State of Oregon
Department of Geology and Mineral Industries
Vicki S. McConnell, State Geologist

Open File Report

OFR O-04-11

Coastal Processes and Shoreline Erosion on the Oregon Coast, Cascade Head to Cape Kiwanda

By

Jonathan C. Allan[1]
Oregon Department of Geology and Mineral Industries

2004

[1]Coastal Field Office, P.O. Box 1033, Newport, OR 97365 Ph: 541-574-6658 (jonathan.allan@dogami.state.or.us)

NOTICE

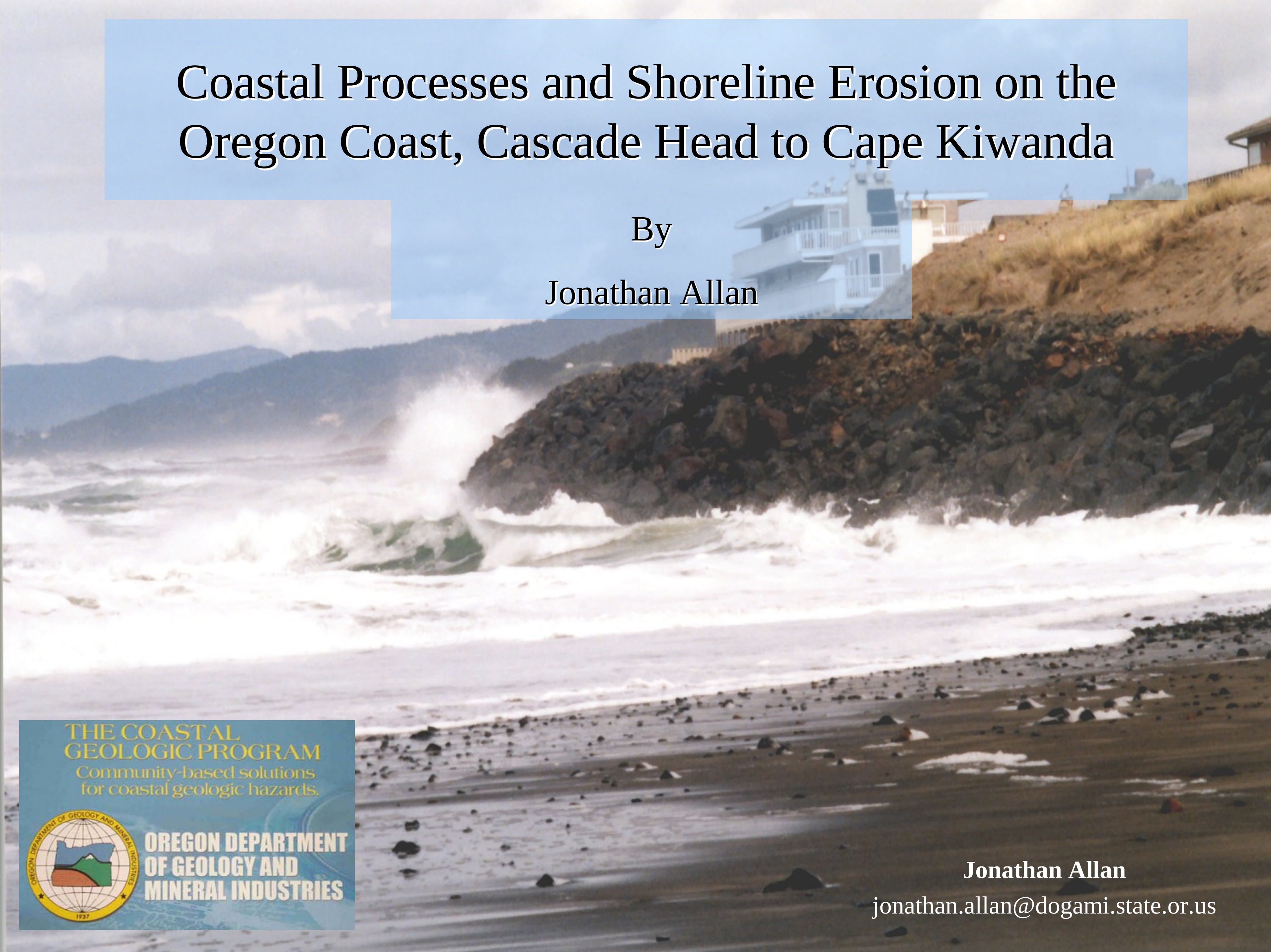
Oregon Department of Geology and Mineral Industries Open File Report
Published in conformance with ORS 516.030

For copies of this publication or other information about Oregon's geology and natural resources, contact:
Nature of the Northwest Information Center
800 NE Oregon Street #5
Portland, Oregon 97232
(503) 872-2750
http://www.naturenw.org

Coastal Processes and Shoreline Erosion on the Oregon Coast, Cascade Head to Cape Kiwanda

By

Jonathan Allan



THE COASTAL GEOLOGIC PROGRAM
Community-based solutions for coastal geologic hazards.

OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

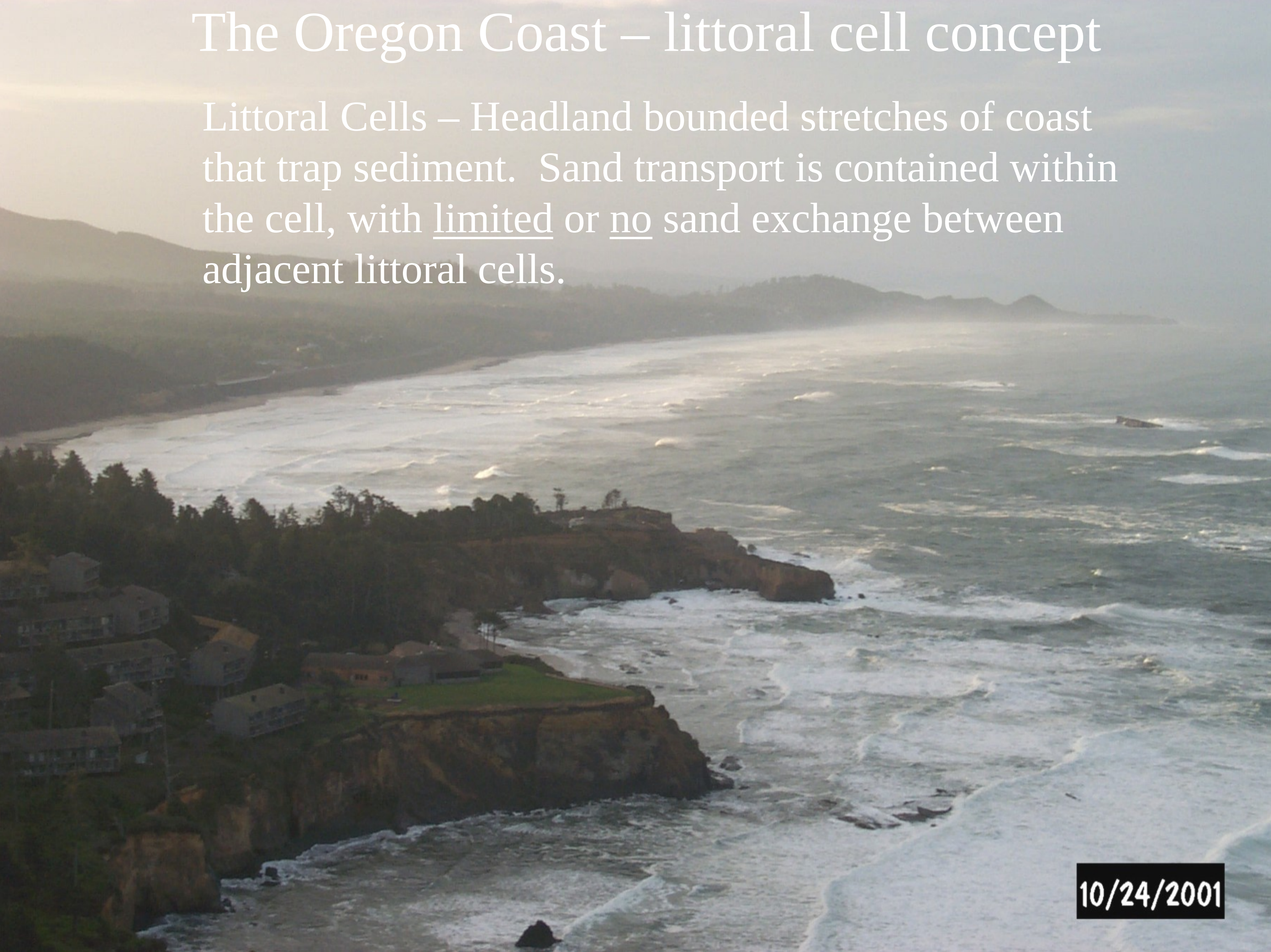
Jonathan Allan
jonathan.allan@dogami.state.or.us

Objectives

- Provide a brief insight on the range of processes that modify sandy beaches on the Oregon coast;
- Provide an insight on recent and historical shoreline changes that have occurred at Neskowin;
- Briefly discuss the role of "hardened shorelines" and their effects on beaches; and
- The future and what it may bring ????

The Oregon Coast – littoral cell concept

Littoral Cells – Headland bounded stretches of coast that trap sediment. Sand transport is contained within the cell, with <u>limited</u> or <u>no</u> sand exchange between adjacent littoral cells.



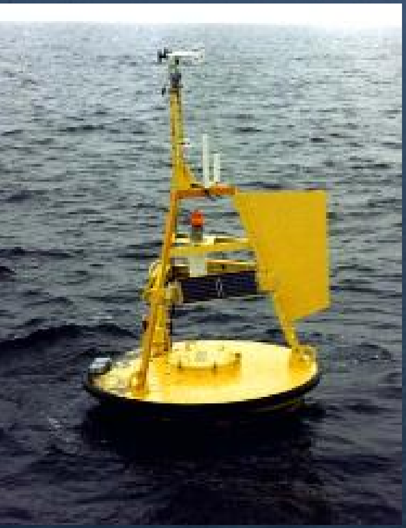
Processes important for coastal erosion

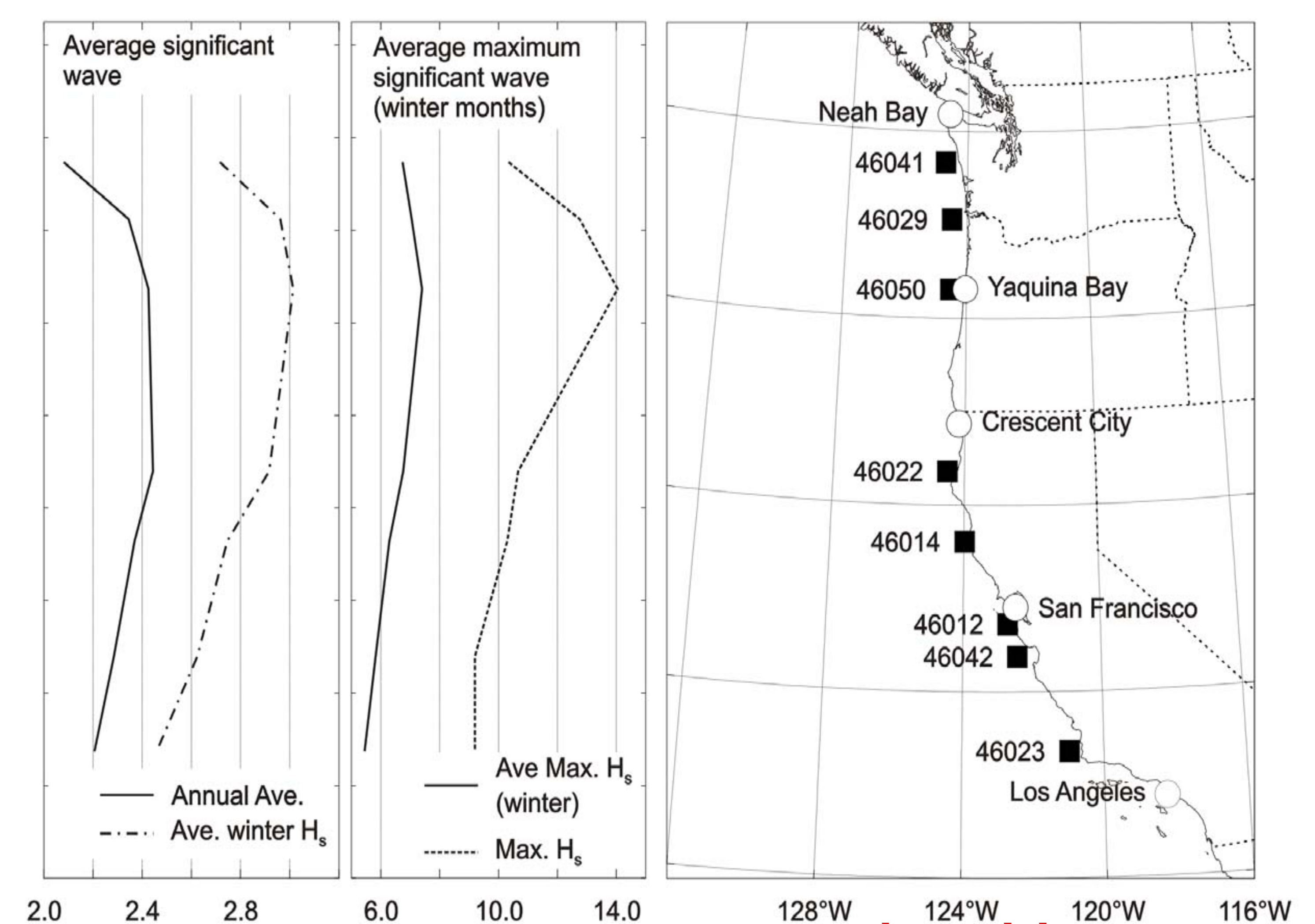
- Storm generated waves **
- Elevated tides above the predicted tidal elevation
  - El Niños (increase water levels by 0.2 – 0.3 m)**
  - Storm surges (~0.5 – 1.6 m)
- Alongshore movement of beach sediment ("hotspot erosion") **
- Migration of tidal inlets and river mouths ("hotspot erosion") **
- Localized erosion due to presence of rip currents ("hotspot erosion")
- Sea level rise due to glacial melting, plus land-level changes
- Human influences e.g. Jetty construction, breakwaters, revetments

** Enhanced during ENSO

Processes important for coastal erosion

- Storm generated waves **



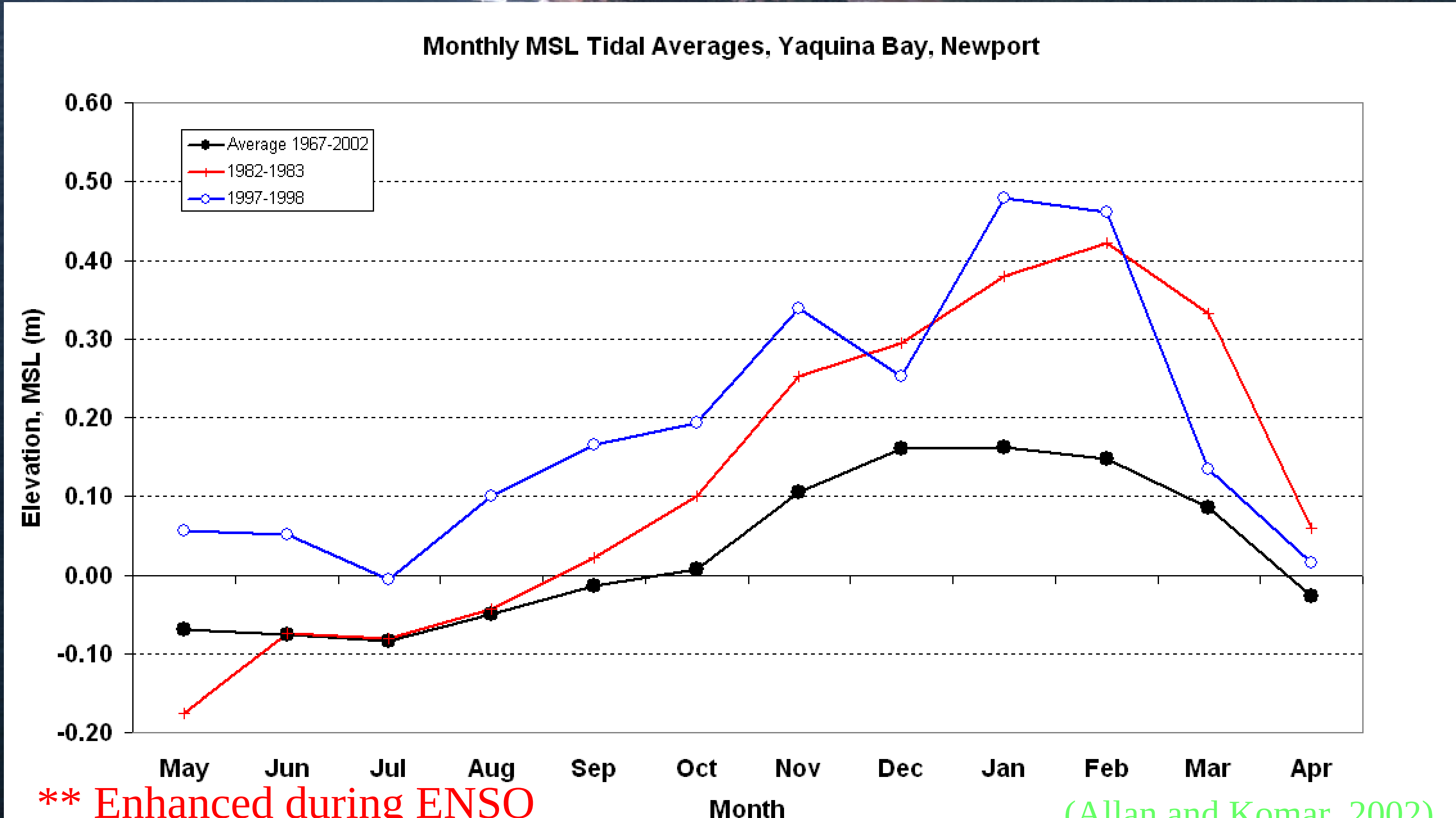


** Enhanced during ENSO

(Allan and Komar, in press)

Processes important for coastal erosion

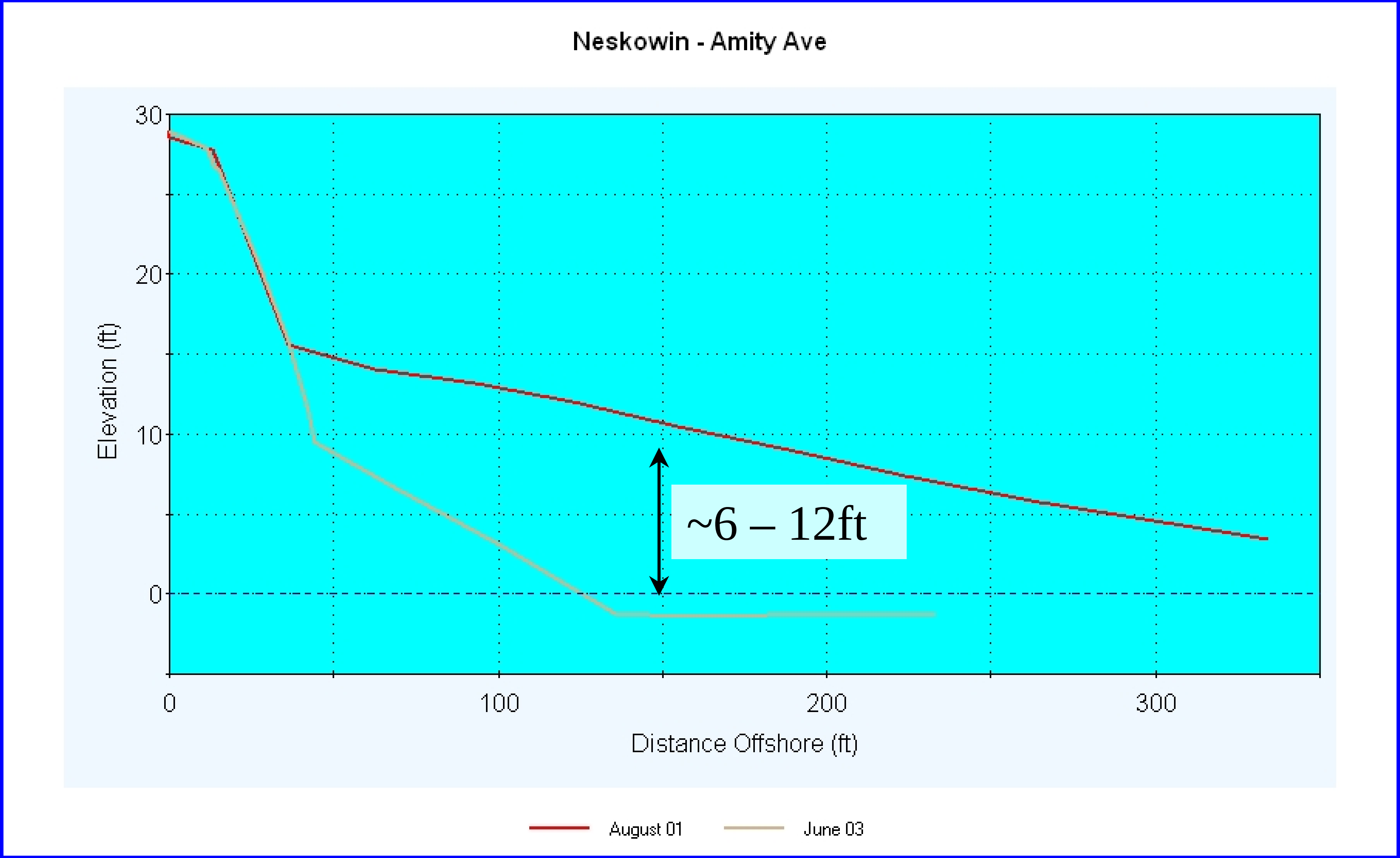
- Elevated tides above the predicted tidal elevation
  - El Niños (increase water levels by 0.2 – 0.3 m)**
  - Storm surges (~0.5 – 1.6 m)



** Enhanced during ENSO

(Allan and Komar, 2002)

Seasonal Beach Profile Response



Dune Erosion = combined effect of wave runup + high tides

Measured coastal retreat on the order of ~100 ft to 150 ft

Komar et al. (1999)

Ruggiero and Voight (2000)

Allan (2003) (Unpublished data)

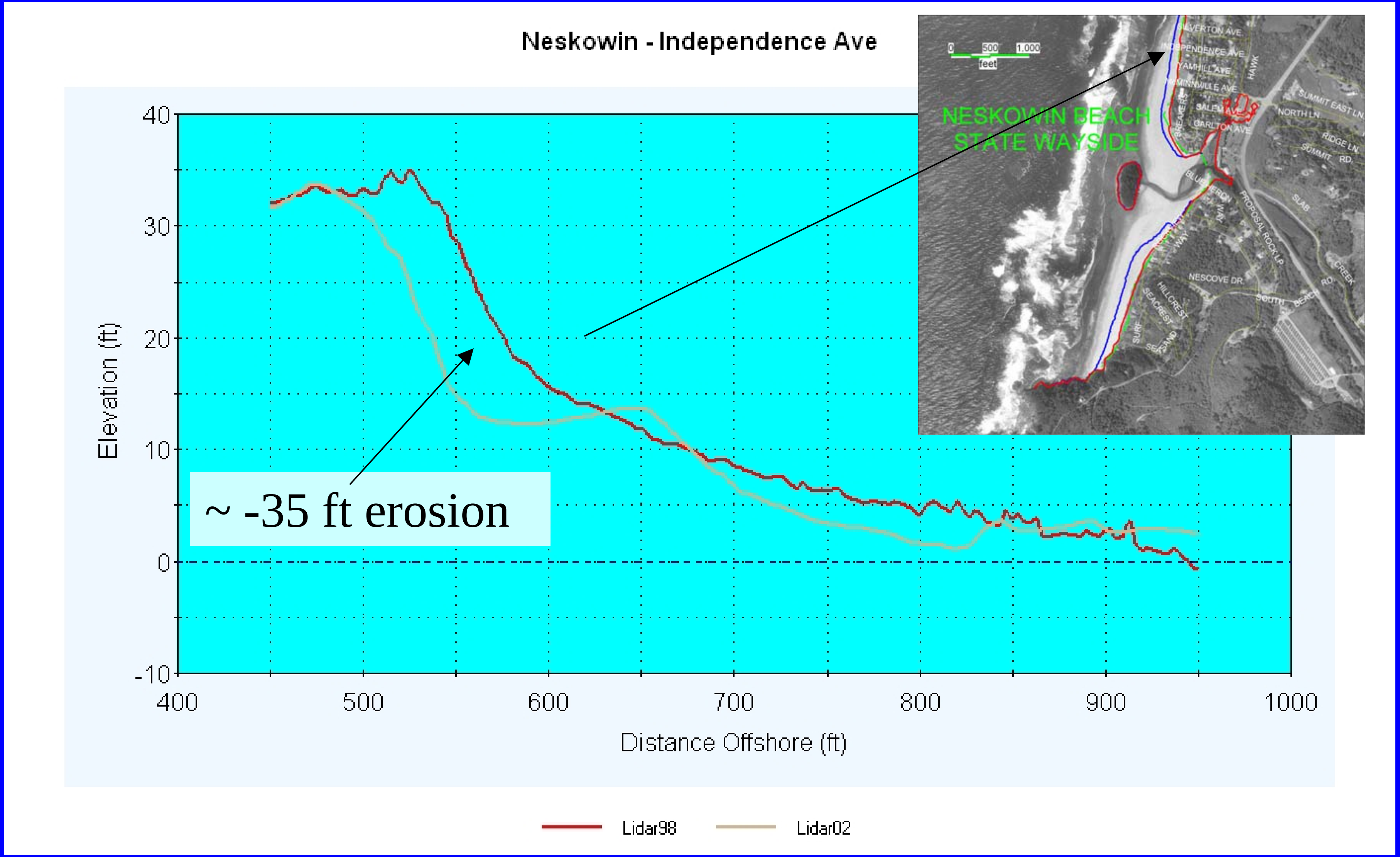
Processes important for coastal erosion

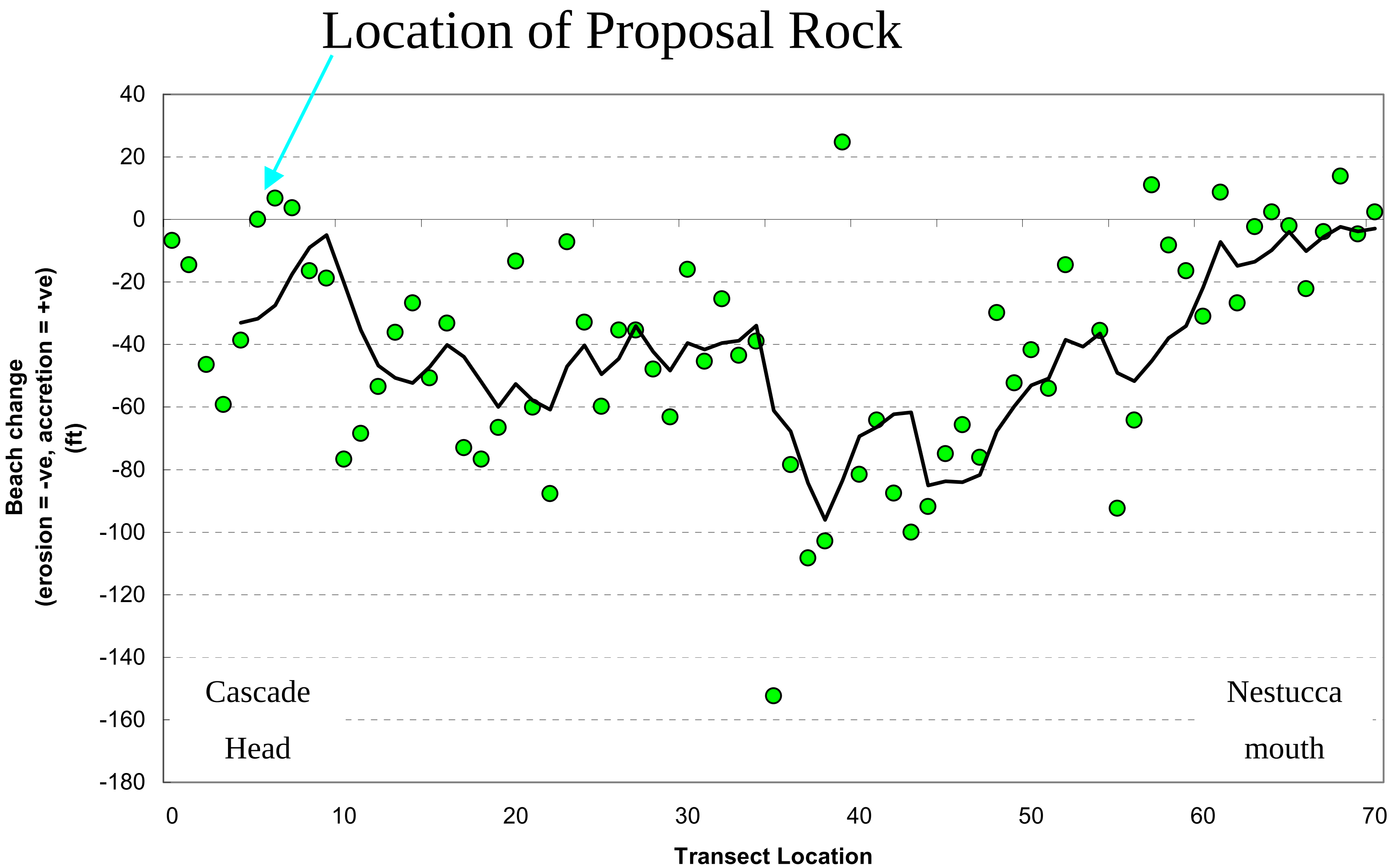
- 1996, estimated 100-year storm = 10 m *(Ruggiero et al., 1996)*

#46050	Date	Significant wave height (m)	Wave period (m)	Breaker height (m)
97/98 El Niño	19-20 Nov	10.5	14.3	11.7
98/99 La Niña	25-26 Nov	10.8	12.5	11.3
	6-7 Feb	10.1	12.5	10.8
	16-17 Feb	10.0	20.0	12.9
	2-3 Mar	14.1	16.7	15.8
1999/00	16-17 Jan	12.1	14.2	13.1
2001/02	21-22 Nov	10.3	16.7	12.2
	28-29 Nov	10.7	14.3	11.8
2002/03	14 Dec	11.1	12.5	-

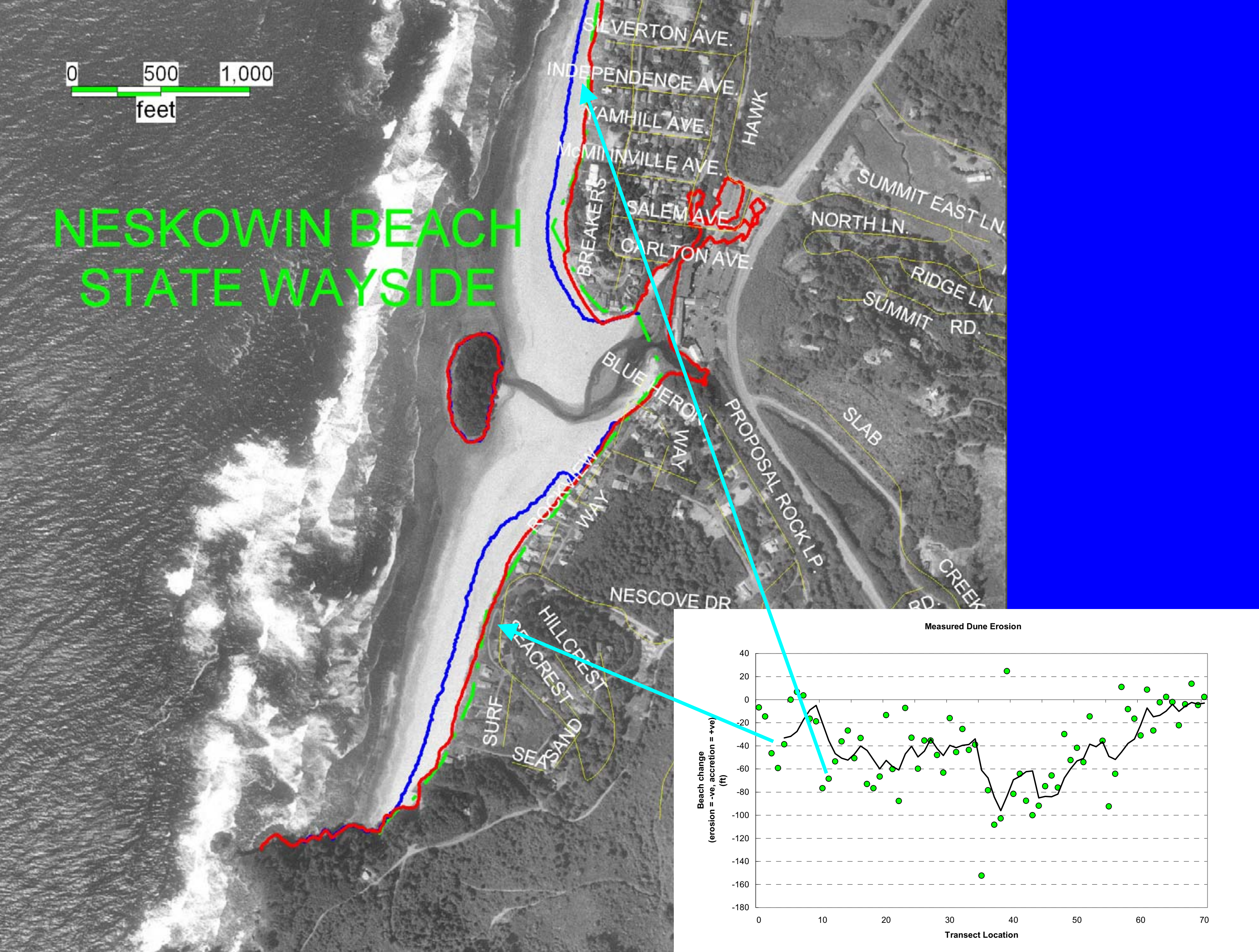
~ 2000, revised 100-year storm wave estimate = 16 m
(Allan and Komar, 2001)

Beach response from Storms

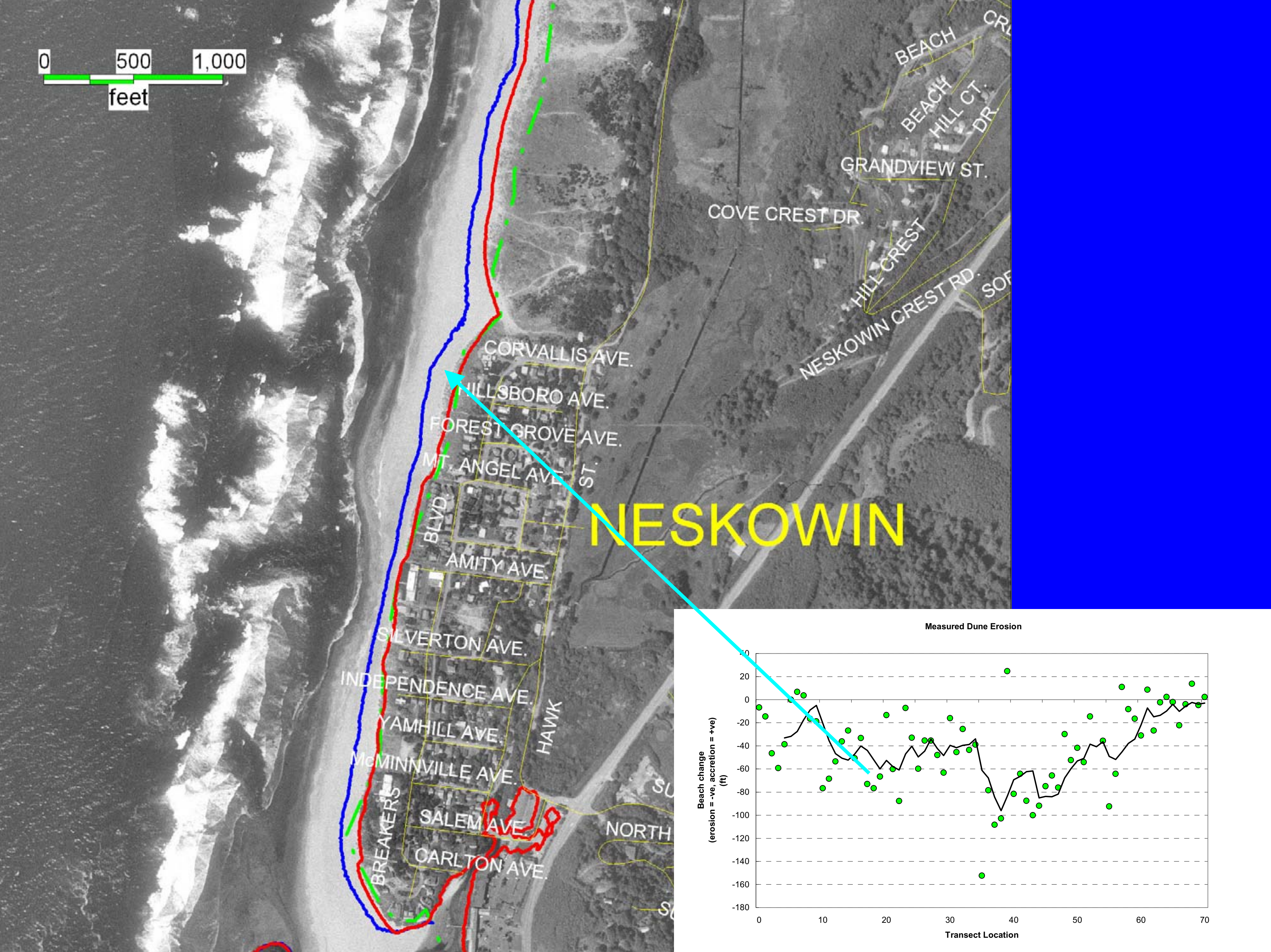


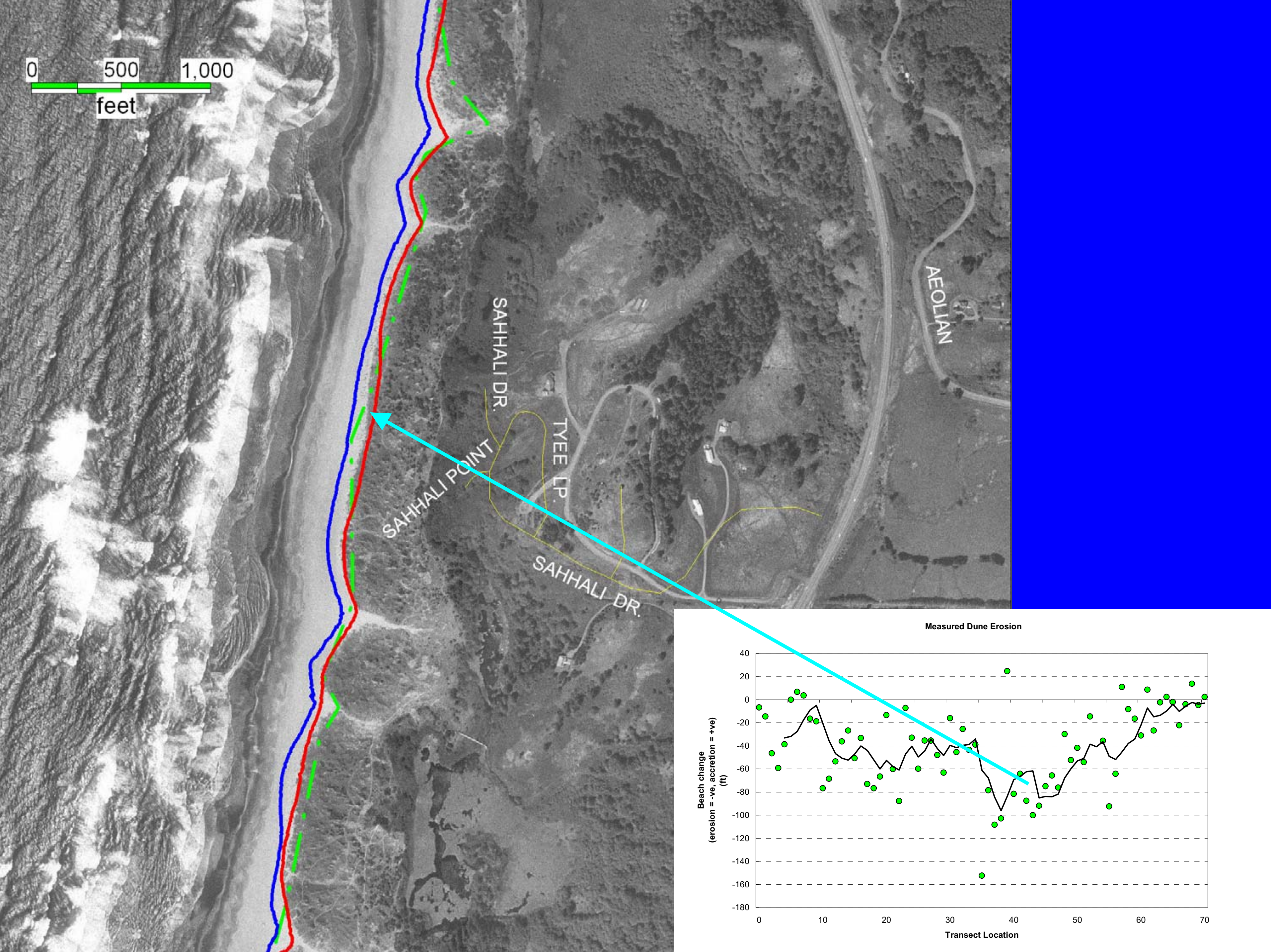


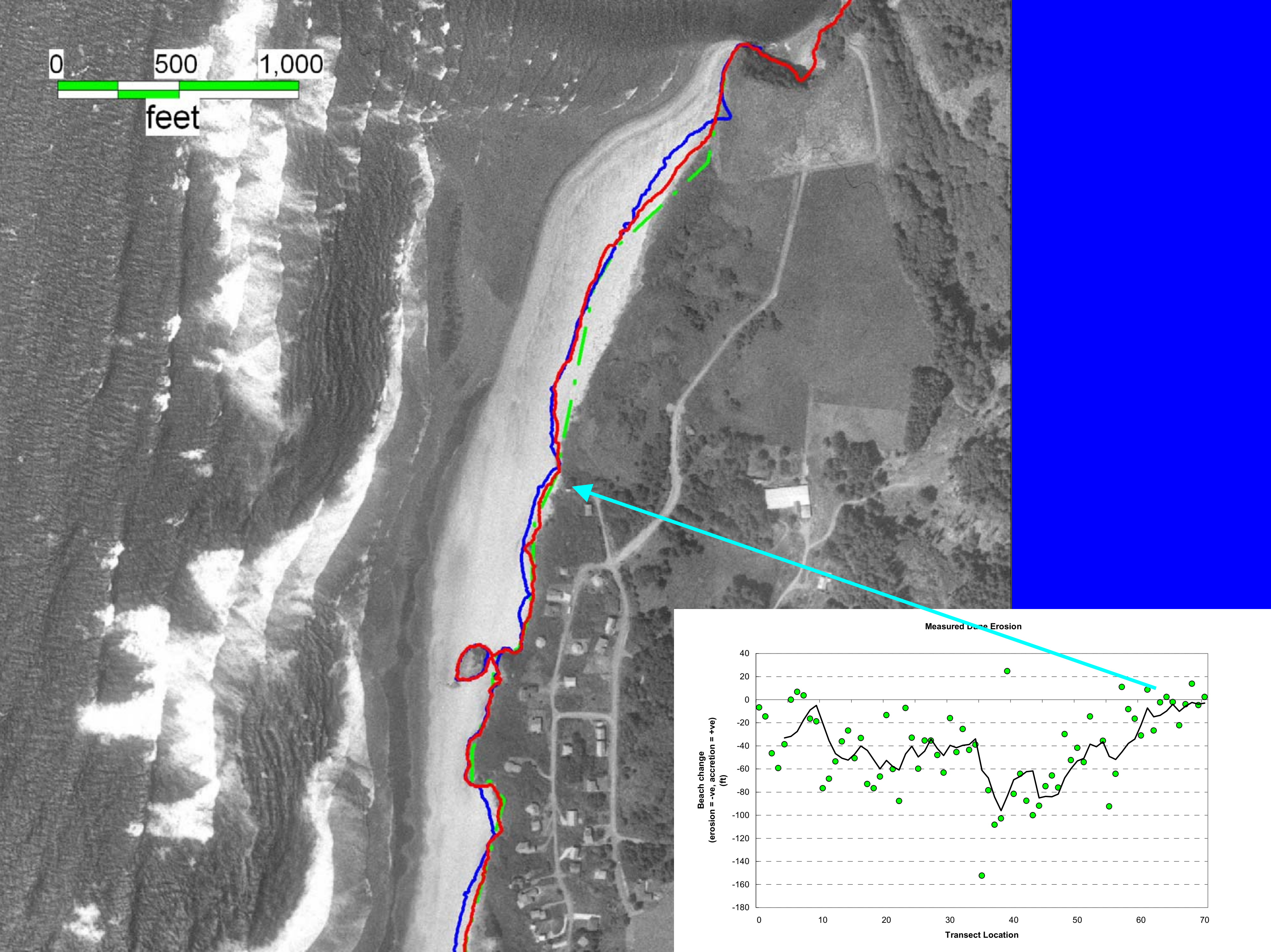
Average dune erosion (1998 to 2002) = -40 ft (area between Neskowin and Nestucca bay mouth)



NESKOWIN BEACH STATE WAYSIDE
0
500
1,000
feet
SILVERTON AVE.
INDEPENDENCE AVE.
YAMHILL AVE.
McMINNVILLE AVE.
SALEM AVE.
CARLTON AVE.
BREAKERS
HAWK
SUMMIT EAST LN.
NORTH LN.
RIDGE LN.
SUMMIT RD.
BLUE HERON
WAY
PROPOSAL ROCK LP.
SLAB
CREEK
RD.
ROCKVIEW
WAY
NESCOVE DR
HILLCREST
SEACREST
SURF
SEASAND
Measured Dune Erosion
Beach change (erosion = -ve, accretion = +ve) (ft)
Transect Location
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
0
10
20
30
40
50
60
70


0
500
1,000
feet
BEACH
BEACH HILL CT.
DR.
GRANDVIEW ST.
COVE CREST DR.
HILL CREST
NESKOWIN CREST RD.
CORVALLIS AVE.
HILLSBORO AVE.
FOREST GROVE AVE.
MT. ANGEL AVE.
ST.
BLVD.
NESKOWIN
AMITY AVE.
SILVERTON AVE.
INDEPENDENCE AVE.
YAMHILL AVE.
HAWK
McMINNVILLE AVE.
BREAKERS
SALEM AVE.
CARLTON AVE.
NORTH
Measured Dune Erosion
Beach change (erosion = -ve, accretion = +ve) (ft)
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
0
10
20
30
40
50
60
70
Transect Location


0
500
1,000
feet
SAHHALI DR.
TYEE LP.
SAHHALI POINT
SAHHALI DR.
AEOLIAN
Measured Dune Erosion
Beach change
(erosion = -ve, accretion = +ve)
(ft)
Transect Location
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
0
10
20
30
40
50
60
70


0
500
1,000
feet
Measured Dune Erosion
Beach change (erosion = -ve, accretion = +ve) (ft)
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
0
10
20
30
40
50
60
70
Transect Location

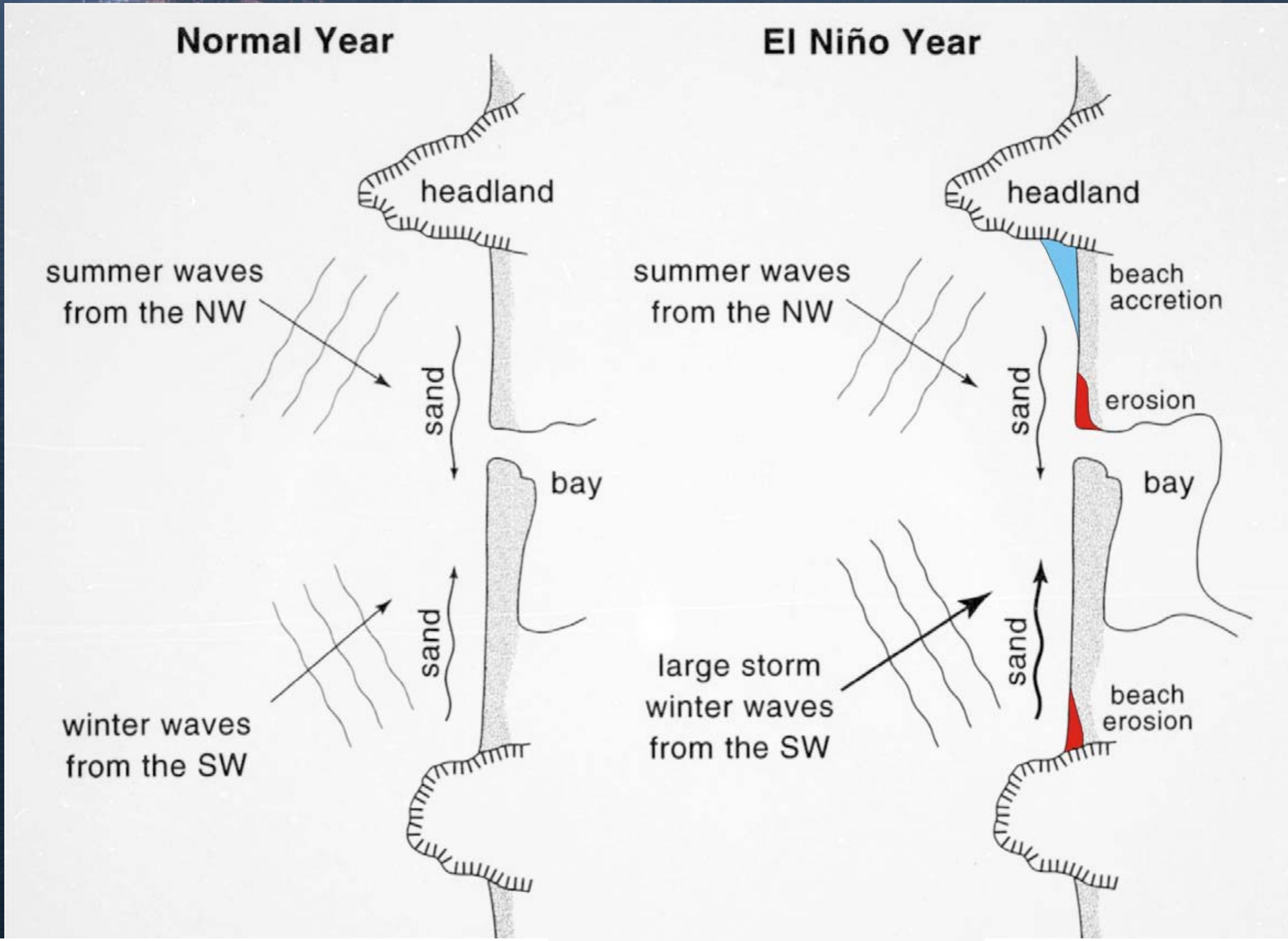
Pacific City, Nestucca Spit

Neskowin experienced problems with excess sand during the late 1980s. Some properties owners were even undergoing dune “scalping” to remove excess sand

(Komar 2003, pers. com)

Processes important for coastal erosion

- Alongshore movement of beach sediment ("hotspot erosion") **



** Enhanced during ENSO

(Komar, 1998)

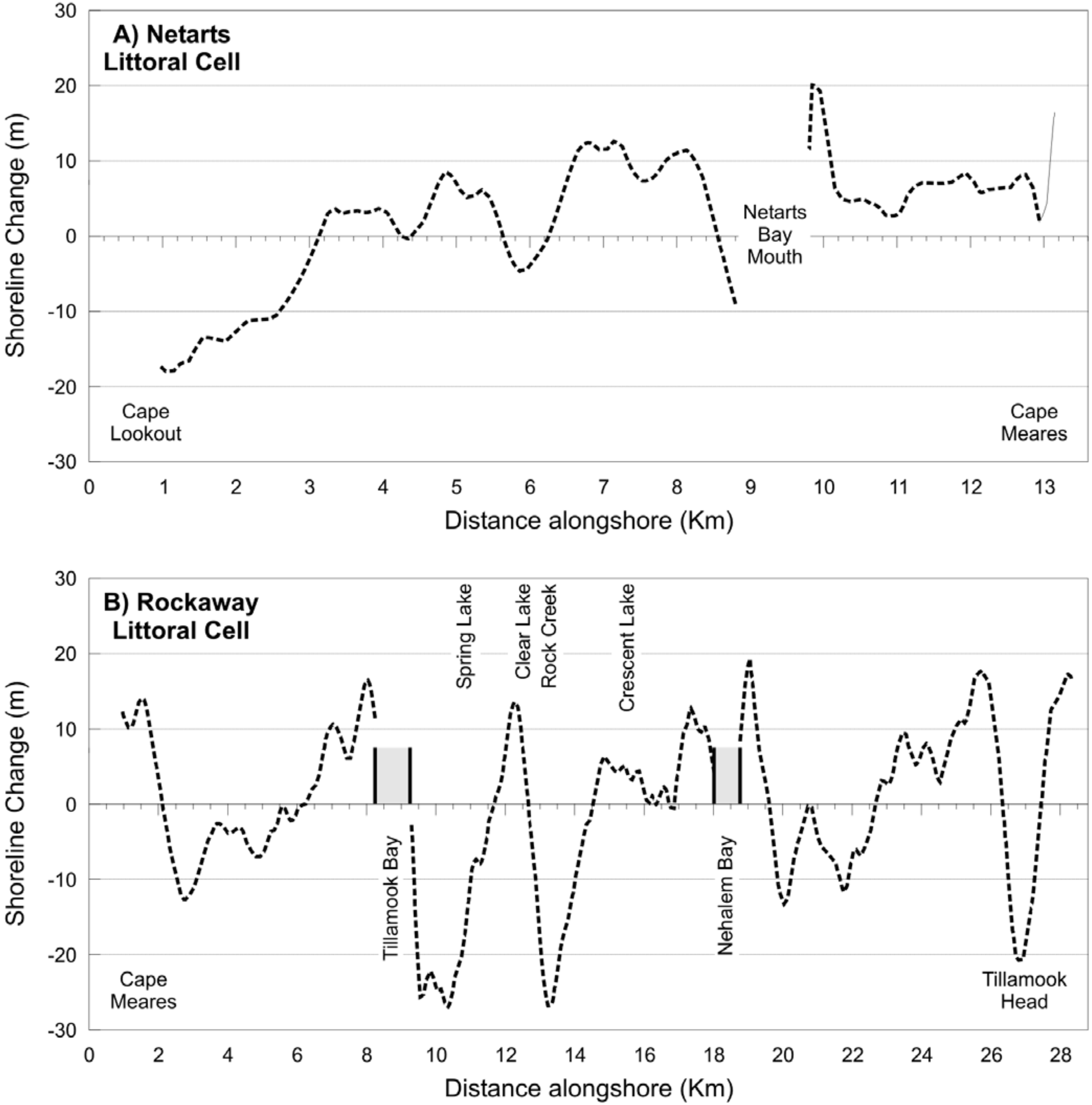
Sediment accumulation (northern ends of littoral cells)

(Photo courtesy of P.D. Komar)

Hotspot Erosion (southern ends of littoral cells)

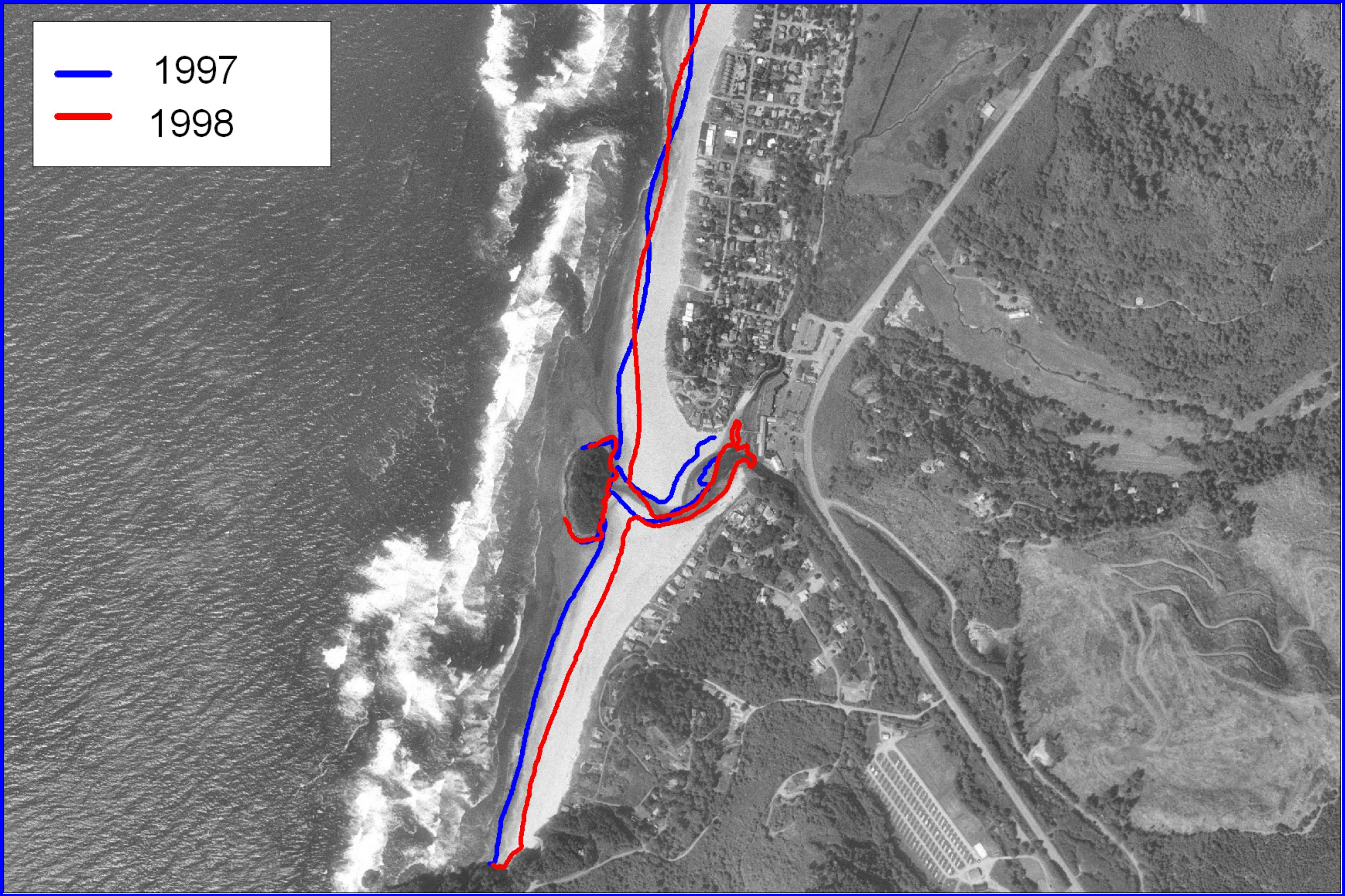
(Photo courtesy of P.D. Komar)

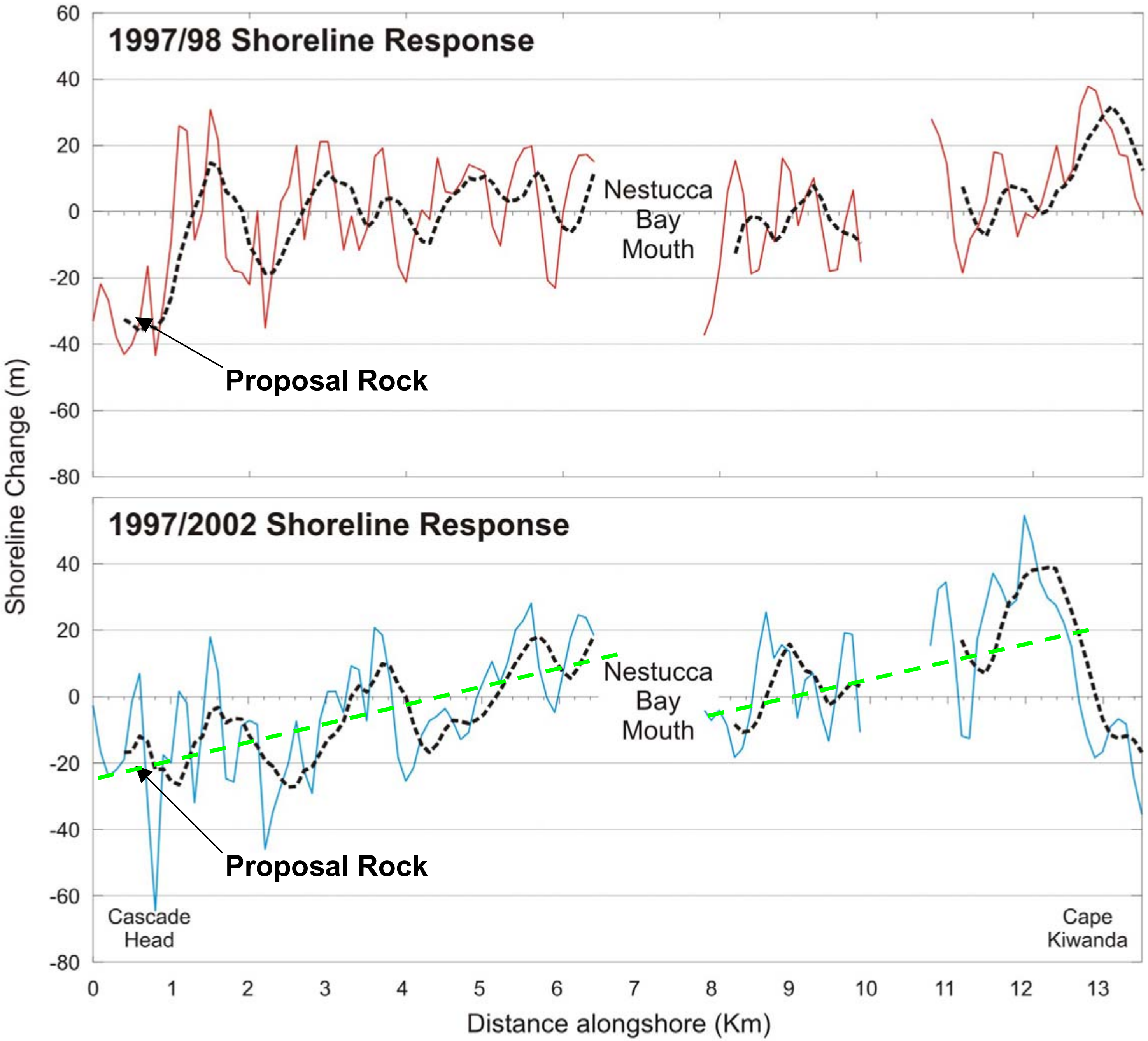
Hot-spot Erosion



(Allan et al., 2003)

Shoreline Variability – Mean High Waterline

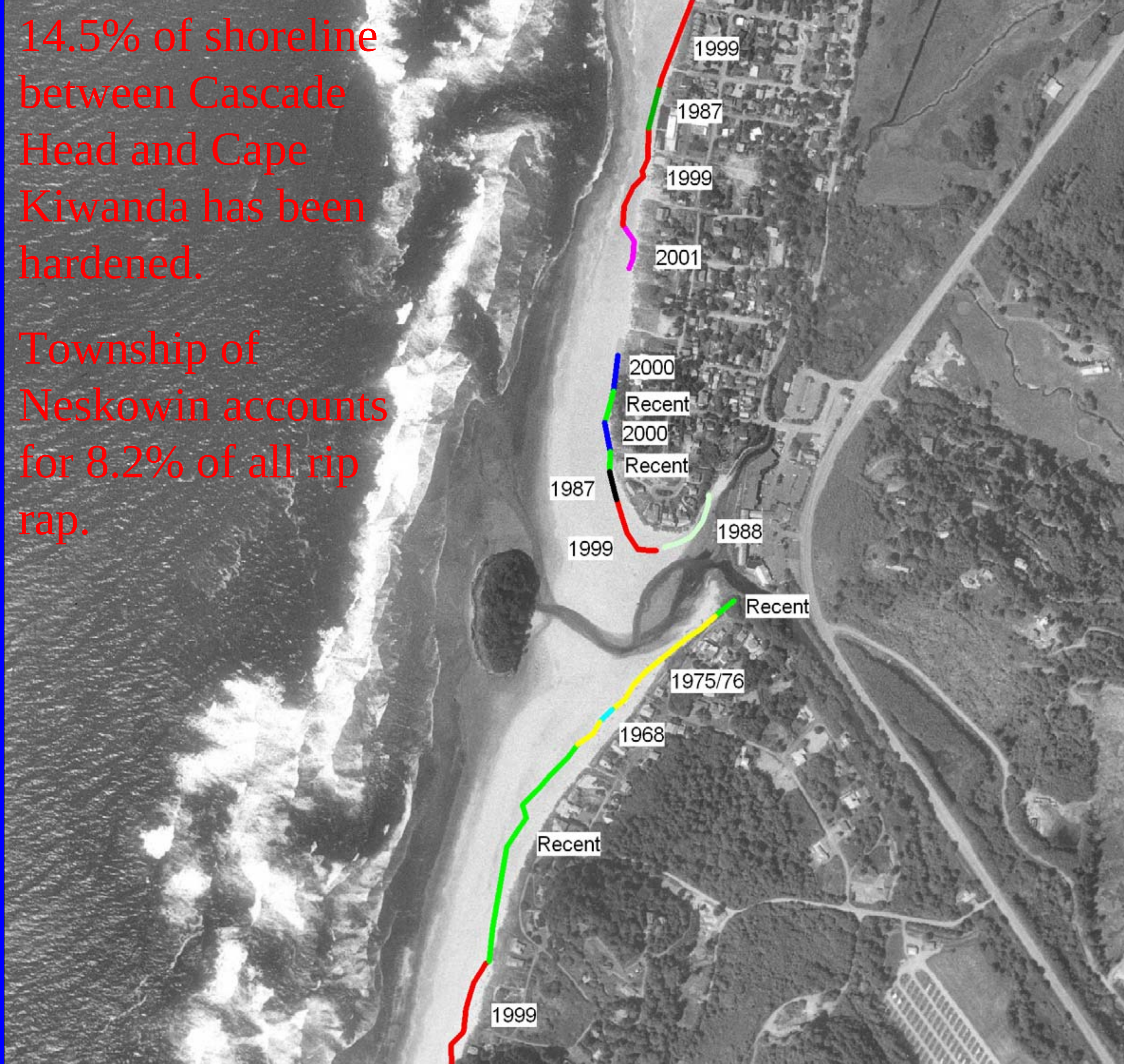




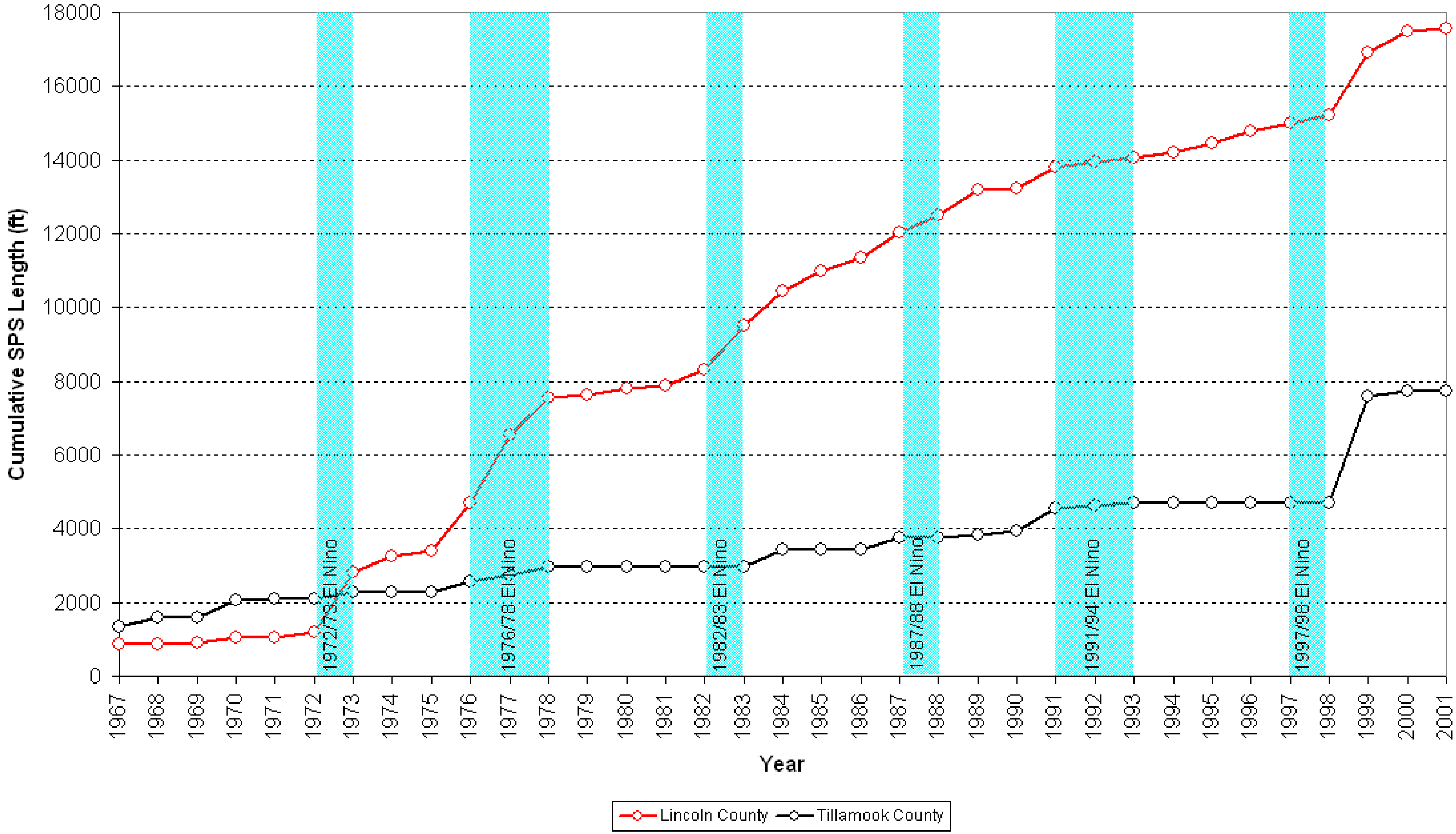
1997/98 Shoreline Response
1997/2002 Shoreline Response
Shoreline Change (m)
60
40
20
0
-20
-40
-60
-80
Nestucca
Bay
Mouth
Proposal Rock
Cascade
Head
Cape
Kiwanda
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Distance alongshore (Km)

14.5% of shoreline between Cascade Head and Cape Kiwanda has been hardened.

Township of Neskowin accounts for 8.2% of all rip rap.



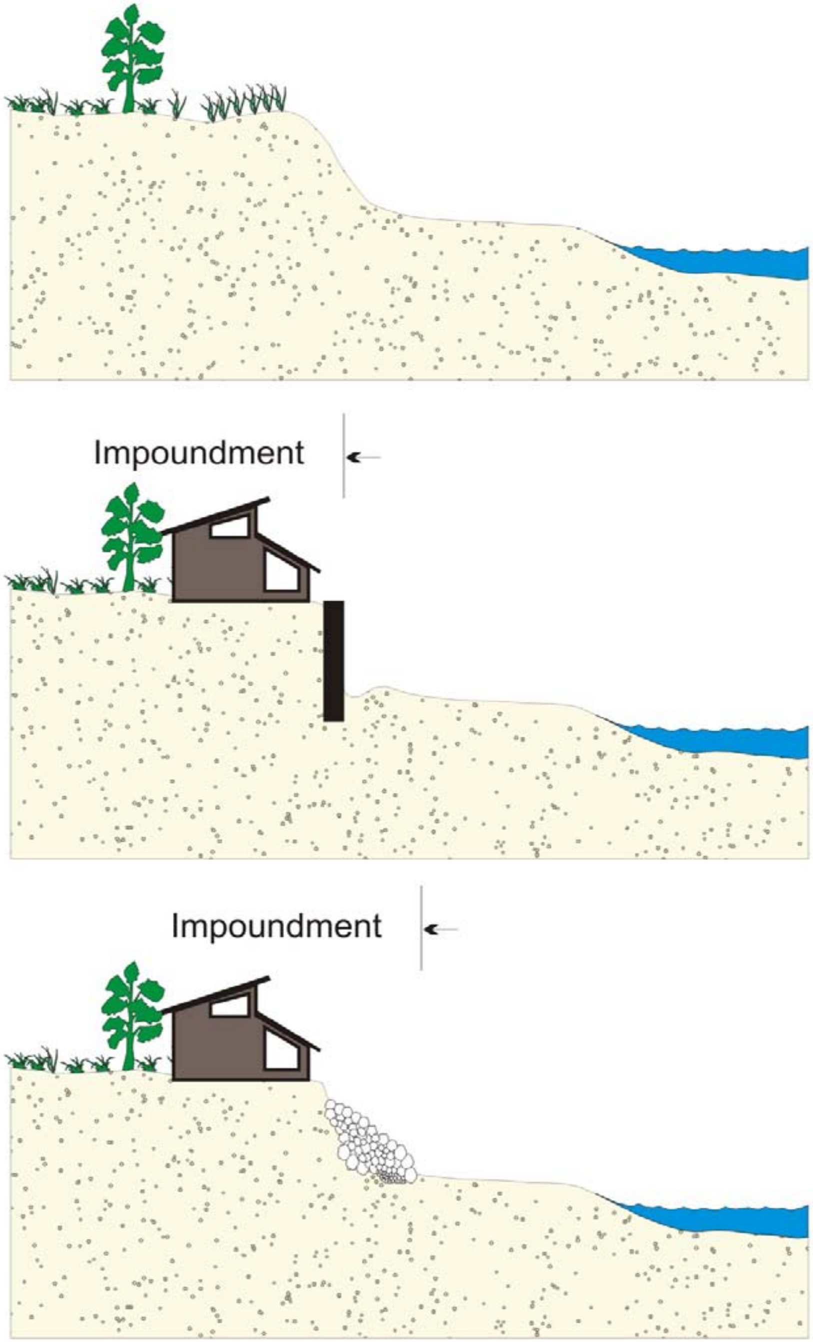
Expansion of Rip Rap in Lincoln and Tillamook Counties



So what if the number of shore protection structures increases.

Concerns include:

- Active erosion
  - Enhanced scour at the toe of the structure (*toe erosion*)
  - Focusing of wave energy to other parts of the beach (*end effect*)
- Impoundment – sediment supply effects
- Passive erosion



a) Beach with no coastal structure

b) Beach impoundment due to construction of seawall or home (note toe scour)

c) Beach impoundment due to construction of revetment

(After Griggs et al., 1994)

End Effects

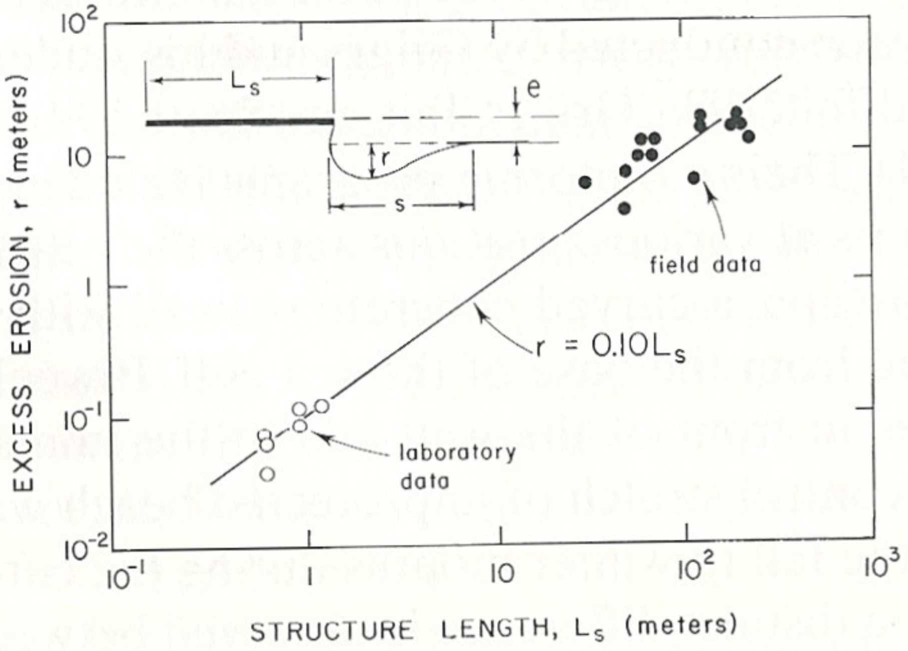
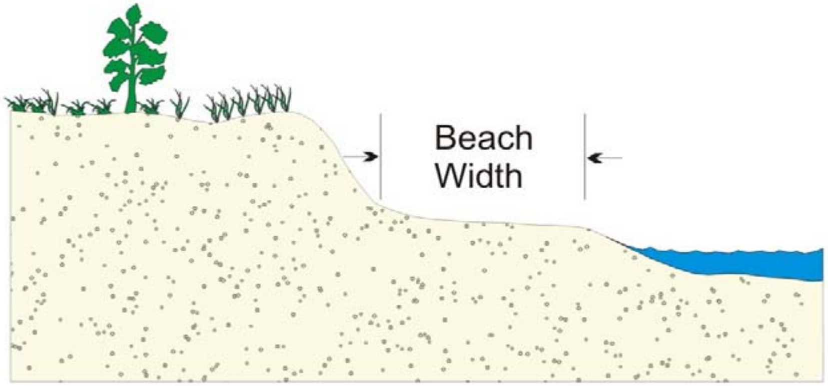


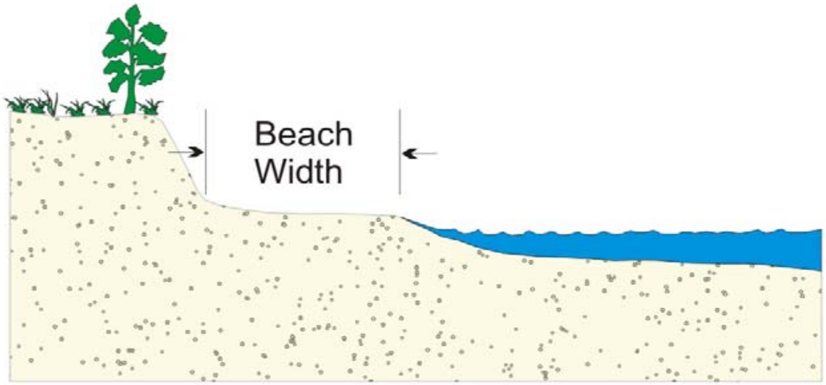
Figure 12-22 Erosion of the unprotected shoreline adjacent to a seawall, based on the wave-basin experiments of McDougal and co-workers (1987) and the field data of Walton and Sensabaugh (1978). [From Laboratory and Field Investigations of Shoreline Stabilization Structures on Adjacent Properties, W. G. McDougal, M. A. Sturtevant, and P. D. Komar, *Coastal Sediments '87*, 1987. Reproduced with permission from the American Society of Civil Engineers.]

$s = 0.7\ L_s$

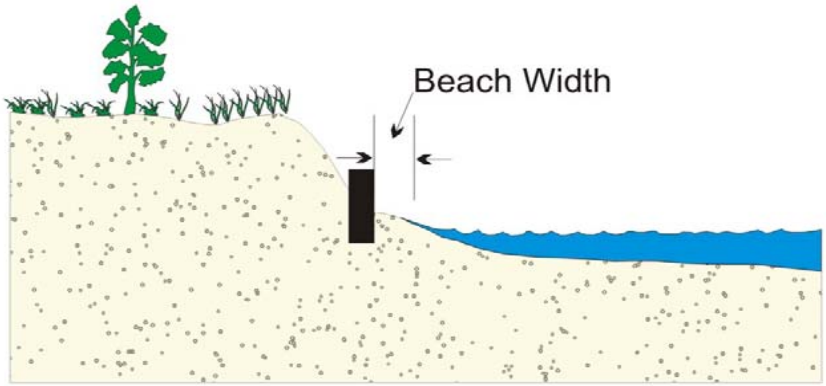
$r = 0.1\ L_s$



a) Initial beach profile showing beach width

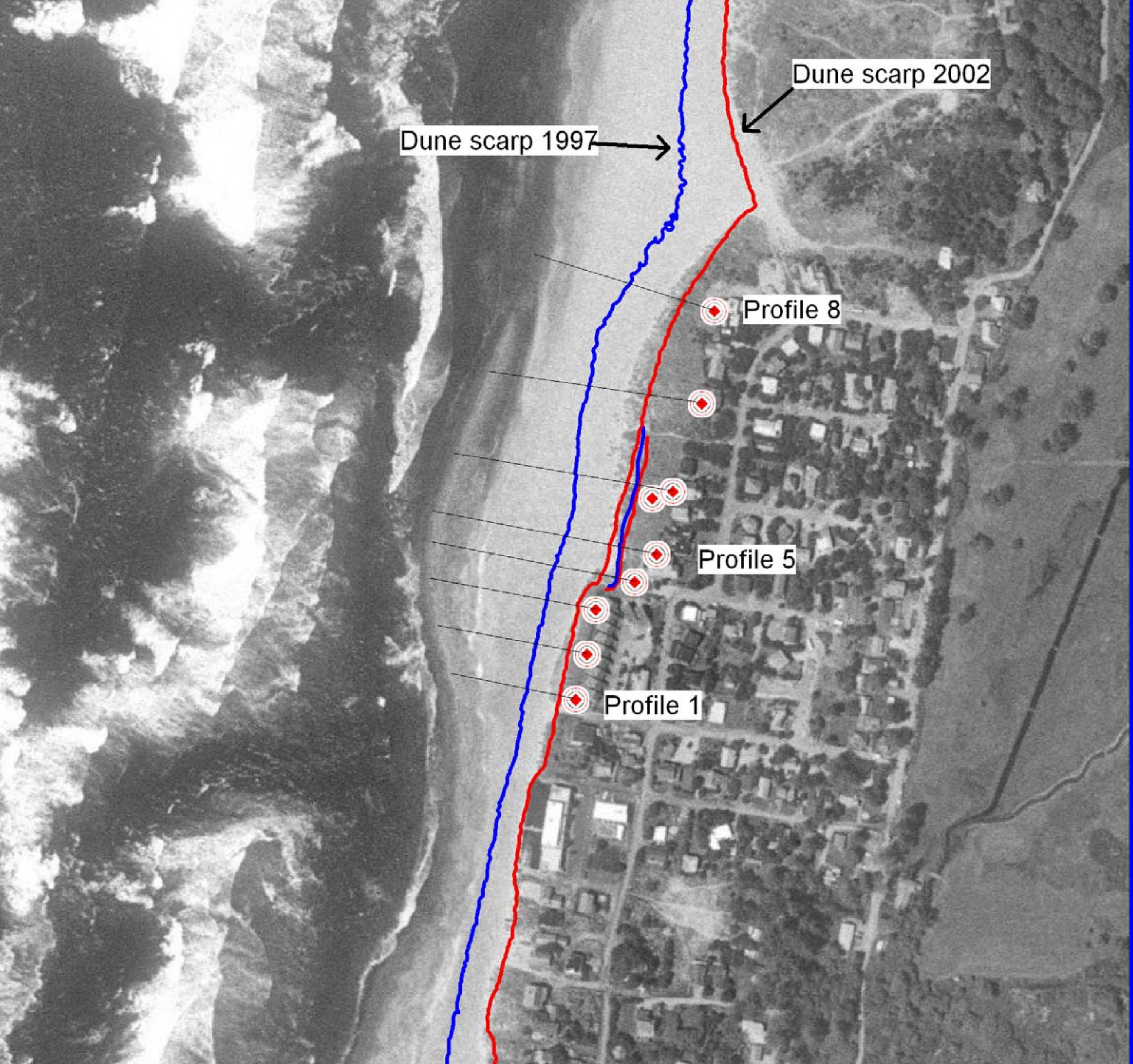


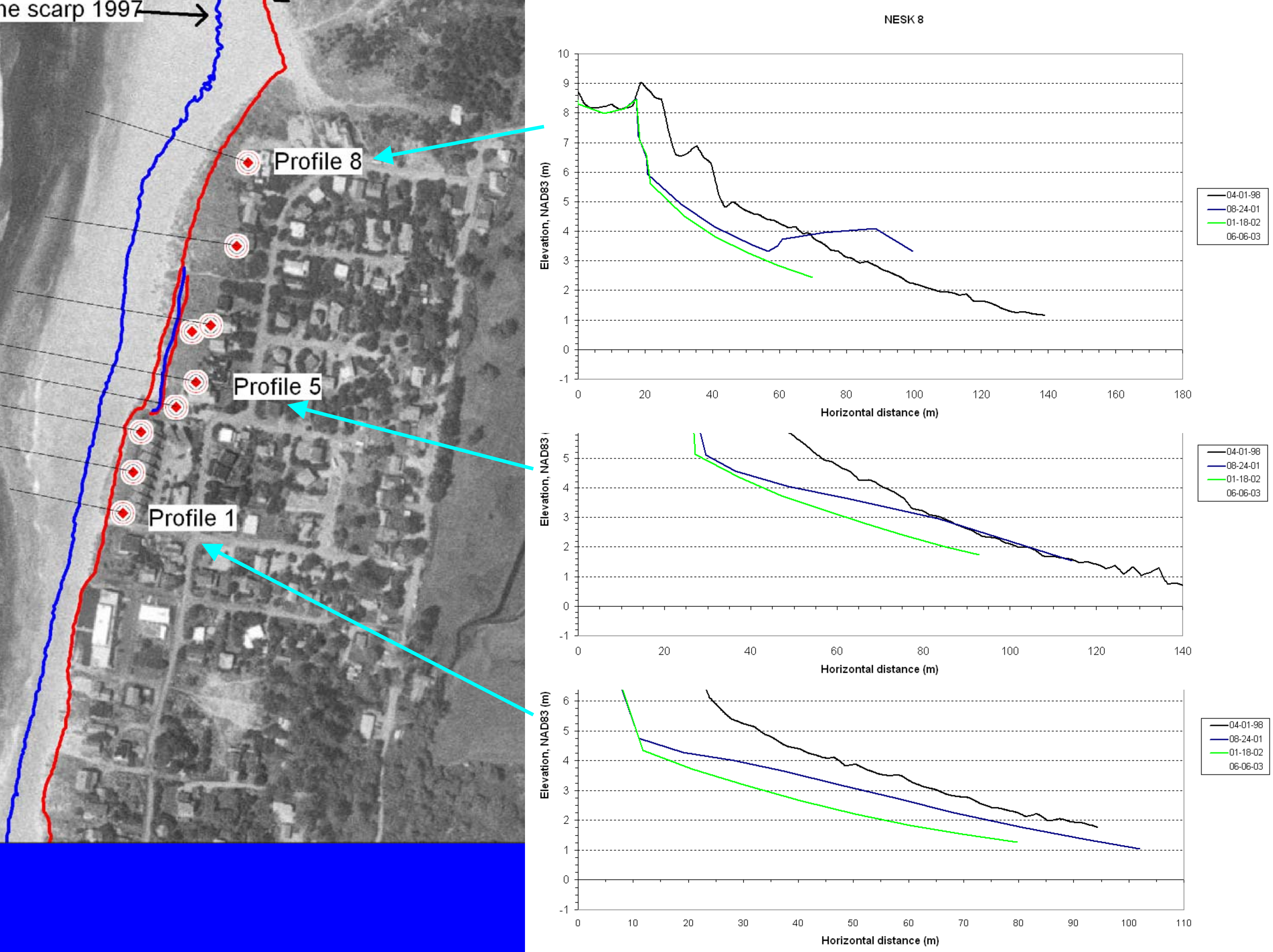
b) Beach response to sea level rise. Dune erodes landward, while beach width remains the same



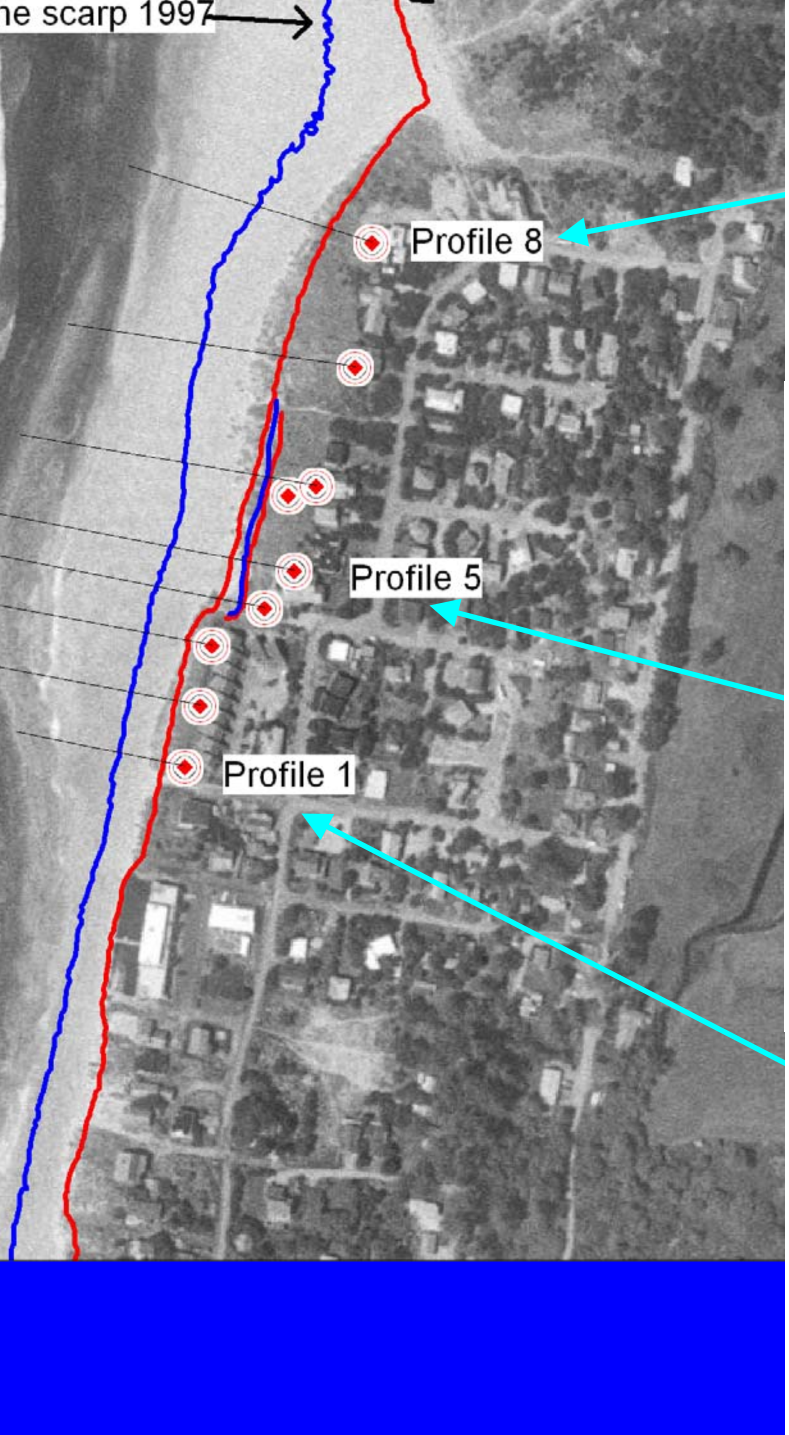
c) Beach response to sea level rise where seawall (or revetment) has fixed the shoreline position

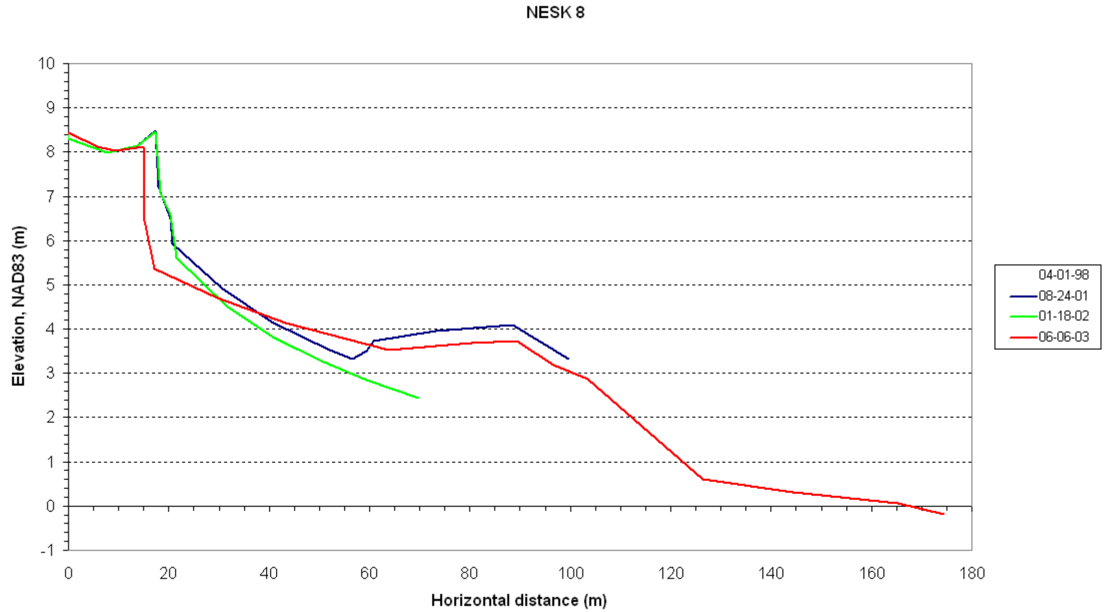
(After Griggs et al., 1994)

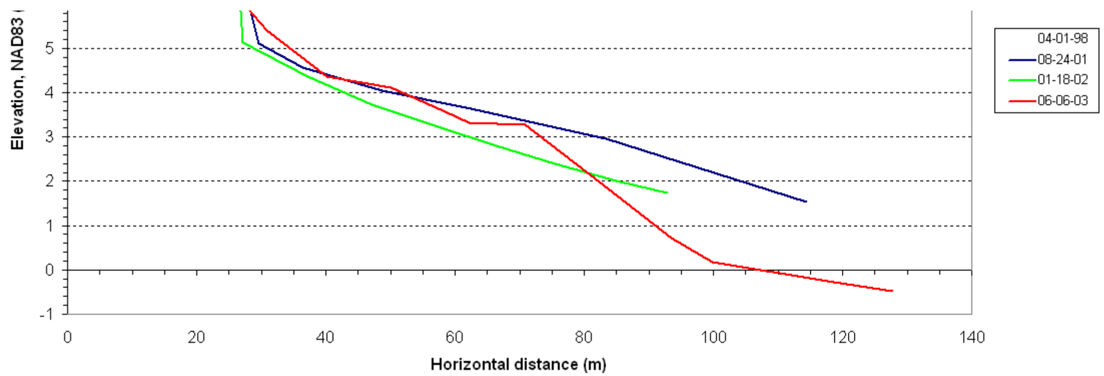

Dune scarp 2002
Dune scarp 1997
Profile 8
Profile 5
Profile 1

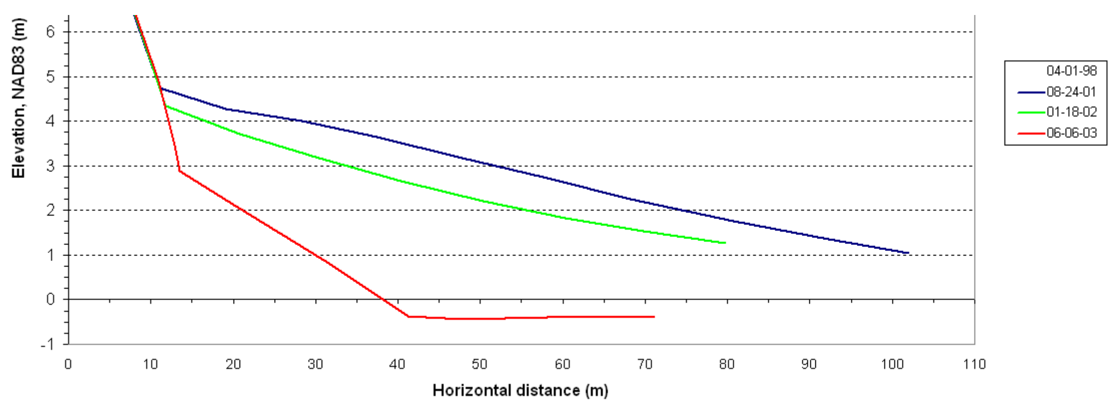


ne scarp 1997
Profile 8
Profile 5
Profile 1
NESK 8
Elevation, NAD83 (m)
Horizontal distance (m)
04-01-98
08-24-01
01-18-02
06-06-03
Elevation, NAD83 (
Horizontal distance (m)
04-01-98
08-24-01
01-18-02
06-06-03
Elevation, NAD83 (m)
Horizontal distance (m)
04-01-98
08-24-01
01-18-02
06-06-03


scarp 1997
Profile 8
Profile 5
Profile 1


NESK 8
Elevation, NAD83 (m)
Horizontal distance (m)
04-01-98
08-24-01
01-18-02
06-06-03


Elevation, NAD83 (
Horizontal distance (m)
04-01-98
08-24-01
01-18-02
06-06-03

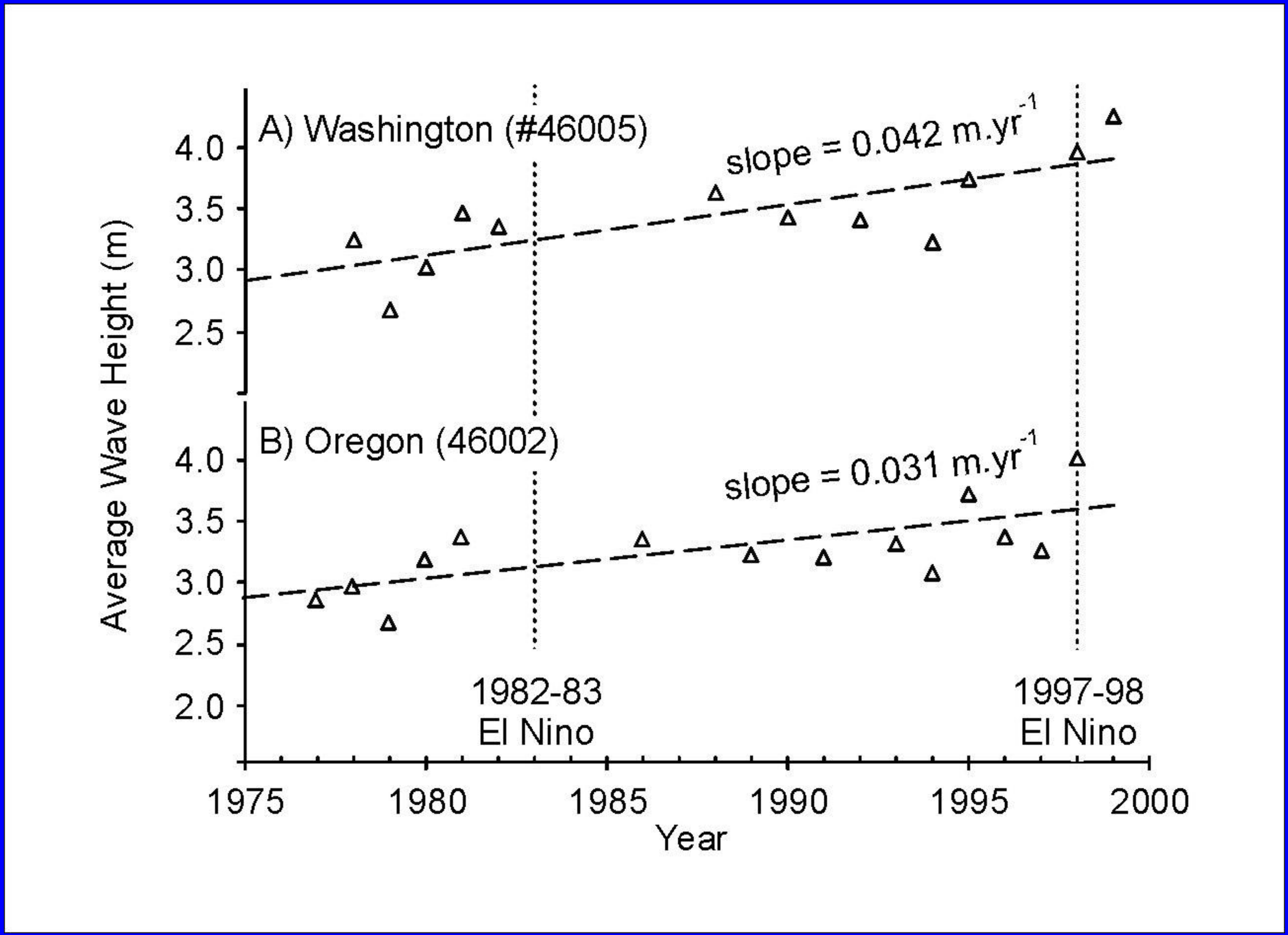

Elevation, NAD83 (m)
Horizontal distance (m)
04-01-98
08-24-01
01-18-02
06-06-03

Processes important for coastal erosion – Rip Currents

- Strong, narrow, seaward flowing currents in the surf zone
- Current velocities may reach speeds of 2 m/s (used by surfers)
- Can cause localized scour (erosion) of beach

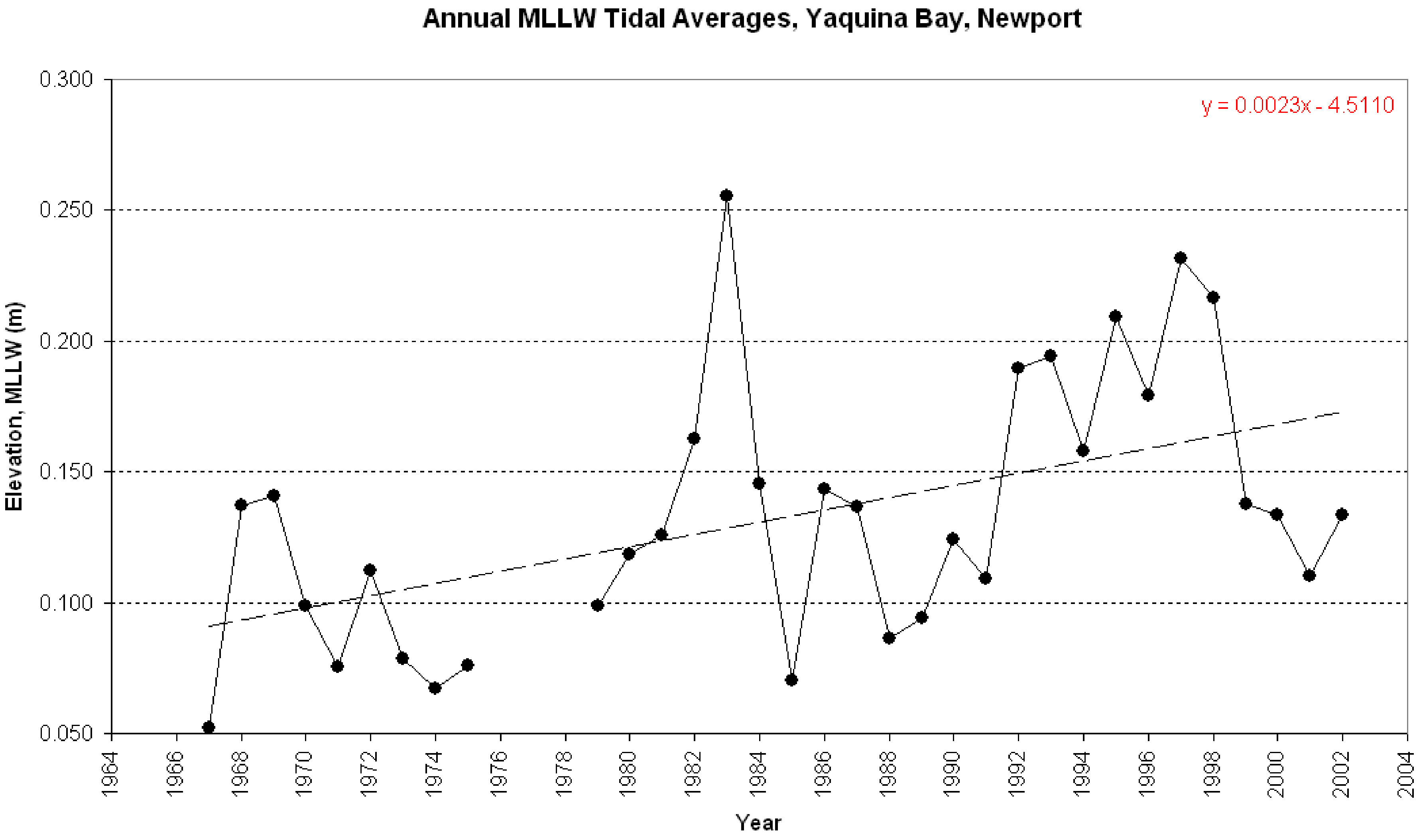
(Photo courtesy of P.D. Komar)

Wave Climate Changes



(Allan and Komar 2000)

Sea Level Rise



Conclusions

- Many factors influence the stability or instability of beaches.
- Of importance are processes that produce high water levels (e.g. El Niños and storm surges, which may raise water levels by up to 1.6 m).
- Large storm waves are especially important (e.g. 2-3 March, 1999 storm was exceptional producing 14 m (46 ft) wave heights).
- Revised estimates of the “100-year” storm wave now ~16 m (53 ft).
- During an El Niño, typically see “hotspot erosion” occurring along the southern ends of littoral cells (e.g. Neskowin, Cape Lookout State Park, Garrison Lake).
- Erosion may be up to 45 m (150 ft) during a winter season(s). However, it is highly variable both spatially and temporally.
- Significant expansion of “hardened” shorelines in recent years, especially following major El Niño events. These structures can impact the beach.
- The next 50 – 100 years may be characterized by ongoing erosion problems due to sea level rise and larger storms etc (product of climate change?).

References

Allan, J.C. and Komar, P.D., 2000, Are ocean wave heights increasing in the eastern North Pacific?: EOS, Transaction of the American Geophysical Union, 81(47): pp 561 and 566-567.

Allan, J. C. and Komar, P. D., 2001, Wave climate change and coastal erosion in the US Pacific Northwest: Proceedings of the 4th Conference on Ocean Wave Measurement and Analysis, WAVES 2001, San Francisco, California, ASCE: 680-690.

Allan, J.C. and Komar, P.D., 2002, Extreme storms on the Pacific Northwest Coast during the 1997-98 El Niño and 1998-99 La Niña: Journal of Coastal Research, 18(1): 175-193.

Allan, J. C., Komar, P. D. and Priest, G. R., 2003, Shoreline variability on the high-energy Oregon coast and its usefulness in erosion-hazard assessments: Shoreline mapping and change analysis: Technical considerations and management implications, M. R. Byrnes, M. Crowell and C. Fowler, Special Issue No. 38: 83-105.

Allan, J.C. and Komar, P.D., in press, The wave climate of the eastern North Pacific: Long-term trends and El Niño/La Niña dependence: Journal of Coastal Research.

Griggs, G. B., Tait, J. F. and Corona, W., 1994, The interaction of seawalls and beaches: Seven years of monitoring, Monterey Bay, California: Shore & Beach, 62(3): 21-28.

Komar, P.D., 1997, The Pacific Northwest Coast: Living with the Shores of Oregon and Washington: Durham and London, Duke University Press: 195.

Komar, P. D., 1998, The 1997-98 El Niño and erosion on the Oregon coast: Shore & Beach, 66(3): 33-41.

McDougal, W. G., Sturtevant, M. A. and Komar, P. D., 1987, Laboratory and field investigations of the impact of shoreline stabilization structures on adjacent properties.: Coastal Sediments 87, New Orleans, ASCE: 961-973.