Virtual Transects:
A Novel Technique for Assessing the Linear Extent of Floating Kelp Beds

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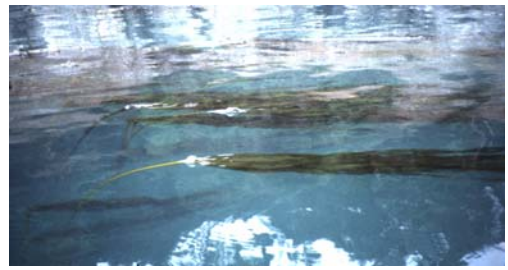
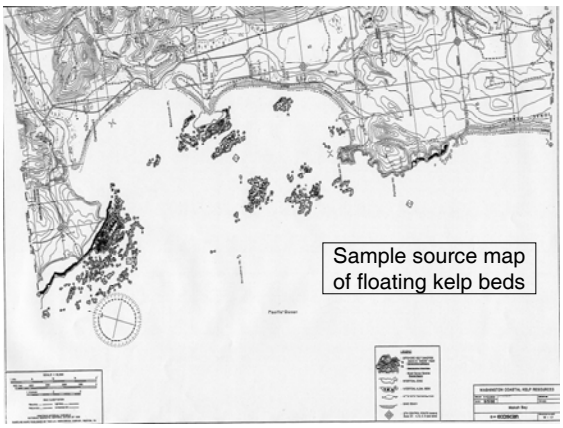
Project Motivation
To Identify, delineate, and quantify Essential Fish Habitat for West Coast Groundfish, including Habitat Areas of Particular Concern.

Primary Question
What is the spatial distribution and abundance of floating kelp bed habitats along the coasts of Washington, Oregon, and California?

Our Objectives
- Create a linear abundance metric for along-shore habitat (kelp), and
- Develop a consistent and robust technique

Nereocystis luetkeana – Bull kelp





Why a linear abundance metric?

- **Habitat Distribution and Function**:
  - Kelp has a linear, along-shore distribution, as well as an areal extent
  - Linear and areal distributions and abundance provide different and complimentary information. Leading to more insight into habitat function and usage by fish.
- **Normalization:**
  - Linear metric can be normalized to the length of the reference line or baseline (in this case, shoreline), providing a relative index of abundance.
  - Areal abundance is difficult to normalize w/out well-georeferenced data delineating 'potential' kelp bed habitat areas (suitable depth and substrate type).
- **Novel:** Not easily derived with standard GIS functions

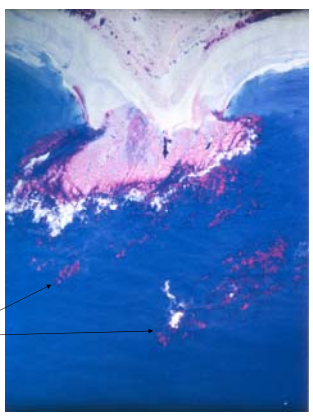
General Approach

- Input vector GIS data:
  - ***Baseline*** = The line from which one will detect another object (example: shoreline)
  - ***Feature of interest*** = the feature to be detected (example: kelp)
- ***Virtual transect*** extended a specified distance from the baseline (shoreline)
- When transect intersects the feature of interest (kelp polygon), assign a code to the origin point on the baseline
- **Final Products**:
  - **Length or proportion of shoreline with kelp offshore**
  - **Delineation of kelp bed distribution along the coastline**

Methods - Specifics

- Algorithms written in C++ (for flexibility and speed)
  - Connect shoreline vertices into contiguous line
  - Generate sampling points at user-specified interval
    - every 10 meters for this analysis
    - Based on source data resolution: minimum mapping unit of 40m
  - Spatially index vectors to increase search speed
  - Calculate transect direction
  - Extend transect to detect kelp and record detections
- ArcInfo and ArcView used to provide data for algorithm (.gen format), and store and view results

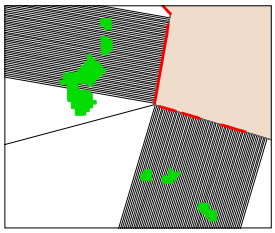
Source Data: Color-infrared photography



Shoreline Resolution and Transect Direction

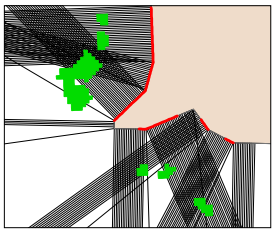
How do they affect linear metrics for kelp abundance and distribution?

1:2,000,000 scale,
no shoreline averaging

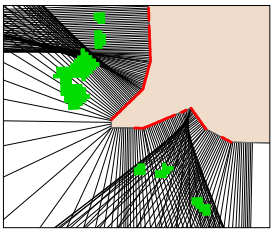


- Compare 1:2,000,000 scale shoreline to 1:70,000 scale shoreline
- Compare methods for calculating transect direction
  - **Basic method**: Perpendicular to a line connecting the two points adjacent to the transect origin (no averaging)
  - **Averaging method**:
    - User-specified averaging distance
    - Find two average positions: one for points preceding the transect origin, one for points following the transect origin
    - Extend transect perpendicular to a line connecting the average positions

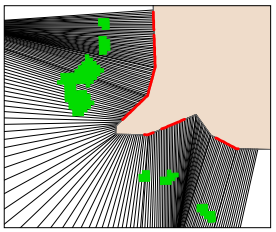
1:70,000 scale,
no shoreline averaging



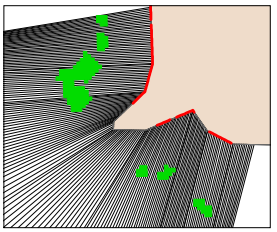
1:70,000 scale,
100m shoreline averaging



1:70,000 scale,
500m shoreline averaging



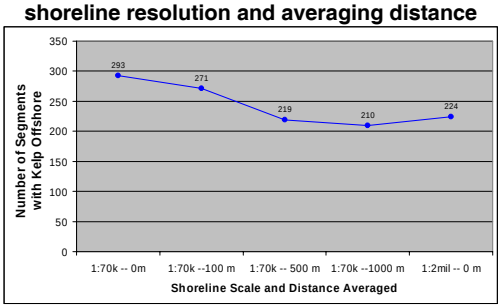
1:70,000 scale,
1000m shoreline averaging



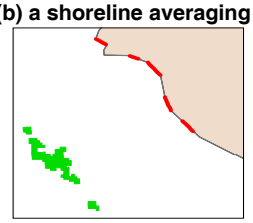
Linear metrics for kelp beds in Washington State (1996) Straits of Juan de Fuca and Pacific Coast.
Comparison of shoreline resolution and averaging distance.

Shoreline Scale	Averaging Distance (m)	Shoreline Leng. w/kelp (km)	Percent of Shoreline w/kelp
1:70,000	0	145.14	**8.6**%
1:70,000	100	148.12	**8.8**%
1:70,000	500	146.87	**8.7**%
1:70,000	1000	146.82	**8.7**%
1:2,000,000	0	153.35	**9.1**%

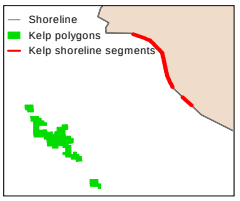
Total number of kelp shoreline segments relative to shoreline resolution and averaging distance



Comparison of kelp shoreline segment distribution:
(a) a non-averaged shoreline and
(b) a shoreline averaging distance of 1000 meters.



(a) 1:70,000 scale,
no shoreline averaging



(b) 1:70,000 scale,
1000m shoreline averaging

Conclusions

- **Linear metrics are robust to changes in**
  - Shoreline resolution
  - Averaging distance for transect direction
- **Spatial representation of kelp segment improves with averaging distance**
  - As transects become more parallel, fewer kelp beds missed or represented multiple times
  - More intuitive representation of offshore kelp polygons
- **Quantitative results are comparable to independent estimate of percentage of shoreline with floating kelp.**
  - Washington DNR ShoreZone estimate: ~%15
  - Virtual Transects estimate: ~9%

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Citation: Bailey, A. and R. Comstock. 2000. Virtual transects: a novel technique for assessing the linear extent of floating kelp beds. Poster presented at the Sixth International Conference on Remote Sensing for Marine and Coastal Environments, Charleston, South Carolina, 1-3 May, 2000.