



Alaska Department of Transportation & Public Facilities

Ruth Carter, PE, and Harvey Smith, PE

Coastal Engineering Section

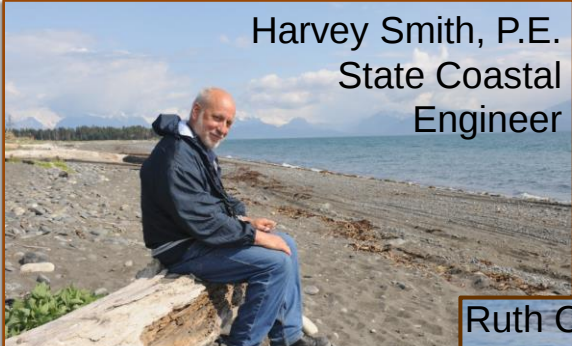
20 October 2014



Soft Designs for a Harsh Climate: Trends in Coastal Engineering



Photo by Harvey Smith



Harvey Smith, P.E.
State Coastal
Engineer

At Bishops Beach, Homer, AK © Ruth Carter

Who We Are



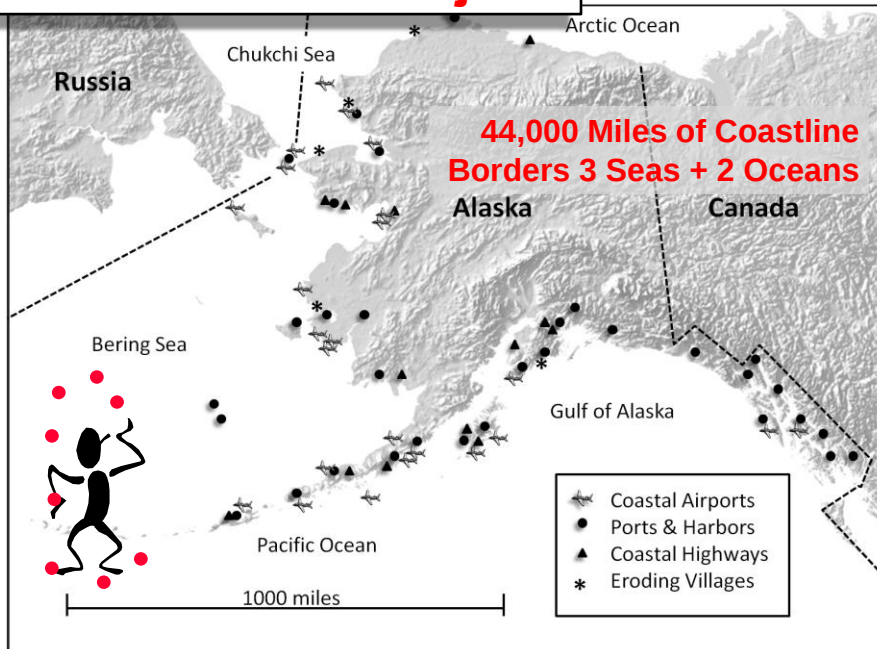


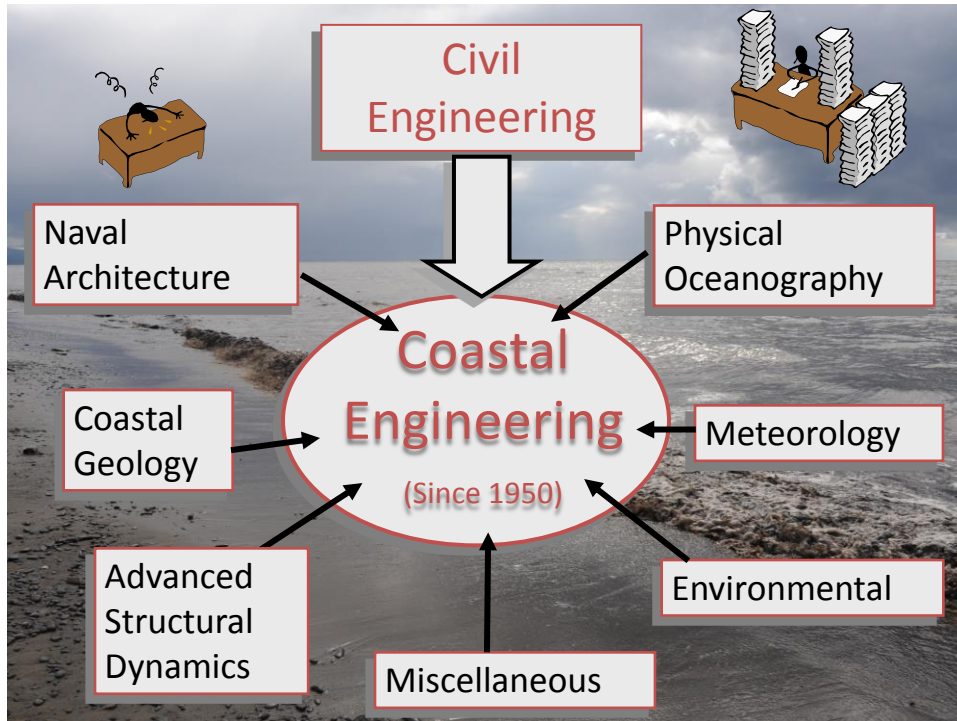


Ruth Carter, P.E.
Coastal Engineer

On St George Breakwater AK 9-2012 © Harvey Smith

ADOT&PF Coastal Projects





Large Coastal Events combined with Improved Communication



Heightened Awareness of Risks.
Greater Concern about Natural Coastal Processes.

MIMIC RATHER THAN FIGHT NATURE

So we need to know what's
happening on our beaches



HOW? Work with Local Community

Rely on Personal Observations
Use a Local Observers to Record Events
Develop Methods for Interpretation
Understand local cultures, beliefs, history
Listen to community elders and leaders
Learn to interpret their stories

Photo by Harvey Smith, Newtown 2011

AND Use Local Materials like this Vegetated Berm Constructed by Shaktoolik, AK

This vegetated coastal berm
combined with wood debris was
the inspiration for a CIAP grant.

Photo © Ruth Carter 2013

Is Your Beach Healthy?

Healthy Beach in state of dynamic equilibrium



Is there vegetation?
Are there dunes?
Can you see seasonal changes?
Do you have cobbles or small
sand? Driftwood?

Eroding Beach with escarpments or small bluffs



Is there melting
permafrost?
Have there been changes
to the beach like
construction of a
revetment?

Photos © Ruth Carter 2013

Identify a Clear, Concise Problem Statement and Objectives

Do you need an Evacuation Road to High Ground? Or do you actually Need a Safe Location for the community during storm surge events.



Criteria

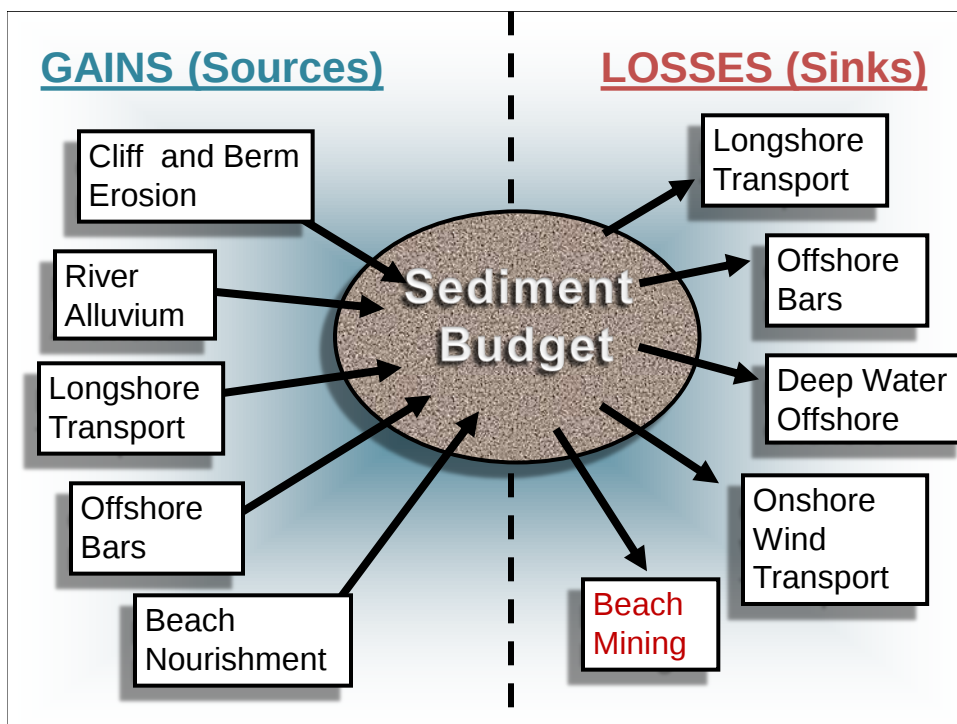
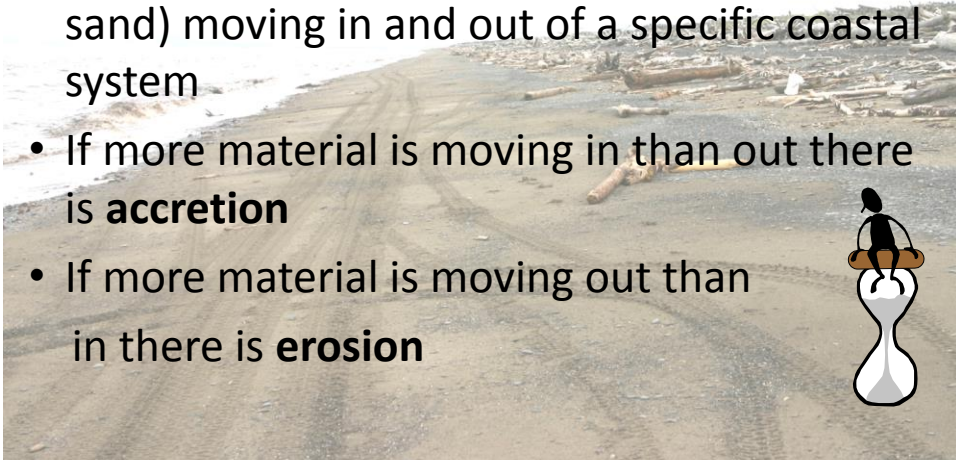
- Quick SAFE access during storm conditions
- Above 500 year storm surge flood elevation
- Provides shelter and is close to the community
- Has multiple uses such as Community Center
- Set back from coast

We also need to UNDERSTAND BEACH PROCESSES



All Coastal Work Begins with a **Sediment Budget**

- Accounts for the balance of material (e.g. sand) moving in and out of a specific coastal system
- If more material is moving in than out there is **accretion**
- If more material is moving out than in there is **erosion**



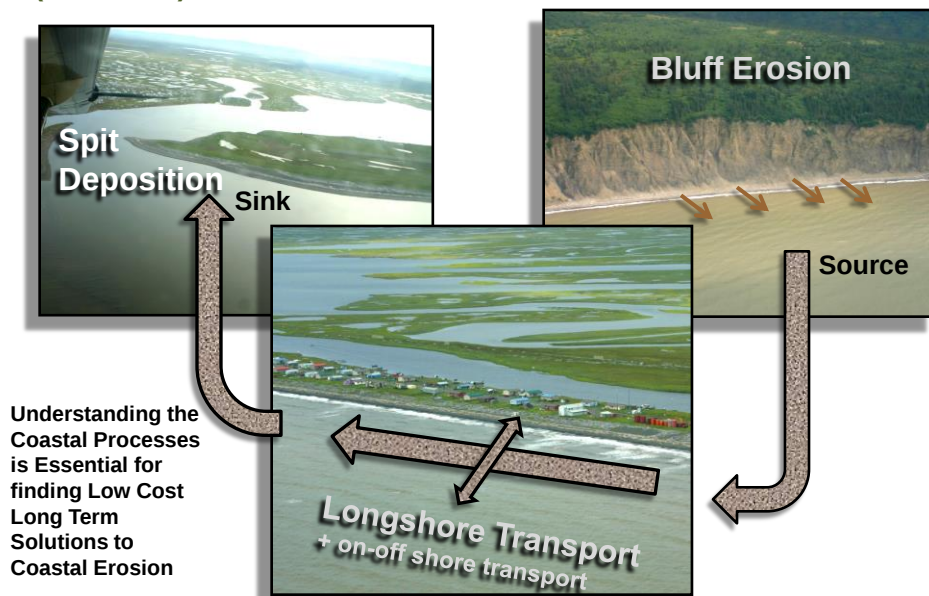
The term “Erosion” tends to have a negative connotation; however . . .

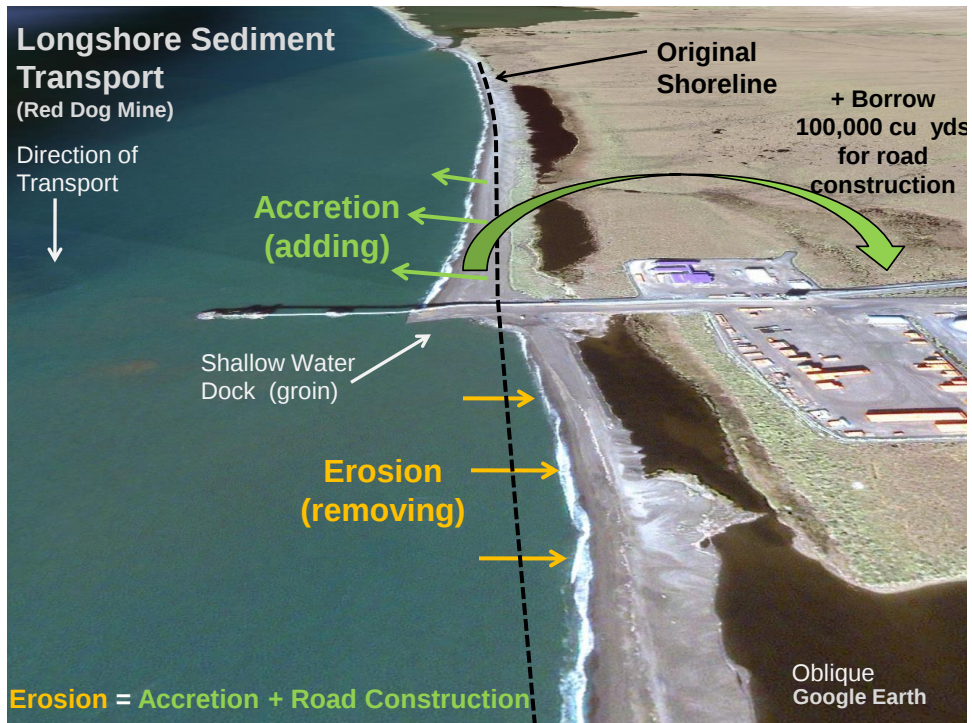
“Without Erosion (of Bluffs and River Banks), we wouldn’t have Beaches.”
~ HNS

Erosion only becomes a problem when the shoreline is encroached on by human buildings, roads and other development

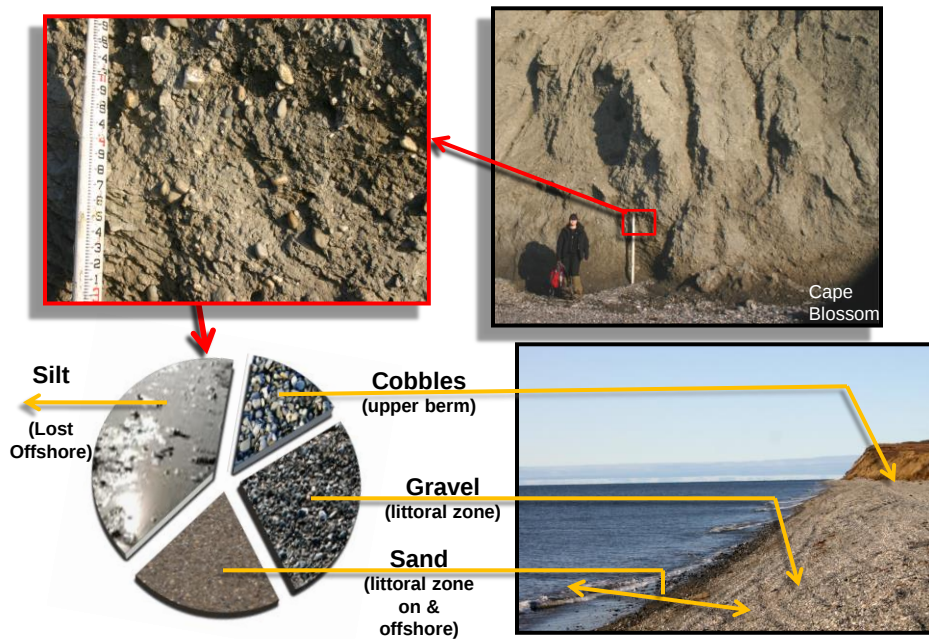
The Sediment Cell

(Shaktoolik)





Bluff Erosion . . . Where Does the Material Go?

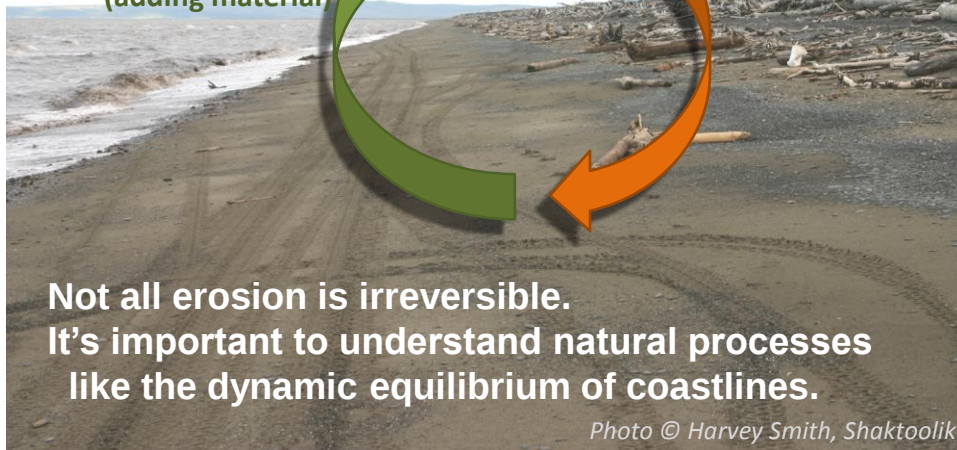


The Natural Beach Cycle

Cross-Shore Transport

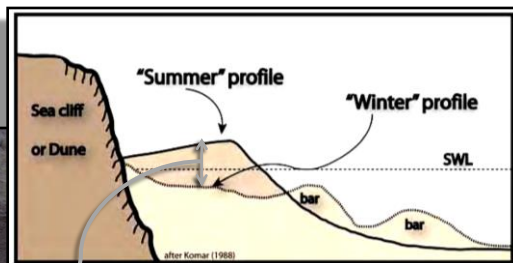
Accretion
Spring and
Summer
(adding material)

Erosion
Fall and Winter
(removing material)



Cross-Shore Transport

Seasonal or Storm-Induced
beach profile change



Determine dynamic (vertical) range of
the beach, so that the structure toe is
not undermined.

For the past 20 years, the International Philosophy of Coastal Engineering has been to . . .

*"Design With Soft
Persuasion ...*

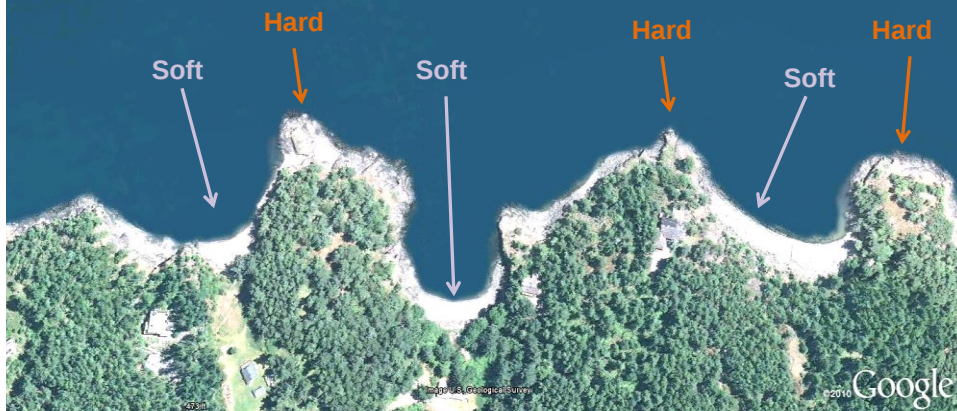


... Not Brute Force"

Hard vs. Soft Designs

Hard vs. Soft can be found Naturally in the Geomorphology of many Shorelines

Headlands are Generally "Hard"
And Pocket Beaches are Normally "Soft"



Design of Rock Coastal Structures Hard to Soft

(Note: structures get “greener” going down page)

Boulders
↑
↓
Sand

- **Statically Stable** (Rock or Concrete Armor Units)
- **Berm Breakwaters** (adjust to “S” shaped profile)
- **Dynamically Stable Beach** (usually cobbles)
- **Beach Nourishment** (usually sand or gravels)
- **Engineered Vegetation**

It can Generally be Said . . .

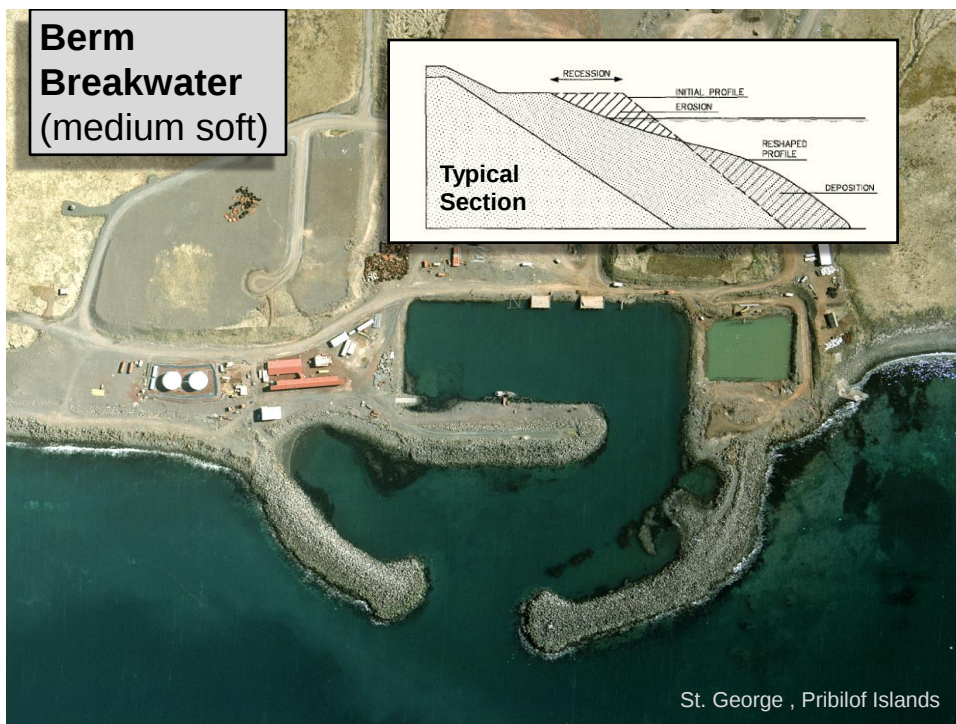
**“The Softer the
Structure the Harder
(more complex) the
Design.” ~ HNS**

- *Soft Structures are always moving and adjusting to natural processes.*
- *Need a thorough understanding of the local coastal dynamics for a successful project.*

Statically Stable - Traditional “Hard” Structure



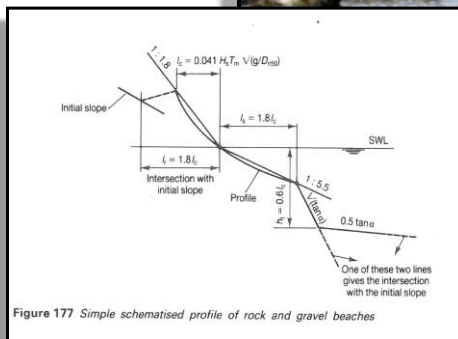
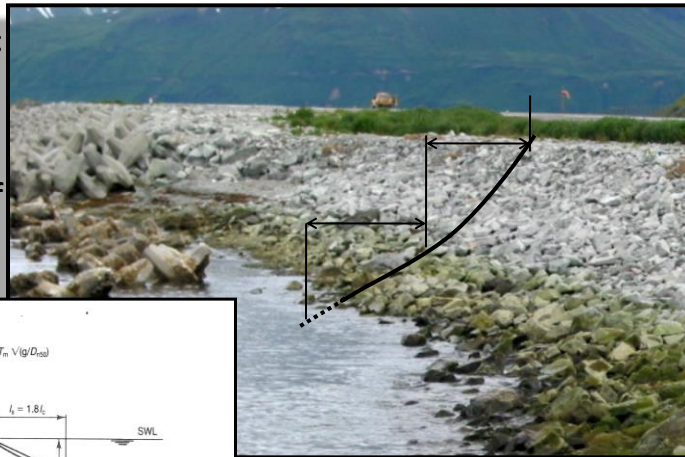
Berm Breakwater (medium soft)



Dynamically Stable Beach (Soft) - Unalaska Airport

Cobble Beach next to 8-ton concrete "Core-Locs"

About 1/10 cost of conventional rock revetment



8" to 12" cobbles placed along shoreline at natural angle of repose.

Wave action reshaped beach to "natural" profile.

Dynamically Stable Engineered Beach (Evolution) Unalakleet (soft)

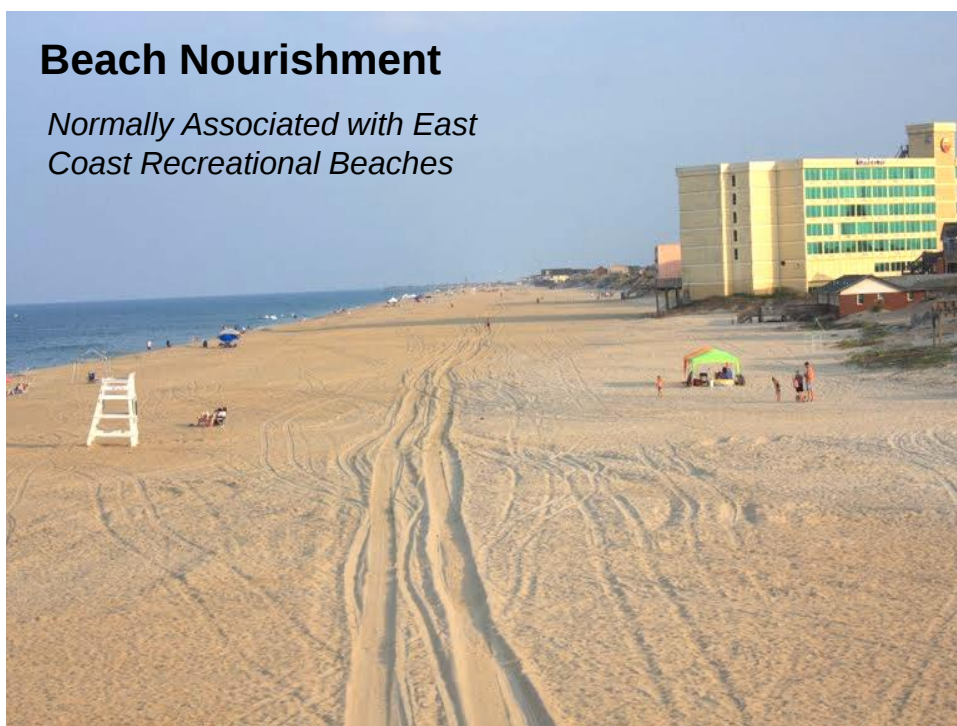
Problem

- 1000' of Coastal Airport Access Road Washed Out
- No Local Rock Large Enough for Conventional Armor
- Shallow Water Offshore
- Insufficient Depth for Normal Barge Access
- Limited Funds

Solution

- Use local rock!

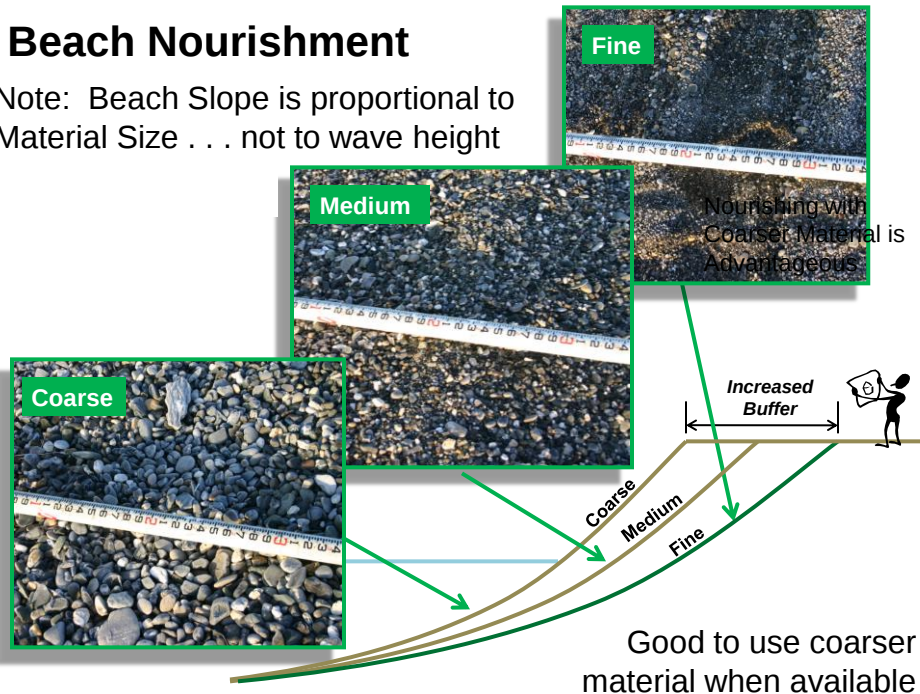






Beach Nourishment

Note: Beach Slope is proportional to Material Size . . . not to wave height

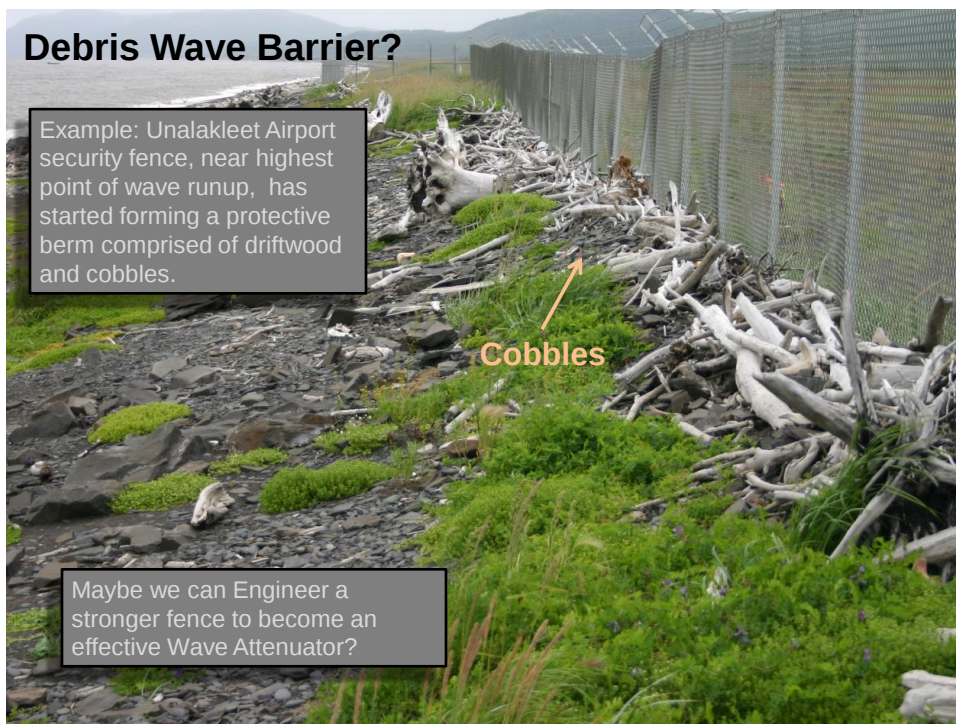


Newly Planted Beach Wildrye Sprigs (Experimental – Engineered Vegetation)









**Use Logs to Induce Turbulence and Attenuate Waves
Promote Gravel Berm Formation by Reducing Wave Inundation**



Beach Scraping

Location of
vegetated berm



Advantages

- Used successfully at Shaktoolik and Point Hope
- Increases barrier to wave runup and overtopping
- Material that erodes stays on the beach, so acts like beach nourishment

Disadvantages

- Creates greater water depth during surge events, which increases wave height
- Many unknowns

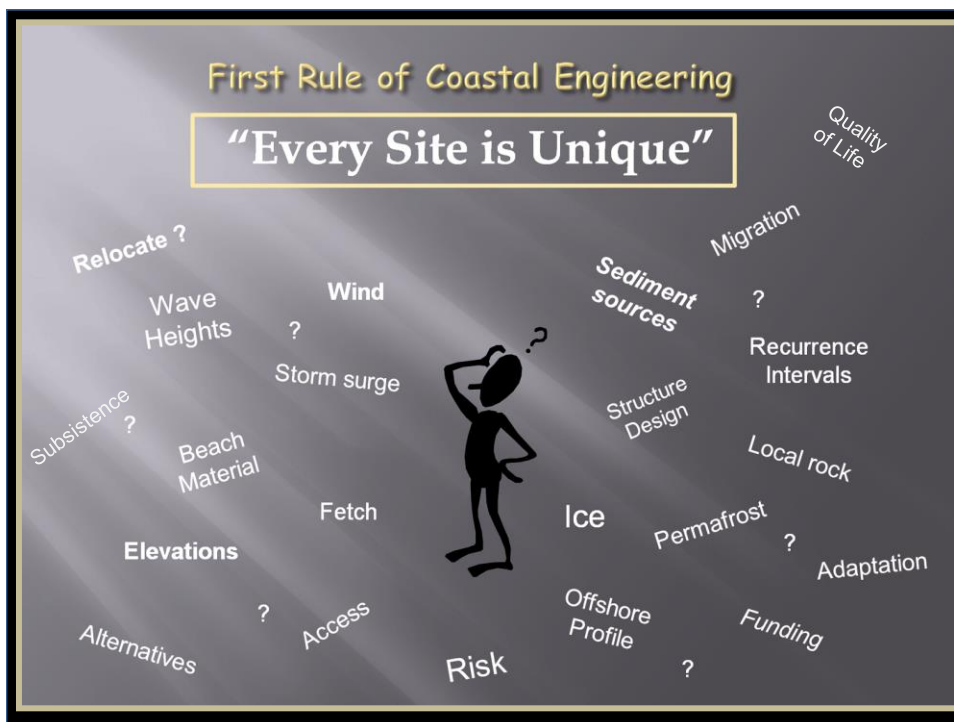


Photos Courtesy of Gloria Andrew, Shaktoolik, AK

QUALITY OF LIFE



Would you rather see rock or beach?
What about access?
Traditional use?



IF ERODING AT SAME RATE . . .



Where's the erosion problem?

Alaska fortunate due to sparse population

-- few dammed rivers and little coastal armoring



Look Toward the Future



Photo Newton © Ruth Carter

Preserve Quality of Life and Traditional Use



About 10 pm – the kids went swimming! -- Photo © Harvey Smith, Shaktoolik 2013

Climate change has become synonymous with natural coastal processes in Alaska, causing a heightened **awareness** of erosion.

Fuel Tanks in Shaktoolik

Concern over localized erosion

Solution

Local Community constructed Berm

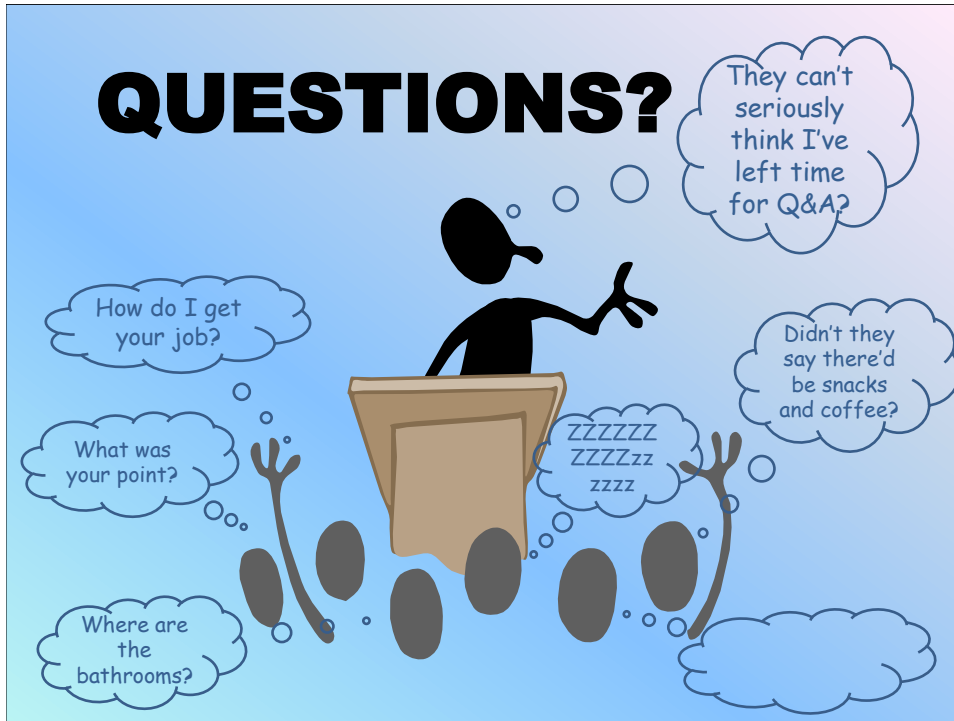
Mimicked Natural Beach

Blended Gravel with Driftwood

Photo Shaktoolik 2010 by Ruth Carter

Quyana - Thank You

Photo by Harvey Smith



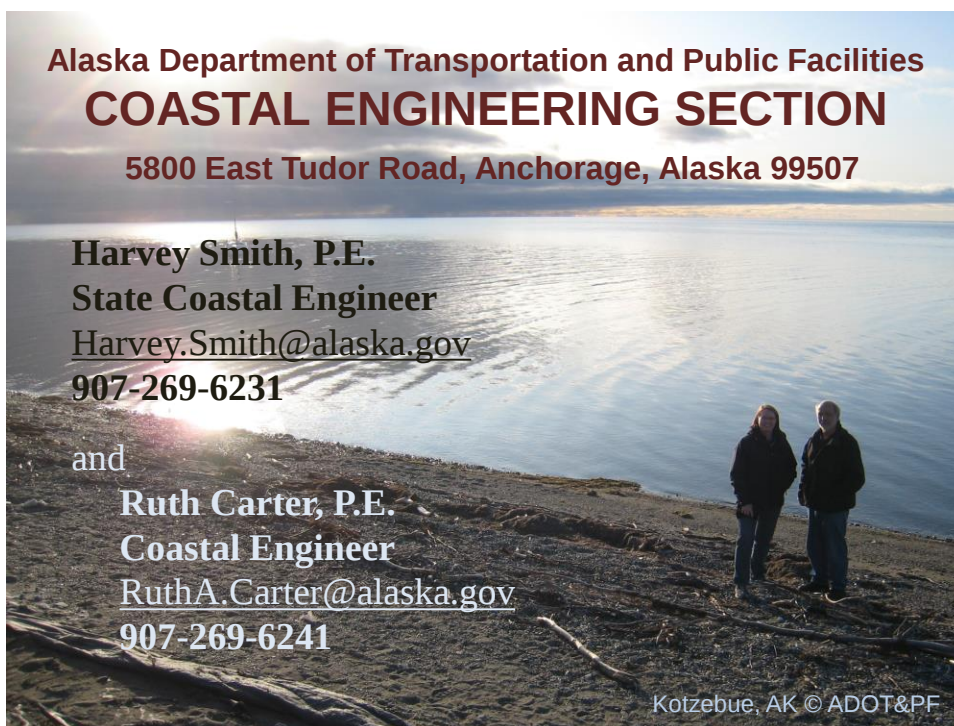
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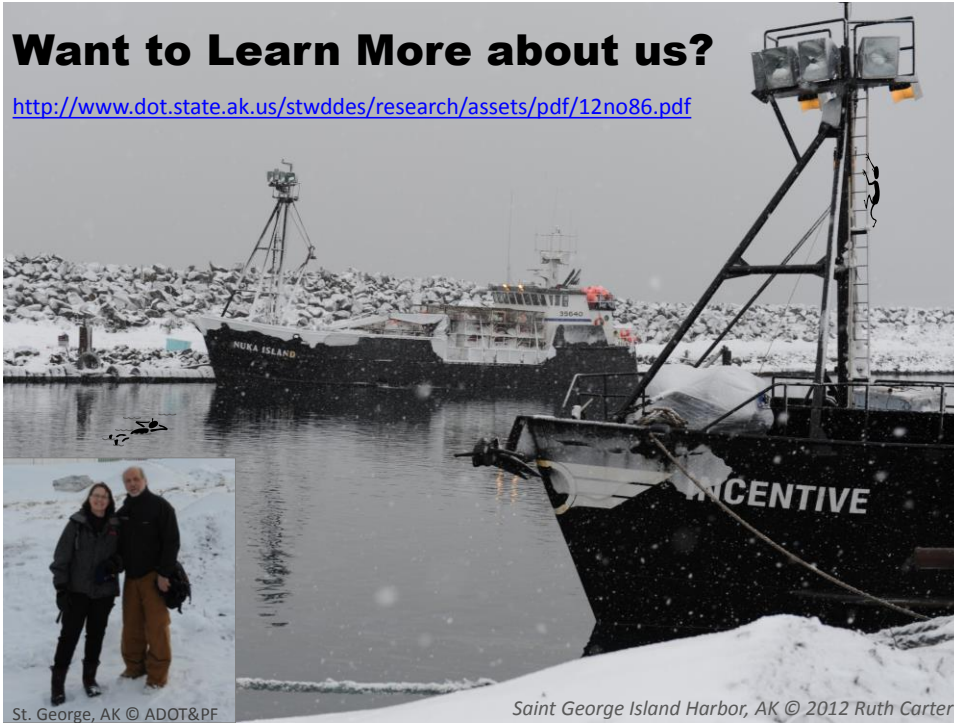
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Kotzebue, AK © ADOT&PF

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