

Using Inventory Data to Predict Potential Forage Fish Spawning Habitat



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IMPORTANCE - Why model habitat instead of just going out and measuring it?

- Limited resources
 - Budget constraints
 - Experienced personnel
 - Large study area



•Of course we would like to actually survey all the beaches in Puget Sound but we are limited by 1)money, 2) trained eyes to find spawn on beaches and the enormity of the study area which in Puget Sound is close to 5,000 km

TEST HYPOTHESIS

- Can the ShoreZone Inventory be an effective screening tool for determining potential forage fish spawning beaches?



- The ShoreZone inventory is the most current and comprehensive inventory of intertidal habitat in Washington State
- We wanted to test ShoreZone's ability as a screening tool.
- We chose forage fish spawning beaches because they are 1) a huge biomass and prey resource for a variety of organisms from birds to halibut, 2) Upper intertidal spawning areas are particularly vulnerable to human development which continues to expand faster than we can survey beaches and 3) We generally don't know a lot about why forage fish spawn where they do.

DATA OVERVIEW – ShoreZone Inventory

- Mapped > 3000 miles of saltwater shorelines state-wide (1994-2000).
- The primary mapping element is a line *Unit*
 - Describes physical and biological habitat attributes.



- SZ Inventory completed in 1994-2000 for all of Washington's 5,000 + km of marine shoreline.
- Primarily a Line Based data set
- The basic concept underlying the SZ inventory is that a shoreline can be divided into geomorphologically similar sections called UNITS.
- Within each unit, geomorphology (I.e. beach form and materials), biological features (like kelp and eelgrass) and anthropogenic features (like shoreline modification, piers) is described.



DATA OVERVIEW - Beach Spawn Data

- WDFW beach spawn data set has been developed from many years of field sampling (by Dan Penttila, WDFW)
- Includes beach spawning data for surf smelt, sand lance, and rock sole

- Primarily the work of one intrepid Biologist at WDFW, Dan Penttila; he was the first one to document Sand lance as an upper intertidal beach spawner in WA state.
- WDFW assembled these data into a line based GIS coverage in 2000.
- The data includes surf smelt, sand lance and rock sole spawning beaches.
- One major caveat to the data set is it does not differentiate between forage fish spawn absence and no data

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- The first step was exclusively a GIS exercise. Each ShoreZone unit was coded for forage fish spawn presence.
- We then had to decide how much spawn occurrence within a unit was adequate for further correlation to ShoreZone attributes.
- Initially, we set the bar at 100% overlap which provides the highest correlation between the forage fish spawning beaches and ShoreZone attributes but uses the least amount of data.
- We then incrementally dropped the required overlap until optimal level was achieved. By optimal level I mean we still achieved significant correlations but we didn't add unnecessary sample noise to the model. That optimal level proved to be 80%.

TWO MODELS				
Model	Species	Study Area	SZ Attributes	Data Set Overlap
Low Resolution	Sand Lance	Statewide	Geomorphic Form	100%
High Resolution	Sand Lance	Puget Sound	Across Shore	80%

- Once the two data sets were combined, we created two models to screen for Potential forage fish habitat in Washington State
- The Low Resolution Model compared Sand Lance spawn occurrence to Geomorphic Beach form and materials for all of the Washington coast where there was 100% overlap between the forage fish data and the ShoreZone data
- The High Resolution Model compared Sand Lance occurrence to ACROSS SHORE attributes in Puget Sound where there was 80% overlap.

RESULTS
Occurrence of Sand Lance in
ShoreZone Units

Occurrence of Sand lance and Surf Smelt			
Spawner	100% Overlap (km)	80% Overlap (km)	Total (km)
Sand lance	96.1	136.4	245.4

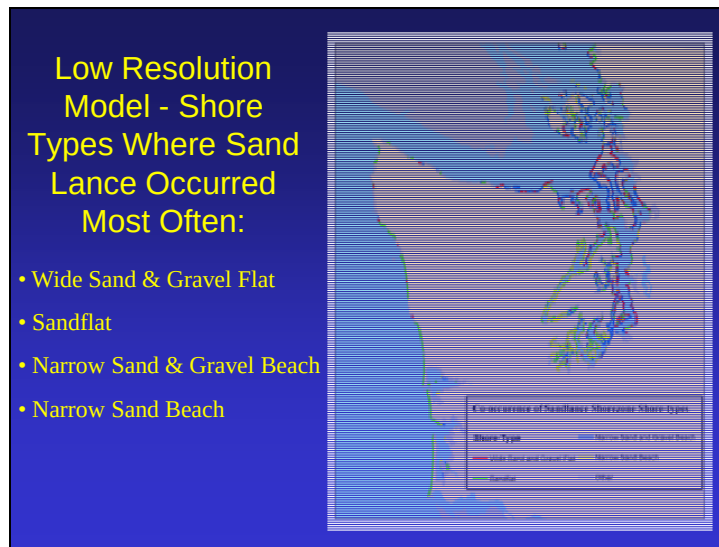
- Looking at this table, we see that more than 245 km's of Washington Shoreline has documented beach spawning occurrence. The #'s to key into here are differences between the 100% and 80% overlap.....40% of data used at 100 and over 55% at 80 - better usage of existing data without adding too much noise to the study.

**Low Resolution Model –
Co-occurrence of Sand Lance and
Shore Types**

Rank	Shore-Type	State-Wide		Sandlance	
		km	%	km	%*
1	wide S&G flat	393.7	8%	23.9	25%
2	sandflat	751.4	15%	23	24%
3	narrow S&G beach	642.4	13%	20.6	21%
4	narrow sand beach	565.5	11%	17.4	18%
5	wide sand beach	123.2	2%	5.7	6%
6	man-made permeable	329.6	7%	1.2	1%
7	narrow S&G flat	29	1%	1.2	1%
8	rock ramp w S&G beach	73.3	1%	0.7	1%
9	platform w S&G beach	28.7	1%	0.6	1%
10	organics / fines	868	18%	0.6	1%

88%

- The most striking finding from this table is the fact that almost 90% of Sand Lance spawn occurs on 4 shore types!
- That's an impressive correlation.
- Next I'll show you what this distribution looks like geographically

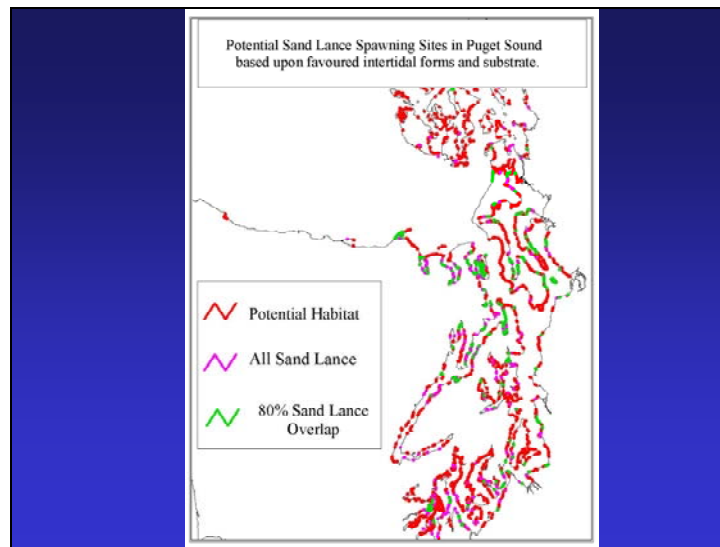


- This map shows the top 4 of 34 total Shore types Statewide where Sand lance are most likely to spawn.
- Someone could use a map like this to prioritize SL spawn surveys

High Resolution Model – Sand lance Spawn Occurrence by Beach Form and Material in the Upper Intertidal						
Co-occurrence of Spawn and Beach Form						
Rank	Geomorphic Form	Puget Sound		Sandlance		Rep. Ratio
		km	%	km	%	
1	Beach Face	1770	45%	78	57%	1.27
2	Beach Berm	351	9%	31	23%	2.55
3	Seawall	342	9%	13	10%	1.12
4	Inclined Beach	171	4%	10	7%	1.63
Co-occurrence of Spawn and Beach Material						
Rank	Material	Puget Sound		Sandlance		Rep. Ratio
		km	%	km	%	
1	Sand, Pebble	414	11%	30	22%	2.12
2	Sand	360	9%	19	14%	1.49
3	Pebble, Sand	169	4%	10	7%	1.72
4	Logs - Sand, Pebble	83	2%	9	7%	3.28
5	Pebble - Sand	306	8%	9	7%	0.89

- Now I will discuss the results of our high resolution Sand Lance Spawning Habitat Model
 - This model correlated Sand Lance Spawn occurrence to beach forms and materials in the upper intertidal zone
 - These tables rank the % spawn occurrence on forms and materials in descending order. The majority of sand lance spawn was found on beach-faces with sand.
 - Another important thing I want to point out in the tables is the Representation ration. A representation ratio of >1 means a form or material was over represented by the Spawn data compared to Puget Sound as a whole.
 - Beach Berm and Logs over Sand and Pebble had the highest ratios. These attributes suggest a stable or accretional environment.
 - We also correlated Sand Lance Spawn to exposure and found that 96% of spawn occurred on Protected or Semi-Protected beaches.
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- We compared Sand Lance spawn occurrence to geomorphic form and material in the upper intertidal zone
 - This slide shows the results. Top table shows the forms most highly correlated to spawn occurrence
 - Representation ratio shows shoreline forms and materials that are over-represented by sand lance spawning habitat ($R > 1$)
 - We also saw beach berms and logs in abundance of 2.5 and 3.28 times on beach on spawning sites compared to Puget Sound as a whole indicating a stable or accretional environment.
 - This next slide supports these findings

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- Now I want to show you the geographic distribution of our Potential Sand Lance Spawning habitat Model results
- 1st map shows the actual distribution of the Sand Lance Spawn data that overlapped with ShoreZone units by more than 80%
- 2nd map shows that a lot of the spawn data occurred in less than 80% of ShoreZone units. However, 80% overlap gives you a good spatial representation of Puget Sound as a whole.
- Final map shows potential Sand Lance Spawning habitat using the highest ranked forms and materials shown in the previous slide. Distribution matches well with actual spawn data in general and includes much more of the sound.
- Not surprising considering WDFW finds Sand Lance Spawn on only about 30% of the beaches where they expect it to occur.

CONCLUSIONS

- ShoreZone is a valuable screening tool for identifying forage fish spawning beaches
- Can serve to focus and prioritize sampling efforts
- <http://www2.wadnr.gov/nearshore/index.asp>

• Nothing replaces actually going to the field and conducting the surveys. However, these results show that ShoreZone can be an extremely useful tool for prioritizing those efforts not only in Washington State, but in BC and perhaps soon in Alaska.

• To be useful data needs to be easily accessible... All Washington DNR Nearshore Habitat Program data is available on our web site:

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- WDFW: Dan Penttila



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