacDonald]

Results by Species:

Red Osier Dogwood
Cornus sericea

Pliant, easy to weave

Medium flat weave

Still self-buoyant after ten days

Initial degree of rigidity and tension persists

Medium slime (biofilm?)

Do local populations grow tall enough for up-scaling the design?

Black Cottonwood
Populus balsamifera ssp. trichocarpa

Stiff, difficult to weave

Stubborn, knotty weave

Needed floats immediately

Initial degree of rigidity and tension persists

Negligible slime

Are larger stakes also as brittle?

Willow
Salix, sp.

Very pliant, easy to weave

Flattest weave

Self-buoyant for first four days, then needed floats

Lost most rigidity, woven structure beginning to fail

Most slime. Very slimy.

Would a dome shaped weave retain enough tension to stay intact without lashing?

Preliminary Plant List for Floating Wetlands

Janice Johnson, Wenny Tsai

All listed are obligate (OBL = >99% probability of being found in a wetland) unless otherwise noted (as in FACW=facultative wetter areas of wetland preferred; 67-99% probability of being found in a wetland.). OBL, FAC, UPL are US Fish and Wildlife Service hydrophyte ratings to assist in determining which plants are officially considered wetland-adapted species. All images were found with a Google image search of the scientific name.

Bold are the more promising prospects

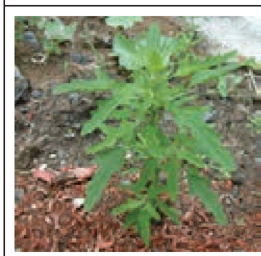
Image	Scientific Name	Common Name	Fresh-water	Salt-water	Associations	Information
	***Alisma plantago-aquatica***	Pondweed	●		*Alopecurus gericulatus, Carex, Scirpus,* and *Typha* sp.	**Emergent** plant; medicinal uses; edible
	*Aster subspicatus*	Douglas Aster	●	●	*C. utriculata, Juncus sp., Solidago Canadensis, Scirpus sp.*	**Upland** plant
	*Atriplex patula*	Saltweed		●		**Upland** plant; edible; phytoremediation potential
	*Azolla filiculoides*	Pacific Waterfern	●		Algae	**Floating** plant; phytoremediation ability; nitrogen-fixing ability
	*Azolla microphylla* Kaulf.	Mexican Mosquito Fern	●		Algae	**Floating** plant; phytoremediation ability; nitrogen-fixing ability

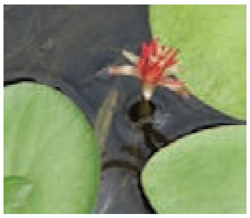
Image	Scientific Name	Common Name	Fresh-water	Salt-water	Associations	Information
	*Beckmannia syzigachne*	American Sloughgrass	●			**Emergent** plant; prefers sunny sites
	*Brasenia schreberi*	Watershield	●		*Potamogeton* species and *Typha sp.*	**Submerged** plant; wildlife value (food sources for water birds)
	***Carex lyngbyei***	Lyngby Sedge	●	●		**Emergent** plant; high wildlife value (birds, amphibians, small animals); phytoremediation potential
	*Carex obnupta*	Slough Sedge	●		Lysichiton sp.	**Emergent** plant; high wildlife value (birds, amphibians, small animals); phytoremediation potential
	*Carex vulpinoidea*	Fox Sedge	●			**Emergent** plant; high wildlife value (birds, amphibians, small animals); phytoremediation potential
	*Ceratophyllum demersum*	Coontail	●			**Submerged** plant; slow-moving water; no roots; wildlife value (food sources for water birds)
	*Cuscuta salina*	Salt-marsh Dodder		●		**Emergent** plant
	***Deschampsia cespitosa***	Tufted Hairgrass	●	●		**Upland** plant; high wildlife value; phytoremediation potential

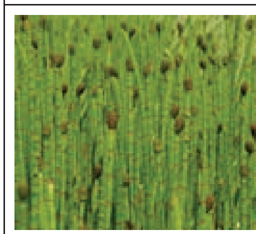
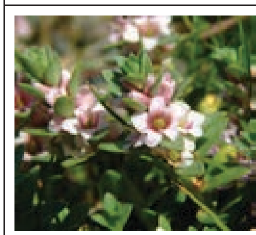
Image	Scientific Name	Common Name	Fresh-water	Salt-water	Associations	Information
	***Distichlis spicata***	Seashore Saltgrass		●		**Emergent** plant; phytoremediation potential
	***Dodecatheon pulchellum***	Few-flowered Shooting Star	●	●		**Emergent** plant; FAC, FACW; showy pink/purple flowers; wildlife value (insects)
	*Eleocharis acicularis*	Needle Spike Rush	●			**Emergent/Submerged** plant; moderate wildlife value
	*Equisetum fluviatile*	Water horsetail	●			**Emergent** plant
	***Glaux maritima***	Sea-milkwort		●		**Upland** plant; showy pink flowers
	*Glyceria borealis*	Northern Mannagrass	●			**Emergent** plant
	*Glyceria elata*	Tall Mannagrass	●			**Emergent** plant; FACW; prefers more open habitats; moderate wildlife value (food source for animals)

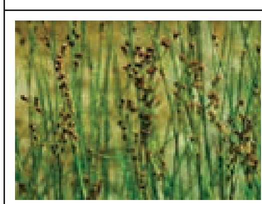
Image	Scientific Name	Common Name	Fresh-water	Salt-water	Associations	Information
	***Grindelia integrifolia***	Pudget Sound Gumweed	●	●		**Upland** plant; wildlife value (nectar for butterflies)
	***Jaumea carnosa***	Fleshy Jaumea	●	●	*Salicornia virginica* and *D. spicata*	**Upland** plant; rhizomatous; wildlife value (insects)
	***Juncus acuminatus***	Tapertip Rush	●		*Veronica sp., Calitriche sp., J. bufonius, Juncus effuses,* and *C. sp.*	**Emergent** plant
	***Juncus articulatus***	Jointed Rush	●	●		**Emergent** plant; may form discontinuous ground cover in saturated soils; rhizomatous.
	***Juncus bufonius***	Toad Rush	●	●		**Emergent** plant; can be weedy or invasive
	*Juncus effusus*	Common Rush		●	*Deschampsia, Distichlis,* and *Scirpus americanus*	**Emergent** plant; FACW
	*Juncus falcatus*	Sickleleaf rush	●			**Emergent** plant; FACW
	*Juncus gerardii*	Mudrush	●	●		**Emergent** plant; FACW

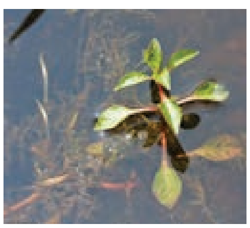
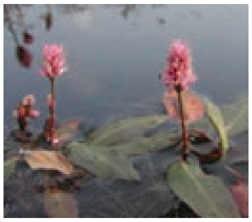
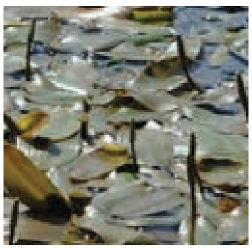
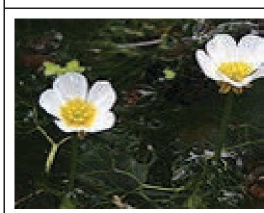
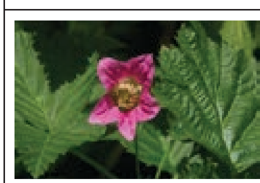
Image	Scientific Name	Common Name	Fresh-water	Salt-water	Associations	Information
	*Juncus nevadensis*	Sierra Rush	●			**Emergent** plant
	***Juncus supiniformis***	Spreading Rush	●	●		**Emergent** plant
	*Lilaeopsis occidentalis*	Western Lilaeopsis	●	●		**Emergent** plant; rhizomatous.
	*Ludwigia palustris*	Water Purslane	●		*Veronica sp., Epilobium ciliatum,* and *Lysichiton.*	**Submerged** plant; may not be native
	***Lupinus nootkatensis***	Nootka Lupine	●			**Upland** plant; showy purple flowers
	*Lycopus americanus*	American Bugleweed	●			**Emergent** plant; can be invasive or weedy
	*Lysichiton americanum*	Skunk Cabbage	●		*Thuja plicata, Alnus rubra, Acer circinatum, Athyrium filix-femina,* and *Oenanthe samentosa*	**Emergent** plant

Image	Scientific Name	Common Name	Fresh-water	Salt-water	Associations	Information
	*Mentha Arvensis*	Field Mint	●		*Juncus speices and Veronica species.*	**Upland** plant
	*Mimulus guttatus*	Common Monkeyflower	●			**Emergent** plant; showy yellow flowers
	*Myosotis laxa*	Small-flowered forget-me-not	●		*Oenanthe samentosa, Carex species,* and *Veronica americana.*	**Emergent** plant; tiny blue flowering head
	*Myrica gale*	Sweet Gale	●	●	*C. opnupta , C. aquatilis, S. douglasii,* and *Doughas spirea*	**Emergent** plant; usually symbiotic with a nitrogen-fixing bacterium.
	*Nuphar luteum*	Yellow Pond Lily	●		*Typha, Myriophyllum species, Utricularia species*	**Emergent** plant
	*Oenanthe sarmentosa*	Water Parsley	●		*Typha* and *Lysichiton*	**Upland** plant
	*Petasites frigidus*	Palmate Coltsfoot	●			**Upland** plant
	*Physocarpus capitatus*	Ninebark	●		*Cornus sericea* and *Rubus spectabilis*	**Upland** plant; tolerant of water table fluctuations.

Image	Scientific Name	Common Name	Fresh-water	Salt-water	Associations	Information
	***Plantago maritima***	Sea Plantain	●	●	*Salicornia, Jaumea*, and *Distichis*	**Upland** plant; indigenous cultivar or food plant
	*Polygonum amphibium*	Water Lady's Thumb	●			**Emergent** plant; rhizomatous; can be weedy or invasive; showy pink flowers
	*Potamogeton natans*	Floating Leaf Pondweed	●		*Myriophyllum*, and *Callitriche*	**Emergent** plant
	***Potamogeton amplifolius***	Largeleaf Pondweed	●			**Submerged** plant; can clean freshwater up to 6 meters deep
	***Potentilla anserina***	Pacific Silverweed	●	●	*Deschampsia caespitosa* and *C. lynbyei*	**Upland** plant; indigenous cultivar or food plant
	*Potentilla palustris*	Marsh Cinquefoil	●			**Emergent** plant; showy pink flowers
	*Ranunculus aquatilis*	White Water Buttercup	●			**Submerged** plant; showy white flower
	*Rubus spectabilis*	Salmonberry	●			**Upland** plant; FACW, FAC+

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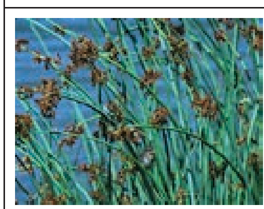
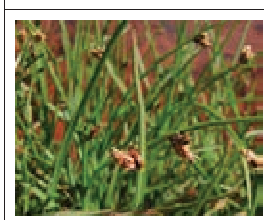
	***Rumex maritimus***	Seaside/ Golden Dock	●	●		Upland plant
	*Ruppia maritima*	Wigeon/Ditch Grass	●	●	*Zostia* and *S. americanis*	Submerged plant; tolerates sudden and large fluctuations in salinity concentrations; Wildlife food value per at least one source
	*Sagina maxima*	Coastal Pearl Wort		●		Upland plant; FAC, FACW.
	*Sagittaria latifolia*	Wapato		●		**Emergent** plant; indigenous cultivar or food plant
	***Salicornia virginica***	Pickleweed	●	●	*Distichis, Triglochin,* and *Jaumea*	**Emergent** plant
	*Sambucus racemosa*	Red Elderberry	●		*Lady fern* and *cattail*	Upland plant
	*Scirpus acutus*	Hardstem Bulrush	●	●		**Emergent** plant; favors mud substrates & water up to 1 m deep; can be weedy or invasive
	***Scirpus americanus***	Three-square Bulrush	●	●		**Emergent** plant; good soil stabilizer and stable substructure for native habitat; wildlife food value per at least one source

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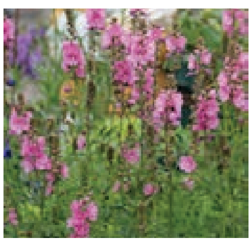
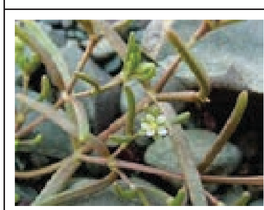
	***Scirpus maritimus***	Seacoast Bulrush		●	*Potentilla anserine* and *C. lyngbyei*	**Emergent** plant
	*Scirpus subterminalis*	Subterminate Bulrush	●			**Submerged** plant
	***Scirpus tabernaemontani***	Softstem Bulrush	●	●		**Emergent** plant
	*Sidalcea hendersonii*	Henderson's Checker-mallow	●	●		**Upland** plant; showy flowers
	*Sparganium emersum*	Narrow-leaf Burweed	●			**Emergent** plant; prefers silt and much substrate.
	*Sparganium eurycarpum*	Giant Burweed	●			**Emergent** plant; prefers clay-rich, mineral soils.
	***Spergularia canadensis***	Canadian Sandspurry	●	●	*Atriplex*, *Salicornia*, and *Jaumea*.	**Upland** plant
	*Spergularia macrotheca*	Beach Sand Spurry	●	●		**Upland** plant

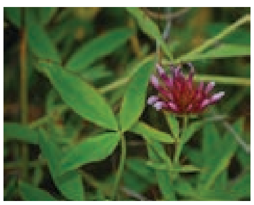
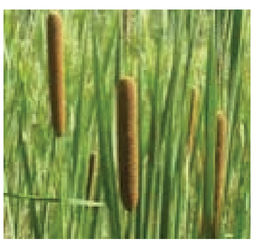
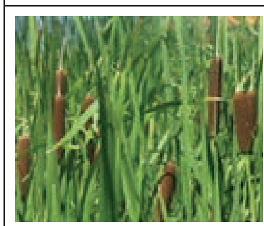
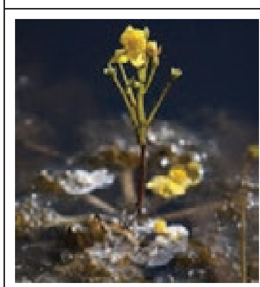
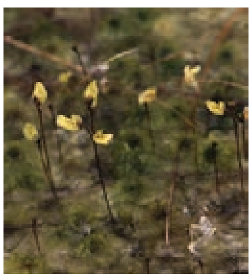
Image	Scientific Name	Common Name	Fresh-water	Salt-water	Associations	Information
	*Stellaria calycantha*	Saltmarsh Starwort		●		**Upland** plant; FACW
	***Stellaria humifusa***	Saltmarsh Chickweed/ Starwort	●	●	*Agrostis, Potentilla*, and *Deschampsia*	**Upland** plant
	*Triglochin maritimum*	Seaside Arrowgrass	●	●	*Salicornia, Jaumea*, and *C. lyngbyei*	**Upland** plant
	***Trifolium wormskjoldii***	Springbank Clover	●	●	*Potentilla anserine*	**Upland** plant
	*Typha angustifolia*	Narrow-leaf Cattail	●		*T. latifolia*	**Emergent** plant; water cleaning ability
	*Typha latifolia*	Common Cattail	●			**Emergent** plant; water cleaning ability
	*Utricularia gibba L.*	Humped Bladderwort	●			**Floating** plant
	*Utricularia inflata* Walter	Swollen Bladderwort	●			**Floating** plant

Image	Scientific Name	Common Name	Fresh-water	Salt-water	Associations	Information
	*Utricularia intermedia Hayne*	Flatleaf Bladderwort	●			**Floating** plant
	*Utricularia macrorhiza Leconte*	Common Bladderwort	●			**Floating** plant
	*Utricularia minor L.*	Lesser Bladderwort	●			**Floating** plant
	*Veronica americana*	American Brooklime	●		*Oenanthe, Juncus,* and *Carex*	**Emergent** plant; showy flowers
	***Veronica anagallis-aquatica***	Water Veronica	●		*Oenanthe, Juncus,* and *Carex*	**Emergent** plant; showy flowers
	*Veronica scutellata*	Marsh Speedwell	●		*Oenanthe, Juncus,* and *Carex*	**Emergent** plant; showy flowers

more information available at
http://greenfutures.washington.edu/