Washington Military Department
Emergency Management Division

Washington Earthquake and Tsunami Hazards:
Impacts to Communications and Critical Infrastructure

Washington Military Department

Emergency Management Division

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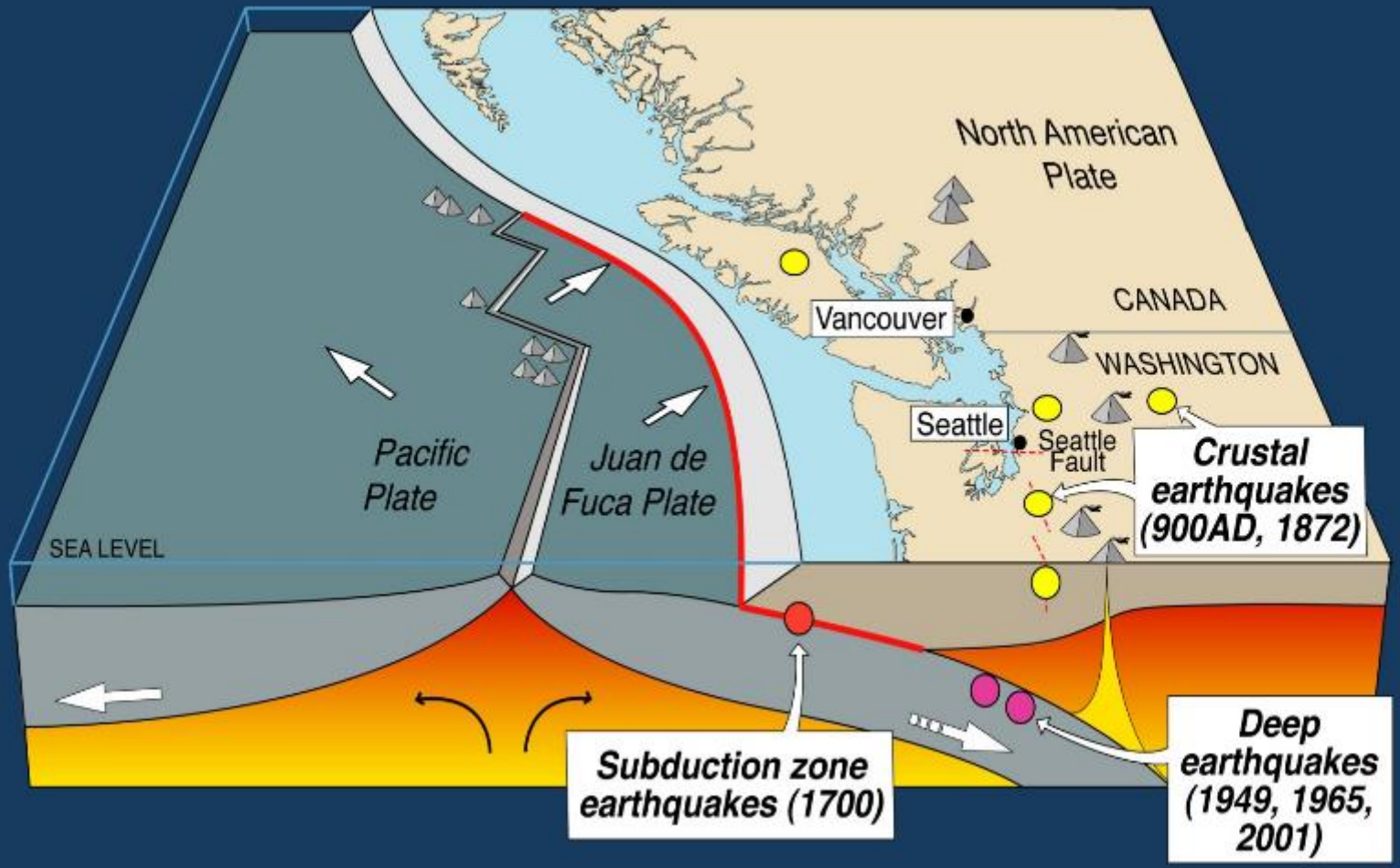
Washington's Earthquake Hazard

- Washington State has a history of frequent earthquakes from three sources:
  - Deep (*Nisqually, 2001*)
  - Shallow/Crustal Faults (*Seattle Fault*)
  - Subduction Zone (*Cascadia Subduction Zone*)

- Washington State has 2nd highest risk of economic loss due to earthquakes in the United States.

- More than 2,500 earthquakes occur in Washington each year with 12 or more that are strong enough to feel the ground shaking.

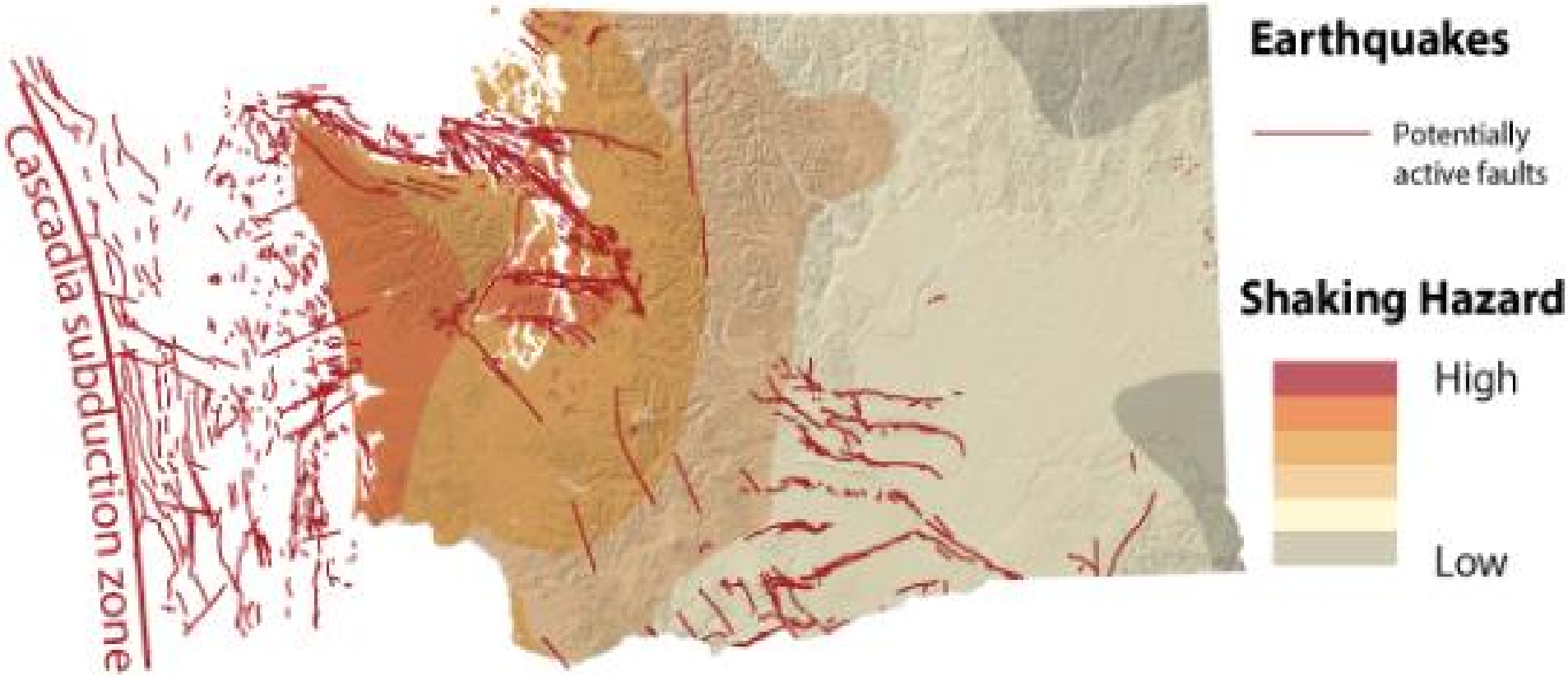


Earthquake Source and Example Events	Estimated Probability of Occurrence in 50 Years	Approximate Recurrence Interval
Deep Earthquakes • 2001 Nisqually, M6.8 • 1965 Seattle-Tacoma, M6.5 • 1949 Olympia, M6.8	84 Percent	30 – 50 Years
Cascadia Subduction Zone • 1700 January 26 Event, M9.0 (est.)	10 – 20 Percent	200 – 600 Years
Shallow/Crustal Earthquakes • Seattle Fault, M6.5 or greater • Random 6.5 or greater	5 Percent 15 Percent	1,000 Years 333 Years

Nisqually Earthquake: **M6.8, February 28th, 2001**

Unreinforced Masonry likely to collapse during shaking, causing injury and/or death

Earthquakes and Faults



Department of Natural Resources report on seismic risk, 2014

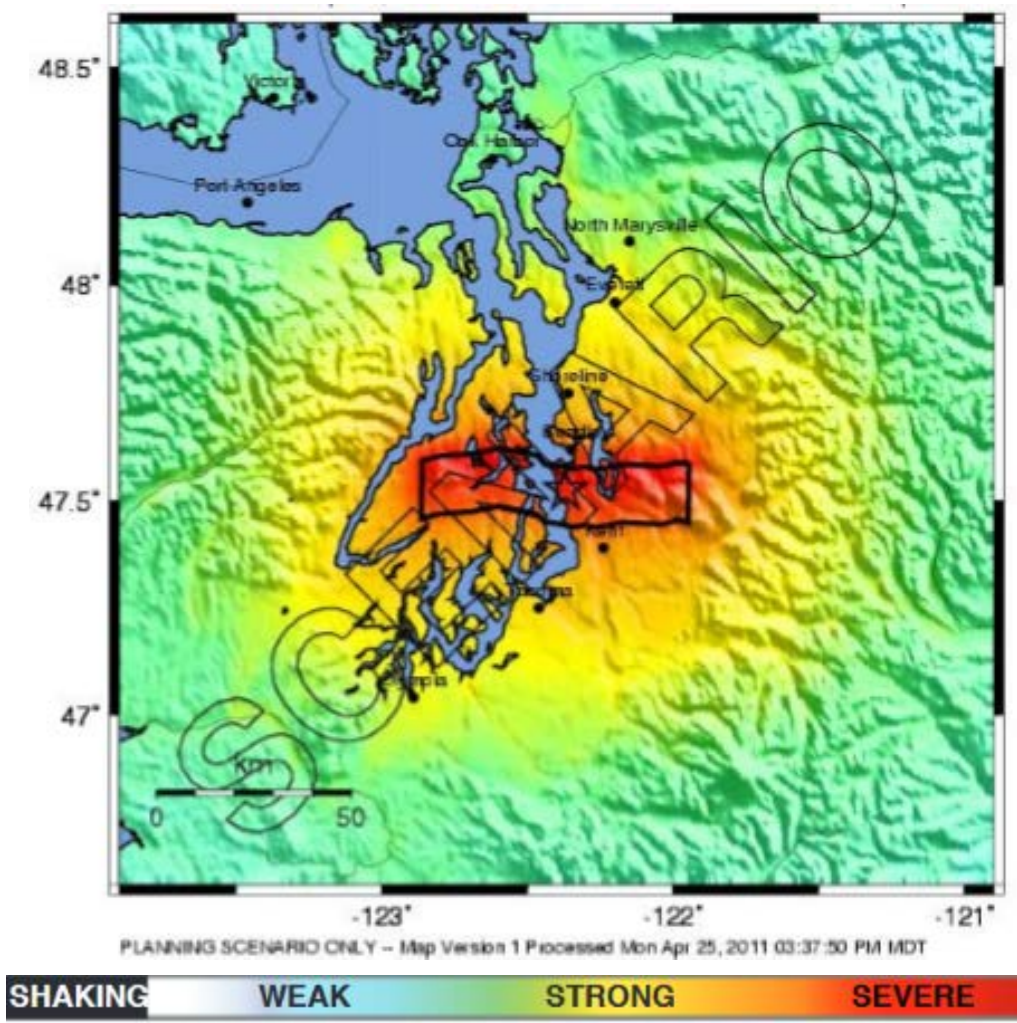
Shallow / Crustal Fault Earthquakes

Seattle Fault Scenario

- Magnitude 7.2
- At least three earthquakes in the past 2,500 years
- Potential to create Tsunami in Puget Sound

Shallow Earthquake

- More intense shaking,
- Heavy infrastructure damage
- More aftershocks than deep



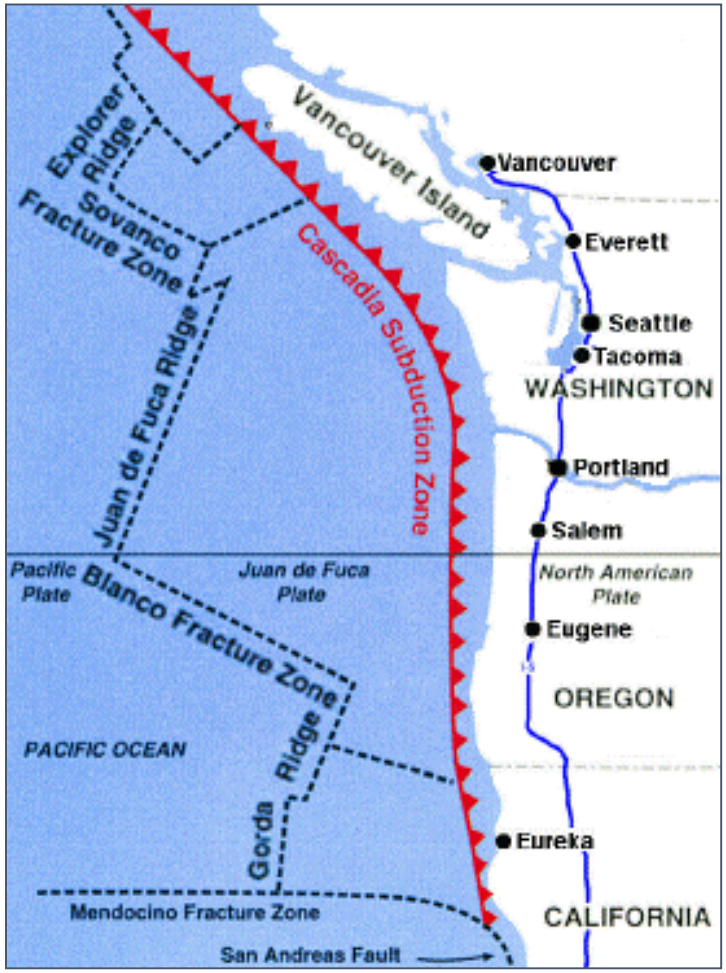
Seattle Fault M7.2 Scenario Impacts

Counties most likely to be affected are:

- King,
- Kitsap
- Mason
- Pierce
- Snohomish
- Thurston

SEATTLE FAULT SCENARIO EARTHQUAKE	
End-to-end length of fault (kilometers)	68
Magnitude (M) of scenario earthquake	7.2
Number of counties impacted	15
Total injuries (*severity 1, 2, 3, 4) at 2:00 PM	17,677
Total number of buildings extensively damaged	29,094
Total number of buildings completely damaged	9,062
Income losses in millions	$5,133
Displaced households	31,278
People requiring shelter (individuals)	18,193
Capital stock losses in millions	$19,868
Debris total in millions of tons	7.42
Truckloads of debris (25 tons per truckload)	296,720
People without power (Day 1)	265,583
People without potable water (Day 1)	399,991

Cascadia Subduction Zone Earthquakes

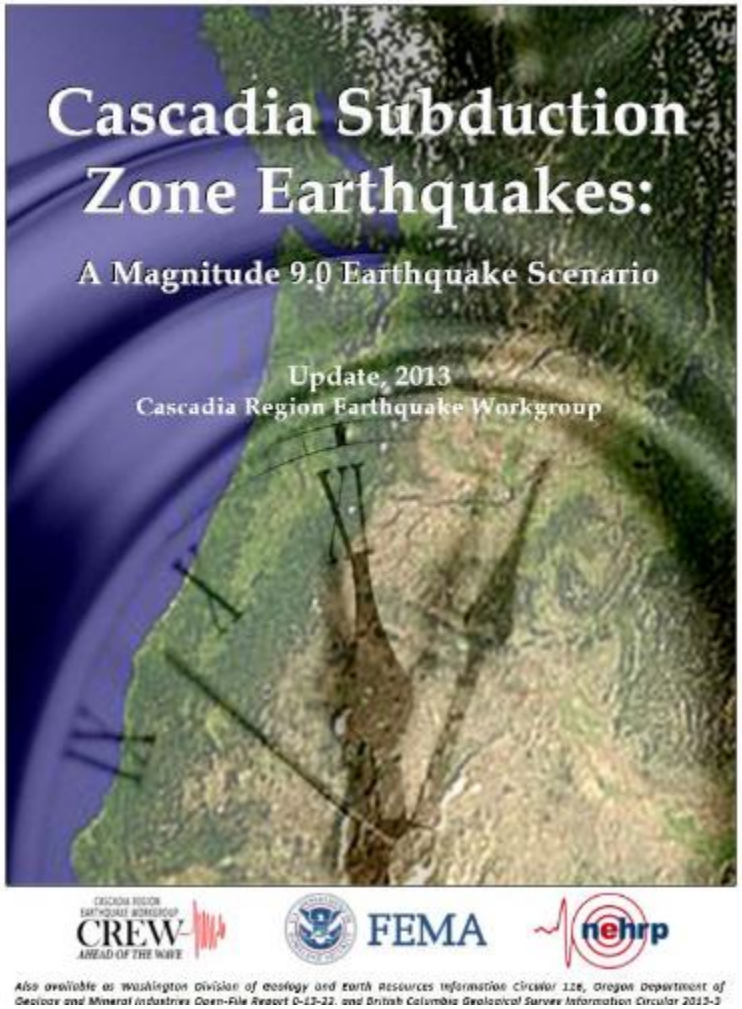


- Plate Interface: 700 miles (1000 km) long
- 50 to 80 miles from the Pacific Coast
- A magnitude 9.0 CSZ earthquake occurs every 200-600 years on average
- The last CSZ earthquake occurred January 26, 1700 or 318 years ago and counting

<u>Subduction Zone EQ:</u>

- *Longer* shaking duration (up to 5-6 min)
- Heavy infrastructure damage
- More aftershocks

HITRAC Study, 2011



Telecommunications:

- *Regional communication disruptions are expected in wireline, wireless, and the internet.*
- *Major undersea transpacific cables are likely severed, disrupting communication service to East Asia. A two- to three-month restoration time is expected.*
- *Undersea cables serving Alaska are likely severed, disrupting communication between Alaska and the contiguous United States.*

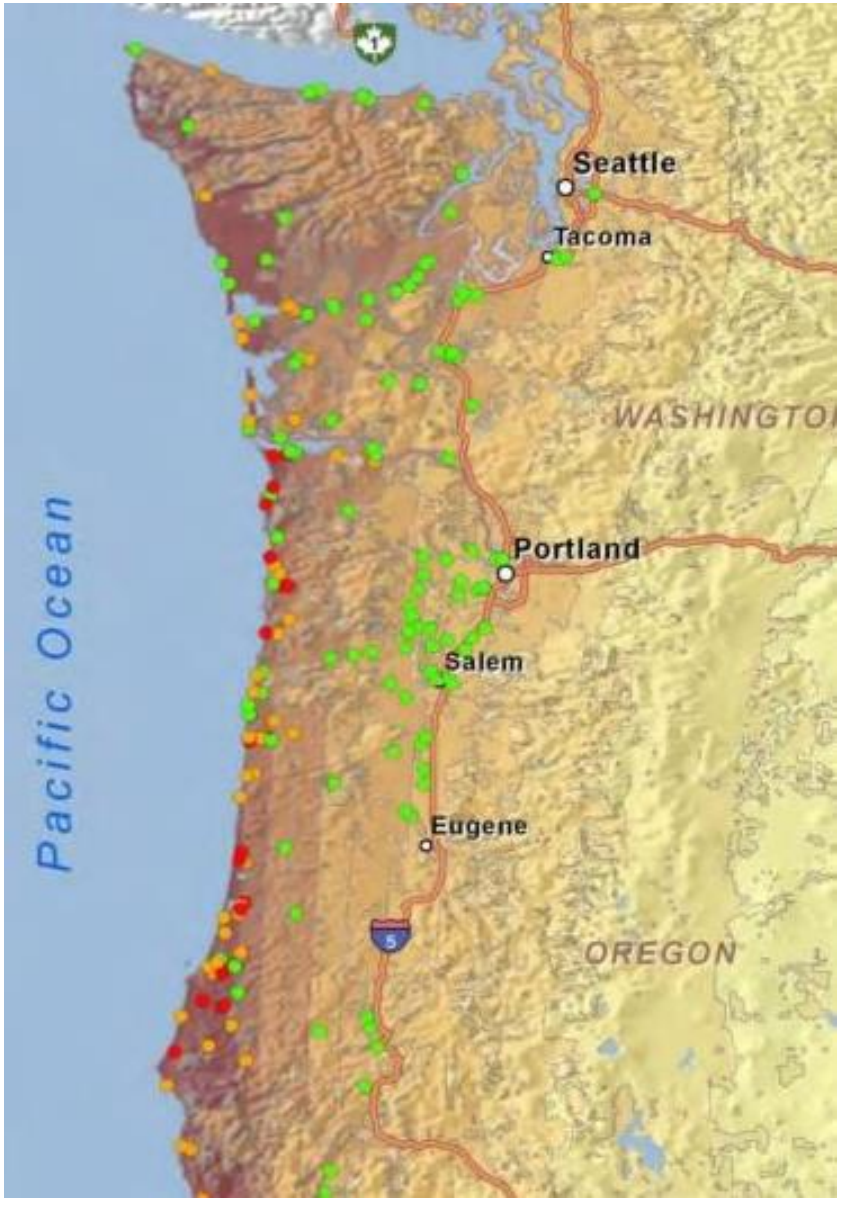
HITRAC Study, 2011

Communication Infrastructure Damage

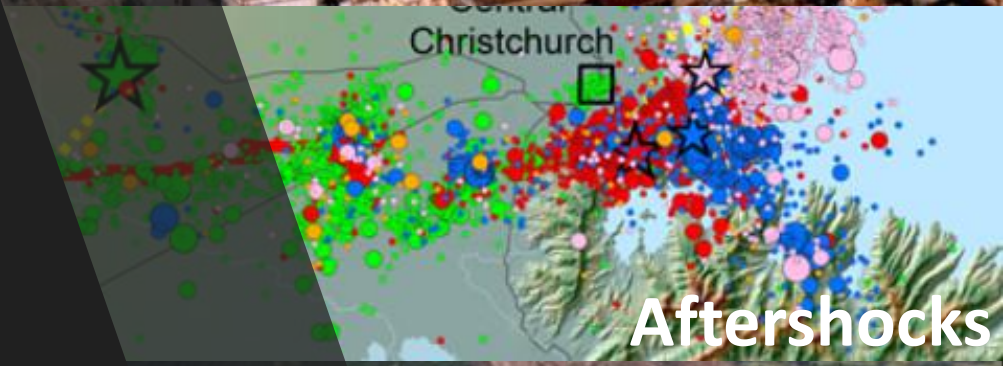
Telecom Damage

Average Scenario

- Complete
- Extensive
- Moderate



Secondary Earthquake Hazards

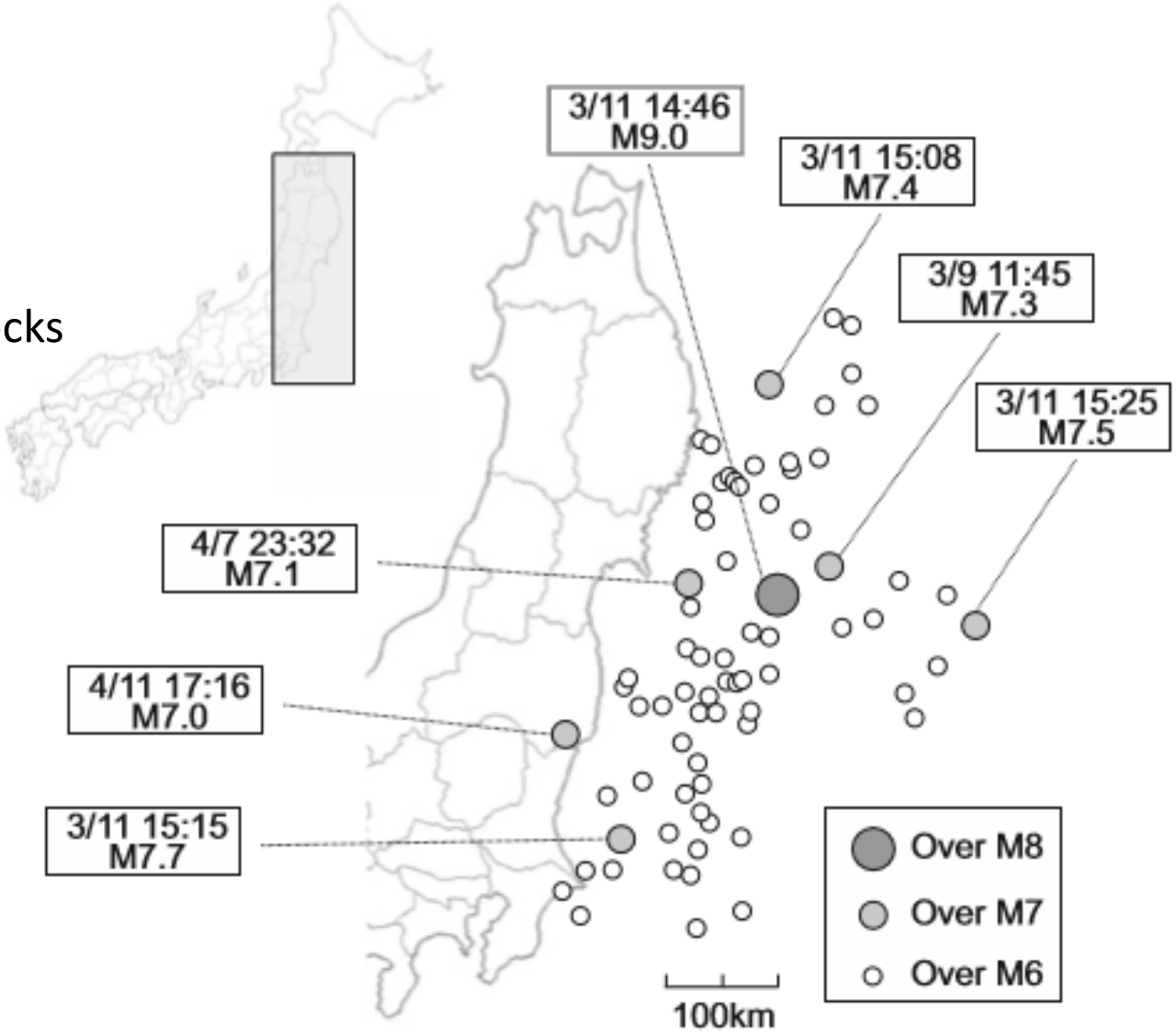


Aftershocks

Japan 2011

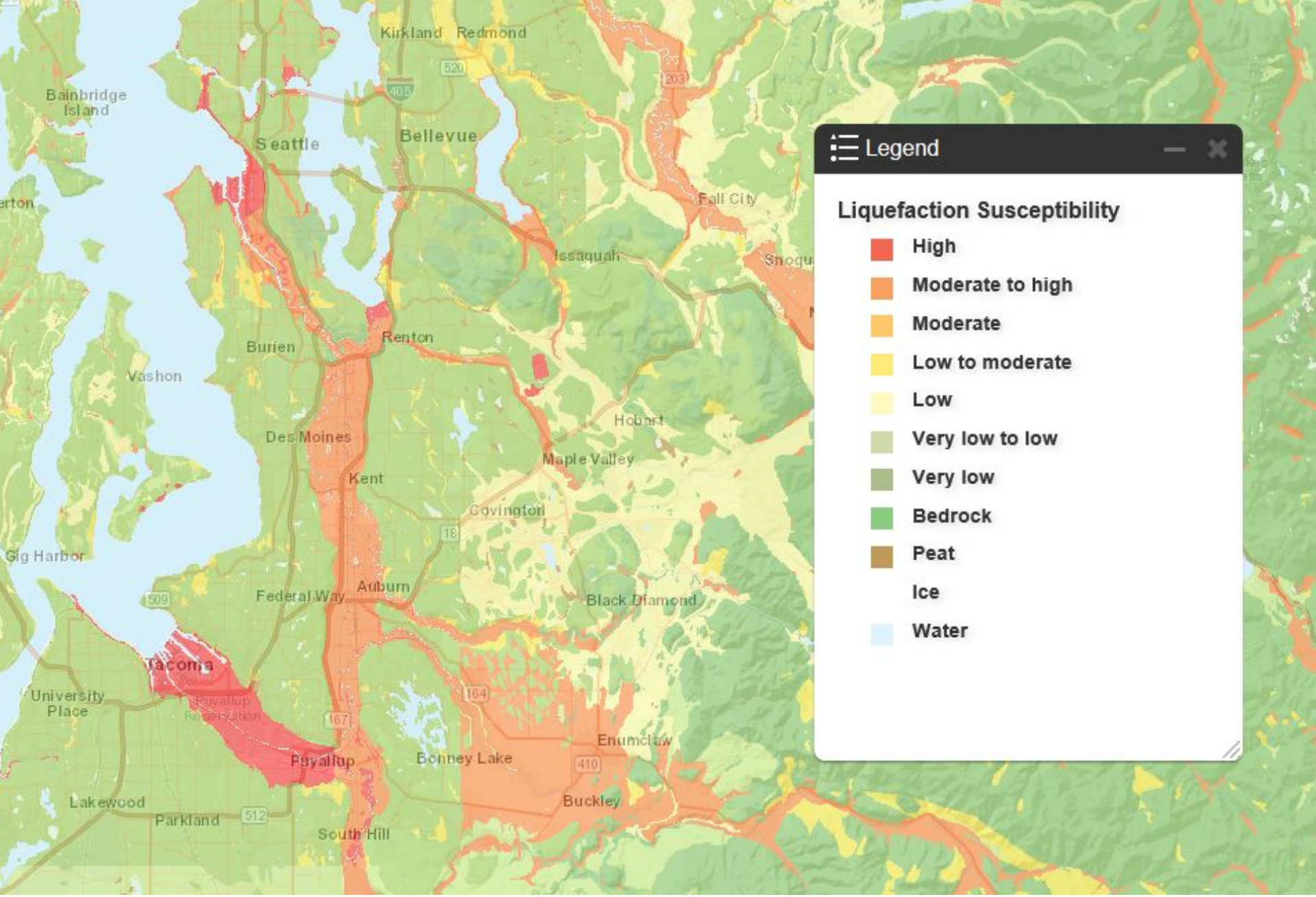
Three months of aftershocks

- 5 events > M7.0
- 82 events > M6.0
- 506 events >M5.0



Significant and Secondary Shaking Impacts:

Liquefaction


Legend
Liquefaction Susceptibility
High
Moderate to high
Moderate
Low to moderate
Low
Very low to low
Very low
Bedrock
Peat
Ice
Water
Kirkland
Redmond
Bainbridge Island
Seattle
Bellevue
Fall City
Issaquah
Renton
Burien
Vashon
Des Moines
Kent
Hobart
Maple Valley
Covington
Gig Harbor
Federal Way
Auburn
Black Diamond
Tacoma
University Place
Puyallup
Bonney Lake
Enumclaw
Buckley
Lakewood
Parkland
South Hill
520
405
203
18
509
164
167
410
512

Landslides

Significant Shaking Impacts: Co-seismic Landslide Risk

Post-Earthquake Fires

Ignition sources/causes

- Electricity (electrical shorts, frayed wires, and tipped appliances)
- Gas Leaks ignited by sparks or open flames
- Reactions from spilled chemicals
- Open flames from stoves, candles, fireplaces and grills

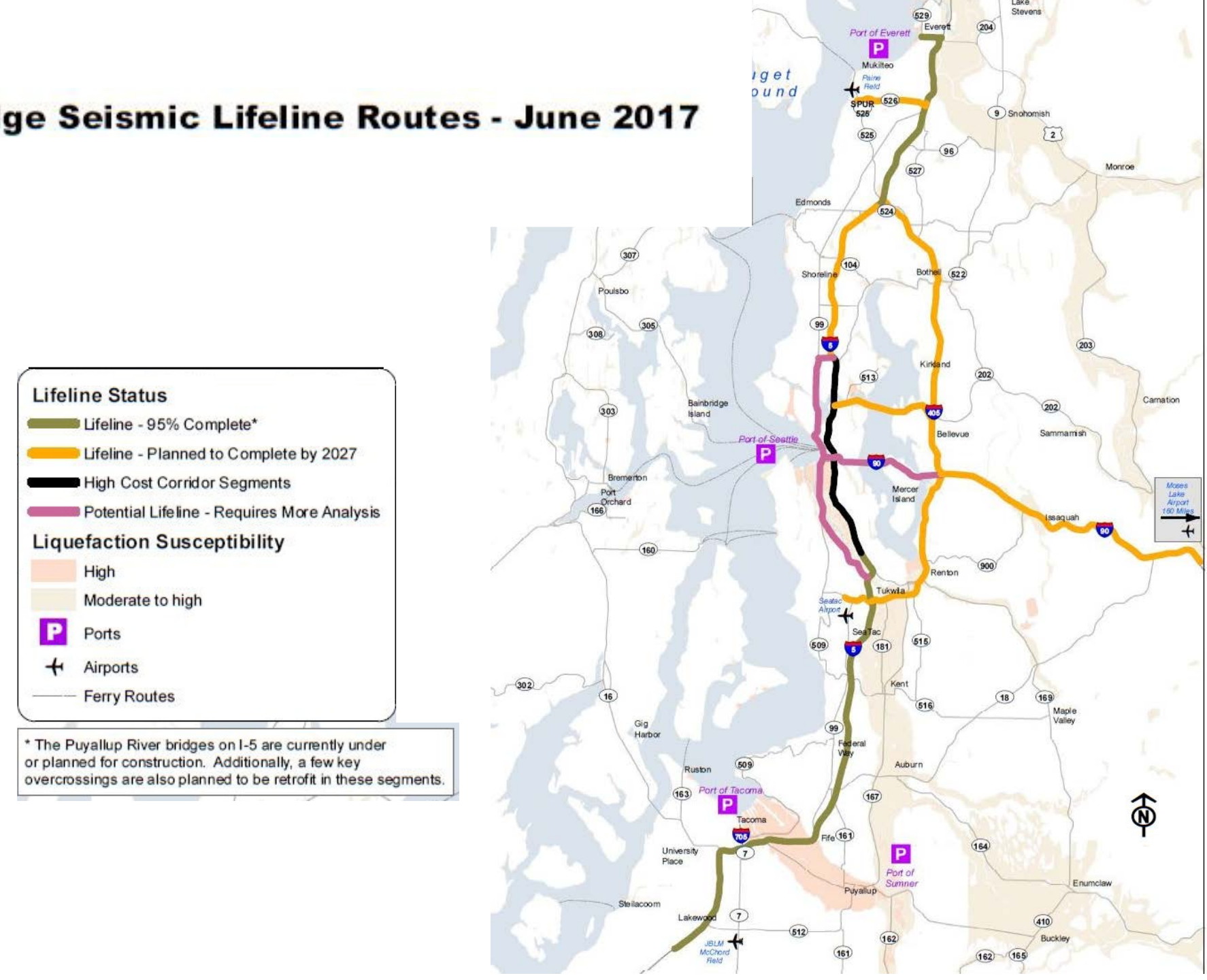
Factors

- Time of day
- Wind speed and humidity (other weather conditions)
- Building density and construction features
- Impairment of communication and transportation systems

Lifeline Damage

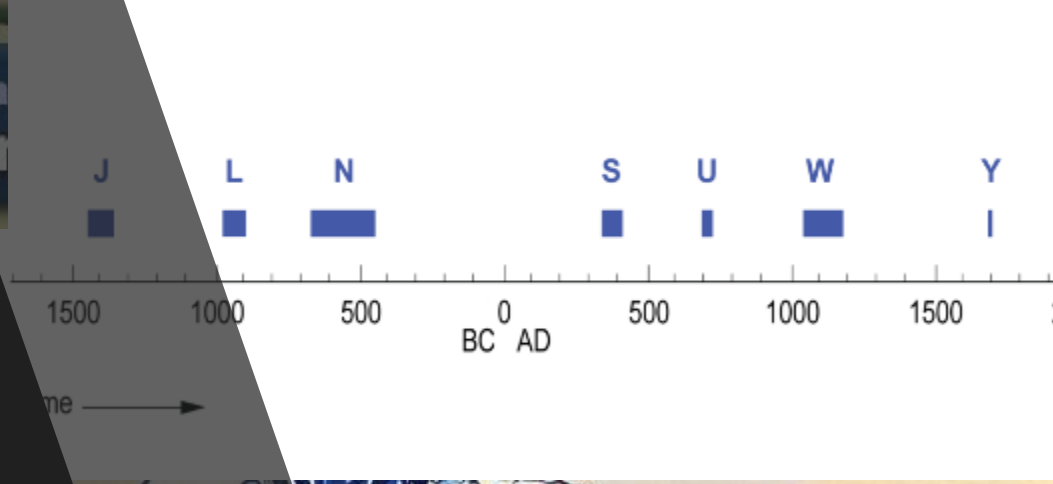
Over 9,000 Bridges to be affected:
~700 in Washington Significantly Damaged or collapsed

Bridge Seismic Lifeline Routes - June 2017



Tsunamis


TSUNAMI HAZARD ZONE
IN CASE OF EARTHQUAKE, GO
TO HIGH GROUND OR INLAND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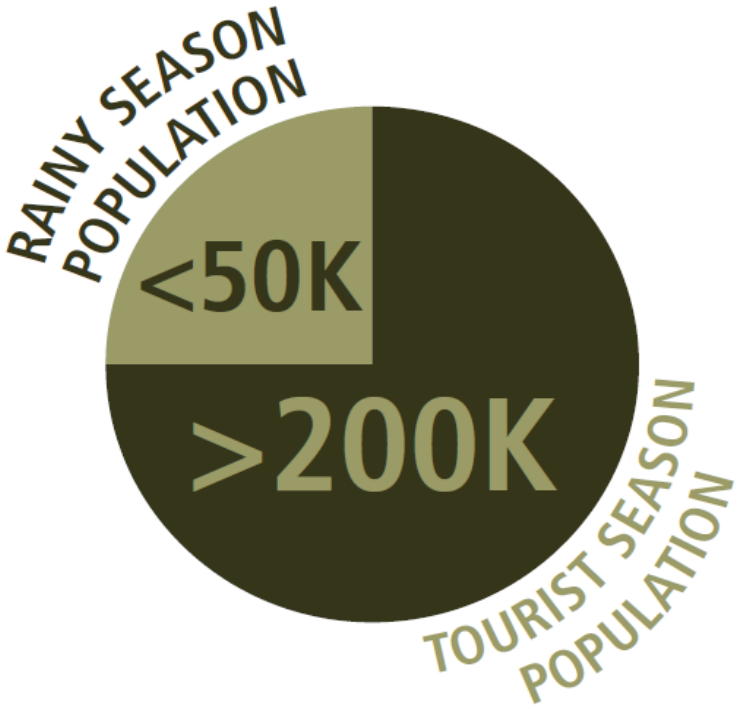
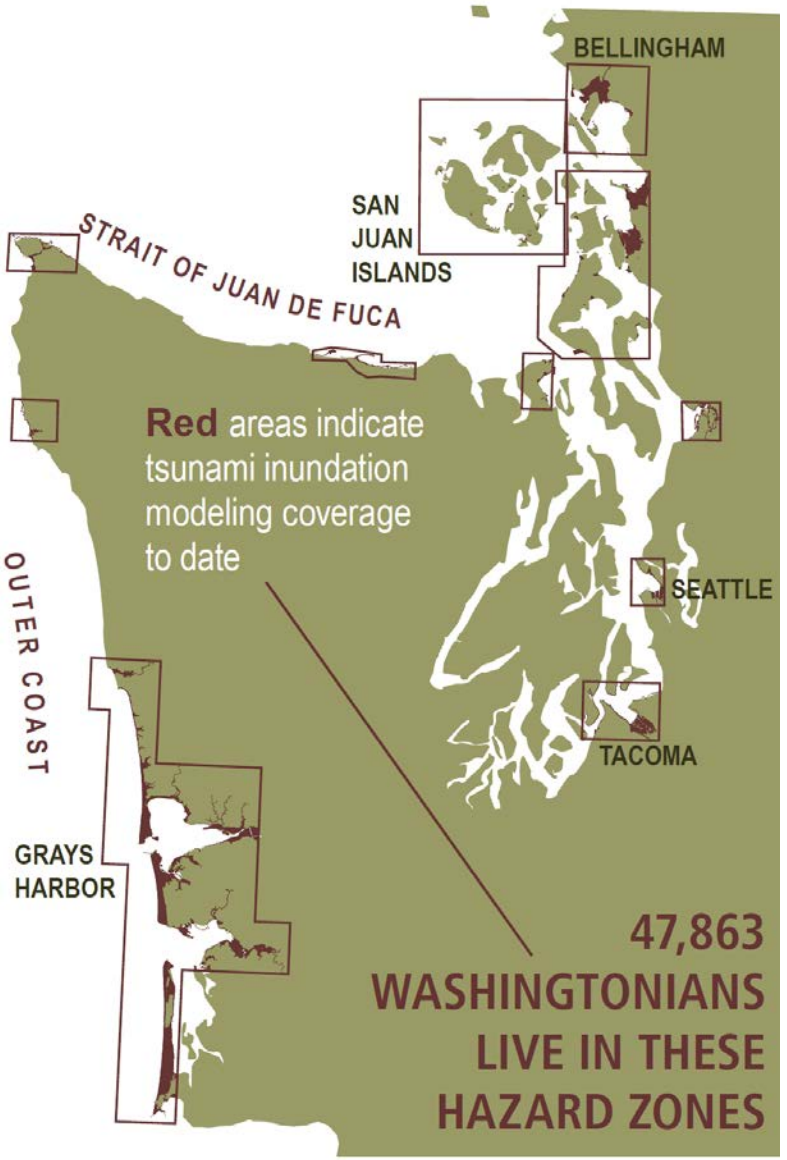
Tsunami Risk

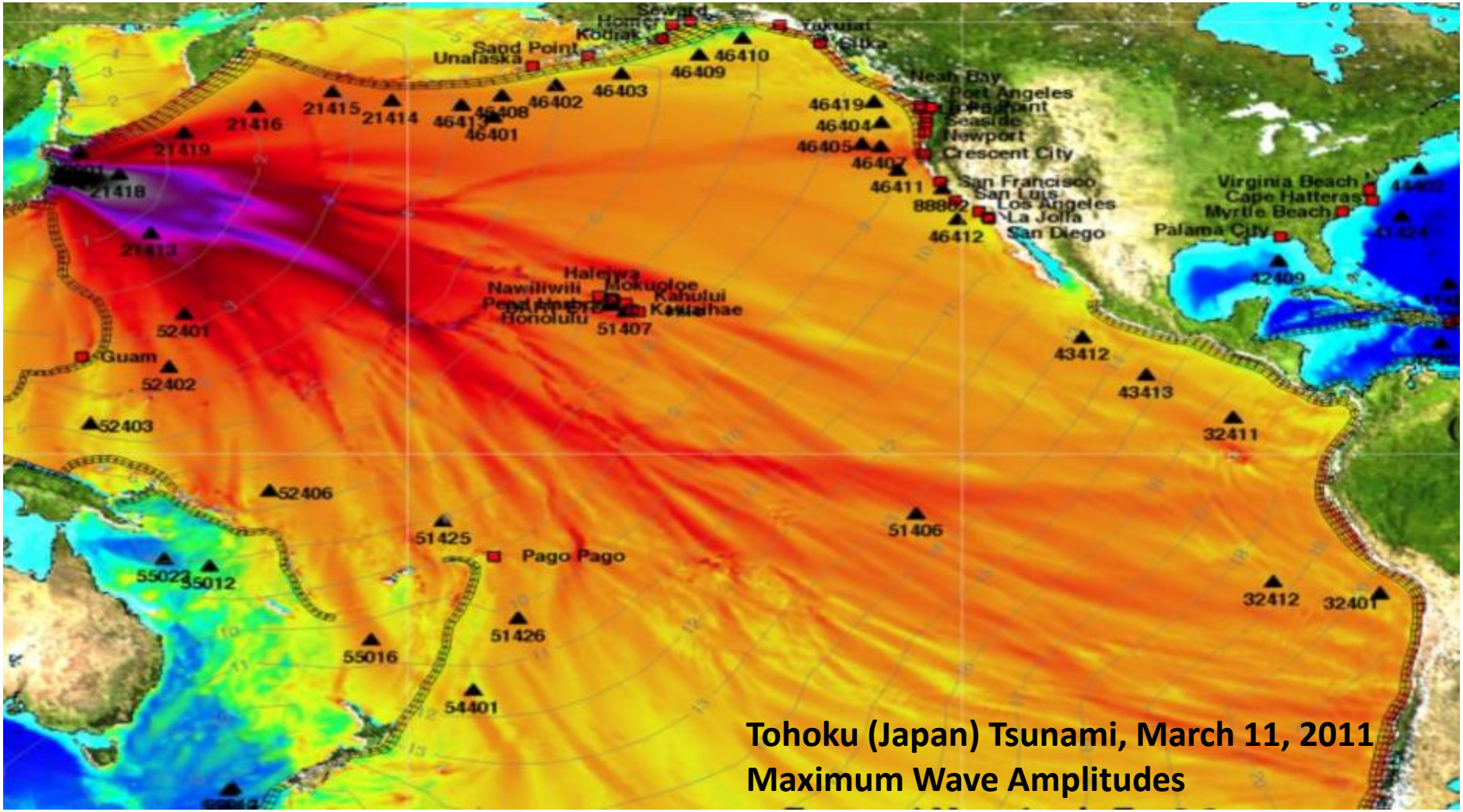
Seven tsunamis in the past 3500yr

Over 3000 miles of coastline





Distant-Source Tsunami



Tohoku (Japan) Tsunami, March 11, 2011
Maximum Wave Amplitudes

Distance-Source Tsunami Video

https://www.youtube.com/watch?v=SQ2nwnRbapE

Near-Source Tsunami

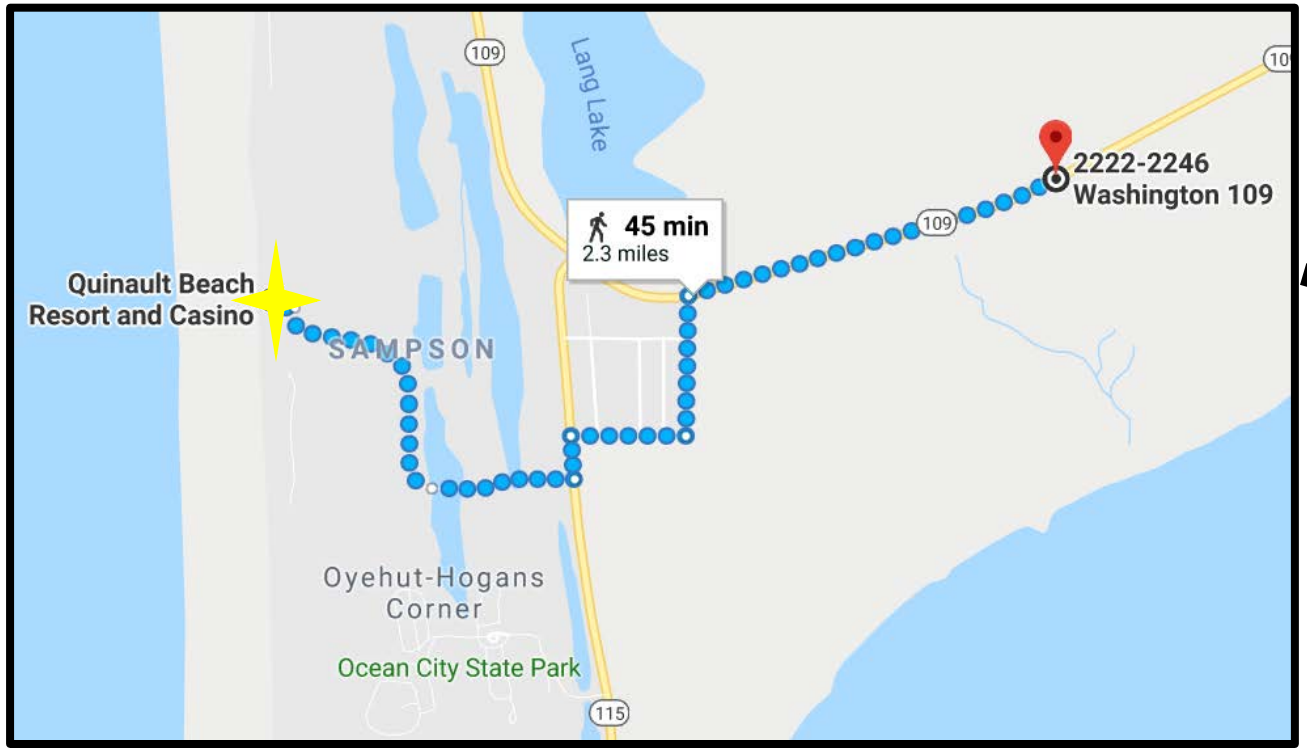
Near-Source Tsunami Video

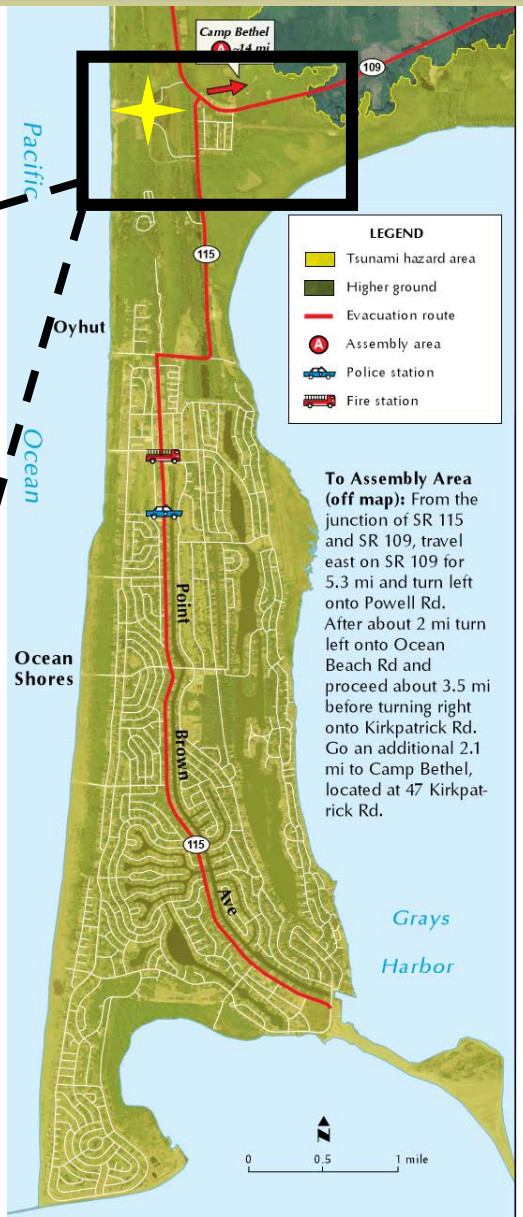
- https://www.youtube.com/watch?v=ZJ50xX_0Ge4

Tsunami Inundation Zone Characteristics

- Total loss of equip.
- Polluted waterways
- Hazardous waste
- Debris
- Persistent Fire/smoke hazards

Our Evacuation Route





Examples of Telecommunications Interruptions

Japan Tohoku Earthquake and Tsunami (9.1), 2011:

- 7 million customers (homes) without power at height of event
- 750,000 reported internet/telephone circuits down
- Updated information on tsunami heights was unable to be sent out due to damaged communication infrastructure
- Irreparable damage to *Fukushima* Daiichi Nuclear Power Plant
- Damaged production stations resulted in 23%-53% reduction in energy production capacity (by company)

Christchurch, New Zealand (2010-2011)

Communications - Initial disruption was due to cell sites being damaged or losing power, with some on batteries/generators for several weeks, but overall service was maintained.

Energy - Initial disruption of electricity was gradually restored to most of the city, sometimes with temporary lines.

Chile, 2010

- Telecommunications disruptions, continued:
  - *Maule Earthquake (8.8), Chile, 2010*
    - *Structural damage: 1 week of telecomms failure*
    - *First 24 hours, emergency response crews had no communications capability, limited for first 72.*
    - *Note: needed more backup systems*
    - *Few post-earthquake fires, due to shutdown of many power plants by shaking.*
    - *Only immediate communications following EQ were via handheld radio*

California –
Different type of Communications blackout:

California Earthquakes: Baja (7.2) and Chino Hills (5.5)

- Telecomms down due to being jammed by phone activity

- New Zealand Partners described this issue following the Christchurch and Kaikoura earthquakes as well
- Part of our messaging – “Text don’t call,” but there will still be a lot of people calling following an earthquake.
    - Out of Area contacts!!

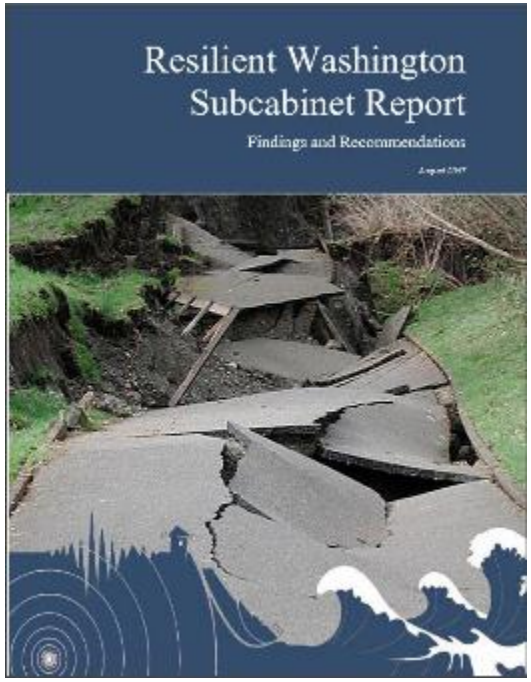
Preparedness Starts With YOU!

The more you and your family are prepared for disaster the more quickly your able to help others

- ✓Be Informed
- ✓Make a Plan
- ✓Build a Kit
- ✓Become Involved

<u>Cascadia Rising Exercise</u>, 2016: Exercised using 9.0 scenario

- *Simulated communications blackout for 6 hours;*
- *Overwhelmed response capabilities:*
- *Did not even simulate tsunami response*
    - *Communications blackout in a real event is likely to be longer, unless infrastructure is hardened*



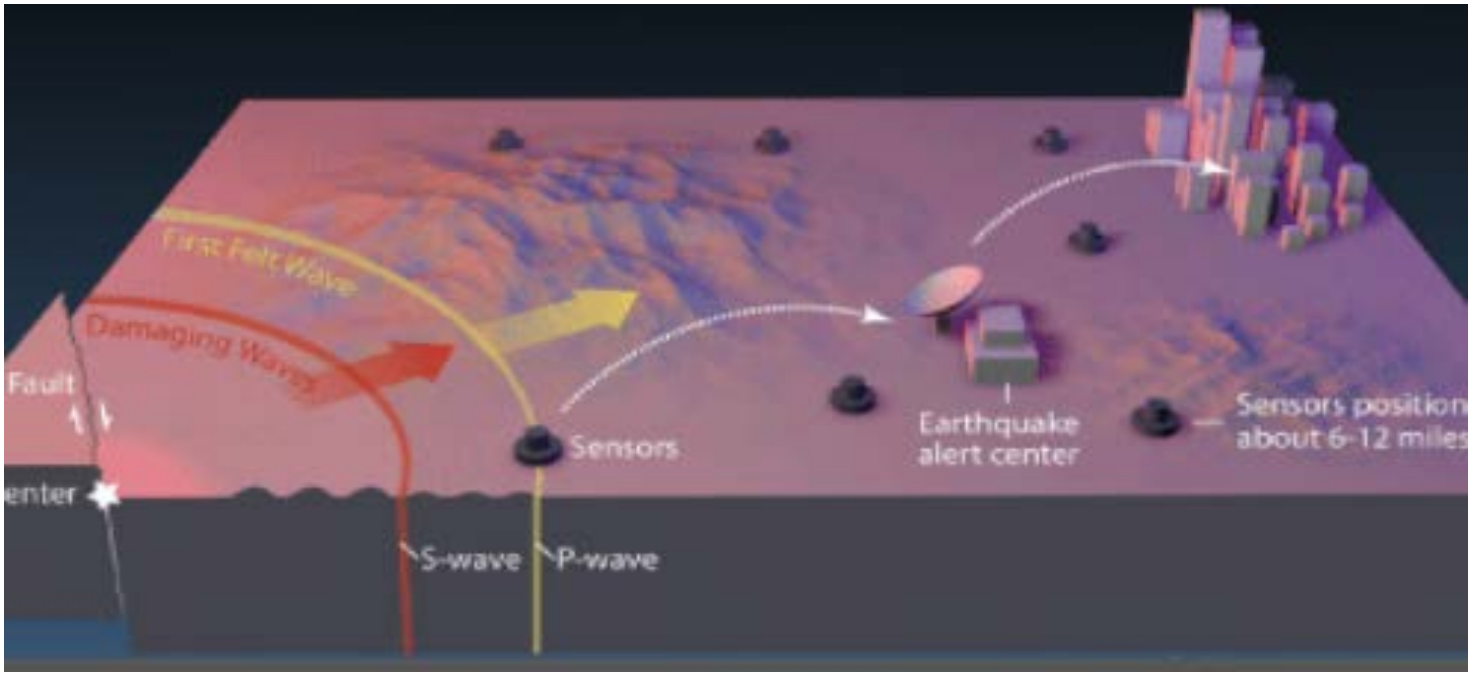
Led to: <u>DIRECTIVE 3</u>

Build resilient communication systems and develop the relevant procedures to ensure reliable communications with clear protocol following a catastrophic seismic event.

Earthquake Early Warning

Seconds to several minutes warning before damaging earthquake shaking

- In use in several countries (i.e., Mexico and Japan)
- Provides public alert
- Technical users as well – Automatic reactions
- Limited Public Rollout – 10/2018
- *Communications Applications?*



Questions?

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