

KELP RECOVERY WORKSHOP 2

June 8, 2018

NOAA Sand Point

In person attendees:

Jamey Selleck (NOAA)
Max Calloway (Evergreen College, PSRF)
Brian Allen (PSRF)
Joe Burcar (Ecology)
Katie Conroy (NOAA Intern)
Lucas Hart (NW Straits)
Sasha Horst (NW Straits)
Stephen Schreck (PSRF)
Austin Rose (Whatcom MRC)
David Williams (Freelance Writer)
Bob Pacunski (WDFW)
Kalloway Page (NRC)
Bill Heath (Project Watershed BC)
Dan Tonnes (NOAA)
Tom Doerge (Snohomish MRC)
Emily Bishop (Port Gamble S'Klallam Tribe)
Linda Rhodes (Island MRC)
Lynne Barre (NOAA)
Kelly Andrews (NOAA)
Jhanek Szypulski (Central WA U, PNP Treaty)
Linda Rhodes (NOAA, Island MRC)
Genoa Sullaway (NOAA)
Emily Chui (NOAA Intern)

WebEx Attendees (continued on next page):

Anne Toledo (Island MRC)
Karin Roemers-Kleven (San Juan MRC)
Tom Mumford (Marine Agronomics)
Helen Berry (WDNR)
Katy Davis (UBC)
Nicole Naar (UC Davis, former NOAA intern)
Steve Copps (NOAA)
Courtney Greiner (Swinomish Tribe)
Byron Rot (San Juan MRC)
Victoria Knorr (Recovery Plan Volunteer)
Suzanne Shull (Padilla Bay NERR)
Braeden Schiltroth (Simon Fraser U)
Sherryl Bisgrove (Simon Fraser U)

WebEx Attendees (continued):

Paul Chittaro (NWFSC)
Sarah Schroeder (U Vic)
Helle Andersen (Clallam MRC)
Elizabeth Gaar (NOAA)
Elisa Dawson (Snohomish MRC)
Jamie Kilgo (DNR)
Phyllis Bravinder (Skagit MRC)
Solenne Walker (DNR)
Paul McCollum (Port Gamble S'Kallam)
Caitlin O'Brien (WWU)
Elizabeth Babcock (NOAA)
Sebastien Clos-Versailles (UW)

Link to WebEx Recording:

[Play recording](#)

Links to presentation slides:

Lucas Hart intro

Rockfish Recovery Plan – Finalized in Oct 2017

- Provides a framework for kelp recovery as important habitat
- Agenda, presentations, scope and plan
- Framework to discuss Data gaps

Background and intro of kelp recovery plan

- Core team formed in October 2017
- Literature review started in October 2017 (Max Calloway as primary author)
- First workshop in March – stressors, trends, and data gaps
- Draft literature review and data gaps to be completed in September 2018
- Year 2 – review and finalize the plan in September 2019

Geographic boundaries

- PSERNP watershed boundaries
- Georgia Basin referenced where appropriate
- Plan organized around a Drivers – Stressors – Controlling Factors – Impacts (DSCr) model
- Response – Research needs, regulatory, management

Max Calloway Presentation

Kelp Ecosystem Connections

- Trophic and ecosystem support for higher fish species
- Objective is to demonstrate importance to Salish Sea ecosystems

Seagrass Meadows Support Global Fisheries Production

- Trends – nursery, stock fisheries, trophic subsidies, biodiversity

Direct Grazing

- Not the most common
- Examples include urchins, kelp crab, Littorina snails (*Lacuna vincta*)

Detrital pathways

- Blades erode to provide POC and DOC (particulate and detrital organic carbon)
- Provide 17-100% of annual NPP
- Dislodgement from rafts, up to 43% of annual NPP
- Australia PSA include importance of Beach Wrack to shorelines and trophic interactions

Stable Isotope Analysis

- Nitrogen and carbon
- Used to examine trophic use of kelp
- Clear differences between terrestrial and marine systems
- Examining differences between plankton and kelp as sources of carbon
- 35-45% of diet for higher level trophic finfish comes from kelp
 - Attaching a dollar value, using WDFW economic data
 - Rough estimates for net economic value for salmon could be as high as \$3 mil/yr
- There are some limitations to isotope analysis
- Historical analysis found differences in carbon contributions before and after European presence, as a consequence of removing otters

Foundation Cascades

- Structural benefits
 - Nursery functions, food subsidies
- Structural Diversity is also important
 - Larger kelp = increased faunal abundance
 - Increased blade complexity = increased invert biodiversity
 - Canopy kelp has a greater effect than artificial structures
 - Studies in Norway and Alaska found relationships between inverts and kelp
- Ecosystem engineer –
 - Shade – limits light availability, many invert exhibit negative phototaxy
 - Water Motion – reduces flow
 - Scouring – reduced sediment accumulation

Fish

- Kelp as nursery, fishery, and hunting grounds
- Kelp provides habitat
- Provide refuge
 - Donelan et al 2017, Ecology – examined refuge quality
 - Reduce predation, improved tissue growth rate
 - O'Brien et al 2018, J of Exp Mar Bio and Eco – turf habitats had reduced refuge and foraging
- Forage fish
 - Spawning, planktonic food sources
- Rockfish
 - Most abundant species in kelp habitats, nursery
 - Detrital transport also important to deep sea habitats, and to adult rockfish
- Salmon
 - Research on diets of juvenile salmon in Puget Sound
 - Importance of terrestrial insects related to fresh water inputs
 - In areas with shoreline armoring, salmon rely more on marine inverts

- Isotopic studies found chinook and coho rely more on marine inverts than other salmon species (which rely more on pelagic)
- Some evidence that salmon also use kelp as refuge, particular for smolt outmigration, and juvenile salmon are attracted to overwater structures

Strengthening connections in Puget Sound

- Diet studies
- Monitoring and field surveys methods

Questions:

Tonnes – kelp importance to salmon

Allen – disconnect between diet studies and habitat use for salmon

- literature on fish assemblages in kelp
- need for plankton tows with kelp surveys

Rhodes – no other chemical tracers, other than stable isotope

Mumford – suggest examining recreational, commercial, and tribal fishers

- fishing popular around kelp beds

Allen – shift from canopy to turf kelps may reduce invert diversity

Hart – what is the difference between richness, abundance, and diversity

Mumford – eelgrass role

Burcar – climate change and seasonal impacts to kelp

- discussed as first workshop, temp (17 C threshold), salinity, etc

Katie Davis – methods for characterizing kelp assemblages

- eDNA as a new tool to identify fish species use

Allen – what macroalgal habitat structures are important to rockfish?

- Pacunski – most WDFW work has focused on adult fish, but YOY found on a variety of algal structures
- Andrews – some seagrass work with kelp too, and varies greatly between species
 - Ex yelloweye settle on rock, and not as much in kelp
- Pacunski – scuba surveys, drift mats, kelp mats, mostly nearshore common species
 - Again varies greatly on species, and ROV surveys has identified previously assumed rare species, and capturing more of real diversity in Puget Sound

Bill Heath Presentation

Bull Kelp Restoration in the Straits of Georgia, and northern Salish Sea

- Collaborative project with Project Watershed Society, Nile Creek Enhancement Society, and Simon Fraser U (and also U Vic and U Wisconsin)

Bull kelp forests are a key nearshore habitat

- Important to salmon highway
- Beds in serious decline, as a result of a combination of factors

- Research and action objectives include growth and survival, restoration efforts, and stress resiliency

Bull kelp life history

- Adult sporophyte stage is focus of studies, but current work on gametophyte to identify conditions for suitable growth of susceptible stages
- Trophic cascade interactions

Survey sites

- Maude Reef and Denman Island near Hornby Island
- Cape Lazo Shoal, was a natural bed until around 2008

Experimental design

- Attachment of seeded spool lines onto a concrete anchor
- Examining feasibility of culturing kelp
- Hobo data loggers for temperature and light, since 2012, data downloaded every two months
- Sori production started in May, and can continue till October during cooler years
- 17 C agreed as a critical threshold for kelp

Temperature effects

- Sori start in May, but may stop in June during warmer years (2015)
- Sporophyte tolerance to 18 C for 30-35 days
- Spore revival can occur with lower temps
- Spore germination reduced at 17 C, and terminate at 20 C
- Dieck 1993 found Gametophyte upper range to 23 C for 2 weeks

Next steps

- Funding from Costal Restoration Fund
- Mapping of historical and current bull kelp distribution
- Sea urchin exclusion and relocation studies
- Seeding of bull kelp and *Saccharina latissimi* in exclusion and long-line
- Continued monitoring

Can long-line cultivation work for restoration

- Requires a network of sites established to provide spore source
- There is increased efforts by other groups in BC as well
- Restoration efforts could be limited by climate change, as warmer temps push north

Site selection

- Substrate: bedrock, boulder, cobble
- Moderate wave exposure
- Nutrient availability

- Appropriate environmental factors (temp, light, turbidity, pH, herbivory, diversity)

Questions:

Doerge – variation in temp with depth (surface versus depth)

- Both important to understand kelp exposure

Mumford – long-line seeding resulting in reoccurring/natural settlement (gametophyte bank)

- Some evidence of localized settlement, but not yet multi-year recruitment
- Maude Reef appears to have the most optimal conditions for early growth and survival
- Early season warming negatively impacts the primary reproductive season
- DNA sampling of natural recruitment may provide evidence of restoration success

Allen – larval abundance for fish and inverts in the beds

- Use of an in situ time lapse camera to examine the site during non-diver presence

Rhodes – bryozoan colonies on kelp in Puget Sound

- BC also finds large coverage between May and June
- Appear to impact early growth

Rhodes – floating blades as seed source for kelp distribution

Allen – full kelp can also pick up and move with rocks attached, as flotation exceeds anchoring

- Maturation of spores can continue when moved, but survival is diminished

Andrews – importance of light intensity and depth with early survival and growth

- Light and temp appear very important to establish nursery areas for best survival
- No noticeable growth differences within the limited range of test beds

Mumford – blue light at depth versus red light at surface used for stipe and blade production

Allen – light availability between May and August is always limited to less than 10 m

- Areas with rivers (sedimentation and salinity) and other turbidity issues impact kelp

Data Gaps Discussion

Discussion addressing key data gaps

Based on list from Kelp Recovery Plan Workshop 1, March 27, 2018 and summarization created by Tom Mumford, May 15, 2018.

Below table illustrates table created by Tom Mumford and edits added during Kelp Recovery Plan Workshop 2 on 6/8/2018. Table will be revised for presentation in Draft Kelp Recovery plan.

Issue	Existing ¹ or new data?	Sequence	Lead	Comment
General kelp trends				
Understory kelp	New		DNR, UW	
Distribution	New/existing			Pacunski existing data, over 5000 camera drops; Szypulski surveys towed camera and kayak
roles	New			
Assemblages	New			Surveys needed (i.e. scuba), Rhodes (kayak towed video, MRC)
richness	New			
diversity	New			Pacunski future ROV all rockfish habitats
Trends (Has peak growth shifted?)	New			
Canopy forming kelp (<i>Nereocystis</i>)	Existing and new		Samish, DNR, NWS Initiative	Sub-canopy species (pteragophora); Olie Shelton herring rake surveys (40 yr data, but potentially spatially limited)

¹ "Existing" means that the data may exist but needs discovery and analysis before being useful. New means data needs to be collected.

Issue	Existing ¹ or new data?	Sequence	Lead	Comment
Distribution	Existing			Pacunski existing data (also ROV surveys and drift kelp); MRC surveys, low tide and beach wrack
roles	New, current (DNR)			Understanding disturbance
Assemblages	New			Berry (broad scale analysis, video tows)
richness	New			
diversity	New			Understanding succession
Trends (Has peak growth shifted?)	New			Pacunski - using historical data in Max Ent model; Mumford teaching scuba surveys at FHL
To do:				
Compile historical traditional ecological surveys and observations	Existing			Nicole Naar is working on one component of this, post-doc in 2019 – supporting kelp aquaculture; potential for recreational and commercial fishing knowledge (fishing clubs, identifying on maps)
Understand economic and socioeconomic implications of kelp absence/presence				
Create list of ecosystem functions and services	Existing	1		Calloway lit review (rockfish, juvenile forage fish, adult salmon); step 1 develop framework or model; carbon sequestration

Issue	Existing¹ or new data?	Sequence	Lead	Comment
X acres of kelp leads to X \$\$\$	New,	2		Rockfish associated kelp habitat; need to identify which service (salmon, other sp); association to traditional foods; CA MPA and harvest docs; kelp as biofiltration and nutrification; lost fisheries
Perform cost benefit analysis	New	3		Target audience to associate importance of kelp to socioeconomic; including other stakeholders (economic, tribes)
Role of kelp as habitat				
Document which species are using kelp as habitat and what are the functional linkages (beyond associations)	Existing and new			CA Reef Check; CA Wheeler North data?; Bruce Leaman 1980s?; gastropod grazers (gap); sea cuc; invasive inverts; competitive spatial species
Rockfish interactions	Existing and new			Rec and comm fishers; intermediate habitat complexity increases diversity; fish structure attraction
Salmon interactions	New			Priority area of concern for PS
Lost fisheries – urchin, cucumber, hake – is there a relationship to kelp losses?	New			Rec and comm fishers
Role of kelp as primary producer				
How does kelp productivity support P.S. food web				Trophic relationships - Ramshaw 2017 (Berry sent), Konigs and Miller

Issue	Existing¹ or new data?	Sequence	Lead	Comment
Kelp carbon in inverts, fish, marine mammals	New		Rhodes	Potentially overestimating isotope
Spatial subsidies- kelp productivity used in deep water, offshore	New			Work with OCNMS; kelp as a blue carbon source, but not quantified; kelp important to fisheries as habitat (but nutrient role unknown – primary prod and export); identifying sub-types of kelp beds and species assemblages
Role in carbon sequestration	New		PSRF	Low priority; land contributions and seasonal timing of productivity, and linkage to life history; much of kelp productivity is seasonally exported (surveys needed to determine quantity); PSRF data available in July; other Mumford lit (DOC and carbon source); aquaculture lit but may not be comparable in situ
Role of kelp in nitrogen cycling, [nutrient refugia]	New			Low priority, work with Ecology
				Other comments - A comment from Courtney Greiner at Swinomish: I would also second Nicole's comment (I believe it was Nicole) looking at kelp restoration and associated

Issue	Existing ¹ or new data?	Sequence	Lead	Comment
				<p>traditional foods. Additionally, it would be helpful if there was some standard monitoring protocol that outlines basic methods as well as preferred time of year, depth range, targeted kelp species, targeted associated species. Maybe it already exists but it would be great to see what criteria we may be able to incorporate into subtidal studies we are already conducting or maybe a "simple" survey we could start to conduct.</p> <p>Also from Courtney: Related to carbon sequestration, I know Brian and PSRF are examining the buffering effect of kelp in the water column. I would encourage more studies like this looking at the spatial and temporal effects of kelp on water conditions and chemistry (temperature, pH, and aragonite saturation state in particular).</p>

Issue	Existing ¹ or new data?	Sequence	Lead	Comment
				Courtney: In terms of water property monitoring, Whidbey basin only has continuous temperature measurements in Penn Cove. Incorporating more monitoring systems in Saratoga Passage or Skagit Bay would be incredibly helpful especially due to the large freshwater input from Skagit River.
Understand suspected stressors and how they impact floating and understory kelp in Puget Sound				
Climate change stressors				
Thermal threshold in Puget Sound	New, existing			Braeden Schiltroth and Sheryl Bisgrove are collecting temperature threshold data for kelp in British Columbia; Cynthia Catton has information out of California; Bill Heath's presentation; surface versus depth difference; Salish Sea is unique with depth distribution; Berry since 2011 aerial kelp surveys and temp, and compared to CA, and kelp recovery associated to water mixing; temp and plant fecundity

Issue	Existing ¹ or new data?	Sequence	Lead	Comment
Sea level rise impacts	New			Modeling? Any current research (UW)? Tombolo Society maps? Identifying kelp associated to side-scan sonar is difficult and needs to be groundtruthed; NRCS potential data for substrate, Mike Racine sonar data; Shorezone classification; PGST have multibeam around hood canal; WDFW multibeam VAC (Lindquist)
https://walrus.wr.usgs.gov/reports/reprints/WA_seafloor_proceedings_final.pdf http://www.seadocsociety.org/geology-and-bathymetry-of-the-san-juan-islands/				
How does sediment impact kelp	New			Max Calloway is researching; Sediment traps are only useful to a certain degree, they do not indicate benthic accumulation. (so, method to improve?) Eric Grossman, SnoCo estuary, Agricultural development, port maintenance dredging; historical loss of habitat (model)?; impacts to kelp recruitment; impacts of accumulated toxins (mumford – EPA study in Newport)?
Sediment- light loss, smothering, lack of adhesion				Turbidity and urbanization; organic/nutrient; seasonal primary productivity; site specific

Issue	Existing ¹ or new data?	Sequence	Lead	Comment
Difference between feeder bluff and anthropogenic sedimentation				Urbanization, longshore transport, scouring and erosion
Role of sea cucumbers				Do they play a role in controlling sedimentation?
				From Suzanne: The data is a 10 year dataset of MERIS satellite imagery shared by Brandon Sackmann of Integral Consulting. He prepared this data for Long Live the Kings. The dataset actually contains several products (kd490, turbidity, chlorophyll calculated using several algorithms ...) at a large spatial scale (from Oregon to BC, including the entire Salish Sea). Bart Christiaen w/ DNR is using the MERIS data to get at this sedimentation/turbidity issue with his eelgrass monitoring.
Historical fishery pressures				
How much have we taken, what species and what are the direct and indirect impacts on kelp	New			WDFW historical catch reconstruction (RF focus), currently low priority for recovery plan
Trophic cascades in food web	New			Is there research on fish and invert interactions and impacts to

Issue	Existing ¹ or new data?	Sequence	Lead	Comment
				kelp (linkage)? – ecological role (cod, RF, etc)
kelp crabs/loss of predators (rockfish)	New			Katie Dobkowski is researching
Are kelp crabs a symptom or cause?				What is the disturbance mechanism, successional change?
Have urchins played a role in Puget Sound?	Existing and New			
Urbanization				Also nearshore development and dredging
Nutrients				Also sedimentation; competitive role with turf species from Suzanne: On nutrients USGS has regional mapping of Puget Sound N and P called SPARROW
				https://water.usgs.gov/nawqa/sparrow/mrb/7.html
Pollutants				Yet kelp still does well near urban shorelines
Invasive species (distribution and ecological effects)				
Harvest (WA closed for commercial, but open for recreational)				DNR whidbey work? Mostly in state parks, not widespread (and maybe not nereocystis)
Understand kelp life history- gametophyte phase	New			
How do microscopic stages act in the field?				

Issue	Existing ¹ or new data?	Sequence	Lead	Comment
Can early life stages be transplanted from the lab to the field successfully?	current			PSRF; other literature on staining sporophytes, or DNA
Can you reintroduce kelp using spores?	current			PSRF, if out-planted at the right time of year
Is Puget Sound spore limited?	New			PSRF, experiment with spore release, but better to create a bed as source
Distribution by species				
Longevity/ "seed bank"				
Turf species assemblage				
Difference between local healthy red turf algae compared to problem turf	New			
Understand physiological patterns	New			
kelp condition				kelp condition index started by Northwest Straits Commission, Tom Mumford, Helen Berry
Fecundity				
Role of Epiphytes				
Genetic populations/distinct populations in Puget Sound				Lily Gierke, UW Milwaukee is studying this
Stock structure				Adaptation to temp tolerance
Do we know how to restore kelp? How do we restore kelp sustainably?	Existing			Bill Heath is working on this. Do not start until we figure out what caused losses
Identify restoration sites that can support kelp				PSRF; consider temp for long-term (i.e. south sound could be more susceptible); need for

