

KELP RECOVERY WORKSHOP

March 20, 2018

In person attendees:

| | | |
|----------|----------|----------------------------------|
| Brian | Allen | Puget Sound Restoration Fund |
| Kelly | Andrews | NOAA |
| Helen | Berry | DNR |
| Emily | Bishop | Port Gamble Tribe |
| Feist | Blake | NOAA |
| Max | Calloway | Evergreen College |
| Dan | Van Hees | Kelp Physiologist |
| Tom | Doerge | Snohomish MRC |
| Lucas | Hart | NWS Commission |
| Sasha | horst | NWS Commission |
| Laurel | Jennings | NOAA |
| Victoria | Knorr | Recovery plan volunteer |
| Tom | Mumford | Marine Agronomics |
| Adam | Obaza | Paua Marine Research Group |
| Betsy | Peabody | Puget Sound Restoration Fund |
| Linda | Rhodes | Island MRC |
| Stephen | Schreck | Puget Sound Restoration Fund |
| James | Selleck | NOAA/NRC |
| Suzanne | Shull | Padilla Bay NERR/ NWS Commission |
| Dan | Tonnes | NOAA |
| David | Williams | Freelance Writer |

WebEx attendees:

| | | |
|---------|----------------|--|
| Sherryl | Bisgrove | Simon Fraser University |
| Byron | Rot | San Juan Salmon Recovery Lead Entity Coordinator |
| J | Bluhm | |
| Karin | Roemers-Kleven | San Juan MRC |
| Katy | Davis | UBC and Port Gamble (kelp microbiome) |
| Elisa | Dawson | Snohomish MRC |
| Phil | Green | San Juan MRC |
| Eleanor | Hines | Whatcom MRC |
| Jordan | Hollersmith | UC Davis |
| Casey | Palmer-Mcgee | Samish Tribe |
| Nicole | Naar | UC Davis - PRESENTER |
| Lily | Gierke | University of WI-Milwaukee |
| Paul | McCollum | Port Gamble Tribe |
| Kathy | Pfister | University of Chicago |
| Solenne | Walker | DNR |
| Kate | Tiedman | UC Davis |
| Woodard | Todd | Samish Tribe |
| Anna | Toledo | Island MRC |
| Sarah | Schroeder | U Victoria |
| Braeden | Schiltroth | Simon Fraser University |
| Ani | Ghosh | UC Davis |

Agenda

Puget Sound Kelp Recovery Plan Workshop

March 20th; NOAA Sand Point, 7600 Sand Point Way NE, Seattle

Theme: Kelp ecosystem services, stressors, and coverage trends

**Workshop attendees must bring Photo ID to enter facility (passport or a WA state driver's lisc.)*

**WiFi access will be provided*

**Parking is readily available at the venue*

10:00– 10:20 *Introductions*

10:20– 10:30 *Kelp recovery plan introduction (Lucas Hart, NWS Commission)*

10:30 – 11:30 *Kelp drivers and services (Max Calloway, Evergreen College)*

11:30 – 12:30 *Lunch (provided; chicken and vegetarian enchiladas)*

12:30 – 12:45 *Report back on relevant lunch discussions – questions/thoughts/insights.*

12:45 – 1:45 *Kelp status and trends in Puget Sound (Helen Berry, WA DNR)*

1:45 – 2:30 *Mapping kelp in the Puget Sound using Landsat satellite imagery WebEx (Jordan Hollersmith, Aniruddha Ghosh, UC Davis)*

2:30 – 2:45 *Break*

2:45 – 3:30 *The Cultural Importance of Kelp to Pacific Northwest Tribes WebEx (Nicole Naar, UC Davis)*

3:30 – 4:15 *Investigating kelp as salmon habitat (Sarah Schroeder, University of Victoria)*

4:15 – 5:00 *Group Discussion: (potential topics)*

What data gaps exist in Puget Sound (summarize from presentations and take additional thoughts)?

Are there gaps that need to be addressed before we can move forward with kelp recovery?

How might we prioritize the data gaps?

What research is needed to address data gaps?

Workshop Notes

WebEx Workshop Recording: [Play recording](#)

Links to presentation slides:

http://www.nwstraits.org/media/2537/schroeder-salmon_pres_march20.pdf
http://www.nwstraits.org/media/2536/calloway_2018_3_19_krpworkshop_slides.pdf
http://www.nwstraits.org/media/2535/berry_dnr_2018_status_trends_9.pdf
http://www.nwstraits.org/media/2538/naar_cultural-importance.pdf
http://www.nwstraits.org/media/2534/hollarsmith_20mar_nwsc.pdf
http://www.nwstraits.org/media/2539/hart_presentation.pdf

Lucas intro

- Rockfish Recovery Plan – finalized in Oct 2017
- Kelp is a component of critical habitat and is a piece of rockfish recovery plan implementation
- NW Straits Initiative leading development of kelp recovery plan with NOAA funding
- Kelp recovery plan core team was formed in Oct. 2017. Likely a two year project.
- Max Calloway is authoring literature review, first step toward understanding kelp trends, stressors and services in Puget Sound
- Year 1, understand the science, identify data gaps, and begin to look at opportunities for recovery
- Second workshop will be planned for June
- The plan will address all kelp, but most data exists for bull kelp.
 - o 22 species in WA
 - o 18 species in rockfish recovery area
- Also looking to work with Hollings Scholar, volunteers etc. to fill capacity gaps to complete the plan.
- Hoping to end up with a plan that outlines the known data, identifies data gaps and offers suggestions for moving forward to protect and restore kelp

Max Calloway, Evergreen State

- Interactions and Consequences of Changing Controlling Factors in Kelp Forests
- Bull Kelp life cycle
- Foundation species for habitat, Facilitation Cascades, Ecosystem engineers (wave energy, light availability, sediment accretion and movement)
- Alternative Stable States, responses to changes in resiliency
 - o Recovery can be challenging to achieve when perturbation has pushed the habitat to an Alternative Stable State
- Controlling factors – Drivers, stressors, controlling factors, impacts
 - o Focus today on how controlling factors impact the ecosystem
- Focus for this talk will be temperature and other stressors
- Temp – thermal stress, susceptibility to increased disturbance, changes to community structure
 - o Examples: hot water near hot water outflows of power plant: 3.5 C increase led to 97% decreased in Nereocystis

Workshop Notes

- Loss of kelp associated to loss of other species
- Resiliency also decreased with increased temperature

- Stressors
 - Turf is a new phenomenon
 - No documented reverses of turf shifts
 - Some evidence of urban proximity, eutrophication (nutrients and sedimentation)
 - Turf traps more sediment (in Italy found 96% of turf trapped sediment)
 - Filbee-Dexter and Wernberg 2018 Bioscience
 - Temp and O2 interactions
 - Connell and Russell 2010 Proceedings: Biological Sciences
 - Epiphytism also contributes to loss – with increased nutrients and temp
 - Sair and Chapman
 - Cause is not clear, if % cover directly or decreased kelp growth with temp
 - Marine heat waves found to contribute to loss of kelp (study on west coast of Australia)
 - Heat also linked to increased storm, etc, pulse disturbances
 - But even after heat wave, community structure not returning from turf

- Salish Sea – our data is only on Nereocystis
 - Towards Recovery – monitoring and research, restoration

Questions:

- Linda Rhodes – CAFEW restoration is challenging
- Adam Obaza – loss of sheephead and lobsters, and urchin increases
 - Flux with storm events and urchin abundance, but system shows recovery
 - North CA is a bigger problem, recovery not occurring
- Helen Berry – 2014 warm water caused kelp to crash in N CA, but now grazers seem to be limiting recovery
- Tom Mumford – also coupled with sea star wasting disease
- Adam – commercial harvest of urchins helps, urchin gonad quality better in kelp
- Brian Allen – difference between sediment turf and perennial red folios algae
 - Our Salish Sea reds are part of the kelp community
 - Problematic Turf species are different
- Brian – epiphyte species examples (algae, bryozoan, diatom) have different impacts
- Jordan (phone) – CA urchin barren extents
- Braeden – Simon Frasier U, temp resilience in BC Salish Sea, temp spikes and season variations – 17 C threshold (again temp lowers growth and increases bryozoan)
- Tom M – Nereocystis is annual, and community shifts may still retain kelp canopy but with different species
- Betsy Peabody – Puget Sound lacks the urchin barrens that plague CA
- Helen – Small scale barrens around, but not large scale
 - WA also has active fisheries for purple and green
 - Patch is not a barren – localized urchin density
- Stephen S – temp varies in Puget Sound

Workshop Notes

- Helen – not all areas have good historical temp data, and many areas have good mixing
- Emily Bishop – long term data on sedimentation? Logging?
- Kelly Andrews – CA nuclear plants increased sedimentation and limited recovery, also consider light
- Max C – sediment traps have had mixed results at collecting data on sedimentation rates
- Brian – sedimentation and organic seasonal, varies in estuaries, difference between runoff, organic, feeder bluffs, etc
- Max – also consider pollutants in the sediments (and oil spills)
- Tom M – Sea Cucs? How do they work with cleaning sediments? And their populations are down.

LUNCH BREAK

Quick review

Defining Puget Sound geographically – Kelp Recovery Plan is using the boundaries and Puget Sound Basins outlined in the Rockfish Recovery Plan

Ephiphyte role

- Linda ask, Tom M answer – some bryozoan (*Membranipora membranacea*) occur on outer coast when warm, and kills kelp
- Brian A – Kelp is quick growing substrate, it's a habitat on the blade too – lots of surface area
- Cathy Pfister – microbial aspect of kelp, Brooke from Pfister lab is presenting at 2018 SSEC

Helen Berry

- Additional info sources
- Knowledge gaps
- Areas of concern – to address in kelp recovery plan
- Data: Status, long-term trends, and short-term trends
- Floating (11%) versus understory kelps (31%)
 - Common in Puget Sound, associated to cooler temp, rocky habitat, higher current
 - Puget Sound defined by Victoria Sill in Straits of Juan de Fuca
 - Latest estimate is 18 kelps in Puget Sound (annual and perennial)
 - More kelps in straits, san juans, but 9 species are found in central Puget sound
 - Really high interannual variability, and variation between species tends to be related, and overall status tends to be stable
- Long Term trends
 - Krumhansl et al 2016 – reviewed 1,500 global diving datasets
 - Global stressors influence, but regional trends dominate
 - Outer coast WA stable, but Puget Sound was concerned lacking enough traditional diving based ecological based data to form a conclusion
 - Thom and Hallum 1990
 - Compared Rigg data 1911 and WDW 1978 maps

Workshop Notes

- Found apparent kelp increases in North Sound, Main Basin, and South Sound
 - 2 areas have been updated (helen with Pfister, Berry and Mumford 2017 Journal of Ecology)
 - DNR 1989-2015 aerial maps with Rigg data 1911 for Straits, agree consistent
 - 1855-2017 South Sound mixed data on Bull Kelp distribution (studies varied on focus)
 - Bull kelp only in high passage areas, not embayments, in South Sound
 - Linear extent of shoreline with bull kelp
 - Split South Sound in 3 sub-regionals (east, west, central)
 - Found some stable abundance, others shift (central down, east increased)
 - Biggest change in presence around 1980
 - Reviewed as proportion of observations
 - Prior to 1980, equal representation of presence observations
 - After 1980 East sub region high presence, but elsewhere near zero
 - Looking at temp data – west subregion reaches 17 C in summer and nitrate-nitrite reach 5-10 umol - lowest in summer
 - Bainbridge island (Brian A) has seen complete loss, and well documented (fast ferry project), lastly Wing Point
 - San Juans (Todd W) reviewing Rigg and other data, against modern WDNR remote sensing
 - Other areas of concern – observations
 - Gedney, Camano (Tonnes), loss since 1980
 - Loss of predators (rockfish), sedimentation and logging triggered landslides
 - Elliot Bay recent increase, unknown why
 - Steamboat Island (Harlin 72 and Mumford & Waaland 2008)
- Short Term trends
- Elwha, CA, north into BC, MRC data, Squaxin
 - Elwha – 10 million tons of sediment
 - Rubin et al 2017 – dive transects, documented recovery
 - Complete loss in 2012-2014 after dam removal, but 2014 also very warm year
 - Conclusions: stressors is turbidity and light, but most sediment carried offshore due to high current environment
 - But by 2017 mostly recovered naturally
 - CA – North shoreline loss, Cynthia Catton 2017
 - Sea star wasting, purple urchin bloom, and warmer temps
 - 90% loss of kelp in CA
 - WA also saw decline in 2014 during el nino and Blob year
 - But WA quickly rebounded in 2015, except for Cherry Point

Workshop Notes

- Temp map (satellite) correlates with areas that recovered
- Well mixed areas staying cooler (also narrow shallow areas don't have satellite temp data)
- Strait of Georgia
 - Mixed findings since 2015, some remained absent, others persisted
 - Lab work suggests damage between 17-18 C
- MRC volunteer data
 - 2015-2017 multiyear
 - 21 sites, acreage varies, standardized based on percent of bed measured
 - High variation, many users
 - Some areas of concern with decline, inside island county Saratoga passage
- Squaxin Island (south Puget sound), bed has persisted, Max study for thesis
 - Detailed monitoring since 2013
 - Bed is contracting, even smaller in 2017
 - Max depth has become shallow
 - Concern is if lost, little chance for recovery (lower fitness, lack of regional recruitment)
 - Many thoughts, but little known - Sargassum, turn, sedimentation
 - Recent photos show similar transition as Bainbridge island loss, and others
- Questions:
 - Who eats kelp crab? Cabazon, lingcod, rockfish
 - Linda R – observations of kelp crab barrens (Whidbey island)
 - Kelly A – recent warm water may facilitate kelp crab recruitment event
 - Betsy P – Jacque White concludes salmon smolts favor kelp in San Juans
 - Tracy Sanderson, Helen clarify – patterns in seasonal nutrients – summer stratification in non-mixed areas
 - And high loss in island county may be loss of already quite small beds
 - Other understory kelps – ex, pteragophora needs high current environment (from South Whidbey to Straits)
 - Emily B – lack of seed source in recruitment?
 - Helen, allele richness in South Sound low, so recruitment problems
 - Nereocystis not as broadly dispersed as it once was
 - Tom M – gametophyte survival

Jordan Hollarsmith – UC Davis (remote WebEx)

- Also with Ani Ghosh and Kate Tiedeman (Ted Grosholz lab)
- Previous work in CA and Chili
- Remote Sensing – satellite measuring spectral signatures – light reflecting off earth's surface – used to create maps of land cover
 - Capturing sites once every 15 days
 - 30 m (squared) resolution with one spectral signature
 - Models to unmix signals – (Multiple Endmember Spectral Mixture Analysis: MESMA)
 - Google Earth Engine: Landsat and Sentinel 2 all using the google servers

Workshop Notes

- Kelp remote sensing is challenging due to small patchiness, daily tidal changes, and seasonal cycles
- High turbidity with chlorophyll can resemble kelp
- Mapping in Puget Sound: small patches, close to coast, turbid water, cloudy
- Example results from Google Earth Engine
 - o Some recent satellites have up to 10 m resolution
- Next steps
 - o Find thresholds for smaller beds
 - o Repeat over multiple time
 - o Mask land to eliminate false positives
 - o Assess accuracy with hi-res samples
 - o Super high res data (Planet Lan <3 m pixels)
- Considering full watershed, effects of land change (urbanization, deforestation, agriculture)
 - o Not just marine effects
 - o Is watershed development a driver in long-term kelp decline
 - o Thank Tonnes, Woodard, and Steve Cobbs
- Benefits
 - o Same method in space in time (Helen B had problems with varied methods)
 - o 1984-2013 will address long term decline versus interannual noise
 - o 30 m pixel, to help define bed size
 - o Sea surface temp SST – NOAA AVHRR satellites (advanced high res radiometer)
 - o Buoy data, additional data
 - o Address temporal log and watershed analysis
- Products
 - o Change hot spots
 - o Watershed change correlated to kelp bed extents
 - o Identify Future targeted studies for causal mechanisms
- Caveats
 - o Conservative bed extents
 - o Limited for causal drivers (nutrients, etc)
- Questions
 - o Tom – trends in Causal factors important with climate change, warming, etc
 - o Lucas – why stop in 2013? – 2013 landsat 5 decommissioned, but landsat 8 has been launched

Nicole Naar

- Cultural perspectives
- Kelp in rockfish bone collagen has decreased over long term
- Kelp isotope distinct from phytoplankton
- Isotopic evidence in salmon too, kelp important to many Puget Sound species
- Local ecological evidence – hunting sea otters, seal, sea urchin, halibut, and crab
 - o Many tales of hunting near, in, and around kelp beds
 - o Kelp stipes hardened and used to make bows
- Lummi reef net fishing, anchored through kelp beds to capture migrating salmon

Workshop Notes

- Roe on kelp
- Kelp also terrestrial grazing for deer
- Kelp technology
 - o Bull kelp stipe used to soften cedar to bend into halibut hooks
 - o Fishing line
 - o Basketry, bark rope, hats
 - o Food storage (bulbs cut to make funnels, and store liquids – liquor, deer fat)
 - o Food prep, fertilizer for gardens, dried kelp for fuel, keep fresh fish, steam pits
 - o Medicine –
 - o Games and play – Makah kids make wheels and stipes to play harpooning whales
 - Rattles, hockey like pucks, toy blow guns
 - o Ceremonial uses – sound effects, send voices or smoke, steam baths and medicinal purposes
 - o Some cranial modifications
 - o Use the Samish kelp story to anchor our kelp recovery plan.
- Questions
 - o Helen – use of findings? Report? (some issues of publishing sensitive materials)
 - o Lucas – reaching out to other tribes?
 - o Max C – datasets (Helen – J Watson otter presence work, Pisco work)

Sarah Schroeder – MS candidate at U Vic

- Kelp as salmon habitat
- Part of Salish Sea Marine Survival Project
 - o Habitat loss of the nearshore
- Kelp important but change in BC not well documented
- Satellite imagery – Geoeye, worldview 3
- Kelp survey 2016 – small scale
 - o Validation and classification for satellite data
- Kelp reflectance and wavelength – varies with kelp density
- Test area near Victoria , compared to Anne Schaffer’s work
- Snorkel and small removable stationary UW video techniques to monitor salmon, try two methods to test results
- Three 60 m salmon transects at two sites, one kelp and one without nearby
 - o Turbidity
 - o Camera placed before snorkel dives, weighted tripod, with two cameras
- Considerations
 - o Kelp growth vs salmon migration seasonality
 - o When hatchery are released
 - o Tides and currents (kelp can block camera)
 - o Changes in turbidity and visibility
- Results
 - o Current strongly impacts daily turbidity and kelp observations
 - o Snorkel video far better at identifying salmon

Workshop Notes

- Majority of fish were shiner perch
 - Also other perch, other fish 1%, YOY fish, and rest juvenile salmon
- Kelp crab 33% of inverts, red rock also
- Also river otters
- Remote video was better at capturing salmon behavior in the kelp (they swim away or through when snorkeling)
- No rockfish or other large predators
- No urchins
- Salmon abundance was highest prior to full kelp abundance
- Inner transects (closest to shore) had significance with salmon and kelp presence
- Overall no difference in salmon presence, so kelp not determining factor for nearshore salmon presence
 - Salmon also using nearshore shallow rock as refuge
- Video analysis: Max N = max number of fish observed, with paired Wilcoxon
 - No difference in kelp presence
 - Video has limited view, etc
- Summary
 - Inside nearshore of kelp preferred for salmon outmigration
 - Does not seem dependent on kelp presence
 - The site was inside bay, therefore warmer and later kelp season
- Questions
 - Tom – species of salmon? Not reliably on video
 - Linda R – nearshore more important for wild salmon than hatchery (sub yearlings)
 - 70% of salmon in beach seine were wild
 - Out migration and nearshore use based on salmon growth (smaller fish use nearshore more)
 - Brian A – epibenthic inverts more common in spring too – so food source
 - Salmon were predominately in top shallow water, top 15 cm of water
 - Kelly A – is goal to recover kelp as species habitat, if salmon use is mismatched
 - Kelp peak varies from July to August between areas (based on temp)
 - Has seasonality of kelp changed over time? Is that cause for mismatch in timing with salmon
 - Tom M – what species of kelp more important for rockfish and salmon?
 - Saccharina main understory kelp
 - Max C – substrate complexity? Difference in rugosity?
 - Emily B – PGST and NOAA nearshore assessment
 - Salmon also converged in shallow embayments following crab zoea
 - Salmon are mobile, using these spaces in transient (not persistent)
 - Acoustic? i.e. hood canal, maybe using areas of lower velocity currents

DATA GAPS - KELP RECOVERY WORKSHOP
March 20, 2018

- Understand kelp early life history
 - How do microscopic stages act in the field?
 - Can early life stages be transplanted from the lab to the field successfully?
 - Can you reintroduce kelp using spores?
 - Is Puget Sound spore limited?
- General kelp trends
 - Has peak growth shifted?
- Turf species assemblage
 - Difference between local healthy red *turf* algae compared to problem turf
- Understory kelp
 - Understand roles, assemblages, richness, diversity and distribution
- Role of Epiphytes
- Compile historical traditional ecological surveys and observations
- Understand suspected stressors and how the impact floating and understory kelp in Puget Sound
 - Urbanization
 - Nutrients
 - kelp crabs/loss of predators
 - Are kelp crabs a symptom or cause?
 - Invasive species (distribution and ecological effects)
 - Thermal threshold
 - Puget Sound has limited temperature data
 - Braeden Schiltroth and Sheryl Bisgrove are collecting temperature threshold data for kelp in British Columbia
 - Synthia Catton has information out of California
 - How does sediment impact kelp

Workshop Notes

- Sediment traps are only useful to a certain degree, they do not indicate benthic accumulation.
- Difference between feeder bluff and anthropogenic sedimentation
- Pollutants
- Harvest (WA closed for commercial, but open for recreational)
- Historical fishery pressures
 - How much have we taken, what species and what are the impacts?
- Climate change stressors (including sea level)
 - Role in carbon sequestration, is there enough info? Do we need more?
 - Role of kelp in nitrogen cycling, nutrient refugia?
- Need to publish data to support government white papers
- Role of kelp as habitat
 - What is important about nearshore for salmon? Is it related to kelp?
 - Rockfish interactions
 - Is kelp good for fisheries?
 - Lost fisheries – urchin, cucumber, hake – is there a relationship to kelp losses?
- Role of sea cucumbers
 - Do they play a role in controlling sedimentation?
- Have urchins played a role in Puget Sound?
- Seed source and recruitment
- Understand physiological patterns
 - kelp condition
 - Fecundity
 - Pigment analysis
- Stock structure
- Identify restoration sites that can support kelp
 - What areas that will support kelp?
 - well mixed areas

Workshop Notes

- Genetic populations/distinct populations in Puget Sound
 - Lily Gierke, UW Milwaukee is studying this
- Document which species are using kelp as habitat and what are the Functional linkages (beyond associations)
- Do we know how to restore kelp? How do we restore kelp sustainably?
- At what scale is aquaculture possible? Is it enough to make a difference?
- Understand economic and socioeconomic implications of kelp absence/presence
 - X acres of kelp leads to X \$\$\$
 - cost benefit analysis
- Need to connect with research, concerns, and interests in BC and Georgia Straits much more frequent than Salish Sea Ecosystem Conference