



Monitoring the Impacts of the UW Green Wall and Water Harvesting

em from the UW Green Futures Research and Design Lab

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Background



The Green Wall





Interdisciplinary Cross Campus Collaboration and Education

38 students, 8+ disciplines

65+ faculty and staff across departments

Local contractor

Outdoor classroom for 8+ different courses and numerous professional tours

Widely publicized including American Airlines Magazine, Green Magazine in Taiwan, NRDC Blog

Outdoor Classroom



what we are researching

Flora - plant growth, death, maintenance

Fauna - bird and insects, habitat, urban impacts

Water - water use, water recycling, irrigation

Temperature – urban heat island effect, building performance



Green Seed Timeline

Flora -(June 2012) – September 2015

Fauna - June 2014 – July 2015

Water - August 2014 – September 2015

Temperature – August 2014 – September 2015

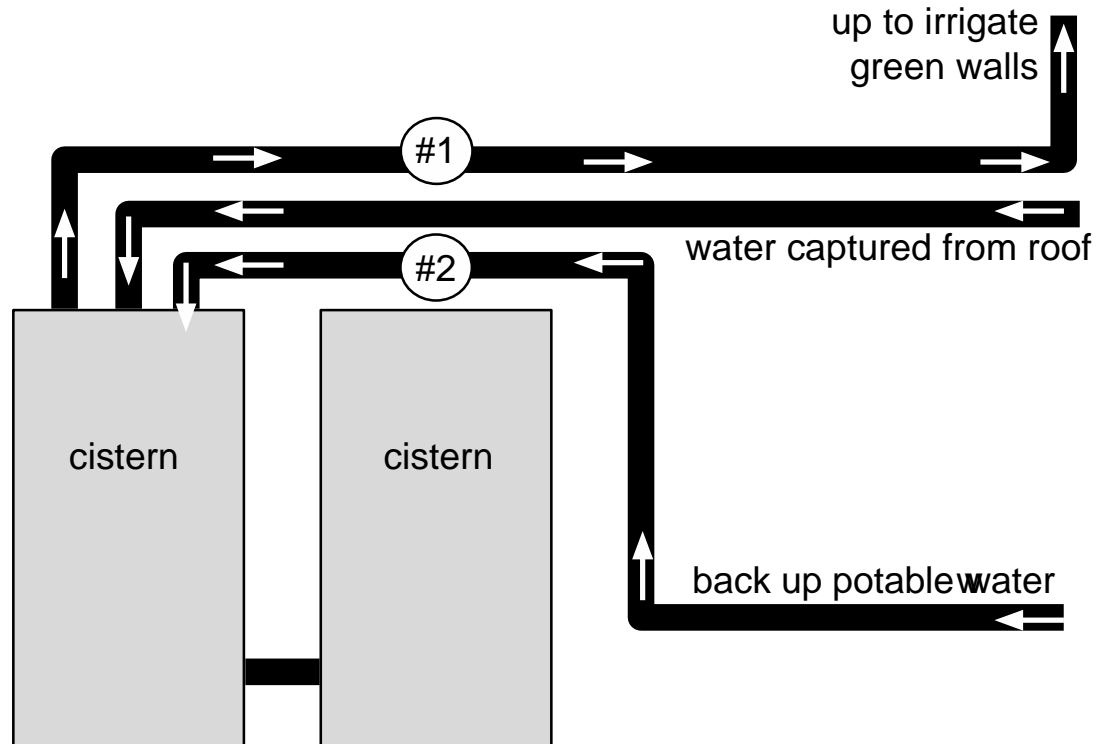
Data Analysis - September 2015 – June 2016

Dissemination:

- On Sustainability Conference Jan 24, 2016 in Portland OR
- Washington Society of Landscape Architects Conference April 1 2016 in Lynnwood WA
- Journal of Living Architecture Article, Submitted February 2016
- 1-2 more journal articles in progress

Water

water use, water recycling, irrigation



#1: upper flo sensor , measures amount green walls are being irrigated
#2: lower flo sensor , measures amount of potable back up water used
(to determine quantity of recycled roof water, subtract #1 from #2)

Water

Date	Sensor PFS0455 (total gallons water used in green wall by month)	Average gal/day used by month	Total Monthly Rainfall	+/- Normal	Average Temp	+/- Normal
February 2014	381.5	5.7	6.11	+2.61	41.7	-1.7
March 2014	473.6	15.3	9.44	+5.72	48.5	+2.0
April 2014	536.1	17.9	4.18	+1.47	52.0	+1.7
May 2014	670.8	21.6	3.15	+1.21	59.1	+3.1
June 2014	464.4	13.3	0.73	-0.84	62.0	+1.1
July 2014	207	7.0	0.77	+0.07	69.2	+3.5
August 2014	233.5	7.8	1.81	+0.93	69.1	+3.0
September 2014	158.9	5.4	2.23	+0.73	64.8	+3.5
October 2014	360	2.1	6.75	+3.27	58.0	+5.2
November 2014	425.4	2.6	4.84	-1.73	46.0	+0.6
December 2014	88	2.9	4.79	-0.56	45.3	+4.8
January 2015	508.3	16.4	3.66	-1.91		
February 2015	816.6	30.3	5.27	+1.77		
March 2015	819.1	27.4	4.47	+0.75		
April 2015	1014.3	34.9	2.03	-0.68		
May 2015	888.6	30.7	0.58	-1.36		
June 2015	828.7	28.4	0.23	-1.34		
July 2015	1829.1	60.3	0.09	-0.61		
August 2015	935.3	32.0	3.28	+2.40		
September 2015	618.9	21.6	0.83	-0.67		
(20 months)	12,258.1	19.2				

How much
water do green
walls use?

Water

Can green walls be designed to recycle runoff?
 How often does back-up potable water need to be used?

Date	Sensor PFS0455 (total gallons of water used in green wall by month)	Average gal/day used by month	Sensor PFS0465 (total gallons of backup potable water entering cisterns by month)	Average gal/day of backup potable water by month	Total gallons of recycled water used by month	Total Monthly Rainfall	+/- Normal	Average Temp	+/- Normal
February 2014	381.5	5.7	0	0.0	381.5	6.11	+2.61	41.7	-1.7
March 2014	473.6	15.3	0	0.0	473.6	9.44	+5.72	48.5	+2.0
April 2014	536.1	17.9	0	0.0	536.1	4.18	+1.47	52.0	+1.7
May 2014	670.8	21.6	0	0.0	670.8	3.15	+1.21	59.1	+3.1
June 2014	464.4	13.3	0	0.0	464.4	0.73	-0.84	62.0	+1.1
July 2014	207	7.0	0	0.0	207	0.77	+0.07	69.2	+3.5
August 2014	233.5	7.8	25.6	0.8	207.9	1.81	+0.93	69.1	+3.0
September 2014	158.9	5.4	0	0.0	158.9	2.23	+0.73	64.8	+3.5
October 2014	360	2.1	0	0.0	360	6.75	+3.27	58.0	+5.2
November 2014	425.4	2.6	0	0.0	425.4	4.84	-1.73	46.0	+0.6
December 2014	88	2.9	0	0.0	88	4.79	-0.56	45.3	+4.8
January 2015	508.3	16.4	0	0.0	508.3	3.66	-1.91		
February 2015	816.6	30.3	0	0.0	816.6	5.27	+1.77		
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April 2015	1014.3	34.9	0	0.0	1014.3	2.03	-0.68		
May 2015	888.6	30.7	0	0.0	888.6	0.58	-1.36		
June 2015	828.7	28.4	1334.2	44.5	-505.5	0.23	-1.34		
July 2015	1829.1	60.3	1837.1	59.3	-8	0.09	-0.61		
August 2015	935.3	32.0	731.6	23.6	203.7	3.28	+2.40		
September 2015	618.9	21.6	0	0.0	618.9	0.83	-0.67		
(20 months)	12,258.1	19.2	3,928.5	6.4	8,329.6				

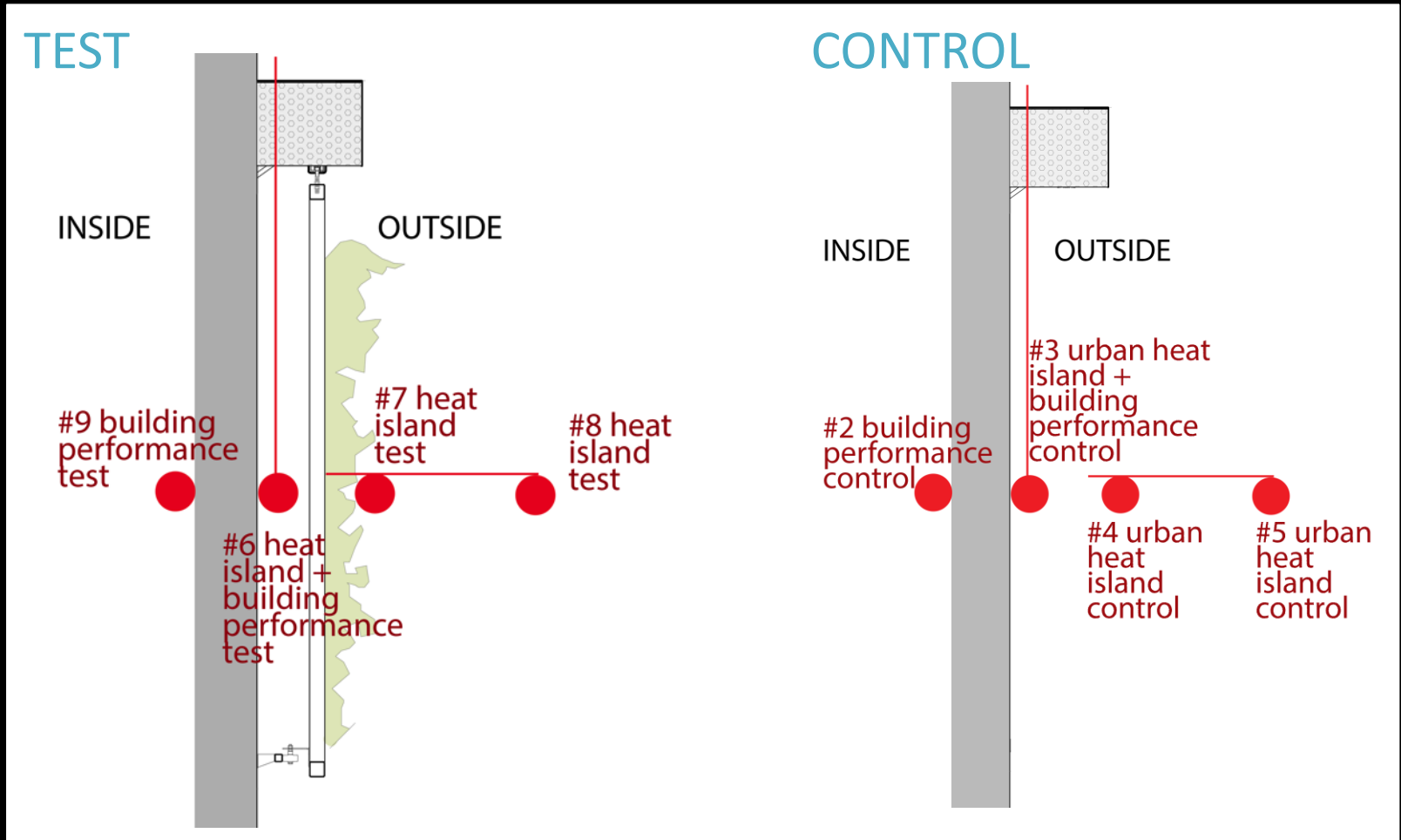
Water



What are the irrigation challenges and opportunities with watering green walls?

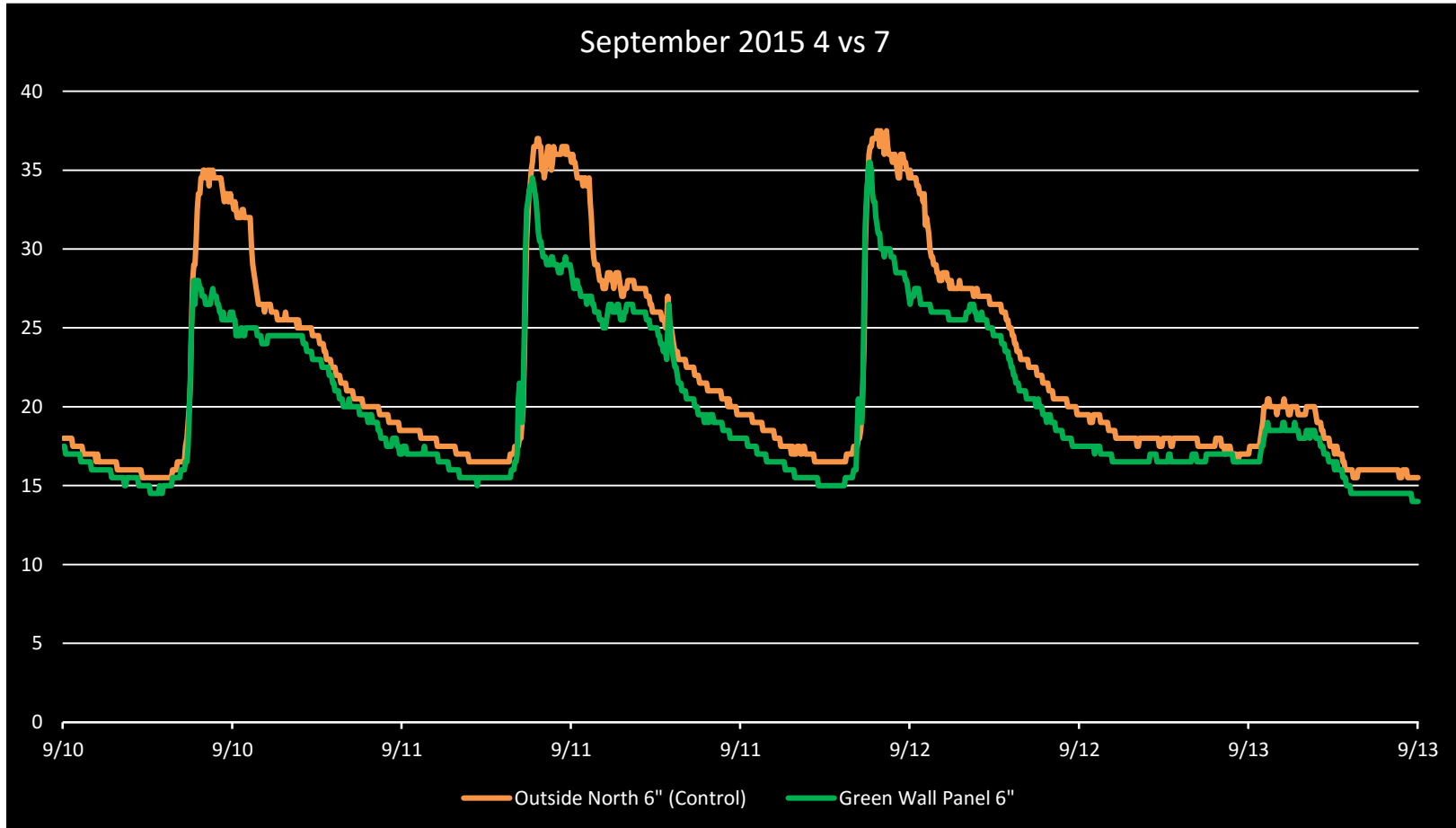
Temperature

urban heat island effect, building performance



Temperature

What are the potentials for green walls to address the urban heat island effect?

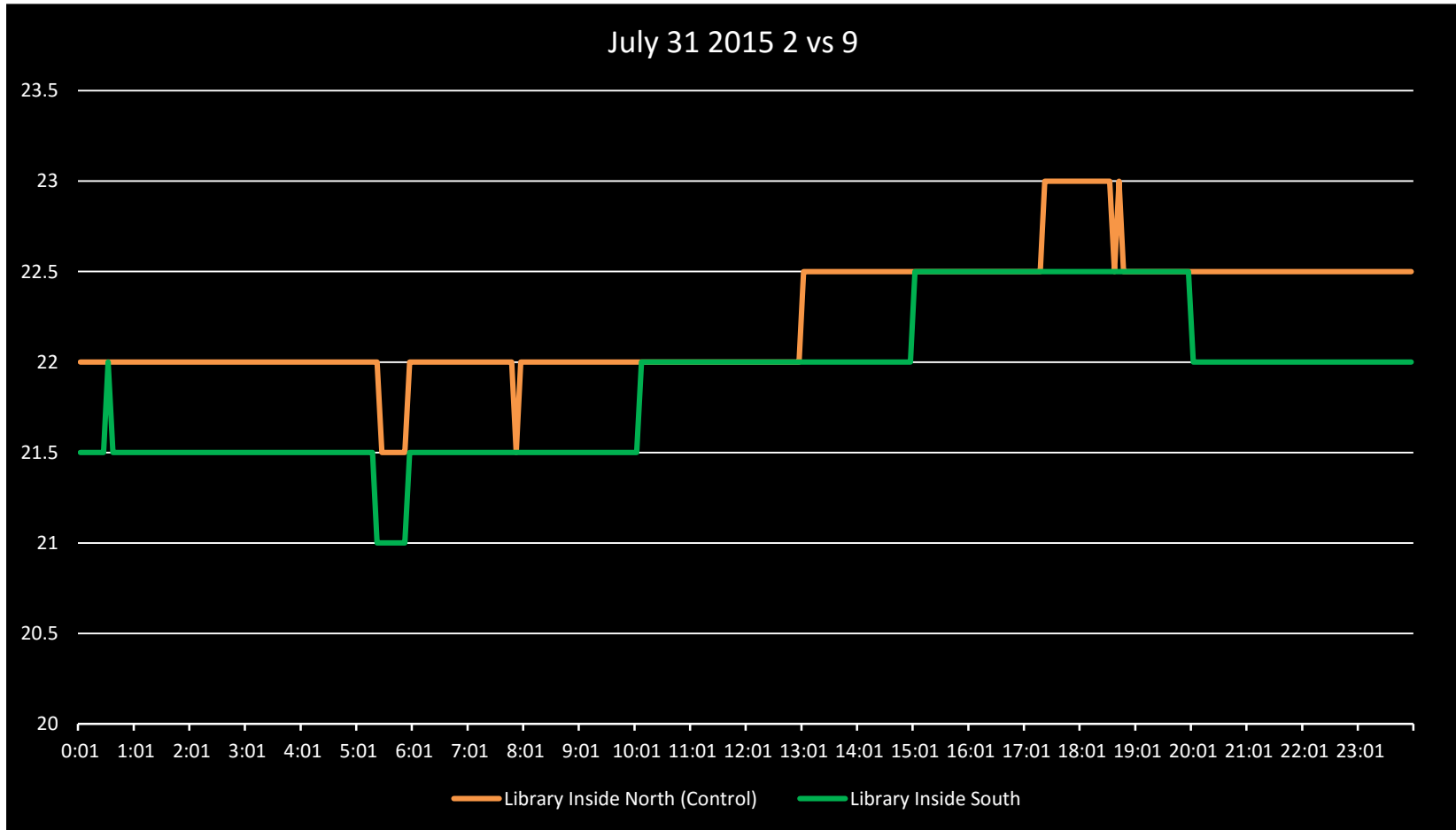


Vegetation can provide up to 8°C of shade

Temperature behind wall up to 17°C less than in full sun on hot summer days

Temperature

What are the potentials for green walls to increase building performance?



Consistent 0.5 degrees C difference (0.9 degrees F)

Fauna

bird and insects, habitat, urban impacts



Birds + Insects

of Shifts / Hours of Documentation: 765

of Birds + Insects Documented: 2,410

Shifts with “no activity”: *197, or 25.75%*

Adjusted Avg # of Birds+ Insects / Shift: 4.24

Birds + Insects “interested in wall”: *1,466 or 66%*

Birds

Total # of birds documented: 1,137

Total # of birds “interested in the wall” : 568

of bird species documented: 20

Most common interacting with wall (#, % of encounters)

Large Birds:

American Crow (20, 4%)
American Robin (26, 5%)
Stellar's Jay (5, 1%)
Northern Flicker (5, 1%)
Sea Gull

Small Birds:

Anna's Hummingbird (100, 18%)	House Finch (6, 1%)
Ruby Throated Hummingbird (1, <1%)	House Sparrow (2, <1%)
Black Capped Chickadee (79, 14%)	Purple Martin
Dark-Eyed Junco (318, 56%)	Song Sparrow
Barn Swallow	Spotted Towhee
Bewick's Wren (2, <1%)	Swallow
Bushtit (2, <1%)	White Breasted Nuthatch
	Unidentified Bird (2, <1%)

Birds



Insects

Total # of insects documented: 1,068

Total # of insects “interested in the wall” : 899

Groupings of insects documented:

Bee (32, 4%)	Butterfly (9, 1%)	Gnat (293, 33%)
Bee / Wasp (23, 3%)	Moth (34, 4%)	Ladybug (2, <1%)
Bumble Bee (30, 3%)	Dragonfly (12, 1%)	Mosquito (1, <1%)
Honey Bee (136, 15%)	Fly (197, 22%)	Spider (35, 4%)
Wasp (90, 10%)	House Fly (5, 1%)	

Insects



Birds

of nests laid (2 seasons): estimated 4-7

of nests that formed eggs (2 seasons): 2-3

of successful broods (1 season): 2 (est.)













Birds, Insects + Vegetation Symbiosis



Green Walls: catalyzing + perpetuating mutually beneficial life support systems for urban wildlife



Plants
Insects
Birds

Elements (e.g. wind, sun etc.)

Pollination Pathways?



Fun Facts

11% of bird activity was interactions back and forth from yews below



65% of bird activity + 94% of insect activity was interaction with plants

23% of bird activity was with water infrastructure elements



12% of documented bird activity was with perching spots

Flora

plant growth, death, maintenance

Plants



of plants: 500 - 528

of plant species: 22 – 24

% plants native: 61 – 66%

-as low as 38% lower wall

-up to 86% upper wall

% of species native: 50 – 59%

-as low as 29% lower wall

-up to 73% upper wall

Plants

Native Plants:

Kinnickinick
Spleenwort
Wild Ginger
Lady Fern
Creeping Oregon Grape
Deer Fern
Bunchberry Dogwood
Slough Sedge

Non-Native Plants:

Painted Fern
Alpine Water Fern
Beetlemania Sedge
Orange New Zealand Sedge
Autumn Fern
Epimedium/ Fairy Wings
Purple Coral Bells
Peppermint Coral Bells

Salal
Pacific Coast Iris
Redwood Sorrell
Licorice Fern
Sword Fern
Alaskan Fern
Oregon Stonecrop
Evergreen Blueberry

Sweet Tea Foamy Bells
Big Blue Lily Turf
Lemon Beauty Honeysuckle
Silver Beauty Honeysuckle
Green Mondo Grass
Black Mondo Grass
Tassel Fern
Takesimense Stonecrop
London Pride Saxifrage

Volunteer Plants:

Canadian Dogwood
(Bunchberry)
Piggyback Plant
Miner's Lettuce
Lady Fern



Plants



Green Wall Plant Death Documentation

Plant Name	Originally Planted 7/13/12	Plant as of 5/2/2013	% Species Death	Replants Update	Plant Aesthetic as of 11/11/2014	% Species Death Removal	Replants Update	Plant as of 1/19/2015	% Species Death
asplenium trichomanes <small>(spleenwort)</small>	5		0%	5		0%	5		0%
asarum latidatum <small>(wild ginger)</small>	13	3	23%	13	13	100%	0		
athyrium filix-femina 'lady in red' <small>(lady fern)</small>	8		0%	8	4	50%	7	7	100%
athyrium niponicum <small>(painted fern)</small>							9	9	100%
berberis repens <small>(creeping Oregon grape)</small>	18		0%	18	2	11%	31	2	6%
blechnum penna-marina <small>(alpine water fern)</small>							24	16	67%
blechnum spicant <small>(deer fern)</small>	44	17	39%	44	42	95%	4	3	75%
carex taryophyllea 'the beetles' <small>(beetle mania sedge)</small>	17	17	100%	0		N/A	0		
cornus canadensis <small>(bunchberry dogwood)</small>							14	6	43%
carex obnupta <small>(slough sedge)</small>	13	14	108%	13	11	85%	2		0%
carex testacea <small>(orange beak sedge)</small>	53	30	57%	53	36	68%	17	12	71%
dropteris erythrosora <small>(autumn fern)</small>	27		0%	27	3	11%	37	8	22%
Epimedium evergreen var. <small>(fairy wings)</small>							8	2	25%
gaultheria shallon <small>(salal)</small>	19	1	5%	19	1	5%	31	18	58%
heuchera micrantha 'purple' <small>(purple coral bells)</small>	19	1	5%	19	19	100%	0		
heucherella sweet sea <small>(sweet sea foam bells)</small>	15	9	60%	16	6	38%	17	17	100%
iris meadows pastel <small>(pacific coast iris)</small>							35	6	17%
liriope muscari 'big blue' <small>(big blue hyacinth)</small>	13		0%	13	13	100%	0		
lonicera tida 'lemon beauty' <small>(lemon beauty honeysuckle)</small>							18	12	67%
lonicera tida 'silver beauty' <small>(silver beauty honeysuckle)</small>							18	7	39%
ophiopogon japonicus <small>(green mondo grass)</small>	0		N/A	18	16	89%	2		0%
ophiopogon planiscapus 'nigrescens' <small>(black mondo grass)</small>	37	1	3%	36	36	100%	0		
oxalis regana <small>(redwood sorrell)</small>	15		0%	15	15	100%	0		
polypodium vulgare <small>(licorice fern)</small>	5		0%	5	3	60%	4		0%
polystichum unitum <small>(sword fern)</small>	117	2	2%	117	7	6%	123	50	41%
polystichum polyblepharum <small>(tassel fern)</small>	18		0%	18	2	11%	25	2	8%
polystichum setiferum 'P. angulare' <small>(alaskan fern)</small>	27		0%	27	14	52%	15	8	53%
sedum reganum <small>(oregon stonecrop)</small>	27	5	19%	26	26	100%	0		
sedum lakesimense <small>(non-native stonecrop)</small>	8		0%	8	6	75%	2	2	100%
saxifraga auribum 'london pride' <small>(london pride saxifrage)</small>							22	4	18%
vaccinium ovatum <small>(evergreen huckleberry)</small>	10		0%	10	4	40%	29	11	38%
TOTALS	528	100		528	279		499	202	
overall % dieback		19%			53%			40%	

Highest Performing Plants:

Spleenwort

Oregon Grape

Salal

Sword Fern

Tassel Fern

Saxifrage

Evergreen Blueberry

Licorice Fern

Iris Species

Poor Performing Plants:

Painted Fern

Lady Fern

Blechnum Species

Carex Testacea + Obnupta *

Heuchera Species

Aslaskan Fern

Sedums

Black and Green Mondo Grasses

Redwood Sorrell



Thoughts and Tidbits

Infrastructure as habitat

Nesting source and destination

Maintenance schedule vs. habitat schedule

Green technologies as people attractors

Researcher experiences and education

Sustainability IS maintenance



Monitoring the Impacts of the UW Green Wall and Water Harvesting

em from the UW Green Futures Research and Design Lab

Many Thanks!!

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Futures Research + Design Lab
of Built Environments
a Systems

Ashley Powell
Amos Chan
Matt MacDonald
Evan Henrich
29 volunteer researchers

Co-PI's:
Nancy Rottle
Leann Andrews