Beach Spawning Forage Fish

Vitally Important, Virtually Ignored

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Sea Watch Society
What is a forage fish species?
What is a forage fish species?
Eulachon (Thaleichthys pacificus)

Eulachon typically live for 3–4 years in the ocean. They migrate to coastal rivers in the early spring, swimming upstream with the incoming tide to spawn at night on shallow gravel bars.

During spawning, each female eulachon releases over 25,000 tiny eggs. These are fertilized by the male eulachon and stick to the gravel and sand on the river bottom.

Eulachon eggs incubate for 1 to 2 months, hatching at night into wispy larvae barely 5mm long. River currents carry them out to the ocean, where they feed and grow into adult eulachon.

Eulachon Spawning Rivers

Eulachon (or oolichan) are members of the smelt family. They are also known as candlefish, oilfish, small fish, salvation fish and fathom fish. When they swim into coastal rivers to spawn in the early spring, they are eagerly sought by sea lions, seals, wolves and eagles.

They are among the first fish that can be readily caught in the spring, providing nutritious and abundant food for First Nations people. The eulachon's high oil content is rendered into a fine grease, a staple food and commerce item for coastal First Nations.
Forage Fish in the NE Pacific

Pacific Herring

Capelin

Eulachon

Northern Anchovy

Pacific Sardine
Forage Fish in the NE Pacific

Pacific Sand Lance

Surf Smelt
Forage fish in the food web

Seabirds
- Common murre
- Black-vented shearwater
- Elegant tern
- Heermann's gull
- Marbled murrelet
- Rhinoceros auklet
- Short-tailed shearwater

Large Fish
- Chinook salmon
- Albacore tuna
- California halibut
- Coho salmon
- Jack mackerel
- Pacific bonito
- Pacific hake

Sharks and Rays
- Blue shark
- Bigeye thresher
- Shortfin mako
- Soupfin shark
- Thresher shark

Cephalopods
- Humboldt squid

Mammals
- Humpback whale
- Baird's beaked whale
- California sea lion
- Fin whale
- Harbor porpoise
- Harbor seal

Credit: Pew Charitable Trust
Drivers of ecosystem change

Forage fish biomass

Likelihood of population decline:

- Forage fish specialists – 7.5X greater
- Forage fish specialist and pursuit diver – 11X greater
- Declining biomass of forage fish - limits predator recovery

Vilchis et al, Conservation Biology 2015
Forage fish in the food web

Forage fish stocks are critical to Chinook and Killer Whale recovery

Chinook – forage fish specialists
• 50% Sand lance
• 22% Herring
• 28% other

BC’s resident killer whales – chinook specialists
Forage Fish Fisheries

Global economic importance of forage fish

**TOTAL** $16.9 BILLION

Direct value of commercial forage catch $5.6 billion

Supportive value of forage fish to other commercial catch $11.3 billion
Surf Smelt Fishery - BC
Forage Fish Fisheries
Marine Shoreline
Spawning Habitat

Surf Smelt eggs
Photo: WDFW

Forage Fish Spawning Habitats in the Nearshore Zone of Puget Sound

Surf Smelt
Sand Lance

Sand-gravel beach zone
Cobble-boulder zone
Outer tidalflats
Eelgrass beds
Red algae

Herring
Anchovy
Pelagic, open waters

Anadromous, to rivers

Herring spawn
Photo: FSJ
Pacific Sand Lance

Life Span

Fisheries

Habitat protection
Pacific Sand Lance

Sand and pebble

High to mid-intertidal

Spawning Season

Embryo incubation
Surf Smelt

Life Span

Fisheries

Habitat protection
Surf Smelt

Pebble/sand

High intertidal

Swash/gravel

Spawning season
Intertidal Spawning Habitat Formation – Beach Geology and Drift Cell Management

Beach spawning habitat *is largely derived from land.*

- Drift Cells start with *erosion* at bluffs and
- sediment is *transported* along the beach face
- to end with *deposition* at sandy spits

Bluff erosion is natural and a primary physical process maintaining sediment inputs – we need to manage it.
Beaches are “dynamic rivers” of gravels erosion from “feeder bluffs” & coastal processes (drift cells) build beaches and distribute spawning substrate along beaches. *Streams and creeks* provide spawning sediments to beaches.

*Logs* deposited on the upper shoreline & gently sloping beach faces buffer wave energies protecting shorelines from erosion.
Beach Spawning Forage Fish

Beaches – likely the most imperiled marine habitat on our coast

Shoreline modifications and climate change

Sea Level Rise and Coastal Squeeze”

“Coastal Squeeze”
Beach Spawning Forage Fish
Virtually ignored - Habitats at Risk

Shellfish Aquaculture

Goeduck “farm”

Denman Island - beaches as roads
Beach Spawning Forage Fish

Virtually ignored - Habitats at Risk

Shoreline pollution
BC Shore Spawners Alliance arose out of the need to raise awareness around the ecosystem value of beaches & the rapid loss of surf smelt and Pacific sand lance spawning habitat.

1. Throughout the vast majority of BC coastline, Pacific sand lance and surf smelt spawning habitats have not been surveyed.

   This data gap hinders coastal zoning and our attempts to maintain marine ecosystem health.

2. There is a lack of capacity for government agency programs to conduct ground surveys for intertidal forage fish spawning habitat.

3. Throughout British Columbia, shoreline modifications are occurring at a rapid pace
1. a. Define and evaluate marine habitats utilized by Surf smelt and Pacific sand lance for spawning
   b. Define marine riparian zones used by juvenile salmonids for rearing
   c. Determine the spawning stock structure of Surf smelt
1. British Columbia Spawning Locations Prior to 2000

No data on sand lance spawning sites until work by Thuringer and friends 2001-2002

Surf Smelt Spawning Locations

- Spawning Survey
- Adults recreationally fished
- Furry Creek, Howe Sound
- Sandy Cove, West Vancouver
- Wreck Beach, Vancouver
- White Rock
- Dundarave Beach, West Van
- Port Renfrew

ONE BIG DATA GAP!

Adding to the 100 positive spawning beach detections to date.
2006-2016 Embryo Survey Results (R de Graaf and BCSSA surveys)

Adding to the 100+ positive spawning beach detections to date – approx. 30 kms. Over 300 beaches monitored.
SoG SPAWNING SEASONS and DURATION OF SPAWNING

- Surf Smelt Spawning Stocks – summer and **winter** spawning stocks
- Prior to our surveys, BC literature only referred to summer surf smelt spawning stocks
- Surf Smelt – year round spawning confirmed for other areas of SoG
COASTAL LINKS and salmon survival
Valued Ecosystem Components

Forage Fish beaches provide FOOD FOR FISH

Diets of more than just chinook are of interest
Cutthroat trout, coho, pinks, chum, and sockeye
Rockfish, halibut, ling cod

Marine Riparian Zone (includes the seaweed wrack)

Juvenile salmonid survival
From chinook, coho, chum
Adult cutthroat

Human Security
erosion protection
water quality protection

Wildlife buffer/corridor
Litter Fall and Nutrient Inputs

Jim Brennan
WA Sea Grant

G.L. Williams Assoc. LLC
Spawning Habitat Characteristics

Terrestrial habitat linkages with the marine nearshore ecosystem – Marine Riparian (“supralittoral”) Zones

Feeding habitat for juvenile salmonids due to significantly greater abundance of terrestrial insects when supralittoral vegetation is present.

Overhanging Shade Vegetation
Stabilizes slopes and provides crucial shade and wind break for incubating summer surf smelt eggs.

Loss of shade vegetation can create influence mortality of surf smelt eggs is 95-100% due to thermal shock after shade vegetation removal.

Source: Brennan and Calderwell 2004

Stomach contents of 14 cm juvenile Chinook salmon

Spawning zone

Wreck Beach
“...the importance of insects as high-quality prey highlighted the terrestrial link to the marine feeding of Chinook salmon and suggests that shoreline development and land use changes will affect feeding opportunities for these fish in Puget Sound.”

Duffy et al. 2010

• Nearshore sites, insect and marine gammarid amphipods (in the sea wrack)
• Are dominate prey sources for juvenile Chinook (Duffy et al 2010)
• 65X more insects at sites with an intact marine riparian buffer (Romanuk and Levings 2010)
• Off shore, adult Chinook feed on juvenile and older herring (Duffy et al 2010)
• Nearshore, adult Chinook feed on larval and juvenile sand lances (Duffy et al 2010)
Slope Stability

Jim Brennan
WA Sea Grant
Understanding the Primary threat to surf smelt & Pacific sand lance spawning habitats: Shoreline Modifications

- Disrupt sediment transport by disconnecting beaches from sediment source, causes beach starvation.
- Physically buries habitat
- Removes riparian habitat critical for egg survival and important for juvenile salmonids

Real estate values win!

Shaffer, 2002
WDFW
Shoreline Alteration

Feeder bluff converted to housing & paved driveways with drainage culverts – starving beaches of sediment

Wave scouring against seawalls results in the loss of spawning gravels for surf smelt and sand lance. Coarsening of sediments can decrease subtidal sand lance burrowing habitat and eelgrass habitat.
Shoreline Hardening & Modification

Rip rap on property line in the upper intertidal zone. Common ineffective “hard approaches” to protecting shoreline properties.

Results:
• loss of upper intertidal zone;
• buried spawning sediments;
• loss of sediment flow seaward
• complete loss of spawning habitat for surf smelt/sand lance

Surf smelt spawning zone

Loss of spawning zone
What are we losing?
Simply put, fewer forage fish = less food for the marine ecosystem = predator population declines

What has the BCSSA found?

- **Lost:** historic surf smelt spawning grounds of White Rock shores
- **Near Loss:** West Vancouver/Dundarave surf smelt spawning grounds (kms down to meters)
- **Rapid Decline:** Burrard Inlet surf smelt stock yet recreational fishing pressure continues
- **Declining on the West Coast:** Port Renfrew surf smelt
- **And coming to a coast line near you:** ?

White Rock Pier & Promenade
Science and Stewardship

Community Monitoring – volunteer and NGO driven!

Sexy scientific gear!

Identify spawning habitat and obtain bulk sample

Smelt eggs

Photo: de Graaf
Beach Surveys are Essential
10% of “potential” habitat surveyed is actually used for spawning

SO FILL YOUR BOOTS – and your buckets

Sieve and wash sediments to 0.5 mm for sorting later

Photos: L. Moulton
Science and Stewardship

Microscope examination of sediments to find eggs

• Surf smelt have an adhesive flange;

• Sand lance eggs usually covered in sand grains)
GIS BASED - BC FORAGE FISH DATA ATLAS

Putting your survey data To work

Providing data to community members and shoreline managers throughout BC

Developed by:
Community Mapping Network
With BC Shore Spawners Alliance
STEWARDSHIP to protect and preserve marine ecosystems
Filling regulatory “gaps” to achieve Official Community Plan
And Land-Use Plan Goals:

1. recognize the need to manage shoreline processes
   drift cell management – beaches and bluffs
   protect marine riparian zones & juvenile salmon corridors

2. Strengthen OCP language to include intertidal forage fish
   spawning and rearing habitat:
   sandy/gravel beaches
   spawning for smelts and Pacific sand lance
   eelgrass and benthic seaweeds
   spawning habitat for herring and rearing habitat for
   many species including smelts and sand lance.
   (herring spawn on more than just eelgrass)
Getting connected with
the BC Shore Spawners Alliance

Our goal: to provide education and training to protect intertidal forage fish spawning and rearing habitats.

- What we are doing:
  We offer training workshops, expertise, GIS data entry tool, presentations, and assistance in designing surveys, and educational materials.

Help protect the marine environment!
Contact us: Foragefish.bc@gmail.com
So long and thanks for all the fish!
Citizens’ Science – Community Monitoring Teams

Prince Rupert
- Hecate Strait Streamkeepers - Haida Gwaii
- Photo: Jason Shafto

Ucluelet
- Sandy Beach Babies
- We slick together

Barkley Sound
- Youth Outreach

Hecate Strait Streamkeepers - Haida Gwaii
- Sunshine Coast Friends of Forage Fish
- Stanley Park/Wreck Beach
- Friends of Cortez Is.

Alliance For Rural Metchosin
- Forage Fish Matter!

Cowichan
- Forage Fish Friends

Project Watershed – Forage Fish Friends