

The Biology and Management of Forage Fish in Washington



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Outline



1. What are forage fish and what role do they play in the ecosystem?
 - How do they contribute to ecosystem stability?
 - What are the threats/pressures they face?
2. How are they managed in Washington?
 - What species occur in Washington?
 - What do we know about forage fish in Washington?
 - What do we **not** know about them?
 - What research has recently been completed, or is currently underway?
 - What's new in forage fish management?

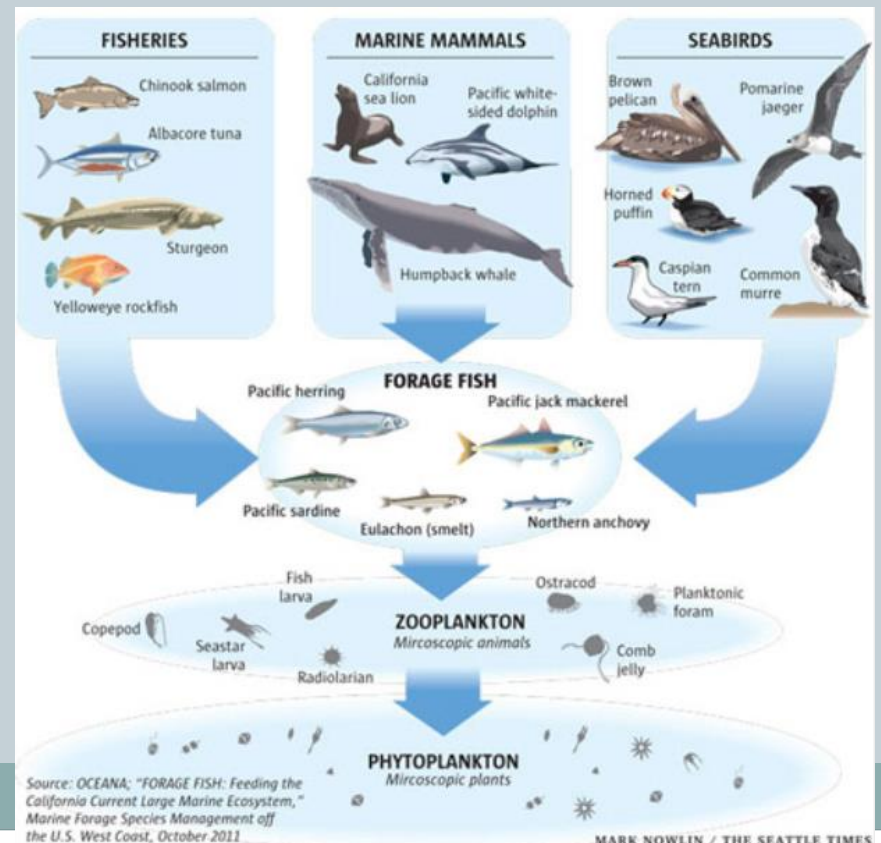
What Makes a Fish a Forage Fish?

- Forage fish are:

- An ecological, not genetic, group
- Generally small, abundant, schooling, “silvery” fish that are central in marine food webs



events over time



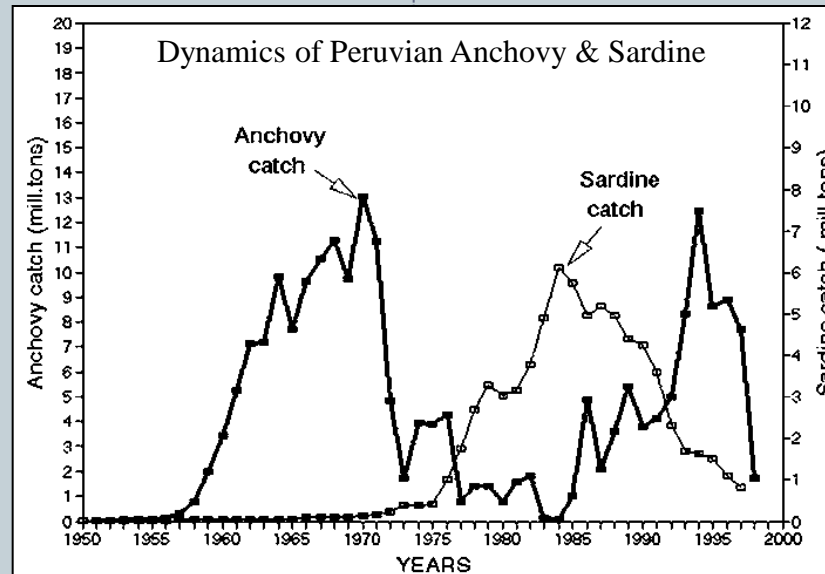
What Makes a Fish a Forage Fish?



- Forage fish are:
 - An ecological, not genetic, group
 - Generally small, abundant, schooling, “silvery” fish that are central in marine food webs
 - A vital conduit between 1^o producers and higher level marine/terrestrial consumers
 - Commercially and recreationally important the world over
 - ✦ Account for 40% of overall marine harvest
 - A valuable indicator species of ecosystem health
- By WAC, forage fish **are not** hake, pollock, juvenile salmon, and many other silvery schoolers

Trends in Forage Fish Stocks

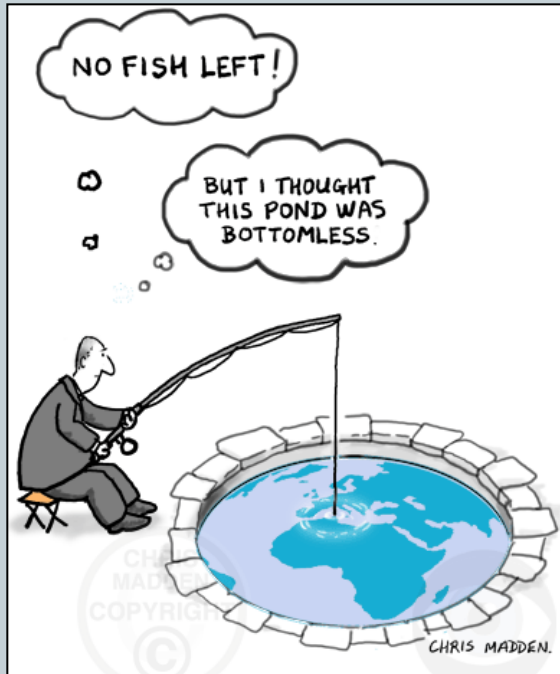
- Stocks of many species fluctuate wildly based on environmental conditions



- Accounting for variability, stocks of many species around the globe have been declining in past 3 decades

<http://www.fao.org/docrep/005/y2787e/y2787e0b.htm>

Challenges Facing Forage Fish



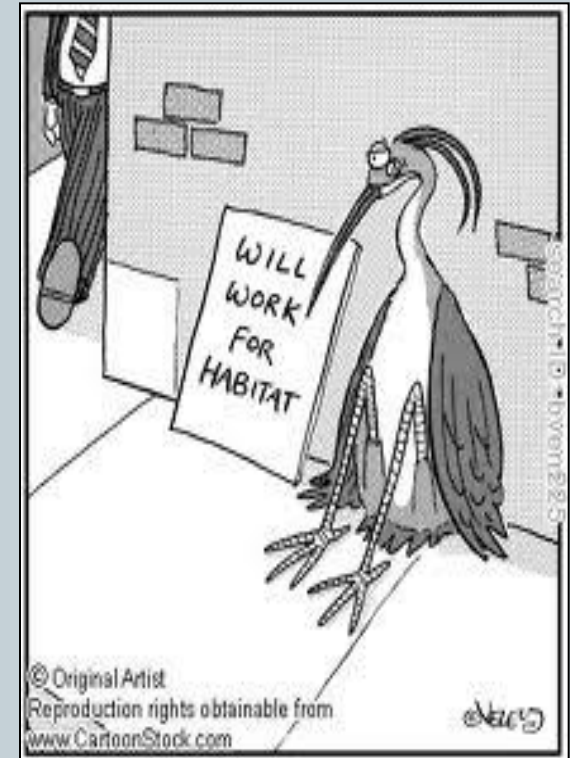
Over fishing



Climate change



Poor water quality



Habitat Loss

Policy C3012 and Management Plan

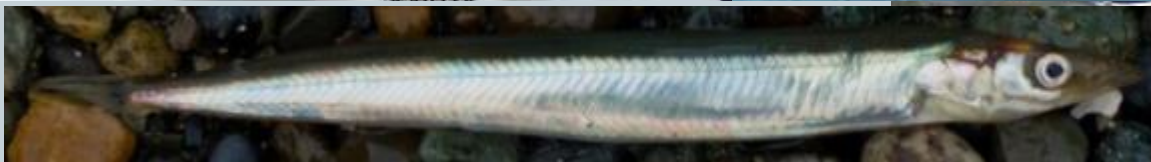


- Tenets of Management Policy/Plan (1998):
 - Primary goal = maintain healthy populations
 - **Must** consider role of forage fish in marine ecosystem
 - If data limiting or resource condition poor, conservative approach taken
 - Achieving maximum yield shall **not** be a goal
 - The best scientific information available shall be employed
- Three major areas of focus:
 - Fishery management
 - Stock assessment/monitoring
 - Habitat documentation and protection

Forage Fish of WA State



- Pacific herring *Clupea pallasii*
- Northern anchovy *Engraulis mordax*
- Pacific sardine *Sardinops sagax*
- Pacific sand lance *Ammodytes hexapterus*



Herring Biology/Management



- Fishery management
 - Once large (1000s of mt), now small (100s mt) bait fishery
 - ✦ Goal = <10% of annual biomass taken in fisheries
- Stock assessment/monitoring
 - Spawn on subtidal macrovegetation (eelgrass, kelp)
 - Focus: long-term series of abundance estimates by 'stock'
 - ✦ Method #1: Acoustic/trawl surveys
 - At night on pre-spawning aggregations
 - Collected biosamples from trawls = age comp, recruitment
 - Cut after 2009 due to funding and outdated equipment
 - ✦ Method #2: Spawn deposition surveys using vegetation grapple

Spawn Deposition Surveys

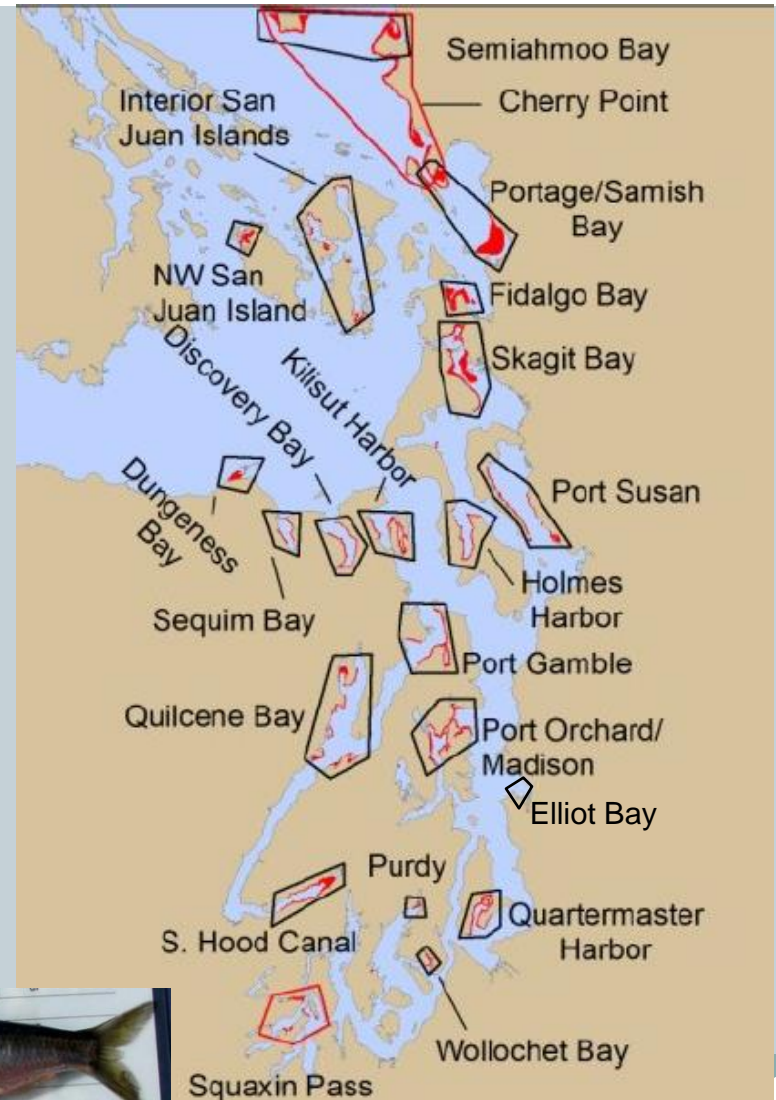
- Occur during spring and summer, during spawning
- Use a rake to collect vegetation
- Egg densities on vegetation and area covered by spawn used to estimate annual spawning population
- Spawning escapement estimated as opposed to prespawning biomass
- Primary status assessment tool since 2010



Herring Stocks



- 22 'stocks' in Puget Sound
 - Survey Jan-April, Cherry Point (Apr-Jun), annually
 - Coastal samples 1998-2007
- 3 genetic groups in Sound
 - Cherry Point stock has declined dramatically (96% since 1973)
 - Squaxin Pass has been steady but small
 - 'Other stocks complex' variable
 - ✦ Quilcene has increased 5-fold since 1970s



Herring Biology/Management



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- Habitat protection
 - Spawning/holding habitat defined as a saltwater habitat of critical concern
 - ✦ No net loss (WAC 220-110)

Recent/Current Research



- Assessment of spawning vegetation “preference” and historical usage trends
- Evaluating toxic contaminant loads in Puget Sound
 - And embryo survival as a function of contamination
- Additional evaluation of genetic relationships along west coast
- Evaluation of stock-specific age class composition
 - Special focus on Cherry Point
- Received funding and commitments to develop Salish Sea-wide assessment and monitoring plan

Anchovy + Sardine Biology/Management



- **Fishery management**
 - Monitored by PFMC under Coastal Pelagic Species FMP
 - ✦ Several recent changes to management (Lorna Wargo)
- **Stock assessment/monitoring**
 - Pelagic spawners in embayments and offshore
 - Periodic (anchovy) or annual (sardine) coast-wide assessments
 - Massive nearshore schools of anchovy in 2016 along entire West Coast. Implications not yet realized
- **Habitat protection**
 - EFH designated since 2010
 - No directed state laws/rules



Sand Lance Biology/Management

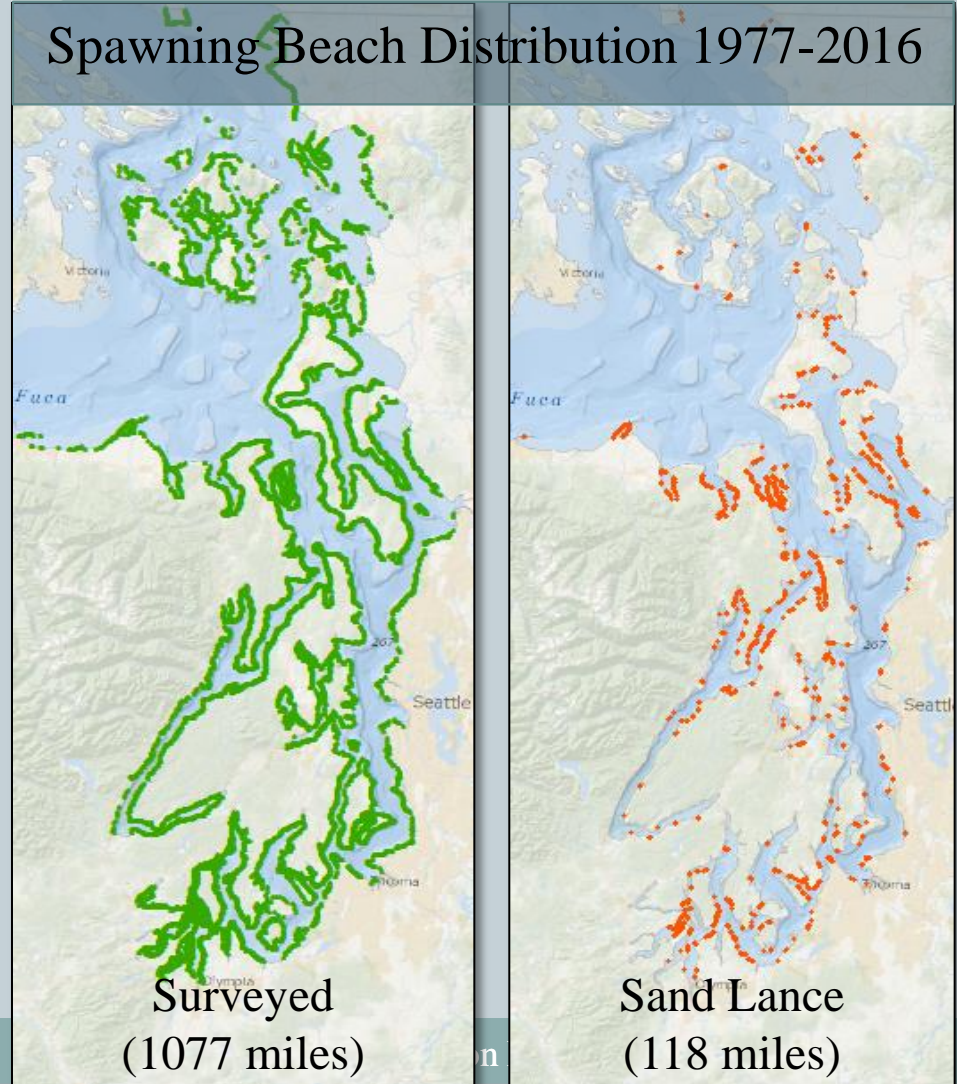


- **Fishery management**
 - No significant fisheries. Commercial fisheries prohibited
- **Stock assessment/monitoring**
 - Spawn intertidally throughout Puget Sound



Spawning Distribution & Timing

- Spawning locations first discovered in 1970s
 - Deposit eggs on fine sand beaches in lower-mid intertidal
- Predominantly winter spawners
- May spawn subtidally



Sand Lance Biology/Management



- **Fishery management**
 - No significant fisheries. Commercial fisheries prohibited
- **Stock assessment/monitoring**
 - Spawn intertidally throughout Puget Sound
 - Known to utilize deep-water sand wave fields
 - Little known about life history, ecology
 - ✦ No population estimates or stock delineation work to date
- **Habitat protection**
 - Spawning/holding habitat defined as a saltwater habitat of critical concern
 - ✦ No net loss (WAC 220-110)



Recent/Current Research



- Updating distribution and spawn timing information
 - Partnership between WDFW and DNR, with WCC
 - Incorporating new data from NGO's and Tribes
- Developing/testing improved methods for recovery of eggs from sediment samples
 - In collaboration with DNR & Point No Point Treaty Council



Developing & Testing New Methods



- New methods find more eggs in less time
- More efficient methods = better survey coverage
 - Blue bowl is now the standard



Dish pan method:
Winnowing separation



Funnel method:
Elutriation separation

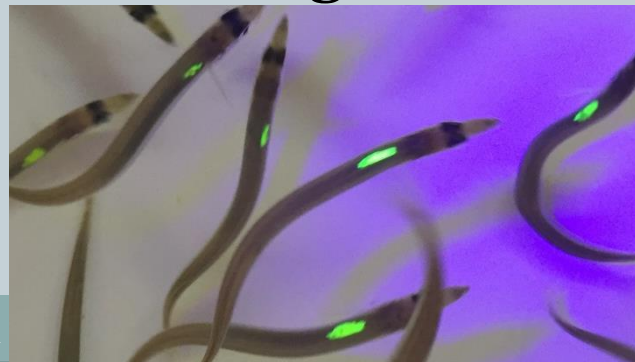


Blue bowl method:
Cyclonic separation

Recent/Current Research



- Updating distribution and spawn timing information
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 - Incorporating new data from NGO's and Tribes
- Developing/testing improved methods for recovery of eggs from sediment samples
 - In collaboration with DNR & Point No Point Treaty Council
- Ongoing beach seining and tagging with UW FHL to evaluate seasonality of occurrence and biological attributes of schools



Forage Fish of WA State

- **Smelt**

- Surf *Hypomesus pretiosus*
- Eulachon *Thaleichthys pacificus**



- Night *Spirinchus starksi*
- Whitebait *Allosmerus elongatus*
- Longfin *Spirinchus thaleichthys*



Surf Smelt Biology/Management

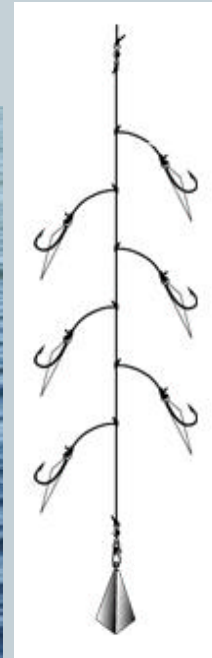


- Fishery management
 - Both commercial and recreational fisheries in the Sound

Recreational Smelt Fisheries



- Dipnet gear – mostly for human consumption
- Jig gear – mostly for salmon bait
- Harvest+effort largely unknown
- **License not required**



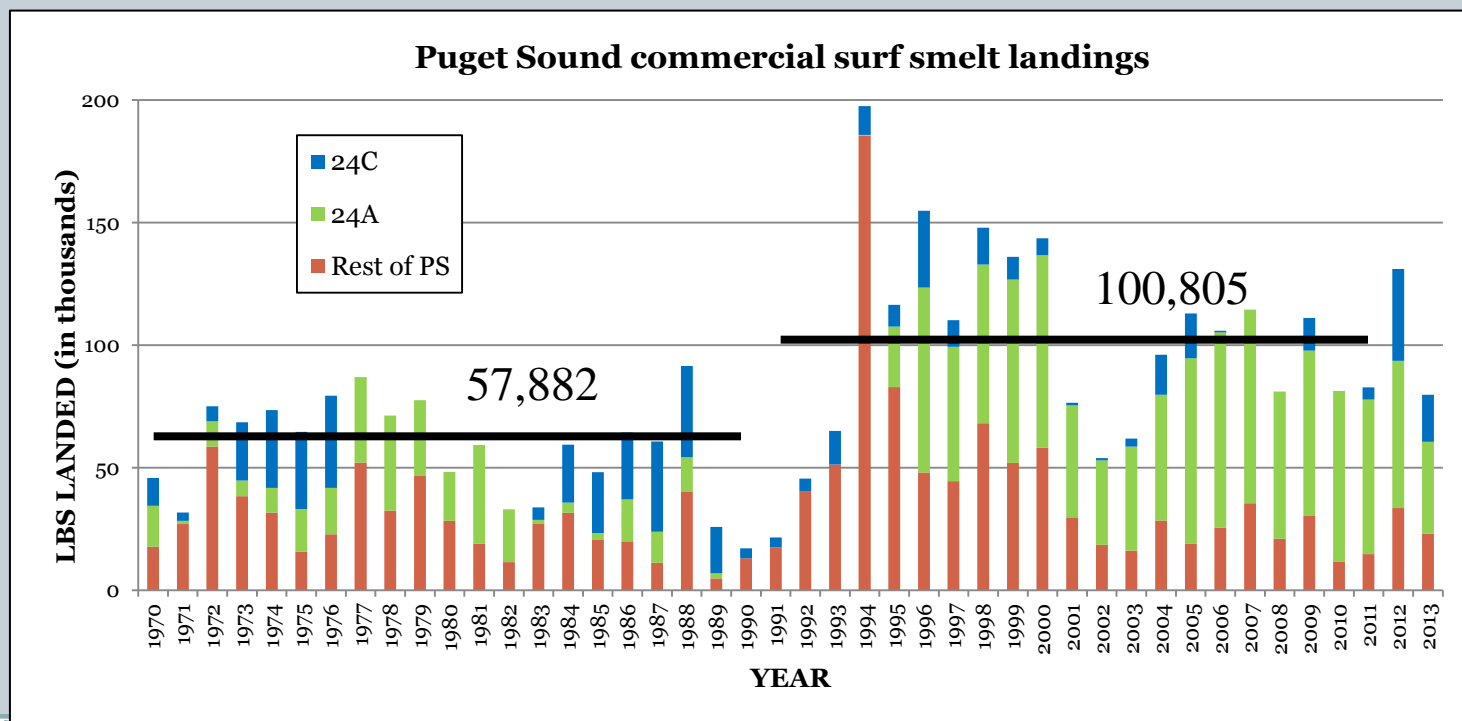
Surf Smelt Biology/Management



- Fishery management
 - Both commercial and recreational fisheries in the Sound
 - ✦ Recent recreational estimate off Camano Island ~4k lbs

Commercial Smelt Fisheries

- Average annual harvest in Puget Sound increased 74%, comparing 1970-80s to 1990-2000s
- Most harvest comes from northern Camano Is.



2014 Fishery Changes

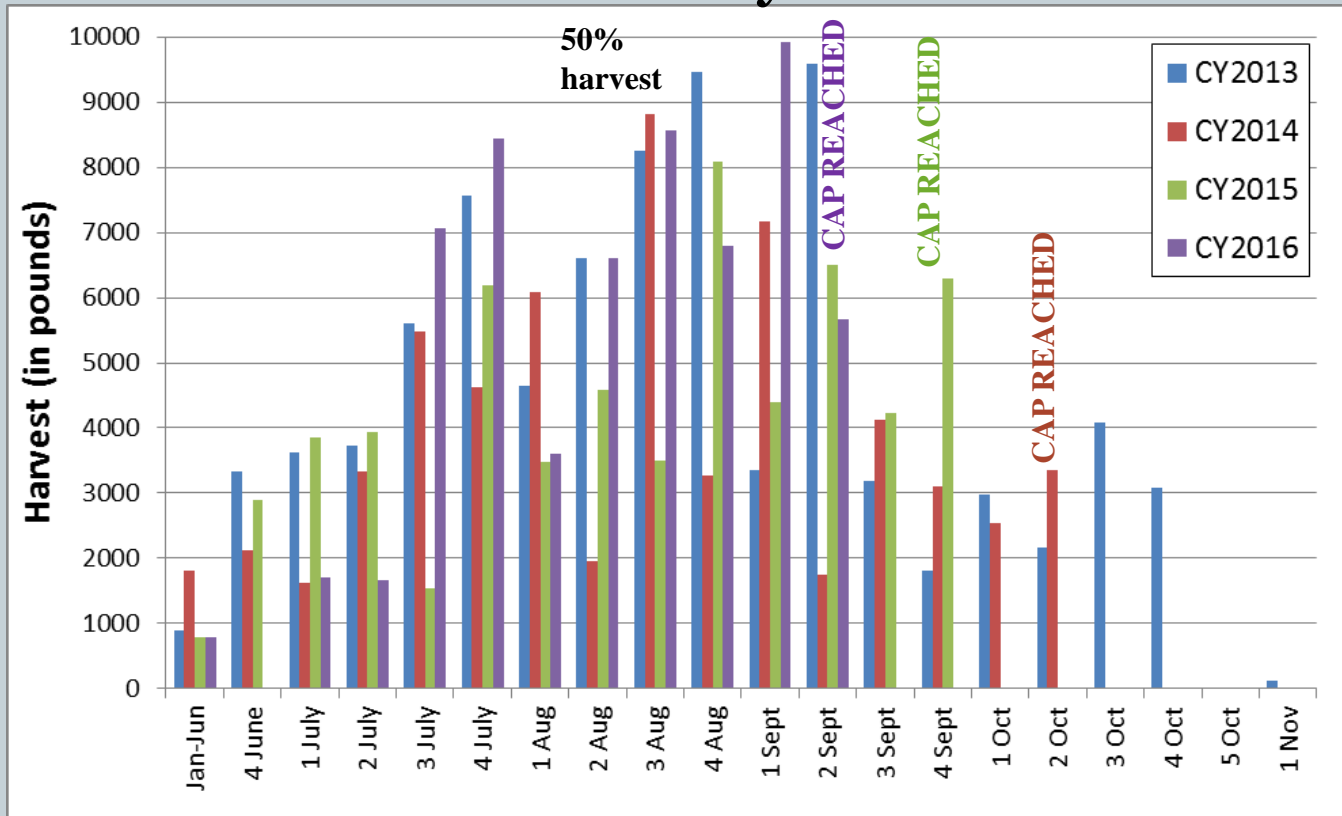


- Closed commercial fishery on Sundays
 - Open Monday through Thursday
- Implemented 10PM-6AM “night closure” on open days
 - For recreational fishery too
- Closed inactive commercial smelt gear types
 - Purse Seine and Dip Bag Net
- Enacted harvest quota of 60k lbs
 - Brings maximum harvest closer to 1970s-80s level
 - Requires active in-season monitoring (i.e., quick reporting)

Harvest With and Without Quota



- First fishing in late March, but year-round openings
- <2% of annual total taken by end of June



Total = 61,209 lbs (102.0% on Oct 10)

Total = 60,263 lbs (100.4% on Sep 26)

Total = 60,824 lbs (101.4% on Sep 6)

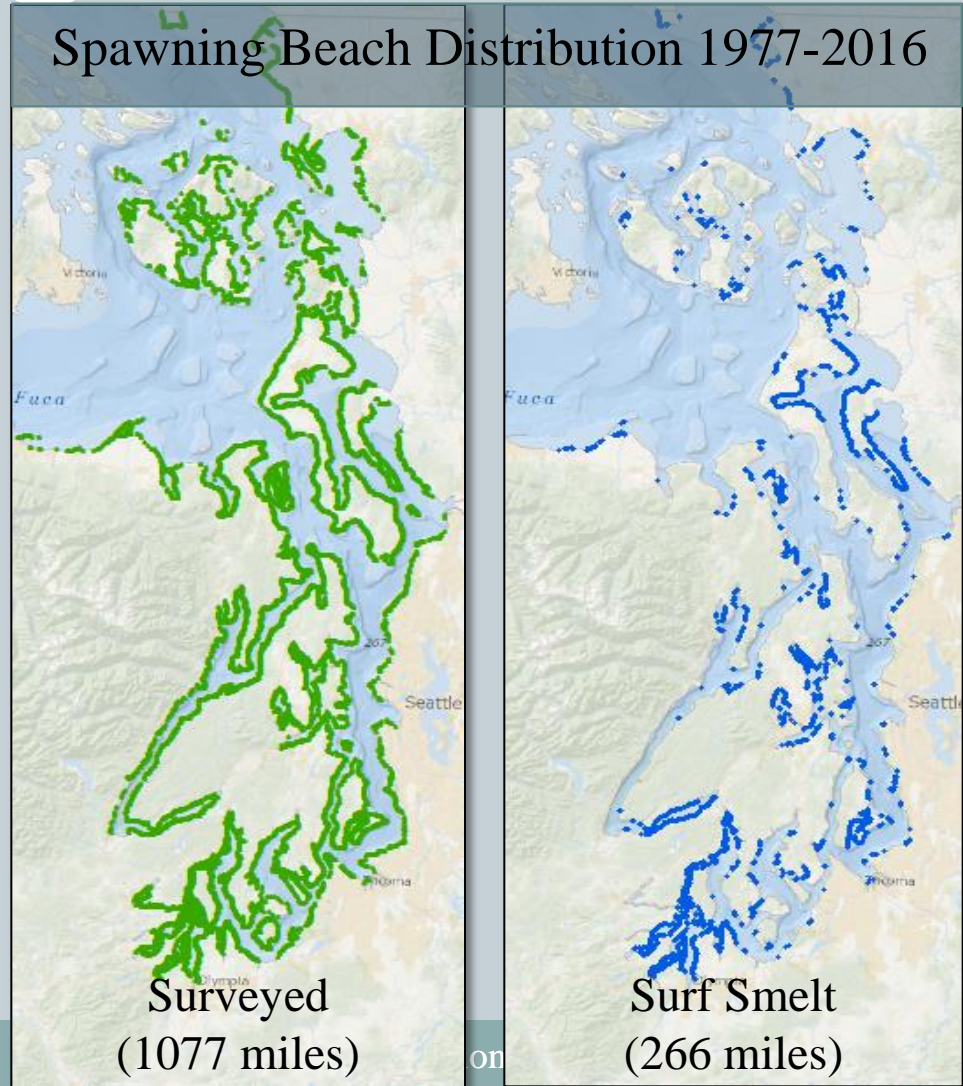
Surf Smelt Biology/Management



- Fishery management
 - Both commercial and recreational fisheries in the Sound
 - ✦ Recent recreational estimate off Camano Island ~4k lbs
 - ✦ Commercial harvest now ~60k lbs
- Stock assessment/monitoring
 - Spawn intertidally throughout Puget Sound

Spawning Distribution & Timing

- Spawning locations first discovered in 1970s
 - Deposit eggs on coarse sand and pea gravel beaches in upper intertidal
- Spawn timing varies by region – mostly summer in north, winter in south
 - Some areas support year-round spawning



Surf Smelt Biology/Management

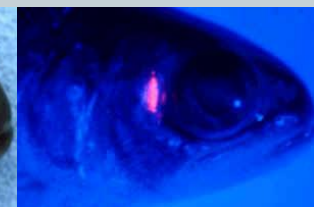


- **Fishery management**
 - Both commercial and recreational fisheries in the Sound
 - ✦ Recent recreational estimate off Camano Island ~4k lbs
 - ✦ Commercial harvest now ~60k lbs
- **Stock assessment/monitoring**
 - Spawn intertidally throughout Puget Sound
 - Little known about life history, ecology away from beaches
 - ✦ No population estimates. Genetic analysis shows no structure.
- **Habitat protection**
 - Spawning/holding habitat defined as a saltwater habitat of critical concern
 - ✦ No net loss (WAC 220-110)

Recent/Current Research



- Genetic assessment being published
- Spawning habitat preference model in the Sound
- Comprehensive assessment of spawning distribution throughout Sound
- Mark-recapture
 - In Eld Inlet, using injectable elastomer
 - In Sinclair Inlet, using surgically implanted acoustic tags
- Assessing impacts of armoring, and adherence with HPA Permit provisions, on spawning habitat
- Model to determine beach “use” for HPA purposes



Eulachon Biology/Management



- **Fishery management**
 - All fisheries closed* since 2010 listing under ESA
 - ✦ Southern DPS listed = Nass River, B.C. to Columbia River
- **Stock assessment/monitoring**
 - Abundance estimates on Cowlitz and Grays Rivers
 - ✦ Report on 4-year study recently completed
 - Efforts to document spawning in outer coast rivers
- **Habitat protection**
 - Critical habitat designated under ESA in 2011
 - ✦ Includes lower Columbia and tribs, and the Quinault and Elwha Rivers on the Olympic Peninsula



Recent Research/Management Actions



- Fisheries reduced to “negligible impact” levels
 - Recreational and commercial fisheries of only a few days on the Cowlitz River since 2011
 - ✦ Monitoring of both effort and catch occur
 - Obtain biodata from harvest on Cowlitz River
 - ✦ Age, sex ratio, fecundity, etc.
- Fall sampling of upper Columbia R. estuary to document larval outmigration
- Draft Federal Recovery Plan released in October
 - WDFW’s Olaf Langness on the plan team



Mid-Water Trawl Survey



- Most research and management is species-specific
- In 2015 session, WA State Legislature passed bill to fund sweeping mid-water survey
 - Hydroacoustics to quantify fish “sign”
 - Trawling to validate composition and obtain biosamples
- Survey bi-monthly from February 2016 – 2017 at 18 stations spanning Puget Sound
- Analysis completed by June 2017
- Represents a significant stride toward assessing forage fish role in Puget Sound as a whole

Data and Management Summary



Species	Stock Unit	Basic Fishery Info?	Basic Biological Info?	Monitoring of Stock Condition?	Habitat Loss Risk?	Fisheries		
						Comm	Rec	Treaty Indian
Anchovy	CA to Canada	Comm landings	Minimal	Poor	Low (Climate Change?)	Y	N	N
Sardine	Mex to Canada	Comm landings	Good	Good	Low (Climate Change?)	Y	N	N
Herring	Isolated spawning grounds	Good	Good PS Poor coast	Good for PS Poor for coast	High	Y	Y	Y
Sand Lance	Spawning grounds/ None	No fishery	Minimal	None	High	N	N	N
Surf smelt	Spawning grounds/ All PS?	Good Comm Poor Rec	Minimal	None	High	Y	Y	Y
Eulachon	Col River and tribs	Good Comm Good Rec	Moderate	Poor (but improving)	Moderate to High (SLR)	Y*	Y*	Y*
Other smelt	Unknown	None (no real fishery)	Very limited	None	High?	N	Y	Y

Data and Management Gaps



Species	Stock Unit	Basic Fishery Info?	Basic Biological Info?	Monitoring of Stock Condition?	Habitat Loss Risk?	Fisheries		
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Herring	Isolated spawning grounds	Good	Good PS Poor coast	Good for PS Poor for coast	High	Y	Y	Y
Sand Lance	Spawning grounds/ None	No fishery	Minimal	None	High	N	N	N
Surf smelt	Spawning grounds/ All PS?	Good Comm Poor Rec	Minimal	None	High	Y	Y	Y
Eulachon	Col River and tribs	Good Comm Good Rec	Moderate	Poor (but improving)	Moderate to High (SLR)	Y*	Y*	Y*
Other smelt	Unknown	None (no real fishery)	Very limited	None	High?	N	Y	Y

For More Information



- Dayv Lowry, dayv.lowry@dfw.wa.gov
 - Puget Sound marine fish science and policy
- Lorna Wargo, lorna.wargo@dfw.wa.gov
 - Outer coast forage fish management and science
 - PFMC representative, Coastal Pelagic Species Group Chair
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 - State-wide herring and smelt science and fishery management
- Olaf Langness, olaf.langness@dfw.wa.gov
 - Eulachon fishery management and biology

